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The future of industrial robot business: Product or performance based?

Steffen Landscheidt[a,*], Mirka Kans[b], Mats Winroth[c], Hans Wester[d]

[a]*Department of Forestry and Wood Technology, Linnaeus University, Lückligs plats 1, 351 95 Växjö, Sweden*
[b]*Department of Mechanical Engineering, Linnaeus University, Lückligs plats 1, 351 95 Växjö, Sweden*
[c]*Technology Management and Economics, Chalmers University of Technology, 412 96 Gothenburg, Sweden*
[d]*Yaskawa Nordic AB, Spångatan 4, 385 25 Torsås, Sweden*

Abstract

The robot market today is mainly based on product-centered sales concepts. In the future, traditional procurement of industrial robots can be expected to become less important and the business models will shift the focus towards leasing or even pay-per-use. This paper discusses how these new business models should be designed and what components and features are needed for successful implementation. Digitalization, circular economy, cultural barriers, business traditions and fear of new philosophies are investigated and put into the context of the advantages offered. A possible transformation process is set into the context of the product-process matrix.

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Keywords: Automation; business model; functionality; industrial robot; product-service-systems; servitization

1. Introduction

Industrial business modeling has lately gained increased attention as the global circumstances and conditions are changing; especially research on business models combining physical products and services is growing [1, 2]. A

* Steffen Landscheidt. Tel.: +46-(0)470-767544; fax: +46-(0)480-446032.
E-mail address: Steffen.Landscheidt@lnu.se

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market segment where physical products and the offered services have not yet been developed in this direction is the industrial robot business. The robot business is mainly based on the sales of industrial robots or complete, functional robot cells. This is especially the case for standardized industrial robots. According to the International Federation of Robotics [3], annual sales of industrial robots has increased from 2015 to 2016 with about 16% worldwide and it is estimated that in 2016 around 294.000 industrial robots will be shipped.

Jackson and Zaman [4] and Jackson et al. [5] describe how new business models can support and be supported by new technological developments, as demonstrated by the factory-in-a-box concept. However, although the factory-in-a-box project has shown promising potential, its industrial breakthrough has not happened, yet. Comparable projects, e.g., the ArcWorld from Yaskawa [6], indicate great capacity. Nevertheless, those business models still focus traditional sales concepts. With the development of collaborative robots, new business models and offerings are possible [7]. The development of new business models is especially for a high-cost country as Sweden of high importance, already lagging behind in its automation [8] and digitalization [9] efforts. Demographic changes and new technological developments [10] will only further accelerate this topic. New business models can offer new possibilities and opportunities, e.g., for small and medium-sized companies and less automated industrial sectors to implement automation equipment. Applying new business models in the logistics sector has resulted in rapid growth in the sector, opened up new business options and created many more jobs than the ones lost through automation or digitalization [11].

This study investigates how the current business model of the robot business (in Sweden) is designed. It also conceptualizes new business models based on existing theory and practical knowledge and expertise of the business area. The objective of this paper is to identify how the robots business is done today and how new business models for industrial robots could be designed in the future. Existing and new business models are set into context to production volume and demands for flexibility for manufacturing philosophies.

2. Theoretical framework

In this section, the business model canvas is introduced. The canvas is a simple but efficient tool for the development of business models. It will be used for describing current and future business models in the robotic area in section 3. In addition, central concepts for the transformation of business models are described.

2.1. The business model canvas

Osterwalder and Pigneu [12] propose a variety of business model development tools, but the focus is on the business model canvas. The canvas represents nine important aspects of the business model:

- **Value proposition:** The value proposition is the means a business achieves to satisfy the customer. The value proposition could be in form of a product, a service, or a mix of both.
- **Customer segments:** Customers can be divided into different groups based on, e.g., geographical or product-specific groups or groups based on a type of relationship. According to Osterwalder and Pigneu [12], a customer group constitutes a separate entity or segment, if a) their needs require and justify a distinct offer, b) they are accessed through different distribution channels, c) they require different types of relationships, d) they gain a profit in substantially different ways, e) they are willing to pay for different aspects of the offer. The value proposition can be targeting the mass market (the same business model is used for all customers) or a niche market, where customer relationships, channels and value offers differ for each customer segment.
- **Customer Relationships**: Osterwalder and Pigneu [12] describe six different relationship categories that can be used, either individually or in parallel, for one and the same customer: personal service and dedicated personal service, self-service and automated services, communities and co-creation. Personal service means that the customer is served by a physical person from the supplier side. Communities are networks where customers interact with the company and other customers, for example, help each other with problem solving and recommendations. Inviting the customer into the product development process is called co-creation.

- **Channels:** A channel is the way the company reaches customers, and how customers want to be reached. A company can use own channels, channels provided by partners, or a mix of both.
- **Revenue flows:** Revenues may be fixed revenues or transaction revenue based on a one-off payment. Pricing allows for using fixed prices based on static variables, such as catalog price, volume or customer segment, or dynamic prices that change depending on market conditions, bidding procedures or negotiations. Fixed assets can be sold, leased or hired, and thus generate revenues. For services, user fees, subscription fees, licensing and emoluments are common.
- **Key activities:** According to Osterwalder and Pigneu [12], there are three generic activities that create value: production, problem solving and platforms/networks. Production is the industry's primary activity while consulting firms and other service companies usually offer problem solving. Companies like eBay offer a platform that is a prerequisite for value creation, in eBay's case sales.
- **Key Resources:** Recourses can be found in four key categories: physical resources such as manufacturing facilities, buildings and vehicles, intangible resources such as trademarks, patents and other knowledge assets, human resources and financial resources.
- **Key Partners:** Partnerships are included to achieve benefits the company currently is not in possession of. It may be due to economies of scale or optimization, where each partner focuses on their specialist area, risk reduction by distributing insecurity between partners, e.g., in development projects, or acquisition of resources by acquiring a partner's expertise or physical resources.
- **Cost structures:** The business model could be either cost-driven or value-driven. A cost-driven model focuses on minimizing costs wherever possible while value-driven models concentrate on value creation primarily with exclusivity and personalized service as a feature.

2.2. Product-service-systems

Customer value has traditionally been seen as the deliverance of physical high-quality products, connected to a business model where producing and selling items are central. From a sustainability perspective, this might not be the best option, though. Concepts like servitization and product-service systems (PSSs) focus on the needs of the customer rather than on the product [2]. The PSS concept with roots in the sustainability program as well as within business innovation [13] is based on the integration of products and services for creating customer value by applying a life cycle and systems approach [14]. The value proposition of PSS could be divided into three main classes: product or function orientation, use or availability orientation, and result orientation [15, 16]. The product-oriented PSSs deliver a physical product with additional services, such as maintenance contracts. The ownership of assets is kept by the company in use-oriented PSSs. Instead, the product or its function is leased, shared or pooled. Result-oriented PSSs are fully service oriented; the company provides performance or utility for the customer according to the customer needs.

2.3. Circular economy

Although there is no clear origin of the concept of the circular economy (CE) [17, 18], the main idea is based on a system of recycling and reusing of goods and materials to both save energy and decrease resource consumption [17-19]. Stahel [19] describes this scenario in closing loops (see Figure 1), where products at the end of their service life get reused, repaired or remanufactured. If this is not possible, goods can be recycled to harvest (some of) their resources. With or without adding of new extracted resources, new products are manufactured with minimal loss of resources. Those new products can then be transferred to the same or new owner. Even though Geissdoerfer et al. [20] state that the concept of CE has increased significantly in research interest, there is still a large gap in the application of practical solutions and successful business models. As examples, the collection and recycling of plastic products or car-sharing models are often cited [19, 20]. Tukker [21] describes how PPSs for CE could have a vast impact on reducing waste of resources wherein industrial niches where sustainable PPSs have been implemented. However, their number is still too small and technical applications are often missing for the industries.

2.4. Product-process matrix

The product-process matrix, originally presented by Hayes and Wheelwright [22, 23], indicates how the choice of a production system may change depending on the structures of both product and process. When having very low volumes, perhaps even down to one-piece flow, the system needs to be very flexible in order to take care of the characteristics of each product. Gradually, as product volumes increase and the number of different products and variants decreases, it is more favorable to have a more flow-oriented system with higher productivity (see Figure 2).

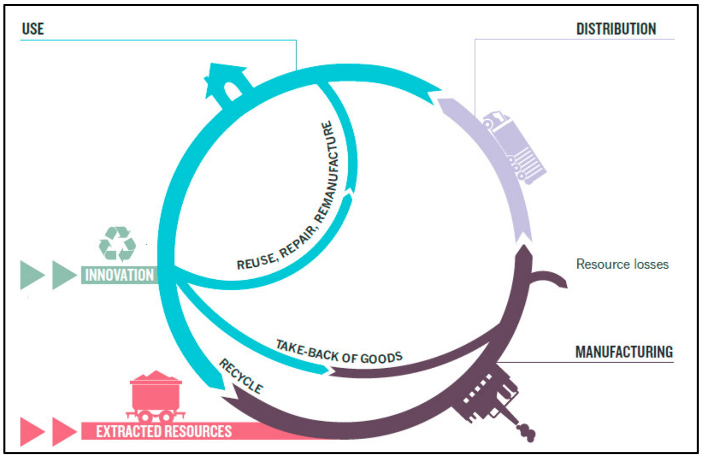

Figure 1 The closing loops of circular economy, adapted from Stahel [19]

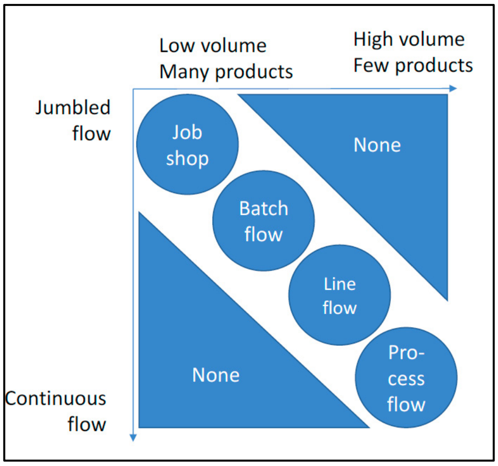

Figure 2 The product-process matrix, adapted from Hayes and Wheelwright [22, 23]

The trend towards providing customized products with the productivity of a mass-production system, often called mass customization, implies turning the diagonal in Figure 2 more and more vertical. This means that differences in a product should not affect the process considerably and necessary changes of tools should be done extremely fast to minimize disturbances. The ultimate stage is to have a line flow system with a one-piece flow, which follows the fundamental lean philosophy.

2.5. Industry 4.0 and digital transformation

The term “Industry 4.0” was coined on the Hannover Fair in Germany in 2011 [24]. It is a collection of technologies, both physical and virtual, consisting of, e.g., connected and interacting machines, smart products and systems and internet-based solutions [25]. Together they create intelligent and integrated computer-based production units, which are monitored and controlled by physical devices. These so-called cyber-physical-systems (CPSs) communicate through an internet-based network forming the "Internet of Things" (IoT) [26]. Many different scenarios of how ideas or concepts of Industry 4.0 can put forward are discussed [27], but a clear standard is not developed, yet. New manufacturing philosophies will allow making fully use of technological advances. Smart products, i.e., products equipped with memory capability, keep track of required resources and orchestrate the production process [28]. Automation, e.g., by industrial or collaborative robots will not lead to less human interaction or worker-less production facilities, but the competence requirements will change [28, 29]. It is expected that the skill requirements of the workforce will alter and become more specialized in the future. Flexibility in production requires flexibility and adaptability also in the support processes such as maintenance and logistics [30]. Smart products can therefore also predict their own need for maintenance [31].

2.6. Change management

Changes are natural for any business due to external forces, such as political, economic or technological, as well as internal forces, such as resource constraints, profitability issues or expectations of people. The change is an alternation of how things are made in one or several change agents: people, structure and technology [32]. The main aim of the change is an organizational improvement. Change management is the process of understanding why and how to make the necessary changes and is an important factor for the successful development of manufacturing strategies, see, e.g., [33]. Organisational changes always affect people and people are the ones who will lead to the success or failure of any change [32]. Therefore, motivating, measuring and managing the change on an individual level is as important as on the team, organization or business level. Organizational changes sometimes affect the culture as well and more important the culture affects the implementation of change. Some measures for managing changes of culture are strong leadership, a clear rationale for change, working with key persons (motivated and willing to do the change) and support for people to implement changes, such as training [34].

3. Business models for the industrial robot industry

In this chapter, the case of the industrial robot industry is described based on expert knowledge according to the nine factors of the business canvas [12]. First, the current business model is characterized and following two new, possible, models are developed. In Table 1, the current business model for industrial robots is depicted according to expert knowledge.

Table 1. Current business model.

Aspects	Current model
Value proposition	The value of the entire product is the robot itself, a robot with a system solution, a robot with a service contract or a combination of those. In some cases, even a pilot-study can offer value for the interested company.
Customer segments	There are mainly three different ways customers are divided today. One possibility is the division into different robot applications, e.g., arc-or spot welding, packaging, palletizing or machine handling. Another one is segmentation by industry sector, e.g., automotive, plastics or electronics industry. Another common classification is a geographical allocation of the market.
Customer relationships	The business is much alike the machine or equipment sales´ based on direct personal contacts to a dedicated sales person of a robot manufacturer or robot system integrator. Of course, the team responsible for the whole robot installation, especially for entire robot cells, often consist of a substantial team of experts specialized in different areas. Often long-lasting business relations (if the collaboration is successful).
Channels	As sales channel mainly three different ways are used: Direct contact with a sales person (often when there already is an existing contact), fairs or bidding procedures.
Revenue flows	The revenue flow consists of the expenses for the product, the development and a profit margin, i.e., one large sum at the beginning. Furthermore, a service contract for a certain amount of years, spare parts and altering and reprogramming of robot cells generate additional revenue.
Key activities	Except for the installation of a robot or robot cell, the adaptation of the application has to be done. Besides, development for a griper is very common and a whole system test should always be included.
Key resources	Four main resources can be identified: The personnel handling the sales process, the research and development environment, the whole robot system and the knowledge and expertise connected to the entire sales and implementation process.
Key partners	Two key partners carry most of the responsibility: Subcontractors, e.g., for griper or specialized generators and the experts designing and creating the robot solution.
Cost structures	The cost structure of the existing business model consists of the hard- and software as well as costs for the personnel.

In Table 2, a leasing-based and a pay-per-use business model are conceptualized. The business models are based on the PPS concept, as they provide integrated services or value propositions beyond the traditional sales of a robot or robot cell. Moreover, the business models take advantage of the possibility to reuse systems and therefore extend their life cycles, shifting focus from the owner to the provider of the system. The focus is hereby on a value proposition of a robot or entire robot cell from the perspective of the robot manufacturer. Some of the fundamental differences in the new business models, compared to the current one, are new customer segmentation based on production type, financial abilities and the maturity of the customer and a simplified procurement process. The latter enables the outsourcing of sales to a third part, which implicates the increased importance of key partners. The technical solution of the value proposition is also changing; both simplifications and new technological solutions are necessary

Table 2. New business models.

Aspects	Leasing model	Pay-per-use model
Value proposition	The value of the offering is the entire leased robot or robot cell with or without additional services, such as maintenance, according to a specific contract agreement. In addition, competent and expert work force could be included.	The value consists of a certain amount of manufactured or assembled products according to the agreement with min and max production volume specified.
Customer segments	Mostly small and medium-sized enterprises (SMEs) with a more dynamic production and volume mix. Companies with no or low previous automation experience.	Usually SMEs with a high product variety and short product life cycles. Companies with no or low previous automation experience.
Customer relationships	Medium term business relations, one-five years.	Very short. Starting from a few days up to a few month, but probably not more than one year.
Channels	Mostly via sales personnel and fairs, but less bidding procedures.	Mostly via dedicated sales personnel and fairs. The value proposition needs to be available very fast.
Revenue flows	Periodical revenue over the contract period. Allows for a more even revenue flow.	Either one payment for the entire production volume or payment for every (successfully) executed operation.
Key activities	Installation and adjustment of the robot/robot cell, service and maintenance, but mostly no reprogramming.	Rapid installation of a movable cell (within a couple of hours), adjustment and set-up.
Key resources	New or used industrial robots. Simplified robots systems and movable, compact cells.	Mainly used robot cells for specific easy teachable tasks, mobile or small collaborative robots.
Key partners	System integrators specialized in leasing agreements and a third party proving funds for the lease.	System integrators or service providers, but with less competence because the products and programming are easier.
Cost structures	Costs for procurement and ownership of robots, set-up, service and maintenance.	Warranty costs for delivering a certain number and quality of finished products for a specific period.

4. Discussion

New business models for industrial robots are not only possible; they are necessary. Customers demand, shorter product lead times, higher variation in the products and therefore often a shorter lifespan for a product and at the same time demanding higher production quality and traceability. Also, manufacturing and product contracts for companies are often shorter nowadays and therefore, the investment volume into automation equipment might be too low. Leasing or pay-per-use business models offer new advantages here. The relation between the product-process volume and business models is illustrated in Figure 3. New business models are mainly addressing the discrete manufacturing and its automation requirements. This calls for flexible and less investment heavy value propositions. The flexibility could be achieved by utilizing new technologies such as mobile and collaborative robots, but also by simplifying the value proposition by reusing old robots for simple and standardized operations. Leasing contracts are suitable for companies with limited investment possibilities as the payment is periodic, and pay-per-use is suitable when additional manufacturing capacity is needed for a short period.

However, acquisition of new equipment with new business models, i.e., not purchasing machines is not that common, and a certain resistance is to be expected from the robot manufacturer as well as from the customer. Overcoming business traditions and principles can set a stop to new developments because of the uncertainty of a successful outcome. From this perspective, leasing or pay-per-use are optimal business models to reduce fear and overcome the barrier for investing in expensive production equipment on a long-term perspective. In the new business model propositions described above, the leasing based contract is suggested as a medium-term agreement, but there are good possibilities to work with leasing based contracts also on long-term basis that include aftersales services, for instance in the form of performance based contracts or partnering contracts [2]. However, as the industry is not fully familiar with the leasing based contract form, the medium-term agreement is a suitable way to introduce these kind of business models.

Digitalization of machine data and implementation of CPSs allow, on the other hand, speeding up the process of technological barriers. So-called plug-and-play equipment offers new possibilities to rapidly include a machine in the production process. Especially for collaborative robots, new business models can work very well. Here, no safety barriers or other “large” extra equipment is needed when moving and installing robots. Furthermore, they are easily teachable even by personnel with little knowledge of robot programming. Mobile and collaborative robots will rather be seen as “workforce resource”, which can be sourced for a specific task. In the future it could be possible that robots can be acquired the same way as today human work force by, e.g., staffing agencies to overcome capacity shortages.

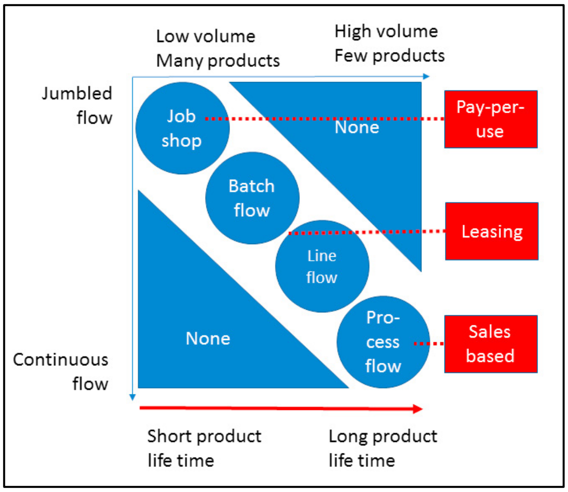

Figure 3 Relation of product-process matrix (adapted from Hayes and Wheelwright [22, 23]) and the three business models

5. Conclusions and future research

The robot business can gain a big push by changing and adding new business models. It would not only allow robot manufacturers to reach new markets, mainly SMEs in new industry segments in order to increase the market size, but also give enterprises new access to automation equipment and raise their level of automation. The importance of automation is now also realized by the Swedish government, which has started an initiative to boost robotization in SMEs particularly [35]. New business models could open up for new opportunities.

Daily business for many robot manufacturers will not change (in the beginning), since they probably will continue to sell their products to third-party providers which in term will specialize on a certain business model and target specific markets.

A large hinder for the successful implementation of new business models for industrial and collaborative robots at the moment is still labor costs for manual labor. In the European Union, labor costs for manual labor are still less than the costs for robot hours [36]. However, costs for robots will continue to decrease, as well as the time for programming and teaching will be reduced, and consequently the market for new robot products will grow.

This study is only based on conceptualization and model development without empirical data. Therefore, future research will consist of case studies and data gathering to strengthen or revise the proposed models.

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