Defining Lean Production: Some conceptual and practical issues

Jostein Pettersen
Division of Quality Technology and Management & Helix VINN Excellence Centre
Linköping University, Sweden
jostein.pettersen@liu.se

ABSTRACT

Purpose – This paper aims to investigate the definition of Lean Production and the methods and goals associated with the concept as well as how it differs from other popular management concepts.

Methodology/Approach – The paper is based on a review of the contemporary literature on Lean Production, both journal articles and books.

Findings – It is shown in the paper that there is no consensus on a definition of Lean Production between the examined authors. The authors also seem to have different opinions on which characteristics that should be associated with the concept. Overall it can be concluded that Lean Production is not clearly defined in the reviewed literature. This divergence can cause some confusion on a theoretical level, but is probably more problematic on a practical level when organizations aim to implement the concept. This paper argues that it is important for an organization to acknowledge the different variations, and to raise the awareness of the input in the implementation process. It is further argued that the organization should not accept any random variant of Lean, but make active choices and adapt the concept to suit the organization's needs. Through this process of adaptation, the organization will be able to increase the odds of performing a predictable and successful implementation.

Originality/Value – This paper provides a critical perspective on the discourse surrounding Lean Production, and gives an input to the discussion of the implementation of management models.

Keywords – Lean Production, Definition, Construct Validity, Total Quality Management

Paper type – Conceptual paper

INTRODUCTION

When initiating research concerning the concept of Lean Production (LP) one line of questions naturally comes to mind: 'What *is* Lean? How is Lean defined? How does Lean relate to other management concepts? What does Lean have in common with other management concepts? What discriminates Lean from other management concepts?'

Seeking answers to these questions, will lead to the realization that they are exceedingly hard to find. It seems logical that a management concept as popular as Lean should have a clear and concise definition. Much disappointingly, the definition of Lean Production is highly elusive. Some authors have made attempts to define the concept (*e.g.* Lewis, 2000; Hines et al., 2004; Shah & Ward, 2007), while others have raised the question of whether the concept is clearly defined (*cf.* Dahlgaard & Dahlgaard-Park, 2006; Engström *et al*, 1996; Lewis, 2000).

A justified question is whether the convergent validity of Lean actually makes any difference – does it matter how we define Lean? There are various opinions on the effects of this.

The absence of a clear definition has a number of consequences for practitioners seeking to implement Lean as well as researchers trying to capture the essence of the concept. These issues have been addressed by a number of researchers. The lack of a definition will lead to communication difficulties (Dale & Plunkett, 1991 *in* Boaden, 1997). It will complicate education on the subject (Boaden, 1997). Researching the subject will be difficult (Godfrey et al, 1997; Parker, 2003) - although Boaden (1997) states that this is *not* essential. There will also be difficulties in defining overall goals of the concept (Andersson *et al*, 2006).

Parker (2003) states that the multitude of interpretations on what Lean really is makes it harder to make claims towards the effects of Lean, thus increasing the requirements that researchers specify exactly what they are researching. Karlsson & Åhlström (1996) point out that the lack of a precise definition also will lead to difficulties in determining whether changes made in an organization are consistent with LP or not, and consequently difficulties in evaluating the effectiveness of the concept itself.

PURPOSE OF THE ARTICLE

The main purpose of this article is to give a presentation of what Lean Production is. This will be done through a review of contemporary literature on Lean and summary of practices associated with Lean as well as the stated purpose of the concept. Based on this, an evaluation of the construct validity of Lean will be made.

The paper will conclude with a discussion of the practical implications of the construct validity of Lean.

RESEARCH APPROACH

Hackman & Wageman (1995) reviewed the TQM concept and raised the question of "whether there really is such a thing as TQM or whether it has become mainly a banner under which a potpourri of essentially unrelated organizational changes are undertaken". This is a valid question for any construct similar to TQM, and the concept of Lean Production is no exception. Following the reasoning of Hackman & Wageman, this question calls for the evaluation of the concept's convergent and

discriminant validity. Hackman & Wageman (1995) describe the two kinds of validity as follows:

> Convergent validity reflects the degree to which [different] versions [of the concept] […] share a common set of assumptions and prescriptions. […] Discriminant validity refers to the degree to which [the concept] can be reliably distinguished from other strategies for organizational improvement. (Hackman & Wageman, 1995)

In other words, the discriminant validity tells us whether or not a concept carries any news value compared to other existing concepts, whereas the convergent validity, strictly speaking, tells us whether or not the concept itself really exists.

For this article, the two major citation databases ISI and Scopus have been searched for articles containing the terms "lean production" or "lean manufacturing" in the topic, abstract or keywords. The 20 most cited articles from each database were selected for further study.

Through reading these and other articles on the subject, the most influential books were identified. This list was verified through using the citation analysis software 'publish or perish'.

The reviewed literature will be compared by listing the characteristics of Lean presented by each author. The idea is that a method, tool or goal that is central to Lean will be mentioned by every author on the topic. The purpose or goal of Lean should logically be the same for all authors. Concurrence among the authors will signify a high convergent validity. If Lean passes this convergent validity criterion, an evaluation of the discriminant validity can be made, based on a comparison with TQM. Hackman & Wageman (1995) concluded that TQM passed the tests of both convergent and discriminant validity, making it a good concept to compare against Lean Production.

LITERATURE REVIEW

The two database searches produced a total of 37 articles, of which 12 of them contained presentations of techniques and/or overall goals associated with LP, thus contributing to a conceptual discussion.

The 12 articles that are deemed suitable for a further analysis are Krafcik (1988), Oliver et al. (1996), Sanchez et al. (2001), Lewis (2000), Mumford (1994), James-Moore & Gibbons (1997), MacDuffie et al. (1996), Dankbaar (1997), White et al. (2001), Hayes & Pisano (1994), Jagdev & Brown (1998) and Cusumano (1994).

A number of books turned up in the literature search. An investigation of the books' citation rankings led to a filtering process with 13 books remaining. These are Womack et al. (1990), Womack & Jones (2003), Bicheno (2004), Ohno (1988), Monden (1998), Liker (2004), Feld (2001), Dennis (2002), Schonberger (1982), Shingo (1984), Rother & Shook (1998), Jones & Womack (2002) and Smalley (2004).

The publications by the Lean Enterprise Institute (Rother & Shook, 1998; Jones & Womack, 2002; Smalley, 2004) are very specific on certain tools (mainly value stream mapping), and were not deemed suitable for a conceptual discussion about Lean in general.

AN OVERVIEW OF LEAN CHARACTERISTICS

Table I on the next page is a presentation of the most frequently mentioned characteristics of Lean in the reviewed books. Characteristics that have been discussed by less than three authors have been excluded from the presentation. The characteristics in the table are sorted based on frequency of discussion in the reviewed literature.

Looking at the table reveals some interesting aspects about the ideas surrounding Lean. The only two characteristics that all authors discuss are ‘setup time reduction’ and ‘continuous improvement’, indicating that these are central to the concept. On the condition that pull production can be seen as a special case of Just-in-time production, all authors lift this characteristic as well. Failure prevention (poka yoke) and production leveling (heijunka) also seem to be central characteristics of Lean Production.

	Womack & Jones (& Roos)	Liker	Bicheno	Dennis	Feld	Ohno	Monden	Schonberger	Shingo
Kaizen/Continuous improvement	X	X	X	X	X	X	X	X	X
Setup time reduction	X	X	X	X	X	X	X	X	X
Just in time production	X	X		X	X	X	X	X	X
Kanban/Pull system	X	X	X	X	X	X	X	X	
Poka yoke		X	X	X	X	X	X	X	X
Production leveling (Heijunka)	X	X	X	X	X	X	X		X
Standardized work		X	X	X	X	X	X	X	X
Visual control and management		X	X	X	X	X	X	X	X
5S/Housekeeping	X	X	X	X	(X)	X	X	X	
Andon	X	X			X	X	X	X	X
Small lot production		X	X		X	X	X	X	X
Time/Work studies	X	X	X	X	X	X	X		
Waste elimination	X	X	X	X		X		X	X
Inventory reduction	X	X		X		X	X	X	X
Supplier involvement	X	X	X	X	X		X		
Takted Production		X	X	X	X		X		X
TPM/Preventive mainenance		X	X	X	X	X		X	
Autonomation (Jidoka)		X		X			X	X	X
Statistical quality control (SQC)	X		X	NO!	X		X	X	
Teamwork	X	X		X	X	X			
Work force reduction				X		X	X	X	X
100% inspection		X		X				X	X
Layout adjustments				X			X	X	X
Policy deployment (Hoshin kanri)	X	X	X	X					
Improvement circles		X		X			X	X	
Root cause analysis (5 why)	X	X	X			X			
Value stream mapping/flowcharting	X	X	X	X					
Education/Cross training (OJT)		X			X			X	
Employee involvement	X	X		X			(X)		
Lead time reduction		X		X			X		
Multi manning	(X)					X	X		X
Process synchronization		X						X	X
Cellular manufacturing			X		X		(X)		
Goal	*make products with fewer defects to precise customer desires*	*One-piece flow*	*Reduce waste and improve value*	*Customer focus (high quality, low cost, short time)*	*Robust production operation*	*Cost reduction*	*Eliminate waste and reduce costs*	*Improve quality and productivity*	*Cost reduction through waste elimination*

Table I A presentation of characteristics associated with Lean Production. The characteristics are sorted by accumulated frequency.

ANALYSIS

CONVERGENT VALIDITY OF LEAN

The characteristics listed in Table 1 (previous page) have some relation to each other, motivating an affinity analysis. One way of grouping these characteristics is presented in Table 2 below.

Collective term	Specific characteristics
Just in Time practices (100 %)	Production leveling (heijunka) Pull system (kanban) Takted production Process synchronization
Resource reduction (100 %)	Small lot production Waste elimination Setup time reduction Lead time reduction Inventory reduction
Human relations management (78 %)	Team organization Cross training Employee involvement
Improvement strategies (100 %)	Improvement circles Continuous improvement (kaizen) Root cause analysis (5 why)
Defects control (100 %)	Autonomation (jidoka) Failure prevention (poka yoke) 100% inspection Line stop (Andon)
Supply chain management (78 %)	Value stream mapping/flowcharting Supplier involvement
Standardization (100 %)	Housekeeping (5S) Standardized work Visual control and management
Scientific management (100 %)	Policy deployment (hoshin kanri) Time/Work studies Multi manning Work force reduction Layout adjustments Cellular manufacturing
Bundled techniques (56%, 67%)	Statistical quality control (SQC) TPM/preventive maintenance

Table II *A suggestion for a grouping of lean characteristics. The bracketed figures indicate the percentage of the authors that have discussed at least one of the characteristics in the group.*

Through grouping the characteristics a more homogenous image of the Lean characteristics arises. For all but three of the groups all authors have discussed at least one of the characteristics in the group. In the group labeled as *human resource management* none of the characteristics are discussed by authors Bicheno and Shingo. The authors Ohno and Schonberger have not discussed any of the characteristics in

the group labeled as *supply chain management*. Furthermore, the *bundled techniques* have slightly lower figures. This indicates that the two groups *human relations management* and *supply chain management* are not *definable* characteristics of Lean, contrary to the findings of Shah & Ward (2003). However, the scores are quite high, indicating that they are important (although not vital) parts of the Lean concept.

Looking at the goals presented by the reviewed authors (Table 1) raises some questions towards the convergent validity of Lean. The general opinion that the purpose of Lean is to reduce waste does not seem to hold, although some authors (Bicheno, 2004; Monden, 1998; Shingo, 1984) argue for this. As discussed above there are two main traditions of Lean; "toolbox lean" and "lean thinking". This is also evident in the differences of goals in the reviewed literature. Generally speaking, there are two different types of goals, internally focused (Liker, 2004; Feld, 2001; Ohno, 1988; Monden, 1998; Schonberger, 1982; Shingo, 1984) and externally focused (Womack et al., 1990/Womack & Jones, 2003; Bicheno, 2004; Dennis, 2002; Schonberger, 1982). One could argue that the differences in formulation of purpose are very small thus making it a minor issue. However, an internally focused cost reduction initiative will differ substantially from an externally focused initiative to improve customer satisfaction.

The division of Lean Production in the two parts discussed above has led to discussions of which one is more correct. A common statement is that "Lean is more than a set of tools" (Bicheno, 2004), arguing for a more philosophical approach to Lean. However, there is also another position that argues for a more practical and project based approach to Lean and that "Lean is a collection of waste reduction tools". This kind of statement is hard to find explicitly in academic texts, but very common among certain practitioners.

Neither of the positions are more correct than the other, since Lean exists at both levels, having both strategic and operational dimensions (Hines et al., 2004). In addition, Lean can be seen as having both a philosophical as well as a practical orientation (Shah & Ward, 2007).

Through adapting and combining the four approaches to Lean suggested by Hines et al. (2004) and Shah & Ward (2007) respectively, Lean can be characterized in four different ways. The terms *practical* and *philosophical* are substituted by the terms *performative* and *ostensive*. The terms *operational* and *strategic* are substituted by the terms *discrete* and *continuous*.

	Discrete (Operational)	*Continuous (Strategic)*
Ostensive (Philosophical)	**Leanness**	**Lean thinking**
Performative (Practical)	**Toolbox Lean**	**Becoming Lean**

Table III *An illustration of the four definable approaches to Lean Production. The bracketed terms are the ones suggested by Hines et al. (2004) and Shah & Ward (2007) respectively.*

In the Table above four different approaches to Lean Production are presented. The term *ostensive* signifies a shift of focus from general philosophy towards issues that can only be defined by examples, whereas *performative* and *practical* focus on the things that are done. The term *discrete* signifies a focus on isolated events, such as individual improvement projects using the 'lean toolbox' (cf. Bicheno, 2004; Nicholas & Soni, 2006), or the final state of 'leanness' (cf. Krafcik, 1988). As a contrast, the term *continuous* signifies a process oriented perspective, focusing on the continuous efforts; the philosophy of 'lean thinking' or 'the Toyota way' (cf. Womack & Jones, 2003; Liker, 2004) or the process of 'becoming lean' (cf. Liker, 1998; Karlsson & Åhlström, 1996).

Although the score is not perfect, Lean seems to be a reasonably consistent concept comprising *Just in time practices, Resource reduction, Improvement strategies, defects control, standardization* and *scientific management* techniques. However, it is hard to formulate a clear definition that captures all the elements of Lean and integrates the various goals in the reviewed literature. In other words, Lean can be said to (barely) pass the convergent validity test, although there is no clear agreement among the authors as to the overall purpose of the concept.

DISCRIMINANT VALIDITY OF LEAN

So what is then the difference between TQM and Lean Production? In the following section Lean and TQM are compared based on the analysis made by Hackman & Wageman (1995). The discussion is done with three different aspects; *basic assumptions*, *change principles* and *interventions*.

Basic assumptions

Quality

In Lean, quality does not receive the same amount of attention as in the TQM literature. The main focus in the Lean literature is on Just-in-time (JIT) production. JIT is assumed to decrease total cost, as well as highlight problems. This is done through reducing the resources in the system, so that buffers do not cover up the problems that arise. In the short-term perspective, the reduction of resources implies a direct reduction of cost. In the long run, the reduction and subsequent elimination of buffers is assumed to highlight the problems that exist in production, thus being a vital source of continuous improvement (*e.g.* Shingo, 1984; Ohno, 1988; Krafcik, 1988).

A common opinion is that the purpose of Lean is waste elimination. The literature review does not show support for this being the very *purpose*, but waste elimination is definitely an important aspect of the concept. Some authors argue that waste is reduced in order to increase the value for the customer (*e.g.* Dennis, 2002; Bicheno, 2004), whereas others argue that it is a strategy for reducing cost (*e.g.* Ohno, 1988; Monden, 1998). Reducing waste is also a significant part of TQM, but under the banner of *poor-quality-costs* (*cf.* Hackman & Wageman, 1995; Sörqvist, 1998). A major difference between TQM and Lean in this aspect is the precision in defining waste. In the majority of the Lean literature, waste or *muda* is based on the seven forms[1] defined by Ohno (1988), whereas TQM has a very general definition of *poor-*

[1] Transportation, Inventory, Motion, Waiting, Overproduction, Overprocessing, Defects

quality-costs, including everything that could be eliminated through improvement (Sörqvist, 1998).

Employees and the quality of their work

One major critique of the Lean concept is that it is generally weak concerning the employees' perspective. The proponents of Lean Production usually have a strong instrumental and managerial perspective, discussing employees in terms of components in the production system (cf. Kamata, 1982; Berggren, 1992, 1993); .

The extensive discussion about *jidoka* and *poka yoke* in the Lean literature suggests that employees cannot be trusted to produce good quality, thus creating a necessity for removing the possibility of human error from the system.

Organizations as systems

One thing that Lean and TQM have in common is seeing the organization as a system (*cf. Womack & Jones, 2003; Bicheno, 2004)*. But there is a slight difference in perspective between the two concepts. Whereas TQM has a strong focus on the internal structure and integration of departments within the organization, Lean stresses a supply chain perspective, seeing the internal production operations as a part of a *value stream* from the sub-suppliers to the end customer (*e.g.* Rother & Shook, 1998; Jones & Womack, 2002).

Quality is the responsibility of senior management

This is another perspective that Lean and TQM share, but again with some differences. TQM-managers should create structures that support the employees in producing products of high quality (Deming, 1986; Hackman & Wageman, 1995). The idea is the same in Lean, but the rationale for doing this seems to be centered around eliminating the human factor from the system through *jidoka* and *poka yoke*. Using the terminology of McGregor, one could argue that TQM seems to be based on *theory Y*, whereas Lean seems to be based on *theory X* (*cf.* Ezzamel et al., 2001).

Change principles

Focus on processes

Within the Lean concept the term *value stream* is usually preferred (Womack & Jones, 2003). The term *process* is usually used at a lower level of abstraction that TQM theorists would call *sub-processes* or *activities* (*cf.* Riley, 1998). The conception that management should analyze and improve the processes and train the employees is also shared by the two concepts.

Management by fact

The literature on Lean does not really stress the *management by facts* explicitly. However, this is implicit in the description of Lean practices, many of which are analytical tools designed to help achieve JIT production. Although this is a shared perspective between Lean and TQM, there is a difference. Within TQM the analysis of variability through using statistical tools is a central concept (Hackman & Wageman, 1995). In the Lean tradition, this is not seen as equally important. In fact, some authors argue *against* the use of statistical tools for analyzing production performance, recommending alternative tools such as increased inspection and visualization of problems (*e.g.* Dennis, 2002; Liker, 2004).

Learning and continuous improvement

In the words of Hackman and Wageman (1995) TQM is "pro-learning, with a vengeance" (p. 330). The learning aspects are not emphasized as much in literature on Lean. As discussed above, the Lean literature is generally weaker on the human behavior side, focusing more on instrumental techniques for improving system performance. There is a clear focus on continuous improvement, which implies that some form of learning is required. However, the question is *who* is learning. TQM is focused on stimulating creativity and individual efforts for improvement (Hackman & Wageman, 1995), whereas Lean places strong emphasis on the standardization of work and collective learning (Niepce & Molleman, 1998; Thompson & Wallace, 1996).

Interventions

Analysis of customer requirements

Customer focus is one of the hallmarks of TQM, where every improvement should be based on an investigation of the customer's requirements, whether the customer is internal or external. The Lean concept does not emphasize customer interests. Some authors argue that the very purpose of Lean is to please the customer (***e.g.*** Dennis, 2002), but methods for analyzing customer requirements are extremely rare in the reviewed literature, suggesting this is not a typical Lean intervention.

Supplier partnerships

The suppliers are seen as important in both Lean and TQM. Both concept stress the point that long term partnerships should be made with suppliers and that improvements should be done in collaboration with them. Although this matter is not discussed by all authors in this analysis, the majority of them do (***cf.*** Table 1).

Improvement teams

Quality circles have a central role in much of the TQM literature, and can be put to use in problem solving or improvement activities. In the Lean literature, Improvement teams are explicitly discussed by just about half of the reviewed authors. However, they are often implicated in discussions about improvement activities.

Scientific methods for performance measurement and improvement

Both TQM and Lean employ various scientific methods for analysis and evaluation of performance. However, these methods differ significantly, and the tools associated with one concept are generally not mentioned in literature on the other one. The purpose of measurements also differs. In TQM measurements are done in order to identify problems and to document improvement, whereas Lean theorists argue that measurements should be made for planning and synchronization purposes; e.g. for setting production rate (***cf.*** Ohno, 1988; Bicheno, 2004).

Process management techniques

As discussed above, the term *process* is used in slightly different ways by authors on TQM and Lean. In the Lean literature, different techniques are presented for both overall process level and individual activities. At an organizational level *value stream mapping* (VSM) can be used for highlighting several kinds of problems in the

processes (Rother & Shook, 1998). At a more operational level, different time/work study techniques are discussed, e.g. so-called *spaghetti charts* (*e.g.* Bicheno, 2004).

Lean and TQM – same but different

At a philosophical level, Lean and TQM have many ideas in common, in particular concerning continuous improvement and the systems perspective. However, at a more operational level, the two concepts differ significantly. The fundamental values of the two concepts are also quite different, especially regarding humanistic values.

CONCLUSIONS

There is no agreed upon definition of Lean that could be found in the reviewed literature, and the formulations of the overall purpose of the concept are divergent. Discomforting as this may seem for Lean proponents, there seems to be quite good agreement on the characteristics that define the concept, leading to the conclusion that the concept is defined in operational terms alone. Formulating a definition that captures all the dimensions of Lean is a formidable challenge.

According to Muffatto (1999) and Hines et al. (2004) Lean is constantly evolving, implying that any 'definition' of the concept will only be a 'still image' of a moving target, only being valid in a certain point in time. This may be an explanation to the apparent differences between authors on the subject. Based on this, it is hard not to raise the question of whether a consistent definition of Lean is possible to produce. Also, one can question whether a definition will be useful at all, regarding the ever changing nature of the type of constructs that management concepts such as TQM and Lean are. Nonetheless, attempts have been made in this article to present the essentials of Lean Production and convey its most salient philosophical elements, hopefully clearing up some of the confusion that surrounds the concept.

Lean is also significantly different from its closest relative TQM, leading to the conclusion that Lean is a management concept of its own. The conclusion from Shah & Ward (2003) that TQM and other bundles are parts of Lean is not supported by this study.

Womack et al. (1990) argue that the Lean principles are applicable to any industry. If this is correct, then the Japanese should logically have distributed the knowledge of these principles throughout all domestic Japanese industry. This does not seem to be the case. The only 'true' Lean producers in Japan are confined to the automobile industry, represented by *e.g.* Toyota, Honda and Mazda, whereas other areas of industry are performing at the same level as (or worse than) western competitors.[2] This was pointed out more than 20 years ago by Keys & Miller (1984), implying that the principles constituting LP have not received any wide-spread attention outside the auto-industry. Cooney (2002) argues that the possibility to become 'lean' (through JIT in particular) is highly dependent upon business conditions that are not always met, thus limiting the 'universality' of the concept.

When embarking on a journey towards Lean, it is important to acknowledge the different perspectives that the concept comprises. Raising the awareness of these differences may help make the message clearer and avoid conflicting opinions on which concept the organization is implementing. The obvious fallibility of the

[2] Shu Yamada, University of Tsukuba – Seminar at Linköping University, 2007

claimed universality of Lean should help motivate an adaptational approach to implementing the concept, aiming to find a production concept that agrees with the contextual factors and previous production practices that exist within the organization. Making active choices with regard to values and techniques should increase the odds of succeeding in the improvement of the production system.

REFERENCES

References marked with an asterisk (*) are results of the literature search.

*Adler, P. S., & Cole, R. E. (1993). Designed for learning - a tale of 2 auto plants. *Sloan Management Review, 34*(3), 85-94.

Andersson, R., Eriksson, H. & Torstensson, H. (2006). Similarities and differences between TQM, six sigma and lean. *The TQM Magazine*, 18(3), 282-296.

*Benders, J., & Van Bijsterveld, M. (2000). Leaning on lean: The reception of a management fashion in germany. *New Technology, Work and Employment, 15*(1), 50-64.

Berggren, C. (1992). *Alternatives to Lean Production: Work Organization in the Swedish Auto Industry*. New York: ILR Press

*Berggren, C. (1993). Lean production - the end of history. *Work Employment and Society, 7*(2), 163-188.

Bicheno, J. (2004). *The new lean toolbox: Towards fast, flexible flow* (3rd ed.). Buckingham: PICSIE Books.

Boaden, R. (1997). What is total quality management ... and does it matter? *Total Quality Management & Business Excellence, 8*(4), 153-171.

*Cappelli, P., & Rogovsky, N. (1998). Employee involvement and organizational citizenship: Implications for labor law reform and "lean production". *Industrial and Labor Relations Review, 51*(4), 633-653.

Conti, R., Angelis, J., Cooper, C., Faragher, B., & Gill, C. (2006). The effects of lean production on worker job stress. *International Journal of Operations & Production Management, 26*(9), 1013-1038.

Cooney, R. (2002). Is "lean" a universal production system? – Batch production in the automotive industry. *International Journal of Operations & Production Management, 22*(10), 1130-1147.

*Cusumano, M. A. (1994). The limits of lean. *Sloan Management Review, 35*(4), 27-32.

*Cutchergershenfeld, J., Nitta, M., Barrett, B., Belhedi, N., Bullard, J., Coutchie, C., et al. (1994). Japanese team-based work systems in north-america - explaining the diversity. *California Management Review, 37*(1), 42-64.

*Dankbaar, B. (1997). Lean production: Denial, confirmation or extension of sociotechnical systems design? *Human Relations, 50*(5), 567-583.

*Delbridge, R., Lowe, J., & Oliver, N. (2000). Shopfloor responsibilities under lean teamworking. *Human Relations, 53*(11), 1459-1479.

Deming, W. E. (1986). *Out of the Crisis*, Cambridge: The MIT Press

Dennis, P. (2002). *Lean production simplified: A plain language guide to the world's most powerful production system*. New York: Productivity Press.

*Dyer, J. H. (1994). Dedicated assets - japan manufacturing edge. *Harvard Business Review, 72*(6), 174-178.

Engström, T., Jonsson, D., & Medbo, L. (1996). Production model discourse and experiences from the swedish automotive industry. *International Journal of Operations & Production Management, 16*(2), 141-158.

*Ezzamel, M., Willmott, H., & Worthington, F. (2001). Power, control and resistance in 'the factory that time forgot'. *Journal of Management Studies, 38*(8), 1053-1079.

Feld, W. M. (2001). *Lean manufacturing: Tools, techniques, and how to use them*. Boca Raton: St. Lucie Press.

*Godfrey, G., Dale, B., Marchington, M., & Wilkinson, A. (1997). Control: A contested concept in TQM research. *International Journal of Operations & Production Management, 17*(6), 558-573.

Hackman, J. R., & Wageman, R. (1995). Total quality management: Empirical, conceptual, and practical issues. *Administrative Science Quarterly, 40*(2)

*Hayes, R. H., & Pisano, G. P. (1994). Beyond world-class - the new manufacturing strategy. *Harvard Business Review, 72*(1), 77-86.

Hines, P., Holweg, M., & Rich, N. (2004). Learning to evolve: A review of contemporary lean thinking. *International Journal of Operations & Production Management, 24*(10), 994-1011.

*Jagdev, H. S., & Browne, J. (1998). The extended enterprise - a context for manufacturing. *Production Planning & Control, 9*(3), 216-229.

*James-Moore, S. M., & Gibbons, A. (1997). Is lean manufacture universally relevant? an investigative methodology. *International Journal of Operations and Production Management, 17*(9), 899-911.

Jens J. Dahlgaard, & Su Mi Dahlgaard-Park. (2006). Lean production, six sigma quality, TQM and company culture. *TQM Magazine, 18*(3), 263-281.

Jones, D. T., & Womack, J. P. (2002). *Seeing the whole* Lean Enterprise Inst Brookline, MA.

Kamata, S. (1982). *Japan in the passing lane: An insider's account of life in a japanese auto factory* Pantheon Books.

Karlsson, C., & Åhlström, P. (1996). Assessing changes towards lean production. *International Journal of Operations & Production Management, 16*(2), 24-41.

*Karlsson, C., & Åhlström, P. (1997). A lean and global smaller firm? *International Journal of Operations and Production Management, 17*(10), 940-952.

Keys, J. B. & Miller, T. R. (1984). The Japanese Management Theory Jungle. The Academy of Management Review, 9(2), 342-353

*King, A. A., & Lenox, M. J. (2001). Lean and green? an empirical examination of the relationship between lean production and environmental performance. *Production and Operations Management, 10*(3), 244-256.

*Krafcik, J. F. (1988). Triumph of the lean production system. *Sloan Management Review, 30*(1), 41-51.

*Lamming, R. (1996). Squaring lean supply with supply chain management. *International Journal of Operations & Production Management, 16*(2), 183-&.

*Lewis, M. A. (2000). Lean production and sustainable competitive advantage. *International Journal of Operations & Production Management, 20*(8), 959-978.

Liker, J. K. (1998). *Becoming Lean: Inside Stories of U.S. Manufacturers*. New York: Productivity Press

Liker, J. K. (2004). *The toyota way: 14 management principles from the World's greatest manufacturer*. New York: McGraw-Hill.

*Lowe, J., Delbridge, R., & Oliver, N. (1997). High-performance manufacturing: Evidence from the automotive components industry. *Organization Studies, 18*(5), 783-798.

*MacDuffie, J. P., & Helper, S. (1997). Creating lean suppliers: Diffusing lean production throughout the supply chain. *California Management Review, 39*(4), 118-&.

*MacDuffie, J. P., Sethuraman, K., & Fisher, M. L. (1996). Product variety and manufacturing performance: Evidence from the international automotive assembly plant study. *Management Science, 42*(3), 350-369.

*Mason-Jones, R., & Towill, D. R. (1997). Information enrichment: Designing the supply chain for competitive advantage. *Supply Chain Management, 2*(4), 137-148.

Monden, Y. (1998). *Toyota production system: An integrated approach to just-in-time* (2nd ed.). London: Chapman & Hall.

*Mueller, F. (1994). Societal effect, organizational effect and globalization. *Organization Studies, 15*(3), 407-428.

*Mumford, E. (1994). New treatments or old remedies: Is business process reengineering really socio-technical design? *Journal of Strategic Information Systems, 3*(4), 313-326.

*Naylor, J. B., Naim, M. M., & Berry, D. (1999). Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain. *International Journal of Production Economics, 62*(1-2), 107-118.

Nicholas, J., & Soni, A. (2006). *The portal to lean production: Principles and practices for doing more with less* CRC Press.

*Niepce, W., & Molleman, E. (1998). Work design issues in lean production from a sociotechnical systems perspective: Neo-taylorism or the next step in sociotechnical design? *Human Relations, 51*(3), 259-286.

Ohno, T. (1988). *Toyota production system: Beyond large-scale production.* Portland: Productivity Press.

*Oliver, N., Delbridge, R., & Lowe, J. (1996). Lean production practices: International comparisons in the auto components industry. *British Journal of Management, 7*(SPEC. ISS.)

Parker, S. K. (2003). Longitudinal effects of lean production on employee outcomes and the mediating role of work characteristics. *The Journal of Applied Psychology, 88*(4), 620-634.

Riley, J. F. (1998) Process Management. In: Juran, J. M., & Godfrey, A. B. (eds.). *Juran's quality handbook*. New York: McGraw-Hill

Rother, M., & Shook, J. (1998). *Learning to see: Value stream mapping to create value and eliminate muda*. Brookline: Lean Enterprise Institute.,

*Sa̓nchez, A. M., & Pérez, M. P. (2001). Lean indicators and manufacturing strategies. *International Journal of Operations and Production Management, 21*(11), 1433-1451.

*Scarbrough, H. (1998). The unmaking of management? change and continuity in british management in the 1990s. *Human Relations, 51*(6), 691-715.

Schonberger, R. J. (1982). *Japanese manufacturing techniques: Nine hidden lessons in simplicity*. New York: Free Press.

*Shah, R., & Ward, P. T. (2003). Lean manufacturing: Context, practice bundles, and performance. *Journal of Operations Management, 21*(2), 129-149.

Shah, R., & Ward, P. T. (2007). Defining and developing measures of lean production. *Journal of Operations Management, 25*(4), 785-805.

*Shaiken, H., Lopez, S., & Mankita, I. (1997). Two routes to team production: Saturn and chrysler compared. *Industrial Relations, 36*(1), 17-45.

Shingo, S. (1984). *A study of the toyota production system from an industrial engineering viewpoint*. Tokyo: Japan Management Association.

Smalley, A. (2004). *Creating level pull*. Brookline: Lean Enterprise Institute.

Sörqvist, L. (1998). *Poor quality costing*. Stockholm: Royal Institute of Technology

*Thompson, P., & Wallace, T. (1996). Redesigning production through teamworking - case studies from the volvo truck corporation. *International Journal of Operations & Production Management, 16*(2), 103-&.

*Weinberg, G. M. (1992). *Quality software management (vol. 1): Systems thinking* New York: Dorset House Publishing Co.

*White, R. E., & Prybutok, V. (2001). The relationship between JIT practices and type of production system. *Omega, 29*(2), 113-124.

*Williams, K., Haslam, C., Williams, J., Cutler, T., Adcroft, A., & Johal, S. (1992). Against lean production. *Economy and Society, 21*(3), 321-354.

*Womack, J. P., & Jones, D. T. (1994). From lean production to the lean enterprise. *Harvard Business Review, 72*(2), 93-103.

Womack, J. P., & Jones, D. T. (2003). *Lean thinking: Banish waste and create wealth in your corporation* New York: Free Press.

Womack, J. P., Jones, D. T., & Roos, D. (1990). *The machine that changed the world: The story of lean production*. New York: Rawson Associates.

*Wood, S. (1999). Human resource management and performance. *International Journal of Management Reviews, 1*(4), 367-413.

*Zhu, Q. H., & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in chinese manufacturing enterprises. *Journal of Operations Management, 22*(3), 265-289.