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Designing Workshops for the Introduction of Lean Enablers to Engineering Programs

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Selection and peer-review under responsibility of the University of Southern California.

Abstract

There is a large and growing body of knowledge regarding so-called Lean best practices, including most recently in the area of program management and systems engineering. However, there is little elaboration of how these documented best practices are to be introduced to a professional workforce. One way of introducing new practices to a workforce is through the use of training workshops, but there is no well-defined method or framework to systematically design workshops for the implementation of a new body of knowledge. This study focuses on the development of a framework that facilitates the systematic design of workshops focused specifically on the introduction of Lean principles and practices to program management and the professional workforce in a program environment. The framework is based on a thorough review of literature on training, workshop delivery, and Lean principles, as well as empirical evidence obtained from data collection and interactions with training professionals from industry. It is embodied in an Excel-based tool that allows the user to quickly assemble a structure for the workshop, including the topic, an agenda and defined goals, and also the theoretical content about the Lean principles. The framework was validated through interactions with training professionals in a large automobile manufacturer, and using subject matter experts from a variety of industrial sectors.

Selection and peer-review under responsibility of the University of Southern California.

Keyword: Lean Enablers, Lean, Program Management, Workshops, LEIW-Framework

1. Introduction

Large-scale engineering programs are one of the most difficult, risky, and – when well done – rewarding undertakings a government or company can attempt[1]. Numerous best practices exist in the domains of project management[2], systems engineering[3] and Lean thinking[4] that deliver concrete advice to program managers to increase their program's performance. Most recently, a best practice collection called "Lean Enablers for Managing Engineering Programs" was developed at the Massachusetts Institute of Technology, which specifically addresses challenges related to the effectiveness, the efficiency and the human aspects in large scale engineering programs. The core of this guidebook contains 43 Lean best practices, also referred to as the Lean Enablers[1]. The Lean Enablers are clustered in six different so-called Lean Principles. Their titles are Value, Value Stream, Flow, Pull, Perfection and Respect for People. The 43 Lean Enablers further contain 286 Sub-enablers, which provide additional detailed guidance on these practices[1].

Since these Lean Enablers are based on best practices from the industry and academia, many of them are already being used in engineering programs. Thus, applying the Lean Enablers to a new or an on-going program would require two steps: First, the Lean Enablers with the highest improvement potential would need to be identified. Second, these selected Enablers would need to be implemented in the program. The implementation could either be achieved through a strategic transformation or a continuous improvement approach[1].

Once the Lean Enablers with the highest improvement potential are identified, the change process starts. The communications accompanying this change are a crucial element in employees' receptivity of this change, which becomes a significant issue for those involved in creating successful change implementation strategies[5]. Workshops are among the most popular training devices in higher education[6] and have a great effect in change communication.

This paper introduces a framework that supports the operationalization of Lean Enablers by facilitating the design of engaging educational-oriented implementation workshops. Through these workshops, Lean Thinking is implemented in engineering programs.

2. The Lean Enablers

The Lean Enablers are a set of Lean best practices, which have been developed specifically for the improvement of large-scale engineering programs. There are 43 Lean Enablers in total, which are sorted according to the six Lean Principals (Value, Value Stream, Flow, Pull, Perfection and Respect for People). The Lean Enablers are subdivided into 286 Sub-enablers. The first Lean Enabler of the first Principle, for example, states: "Build a program based on

respect for people". The first Sub-enabler of this Enabler then states, "Understand that programs fail or succeed primarily based on people, not processes. Treat people as the most valued assets, not as commodities." The Sub-enablers give more details on what needs to be undertaken in order to fully implement the Lean Enabler. The Guide to Lean Enablers for Managing Engineering Programs[1] furthermore gives a number of examples for each Lean Enabler, shows which program performance domain the Lean Enabler is related to, indicates which challenge the Lean Enabler addresses and also links each Lean Enabler to the appropriate process number of the systems engineering process.

3. Potential Workshops for the Implementation of Lean Enablers

This section describes how the need for a standardized framework for the development of implementation workshops for Lean Enablers was identified. The overall approach was to examine, to what degree existing Lean workshops already addressed the Lean Enablers and if these could be used for their implementation.

3.1. Identification of Potential Workshops

In order to understand which Lean Enablers are already being addressed by existing workshops, an expert workshop was conducted, in which the participants were asked to map workshops from the field of Lean against the Lean Enablers. Eleven workshops were suggested by the participants of the expert workshop.

A mapping of these existing workshops against the Lean Enablers, which was done by the participants of the workshop, resulted in Fig. 1. The figure shows one column for each Lean Principle, listing the Lean Enablers that fall under each Principle. The number in the colored field indicates the amount of times the Lean Enabler has been identified as being addressed in a workshop. The three-color code indicates whether there are more than one workshop (green), only one (yellow) or no workshops at all (red) that address the particular Lean Enabler.

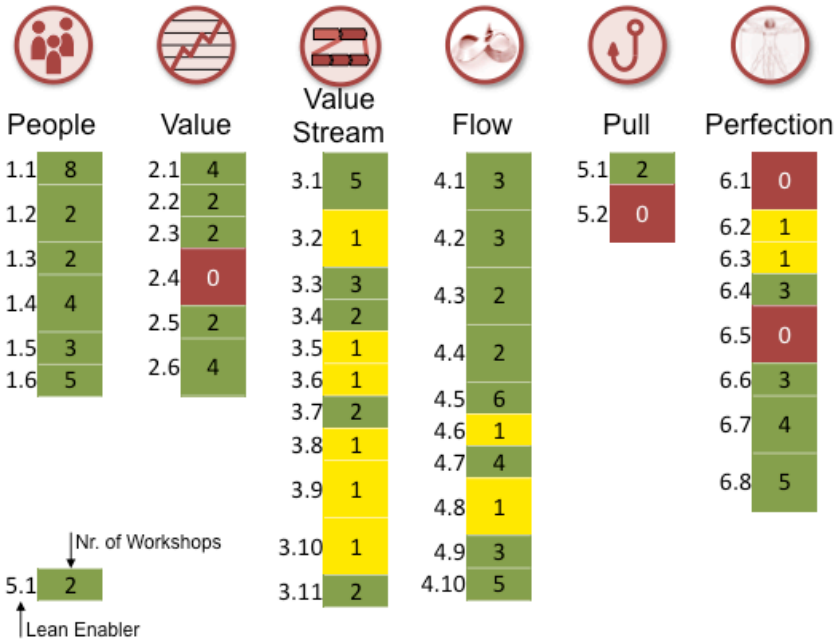

Fig. 1. Mapping of Lean Enablers to existing workshops

Fig. 1 shows that 93% of all Lean Enablers are being addressed through at least one of the eleven workshops. Furthermore, almost 70% of the Lean Enablers are being addressed by more than one of the workshops. The main

conclusion that was drawn from these results was that almost all Lean Enablers are being addressed in existing corporate and academic workshops.

3.2. The need for a Standardized Workshop Framework

Having a pool of workshops that address the Lean Enablers would be a first solution for the workshop-based implementation of Lean Enablers. There are three major problems with this approach though:

- The workshops are not always accessible, since most of them have been developed inside a company or organization, which wouldn't share the content for competitive advantage reasons.
- Since the workshops come from different sources, they all use different frameworks and workshop techniques. For the facilitator it would be hard to align them in a way that they are all conducted using a consistent approach.
- Having a set of predefined workshops which all implement specific Lean Enablers causes the problem that if a set of Lean Enablers should be implemented together, multiple workshops would need to be conducted instead of just one that covers them all.

In expert interviews these conclusions were confirmed[8, 9]. Having a completely standardized set of workshops would not be the right thing to develop, "since the presenter usually wants to be able to adapt the material to his or the company's style of teaching and training[9]".

Based on this feedback, the development of a new workshop framework was begun, which facilitates the development of implementation workshops for Lean Enablers. This decision was validated through a focus group, a group of subject matter experts, as well as through an expert interview.

4. The Lean Enabler Implementation Workshop Framework (LEIW-Framework)

4.1. The Elements of the LEIW-Framework

A workshop development process developed by McGill University[10] served as a structure for the development of the LEIW-Framework. The four main elements of the LEIW-Framework were defined as[11]:

- **Assessment** and prioritization of the high potential Lean Enablers
- **Definition** of the workshop goals, objectives and workshop topics
- **Providing** an agenda structure, topical content and an evaluation survey
- **Matching** workshops methods to the participants and giving a recommendation on which demonstration tools should be used for the selected Lean Enablers

In the following sections, each one of the four elements will be described in more detail.

4.2. The Assessment Process of the LEIW-Framework

The prioritization of the Lean Enablers is done using a risk-based approach. An approach was developed by FRITZ (2013)[16], which served as the primary input for this framework. The assessment basically consists of two parts: (1) An estimation of the criticality of the top ten challenges in engineering programs, and (2) a maturity assessment of the Lean Enablers in use in the program. The criticality of the risks is assessed by first providing the list of challenges and asking participants to estimate their likelihood of occurrence in the program. In a second step their impact is assessed based on a three-level scale. The likelihood and impact values are multiplied to produce the criticality of each risk. The maturity level of the Lean Enablers are assessed using five levels of maturity of implementation for each Lean Enabler, based on a 5-point maturity scale similar to that used in CMMI assessments.

Based on a mapping of the Lean Enablers against the top ten challenges[1], the tool then chooses the Lean Enablers that address the most challenges and that have the lowest degree of implementation. This results in a list of the ten Lean Enablers that have the highest potential of reducing the risk or challenges facing the program should they be

implemented at a higher maturity level. In the further context, these Lean Enablers are referred to as high potential Lean Enablers.

In order to reduce the complexity of the Lean Enablers and give the user of the framework a better understanding of which broad improvement areas and change efforts should be focused on, the high potential Lean Enablers are mapped to impact areas.

The impact areas were derived from the Toyota Production System (TPS) and adjusted to the field of Lean program management and finally validated through discussions with subject matter experts. The TPS can be seen as an integrated and interdependent system involving many elements, that can be split in a triangle, consisting of philosophy, tools and techniques (practical), and management (leadership), which is built around the people of a corporation[12 13].

The impact area needing most to be addressed are assessed for each of the three hierarchy levels, upper leadership, middle management, practitioners level. This assessment is done through a matrix structure, in which the user can select the degree of criticality of each enabler at each level, respectively. On this level of detail, the user of the framework is able to estimate the need as well as the criticality intuitively, without needing further analysis. This was validated through a focus group[11] as well as through discussions with subject matter experts.

4.3. Matching Educational Methods, Active Learning Tools and Workshops

The educational methods for a workshop or training must fulfill the following requirements: They must fit the needs and the performance level of each participant and it must address the target objectives. The process of matching the educational methods to the workshop that is being built by the user of the LEIW-Framework is built around these two main criteria.

The following list shows andragogical factors that have been identified as important for the description of the difference in needs and performance levels between young and adult learners:

- Self-efficacy
- Previous experiences
- Motivation
- Goal-orientation
- Attitude
- Cognitive ability

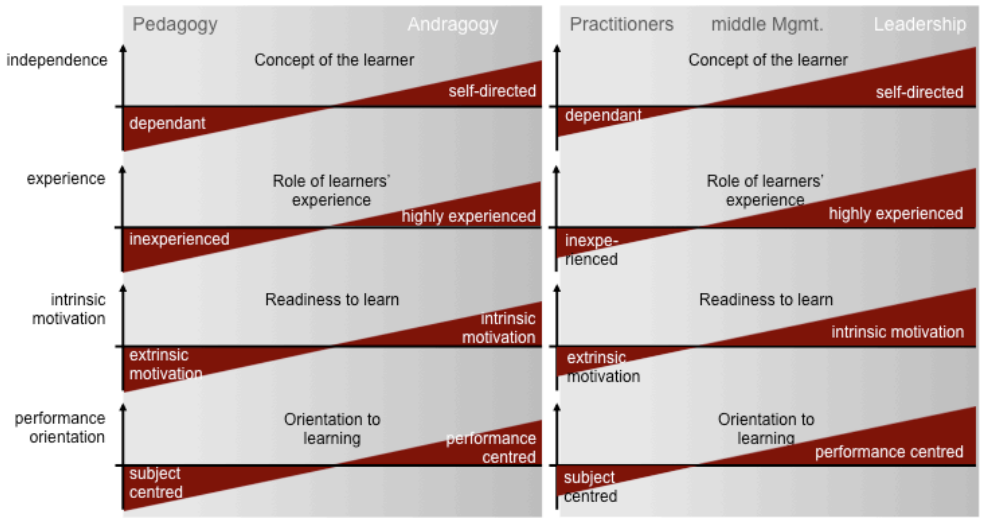

Fig. 1. Analogy of pedagogy vs. andragogy to practitioners vs. leadership

The first four factors have been identified as the most relevant for describing the difference between older, more experienced learners and younger, inexperienced learners. In order to find the right educational methods for each hierarchy level, the assumption has been made that there are parallels between the difference of pedagogy to andragogy and the practitioners' level to the upper leadership level, respectively. Thus, as mature adult learners, upper leaders are generally more self-directed, more experienced, more intrinsically motivated, and more performance-centered than practitioners. **Error! Reference source not found.**2 shows how the comparison between pedagogy to andragogy was used to explain the andragogical differences between practitioners, middle management, and upper leadership.

Based on this assumption the LEIW-Framework evaluates numerous educational methods in a utility value analysis. As a result the user gets a suggestion of a number of different educational methods that can directly be applied in the workshop. The user is able to change the degrees of importance of each of the factors in the utility value analysis to reflect their own audience.

4.4. Defining Topics and Objectives

For each combination of hierarchy level and impact area, one workshop topic and goal is defined. Fig. shows the matrix with the nine different topics that the LEIW-Framework provides.

The objective of every workshop is that having completed the workshop, the participants will have a deep understanding about the implemented Lean Enablers and will be able to conduct a workshop on the content. The mission is that the participants of the workshop will learn the theory about the Lean Enablers and also deeply understand the Lean Enablers through engaging demonstration tools.

Each topic circle in 3 overlaps two levels in the organizational hierarchy. This is consistent with the recommended practice of using a multiplier model (also referred to as the "train-the-trainer") approach for the implementation of the Lean Enablers. For instance, the facilitators might train the upper leadership in a way that they can carry on the knowledge to the middle management and so on.

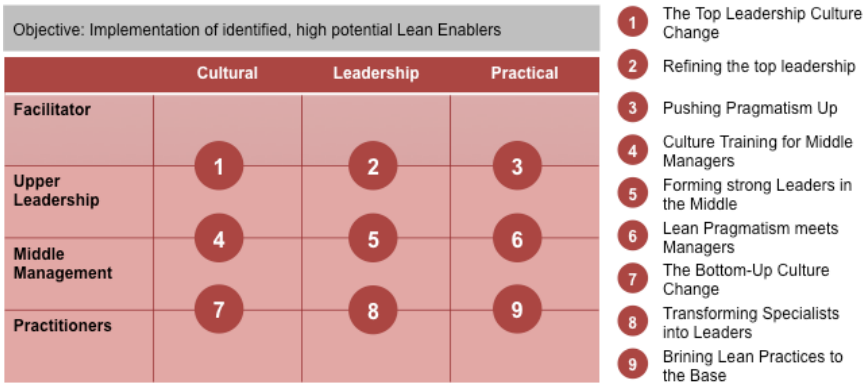

Fig. 3. Multiplier structure with topics of workshops

4.5. Providing the Workshop Content

The objective is that the LEIW-Framework would automatically provide the user with one slide deck on the topical content for each Lean Enabler. Each slide deck has the same structure, which is based on the structure of an existing online Wikipedia reference for Lean program management[†]. The following list shows the main topics of each element of this structure and briefly explains what each element is about:

[†] See http://www.lean-program-management.org/encyclopedia/index.php?title=Main_Page.

1. **Enabler Overview**: Each Lean Enabler is introduced containing the most important facts.
2. **Sub-enablers**: In this section each Sub-enabler of the Lean Enabler is introduced separately.
3. **Implementation suggestion**: Here a short list of important points about the implementation of the Lean Enabler is given. These suggestions are based on the experience of the authors.
4. **Concrete example**: Each example gives a short description of a certain program, in which the Lean Enabler was implemented successfully or in which the Lean Enabler came into play. The examples are based on the experience of the authors.
5. **Metrics**: The list of metrics introduces, which metrics should be for measuring the success of the Lean Enabler. These suggestions are based on research conducted at the Consortium for Engineering Programs.
6. **Additional reading**: Finally, a list of books for additional readings will be provided to the participants of the workshops.

In addition, the LEIW-Framework provides an agenda as well as an evaluation survey that can be directly applied in a workshop or training.

4.6. Selecting demonstration tools for the workshop

Finding the right demonstration tools for the workshop is the next goal of the LEIW-Framework. The selection process is based on a second utility value analysis. The degree to which a demonstration tool fulfills the target criteria of implementing each of the selected Lean Enablers was evaluated according to the process shown in Fig. 4. Through this process, any demonstration tool can be mapped to the Lean Enablers. The LEIW-Framework is designed so that further demonstration tools can easily be implemented into the framework.

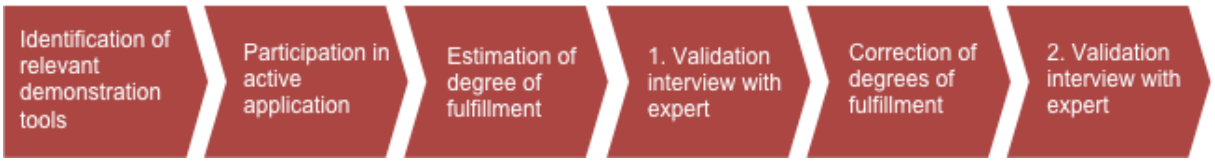

Fig. 4. Process for the evaluation of the degree to which a demonstration tool addresses the Lean Enablers

Once the set of high potential Lean Enablers has been identified, the total utility value of each demonstration tool is calculated by adding up the fulfillment factors for each of the high potential Lean Enablers. The demonstration tool with the highest utility value is then returned to the user of the LEIW-Framework as a recommendation.

4.7. Validating the LEIW-Framework

The feedback from the focus group as well as the interview partner was generally very positive. The feedback about the LEIW-Framework was summed up in these statements from interviews:

- The LEIW-Framework is easy to understand with a little support[14]. It is very powerful and helpful once a company has decided to move in the direction of the Lean Enablers[15]. The tool would instantly tell you what to do which is very helpful[15].
- An interesting use case for the framework would be to use it as a guideline in the structured development process of a workshop[14]. The facilitator would walk through the front-end and the back-end material of the framework while building a new workshop. While doing so, the material would help him structure his thoughts and get interesting ideas for all the different elements of the framework.
- Furthermore, the framework delivers materials and content for the workshop, which can be very helpful and saves a lot of time[15]. Putting templates together and suggesting implementation and demonstration tools is very helpful for the facilitator [8]. In many cases willingness to change is there, but usually in everyday work there is a lack of time to turn it into actual content. The LEIW-Framework would clearly solve this problem[8].

5. Conclusion

The LEIW-Framework gives a facilitator the possibility of constructing a workshop in a very fast and uncomplicated way and therefore enables the implementation of the Lean Principles in engineering programs. The high level of usability as well as the applicability in the corporate environment has been validated through expert interviews and focus groups. The content, which is provided by the framework is very useful and can be directly applied.

The LEIW-Framework was validated through a focus group. The final outcome was furthermore validated through an expert interview. These methods are purely qualitative. Consequently, a major task for further research is the quantitative validation of the usability of the framework.

The quantitative validation could be done based on two different approaches. Either the single elements of the framework are being validated by presenting them to a certain number of experts, asking for their opinions on the framework, or the framework is validated completely based on its outcome. This could be done by designing several implementation workshops for Lean Enablers, conducting them to a numerous participants and finally collect empirical feedback on the workshop quality and its impact. This would be an indirect validation of the framework, which however would contain the critical factor of the influence the facilitator has on the subjective perception of the participants.

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