How to build up a Lean Production Systems

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***Abstract*—** The article is focused on building lean manufacturing systems. Certainly it is not possible to design a universal method which will be valid for all businesses. When you create your own system it is always necessary to consider the specific and unique conditions, which are undoubtedly the size of the company, the production program, the company culture or way of proceeding. However, we can define a number of principles and recommendations which we can direct use on the right path for a functioning system of production. And this is the main aim of this paper. They are presented the various methods and tools of the modern industrial engineering, which is suitable to used in the individual stages of building own production system.

These methods are not focused only to the production, but we must also take into consideration support and service processes. Without consistent synergy of development, production, logistics and administrative processes is not possible to build a functioning production system. Strong emphasis in the article is not given only on the methodology, but also a practical demonstration of building a lean manufacturing system in terms of a specific enterprise.
Therefore, the article is supplemented by at the end of the case study that is focused both on the methodology, as well as the declaration of the benefits arising from the implementation itself.

***Keywords*—**Lean Manufacturing, Wasting, Visualization, Standardization, Utilization of Machinery, Production System.

I. Introduction

BUILDING your own production system is not a matter of days, weeks or months. It's a long run that lasts for several years. But we are talking now about the production system in its true meaning, it means a functioning production system. We have come across many companies that "built" their production systems in a few days. Actually, for them this expression meant only a set of methods such as 5S, SMED, VSM, TPM, etc., that were visualized and described in the booklet entitled "The production system of XY company". From our point of view, this is definitely not what a production system should be. A system can be interpreted in many ways and thus the understanding of the production system can be completely different, as it is demonstrated by the following example. When the couple of Czech managers visited several Japanese companies, they also happened to discuss production systems during their talks. Not even thirty years old Czech manager, during the interview with his Japanese counterpart in his 70s, didn't want to fall short and said: "I have already established a production system in two companies." And the Japanese colleague responded: "In our company, we have been trying to achieve that for more than 10 years and I think we still have a long way to go." It naturally raises the question: What represents the lean production system and how we should understand it? The production system can be defined as a set of methods and tools that aid in the way of the high quality and productivity of labour through continuous process improvement and reducing unnecessary waste of natural, human and corporate resources. But it is certain that the methods and tools are not as important as functioning processes => efficient production => functioning organization.

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II. Building up A Lean Production System

The approach now known as lean production has become an integral part of themanufacturing landscape in the United States over the last four decades. Its link with superior performance and its ability to provide competitive advantage is well accepted among academics and practitioners alike e.g., Krafcik [2], MacDuffie [3], Pil and MacDuffie [4] Shah and Ward [5], Wood et al. [6]. Even its critics note that alternatives to lean production have not found widespread acceptance for example Dankbaar [7] and admit that ''lean production will be the standard manufacturing mode of the 21st century''[8].

Lean production uses half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. It requires keeping half the needed inventory, results in many fewer defects, and produces a greater and ever growing variety of products said Womack Jones and Roos in their book entitled The Machine that Changed the World [14].

If we will compare the earliest publications related to Japanese manufacturing/production systems ending with the most recent publications related to lean production, we can say that: the early Japanese books were more precise in defining Toyota Production System and in identifying its underlying components for example Monden [9] and Ohno [10] compared to the research articles because the latter focused on defining and describing specific components of the system rather than the whole Sugimori [11] and Monden [12]. Shah and Ward [13] in their article evaluated time line marking the critical phases in the lean production evolution, from 1927 (Philosophy of Henry Ford), cross progress in Japan (1945-1978), Toyota Production System in North America (1973-1988), academic progress (1988-2000) till present.

If we will ask how stabile the lean production system of the company is, we can find different answers. The lean production system is fundamentally a fragile system, in which slight perturbations or deviations from the working conditions planned for can seriously affect system performance, because of the considerable reduction of resources the lean production approach implies [24]. It is not difficult to imagine what the implications of this are, in terms of stress, for all the firm's resources. Think, for example, of the way the work force is involved, a work force which must be both qualified and willing to collaborate. In more general terms, at this first level, the relationships between the interventions in the different functional areas, the way in which actions are taken, the links between adoption of best practices and the firm's performance all have to be studied in depth.

Many companies think that they are absolutely unique and absolutely different from others. Often, especially related to the implementation of Lean production, we hear plenty of arguments why it is not possible in their company. Usually they use to defend themselves with the most clamant argument that they are different because they are no automotive company. Well, is there any general advice for companies or every company is indeed distinctive and has to build its production system on completely different principles?

In our opinion, there is one thing all enterprises have in common. Leaving aside the economic crisis that actually affects more or less all of us, there is another evident and irreversible trend emerging in recent years. It is the individualization of the product and its short life cycle. This obviously brings along increase in variability and small batches in production. Let's add to that also the difficulties with predicting customer demands, high standards on quality and speed of delivery, and we get a real picture of the market. How to respond to the situation? How to deal with it? The answer is flexibility. Only a flexible manufacturing system can satisfy the requirements of current customers and it does not matter whether we operate in the automotive industry, mechanical engineering or food industry. Lean production system = flexible manufacturing system. Flexible manufacturing system represents the ability to produce and assemble any product range in any order and quantity. What we mean by flexible manufacturing system is shown below in the table 1.

Flexible manufacturing system cannot exist without rotation of the workers. Pérez and Sánchez describes this pillar in their article entitled "Lean production and supplier relations: a survey of practices in the Aragonese automotive industry". Table 2 indicates data of task rotation practices in the surveyed companies. The rotation of tasks is one of the measures that contribute positively to the functional flexibility of the workforce [26]. The workers learn a greater number of tasks in their workplace that enables them to substitute other workers in illness or in other ways. The rotation of tasks facilitates the running in the production process when any substitution is required and allows absorption of peak production periods in the company. The rotation of tasks enriches furthermore the content of the work [26].

Production mix	How many types of products are we able to produce in the production system? How quickly can we switch from one type to another?
Output	How much volume are we able to produce in the production system? How quickly can we respond to the increase in orders?
Facilities	How many types of operations can we handle with current production facilities without further investment?
Employees	How many different activities can employees handle in the production?
Start-up products	How many new products are we able to implement without a change in our performance? How quickly does it take for launching a new product?
Tact	In how much different tacts are we able to produce?
Layout	How many variations of workplaces are we able to create in the workarea?
Manipulation routes	By using how many different routes can we manipulate with the products?
Transport of products	How many types of products are we able transport from point A to point B?
Packaging of products	How many types of products are we able to pack by the use of the equipment?

Tab. 1 Ten elements of flexibility of the production system [1]

	Component manufactur-ers (*n*=16)	Subsystem manufactur-ers (*n* =12)	Total sample (*n*=28)
Percentage of companies with task rotations	93.75	91.66	92.85
Number of employees who participate in task rotations	590	562	1152
Percentage of companies with task rotations where there has increased the number of participant employees in the period 1997–1998	73.33	63.63	69.23
Percentage of companies with teamworks	62.50	83.33	71.43
Number of employees in teamworks	132	607	739
Percentage of employees who participate in teamworks	5.30	28.83	16.09
Number of proposals received in 1998	242	408	650
Number of proposals by team member and year	1.83	0.67	0.87
Percentage of savings to sales made with the proposals received	0.35	0.24	0.29
Percentage of employees who participate in task rotations	23.71	26.69	25.08

Tab. 2 Functional flexibility of the workforce [26]

III. Let´s Learn From The Best

Certainly, it does not make sense to invent something that has been already invented and testing during decades. Apparently it is not possible to copy a production system literally "from one to one" and then wonder about its unsuccessful application and dysfunction. However, why shouldn't we draw inspiration from the best in the area? And it definitely gives a lot of sources. When you say production system, many people imagine only the Toyota Production System (TPS). We don't even have to go that far. A brilliant businessman Tomas Bata, coming from Czech Republic, introduced original production system in shoe industry. The whole system of production and management of company, which brought him to the peak in production and sales, are timeless, complex, and we can still get inspired by them. First of all an endless effort for the continuous development of employees who afterwards contributed to the improvement and rationalization of the process and to the increasing of labor productivity could still serve as a pattern for today's businesses.

But let's go back to Toyota. What is the secret of so successful production system that thousands of businesses around the world try to implement? What principles is the Toyota Production System built on? First of all, we must realize this production system was based on many years of cooperation among production managers, production workers, suppliers and customers. The whole idea is consists of elimination of wasting, and not only in production. To achieve this, Just-in-time and autonomy in production has been applied as fundamental Toyota principles. The aim of Just-in-time method is to manufacture the right product in the right time, right place and the right quality. Autonomy (also known under the name Jidoka) essentially means the transfer of human activities onto the machinery so that the operator doesn't have to continuously supervise the equipment any longer.

Human resources have taken on a strategic role in carrying out the continuous quality improvement plans which are the basis for success in the lean production model [17]. A lot of attention has also been devoted to the study of the relationships between product development and manufacturing [18]. All practices which seek to improve product manufacturability and assembly (such as product simplification, parts standardization, modular architecture of the product and mushroom concept) play an important role in adopting advanced production methods [16].

IV. The Basic Pillars of Modern Production Systems

How to build your own production system? How to start? How to proceed? Which methods to use? What to build a production system upon? These are the questions almost every company asks. When establishing a modern production system, we cannot omit using some fundamental building stones. Firstly, we must definitely focus on the identification and elimination of waste. Secondly, we have to work on a visual management and standardization, maximum utilization of machinery, towing systems, flexible layout of production, simulation of manufacturing processes, mutual synergy in development, production, logistics and administration, and ultimately on a performance policy and focus on goals. Due to the nature of this publication we can't analyze in detail each of the pillars, so let's have a closer look at some of them.

What say experts and managers about basics techniques and tools of lean production? Lean tools, such as statistical process control (SPC) [22], failure modes effects analysis (FMEA) [23], single minute exchange of dies (SMED) [24], fool proofing and process mapping [25], involve mainly explicit knowledge, which can be codified. These techniques are well documented and are relatively easy to learn from the literature. However, other tools such as total productive maintenance (TPM), Kanban, 5S/5C, standardised working and policy deployment require mainly tacit knowledge [21] to apply them, which makes them difficult to implement without support.

For example the general manager of international purchasing for Toyota commented that the ideas behind the Toyota Production System (TPS) have basically diffused and are understood by our competitors. But the know-how regarding how to implement it in specific factories and contexts has not. I think we are better at learning'[19, 20].

A. Identification and elimination of waste

Based on our experiences, a space is in many companies often ignored. It was Toyota who created their own production system based on this principle and achieved therefore a significant competitive advantage. Most of the managers and also production workers are fully aware about seven, actually eight main types of waste that were defined by Lean Manufacturing Guru Taichi Ohno. The problem is that in our own workplace, on our own production line, in our own company, we don't see the waste or maybe we just don't want to see it. Now we can try to figure out what exactly waste means.

Waste can be described as anything that raise the costs of our product or service and doesn't add its value. If we give this definition a deep thought, in a second we can come up with tens of examples. You just have to keep on looking around you carefully and critically with focus on identification of waste. After a certain time man suffers with so-called professional blindness and stops noticing defects. But you can deal also with that. There are many companies where industrial engineers or Lean coordinators wouldn't work with one production line for more than half a year. Moreover, they keep on switching between various lines, processes, technologies. Another option is constant training and educating in this area. Mostly a shooting of a video of each type of waste is enough, then workers should watch it together and discuss, and success is guaranteed. Only a video footage can reveal during the operation processes is produced and one naturally asks a question: Is it even possible that we are working like this? In most cases the only thing needed you need is common sense and sharp eye, so that you can identify the waste easily. Identification itself is usually not enough; the next step is to quantify the waste. This is usually ignored, and yet, it is the most important aspect in decision-making process. We have witnessed many times that an industrial engineer went to his superior and said: the worker during the assembly walks too much; we need to reorganize lay-out. The manager reacts: At first I want to know, how many unnecessary steps the worker does, how many costs it means for us in one year and how many savings there will be after a new lay-out is made.

If we can't calculate the waste and we are not able to define savings, which we can achieve by waste elimination, it is almost meaningless to bother with its identification. But if we could, we would find a lot of opportunities to enhance performance, and not only the in production area. Similarly to the production, we can also identify wasting in logistics, administration or pre-production phases.

B. Visualization and standardization

Another widely ignored element is visual management and standardization. Companies would like to implement complicated systems, but they forget to apply these simple and most basic steps. Even in spite of the fact that there exists a fairly simple and elegant solution hidden in the permanent implementation of the method called 5S. Of course, we mean 5S in its true sense. This method is not only about „cleaning up“. If it is understood like this, it is not surprising that most people are not enthusiastic about it and doubt its real benefit.

This method deserves to be understood much deeper. With its consistent implementation we are able to remove basic types of waste, we can define lay-out, standardize production system, increase the quality of the production, reduce the necessary for training a new employee, save the space, prevent tools searching, secure order and cleanliness in the workplace, and last but not least to improve company culture and create conditions for further improvements and optimization. If only we had set clear and equal standards for all workers, we could undergo steps for further improving the efficiency of performed activities.

C. The maximum utilization of machinery

As Thomas Bata used to say:„the driving forces of every company are people“. It's for sure we will always need machinery and the costs of its purchase and operating are not low. So we have to try to use them as much as we can. The best global companies achieve the effectiveness of machinery around 85-95%. What does this number mean and how can we to evaluate the usage of the machinery the most accurately?

Nowadays, the most widely used and, with no doubt, also the most objective evaluation method is the index OEE (Overall Equipment Effectiveness). The advantage is that this index counts with overall available time of the machinery, real speed of the machinery and its qualitative level of production. It provides a manager with information which is the result of multiplied availability, speed and level of production quality. So he doesn't have to make his way through lots of excel tables, in which he would separately watch the machine downtime, quality of the production or percentage of the delayed orders. However, the information itself or observation of the effectiveness of machinery doesn't solve anything yet; the goal is to constantly increase the value of this index. How to manage that? It is important to constantly watch the downtime reasons or reasons of quality issues.

These problems, their causes and corrective actions should be used afterwards in action programs for increasing the OEE index, for example by means of moderated workshops. Generally we can say that you will always run into problems related to equipment failure and downtime when switching to another type of production. In this aspect, implementation of TPM can be really helpful. It means a systematic method focused on increasing the effectiveness of machinery by establishing a complex system for maintenance involving both service and custom operators. To reduce the time between finishing the last piece of current type of production and creating the first piece of the next production, i.e. the cast time, we use a method called SMED. This method is based on reducing the time of the intern cast (time when the machine is off) to a minimal value by means of systematic procedure defined in advance.

D. Flexible organization of production

As mentioned already, flexibility is nowadays considered as one of the most important aspect of pure Lean production systems. Times, when production was dedicated to huge and heavy machinery and one-purpose assembly lines, are gone for good. Flexible production can be built only on small, mobile machines, which can handle as big product range as it is possible, and all this should be carried out with minimal time needed for their cast. We must be able to complete various types on one production line as well, fluently and in various orders. One example of perfect flexibility can be demonstrated in a production cell of one company from the automotive area. This production cell can produce 5 different types of product, each in different production volumes. And what is the secret?

The whole cell is organized in U shape so that the distances in case of serving multiple operations by one worker are minimized. Cell occupation changes due to customer requirements. Actually, there are three possible variations of workplace organization and operations between operators. It places very high demands on flexibility of workers who are able to work on 4 different job positions at least. If the product type changes, they can react with 3 types perfectly and another two types require only slight changes in lay-out and the input material. Considering that the workplace is on wheels, the whole operation cannot last longer than 5 minutes.

Flexible organization of the workforce and the workplace in order to accommodate the modifications in the level and in the variety of production is typical pillar of Lean Production system. A flexible organization of the workforce can be obtained in a simple way by increasing the percentage of part-time and temporary workers — numerical flexibility. However, this measure is not always compatible with a closer supplier involvement in component design as said Kaplinsky [29]. The numerical flexibility even becomes inadequate when the production system has to face quality requirements, customization, continuous innovation and product differentiation. Then a flexible workforce requires some organizational measures — functional flexibility such as the rotation of tasks or the polyvalence of the workers. Both these measures require a training effort in the companies. A recent study for example from Eurofound [30] indicates that 81% of the workplaces in Europe have some sort of workers involvement in the decision-making process, even though less than 4% used teamworks regularly. It is possible to say, that this section of the paper collects the results of the survey related to the flexibility and to the training in the workplace.

E. Interconnection with pre-production phases

Another very important aspect is the interconnection of the production system with pre-production phases. Building a manufacturing system is much easier when the above described principles are respected in the phase of product design and its implementation into production. The simulation of the future state of production is now absolutely common part of modern manufacturing systems.

This is the reason why simulations are great to use to detect potential reserves in the processes, instant planning verification and the eventual revelation of bottlenecks. In practice we find multiple machinery service models, status verification of designed and newly constructed lines, etc. To establish flexibility, simulations together with computing technologies promise huge potential. Well build model verifies facts also in planning intentions. Moreover, we can simulate optimal production batches; time needed for entering the plan into production, manage production shop, but also design and implement crisis "what-if" analysis.

F. Flexible automation in automotive

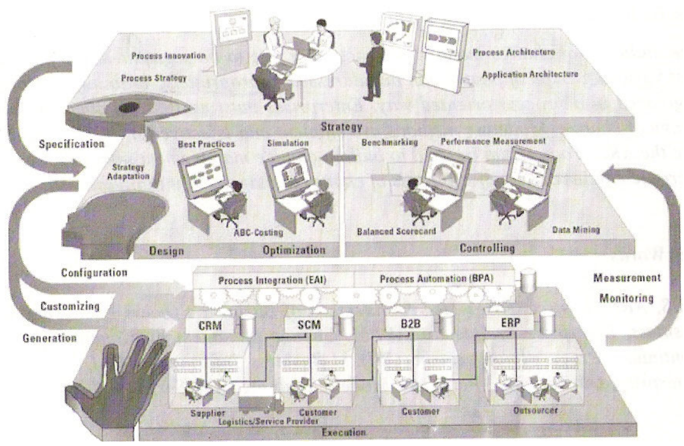
The basic pillars of Lean production in previous chapters are valid in general. The next pillar is especially valid in automotive. One of the basic features of lean production is the involvement of first-tier suppliers in automotive component design. Clark and Fujimoto [27] said: there is evidence that the early involvement of suppliers in product development contributes to reduce lead time and to avoid costly downstream production problems, therefore the techniques employed for managing supplier's roles in product development achieve strategic significance. Clark [28] found that an added benefit some automakers gained from having close ties to suppliers with superior product development capability was a greater proportion of unique parts without the disadvantage of increasing their own internal engineering workforce. These suppliers are then in need of more Research and Development (R&D) activities and new technology adoption.

V. LEAN PRODUCTION VS. BUSINESS PROCES EXCELLENCE

Before application of Lean production it is very useful, when the organization applied Business Process Management components before [31]. The fourth level of BPM, it means Business Process Excellence is very welcome. In today's business environment enterprises have to act in a flexible and customer oriented way in order to meet economic challenges and ensure a long term survival of the organization. Therefore organizations move towards business process oriented architectures like defined with the Three-tier Architecture of Business Process Excellence" [37], [38].

On strategy level aspects like the general business process structure and strategy, the planned innovation and the underlying application system architecture are defined. The information is forwarded to the process specification layer, where the blueprint for the resulting business processes is specified, using techniques like simulation, best practice reference models or ABC costing. This process specification is used as the guideline for the implementation of all physical and information handling processes on the execution layer, within and across enterprises. All information systems, based on standard application software packages, individual developments, EAI components, web services, or business process execution engines are based on Fig. 1: Three-Tier Architecture of Business Process Excellence level. If there are differences observed between planned key performance indicators and the actual values, either a continuous improvement process (CPI) is started through the process specification layer or the situation is resolved on a strategic level. The Three-tier Architecture of Business Process Excellence is shown in Fig. 1. [39].

Fig. 1: Three-Tier Architecture of Business Process Excellence [39]



Key advantage of such process-centered organizations is that it enables a fast and flexible reaction to changes. Changes that influence business processes may be caused by:

- new or changing customers, suppliers or other market partners;
- new or changed market offerings (goods, services, information,
- mergers and Acquisitions;
- changing legal regulations;
- availability of new or modified technologies like application systems;
- outsourcing of specific activities;
- new business models;
- cultural differences in various enterprise locations;

others;

- the business driven use of new technologies like m-business create a tremendous;
- change of business processes [41].

What does it mean to be flexible in the context of new economy? In the new economy companies are ought to be able to adapt to differing customers' demands and fast changing environments. Thus, flexibility of a company is a fundamental factor that enhances competitiveness as a result to fast adjustment to their diverse demands and requirements [47]. Results of some authors say [33], that this factor was measured through two sub-questions: Faster creation of documentation; and faster process flow with fewer mistakes made. Over 67% of the companies believe that faster creation of the documentation has greater or major impact on competitiveness. On the other hand, less than 9% companies questioned expressed that use of internal server does not show benefits in companies' flexibility. Moreover, second sub-question also proved that flexibility does have important role in achieving enhanced competitiveness.

All the described business changes require according modifications or creations of business processes. Goal of change management is to ensure that the necessary changes of a business process fulfill the following conditions [43]:

necessary actions are initiated with an acceptable delay after the change has happened (or has been decided to happen, if pro-active change management is needed);

necessary actions are executed in a fast and effective way;

all reactions and actions are initiated and executed in a controlled manner.

An effective management of the permanent change becomes a key success-factor for an enterprise [34]. It is of fundamental importance that the people involved in changing processes are able to understand and accept those changes and make them finally happen. Therefore the most appropriate definition of change management is from Hammer and Stanton [42]: Information quality, communication and training. Information quality (IQ). Internal use of IT makes the supplier's processes more reliable because it supports decision making, production planning, and quality management by improving the scanning and monitoring of the internal and external environment [36]. Hence, quality of information as one of the fundamental elements of this process change has a significant impact on evaluation of company's competitiveness [46].

People have to be informed about the changes. Then their feedback is required. An intense communication starts. And finally people have to be trained to be successful in the new business process environment [43], [48].

Some authors say that Organizational change using IT can begin with an analysis of existing organizational elements and an identification of ways to change the dependencies among them, especially between processes [44]. Therefore, IT is

one of the fundamental elements of Business Process Change (BPC) [40], [35], [32], [45]. Its role is significant throughout the entire duration of process change: before the process is designed (IT as an enabler), while the process is being designed (IT as a facilitator) and after the design is complete (IT as an implementer) [32].

Therefore, building a responsive IT infrastructure [35] is the key factor for successful implementation of BPC.

VI. Case Study

The following case study is an example of the pilot project from the assembly workplace of one of the world's leading producers of hospital equipment. This project was focused on the optimization of the material flow, defining the best of assembly process, the implementation of the elements of visualization and standardization and not least increases the productivity at the workplace.

Goals of the project:

- Implementation of the basic tools of lean manufacturing on a pilot workplace.
- Providing the real measurable benefits to be evaluated on a pilot workplace.
- Setting up the process improvement system that will be extended to other workplaces.

In the first instance the project was launched the opening workshop with the company management and the project team members. At this first meeting was introduced the philosophy of "Lean" methods and tools for process improvement and defined objectives and specifics of the project. After the introduction followed the initial analysis of the current situation of the assembly workplace. This analysis was mainly focused on the existing material flows in the workplace, including transport distances, the appropriateness of layout, identifying waste, defining the activities that add or not added the value, the time consumption of individual operations, the "snapshot" of working day of assembly workers, the utilization of machinery, etc. The main aim was to find the potential to improve the performance of the workplace and the exact defining of the necessary remedial actions. The potential for increase the performance of the assembly workplace was set at 30% by the project team. The ways to achieve it have lead mainly through the changes of layout, designing the new assembly procedures, the implementation of the method called 5 S including a visualization of assembly process, defining performance standards or changes in work organization.

The implementation phase of the project was started by defining the new assembly procedures, which were against the current situation mainly characterized by merging and substitution of sequence of operations and the relocation of the preparatory activities that do not add value outside the assembly workplace. Along with the new layout were also designed many of preparations to improve the performance of assembly workplace and the facilitation of work for operators. After defining the optimum layout followed the implementation of 5S. A pivotal was to eliminate all unnecessary items, visualization on the floor, cleaning and scheduling system of preparation and the workplace supplying for small connecting material and creating visual assembly procedures.

The next step was to identify the time consumption of individual operations and the definition of performance standards in the actual conditions of the optimized workplace. It was also necessary to make balancing the various assembly operations in order to avoid unnecessary waste in the form of waiting of workers. Two variants have been suggested for distribution and balancing of assembly operations, depending on the required production volume.

In the production start-up phase were primarily to define the start-up curve and the necessary conditions to achieve the required performance. At the beginning of this phase were again analyzed the activities of the assembly workplace, this time on a smaller scope and more detail than the initial analysis. The whole start-up was accompanied by careful monitoring of performance attainment of any delays and problems on the assembly workplace. Starting curve was calculated and designed for 8 weeks and started on approximately 60% of the requested production. During this period the start-up curve met at 98% for defined volume of production.

The results of a pilot project:

- Increasing the productivity of assembly workplace by 33%.
- Defining straightforward and consistent of assembly procedures.
- Define the objective performance standards.
- Creating a visual assembly procedures and instructions for the operators of machinery.
- Setting up control plans, cleaning and supplying of the materials.
- Improving the working environment.
- Defining of the progressive steps for the optimization of other workplaces.

After the successful optimization of the pilot assembly workplace, the attention was focused on the follow-up assembly workplaces. This workplace had to be treated as a whole under the concept of the entire assembly. The main objective was to secure continuity of follow-up processes, namely the principle of "one piece flow". As a big part of an introductory analysis was determining weak spot, which was disposing of the key machinery. Subsequently were carried the activities, which leading to the best use of this workplace, and which indicates the tact for all other processes. After optimization of the narrow place, providing the maximum throughput, the attention was paid to other workplaces. There were balanced and performed a partial redistribution of individual work activities between sites. Followed the optimization of their own workplaces focused on effective layout and standardization of procedures with a strong attention on continuous process improvement. The entire project, of course, required a whole series of organizational changes. Perhaps the most important change was the creation of new multi-teams and setting up a new remuneration system, ensuring a high level of motivation.

The final conception of production allowed the reduction of the number of workers, the equal level of production was carried out with 15 workers from the original 21st. Another major contribution of reorganization was the improving the quality of output, which managed to reduce the internal non-quality by 20%. Considerable were the savings in the production area - more than 10%. Another very difficult to measurable contribution was very fundamental substitution thinking when workers began feel themselves activity related to lean manufacturing processes and improving very positively. Undoubtedly, it helped the fact that the entire project was accompanied by a relatively extensive training and methodological training of employees.

These employees were then also directly involved in the optimization and implemented workshops at individual workplaces. They had the opportunity to participate in proposed a detailed form of workplaces. A great emphasis was placed on ergonomics and economics of labour movements, which contributed very significantly to the final positive perception of employees.

VII. Conclusion

In conclusion we can say that the case study is an example of the functioning of the individual pillars of lean manufacturing system. It would be definitely interesting to imagine there was a universal practice in building production systems, which could lead us step by step towards the goal. Unfortunately there is no such procedure that guarantees universal usage. However, we can define a number of common principles and recommendations that we can give us the right direction to a working production system if used properly [49].

- Don't try to invent anything that has already been invented. Rather inspire and compare yourself with the best companies. Tomas Bata constantly compared his business with world class companies as one of the cornerstones of its production system. However he did not mean to copy, but to learn and compete with the best.
- Learn to see the waste. Wasting should be seen, identified, quantified and eliminated.
- Understand the flexibility of absolute necessity of a modern production system.
- Try to make maximum use of machinery.
- Do not try to introduce a specific method, but implement a solution that leads to removing of the problem. The method is not important, important is the result.
- Understand the management by objectives. Aim to define the level of individual workers. Only if it is clearly defined by means of measurable objective, which may affect an individual or a team; their work becomes effective. Objectives should always follow the system of remuneration.
- Introduce pull systems based on responding to the requirement coming from the following workplace or manufacturing process.
- Do not understand the production system only in association with the production. There is no lean production without optimization of other supporting processes.

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