R&E-SOURCE https://journal.ph-noe.ac.at
Online Journal for Research and Education
Special Issue 18, June 2020, ISSN 2313-1640

Accelerating manufacturing companies' response to changes in society

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Abstract

Approach to production and production planning is changing and evolving over the years according market needs. As the last-known methodologies can be regarded as LEAN production and AGILE manufacturing, each of these methodologies focuses slightly different direction. The methodology itself does not mean anything unless people use it. From this perspective should be the next evolutionary step or methodology focuses on people, because people make the difference between an ordinary company and successful company.
Therefore it is important to focus on educating people and employees, because they are co-responsible for the success of the business. Education should begin in the field of production and supply chain process at secondary school, because their graduates are often employees of companies implementing new processes.
Therefore this article compares and discusses the methods mentioned, in particular, from the application point of view, and suggests some ways that can help their successful implementation, e.g. changes in vocational curriculum.

Keywords:
Educational research (example)
Alternative teaching methods (example)
Teaching aids (example)

1 Introduction

These days, if a company wants to stay alive, it has do its best keep its competitiveness on both, domestic and foreign market. The pressure of competitive environment is greatly influencing the business activities, strategic goals and economic results of every company.

In the environment of business systems, the planning process requires not only increase of flexibility and adaptability, but development of mutual activities that create and bring values to customers. As a result, principles such as cooperation or integration of information and communication technologies are being highlighted.

The necessity and speed of companies' flexible reaction created the need of increased competitiveness by means of leaning the organization, increasing effectiveness, optimization of manufacturing capacities, decreasing stock and delivery times. For that reason, the thoughts in "Lean Manufacturing" (Womack, 2003b) and its broader version "Lean enterprise" (Womack, 2003a) recently became a "must have" of every business process.

However, changes in the supply chain are coming more and more often and the knowledge arising from consequences and manifestations of the present business environment brings out a question – how to properly define requirements on the global strategy in this environment, how to achieve even higher effectiveness and savings within the chain. For these purposes, an agile approach was defined as an alternative to lean operations (Richards, 1996), while the lean manufacturing systems are applicable in the constantly shaping global market. An example may be demonstrated on assembly plants in the final stage of product differentiation, since the impact of changes can be best observed here.

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In these operatively shaping conditions, discussions are led to create a combination of lean manufacturing that would be agile at the same time. This methodology is to be the key to company's success, and in literature, it can be found under a combination of both methodologies – **Leagile**. (Mason-Jones, 2000).

The aforementioned methods (**Lean**, **Agile**, and **Leagile**) should not be isolated within the supply chain, even though they have some contradictory traits. On the contrary, compromises between these methods might help the company.

A trait that is common to all three methods is the necessity of sustainability of the established system. Here, the focus is not on the methodologies themselves, but on the people using them.

The aim of this article is to use the comparison of these methods and imply and discuss possible ways of successful implementation and consequent sustainability of the companies' established system.

2 Mutual Relation of Lean Production and Agile Manufacturing

The terms leanness and agility should not be interchanged, since they may intersect each other. Such intersection may offer more significant effect than each of the methods separately (Christopher, 2000b). However, it can vary in each organization. It is therefore important to examine these methods and understand their benefit to society.

2.1 History of Lean Production

The foundations of Lean Production (LP) were laid in terms of the Toyota Production System (TPS), and introduced by Ohno (1988) in the *Toyota Production System: Beyond Large-Scale Production*. Lean Production is a mind-changing concept.

LP aims to remove waste and losses in the manufacturing system with a goal to minimize resources usage (Sarkis, 2001).

Pernica (2008) adds that the counterpoise to waste is creating values in the interest of the customer and a continuous process-oriented production using the Just in Time (JIT) and Pull principles.

The vision of "Lean Thinking" – transformation of mass production to lean production – is elucidated by Womack (2003b) as well. However, they tend to use the term Lean Enterprise rather than Lean Production (Womack, 2003a).

By adapting the lean thinking, the lean methods were applied in every business unit or function, i.e. from development to final production (Pernica, 2008). The centre of the lean production lies in many levels of manufacturing systems management. However, it ingressed into all related fields of manufacturing process, from Quality Control, through Human Resources, to Department of Logistics as a whole, to SDC (Supply Chain Management).

2.2 Fundamental Principles of Lean Production

The term Lean is often connected to implementation of "zero stock" and the JIT principle (Christopher, 2000b). The main goal is to systematically approach the identification and consequent removal of operations that do not add any value within the manufacturing process, thus offering better conditions to the customers. This system can be considered to be a very strong tool for elimination of waste in every organization (Womack, 2003b) The process is not just about eliminating waste, it also offers development of a chain of values (Naylor, 1999).

Regardless of the fact that most research points out that the increased competitiveness resulting from the Lean Production lies in the achieved savings, the aim of the Lean itself focuses on the psychics of a man and appropriate use of lean methods (Recht, 1999). Therefore, it is necessary to implement it in the whole company, thus change its culture (Wong, 2010).

The Lean Thinking that is a part of Lean Production can be summarized to five following principles:

- precisely define value of a product in product portfolio,
- identify the value stream for each product,
- make the best effort for the value stream to be without any interruptions,
- have the value stream directed towards the customer in a form of a line,
- try to achieve perfection of all the processes.

Appropriate understanding of these principles and its interconnection allows maintaining a balanced stated in the company (Womack, 2003b).

Currently, the Lean Thinking is widely spread in many industrial branches, where the value of coin is the main criterion (Hill, 1993). The Lean principles will work well in places with a relatively stable and predictable customer demand, and where the product portfolio is thin and the production volumes are high (Christopher, 2000a). However, authors' experience with solving various projects indicate that the principles of lean thinking and the selected methods can be applied practically in all production companies, regardless of the production type. However, it is necessary to be actively involved and have a high motivations of workers.

2.3 History of Agile Manufacturing

The term Agile Manufacturing is often connected with another development level of Lean Production systems and became a concept for further development of competitiveness of American industrial companies (Drucker, 2008). With its gradual development, Agile Manufacturing managed to expand itself into all related management disciplines: Agile Organization, Agile Enterprise/Company, operational management and logistics – Agile Logistics and Agile Supply Chains.

First mentions and constitutions of Agile Manufacturing are associated with publication of Iacocca Institute summary report (1991). Agile Manufacturing combines the Lean approach with flexibility, and focuses on individual inputs and outputs within the company, analyses internal processes and seeks ways of optimization (Sarkis, 2001).

Hai (2001) state that Agile Manufacturing is a typical representative of the highest level of current continuous development of manufacturing system resulting from the competition pressure.
Agile manufacturing focuses on savings within fixed production costs of similar products or their range. (Hormozi, 2001)

2.4 Fundamental Principles of Agile Manufacturing

The agility uses the knowledge of market and cooperation in a supply chain in order to gain profit on an unstable market (Naylor, 1999). Christopher (2000b) comments that in order to reach better reactions to the market demand, one needs more than speed, since a high level of process management is important as well. We can include logistic processes, organization structure, or information systems into these processes, but primarily a general company culture is regarded.

The main purpose of agile approach is the ability to react and use the changes in the market, such as unused production capacity, swift modification to a product according to the customer's demand, etc., meaning that the agile organization forms whole supply chains that are able to adapt to changes in demand, product or technology in a short period of time. Agile supply chain is a practical approach to organization of logistic capacities with regard to end customer's demand (Harrison, 2008).

The main features (Gunasekaran, 2001) of agile manufacturing can be summarized as follows:

- **Products**: Are a tool for satisfying customers' individual need and the agility lies in a switch change of the product needed by the customer.
- **Interconnection of the supply chain**: Partnership and cooperation towards the supplier may be considered to be a part of agile strategy. This approach enables bringing an agile product to the market in a minimal time with nominal costs.
- **Company culture**: The company must be able to quickly react to changes in the market. That means having employees that support this approach and that are able to act quickly.
- **Organization and knowledge**: A key for future functioning of the company are its employees and information. From this perspective, agility uses decentralization of the decision-making system, thus making a better use of human and information resources.

As the above implies, the real agility is formed by interconnecting processes within the supply chain, while the first area is the ability to read the market demand, which is not enough to set the processes, it is necessary to share these information throughout the whole value chain. If we take a look at the interconnection from the bird perspective, we will see that this interconnection and info-sharing forms a kind of network based on info-sharing and in this case, the stock and value of coin are secondary. (Christopher, 2000b)

The aforementioned implies that agility is not just about the company itself, but about the whole supply chain. And from this perspective, the agility can be divided into three layers, first represents the relationship with the customer, the second one represents the company itself, while the third one addresses the relationship with the supplier. The capacities, delivery times and other information are shared throughout the layers.

The agile methods are suitable for less predicable environment, where the demand is volatile, product portfolio is broad, the production volume is smaller, and where the primary motive is not money – a value tied to stock. (Hill, 1993)

2.5 History of Leagile Manufacturing

Although most of the literature defines the terms Lean and Agile separately, several authors Mason-Jones (2000), Christopher (2000a) addressed a mutual intersection. The goal is to find mutual connections between agility within the supply chain and leanness of the company as a whole. Knowledge of such relation is necessary when starting to implement this methodologies, since both of them should be implemented concurrently. (Mollenkopf, 2010)

Leanness and Agility are models that are not nearly similar to each other. Both have their advantages in difference areas and directions, however, both approaches may complement the other, thus enabling to establish a hybrid strategy (Christopher, 2000b). Such hybrid strategies may lead to creation of cost-effective supply chains (Christopher, 2000b).

2.6 Fundamental Principles of Leagile Manufacturing

Leagile Manufacturing is a combination of lean and agile methods in terms of the whole supply chain. It features a decoupling point placed to best suit the volatile demand and provide with comfort planning and source optimization. (Naylor, 1999)

Basically, it uses the Agile Manufacturing principle in facilities with unstable demand, and the Lean Production where demand is stable. The practical way of combining the Lean and Agile method may be for example when using the decoupling point. The purpose of such point is to make the chain lean before this point and agile after this point (Hoekstra, 1992). The method allows high productivity, low costs of production, and agile processes. The whole system can be perceived and set from two perspectives – time and costs.

Another perspective on this hybrid strategy may be dividing the portfolio into two parts, while the first part will relate to good prediction and stable demand (using Lean Production), and the other part is unstable custom production (using Agile Manufacturing), similarly to description of in (Mason-Jones, 2000).

Additionally, it is possible to divide the demand into the fundamental part governed by means of Lean method, and balance the deviations using Agile methods. (Christopher, 2006)

Regarding the frequency of changes in market conditions, this strategy will be modified several times during a life cycle of a product.

3 CASE STUDY

This chapter briefly outlines the implementation of leagile approach from the perspective of swift reaction to changes in the customer's demand.

3.1 Acceleration of reaction to changes

This case study refers to factory producing injection nozzles. The main products of this company are injection systems and their components for diesel engines; the company has approximately 1 000 employees.

The Leagile Approach was implemented, because the company transited the production from OEM customers to spare parts market. This change of market segment caused extension of the range of products and high variability of customer requirements that were difficult to predict. The impacts of this change greatly affected the production process and the fulfilment of customers' demands within the required time. During the current process, the production was not able to continuously react to changes of customers' demands, an unnecessary surplus was being produced, while the customers' demands were not being timely satisfied. Based on the above, the process had to be modified to make it more effective and able to adapt to changes in the market segment.

In the beginning of the change, the whole process had to be thoroughly mapped in order to define an area, where the increase of effectiveness will be most beneficial. There were several options to solve the situation:

- establish a warehouse for all completed products from the nozzle portfolio,
- decrease the continuous production time period,
- create the technological decoupling points.

Establishing a warehouse for all completed product may be the simplest and the fastest solution, however, considering the range of products containing hundreds of products, their storage would mean having millions worth of stock without any guarantees of sale. Therefore, this option was immediately refused by the company management. The decrease of continuous production time period and technological decoupling points were approved and further addressed.

In order to decrease the continuous production time, it was necessary start at the very beginning of the supply chain – at the input material. The first task to address was to establish a new way of communication and reference system with the suppliers so that they are able to react to the changes sooner. Then it was necessary to optimize the production process itself. This optimization consisted of two main parts – the first one was aimed at production that already started and its significant reduction in order to ensure faster passing through the individual production facilities. In this case, the Little's law and its application was used. The second part was addressing Lean – implementation of Lean methods and convincing the employees about the benefits of this solution. The 5S methodology was being implemented throughout the whole production system, management facilities started to use Kanban, and all employees underwent a thorough education to ensure mutual understanding of the implemented solution.

An appropriate creation of technological decoupling points turned out to be an effective agile methodology. These decoupling points helped to strategically distribute stock and control the key facilities. Similarly to Lean, a thorough knowledge of agility principles is necessary, as well as understanding of these principles by all employees throughout the whole company. The main attributes for setting the decoupling points are the technology and construction, while the technical department uses its newly implemented agile approach in order to create these points. In several cases, it was necessary to perform the change on the customer's side and implement the methodology there.

Thanks to this implemented methodology, in six months, the suppliers' reaction time with secured input material shortened from three months to one, the production process shortened from six to five weeks, inventory was decreased by 15 % and due to the decoupling points, the reaction time of customer delivery was shortened by another week.

3.2 Summary

When optimizing processes in the company, it is not appropriate to enforce only one solution, since the suitable method varies for each field of industry and the resulting effect is greatly depending on the implementers' approach.

As the application of Agile and Lean methods implies, by appropriate selection and combination, one may not just make the production process faster and more effective, but decrease the financial resources in a form of stock, and in case the suppliers and buyers are using this system as well, the effect of financial solution is far higher and the company may succeed even on an unpredictable and volatile market.

4 Selection of Methods and Their Integration and Sustainability

This chapter briefly outlines several observations and recommendations that may help to successfully implement the discussed methods.

4.1 Selection of the optimal method

Before the application of the method, it is far more important to choose the right method, since a successful application of wrongly chosen method may result in a state worse than the initial one. It cannot be clearly determined which methodology is better for the given company, since there are many influential factors that are changing with time. However, it is possible to use a detailed analysis of the products and find an optimal method that will be beneficial to the company.

4.2 Integration and Sustainability of the Methods

A change of company culture on all levels is important for an easy integration, while the most important cultural change lies in the top management. It is imperative that the company uses not just its resources, but its time and energy as well. One of the reasons why some efforts to establish these new methods fail is the insufficient involvement of the management. It is not just about initiating a controlled change in the company (Rais, 2012), but it is absolutely crucial for the company management to understand the philosophy of the given methodology and controlled the company processes in accordance with this methodology, thus supporting the cultural change of the company. The implementation of these methods does not lie in their simple implementation (Kanban, etc.), but in the understanding of the culture-changing philosophy.

In the following integration phases, it is necessary to include the whole supply chain into the process in order to ensure complex cover and complete and identical understanding of the problematic area.

Additionally, the sustainability of the methods will lie in understanding of the philosophy and change of culture as well. As Rais (2012) states, in connection with the controlled change, it is necessary to set control mechanism and continuously evaluate, whether the change reaches the desired parameters. In case a deviation is detected, or there are doubts regarding the new culture, it is necessary to make immediate remedies. Otherwise, the company might return to the initial state.

5 Preparation of employees for the choise of the method and its integration into the work process

As mentioned above, before we innovate the production process in the company we analyse the current state and needs of the company. This process is preceded by training of responsible employees who will implement the method. In order to achieve maximum potential it is necessary that all employees also identify with the new methods, so new values must be internalized. To make the internalization process as quick and smooth as possible, we recommend that employees across the enterprise have a basic understanding of decision-making processes. This skill is necessary for every person, because in everyday life we constantly analyse the inputs of events around us and try to maximize the profits on the outputs.

The decision-making process is a logical sequence of follow-up steps. The string begins with the identification of the problems and ends with the formulation of the decision. The whole process is complemented by controlling and giving feedback. These steps identify deviations between achieved results and predetermined goals. If necessary, we update and optimize the process based on their results. (Blažek, 2014)

Many employees perform this process intuitively, but it is advisable to teach them in a controlled way. As we said, this is a logical sequence of actions we perform. We will therefore be interested in logic, which is very close to mathematics. It would therefore be appropriate to strengthen the teaching of Mathematics by the basic principles of decision-making processes and logic. One of the parts where according to the Framework Educational Programs across secondary vocational education (according to ISCED 97 3A, 3C, 4A, 4C or according to ISCED 2011 353, 344, 354) is the educational field Mathematical Education - Curriculum: Working with Data. Then, of course, the heading Economics and Law - Curriculum: Management, but this is not common to all fields.

We are aware that such an implementation will have an impact on the hourly allocation of the educational fields concerned and their subjects. Therefore, we propose that the teaching of Mathematics be even more interconnected with vocational subjects. Teachers would thus share the same tasks that the students would solve from different perspectives and thus deepen cross-curricular links. The second variant is an extension course.

The extension course would be constructed in such a way that the core would be common to different fields and in the last part the course would focus on a specific field. The course would consist in five basic topics: Introduction to terminology; Process mapping; Process management; Process Optimization; Practical examples. Each block would be devoted to 4–6 hours, in total we would talk about 25 hours, which can be divided into three working days of eight hours. Courses would be of two types: Conducted in parallel with school education system and Conducted on taking up employment. The advantage would be that the student (future employee) would acquire knowledge and skills of a general perspective and more detailed in connection with their employment.

This concept, we are talking about business education, is currently applied during the initial training of employees, but to an insufficient extent, usually 2 hours of initial training. A more detailed elaboration of education will be the subject of a further contribution.

6 Conclusion

In current conditions, orienting on Leanness is no longer sufficient and the principles of Agility are joining the game. The analyses of company processes are crucial when implementing the methods. Yet the knowledge of fundamental principles of the individual methods, differences between them and their suitability are important as well. A mutual and important perspective is that these methodologies do not have their added value in simple implementation in the given company, but in setting a behaviour for the whole supply chain, where everyone solves the occurred problems and shares information with each other. It is therefore good to have interconnected indicators and goals within the chain, as well as functioning mutual partnership.

This area has a great potential for further research since each company works in a slightly difference way there is a huge amount of data and questions within the whole chain, while these questions and data must be evaluated in a controlled manner.

However, it should be taken into consideration that change of organization culture and understanding the philosophy is far more important than the implementation of methodology and principles.

It is equally important to prepare current students = future employees to be able to make decisions in everyday life as well as in the workplace.

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