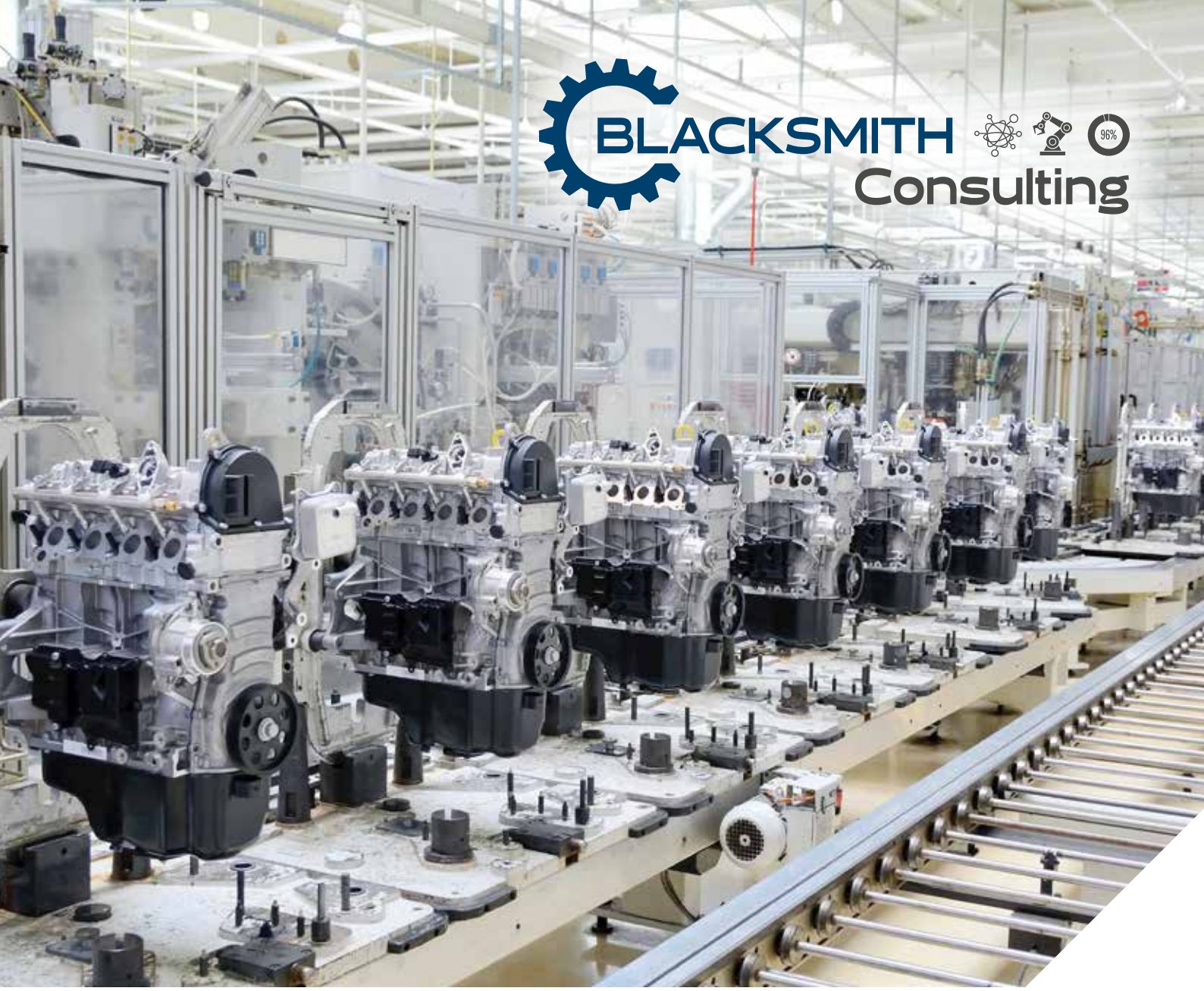
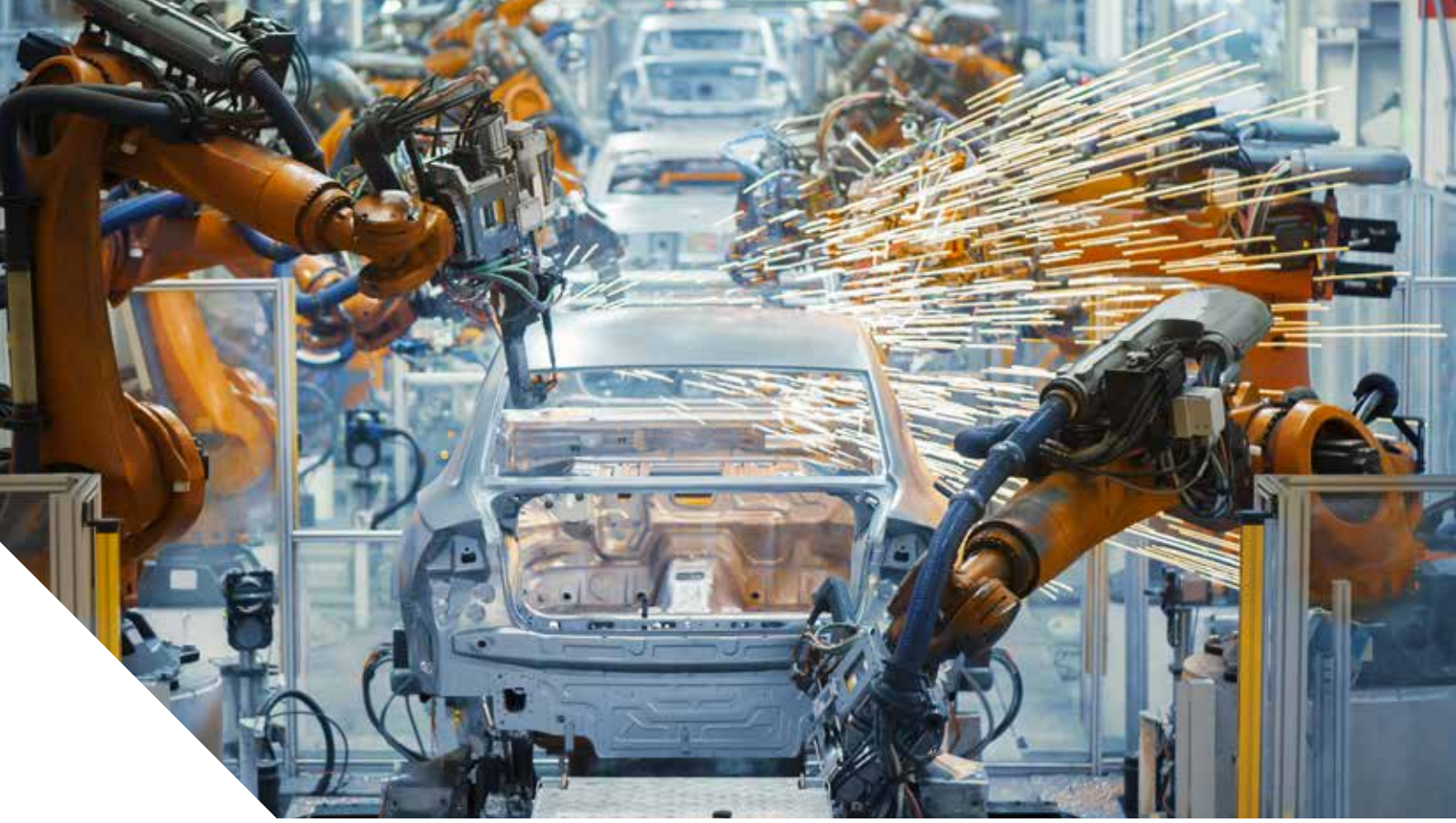


BLACKSMITH Consulting

THE EVOLUTION OF EFFICIENCY PARADIGM FROM RESOURCE EFFICIENCY TO FLOW EFFICIENCY

In this article and the related Case Study, we look at productivity, especially from the perspective of resource and flow efficiency. The framework is built on the remarkable work that Toyota's organization and supplier cluster has done over the last 100 years, and on how the Western-based Lean Manufacturing / Management strategy developed from these ideas works. Our case study focuses on welding and its development, but operational strategies are generally applicable to production, information and service industries.

The strategies and methods derived from them have been created in the environment of automotive industry, which means that organizations have to develop their own solutions, methods and tools to help them deal with the wastage and variations that occur in their operating environment. That is, instead of one orthodox and static model, the methods evolve with each new application. However, the key is to establish a common language and methods within the organizations and between different functions that facilitate the interaction which is essential in a flow-centric enterprise.



The current internationalizing and rapidly digitalizing marketplace has created both threats and opportunities at an ever-accelerating pace. The ease of scaling and cost efficiency brought by digitalization has lowered the “go to market” threshold in many industries. One interpretation is that Finland is moving, or has already moved, from the industrial mass-production era to the post-industrial era, where the definition of efficient, intelligent and value-creating work is changing. The success and growth of a company is based on the strengthening of its competitiveness and the growth of the market. This requires improved profitability. The single most important way for an individual company to increase profitability is to try to influence productivity growth. The price, as well as the margin between price and cost, is determined by the market. Productivity shows how effectively the ratio of outputs to inputs is formed, with the main components of productivity being labor and capital productivity, with the later constituting current assets, fixed assets and financial assets. In this article, we shall address the concept of production and supply lead-time, which refers to the time taken to produce, ship, and store a product or part of a product at some point in the manufacturing chain or throughout the process.

Effective use of resources was begun to be seen as important in the early 20th century as part of industrialization. One of the drivers of the trend was Fredrik Windsor Taylor, who, for example, experimented with the effect of different sizes of shovels and shovel speeds on work results to optimize factory worker shoveling. Scientific business management and the economics of scale were very much the spirit of the time. Resource efficiency is thus a traditional form of efficiency and means the most extensive use of resources. The division of labor and efficient, skillful repetition were sources of productivity. It was thought that efficiency would only be scaled through specialization and repetition. The more we do the same thing, the lower the marginal cost gets.

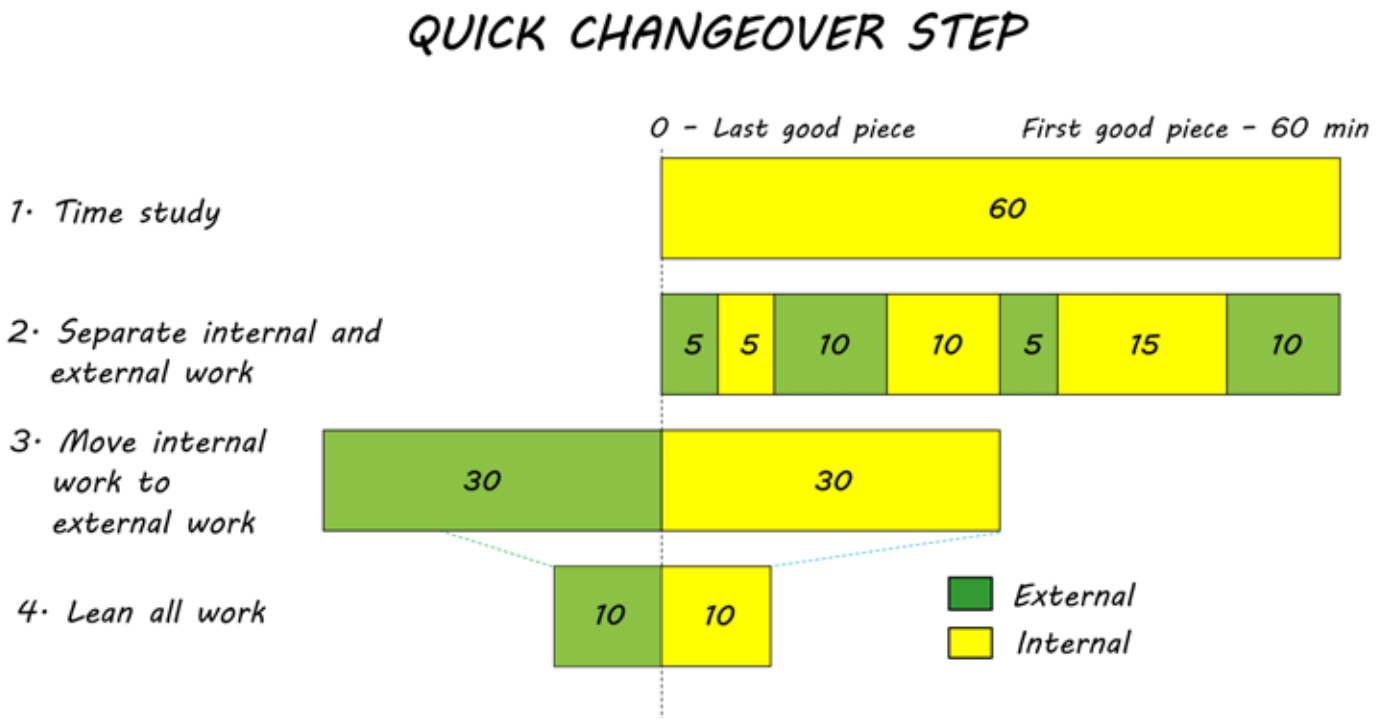
After the World War II, Japan had to rebuild its industry. The Japanese began to explore the US automotive industry, looking for solutions to eliminate wastage and improve productivity. In 1950, a number of Toyota leaders went to visit US factories and learn about local production methodologies. They found that mass production had not developed much since the 1930s; a large number of capital-intensive technologies were used to produce large quantities of products for storage, from which they could be transferred to the next stage and re-stocked. This was the beginning of Toyota Production System (TPS). The industrial market in Japan was the opposite to the US: many industries were destroyed by the war; consumers had no money and supplies were negligible. The current giant of the automotive industry, Ford, mass-produced successfully; it had a lot of capital and a massive market for which it made large numbers of limited number of models. Toyota would not be able to do this because it lacked both resources and capital. The Japanese market was weak and demand was low, steered towards high versatility of models with small serial quantities.

Limited resources forced the Toyota Motor Company to develop a new way of thinking about efficiency. In the 1940s and 1950s, Toyota had no excess production or storage space, so the goal was to eliminate time, material and waste at each stage. It was resource scarcity that forced Toyota to develop a new way of thinking about efficiency: the resource shortage was addressed by focusing on flow efficiency. The goal, and thus the [only] focus of the review, was the time between the order received from the customer and the arrival of the payment [transaction]. Flow efficiency is, in simplified terms, the sum of value-generating actions relative to lead-times. There are many known operational strategies and methods / tools derived from these strategies, but the underlying philosophy of action is to continually cut back on unprofitable activities, in order to shorten that order-transaction interval. The key here is to note that the focus is not on the manufacturing operations but on the entire order-supply chain related information, material and cash flows, including after-sales services.

Taiichi Ohno is often referred to as “The father of Toyota's production system”. He began his career with the Toyota Group in 1932. Ohno developed his production philosophy for nearly 60 years and named it the Toyota Production System, or TPS. Ohno rejected the main paradigm of resource efficiency in Western industries, namely the paradigms of economies of scale and mass production, where large series could be produced cost efficiently to stock. He suggested that productivity is brought about by a flow of continually pruning unprofitable operations. Toyota's management's view was that focusing on resource efficiency easily leads to sub-optimized efficiency silo's, as opposed to flow efficiency, where the focus is on resource efficiency across the whole system. At the heart of the production system was the elimination of waste or mud: systematic efforts were made to eliminate handling, storage, transportation, overproduction, movement, waiting and production errors.

Overflow, which occurs particularly in push-driven production, can be considered as the most significant flow-reducing waste. This results in unnecessary intermediate storage and the accumulation / hiding of problems between different departments and functions. Unnecessary transportation refers to the extra transfer of things [materials, supplies, tools and paperwork]. For example, tools shared between workstations that need to be repeatedly searched and transferred.

Over processing means extra work for which the customer is not prepared to pay. For example, additional quality inspections and approvals which do not add customer value. Too high quality, on the other hand, i.e. inadequate and too precise surface quality and/or tolerance requirements also result in waste. Unnecessary movement refers to any non-value-added movement and effort of people to complete the specific tasks. Examples include finding and retrieving tools outside the workstations and unnecessary reaching out for accessing and using tools. Value-added work as an example is the processing of raw materials or components into products. In turn, unprofitable work is work done to produce a product, feature or functionality that does not add value to the customer.



The eighth waste category today is the untapped human potential. This refers to the mental, creative and physical skills and abilities of employees, which, if ignored, can weaken the flow and corporate culture, lead to poor recruitment and lack of training and increase employee turnover. One of the major influencing factors of the flow can be considered the underutilization of human potential, which also directly leads to a decrease in the work motivation of the employees. Learning also has an innate link to motivation and pleasure, which at its best creates a positive spiral of working. This is also one of TPS 'key capabilities when it comes to productivity at work through learning and scaling learning.

Kiichiro's Toyoda was the one who's decision to change the business focus from automatic loom manufacture into automobile manufacturing created what would become Toyota Motor Corporation. His father, Sakichi Toyoda, had previously developed some basic ideas about efficiency, which later turned out to be very important to Toyota's car production. Sakichi was an entrepreneur and in 1896 launched fully automated looms which revolutionized the entire textile industry. The loom had a unique function which enabled production to stop automatically if the yarn was broken. Auto-stop feature enabled the problem to be identified, analyzed and eliminated immediately. The concept was later named "Jidoka", which means "automation with a human touch" and is thus one of the main pillars of TPS. Jidoka is based on the fact that production stops automatically when it detects an error in the process. In the case of machines, these shall be fitted with devices which detect anomalies in quality and stop the machine when they occur. It is also important in this thinking that instead of a quality, production and / or factory manager, every employee is entitled and obliged to stop the production line in the event of a disruption. This is to minimize the production of defective pieces and to achieve the highest quality possible. Problems are solved in a collaborative, systematic way, always addressing the root causes. For example, the Ishikawa diagram and the 5 times Why method [5x Why?] are used to study problems and find solutions. Kaizen focuses on small, regular and gradual improvements. Small improvements continually add value and improve productivity. Western companies tend to focus on innovation, which in turn makes big one-off leaps, but according to Kaizen, major reforms can easily lead to problems, so subtle, cheap, and many small changes may lead to better results in the long run.

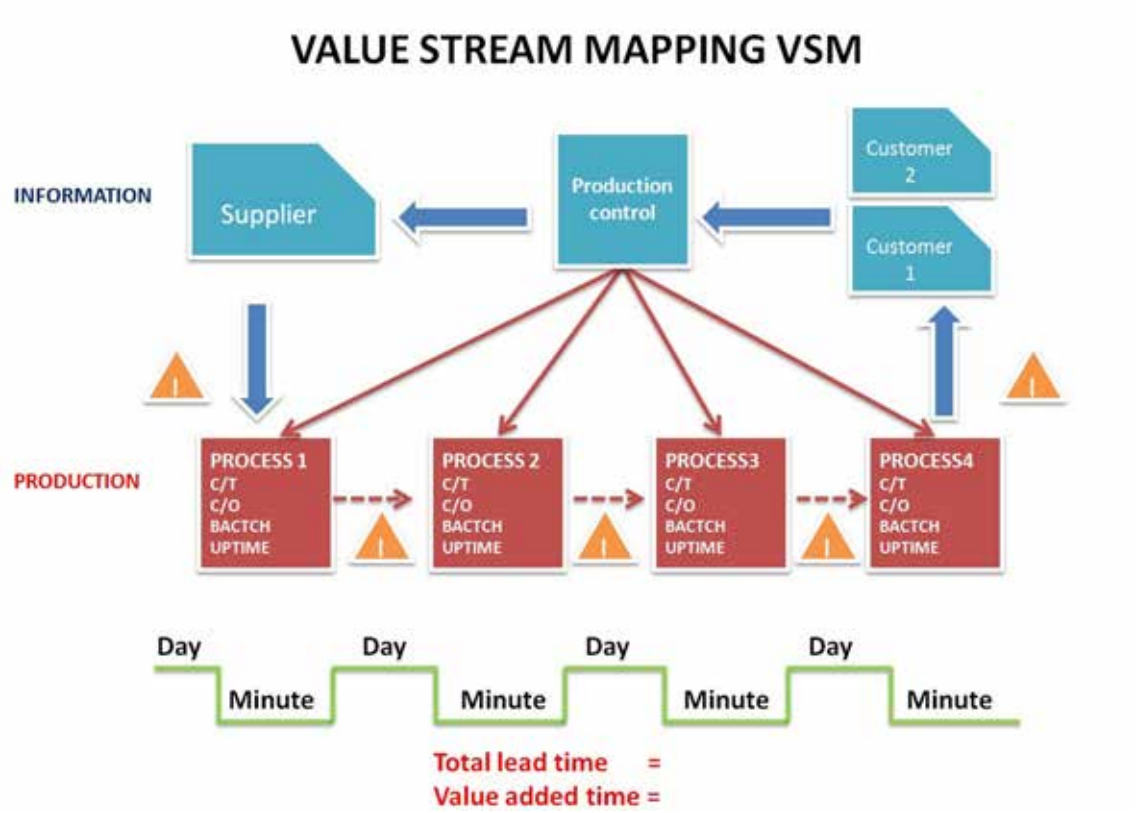
When manufacturing involves workers in addition to machines, human errors are always possible: these can be difficult to anticipate and cannot be completely eliminated even if the workers are significantly trained. Poka-yoke is a method developed by Shigeo Shingo, which attempts to get rid of human errors by using error gates. The most common uses of Poka-yoke are machine stoppages in the event of a fault and automatic repairs and warnings. Poka-yoke also helps with efficiency by allowing employees to focus on other tasks instead of watching the machine and increase quality through reduced error. This is a central scheme in terms of cell production.

During its visits to the United States, the Toyota team noticed the special process in which local supermarkets filled their shelves in a customer-oriented way. The customer arrives at the supermarket, buys the amount they need, and then the supermarket workers fill the shelves with new products. Supermarkets inspired Ohno to apply this approach to Toyota production. The subsequent process obtains the required amount of goods from the earlier process at just the right time. This finding underpins TPS's other guiding principle: customer demand-oriented pull production, Just-in-Time [JIT]. According to the JIT concept, each process produces only what the next step requires in a timely and quantitative manner. This is ensured by creating a continuous flow, setting the takt time and creating a pull system. At JIT, the key is to link the supplier network to a common strategy. Toyota has therefore been a clear pioneer in networking, and one of their key principles is to add value to the organization by developing people and partners. Continuous flow can be achieved in a variety of ways, ranging from portable assembly lines to manual cells.

Ohno was also influenced by William Edwards Deming, an American pioneer in quality control. The goal of the Deming method was to improve quality at every stage of the business, from product design to production and after-sales service. Deming taught that every step of the production process should be considered as a customer of the upstream, which was a perfect fit for Kiichiro's Just-in-Time philosophy and the Kaizen principle.

After returning to Japan, Ohno developed the concept of Kanban based on his insight. An example of this is the general manual control system, that is, when a box is empty on a shelf, it is a pulse to the person filling the box. The box is filled and the amount of material is read from the Kanban card and how many pieces are placed in the box and where it is placed after filling. Another frequently used pull control system works by marking the area on the production floor where the full pallet is placed. When the pallet is empty it means that it is the time to bring the new pallet to the next workstation. That is, the impulse comes from the customer's direction from the next workstation to the previous workstation. Kanban is a simplified information card that contains the information needed to make, assemble, move and complete an inventory; it manages inventory and prevents overproduction. The card always moves with the goods, sharing information and connecting processes. Essentially, Kanban is a buffer storage organization system and is a powerful tool that forces production processes to evolve, because without a functioning and reliable production system, Kanban easily causes downtime. A decrease in inventories implies a decrease in the capital requirements. Funds released from inventories are available either to streamline the company's financial structure or to be re-invested in productive activities.

Value Stream Mapping [VSM] is a qualitative tool that simply and visually describes the value stream production processes and the material and information flows between them. VSM aims to improve flow throughout the production chain by highlighting sources of wastage that are subsequently systematically and permanently eliminated. The value flow chart guides one through the current state of affairs and the work that moves through the organization from the customer's perspective. The VSM includes a mapping and implementation plan for the current state and the target state. While VSM can analyze and improve existing processes, it is a particularly powerful tool for new products and production lines during the design and launch phase.



Hiroyuki Hirano developed the 5S method at Toyota in the 1960s to improve quality, productivity and the work environment. The goals are pursued through workplace-specific organization, daily diligence and standardization. The method is visually based and puts employees at the center; everyone's participation is important. 5S is a five-step tool focused on organizing the work environment. The five S's are derived from the Japanese words Seiri (Sort), Seiton (Set in order), Seison (Shine), Seiketsu (Standardize) and Shitsuke (Sustain). Its principle is to cleanse and make visible. When loss and inefficiency are seen, these can be eliminated more quickly and efficiently. A well-organized work environment is efficient, comfortable and facilitates business development. 5S provides a good foundation and also prerequisites for adopting other TPS tools.

Set-up times are inescapable in production – still without any added value – and according to TPS, the time spent on set-up must be minimized. This form of waste is tackled by the technology developed by Single-Minute Exchange of Die [SMED] developed by Shigeo Shingo at Toyota to minimize setup times. Internal settings are steps that can only be performed when the machine is at a standstill. These are usually physical functions related to the machine, such as inserting or removing the product to be machined. External settings, on the other hand, are steps that can be performed while the machine is running, such as preparing the next part for machining. External settings are not counted as wasted time, so it's a task to convert as many internal settings as possible to external settings to save time. Once the settings have been identified and all potential settings have been externalized, the remaining internal settings will be refined and completed in less than ten minutes. While external settings are not to be wasted, these also need to be streamlined to free up time for other value-adding tasks.

The last TPS key concept we introduce is Genchi Genbutsu or Gemba Walkthrough. According to the philosophy, the best way to solve problems and identify potential for improvement is to go into production and walk through the processes. This is to ensure that we know for sure what are the key topics we're dealing with and avoid any false assumptions or guesses. This leads to better solutions as compared to a situation where solutions are only based on and derived from historical data and reports.

Western researchers developed the Lean concept inspired by Toyota's approach. Lean is based on Toyota's production system, which Western researchers explored in the late 1980s. They named their observations Lean and thus invented a new concept. Today, TPS is a well-known concept in Western countries and a model for many industrial and service organizations. For example, Krafcik (ex-Hyundai Motor US CEO with significant influence on Lean's conceptual development) found Toyota's unique approach to manufacturing capable of high productivity and quality. The production method was different from other car manufacturers who relied on the benefits of high-volume production and advanced manufacturing technology. In 1990, James P. Womack, Daniel T. Jones, and Daniel Roos published "The Machine That Changed the World," which brought Lean to wider public awareness.

Although Lean is created from Toyota's premise, Lean and TPS are two different concepts. The Lean strategy is the organization of company-wide operations that create efficient processes with minimal resources. Lean is a combination of various tools and methods that improve process productivity. Lean seeks to find value-added functions in processes, to put them in the best order and to execute them without interruption simply based on actual demand. The goal is to increase efficiency, do more with less, and give the customer exactly what they want. Generally, the words Lean and TPS are considered synonymous, but the difference is that TPS is a system specifically used in Toyota's car manufacturing and Lean is a refined management and production philosophy.

CASE PEMATIC OY
ROBOTIC WELDING OF CYLINDERS

In the above history as well as in the theoretical review, we wanted to provide a basis for examining the productive environment (including bottle neck removal), increased capacity, elevated quality, and reduced variation in quality. The following is a Case Study showing how we and our customer apply the TPS and Lean principles in solving welding and welding production challenges in Pematic Oy's production. Pematic Oy is one of the largest manufacturers of hydraulic cylinders in Finland and its production is located in the Muurame industrial area in Central Finland. Pematic is focused on very fast and flexible customer service and this is done in a cost-effective way: lean organizational structure and self-organizing teams, as well as a very quick turnover of working capital.

The cooperation started when Pematic Oy contacted BlackSmith Consulting Oy. The customer had identified a need for technical consultation regarding changes in customer needs and a quality improvement project. These challenges related to robotic welding of cylinders and the customer wanted external expertise and support in both analysis and improvement steps.

The project started in close collaboration with Pematic's production and focused on how to reduce the quality variation in cylinder production and, on the other hand, improve turnaround times. Here, for example, sensitivity analysis for key parameters was found efficient analytical instrument. At the same time, more attention was paid to more precise welding instructions and improving the skills of operators. These measures also resulted in improved welding economy and customer satisfaction. Welding instructions were approved through pre-production tests (SFS-EN ISO 15613) and operators were qualified according to SFS-EN ISO 14732.

The main improvements made during the project were:

- Modifications of groove types to make them more optimal and rational in terms of welding performance and welding technique. As a result, groove volumes were reduced and also additive material consumption significantly reduced.
- Increased welding speed by increasing wire feed speed / current. As a result, penetration and weld yield were improved and product turnaround times were reduced.

These changes improved product quality by reducing variation in the welding process. This improvement was verified in the course of a material inspection during the approval process for welding instructions (Macro sections).

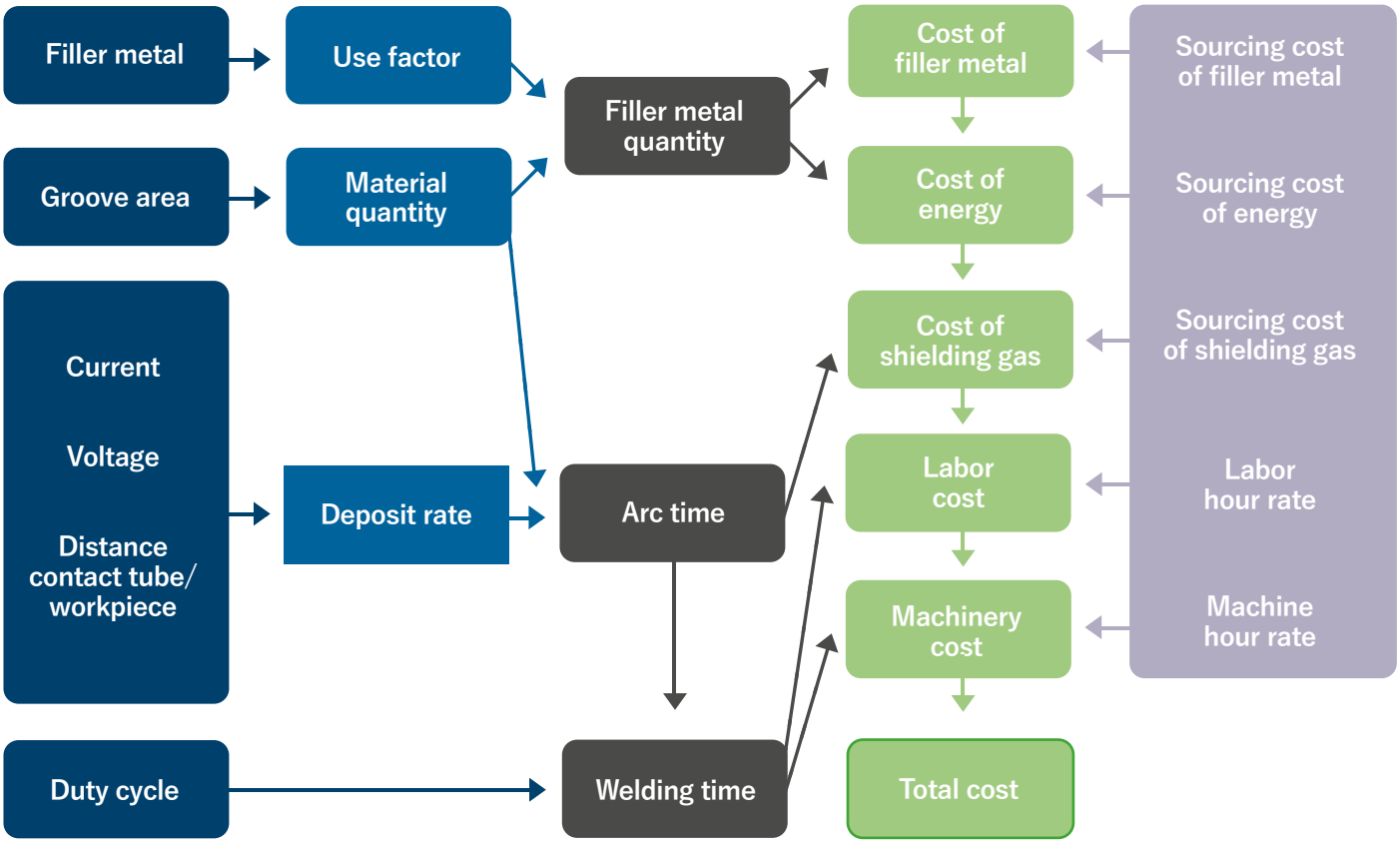
In addition to quality improvements, the cooperation aimed at increasing productivity. The optimization of the welding process enabled Pematic to improve the welding economy and also production to be made more efficient. An example of this is a 20% improvement in welding speed. With this practical example, we can demonstrate how optimization of the welding process can improve quality and productivity. This without losing sight of the educational aspect that seeks to improve the knowledge of welding economics among key employees of the client company.

"Pematic Oy is one of the largest manufacturers of hydraulic cylinders in Finland and we have been manufacturing cylinders for over four decades. BlackSmith Consulting Oy is an important partner for us. Our products operate in critical areas and continuous development, quality improvement and process enhancements are absolutely essential for us.

Further knowhow and competitiveness will continue to be formed through partnerships and interaction. We can recommend BSC Oy as a partner for this type of dialogue."

Petteri Nokkala, CEO, Pematic Oy

Algorithm of welding costs in MIG / MAG- welding



The purpose of this article, and following case study that concretizes it, is to help the readers to understand why flow efficiency is worth pursuing and, on the other hand, to develop the ability of companies to respond to changes as customer needs and competition continue to change. This can be accomplished by focusing on flow efficiency rather than resource efficiency, minimizing the risk of obsolescence, the need for inventories, and increasing productivity. In Toyota's example, increasing automation and robotics is not seen as a threat, but on the contrary: at its best, technological intelligence does not function as distinct of human being, a substitute for human labor, but in a mutual partnership. Working with BlackSmith Consulting can identify new ways to manage resources and reduce the risk of scarcity. The goal is to get rid of tool-orientation and abstraction levels, but just the opposite, while respecting company and industry boundary conditions to help to apply the suitable concepts quickly and efficiently. Sales, marketing and management will thus remain responsible for ensuring that the organization exists to address problems that are still existing so remain relevant to customers. The customer is no longer seen at the end of the value chain as its last step, but as its first step as the chain's initiator. Modern and pragmatic utilization of TPS and Lean Management form an excellent foundation to perform this efficiently.

An important part of the success of this project was Pematic's staff and we would like to thank everybody for their excellent cooperation.

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