

ABSTRACT

Service Based Manufacturing Strategies Implication for Product Development, Production and Service Operations in Global Companies

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Mature products have limited market expansion and the profit per sold product is usually rather low. Companies with mature products are therefore moving downstream into the more profitable service focused aftermarket. This paper describes 3 cases of action research (Trucks, Fast Trains and Medical Devices) that successfully implemented aftermarket based manufacturing strategies. The Truck business has very low profit per sold product (0 - 1 %) and has therefore been forced into an aftermarket based manufacturing strategy. The Train Industry has products that last for 30 years. This long product lifecycle has forced them into leasing and an extended aftermarket strategy. The Medical Device industry on the other hand still has high profit from the sale of the product (30 - 40%) but due to limited market expansion they must also expand within the aftermarket and adopt an aftermarket based manufacturing strategy. This paper analyzes in depth the key areas and operations for the development and implementation of a successful aftermarket/service based manufacturing strategy. Under this strategy, traditional maintenance approaches and supply chain management of spare parts are not appropriate. Focus is instead on production cost reduction by redesign of the product (modularization, design for manufacturability, platform rules), spare parts engineering (design for aftermarket, repair-ability, logistic solutions for uptime and strategic spare parts) and extended offer (business expansion to offer the as much as possible to support the customer's business). The cases show that Aftermarket

Branding Operations are crucial to increase customer loyalty. Uptime was found to be the main aftermarket branding factor. Advanced global price setting strategy of aftermarket products and local adaptation of service concepts are areas that strongly affect company profit.

Key words: Servitization, Manufacturing Strategy, Profitability, Extended offer

Introduction

Mature products have limited market expansion and the profit per sold product is usually rather low. The way to increase the profit and thus survive for a manufacturing firm is to move downstream into the more profitable aftermarket service area. This transformation of manufacturing strategy will have impact on most of the company's operations. In the literature there are few examples of the implementation of servitization of manufacturing companies. This study shows three cases, a train manufacturer, a truck manufacturer and a medical device manufacturer that all have changed to aftermarket/service based manufacturing strategies. The aim is to explain the implications for Product Development, Production and Service Operations in Global Companies.

Frame of reference - theory and practice

The differences between manufacturing and service firms are breaking down across the globe. Neely (Neely 2007) states that UK's 300 largest manufacturing firms annually accounts for over \$2000 billion in sales. Over half of these sales come from firms, who although classified as manufacturing firms, actually describe their offerings as a combination of manufacturing and service.

Manufacturing firms in developed countries can rarely survive as pure manufacturing firms due to limited profit from product sales. The exemptions are high-tech products (medical devices for example) that still have high profit from product sales, mainly because of limited competition. Most manufacturing firms are therefore forced to move downstream into the more profitable service to be able to survive. The trend to servitize manufacturing is first mentioned in the literature in the late 80th (Vandermerwe and Rada 1988) but there exists few examples. Two articles in Harvard Business Review, written by consultants are pointing out the increased profit for manufacturing companies moving downstream into service (Wise and Baumgartner 1999 and Allmendinger and Lombreglia 2005). The existing literature describes some cases but how to change manufacturing strategy is not addressed. The lack of a theory or best practices has led companies try themselves to move downstream with varying degree of success.

Research question

Manufacturing companies that focus upon service based manufacturing strategies are interested in achieving two goals: increased customer loyalty and increased aftermarket sales (extended offer). This type of manufacturing strategy has very large implications for Product Development, Production and Service Operations in Global Companies. This paper analyzes the necessary changes within these areas in three manufacturing companies that implemented service based manufacturing strategy.

Research Method

The empirical data for this paper was collected over a five-year period. The research question was complex with few references in the literature. The research method chosen was therefore action research in combination with longitudinal case studies, a method that the author has been familiar with for more than 25 years. The business model and manufacturing strategy in the three cases were relative clear but the author had a role as consultant to implement the strategy within two of the cases. In the third case, the train manufacturer was the action researcher a Ph.D. student who also worked as a consultant in his own firm.

Results and analysis

Case A Train manufacturer

The customers had problem to get traffic operation contracts longer than 6 years and because of that they were reluctant to invest in a train with a lifecycle of about 30 years. The train manufacturer was therefore forced to change to a manufacturing strategy with focus upon leasing. To be able to sell trains the manufacturer has to come up with a 6 years leasing contract including service. The train is fully own by the manufacturer. The customer then knows exactly what the train would cost to during the 6 years. As cost for buying the train is about 4% of the total cost for the train operation during the train's lifecycle, the train manufacturer created a win-win situation for the customer and the manufacturer. The train operator now can to lease the train, the manufacturer don't have to make the train so customized as before (better control over the product development). This is a paradigm shift from sales of spare parts to sales of service contracts with high uptime and decreased service costs for the manufacturer. To decrease production cost the whole train was modularized and standardized. The whole production system was redesigned with large pre-assembly/modules - were most of the variants are taken up. This type of system is called Adaptable Production (Bennett 2003).

Aftermarket potential

The potential for aftermarket sale is large as the cost for the product sale is only 4% of the total cost the customer has for the operation during the products lifecycle (30 years).

Uptime

The spare parts were designed in the form of sub-modules, which are easy to change during the night when the train stands still. A monitoring system was installed in the train so that the train driver can see on a display which sub-module has to be changed (and when) and then contacts the train manufacturer's service engineer. The train high uptime has been designed with parallel system back-up systems. Focus upon uptime in the product development process created a very high uptime.

The focus upon uptime led to:

- **Increased preventive maintenance**
- **Local warehouses globally for uptime parts**
- **Design of uptime sub-modules that service engineers have in the service van**
- **Design of preventive maintenance kits**
- **Establishment of Spare Parts Engineering activities (Karlsson 2003) - design of spare parts assortment, breakdown level of spare parts with focus upon complete units/sub-modules, backup systems and increased lifecycles for spare parts (goal 6 years)**
- **Remanufacturing after 6 years**

Spare parts

Most of the spare parts are complete units or sub-modules that re easy to change. Some of them can be remanufactured. Product development had to focus upon uptime and 6 years lifecycle for spare parts. Logistic is restructured and the number of spare parts reduced.

Extended offer

The manufacturer takes care of the train for 6 years, after that the train is remanufactured. The manufacturer has total control over the products lifecycle. The train operator takes care of the timetable and the personal running the train. It is a win –win situation. The train operator has a fixed price for 6 years. The train manufacturer has a fixed income over 6 years.

Helpdesk/advisory center

The helpdesk is easy to handle as the train has a monitoring system.

Top management involvement in the change to the new manufacturing strategy

Top management informed product development, production and market about the new manufacturing strategy. Information was given to all employees.

Establishment of Cross-functional processes

To succeed in the manufacturing strategy change a number of cross-functional processes were established.

- **Extended offer development - between business units and after sales product development**
- **Uptime (parts, preventive maintenance, logistics- availability) - between service engineering, after sales development, logistics and product development**

Spare parts engineering Cross-functional processes

- **Spare parts assortment including kits, Design for Aftermarket (Karlsson 2005) – together with service engineers and product development**
- **Repair instructions together with service engineers**
- **Suppliers together with purchasing**
- **Modularization together with product development, production and service engineering.**

Manufacturing cost

The production volume is relatively low and focus has been to reduce the cost for variants by modularization. An advanced modularization with fixed interfaces between modules to systematically reduce the cost by design for manufacturability. The adaptable production concept was used with large sub-assemblies and a short final assembly line. Most of the variants were taken up in the subassemblies.

Case B Truck manufacturer

The truck manufacturer has a very competitive situation. The margins are low in the truck business 0-1 % and most of the profit comes from the aftermarket. Service contracts are purchased by 50% of the customers and less than 50 % lease the product. Due to the diversity among the customers the manufacturing strategy must focus on very different extended offers, how to obtain uptime to secure customer loyalty and how to handle variety within the product development, production and spare parts assortment. Due to the size of the company a number of cross-functional processes were developed to secure the aftermarket business.

Aftermarket potential

The potential for aftermarket sales is large as the cost for the truck is only 10% of the total cost the customer has during the lifecycle (3-6years).

Uptime

The customers loyalty is very much dependent upon uptime. Breakdowns make it difficult for the truck operator, as they have to reschedule transports. A breakdown includes diagnostic time, waiting for the spare parts needed, the repair time and the test time. The waiting time for the spare parts is long (4 - 24 hours or more dependent upon where they were globally stored). Test time is short (less than an hour). Repair time is rather short (1-2 hours). The total stop is very often up to 1 day. The company must therefore increase uptime. When interviewed customers perceived uptime as the main branding of a truck company. Uptime is a major consideration in the purchase decision and thus very important for maintaining customer loyalty. A 3 years, 1000 trucks breakdown analyze identified 109 spare parts as uptime spare parts. If more preventive maintenance were done the number of uptime parts decreased to 91. The traditional logistic model is based upon sale frequency per spare part. Uptime parts that often have rather low frequency will therefore be stored in the central warehouse. In an aftermarket based manufacturing strategy uptime parts must be stored locally (to a higher logistic cost) and be available within 4 hours. To increase uptime the following service operations have been changed:

- Increased preventive maintenance (planned downtime)**
- Local warehouses at dealers globally for uptime parts**
- Establishment of spare parts engineering activities - design of spare parts assortment, breakdown level of spare parts (complete units, kits, single parts) design of specific spare parts that differs from the production parts and obsolete parts, design for aftermarket**

Spare parts

The analysis of the spare parts showed that 364 spare parts were classified as strategic spare parts. They are called strategic parts as they stand for nearly 80 % of the sold spare parts revenue per year. Totally there are 65 000 spare parts. Of them 45000 stored and 38700 are used annually. To cut logistic cost, the number of spare parts must be decreased. Spare parts engineering activities reduce spare part numbers. By decreasing the number of strategic parts with 50% to 182 the total logistic cost is decreased with 15 %.

Spare parts price setting strategy and process were found to be very important to achieve as high revenue as possible from spare parts sales. Strategic spare parts stands for 80% of the revenue and increase in price of these parts are therefore very important. Globally every business unit has their own price-setting unit that sets local prices. Once a year the price setting is reviewed to adjust to what the local market will bare. A service contract will give about 5% more revenue than sales of spare parts and repair service. To increase the number of service contracts globally is a strategic goal. The lesson learned is that it is important to work with sophisticated price setting of spare parts to increase revenue. The main cost reduction for spare parts logistic is reduction of spare part numbers by spare parts engineering activities. Aftermarket competitors are selling the more common spare parts and take about 50 % of the market. They focus upon high volume parts (strategic parts).

Extended offer

The profit on sale of the truck is much lower than the total aftermarket profit for the truck's lifecycle. An analysis of one typical customer showed that the cost - truck and service are 20% of the total truck operation. An extended offer in the first step is to supply the customer with a service contract. A second step is to offer leasing for 3 years. A third step is to offer the customer a price per ton km that he drives. The manufacturing company is now at step three in some markets. The company has not offered yet developed a scenario to even offer personal to drive the trucks.

Helpdesk/advisory center

The helpdesk was a branding activity that the company paid little attention to. When we interviewed customers they pointed out that the helpdesk was the only contact they have with the manufacturer after the sale of the product. They also rated helpdesk second after uptime as an activity that strongly affected their customer loyalty. Their demand on the helpdesk was that they should be able to help with or answer all questions that the customer has. They also wanted to discuss different aspects for example if they should buy extra equipment etc. The manufacturer now has changed the helpdesk to an advisory center and have personal that are trained to handle all types of customer relationships and have increased empowerment. An important factor has been that the personal will be able to speak the customer's language.

Top management involvement in the change to the new manufacturing strategy

Information has been given to all employees about how important aftermarket is for the company and how important it is to keep production cost down. In the product development process is an activity installed called Design for Aftermarket, which must be performed in every phase of the product development process. If Design for Aftermarket isn't done in one phase, the product process cannot continue.

Establishment of Cross-functional processes

To succeed in the Manufacturing Strategy Change a number of cross-functional processes were established.

- **Extended offer development - between business units and after sales product development**
- **Uptime (parts, preventive maintenance, logistics- availability) - between service engineering, after sales development and logistics**
- **Spare part Q – problem -between advisory center, quality control, after sales development and purchasing**
- **Price setting & local price and goals - between after sales development and business units**
- **Branding activities – between advisory center, logistics (parts branding) and after sales development**
- **Aftermarket sales material and aftermarket sales training – between after sales development and business units**

Spare parts engineering Cross-functional processes

- **Spare parts assortment including kits, Design for Aftermarket – together with service engineers and product development**
- **Repair instructions - together with service engineers**
- **Supplier relationship - together with purchasing**

Manufacturing cost

As the production volume is relatively high and the profit is nearly zero there is a strong focus on reduction of cost by design for manufacturability and modularization. Specific platform rules from production and aftermarket have been developed. These rules focus upon fixed interfaces between modules and fixed interfaces for uptime and strategic spare parts. Adaptable production is used with few large pre-assemblies. Most of the variants are taken up in the pre-assemblies.

Acquisition of companies to sell aftermarket products even to competitors

The company has considered buying up companies that sell spare parts to all common trucks.

Case C the medical device manufacturer

The Medical Device industry has high profit from the sale of the product (30 - 40%) and 10-15% annual product market increase. Most product sale is to old loyal customers. Customer loyalty is very important. The aftermarket is the base for customer loyalty. As the company wants to increase the revenue per customer they must expand within the aftermarket and adopt an aftermarket based manufacturing strategy.

Aftermarket potential

The potential for aftermarket sales is large as the cost for the product in relation all other cost the customer (the department at the hospital) has is 5% during the life cycle (7 years). Some of the costs are service bought internally within the hospital so the real potential is about 75%.

Uptime

Most of the customers buy a service contract including spare parts. But in some European markets are the hospitals self-maintainers. Sales of spare parts to self-maintaining hospitals are a sensitive business. The price setting has to be perceived as fair by the customers. The prices for spare parts differ a lot between different global markets. The customer's loyalty is very much dependent upon uptime. Breakdowns make it difficult for the hospitals, as they have to reschedule patients. A breakdown includes diagnostic time, waiting for the spare parts needed, the repair time and the test time. The waiting time for the spare parts is long (4 - 24 hours or more dependent were they are globally stored) and the test time after repair is long (6 - 8 hours). Repair time is rather short (2 hours). The total stop is very often 1,5 – 2 days. Uptime performance is also the main factor in the customer's repurchase decision after 7 years (lifecycle for the machine). The company must therefore increase uptime. The customers perceived uptime as the main branding factor of the company when they were interviewed. An analysis of breakdowns over 3 years for 24 machines showed that 87 spare parts were uptime parts.. If more preventive maintenance were done the number of uptime parts decreased to 21. The traditional logistic model is based upon sale frequency per spare part. Uptime parts that often have rather low frequency will therefore be stored in the central warehouse. In an aftermarket based manufacturing strategy must uptime parts be stored locally (to a higher logistic cost) and be available within 4 hours. To increase uptime the following service operations have been changed:

- Increased preventive maintenance (planned downtime)**
- Local warehouses globally for uptime parts**
- Design of uptime kits that self-maintainers can buy and store in the hospital**
- Design of uptime kits that service engineers have in their Vans**

- Design of preventive maintenance kits
- Redesign of the test process to be done by software to decrease test time
- Establishment of spare parts engineering activities - design of spare parts assortment, breakdown level of spare parts (complete units, kits, single parts) design of specific spare parts that differs from the production parts and obsolete parts

Spare parts

The analysis of the spare parts showed that 274 spare parts were sold more than 25 per year and of them was 46 sold more than 250 per year. The 274 spare parts were called strategic parts as they stand for 81 % of the revenue of the total spare parts sale. Totally there are 10 000 spare parts. Of them are 4500 stored and 2300 are used annually. To cut logistic cost, the number of spare parts must be decreased. Spare parts engineering activities reduce spare part numbers. By decreasing the strategic parts numbers with 50% to 137 the total logistic cost is decreased with 16%. The whole logistic system had to be redesigned globally and was outsourced to a third party. Spare parts price setting strategy and process were found to be very important to achieve as high revenue as possible from spare parts sale. Strategic spare parts stands for 81% of the revenue and an increase in price of these parts are therefore very important. A price-setting model was established with a base price for every strategic part (highest price). Then every business unit globally is allowed to give rebate or raise the price as long as they can achieve their annual spare parts sales goal. The rest of the spare parts have a simple markup model. Expensive (more than \$400) slow moving parts (435 spare parts) have the same price setting as strategic spare parts. Once a year the prices are reviewed and adjusted to meet market constraints. By using this price setting model - developed by the author - it is possible to have an efficient price setting operation that takes very little time to perform. A service contract will give about 5% more revenue than sales of spare parts and repair service. A strategic goal is to increase the number of service contracts globally.

Extended offer

The profit on the sale of the machine is the same as the aftermarket profit for 7 years (the machine lifecycle). An analysis of one typical customer (hospital department with two machines) showed that the cost - machines and service are 5% of the total budget but that nearly 50% of the personal worked with the machines. The head of the hospital department wanted to outsource both personal and machines to the manufacturing company. An extended offer in the first step is to supply the customer with all products (including software) needed to run the machines. A second step is to offer more training/certification for personal. A third step, not yet offered, is to offer outsourcing of machines and personal. The fourth step is to run the whole department outsourced including doctors etc. The manufacturing company is now in the first and second steps.

Helpdesk/advisory center

The helpdesk was a branding activity that the company paid little attention to. When we interviewed customers they said that helpdesk was the only contact they have with the manufacturer after the sale of the product. They also pointed out that second after uptime came helpdesk as an activity that strongly affected their customer loyalty. Their demand on the helpdesk was that they should be able to help with or answer all questions that the customer has. The manufacturer now has to change the helpdesk to an advisory center and have personal that are trained to handle all types of customer relationships and have increased empowerment.

Top management involvement in the change to the new manufacturing strategy

- **Two days training of all vice presidents and higher level managers to understand what an aftermarket based manufacturing strategy is**
- **Reorganization of the company into three business areas: Product A, Product B and Lifecycle business to secure the aftermarket business.**

Establishment of Cross-functional processes

To succeed in the manufacturing strategy change a number of cross-functional processes were established.

- **Extended offer development - between business units and after sales product development**
- **Uptime (parts, preventive maintenance, logistics- availability) - between service engineering, after sales development and logistics**
- **Service recovery - between after sales development, advisory center and business units**
- **Spare part Q – problem -between advisory center, quality control, after sales development and purchasing**
- **Price setting & local price and goals - between after sales development and business units**
- **Branding activities – between advisory center, logistics (parts branding) and after sales product development**
- **Aftermarket sales material and aftermarket sales training – between after sales development and business units**

Spare parts engineering Cross-functional processes

- **Spare parts assortment including kits, design for aftermarket – together with service engineers and product development**
- **Repair instructions together with service engineers**

- **Supplier relationship together with purchasing**

Manufacturing cost

As the production volume is relatively low and the profit still high from the product sales has there has yet been no attempt to systematically reduce the cost by design for manufacturability and modularization. A low cost machine for markets in Asia, South America, Eastern Europe and Africa are now manufactured in China and will be on the market within a year.

Acquisition of companies to sell aftermarket products even to competitors

The company bought a number of companies to have more after sales products to offer the customers. These products are also offered to the competitors.

Conclusions

Top management were actively involved in the change in the three cases. Experiences from the three case are that changing the manufacturing strategy to an aftermarket/service manufacturing strategy strongly affects the operations and that a number of cross-functional processes must be established. Development of aftermarket focused cross-functional processes was developed together with market, product development, production and purchasing/logistics.

The following 11 activities seem to be similar in the three cases and can be a base for more general theory about servitization.

- 1. Development and implementation of a number of cross-functional processes to secure customer loyalty and aftermarket profit**
- 2. Production cost reduction in two of the cases by redesign of the product (modularization, design for manufacturability) and implementation of adaptable production (all variants in large sub-assemblies)**
- 3. Establishment of Spare Parts Engineering and Design for Aftermarket (DFAM), two new concepts,**
- 4. Uptime focus as a branding activity (repair-ability, logistic solutions for uptime spare parts)**
- 5. Extended offer (business expansion to offer as much as possible to support the customer's business).**
- 6. Financial models to suit the customer's need**
- 7. Change of the helpdesk to an Advisory Center**
- 8. Aftermarket Branding Operations to increase customer loyalty. Uptime and Advisory center are the main aftermarket branding factors that strongly affect customer loyalty**

9. **Advanced global price setting strategy of aftermarket products and local adaptation of service concepts are areas that strongly affect company profit. Identification of strategic spare parts. Price setting of extended offer has a very strong impact upon profitability**
10. **Acquisition of companies to be able to sell more aftermarket products even to competitors**
11. **Global local adaptation of service concepts (price-setting and offer)**

Customer's needs differ in the different areas of the world due to their specific business. When a manufacturing firm changes to service based manufacturing strategy it is necessary to analyze and focus on the customer's business globally. By focus upon the customer's needs and adapting the strategy to them, the manufacturer can be more competitive and profitable. Service based manufacturing strategy changes the whole company and affects especially product design, logistic structure and service operations. Backoffice-frontoffice relations are changing so that front-office and customers will be much more important in development of products, production systems, extended offer and service operations. Servitization of manufacturing firms means that focus has to be on the customer's business to design and deliver integrated product and service offerings. The organizational change that is necessary is more focused on cross-functional processes and operations than on the organizational structure.

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