Possibilities for Robotics in theElectrical and electronic appliance (EEE) refurbishment

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Abstract.
What we call "remanufacturing" in the business world is really just taking used parts and making them work again. All the cores go through a series of steps in this manufacturing process, including inspection, disassembly, cleaning, reprocessing (repairs), storage, reassembly, and final testing. Remanufacturing is also seen by many firms as a way to achieve better social, environmental, and economic sustainability. Electric and electronic equipment (EEE) remanufacturing has been on the rise recently around the world, and recent innovations in robot technology have increased the possibility of implementing more automation in this sector of the manufacturing industry. This article's goal is to provide a comprehensive list of all the ways robots may be used in EEE refurbishing. A numerous case study was conducted at four EEE remanufacturing enterprises to attain this purpose. Both the case study and the previous studies show how EEE remanufacturing uses manual techniques. All four of the remanufacturing case businesses had cleaning, disassembly, and reassembly procedures that might be automated according to this study's results.

Automation, remanufacturing, HRC, small and medium enterprise, work environment

Introduction

According to some estimates, Europe could reap yearly advantages of almost €1.8 trillion if it switched from a linear to a circular economy, which is a step in the right direction towards sustainable development [1]. Since remanufacturing involves reintroducing previously used items to the market rather than discarding them, it plays a crucial part in the circular economy [2]. Products are brought back to a state similar to their original state via the industrial process known as remanufacturing. Industry should prioritize sophisticated remanufacturing as a production sector for the foreseeable future, according to the World Economic Forum [3]. Furthermore, the sector of remanufacturingFrom its present annual turnover of €30 billion to €90 billion by 2030, the remanufacturing business is projected to grow, according to the European council [2]. Both of these realizations prompt questions about the direction that science and business must take moving forward.See, for instance, [4] and [5] for a few of the many varying definitions of remanufacturing. Stlin [6], building on Sundin [7], provides a wide definition of remanufacturing as "an industrial process wherein items, referred to as cores," and this is the definition adopted in this study. For the core to be fit for its intended purpose, it must pass a battery of tests after undergoing disassembly, inspection, component reprocessing, reassembly, and testing.Based on their connection with the original equipment manufacturer (OEM) from whom they get components, three types of remanufacturing companies are now in operation. Remanufacturing may be handled in-house by the Original Equipment Manufacturer (OEM), outsourced to a third party by the OEM, or carried out by an entirely distinct entity.

Remanufacturing is often considered more eco-friendly than producing new parts since it allows for the reuse of many resources that would otherwise be consumed in the production of new components [8]. Remanufacturing decreases environmental impacts by 14-60% in terms of resource efficiency and CO_2 equivalent emissions, according to Sundin and Lee [8], who analyzed seven research from the EEE sector. This makes it more ecologically favorable than manufacturing brand new goods.Performing manual labor-intensive operations, such as sorting and disassembling, is now essential to the remanufacturing industry. Many companies, particularly SMEs, struggle to stay competitive due to issues with process cost, disassembly planning and scheduling, process duration and sequence, number of operations, and performance evaluation [9]. The remanufacturing industry is predicted to progressively improve as a result of increasing efficiency and better working conditions brought about by more widespread use of robotics and automation in these industries. This will allow them to handle challenging challenges better. In addition, automation solutions create environments where humans and robots work closely together. The study of human-robot interaction is multidisciplinary and transdisciplinary, says Dautenhahn [10]. This is of the utmost importance in an industry such as electronics remanufacturing, where human and robot workers collaborate closely. With the results of risk assessments in hand, human-robot collaboration (HRC) makes it possible to have robots do mundane and perhaps hazardous tasks, allowing humans to concentrate on higher-order, more creative tasks [11]. Robot manufacturers have expanded their product lines with the release of ISO/TS15066 in February 2016. This includes cooperatively created robots with different levels of safety features, including the CR-7 from FANUC and the HC10 from Yaskawa.Previous research (e.g., Kernbaum et al. [12]) has shown that automating remanufacturing at a low cost is difficult. Nevertheless, there has been a resurgence of interest in the subject due to the increasing needs for automation in remanufacturing and the remarkable progress in robot technology. Thus, the objective of this piece is to delve into the breadth of the automation possibilities offered by EEE remanufacturing.

1. Research Methods

A multi-case analysis of four Swedish remanufacturing companies accomplished the purpose of this article. Small and medium-sized enterprises (SMEs) in the EEE sector are the ones being studied, as shown in Table 1. Companies in this sector vary greatly in terms of product volume, corporate size, and the techniques they use for repair and remanufacturing. The general steps of their procedure include checking, cleaning, disassembling, reprocessing (repairing), reassembling, testing, and packing.

Table 1. The characteristics of the companies included in the multiple case study of this paper.

Company	Product	Type of remanufacturer	Experience
Company A	IT equipment	Independent	21 years
Company B	Photocopiers	Contracted	36 years
Company C	Toner cartridges	Independent	26 years
Company D	Car electronics	Contracted	43 years

Companies took part in this study because they wanted to learn more about a Swedish research project called Automated Repair and Remanufacturing (ARR) and how it may help them enhance their own repair and remanufacturing procedures. The proposed case study methodology [13] was deemed to be adequate in light of the current state of knowledge about the potential for automation in remanufacturing processes in order to research and grasp the applicability of automation on the repair and remanufacturing processes of the case firms. Direct observations, unstructured interviews, and focus groups were used to collect qualitative empirical data. The authors took part in a tour at each organization as part of their observation, learning about things including repair and remanufacturing procedures, internal logistics, product movement within processes, and remanufacturing difficulties. Notes and photographs were collected throughout the inspections and walks around to capture the findings. Furthermore, a contact person led the way, provided details about the procedures, and fielded inquiries. Several people from both the business and academic sectors participated in the focus groups, where they addressed a predetermined issue facing the organization. Each participant in the industrial project had a broad requirement that led to the identification of the issues addressed in the focus groups. The empirical data were then contrasted and analyzed in an iterative and exploratory fashion to improve their clarity and applicability.

Research papers outside this area tackling either automation or remanufacturing were included (e.g., Kurilova-Palisaitiene et al [9]), and a literature search focused on papers addressing automation within the repair and remanufacturing processes (e.g., Kernbaum et al [12]). We also did an upstream and downstream qualitative search for pertinent references. Theory in this field was also based in part on the authors' prior research experiences in remanufacturing and automation.

1. Theoretical framework

Electrical and electronic product refurbishment 1.1

Recent years have seen an increase in the remanufacturing of EEE, following in the footsteps of the aerospace and automotive industries. Several EEE remanufacturers were studied as part of a European Union initiative called the European Remanufacturing Network [14]. This study looked at the specific remanufacturing processes that each company used.

Table 2. Examples of process steps at European EEE remanufacturing companies (modified from [14]).

Comp.	Borg Automotive	Büroservice Hübner	IT Lyftet	Leapp	ATP	ARP
Product	Electric steering racks	Printers	Laptops	MacBook	Trans-missions	Toner cartridges
Reman steps	Disassembly, Cleaning, Inspection, Recondition, Replenishing, Reassembly, & Testing.	Testing, Cleaning, Part changing, & Testing.	Inspection, Cleaning, Inspection, Data wiping, Testing, Replacing, Reconfig., & Assembly.	Quality screen, Decompose, Inspection, Repair, Data wiping, & Packing.	Inspection, Teardown, Cleaning, Renewing, Assembly, & Testing.	Disassembly, Cleaning, Assemble toner, Refilling, Assemble cartridge, & Testing.

At the EEE remanufacturing companies, there is little or no automation ongoing within the process steps exemplified in Table 2 above [14]. As one can see from the examples in Table 2, there are several steps in different orders, depending on what kind of EEE is being remanufactured. However, according to Sundin and Bras [15], there are seven generic steps that a used product (a.k.a., core) goes through in order to become a remanufactured product (Figure 1).

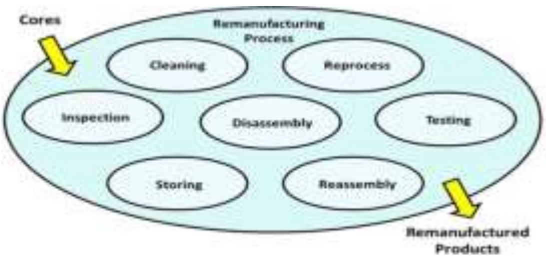

Figure 1. The seven generic steps included in a generic remanufacturing process [15].

1.1. 1.1 Industrial Robot Collaboration Use Cases

Safety fencing is commonplace for industrial robots, which often do heavy lifting and other tedious activities with great consistency and efficiency over extended periods of time [16, 17]. In such an application, the processing stages tend to follow a predictable

Quality, placement, and output parameters: a set number of processes are performed for a given input, yielding a fixed number of products.

Such input criteria are not always obvious at the outset when dealing with the repair and remanufacturing of EEE; for instance, the screws used to remove a product may be unclean, rusted, or broken. Humans in the EEE business are responsible for practically all of these duties since they are the only ones able to recognize uncertainty and make product-specific decisions.

Human-robot cooperation (HRC) is necessary to combine the strengths of robots, such as endurance, suppleness, and accuracy, with those of humans, such as intuition, adaptability, and problem solving [18]. Human-robot collaboration (HRC) makes it possible to build applications in which people and robots interact closely together. Figure 2 shows the many degrees of collaboration that exist. On the far left, we see a typical industrial robot housed in a cage where the human worker has no access to the robot. The other four setups depict varying degrees of robot-human collaboration. After doing a risk assessment, Gopinath and Johansen [11] state that repetitive and potentially dangerous jobs may be delegated to a robot so that people can focus on more creative and mentally taxing work.

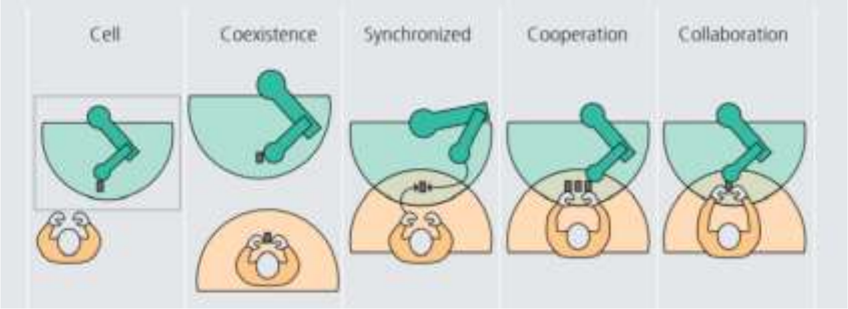

Figure 2. Various levels of cooperation between a human worker and a robot [19].

2. Case study results

2.1 Firm A

A company's goal in remanufacturing electronic products including computers, tablets, displays, and telephones is to encourage better use of these tools. The decision to focus just on laptops was reached after discussing the matter with the company and taking into account the quantity of refurbished computers. Donated computers from customers, like companies, are kept in cabinets (Figure 3a). The things stored in these cabinets could change from one customer to the next. One possible arrangement is to keep the cables on a different shelf from the other pieces of IT gear. The process map for laptop refurbishing revealed the following procedures:

The laptop cabinets are emptied first.

a) All laptops have been registered and assigned a unique serial number.

b) The wires have been rewound, detangled, and neatly stored.

Thirdly, laptops and cables are buffered, which causes a pause.

If the recipient company does not have the means to erase data, the system signals and non-erasable hard disk drives are physically removed and destroyed (Figure 3b). The first step in getting laptops ready to sale is to physically inspect them, clean them if necessary, and then categorize them into several classifications.
storage.
Figure 3. a) An example of a cabinet used to collect IT equipment for remanufacturing at Company A.
b) Workplace for erasing data from laptops at Company A.
The computers are then put into storage until they are ready to be sold. The last touches on a product's individuality are applied at the point of sale. This process typically consists of the two phases for a typical customer: Laptops will be sent to the client after (1) being re-configured and (2) having the operating system installed.
Potential for automation at Company A
The entire remanufacturing process at company A is currently manual. The potentials found and shown in Table 3 for this remanufacturing process automation.
In Table 3, we can see all of Company A's possible automated processes, along with their descriptions and where they came from. F=Focus group discussion, WE=Work Environment, O=Observations, and I=Interviews. The data source and the grounds for automation are listed in the order they were mentioned.

Process step	Reason for automation	Source of data
Rewinding of laptop cables (strenuous for hand wrists)	WE and Efficiency	I, O and F
Placing, connecting and setting up laptops for data erasing	Efficiency	O, I and F
Accessing laptops for data erasing	Efficiency	O and F
Disconnecting and picking up laptops for buffering classification (sorting)	Efficiency	O, I and F
Destruction of non-erasable hard disc drives	Efficiency	I and O
Raising boxes for packing the remanufactured laptops	Efficiency	O and I

2.1. Company B
One of the largest photocopier remanufacturers in Europe is Company B. The firm remanufactures products and ships them to 60 different countries after sourcing them from European markets via logistics centers in Germany and Sweden. Company B remanufactures 6,000-7,000 metric tons of photocopiers each year, from a range of manufacturers. Its primary focus is on monochrome photocopiers as well. As a whole, the operation is hindered by the fact that the flow of new things fluctuates drastically with the seasons and that the variety of incoming products is usually unknown to the business at the time of acquisition.The fundamental processes involved in restoring and remanufacturing it are as follows: labeling and tagging, testing and inspection, hard drive wiping, sorting and separation, disassembly, component repair and exchange, final testing, cleaning, and packaging. Any component or part that is beyond repair or replacement might find a new home in the materials recycling process.

The toner cartridge refilling procedure is the focus of this study. It is now mostly done by hand and averages 60 refills per day at the firm. Model and color are used to perform the refilling. We replenish the toner cartridges. process includes (1) emptying, (2) sorting, (3) refilling toner cartridges with the help of a machine (Figure 6c), (4) sealing, (5) cleaning, (6) marking and (7) packing (Figure 4).

Figure 4. Equipment used for emptying and refilling toner cartridges at Company B: a) storage of sorted toner cartridges, b) barrel for recovered toner and c) refilling machine.Potential for automation at Company B

Based on the data collected at Company B, the potentials for automation in this remanufacturing process are identified and presented in Table 4.

Table 4. The identified potential processes for automation at Company B, where the source and the automation reasons are described. WE=Work Environment, O=Observations, I=Interviews, F=Focus group discussion. The source of data is mentioned in order of appearance.

Process step	Reason for automation	Source of data
Emptying toner cartridges (recovering the toner) – a workenvironment issue in the form of powder contamination (hazardousness)		
Refilling toner cartridges - a work environment issue in the form of ergonomicissues and repetitive work - a precision requirement, as colours and toners must notbe mixed. In addition, toner cost is high, and toner waste has economic drawbacks	WE and Efficiency	O and F
	WE and Efficiency	I, O and F
Cleaning toner cartridges (on the outside after being refilled) – a customer requirement to have a clean toner cartridge (quality issue)	Quality and WE	O and F

2.2. Company C

Printer cartridges are remanufactured and distributed throughout Europe by Company C. In the Nordic nations, it dominates the market. Company C is able to remanufacture toner cartridges of almost all brands and models. The main problem with the firm is that not enough time is spent getting ready to produce lesser quantities of a variety of incoming items.

Toner cartridges undergo a rigorous procedure before they are ready for distribution. This includes collecting, sorting, disassembling, inspecting, emptying, cleaning, drilling (if needed), repairing, refilling, reassembling, testing, resetting, and coding. Things that are irreparably damaged or useless may be dropped off at a materials recycling facility.

Company C's present remanufacturing process is executed entirely by hand, owing to the wide diversity of cartridge types and the specific techniques used to disassemble and refill them. Following an analysis and mapping of the remanufacturing processes, the emptying and cleaning phases, together with the refilling phases, were determined to possess the greatest potential for automation (refer to Figure 5).

Figure 5. Cleaning and disassembling toner cartridges at Company C.

Potential for automation at Company C

Based on the data collected at Company C, the potentials for automation in this remanufacturing process are identified and presented in Table 5.

Table 5. The identified potential processes for automation at Company C, where the source and the automation reasons are described. WE=Work Environment, O=Observations, I=Interviews, F=Focus group discussion. The source of data is mentioned in order of appearance.

Process step	Reason for automation	Source of data
Cleaning toner cartridges – a work environment issue inthe form of noise from the fume hood space, ergonomic issues and repetitive work for the operator	WE and Efficiency	I, O and F
Refilling toner cartridges - a work environment issue in the form of ergonomicissues and repetitive work - a precision requirement, as colours and toners must notbe mixed. In addition, toner cost is high, and toner waste has economic drawbacks	WE and Efficiency	O, I and F

2.3. Company D

When it comes to engine electronics and entertainment systems for vehicles, Company D is at the forefront of the repair and remanufacturing industry. One step in the value chain of Company D is a major automaker. Remanufactured products are sold by the automaker's service network after they recover damaged components.

This inquiry is focused on the electromechanical component of an engine (Figure 6). We also consider additional components that are now in production or will be in the near future that possess similar characteristics. Mechanics, electronics, and a framework are all integrated into the component. Because of their mechanical strength and dimensional stability, as well as their suitability for handling and fixturing, these components facilitate automation. Remanufacturing the electro-mechanical components was planned out in a nine-step process, which included:

looking at and assessing two) washing
3. Opening the lid 4) Cleaning and taking it apart
5. Stripping off sealant
Restoring malfunctioning electrical devices

Section 7: Applying Sealant
8) Taking off the previous canopy
9) Assessment

Figure 6. The electro-mechanicalcomponent remanufactured at Company D.

The examined components, like the engine compartment of a vehicle, need to be sealed to prevent the harmful elements from getting inside. Therefore, when remanufacturing, it is necessary to reseal the components. In these contexts, sealants are often utilized. This necessitates the recurrence of processes such as component separation (which may be achieved by severing the seal), residual cured sealant removal, and sealant dispensing and curing. These procedures are now carried out by hand, which may be a time-consuming operation.

Potential for automation at Company D

Based on the data collected at Company D, the potentials for automation in this remanufacturing process are identified and presented in Table 6.

Table 6. The identified potential processes for automation at Company C, where the source and the automation reasons are described. WE=Work Environment, O=Observations, I=Interviews, F=Focus group discussion. The source of data is mentioned in order of appearance.

Process step	Reason for automation	Source of data
Cleaning electro-mechanical component	WE and Quality	O, I and F
Removing the sealant from the electro-mechanical component	Efficiency and WE	O, I and F
Sealing the electro-mechanical component – mainly precision work	Efficiency and Quality	O, I and F

3. Analyzing each situation independently

This section provides a summary of the case businesses' case study data on the potential for automation at the examined remanufacturing enterprises. The data is based on a theoretical framework that takes into account the levels of HRC [19] and the seven typical process phases of remanufacturing [15]. To complete the study, the writers draw on their diverse backgrounds in automation and remanufacturing, including topics like their struggles with the industrial system and the environment. Pictured in Figure 1 are the primary procedures. You may see the applications that were identified experimentally in each example firm in Tables 3-6. The HRC degrees are shown in Figure 2. Below you can see the findings of the cross-case study in Table 7. Human operators may engage in novel types of robot-human interaction in the current production system, as indicated by the identified automation possibilities. However, our study was mainly driven by our ongoing discussions with our industrial partners on the potential for more automation in the remanufacturing business.

Table 7. The prospects for automation that were highlighted for the sample firms in this research.

Potential levels of HRC are given in parentheses.

Remanufacturing step	Company A	Company B	Company C	Company D
Inspection				
Cleaning	Data erasing *(N/A)*			
Disassembly	Disconnect laptops *(N/A)*			
		Reprocess		
Reassembly	Connect laptops fordata erasing *(N/A)*Sealing *(Coexistence)*			
Testing				
Packing	Raising boxes *(Cell)*			

According to Table 7, cleaning, disassembly, and reassembly are the three most potential areas for automation. Automation of these remanufacturing processes has the potential to increase worker safety, especially during the toner refilling and cleaning processes that occur during assembly (Companies B and C). Companies A and D are driven by the demand for more accurate processes, while the other prospects are driven by the need for more efficient processes overall. When deciding to automate, companies B and D emphasized quality.

3. Final thoughts and analysis

Similar to conventional manufacturing, the case study and literature provide arguments in favor of automated remanufacturing, including the need for more streamlined processes and reduced lead times. Nonetheless, for reasons pertaining to the work setting, the cleaning processes shown a great deal of potential in the cases. Due to its potential length and significant contribution to total lead time, this remanufacturing step is crucial (for examples, see Sundin and Bras [15]).Also, previous research (e.g., Kernbaum et al. [12]) has shown that long process durations can make it hard to use robots in remanufacturing. The cleaning and assembly of car components by

Autocraft is one example of a successful installation and potential [20]. Based on our findings, there are potential areas for automation in the EEE item cleaning and assembly processes.

But according to Wang et al. [18], we need to examine the five different levels of collaboration in order to build a successful HRC, and Bauer [19] says that we need to compare the advantages of robots versus humans. The best setup, according to these shades of gray, depends on the unique demands of every job. For Company D's cleaning, for instance, we could need a very sharp tool to scrape off sealant. A cell layout philosophy is recommended for safety reasons, since the risk assessment [11] would reveal an increase in hazards if the tool is positioned in the robot's end-effector. This might be related to problems in the workplace.

4. Ongoing studies

Due of the extensive nature of the EEE remanufacturing industry mapping, many issues remain unsolved. More study into technology demos is clearly required to identify the most effective and efficient ways to increase automation in remanufacturing applications. Despite facing distinct obstacles like low product quantities, a high number of variations, and varying incoming quality, all of the case study organizations share a common problem: the need for technological flexibility while investing in more automated solutions. It is equally important to invest in automated solutions that can benefit both the economy and the environment. While this study primarily focused on small and medium-sized firms (SMEs), future research may expand to include a large remanufacturer. The conceivable levels of automation of HRC and their link to the remanufacturing process stages need more investigation. The reassembly procedures of three of the case businesses (B, D, and E) adhere to a pattern where they can only use coexistence HRC, whereas the fourth remanufacturing company (A) goes against this trend.

Praise and thanks

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Works Cited

[1] A circular economy strategy for Europe's competitive future: fostering growth from within. year 2015. (1) The McKinsey Center for Business and the Environment, the Ellen MacArthur Foundation, and SUN.

[2] in(European Council for Remanufacturing, 2020) Source: [2] remancouncil.eu. Effective immediately, Tuesday, March 2, 2020.

[3] The World Economic Forum, 2020, https://www.weforum.org/, announced the launch of a climate action platform to achieve carbon neutrality in industries that are difficult to regulate. Ready for use as of March 2, 2020...

[4]Thierry, Michael, Salomon, John Van Nunen, and Van Wassenhove's Strategic Considerations in Product Recovery Management. 1995, 37(2), 114–135 California Management Review.

A study by R. Lund from Boston University in 1996 found that the remanufacturing business was a hidden behemoth.

Sixth reference: J. stlin, "On Remanufacturing Systems: Analyzing and Managing Material Flows and Remanufacturing Processes," 2008, UniTryck, Linköping, Linköping Studies in Science and Technology, Thesis No. 1192.

A dissertation published in 2004 by Tabergs Tryckeri AB and published in the Linköping Studies in Science and Technology series. Remanufacturing-effective product and process design, by E. Sundin [7].

[8] In what ways is remanufacturing good for the environment? In 2011, E. Sundin and H.M. Lee published a work. Pages 551–555 of the Seventh International Symposium on Environmentally Conscious Design and Inverse Manufacturing (EcoDesign-11), held in Kyoto, Japan, on November 30–December 2, 2011.

The challenges of remanufacturing as well as the possibilities for lean improvements [9] B. Poksinska, J. Kurilova-Palisaitiene, and E. Sundin made the paper. Article from the 2018 Journal of Cleaner Production, pages 3225–3236.

[10]The realm of socially aware robots: where technology meets humanity authored by K. Dautenhahn [10]. Page numbers 679–704 in Volume 362, Issue 1480—2007 Publications of the Royal Society of Philosophy, Series B: Biological Sciences.

the eleventh"Understanding situational and mode awareness for safe human-robot collaboration: case studies on assembly applications" is the title of an article published in the journal Production Engineering by V. Gopinath and K. Johansen. The paper is part of Volume 13, Issue 1, and runs from pages 1 to 9.

[12] Disassembling and testing flat screen monitors for remanufacturing, [12] G. Seliger, S. Kernbaum, and C. Franke. Volume 1, Issue 3, Pages 347, Sustainable Manufacturing: An International Journal, 2008, 2008–2008.

[13] Applications of Case Study Research, written by R.K. Yin, was published by Sage Publications in 2003.

[14]An overview of the landscape of remanufacturing business models, authored by E. Sundin, T. Sakao, M. Lindahl, C.-c. Kao, and B. Joungerious cited as [14]. In 2017, www.remanufacturing.eu became the official website of the European Remanufacturing Network.

[15]Reselling functioning products in an environmentally and financially responsible way via product remanufacturing [15] Bryant and Sundin, E. Journal of Cleaner Production volume 2005, pages 913–925.

[16]In Part 1, we introduce the concept of robots; in Part 2, we explore their construction and interplay. international standard ISO 10218-1/2, issued by the ISO in 2011.

[17]The Integration of Robots, Automation, and Other Systems for Efficient Production (M. Wilson, 2014)[17] Roberts & Heinemann.

[18] inR. Gao, L. Wang, J. Krüger, S. Makris, G. Chryssolouris, J. Váncza, and X.V. Wang Cooperative assembly including human and robotic workers. Publication date: 2019; volume: 68(2), issue: 701.

[19][19]Start with the Fundamentals When Working with Lightweight Robots in Manual Assembly, With contributions from W. Bauer, M. Bender, M. Braun, P. Rally, and O. Scholtz, Fraunhofer - Institut für Arbeitswirtschaft und Organisation IAO, Stuttgart, 2016.

20] Editor F.J. Weiland (Dukarnia Press, 2016) and M. Hague-Morgan (Automotive Remanufacturing) discuss how automation and innovation may improve the industry. How Robotics and Digital Manufacturing Will Shake Up the Reman Industry. In 2019, the printing house published pages 133–144.