Lean product development process for a Chinese commercial vehicle supplier

Preparation and implementation of changes in the thinking and acting of a Chinese production company on the basis of Lean Production Management

Dipl. Ing. Kay Hömberg, Ebertconsulting GmbH, Köln, Deutschland;

Dipl. Soz.-Wiss. Cornelia Keller-Ebert, Ebertconsulting GmbH, Köln, Deutschland;

M.Sc. Gongbo Chen, Zhucheng Yihe axle Ltd., Zhucheng City, China;

B.Sc. Wentao Li, Zhucheng Yihe axle Ltd., Zhucheng City,China

1. Abstract

ZHUCHENG YIHE AXLES CO., LTD (YIHE) is the world's largest brand-independent manufacturer of commercial vehicle steering axles. YIHE has an annual capacity of 1.2 million axles and in 2018 delivered more than 1.0 million units to almost all Chinese commercial vehicle manufacturers. YIHE is also growing above average in the Chinese market against state-owned companies, but nevertheless faces a continuous decline in margins. This was the reason to introduce an overall product development process based on the German model.

After some benchmarks, also with Japanese providers, Ebertconsulting GmbH was selected to accompany this process with their MSCDPS® method. The MSCDPS® method is specially tailored to the needs of large SMEs and combines continuous improvement based on the Japanese model with the European approach to revolutionary development leaps. The method is based on the close integration of production optimization with the establishment of a development landscape with continuous search for cost savings with simultaneous quality improvements.

The introductory pilot has been the development of a standardized hub unit (wheel bearing unit) which will also be offered in the world market.

As part of the project, the assembly and in-house logistics were synchronized as a pilot project, the result is the personal reduction in the assembly of the so-called M4 axle (for trucks from 5.5t to 12t total weight) from existing 16 to 10 workers. In parallel a cost-optimized hub unit was developed, as a paragon for the future development landscape.

The main objective has been to set up and demonstrate a German like product development process. With support of EC GmbH in the mid of this year this service life-optimized hub unit will be launched worldwide.

In addition to the commercial-technical content, the presentation also deals with the cooperation between different cultures and how the resulting intensive confrontations can be used for innovation and quality improvement.

2. Two worlds encounter

In the beginning it sounds like a simple task. ZHUCHENG YIHE AXLES CO., LTD, the world's largest brand-independent manufacturer of commercial vehicle steering axles, is planning to introduce a holistic product development process based on the German model in order to be able to compete with its products not only on the Chinese but also on the world market. For this purpose, a structure is to be created and established, which at the same time promotes the continuously optimized production process in addition to a development process for new, innovative products.

YIHE currently produces approx. 1.0 million steering axles per year, split in approx. 350 different axle types. It is based on a historically grown, typically Chinese production structure, which relies on maximum flexibility both in terms of personnel requirements and the processes themselves. This extends throughout the entire process from purchasing through production to sales. For example, there is no integrated production planning and control system in place across the enterprise, instead WeChat is used (a counterpart to WhatsApp and other messenger services), which is very popular in China, to communicate for both internal and external production control.

The production system is now facing, due to the rapid growth of the company in recent years, its theoretical total capacity of 1.2 million axles per year, calculated purely by the optimal cycle

time of the assembly lines, so the typical marginal phenomena which occurred before in sooner developed economic regions of the world have led to a rethinking of production towards the methods of Lean Production Management.

Massive supply bottlenecks of components, frequent downtime of production lines due to unplanned set-up processes, high employee turnover due to the compensation of these production losses with extremely flexible overtime or lack of correction measures for quality issues along the production process are just some of the typical problems.

It seems logical and easy to complete the previous production structure strictly with the methods of Lean Production Management as described above or to replace it completely in some places.

During planning phase and with ongoing implementation, however, the fundamental strength of the Chinese production system became evident, especially the cultural, anchored in education clear, hierarchically very flat top down structures using maximum disciplinary enforced flexibility for the introduction of a production system, that counteracts team building as well as continuous improvement by free thinking of each individual on the basis of extreme standardization. A system shall be created in which highly trained employees are able to implement predefined processes, and to develop them for all applications to create standards along the entire supply and production chain, to guarantee individually optimized but reliable processes based on a solid database.

3. The MSCDPS® product development process: agile and lean

An early definition of agility from the 1980s states that “Corporate agility, the capacity to react quickly to rapidly changing circumstances, requires a focus on clear system output goals and the capability to match human resources to the demands on changing circumstances.” (Brown and Agnew, 1982, p. 29).[1]

With this definition, the special focus is already on

- Swift response to environmental changes

[1] As 3), p. 7

- Requirement of clear targets
- Evaluation of human resources

Later on it reads: “Since the late 1990s, there is greater emphasis on individual customer value as well as on product development initiated by customer requirements.”[2]

To a large extent, our approach is in line with a model from the turn of the century that was designed as an “agile-manufacturing model” in cooperation with various authors.

[2] As 3), p. 8

Fig. 1: Generic Framework of agile manufacturing (based on Gunasekaran & Yusuf, 2002, P. 413)

"The framework comprises the attributes strategy, technology, organization, and people, to which various concepts are applied. The attribute strategy includes the concepts reconfigurability, flexibility, virtual organization, strategic alliances, integration, and parallel development. As concepts of the attribute technology, Gunasekaran mentions modular software components, real-time checks, information technologies, multimedia, graphic simulators, and more. The attribute people include the concepts flexibility, IT, top-management support, and employee knowledge and under the attribute systems are grouped MRPII, Internet, WWW, electronic trade, CAD/CAE, ERP, JIT, etc. (Gunasekaran, 1999, p. 100)."[3]

The characteristics quality, training, education, and incentives system are key components of this framework, also in terms of organization and people. In the end, Foerster und Wendler

[3] As 3), p. 12

(2012, p. 13) describe agility from the angle of organization theory as a “conglomerate of elements from various theories and concepts, that […] are continually expanded with new approaches [...]. Its strength may be that the term agility continues to be adapted to current developments and can therefore be considered as ‘modern’ in spite of its 20-year history.”

3.1 **Agility in companies**

Employees with their skills and qualifications are unquestionably the key resources of companies. For example, another strand of agility theory—a psychosocial and systems-theoretical strand—includes team theory. “The self-organization theory (a variant of the systems theory, dA) and team theory were selected (by Foerster und Wendler, 2012, dA), because the requirement of self-organised groups, who independently accomplish complex tasks as a team, constitutes a distinctive attribute of agility.”4 From the point of view of organizational theory, various approaches play a role herein. In the field of psycho-social organizational theories, they include the

- **Human-relations approach**, an alternative to Taylor’s principles of assembly-line work with fixed cycle times, as well as the
- **Human-resources approach**, a motivation-oriented model with focus on development opportunities for employees and self-control instead of external control: “The idea is to shape the organization so that through the achievement of individual targets organizational targets are achieved simultaneously. Work is no longer seen as ‘plight, but as ‘joy,’ as a source of needs fulfilment” (Schreyoegg, 2003, p. 54). Parallels can be drawn to lean production and agile organization that pursue flat hierarchies, in which decision-making is transferred to lower hierarchical levels.5

---

[4] As 3), p. 14

[5] As 3), p. 15

Among other things, process orientation plays a central role in the self-organization theory (a variant of the systems theory).

In the team theory, the team is seen as “a target-compliant group of actors whose members perform various tasks, which they may complete using non-identical information. The members pursue similar targets, so there are no conflicting goals (Wolf, 2011, p. 141; Hofmann, 1973).[6] So this is about job-sharing, communication of information exchange, and rules of conduct for team members.

“The teams work with various team models, although the concentration on self-organized teams in a decentralized organizational form is a key agility hallmark. The architects of the agility concept relied on insights of the team theory, established for several decades and already an integral component of various organizational models (including lean production), before it was incorporated into agile models.”[7]

3.2 **The flexible company—agile and lean**

In times of change and restructuring, it becomes apparent whether companies manage to operate flexibly and make readjustments. Increasingly, companies must be able to adapt ever faster to environmental changes with regard to product variants, time, and costs, which makes their effectiveness measurable. Company flexibility is the requirement for an unequivocal focus on customer requirements.

Foerster und Wendler (2011) comment on flexible manufacture and lean organization: “The manufacturing concept known as lean production, as with flexible manufacturing, represents a direct answer to the mass-production system and already contains many agility characteristics” (p. 25). Although the practice originated in the 1950s in Japanese companies, the concept continues to be a familiar and current approach. Having said that, the Japanese model has met with increasing criticism in subsequent years: a study of the Massachusetts Institute of

---

[6] As 3), p. 18

[7] As 3, p. 20

Technology (MIT study) points to worker strain, high levels of fluctuation, and an inadequate environmental approach.8

Shah and Ward (according to Foerster and Wendler, 2011) count 10 characteristic dimensions for lean production:

dimension	description
supplier feedback	provide regular feedback to suppliers about their performance
JIT delivery by suppliers	ensures that suppliers deliver the right quantity at the right time in the right place
supplier development	develop suppliers so they can be more involved in the production process of the local firm
customer involvement	focus on a firm's customers and their needs
pull	facilitate JIT production including kanban cards which serves as a signal to start or stop production
continuous flow	establish mechanisms that enable and ease the continuous flow of products

[8] Compare: as 3), p. 25

set up time reduction	reduce process downtime between product changeovers
total productive/ preventive maintenance	address equipment downtime through total productive maintenance and thus achieve a high level of equipment availability
statistical process control	ensure each process will supply defect free units to subsequent process
employee involvement	employees' role in problem solving, and their cross functional character

Table 1: Dimensions of lean production (Shah & Ward, 2007, S. 799)[9]

With regard to the production system, it shows that a lean factory "(transferred) a maximum of tasks and responsibilities to those employees who actually added value to the car on the assembly line, and (has) installed a system of fault detection that quickly traces each identified problem to its final cause" (Womack et al., 1992, p. 103).[9]

In this concept, teamwork is of great importance, both in manufacturing and product development: "Lean product development/construction is largely a construct of four basic elements management, teamwork, communication, and simultaneous development."[10]

---

[9] As 3), p. 27

[10] As 3), p. 28

To be able to quickly respond to customer requirements, we develop close ties to customers. This makes it possible to quickly obtain feedback, for example on trends. A comparison of lean and agile principles is given.[11]

4. The pilot project to practice

In order to develop and implement the new methods and processes, a highly efficient assembly line was selected as a pilot project, so that from the beginning as many as possible issues occur with the pilot project and as an advantage, the resulting improvement potential can be demonstrated holistically in a the Chinese culture compliant, standardized recipe structure for roll-out to additional company divisions.

Initially, however, it was necessary to introduce further hierarchical levels throughout the company structure, thus creating the basis for the necessary team building.

In a parallel, continuous training process, the methods of Lean Production Management were presented again and again at each newly introduced level, and the most helpful methods were selected in a joint decision-making process.

During the pilot project, for example, the first step was to record and independently analyze workflows and process times using value stream mapping charts and with the help of video recordings of the entire process.

[11] ***Hochschule Koblenz, BPM-Labor - Labor für Business Process Management und Organisational Excellence,*** *Prof. Dr. Ayelt Komus,* Version 1.0 vom 06.05.2014

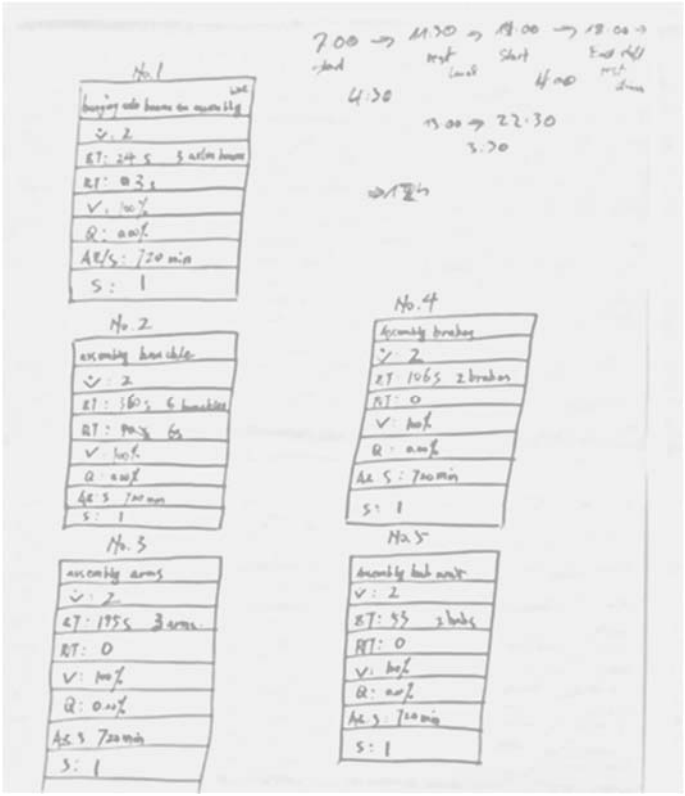

Fig. 2: Value stream map of the processes at the assembly stations

After all kinds of waste was detected both in the material and information flow as well as in the areas of handling and quality, workshops under guidance of EC experts together with YIHE workers for continuous improvements of the processes were executed. Previously established one-piece-flow structures, which are lean according to the recipe definition, were abolished for areas in which they make no sense, such as the supply of the assembly line with miniature fuse elements such as standard nuts or screws, and a KanBan-System replaced.

The difficulty of implementing the use of two different supply strategies at the same assembly line, demonstrated the mental balancing that employees were repeatedly exposed to in this process of change.

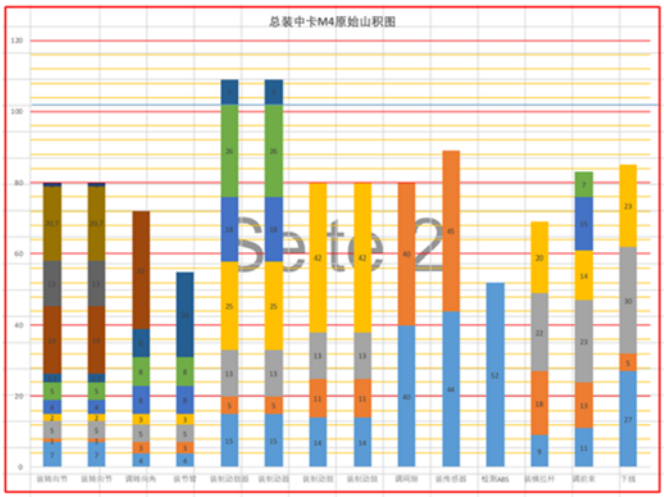

Fig. 3: Process times of non-optimized and non-synchronized assembly processes

After the most obvious wastes had been skipped with suitable measures, the optimized processes were synchronized as far as possible for all assembly stations. This synchronization resulted in a significant reduction in average cycle time at the slowest station on the line, resulting in a 6 Employees saving on the entire assembly line.

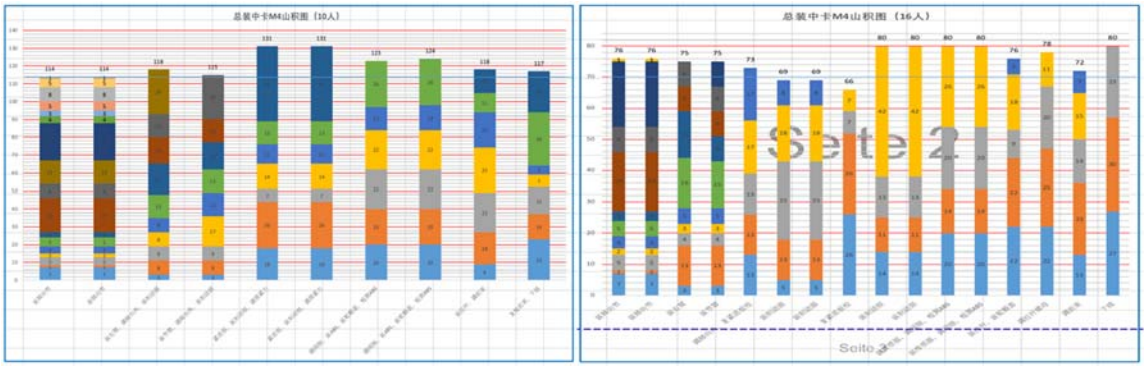

Fig. 4: Process times of optimized and synchronized assembly processes (left for today's capacity requirements with 10 persons, right for possible capacity requirements with 16 persons)

The future challenge is now to stabilize the newly created structures in general as well as going on with a strict, sustainable continuous improvement process.

[1] Jens Bergstein: Agility – überlebensnotwendig für Unternehmen in unsicheren und dynamischen Zeiten Unternehmensberatung Kienbaum Change-Management-Studie 2014/2015

[2] HR Pioneers: „Agil anpassen!“ Artikel Personalmagazins in Ausgabe 11/2014

[3] HR Pioneers

[4] Kerstin Förster, Roy Wendler: Theorien und Konzepte zu Agilität in Organizationen kerstin.foerster@mailbox.tu-dresden.de roy.wendler@tu-dresden.de

[5] Bernd Oestereich, Claudia Schröder: Das kollegial geführte Unternehmen: Ideen und Praktiken für die agile Organization von morgen; Vahlen, Auflage: 1, 2016

[6] Malte Foegen, Christian Kaczmarek: Organization in einer Digitalen Zeit: Ein Buch für die Gestaltung von reaktionsfähigen und schlanken Organizationen mit Hilfe von skalierten Agile & Lean Mustern; wibas GmbH, Auflage: 3., 2016

[7] Svenja Hofert: Agiler führen: Einfache Maßnahmen für bessere Teamarbeit, mehr Leistung und höhere Kreativität; Springer Gabler; 1. Aufl. 2016

[8] Brian J. Robertson: Holacracy: Ein revolutionäres Management-System für eine volatile Welt; Vahlen; Auflage: 1, 2016

[9] Sascha Armutat u.a.; AGILE UNTERNEHMEN – AGILES PERSONALMANAGEMENT, DGFP-PRAXISPAPIERE Best Practices 01/2016

[10] Kerstin Förster, Roy Wendler: Theorien und Konzepte zu Agilität in Organizationen, DresdenerBeiträge zur Wirtschaftsinformatik, NR. 63/12, TU Dresden 2012

[11] STAUFEN AG (Hrsg.) 25 Jahre Lean Management: Eine Studie der Staufen AG und des Instituts PTW der Technischen Universität Darmstadt, 2016