The History of Lean Manufacturing by the view of Toyota-Ford

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Abstract—Manufacturing sectors and companies worldwide are successfully implementing lean principles within their processes. Nowadays, lean has become an indispensable part of global players. Recently, lean manufacturing have moved passed the automotive industry and conquered almost all suitable industries worldwide. Insurance companies, hospitals, even governmental organizations continuously improve their processes using lean principles. Nevertheless, there was a time when the implementation of lean principles within companies and their processes was not a necessary and/or competitive advantage. Where did the trend to a lean manufacturing world start and how was it passed through generations and nations? Who played a role in developing the set of tools offered today by lean principles and where are the origins of this manufacturing change? This paper addresses all of these questions and settles the roots of lean management. Moreover, it focuses on giving a brief and structured overview over the fundamental points and key players of the lean history and evolution.

Keywords— lean principles, lean manufacturing, lean management, Toyota, Ford, productivity, Utilization.

1. INTRODUCTION

Lean manufacturing, lean production or often simply Lean, is a production practice that considers the expenditure of resources for any goal other than the creation of value to be wasteful and thus a target for elimination. From the perspective of the customer "value" is defined as the price for which the customer would be willing to pay for. The lean concept is not a new one, originating from the end of 19th century and the beginning of the 20th century, with the development of the production systems by Henry Ford and other producers. A brief overview over the evolution of lean management over the years is offered by (Figure 1). Key contributors to the evolution of the lean concept such as Eli Whitney, Taylor, Gilbreth, Henry Ford, Shingo and Ohno will be mentioned and discussed in the following chapters. In today's competitive world, there are so many companies who actually develop their own area with few resources. And at the end, they need more beneficial from the manufacturing of the product department. Means there are so many businesses, which opted few resources to get more benefits from it. One of the best ways to increase the effectiveness and efficiency of the product is to adopt the lean management technique. The manufacturing service, for profit, not for profit, education and health businesses can be improve through the help of this technique. There are number of businesses, which depend on the small industries. So the big industries are using fundamental components to define their importance in a different way. Different industries have been implementing the lean approach for producing better product in less time with fewer efforts [1],[2].

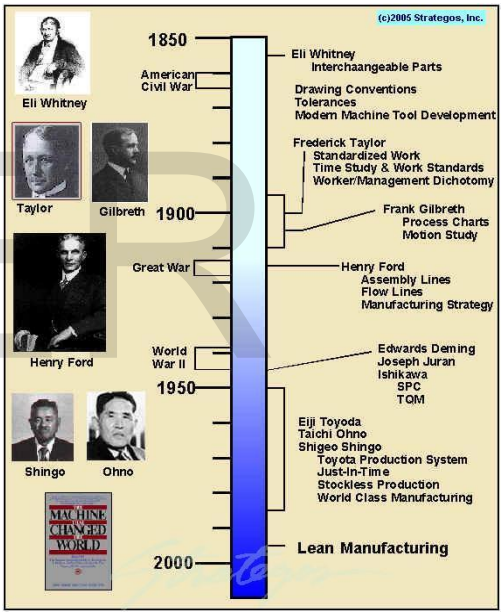

fig. 1 History of the lean manufacturing

2. THE ROOTS OF LEAN

Starting with the 1980s, many models of business have been developed to teach and show managers how to run their business. Many of these models have been conceptually sound; nevertheless just few offered a sustainable and solid basis for implementation. For many years before, managers, consultants and academics have struggled with the thought of how to change, improve or replace existing business operations and processes. Most of the companies lacked in a toolbox of techniques on how to improve their businesses and successfully conduct a transformation process [3]. Therefore, during the late 1980s, many companies have taken Japan, as a rising manufacturing nation, as an example. Companies like Toyota, Nissan, Sony or Honda

started to gain market leadership not only in the Japanese market but also in North America and Europe. The sudden and rapid rise of these companies set a quest for other market players, consultants and academics to find out how these companies designed, implemented and operated their manufacturing systems. These processes were to be called "lean production" processes. The origins of lean can be traced back to the American fears that the Japanese manufacturing companies within the car industry would take over and gain an unbeatable competitive advantage. These fears drove academics and Western competitors to conduct a series of benchmarking activities in order to reach the roots of the Japanese success. The first results were published altogether in the publication "The Machine that Changed the World by Womack, Jones and Roos" in 1990. For Western manufacturers this text provided the first written data concentrating on the Japanese success and on the huge gaps they would have to overcome in order to reach the Japanese success. The authors found the Japanese manufacturing model to use not only less effort, but also less of any resource invested in the manufacturing circle: fewer inventories, less space, less capital [4].

3. THE EVOLUTION OF LEAN MANAGEMENT – A CULTURAL TRACE

The evolution and history of lean management can be traced back using different determinants. Nevertheless, the following chapter focuses on offering a cultural standpoint of the history of lean management over the years.

3.1. The American contribution

Eli Whitney and his concept of interchangeable parts made the first step in the Lean production development and Just in Time (JIT). He became famous after inventing the cotton gin, but this was a minor accomplishment compared with the development of interchangeable parts, a concept that would later become the basis of industrial evolution [5]. It must be known that not Whitney created this concept of interchangeable parts, but it is mentioned long before him, since the time of Chinese emperor Qin Shi Huangdi (221 B.C.) who ordered the manufacturing of standardized parts for the crossbows, parts that could be quickly changed on the battlefield. Whitney improved this concept in 1799 when he took a contract from the U.S. Army for the manufacture of 10,000 muskets, for the Quasi war, at the unbelievably low price of $13.40 each. The concept of interchangeable parts was later applied in companies as Cadillac, Chrysler and this led to an increase in both production volume and speed. With the evolution of interchangeable parts concept in America, until 1850, all the armoires were producing standardized metal parts for standardized weapons but with large effort of manual work in order to make every piece right. This was due to current technology at the time, which did not allow the processing of hard metals. The army but accepted the costs but the clients did not. Yet, no armories were concerned with what was happening between processes, how many multiple processes were taking place in order, how the chain processes functions as a system and how each worker went about the task.

This operation changed at the end of the 1890's with work from the first industrial engineers. A representative of these engineers was Frederick W. Taylor. Taylor focused on analyzing workers individually and their job methods. The result of this analysis was Time Study and Standardized Work. He introduced his ideas in a new management class called, "Scientific Management" or "Taylorism." The main purpose of his ideas was economic efficiency improvement, especially in the area of productivity [6]. The title of this practice was controversial because the idea of introducing the science in management was revolting. Taylor ignored the attitude of those around him, focusing on the workers for better analysis and process time reduction. Shortly after Taylor's Time Study another representative figure, Frank Gilbreth, added his contribution into Lean history with Motion Study and Process Maping. Apart from Taylor's philosophy, efficiency by reducing the length of the processes, Gilbreth, through Motion Study, intended reducing the workers movements during the production process (ergonomy). In his vision Gilbreth was after the workers wellbeing, while Taylor was after the profit. Gilbreth's second contribution, Process Maping, focused on all the process elements, even on non-value added ones and which usually were classifications of official elements within the process. The main benefits of Process Maping are: waste exposure, revealing the process-flow, defining and standardization, and encouragement towards a better understanding of the processes [7].

F. Gilbreth's study was closely supported by his wife, Lilian Gilbreth, through the introduction of psychology in this field. By adding psychology to the mixture of ideas, Lilian studied worker motivation and how it affected attitudes and process results. F.W. Taylor, Frank and Lilian Gilbreth, alongside other contributors, created the idea of "eliminating waste." This idea stands as one of the principles in JIT production system and Lean production. Henry Ford, the founder of Ford Motor Company, made a major step in the evolution of Lean. Ford's vision was to build a car for the great multitude. Thus the electrification of steam engine and the new production and management techniques, allowed him to take the 20th century production to a whole new level and produce the famous

"T Model" in only 93 minutes [8]. Therefore, starting with 1910, Ford together with his right-hand, vice president Charlie Sorensen, created the first Intelligent Production Strategy. They took all the elements from the production system—people, machines, tools and products—and arranged them in a continuous system for the T Model production. We can conclude that this was the first systematic approach of a process-flow. Ford's management approach was strongly influenced by the F.W. Taylor's theory of Scientific Management, published in 1911. Although Scientific Management allowed Ford to increase his productivity, this production system wouldn't survive against the future Japanese competition. Ford's accomplishments had a major impact on competitors, resulting in many unsuccessful attempts from other companies. Failure was caused by the inability to understand the basic principles and apply Ford's methods.

3.2. The Japanese contribution

While Ford's mass production system prospered during the period economic growth in America, Toyota Production System (TPS) was proposing another system of standards for obtaining maximum economic efficiency with minimal resources. The TPS's key was to eliminate any kind of waste. This meant any activity that didn't add value to the product: overproduction, stocks, transport, waiting time, stocking space, maintenance/errors, and supply time. The approach of this basic TPS principle was made by continuous improvement of the standards. Significant differences between the two companies were the means by which they would alter the standards. Ford was using his industrial engineers to define work standards, while Toyota was passing this responsibility to the workers in Gemba (the production area) [9]. Taiichi Ohno, Shigeo Shingo and Eiji Toyoda developed the Toyota Production System between 1948-1975; originally it is being called Just-In-Time Production. However, for a better understanding how Toyota came to this system, the company must be analyzed from the beginning. In the first decades of the 20th century, the local automobile industry in Japan was poorly developed, so the production was relatively small. This changed in 1925, at the same time with the entry of the Japanese market as automotive Ford Company and also with General Motors in 1927. U.S. automobile companies in a short time (to 1934) covered Japanese automobile demand with 92%, while Toyota owned a percentage of only 3%.

In order to fix this situation, the Toyota automotive branch (Toyoda Automatic Loom Works Ltd. at the time and later became Toyota Motor Co. Ltd.), led by Kiichiro Toyoda, the son of the founder of Toyota, Sakichi Toyoda. He performed research in automotive engines and in the autumn of 1934, the first prototype of Toyota's engine was manufactured. Also, Kiichiro encouraged the leadership to visit American auto manufacturers in order to improve Toyota's mass production system with visualization. All efforts made by Kiichiro culminated from the introduction of the first Model A1 car prototype in May 1935. However, all these efforts made by the Japanese seemed useless when compared to the development of American the giants. The American domination ended in 1936 with the introduction of the Enterprise Law automobile which planned the closing the Americans factories and subsidized three big Japanese trucks producers companies: Toyota, Nissan and Isuzu. At this point the Japanese automobile industry had to develop freely without falling behind of U.S. companies. Toyota tried to introduce the American mass production system in the factory from Komoro. However, this system had to be adapted according to both that time period and the existing production system. The intention was to use creativity in the development of a Japanese production system from a cultural and economic perspective. These efforts suffered resistance from employees, whom were still guided by the traditional production techniques with the Ford system.

The crucial moment in LEAN concept evolution was the decision made by Toyota to improve productivity from the inside. This decision was made due to the financial situation after the Second World War, which meant cancelling the modernizing of production equipment. To achieve an internal improvement, Toyota combined Taylorism elements (standardization) with specific company. These elements included production flow, multitasking and establishment of the production system. The results were better than expected. Production had grown so much that it reached overproduction. This lead to a production of waste, that TPS personally tried to eliminate and place the company into possible bankruptcy. The company solved this issue by delivering automobiles to the American army during the Korean War. Another step towards progression made by Toyota was the arrival of two great Quality Management parents in Japan: Edwards W. Deming (1950) and Joseph M. Juran (1954).Deming made himself known in Japan with top management instruction by introducing Statistic Quality Control (SQC) and defining the famous "Deming circle": Plan, Do, Check and Act. In the eyes of the Japanese, Deming was a hero by putting a solid foundation on Japanese quality [10]. Juran, the second player on the Japanese quality scene, made his appearance in 1954 bringing essential contribution in the areas of:

- Defining the Quality Management System, which is a basic requirement for every company producing material goods and services?

- Using the Pareto principal in control quality. It must be remembered the Pareto principal was created in 1906 by the Italian Vilfredo Pareto who observed that 20% of Italy`s population owned 80% of its territory.
- Non-quality cost study: "Juran Trilogy" defined quality components like planning, control and quality improvement [11].

At the end of the 1950s, Toyota introduced a stock gestation system named Kanban, in translation "card" which was supposed to reduce the waste created in stocks [12]. As a result of the TPS success, Toyota was supposed to invade the American automobile market and place themselves amongst top companies like Ford and General Motors. Another factor that contributed to Toyota`s company development and the LEAN Management, was the Japanese engineer Shigeo Shingo. Shingo created the SMED method and the "Non-Stock Production" system. This system was created in 1975 and means cutting the strings of the stock products and the necessary space and their cost [13]. Single Minute Exchange of Die (SMED) is a method applied for the first time in Toyota Company and follows a reduction in the setting time of equipment. The method was successful, with the setting time being reduced from 1-2 hours to just a few minutes. Related to this method is the "6 Sigma" concept developed by Motorola in 1985, which came to the world`s attention in 1995 when it was introduced by General Electric company via Jack Welch. 6 Sigma improves process quality by identifying and eliminating defections.

4. CONCLUSIONS

Comparing the Japanese and the American contributions, we can conclude that the American contribution resulted in a spectacular productivity growth and decrease in price. These two factors lead to wider product accessibility for customers. On the other hand, the Japanese contribution leads to the elimination of waste and reducer of resources within the automotive industry. Lean nowadays, continues to spread not only to every country worldwide, but has settled its roots in Europe. Successful companies are adapting and implementing lean principles beyond manufacturing. Despite the origins of lean manufacturing being the Japanese car and automotive industry, lean has gathered appreciation not only worldwide but also industry wide. Lean principles are spreading knowing no industry barriers from logistics and distribution to retail, construction and even healthcare and government institutions. The goal is to improve the organizational performance on all operating levels by trying to eliminate all kinds of unneeded or wasteful activities. The biggest challenge nowadays remains the managerial question of what tools and principles to use and how to apply them. Differences in culture, industry and infrastructures make it impossible for managers worldwide to implement the same lean tools and principles that once worked in Japan. The approach must be held under continuous improvement and must be tailored to the realities of each specific company, industry and country.

Currently in Europe the great promoters of this manufacturing system are companies like Porsche or Daimler. Suppliers of these companies already entered the Eastern European markets. Moreover, there is valid market information about further investment strategies of automotive suppliers in countries from Eastern Europe. When looking at a country like Romania, the increasing concerns of the industry for lean manufacturing is underlined not only through the increasingly lean implementations in manufacturing companies but also through the emphasis on empirical research in this field. Higher education institutions in Romania and Eastern Europe are adding lean management disciplines to their curricula in order to educate specialists. Last but not least, the number of conferences in the area of lean management and manufacturing, as well as the number of consultancy companies is increasing rapidly throughout all Eastern Europe.

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