A Review of Lean Development: origins, principles and practices

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Abstract
In the recent context of increased competition, a strong push for innovation has appeared in most industries. A number of solutions to improve the performance of R&D and product development processes have appeared in both academy and practice. Among these approaches, special attention has been given to Lean Development. Although academic literature about Lean Development is still scarce, this concept was particularly well received by practitioners. This paper aims to cover this gap by presenting a theoretical review on the topic of Lean Development. It highlights a historical retrospective on the origins of Lean Development and comments on a number of current practices associated with this approach.
Keywords: lean development; lean thinking; innovation management; innovation practices and tools.

1 Introduction

Independently of time, industry or country, management is always aiming at improving efficiency, that is, to achieve an organization's goals with the minimum amount of resources. This imperative has become even more prominent in the last decades, as competitive pressures build up in a globalized, integrated and interconnected business environment where industry boundaries and business models are not clearly defined anymore and the accelerated rate of technological progress push customer expectations to ever higher levels.

Given this context of increased competitive pressure, a very common response by manufacturing firms has been to try to improve their ability to introduce new products and processes ahead of the competitors (SCHILLING and HILL, 1998), thus benefiting from first mover advantages. Obviously, such as approach requires an overall improvement in innovation efficiency. However, the process of innovation is inherently complex given its cross-functional nature and the risks associated with ever changing customer expectations, and even small gains in efficiency can be hard to achieve.

A number of tools and methods have been proposed to improve innovation efficiency, particularly within the product development process. Many proposals are originated in process management literature and practice (ADLER et al., 1996). Among these, one that has gained much attention in recent years is the "Lean Development" approach or, as Morgan and Liker (2006) put it, the "Toyota Product Development System". Basically, it means the adoption of the "lean" paradigm, originally developed within the operations management area, to product development activities. However, although very popular particularly in practitioners' circles, there is a striking lack of published academic research on this topic. Thus, the aim of this paper is to present a theoretical review on the topic of Lean Development, highlighting a historical retrospective of its origins and commenting on current practices.

This paper is structured as follows: after the Introduction, Section 2 discusses the origins of the lean thinking, while Section 3 presents and comments the principles behind the Lean Development approach. Next, Section 4 brings into discussion the concept of Value System and Section 5 presents a summary of the main practices commonly associated with Lean Development.

2 Origins of the Lean thinking

The origins of Lean Thinking can be traced back to Japan in the years following World War II. At the time, the Toyota Motor Company had to reinvent its manufacturing management model in order to compete with very limited resources in a national market recently devastated by war. As a response, Toyota managers developed over the years a very efficient small-lot, just-in-time manufacturing approach that allowed the company to increase both quality and productivity at the same time. Given that these positive results were attained even with the deployment of fewer resources, it was commonly referred to as the "lean" approach. Since then, the lean manufacturing paradigm has been systematically studied and copied all over the Western world (WOMACK and JONES, 1994). The next obvious step was to extend the lean paradigm to more than operations management. This extension has become known as Lean Thinking.

Thus, Lean Thinking is basically an approach to management that aims to minimize waste and increase value adding activities with a focus on customer needs. The concept of customer value represents the fundamental element in Lean Thinking (SCHUH, LENDERS, HIEBER, 2008). Although Lean is a new approach in product development management, it has been applied in operations management for at least 30 years (THYESSEN et al., 2008). In this context, the lean approach encompasses a wide variety of management practices, such as Just-in-Time (JIT), quality systems, work teams, cellular manufacturing, supplier management, etc. (GATI-WECHSLER and TORRES, 2008). These practices were first used in the Japanese automotive companies in the early 1980's (GATI-WECHSLER and TORRES, 2008; METHA, ANDERSON and RAFFO, 2008). In early studies about this kind of production management system, researchers coined the term 'lean manufacturing' by stating that the Japanese seem to be really lean in the consumption of resources to produce automobiles, and it seems that they are pursuing what can be called lean manufacturing (METHA, ANDERSON, RAFFO, 2008).

Product development is the second "Toyota paradox" (the first is production), as the company's lean mentality allows innovation to be more frequent and efficient in terms of productivity (GATI-WECHSLER, TORRES, 2008). Nowadays, the intention of Lean Innovation is the transfer of the Lean Thinking approach to the management of R&D. It means, basically, that product differentiation strategies have to be achieved under a more constrained regime, that is, within a context of reduced deployment of resources. This is the central objective of Lean Innovation – by applying the Lean Thinking principles to R&D management (SCHUH, LENDERS, HIEBER, 2008).

But the implementation of Lean Thinking in innovation management has not been executed systematically so far (SCHUH, LENDERS, HIEBER, 2008). For instance, Schuh, Lenders and Hieber (2008) surveyed 143 companies in the German manufacturing industry in 2007. Results have shown that only a third of the companies have begun to systematically identify waste in their product development processes. Therefore, it can be seen that many companies have still problems to identify and implement the Lean principles. These principles will be presented next.

3 Lean Innovation and Development Principles

According to Mehta, Anderson and Raffo (2008), in the Lean approach functional managers should then be made responsible for managing and achieving the leadtime goals of intermediate subprojects, the elimination of waste in the coding activities using the concept of value-added tasks and non-value-added tasks, and reduction of common cause variation in the form of small errors. Lean defines value-added tasks as activities that add value to the process as defined by the final customer, and non-value-added tasks are activities which the final customer would not like to pay to be performed, and would like them to be altogether eliminated.

However, for Mehta, Anderson and Raffo (2008), Lean is not only a process improvement and control tool but it is also a cultural movement for continuous improvement utilizing the joint efforts of the very people who perform the work on a day-to-day basis. (METHA, ANDERSON, RAFFO, 2008). In lean thought there has to be an effort to create a culture of continuous improvement through team training and team-facilitation assistance. To promote this, joint metrics for team achievements and accountability should be instituted. In such an environment, senior management should promote a failure tolerant culture to encourage risk taking and learning new methods to solve old problems.

Some Lean characteristics can be synthesized in the following principles (GATI-WECHSLER, TORRES, 2008; POPPENDIECK, POPPENDIECK, 2003; METHA, ANDERSON, RAFFO, 2008):

a) Eliminate Waste. Do only what adds value for a customer, and do it without delay.

b) Delay Commitment. Make decisions at the last responsible moment.

c) Deliver Fast. The measure of the maturity of an organization is the speed at which it can repeatedly and reliably respond to customer need.

d) Empower the Team. Assemble an expert workforce, provide technical leadership and delegate the responsibility to the workers.

e) Build Integrity In. Have the disciplines in place to assure that a system will delight customers both upon initial delivery and over the long term.

f) See the Whole. Use measurements and incentives focused on achieving the overall goal.

g) Continuous improvement as an incremental innovation, both for processes and for products.

h) Amplify Learning. Experience and production training to allocate personnel to other areas, focus on shop floor work as a key aspect of developing a learning organization.

i) Focus on the experiment. Focus is on on data obtained from experiments conducted in a real environment, whether represented by production of many prototypes as part of the R&D process, by the implementation of shop floor kaizen, or by other practices.

j) Multiskilling. All modifications, whether to processes or to products, are discussed by multi-functional groups in which people are strongly interrelated.

k) Relationship between lean manufacturing and R&D. It is one of mutual reinforcement of lean principles.

Another approach to describe Lean Thinking was proposed by Schuh, Lenders e Hieber (2008). These authors propose a Lean Innovation approach relied on ten key principles that need to be implemented in R&D (Figure 1). The ten principles are distributed in three principal Lean characteristics: (i) Structure early, (ii) Synchronise Easily and (iii) Adapt Securely.

Structure Early aims on a motivated project team, concrete, transparent and prioritized requirements and values, as well as the composition of project and process as a basis for an efficient and synchronized development. Synchronize Easily requires value stream mapping, capacity planning and synchronization to arrange all activities as effective as possible. Adapt Securely provides the basis for a sustainable adjustment of robust products to changing market requirements (SCHUH, LENDERS e HIEBER, 2008).

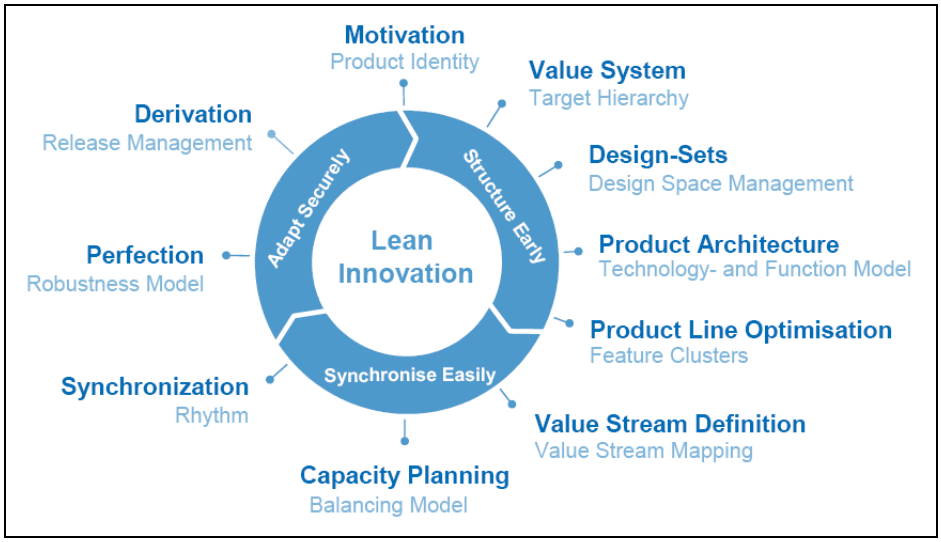

Figure 1: Lean innovation characteristics
Source: Schuch, Lenders & Hieber (2008)

4 The Value System in Lean Innovation

In order to provide the customer with a product that satisfies his individual requirements, two main processes must be executed in the Lean Innovation Approach. The first process includes the transformation of customer needs into detailed technical requirements at the beginning of a project. The second process includes the handling of requirements during the development process. In order to deal with changing and new requirements, a consequent configuration management and change management has to be included as well. A frequent cause for wrong decisions and late iterations is the missing transparency of customer values and needs as well as resulting project objectives. Even if customer requirements are known, they run out of focus during projects very often. An emphasis on techniques and technologies leads to Overengineering. Contrarily, lowered competitor prices enforce cost-savings, which provide the risk of under-fulfilment of innovation performance (see Figure 2).

In terms of Lean Thinking, one aim is the value oriented design of processes. The ability to create a Lean Innovation by an implemented value stream in product development needs more than just the right definition of mere customer requirements - relevant customer values and the resulting objectives for a specific development project have to be defined previously, as well.

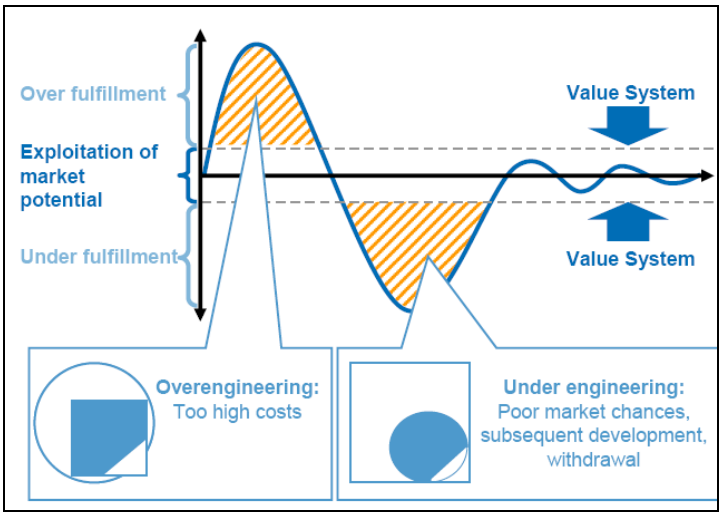

Figure 2: System Value in Lean Innovation
Source: Schuch, Lenders & Hieber (2008)

Essential for Lean Innovation is a definition of value for a development project. Therefore starting point of Lean Innovation is a systematic method to define and handle target values and requirements regarding process and product as an enabler for a lean development process – the Value System. The Value System represents a framework for mapping value in a holistic, hierarchical, dynamic and transparent way.

5 Lean Development Practices

Literature cites some Lean Development Best Practices used by the Toyota Company. These practices will be presented next.

Practices cited by Thyssen et al. (2008):

a) Extensive customer analysis prior to each development program.

b) A strong leader who is responsible for the development from start to finish and acts as a system integrator.

c) The leader and his staff write a concept paper describing the vision that is to be regarded as the law of the program. Work is aligned by decomposing the vision in specific objective for each functional team.

d) Cross functional cooperation is achieved through the forming of Module Development Teams.

e) Focus is on face-to-face team integration not coordination.

f) Meetings are kept effective through extensive preparation and the use of simple and visual communication.

g) A lot of resources are spent in the early phase of development.

h) Product and production are co-developed and system compatibility is given high priority.

i) Information is ‘pulled’ just in time.

j) Engineers performs a hand on approach and integrates relevant suppliers in the development process.

k) Process, engineering skills and components are standardized as a means for productivity and continuous improvement.

l) A learning culture, which honors and actively ‘produces’ highly skilled engineers, with a constant strive for improvements.

Practices cited by Gati-Wechsler and Torres (2008):

a) Gatekeepers that reduce the impact of communication barriers between their project team and information-generating areas.

b) Multidisciplinary work teams in the NPD process, with some advantages as the following: (i) they are able to cross vertical hierarchical lines; (ii) they decentralize the decision making process; (iii) they reduce the amount of information for higher levels.

c) Employ traditional matrix structures, and do not use dedicated or co-located teams. Some engineers work together during the entire project; the remainder only take part in critical stages (such as prototyping) and are coordinated by an experienced head ngineer, whose job it is to ensure that participants do not make overly hasty decisions.

d) Use a relatively small group for each project to organize them as best as possible.

e) design engineers use a checklist or "lessons learned book" to record the evolution of knowledge in projects.

f) Employ a set-based concurrent engineering (several groups work on the project and converge on a solution), in which alternative parameters are explored within a predetermined range.

g) Using many prototypes before the final project and porting the final project to production, therefore increasing personnel integration with the project.

These lean practices speed up the product development process and make its implementation and production phases more efficient. Due to its use of these practices, Toyota has been considered the most innovative manufacturer in the auto sector (GATI-WECHSLER, TORRES, 2008).

Although hard to fully appreciate without explanatory examples, a quick summary of the 13 principles constituting the framework on which Morgan and Liker (2006) hang Toyota Product Development System give a flavor for the book:

a) Establish customer-defined value to separate value-added from waste.

b) Front-load the product design process while there is design space to thoroughly explore alternative solutions.

c) Create a leveled product development process flow.

d) Use rigorous standardization to reduce variation, thereby creating both flexibility and predictable outcomes.

e) Develop a chief engineer system to integrate development from start to finish.

f) Organize to balance functional expertise and cross-functional integration (more is involved here than your father's matrix management).

g) Develop towering technical competence in all engineers.

h) Fully integrate suppliers into the product development system.

i) Build in learning and continuous improvement.

j) Build a culture to support excellence and relentless improvement.

k) Adapt technology to fit your people and your processes.

l) Align your organization through simple, visual communication.

m) Use powerful tools for standardization and organizational learning.

6 Conclusions

This paper has presented an overview about what Lean Development is and which are the main principles and practices involved in this approach. Summarizing what has been presented, we can say that Lean is a new approach for product development that proposes a simpler manner to deal with the product development project structure. Therefore, managers can use such approach to improve the value of project activities by reducing

unnecessary stages and tasks and by focusing on customer added value. So, several activities were described here which can help to achieve this goal. Based on this overview, future works could focus on a systematization of such principles and practices in a framework, aiming at proposing an organized way to implement Lean Development in traditional product development structures.

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