

Similarities and Differences between Lean Production, Tayloristic and Socio-Technical Systems Revealed in the Methodology Characteristics Map

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ABSTRACT

In this paper we illustrate similarities and differences between Lean Production, Sociotechnical System Theory and Taylorism (Scientific Management) in the methodology characteristics map. 10 categories are extracted from basic literature and classified for each of the methodologies, for the construction of the chart. 4 of the categories relate to division of work, where we discuss integration and segregation of work. 2 categories relate to instructions and information, while the remaining 4 are related to the general focus of the methodology. With reflections to the illustrated results in the chart, we discuss sources to disagreement about similarities and differences between the methodologies.

1. INTRODUCTION

Lean production and the Toyota production system are widely regarded as the route to world class manufacturing today. The implementation of lean production is however performed in complex environments with heritage and long experience from tayloristic and sociotechnical production systems.

Industrial production is historically based on the principles stated by F W Taylor [1], [2] in the beginning of the 20th century. He mentions four duties (“a science for each element of a man’s work”, “scientifically select, and then train, teach and develop the workman”, “cooperate with the men so as to insure all of the work being done in accordance with the principles of the science” and finally “division of the work and the responsibility between the management and the workman”) for management, as the fundamentals of Scientific Management (SM). In this paper we have mainly considered the first and the last one, which both are connected to the practice to establish the best procedure for work operations, and the organisation to implement it as the standard operation.

The theories of sociotechnical system (STS) design in manufacturing were developed during the 1950ies and onward in opposition to the tayloristic production systems. The STS theory developed by F. Emery, E. L. Trist and others at Tavistock Institute [3] approach production environments as a system with two integrated parts, the technical and the social system. They suggest that both these part systems must be considered simultaneously during the development of a production system. With the introduction of the social system, STS drew the attention to team work. Ten principles (compatibility, minimal critical specification, variance control, boundary location, information flow, power and authority, the multifunctional principle, support congruence, transitional organisation and incompleteness) are used by Chern [4] to describe the STS theory.

What we today know as Lean Production (LP) [5] is based on the production system originally developed by Toyota. The corner stones of Lean Production are concentration on value creation by elimination of waste, value flow and perfection by continuous improvement. The focus on steady flow in production leads to emphasis on standardized operations to be performed with minimal variance. Womack and Jones [6] explain the basics of lean

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thinking with the five principles, specify value, identify value stream, make the value-creation flow, embrace pull and strive for perfection.

Several studies with analysis of lean production, sociotechnical and Tayloristic production systems are reported in literature [7-15]. And questions like “Neo-Taylorism or the next step in sociotechnical design?” [9] and “Denial, confirmation or extension of sociotechnical systems design?” [11] were raised.

Niepce and Molleman [9] evaluated STS and LP against the STS design principles formulated by Chens. They conclude similarities among STS theory and LP in how they differ from Taylorism in the attention to team work and continuous improvements. They also conclude that the most obvious differences concern control and coordination of work.

Dankbaar [11] claims that lean production appears as an extension rather than a successor to Tayloristic mass production system.

Most papers compare the two most recent developed methodologies, STS and LP, while comments often are made in relation to Taylorism. Even though large parts of Taylor’s statements on SM feels out of date, we decided to include it in our study because of all the reflections to it, and the parts that in fact are relevant even today.

In this paper we highlight similarities and differences between SM, STS and LP graphically in the methodology characteristics map, where the results are based on evaluation criteria with roots in all three methodologies. The study is limited to basic descriptions and principles for the methodologies, and we have made an effort to exclude dialects [16] and flavours of each methodology which is expected to be found in practical implementations. Each of the methodologies has a broader view (though in different directions), as product design and supplier relations in LP, which we excluded from the study.

Most studies presented in literature are made on existing systems in industry. These systems are all influenced by several methodologies. The aim of this study was to establish a frame of reference for further studies of applications in industry. It was also expected that the differences between the methodologies would be most accentuated in the basic literature. The main categories division of work, instructions and information and general focus of the methodology were selected for more detailed studies. By selection of a limited number of categories, the methodologies are not covered in full, which may have made the presentation of each of them more or less accurate. It is expected that the reader holds this in mind while interpreting the results.

2. METHOD

A set of categories for comparison of SM, STS and LP were extracted from basic literature [1-3] on each of the three methodologies for design of production systems. Some of the categories are discussed in the literature for all three methodologies, whilst other only may be found in the literature for one of the methodologies. The selection of categories was based on our experience and knowledge.

The methodologies were then classified for each of the categories. Four rating classes according to table 1 were used, and the ratings were made by the authors. Finally the classification is presented in a radar chart – the methodology characteristics map. The figure for each of the classes gives a relative value to the class definition. A low rating for a category will reflect a position close to the center in the chart, while a high value will reflect a peripheral position. Radar charts are excellent for visualization of characteristic similarities and differences in comparing scenarios [17, 18]. The tables 2-5 were integrated into one single table, where the rows were reorganized to give a good visual appearance in the chart. The best visual appearance is achieved when the categories giving the axes are clustered. The principal for clustering may be subject based similarities, levels in the numeric values or other relevant features. In this case the rating levels were selected to give the best visual appearance.

Table 1: Classes for rating methodologies for design of production systems

Rating classes	Class definition
0	The methodology does not deal with the category
1	The methodology gives some contribution in the category
2	The methodology gives considerable contribution in the category
3	The category is a very important part of the methodology

3. CATEGORIES FOR COMPARISON

The categories shall give a good representation of all three methodologies, while they also reveal similarities and differences between them. The main categories division of work, operating standardization and information were selected, and the broader category general focus was added. These categories were then subdivided into more detailed categories.

The results are presented according to the detailed categories, and any evaluation against the main categories is left to the reader. When all categories are bipolar (in some way opposite to each other), an axes based chart with the two categories in opposite directions, may be developed. This is case for the subcategories on division of work below. But as the other selected categories are unipolar the developed chart will be of vector type.

3.1 DIVISION OF WORK

Work is always to some extent divided into separate tasks to allow for some level of specialization. In this paper we use the words integration, generalization and unification for efforts to bring different work tasks together for individuals or work groups, and segregation, specialization and fractionation for efforts to divide work into smaller tasks for individuals. As indicated in figure 1 the division of work may be vertical or horizontal [19]. In vertical division of work supporting tasks are separated from core operations and from each other. In horizontal division of work the core operations as well as the supporting work tasks are divided into specialized unit operations.

SM strongly promotes vertical as well as horizontal segregation of work, which corresponds to the upper right section in figure 1. In the original writing by F. W. Taylor [1], 7 different “teachers/bosses” are mentioned, among whom supporting work is divided, which leads to extensive vertical segregation. In SM each worker is expected to have an individual and well defined work task, which is the base for training as well as feedback on performance and pay according to measured output. The work is expected to be horizontally divided to the level of an individual worker, while further division of work and shorter work cycles is not included.

The main focus in STS is on the situation for the individual worker performing the unit operation, and STS promotes limited horizontal division of work (integration). One example is when Emery [20] claims that, while fractionation (or segregation) has a positive effect on cost at lower degrees, the effect is the opposite at higher degrees of fractionation. STS stresses the importance of giving the group and the individual worker control on their own work task. Still very little is written about vertical division of work.

LP strongly promotes integration with respect to vertical division of work, while there is an acceptance of segregation in the horizontal division of work. Workers are expected to have the responsibility, knowledge and authority needed for keeping machinery running and material flowing through the production system [6, 21]. This knowledge is strongly related to vertical integration of work. Balancing of production systems for a smooth flow leads to well defined, standardized and segregated unit operations.

Classification of the methodologies for each of the four categories is presented in table 2. As a methodology must support either integration or segregation in each of the directions, two categories for each methodology is rated to zero. SM was rated to 3 for both vertical and horizontal segregation due to the strong and detailed treatment of specialisation. STS was rated 3 for horizontal and 1 for vertical integration, as the literature strongly promotes unification of work, and opposes fractionation. Some consideration is given in the literature to vertical integration and it was rated 1. The literature on LP has a extensive coverage of responsibilities wider than the individual operation, and the vertical integration was rated to 3. Little is written about division of on the operation level, but the methods imply standardisation and horizontal segregation was rated to 1.

Table 2: Classification and rating on division of work

Category	SM	STS	LP
Vertical integration	0	1	3
Horizontal integration	0	3	0
Vertical segregation	3	0	0
Horizontal segregation	3	0	1

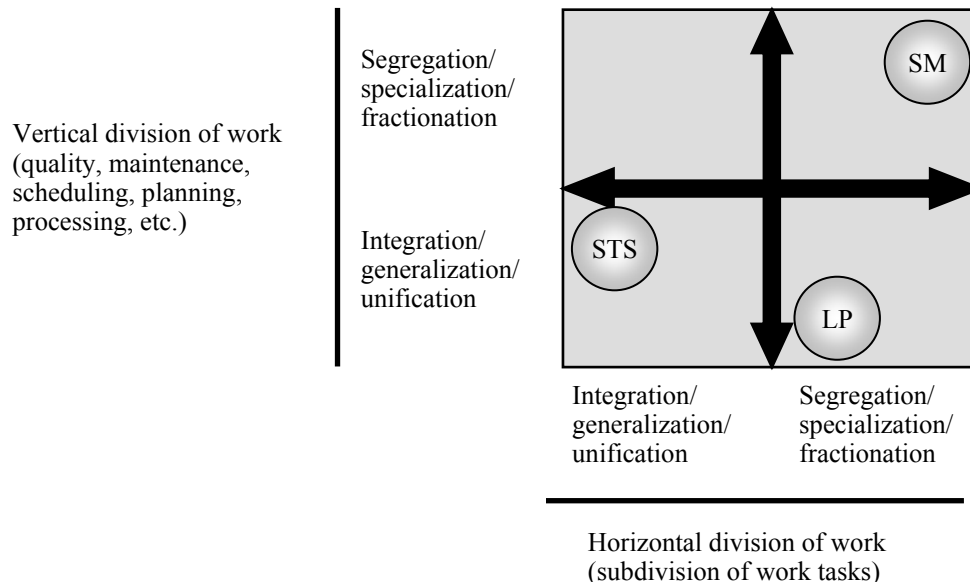


Figure 1: Vertical and horizontal division of work

3.2 INFORMATION AND INSTRUCTIONS

SM presents detailed work instructions as an important tool for spreading and assuring the use of scientifically developed best practice standardized operations. The worker must be made aware of the standard operations, otherwise they will mean nothing at all. The standard operations in SM are very detailed, which rules the detailed level of the instructions, the rating was set to 3. In the literature nothing is mentioned about information in wider context to operation and a rating of zero was given.

STS proposes relevant product and system information in a wider context to the worker and the group. The wider context and knowledge is expected to support the development and quality of work by the individual worker and the group. Operation instructions are expected not to be more detailed than “the minimal critical” level. As the focus is very pronounced on the wider information this was rated 3. As STS more or less is in opposition to detailed instructions this was rated to 0.

Visibility is frequently stressed in LP. Interruptions in one part of the production system are expected to be visible to workers in other areas. Use of the value stream tool [6] is another example on how to work with process and system information in a wider context. Subsequently, strive for standardized operations introduce a need for detailed instructions. Very low process variation, which is supported by standard operations, is important in LP.

The information in wider context mainly addresses the manufactured product in STS, and the production system in LP.

Table 3: Classification and rating on information and instructions

Category	SM	STS	LP
Detailed instructions	3	0	2
Information in wider context	0	3	3

3.3 GENERAL FOCUS

Additionally to the categories introduced so far there are a number of intangible and minor features in each of the methodologies, which define the primary focus for each methodology. Our conclusion is that these focuses can be expressed through the importance of the operation, the individual, the group and the system in each of the methodologies. There is a considerable difference in how the production system is interpreted, with respect to a technical and a social subsystem. The focus on the group was found to be closely related to the social system, and is included in that category in table 4.

The general focus in SM is the the performance of the individual worker, and methods to increase the productivity of the individual. The use of scientific analyses of work operations to establish the best procedure is one of the core elements in SM. The best procedure for each specific operation is then expected to become the standard. The technical system is closely related to the operations, and SM deals to some extent with this system level, while the social system is not considered in the methodology.

STS has a first general focus on the production system, which is analyzed through its constituents the technical and social systems. The study of the social system introduces the group as important in the system. The detailed study of the operation is of minor interest in literature on STS. Emery [21] touches the subject in his writing on the unit operation, but he is far from dealing with the operations. STS supports the freedom by the worker and the group to find the best practice, which makes they about operations rather obsolete.

The general focus in LP is the value flow in the production system. The group and the individual come second to the technical system. The operation standardization in manufacturing is used to assure that operations are performed the same way in different locations and at different times. The same standard shall be utilized regardless space and time. LP has a strong focus on standardized operations, as an important mean to lower variance in processes and support stable and smooth flow in production.

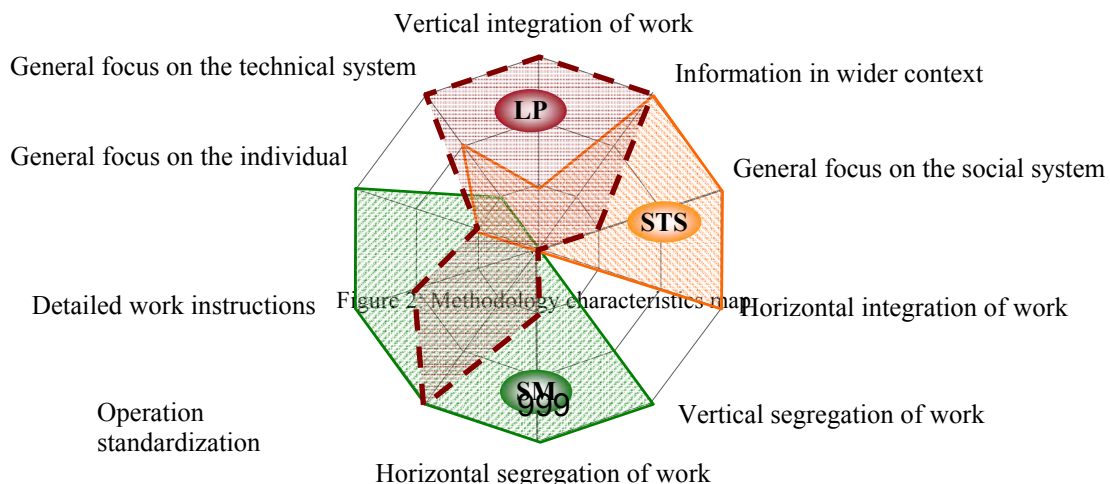
Table 4: Classification and rating on general focus

Category	SM	STS	LP
Technical system	1	2	3
Social system	0	3	1
Individual	3	1	1
Operations	3	1	3

4. RESULTS AND CONCLUSIONS

The results presented in the methodology characteristics map (figure 2). The map gives a general view of similarities and differences between the studied methodologies. The other way to interpret the map is to choose an axis of interest and discuss the relations between the three methodologies.

The selected categories indicate significant differences between tayloristic (SM) and sociotechnical (STS) system principles. This was of course expected, as SM primarily addresses individual workers and work tasks, while the primary focus of STS is systems and work groups.



According to the categories in the study, there are considerable coincidence between lean production (LP) and the other two methodologies. This is not surprising as the early development of the Toyota production system started with studies of existing production system, and LP includes a lot of best practice. It can also be expected that methodologies developed and used in parallel, as STS and LP partly are, will be influenced by the society of the time.

5. DISCUSSION

When discussing the results it is important that we bear in mind that the three methodologies are developed at very different times, where the environment at that time have had a great influence. The tayloristic systems were already on the market when the development of STS and LP started.

Now – is Lean production a neotayloristic production system principle? Or is it an extension of the sociotechnical system principles?

According to the results from this study of basic literature the answer to both questions can be yes and no.

The focus on operation standardization and detailed work instructions may well be used to show that tayloristic ideas have a significant position in the lean production systems. But on the other hand lean production does not embrace the tayloristic ideas of extreme divided work and detailed management control.

We often come across discussion on whether lean production involves the individuals and teams in work development. Some have the opinion that work is highly segregated in lean production, while others mean that work is highly integrated. One source to the disagreement may well be that the reference for one party is horizontal division of work, while the reference for the other one is vertical division of work. The results here show that the choice of view will have a crucial influence on the conclusions.

Another source to disagreement may be whether the opinion comes from a standpoint based on theory or practical experience. It is expected that the practical implementation of a new production system will carry a number of elements and history from preceding systems, resulting in deflection from some of the theoretical principles. Dialects of the basic methodology are developed in different regions and countries [16]. Knowledge on differences between theoretical base and implemented methodologies is of course of great interest, though not a part of this study.

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