IDENTIFICATION AND DESIGN OF PILOT PROJECTS TO IMPLEMENT LEAN DEVELOPMENT

Katharina Helten, Katharina G.M. Eben, Udo Lindemann
Institute of Product Development, Technische Universität München

ABSTRACT
The implementation of philosophies such as lean development requires special conditions and measures. Process improvements and positive effects of changes are difficult to quantify. Pilot projects help to involve employees in earlier stages. In the field of product development such projects allow the a team to be fully involved in all important phases such as process and waste analysis as well as enable the search for improving measures and their execution. Thereby the change is enforced by means of a "self-help approach" that is essential in SMEs that cannot afford staff functions. Therefore, the presented research project examines three companies during their lean development implementation in order to search for methodologies and suggestions for a successful execution of a pilot project. The authors support the companies with their knowledge in the field of lean development, including moderating workshops and discussions, helping throughout the analysis and synthesis phases, and performing an ongoing evaluation. This paper presents a framework for the design of pilot projects based on company context, waste analysis and measure design. Furthermore, it gives an overview of the most influential factors in the design of a pilot project and the first findings from the project.

Keywords: Pilot project, lean development, implementation, change management

1 INTRODUCTION
Whenever companies seek to optimize (internal) processes, crucial problems and causes need to first be identified. In the field of lean development (LD), these are waste symptoms and the underlying waste drivers. In order to identify and quantify these wastes, a detailed analysis is necessary, including a discussion regarding measures to eliminate the waste and appropriate performance figures.
Major changes such as LD represent more than just the implementation of a checklist – they require a fundamental change of behavior and mentality within a company. Therefore, employees need to be involved as early as possible. Already in the stage of identifying problems, their perspective of the current situation and the way they express their opinion is of importance for successful implementation of LD. Moreover, it is essential to involve employees in the discussion of correctional measures in order to ensure the acceptance of said measures. This is the most important success factor. Even though lots of studies and literature mention the importance of exemplary projects and the overall involvement of the employees for a lasting success, clear rules or guidelines concerning the design of such pilot projects are still missing.
Conducting a pilot project for LD means giving all participants the opportunity to focus on the (optimization) activities on one project or context. Experiencing success through a concrete example paves the way for a long-term implementation of the lean philosophy. Pilot projects that are related to major changes need to be supported by the entire internal team. Therefore, it is important to enable companies to lead the change by themselves. Identifying a pilot project is more than asking a consultant for help for a specified problem. Its design requires an already existing understanding of main procedures and mentalities within the company – and is therefore already the first step towards a change.
In the ongoing project, three small and medium-sized enterprises (SME) are at the center of the research. The identification of a pilot project and the implementation of LD are even more difficult in this context since SMEs have only limited resources. For example staff functions are missing that are often responsible for topics such as LD or Total Quality Management. This context requires a special implementation and helps to understand the mechanisms to encourage a "self-help approach".

2 STATE OF THE ART

2.1 Lean development

Lean development (LD) - as quite a young philosophy - is based on the approaches of lean production. In the 1990s the Toyota Production System (TPS) was regarded as the ideal example of lean processes, and the idea of “lean thinking” has attracted engineers the world over [1]. The main goal of any activity is the creation of value for the customer through the elimination of wasteful tasks. Womack and Jones [1] identified five main principles for a lean process: value, value stream, flow, pull and perfection. By that time, non producing units such as product development also began to become a focal point for improvement. Many authors and researchers have tried to apply the lean ideas to product development, but the transfer is difficult, since several conditions are different. Product development processes are characterized as highly connected, parallel and iterative, since the specification of the product is part of the process itself. Instead of physical products, developers deal mostly with data and information. The work might last for months or even years, and accomplishment is difficult to measure during the development process [2]. Nevertheless, authors have tried to categorize waste as well as waste drivers in the field of product development. Oehmen and Rebentisch have condensed the findings of several authors and name the following eight types of waste: over production of information, over processing of information, miscommunication of information, stockpiling of information, generating defective information, correcting information, waiting of people, and unnecessary movement of people [3]. For the identification of waste, different methods and tools can be applied. Authors have proposed different approaches, such as Value Stream Mapping (VSM) [4],[5], Snap Shot Analysis [6], or the use of learning tools such as the A3 process of managing to learn [7].

Most studies in the field of lean development focus on Japanese or American companies, as well as large-scale enterprises. They lack a discussion about the suitability of certain categories and measures to specific circumstances. Probably, certain waste drivers do not occur in certain companies, whereas others could not be exposed with traditional tools, especially in the field of SME (see 2.1). In addition, literature does not describe the setting of the change project, e.g. the involvement of certain persons, the number and content of workshops, the specific means and responsibilities. Only a few authors describe the execution of change projects, but mostly related to manufacturing or supply chain [8], [9]. Nevertheless, Graebsch et al. have shown the industrial importance of pilot projects in their study [10].

2.2 Change management

The implementation of LD means a significant change within companies´ processes. In contrast to a successful implementation of a method or a methodology, a new philosophy can only be anchored permanently if the whole organization and the product development department change.

Kotter [11] names eight crucial steps for successful change projects (Create urgency, form a powerful coalition, create a vision for change, communicate the vision, remove obstacles, create short-term wins, build on the change, anchor the changes in corporate culture). In addition, he names important errors that can occur. Without emphasizing the urgency of the change by the management, people will hardly be motivated to overcome traditional approaches. Furthermore, Kotter underlines the need of an appropriate team composition. 5, 15, or even 50 team members can be necessary to evoke a commitment to the company´s needs and urge action. In addition, he proposes a successful guiding team of only three to five people during the first year of a renewal effort. He underlines the need to “walk the talk” - executives need to act as models for others. In addition, certain elements of change need to be implemented as fast as possible to make them “touchable” for the employees. In general, managers need to care to ensure clear performance improvements, establish goals and reward people. In the example he refers to, the special product was chosen for an introduction because it could be designed and launched in a very short time and be handled by a small team. In addition to a pilot project, continuous implementation needs to be ensured, since changes take effect only very slowly in a company. According to Kotter, this process could take as much as five to ten years. That makes it especially important to choose the responsible team accordingly so that the spirit of the change is maintained for a long period by (ideally) the same people.

Changes need time, and accordingly a pilot project will go through different phases of acceptance and success. Lewin [12] defines three stages every change project goes through - unfreezing, changing and refreezing. Especially at the beginning, there might be a lot of restraining forces. For example long-

time employees might be afraid of the new changes that come up. As a result, the performance decreases, whereas the idea of the change incubates. Afterwards, the driving forces increase and help the project to become a success. Vahs [13] describes four ways to effect change within an organization. The change can be managed either top-down (driven by the top-management) or bottom-up (driven by employees). It is also possible to combine both approaches. As a forth way, Vahs mentions a strategy called “Multiple Nucleus”. The change this strategy effects is driven by different people on different levels, probably focusing also on different problems or measures. Moreover, Vahs names seven ways to react to a change with a Gaussian distribution. Small in number are visionaries and active followers, as well as people that flee and articulate their resistance openly. Most people can be characterized as expectant and indifferent.

2.3 Pilot projects and implementation

Some literature claims the need for pilot projects in order to implement or even to analyze problems in industry [10]. But a consistent definition of the term is still missing. A pilot project gives a company the possibility of running a test after certain areas of change are defined. Pilot projects can be applied in very different fields, such as education, software, finance, etc. Pilot projects are necessary if the change could lead to high societal, economical or technical risks. This can include instances where huge investments have been made and therefore situations in which it is of utmost importance to see how people adopt new procedures [14].

The product development process as a unique, generating process deals with a lot of uncertainties. Thus, the definition of a pilot project, including clear processes, gates, etc., is quite challenging. Once (the aim of) a pilot project is fixed, relevant parameters need to be identified that allow an evaluation of the change. Running a pilot project is a sensitive task. If a project fails, it is likely that no further implementation is possible. Therefore, these projects need to be planned carefully to yield the best possible results. Literature names certain influencing factors (see section 2.2) but still there is no clear instruction of how and when. E.g. it needs to be analyzed whether the senior management should already be involved in the analysis of value and waste. On the one hand its involvement pushes the change, on the other hand employees could be reluctant to address certain drawbacks.

Rarely can practical examples in the context of a particular company be found. Most literature focuses either on production (older discipline, and measurement is much easier in most cases) or on the implementation of methods or methodologies. For example Loch et al. [9] describe a pilot project to adapt the production lines to address the challenges of aging workers at BMW. To apply the change to a specific example, a centrally located production line was chosen. At the beginning, the line was labeled a “pensioners´ line”. But several one-on-one conversations were helpful during that stage to overcome prejudices. Parallel to this pilot project, a company-wide health awareness initiative was run in which more than 10000 workers took part. Several workshops in the company pushed the idea. Once the pilot project was finished with success, several follow-up projects guaranteed a continuous implementation. Retrospectively, it was very important to address the specific conditions of the workplace – hence resulting in an customized pilot project.

With respect to the implementation of a methodology, Ehrlenspiel [15] lists main aspects for the search of a pilot project such as the composition of an interdisciplinary team, the identification of requirements of the pilot project, the possibility of alternative projects, and finally the identification of an appropriate project. As sub-categories, he proposes the analysis of the product development process (actual processes, documents, product portfolio, applied methods and tools, weaknesses), a structuring of order processing (relevant parameters, actual process, documents, methods and information), the generation and adaption of the methodology (standard processes, documents and results, sub methods), and a testing of the methodology. Filson and Lewis [16] describe how the methodology Concurrent Engineering (CE) was put into practice. In that particular case, the senior management had already decided to use CE, and employees were not involved in initial discussions. To ensure that new procedures were followed by the personal, job descriptions were changed accordingly. The authors describe that especially those employees that had worked for many years in the company showed the greatest reluctance. This shows that every change project has to take into account “employees´ baggage” – i.e. old habits, attitudes and project histories.

2.4 Small sized companies

Small and medium-sized enterprises (SMEs) face different challenges than large-scale companies do. Even if politics emphasize the importance of these companies for the economy, a common definition is still missing. The European Commission defines SMEs as companies with less than 250 employees and a maximum annual turnover of 40 Million Euro or a maximum balance sheet total of 27 Million Euro [17]. Other authors additionally take the ownership structure into account [18]. But in order to understand the challenges SMEs are facing in the field of product development, their development processes need to be examined for main influencing factors. Vossen [19] characterizes SMEs by little bureaucracy and a rapid decision making. These companies are able to react fast to changing markets, cover market niches and have rapid and effective internal communication. The management and other members are highly motivated, and the product development process is efficient especially. Small companies usually run the development processes in informal fashion and the lack of resources and knowledge requires a certain level of improvisation within the process. SMEs often do not show up with a long term strategy due to lack of resources and functions [20]. In addition, they lack strongly formalized and established requirements engineering [21]. Millward and Lewis [22] emphasize the difficulties in managing design processes due to the autocratic management style in SMEs and turbulent organizations. In particular, the fact that most SMEs are still run by the owner-family has to be taken into account, especially with focus on the decision making process. Lövquist further shows that the development context of SME is characterized by a high interaction with customers and users [23].

Concerning changes in SMEs, only a limited amount of literature offers some suggestions. Filson and Lewis [16] describe how Concurrent Engineering (CE) was implemented in an SME (see also section 2.3). In that case, the senior management decided to conduct a trial on a small number of projects to observe the improvements. Reasons for implementing CE were among others the fact that many projects were largely not monitored, and little structured communication. The authors describe the SME as concentrated on low-volume and high-value, as well as detailed customer specifications. The authors also underline the need for an organizational change as the biggest hurdle. Accordingly, SMEs are mostly reluctant to change since they are characterized more by a fire-fighting attitude and constantly changing priority lists.

3 FRAMEWORK FOR THE DESIGN OF A PILOT PROJECT

Pilot projects that promote a change in the product development process depend on a lot of factors. Therefore, the ongoing research aims to establish a framework that enables companies, especially SMEs, to characterize their development contexts, to choose appropriate pilot projects and to learn which steps and procedures are necessary. Therefore, companies and their development context need to be described first by identifying the most influencing factors (see section 4.1). Such factors are for example the size of the company, the market dynamics, the owner-structure as well as the use of process models. Afterwards, main waste symptoms as well as drivers are assessed. Based on this discussion, measures are identified and executed that help to eliminate the waste. Both the waste and the measures are clustered to allow a classification as shown in figure 1 (their analysis is not part of this paper). The axes are not meant to be numeric, but will indicate main descriptions of a relevant case. To ensure a broad overview of possible cases, other companies will be interviewed as well. The axes span a cube of sorts, within which companies will be classified. According to their position in this cube, appropriate steps (activities, involved people, tools, measures, etc.) for the execution of a pilot project will be indicated. Companies will be enabled to run such change projects internally without external support that they mostly cannot afford. In order to formulate the mentioned framework for the design of a pilot project in the field of LD, this paper presents an initial categorization of most influencing factors (see section 4.3). They base on first findings within the ongoing research and need a further discussion in parallel to the project.

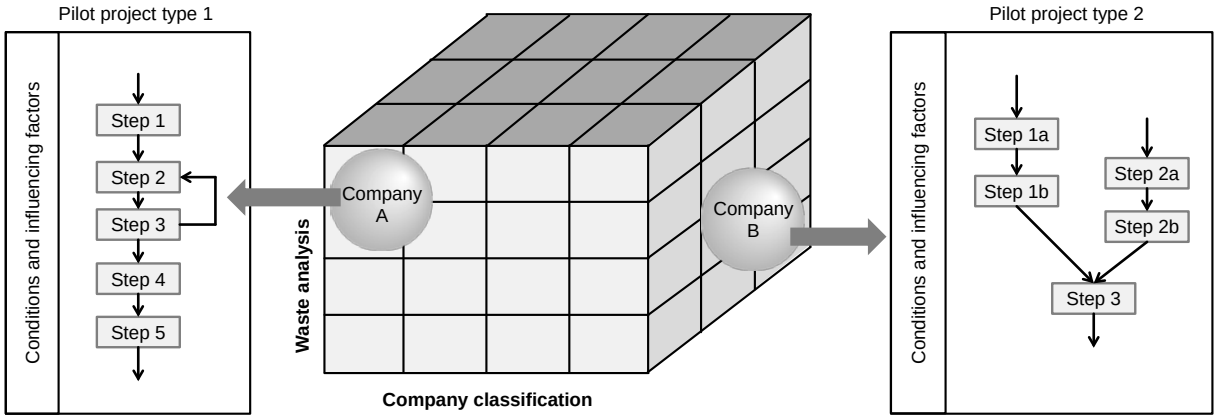

Figure 1.Framework for the choice and design of pilot projects within LD

4 APPROACH WITHIN THE RESEARCH PROJECT

4.1 Setting of the project

Within the actual project, three SMEs are analyzed and supported during the pilot phase. They vary in their size (200-1200 employees) and their product portfolio. A first analysis of the product development process as well as waste types has shown the importance of the product market. Main descriptive categories are e.g. the velocity of the market (short or long life cycles), the number of customers (single customers with (partly) close interaction with the product development team or mass market), the supply level (OEM up to 4th Tier) as well as the type of good (capital or consumer good).

Within the SME context, the management and organizational structure is especially relevant. This refers e.g. to the involvement of the company owner – whether the business is still run by members of the owner-family and therefore also product design decisions are made by them – or whether managing directors have already been installed. This influences also the necessity and the extensiveness of the process as well as job descriptions. Also relevant is the disciplinary power of project leaders and whether employees have access or work with diverse process models on diverse generic levels.

Even though most literature only refers to the total number of employees as a characterizing factor, this characterization also concentrates on the number of employees in the product development department itself. In the ongoing cases, the number varies from approximately five to 100. Moreover the number of projects one developer has to work on in parallel, the number of involved departments as well as the size of the project teams need to be analyzed. Especially in a SME environment, the composition of the development team in terms of academic level, regional background and history of work experience are important to understand. This is of special importance since any diversity has an impact within small groups of employees.

With respect to tools in general, the training and the application of product as well as process modeling tools are relevant. So far, the analysis has indicated a high importance of prototypes and therefore a high number of interfaces with production processes to be managed. Design processes are managed quite individually, only some generic processes are defined. In addition, performance figures as often applied in large-scale companies are rarely used. Table 1 shows an overview of the most important criteria that characterize a SME best in the context of its product development process.

Table 1. Important factors for PD process characterization in SME

Category	Value/ Specification			
Company size	1-25	25-100	…	> 1000
Market dynamics	Short	Long	…	
Number of customers	1	2-10	…	Mass
Formulation of strategic goals	Yes	No		
Supplier Level	OEM	1st	…	4th
Type of good	Capital	Consumer	…	
Management structure	Owner	CEO	…	
Size PD department	1-5	5-10	…	50-100
No. of PD projects	1	2-5	…	>10
Composition of PD team (e.g. academic level)	Academian	Technician	…	Trainee
No. of involved departments	1	2	…	5
Product assessment	Simulation	Prototypes	…	FEM
Test department	Yes	No		
Process models	Yes	No		
Performance figures	Yes	No		
Etc.				

4.2 Approach for the ongoing research pilot projects

The execution and the evaluation of the ongoing research pilot projects differ clearly from the striven pilot projects in the involvement of the researchers. The setting can be described by means of action research. As Ottosson [24] describes, the close interaction with the “research object” enables a focus on prospective study parts that allow a testing of new methodical elements, methods and procedures. In general, the reliability of the results increases the smaller the distance from the objects is. The researchers in the ongoing project function as observers and push several process steps and related tools and steps during the project run. Further, the research project is monitored in detail by means of an observation sheet. Important process steps, suggestions, and methods are noted down. But also the involved persons, their reaction, and problems are examined. By monitoring these aspects, it can be analyzed prospectively-retrospectively whether a measure is elaborated fully or whether new aspects, possibly also different wastes, come into the discussion, and require an adjustment.

The overall procedure within the ongoing project is shown in figure 2. Based on a detailed waste analysis for each single company, measures and appropriate procedures are discussed. Due to the limited time within the research project, several different major areas of relevance of waste and measures are extracted for a single company (see parallel layers, 3-5 areas). To stimulate the discussion about possible measures, literature is included. The suggestions are mostly formulated on a very abstract level. Haque and James-Moore [25] e.g. propose the continuous analysis as well as a standardization of the processes, a performance measurement and the visualization of the process. Others such as Ward [26] focus on an effective communication and a careful handling of information and documents. The extracted measure areas refer to different abstraction levels of waste – some on activities, others on process steps or communication in general. Even if one person in the company is mainly responsible for the entire lean initiative, several other persons obtain responsibilities for different measures to expand the lean idea throughout the company. In the ongoing projects, the managing level is responsible for measures that focus on “big picture” and are needed e.g. for reporting to the board of management. Other employees on the operational level focus on improvements and changes of the everyday work and are given responsibilities in that field.

The procedure within the pilot project is characterized by a decreasing discussion part and an increasing execution part, see figure 2. The three main activities - design of measures, design of performance figures and comparison with wastes - rely on each other and are run through cyclically. The more often the cycle is carried out, the more specific the measures become. This is of utmost importance, since measures in the field of LD cannot just be extracted from a list, but need a discussion about internal needs and circumstances - the discussion itself is already part of the change.

In other words, the procedure of designing measures in a pilot project can be described as a rotation of descriptive and prescriptive phases. Based on a first analysis, the actual development process is

described, followed by the prescriptive formulation of first abstract measures. They again are either applied, or at least run through theoretically. Afterwards, problems are analyzed and described, before starting another prescriptive phase.
The ongoing projects are embedded differently in the project landscape of the single company. Partly they are part of an overall lean roadmap, in other cases they are part of a major development project. At the beginning of the analysis, a first pilot team is defined and gets invited to a meeting to get an overview of the project and the lean philosophy. The analysis takes about three months, including first brainstorming sessions about possible measures and performance figures. As expected, the motivation decreases during the first three months, and the participants expect specific applications. In that phase, a second kick-off is conducted. If necessary, additional employees (from other departments) are also invited. Since all developers in charge are dealing with the topic of lean besides their daily business and project work (see missing staff functions), main results of former discussions are forgotten or wastes cannot be linked directly to the actual discussion about measures. Therefore, new media is introduced. Main ideas and goals as well as the latest results are summed up on several sheets and posters [5]. These posters help to bring the group together quite fast and are useful as a common communication basis. They also help to show first improvements and changes, even if measures are not yet fixed.

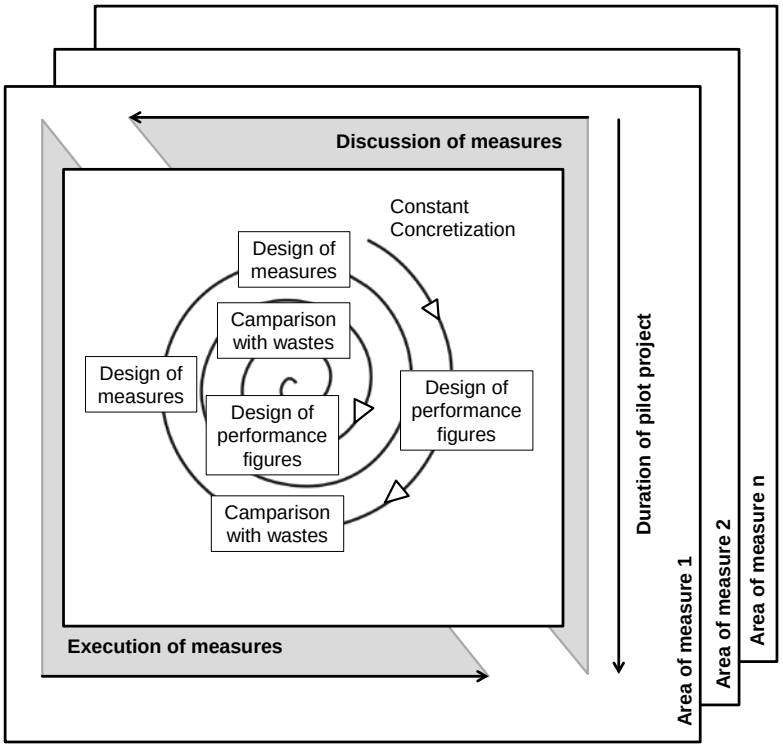

Figure 2: Research procedure within the pilot projects of the ongoing project

The actual pilot projects also show that in the beginning a certain “incubation” phase is necessary. LD needs time be understood. Interestingly, several project partners come up with measures and their own ideas on how to improve processes. It seems as if this philosophy leaves room for improvements that might have already been in the mind of several employees, but could not be addressed before. Moreover, as written above, the integration of the whole initiative into already running improvement or change processes is very important. Especially since e.g. already started processes such as first steps towards process monitoring lead to a faster execution of the measures and therefore to the opportunity to measure changes and performances within the ongoing research project.

4.3 Assessment of main factors for the pilot project design

Based on a literature search and first experiences within the project, the following table 2 gives an overview of factors that are considered for the design of the ongoing pilot projects and that seem to be influencing for pilot projects in general.

Change management

LD can be widely interpreted. The main goal – to increase the value for the customer – can be realized in various ways and on different abstraction levels as well. Therefore the main internal aims for a LD implementation need to be clarified. Furthermore, the initiation is relevant. Is the change pushed by a CEO, or do several employees articulate the need for a change? This correlates with the degree of urgency the company is facing. If the product development processes are running smoothly, the involved development team might not be willing to change anything dramatically. In addition, the degree of self-reflection is interesting. A company that has already started to reflect on internal processes and has probably already drafted roadmaps or the like will adapt the lean philosophy faster since the change can be connected to several existing elements such as procedures, personnel development, etc.

Size of the pilot project

Literature proposes to start with broad initiatives and campaigns to initiate a philosophy. Thus, as many people as possible are addressed. Problematic for SMEs is their lack of specialized staff to push such measures. Therefore, small project team might be required to take the lead and aim to make small but visible progress. In addition, the pilot project needs to have a defined duration, from about three months to several years. The pilot project needs to be representative of the product development work. Hence the ratio between the pilot and the "real" project is important. In most cases the pilot might be part of a major project. Even then, it has to be examined whether a common start for both of them is more important than a common end. A common start enables better teambuilding and a common understanding (including goals) at the beginning; a common end ensures greater opportunity to assess the changes and improvements in the end. Besides the number of core members in the pilot team, it is also relevant to what extent "external" employees (i.e. developers from others departments) need to be involved.

Stage of pilot project

Closely related to the former category is the decision in which stage of the product development process a pilot project should be run. Since in most SMEs only one development department runs all the projects, the analysis of waste drivers and symptoms needs to differentiate clearly between the early design phase, the evaluation phase or the market launch phase.

Course of the project

Since a pilot project for LD will run over a long period, the continuous involvement of the employees needs to be discussed. Kick-off-meetings can be supported by distributing responsibilities to several developers. Of utmost importance is the formulation of a procedure of the pilot project and necessary responsibilities since this aspect addresses the involvement of the employees. Right from the beginning it has to be discussed which roles are necessary and which work packages need to be done by whom. Thus, a first kick-off-meeting is essential to start the pilot. Already in this meeting the question is who moderates and takes the lead (see initiation of the lean initiative, change management). Even without staff functions, several persons must take the lead. In the ongoing project, the assistants of the institute are external consultants of sorts, but with the aim to enable the companies to help themselves. These activities must be chosen carefully. As often as possible, the lead for activities is left to the company members. Closely related is the assessment of the level of autonomy shown by the participants. Their behavior can be an indicator of to which extent SMEs are able to design pilots by themselves. Furthermore, the level of detail of the waste analysis as well as of the measures is relevant. Together with the pilot team, it must be decided upon which abstraction level the discussion of waste would be helpful on (activities, process steps, etc.). Closely related is the question of how many areas of measures can be addressed in one pilot project. Furthermore, the possibility to include so called quick wins has relevance, as seen in section 2.2. This is a difficult task. It is difficult to explain on the one hand the need for a long perspective and the need for time, and to force quick improvements on the other. In order to minimize the risk of decreasing motivation after initial improvements, the quick wins are closely related to main measures in the ongoing project, i.e. can be seen as necessary first steps.

Table 2. Main categories for designing an appropriate pilot project for LD (different grey shades indicate different settings for a fictive example)

Main Category	Sub-Category	Value/ Specification			
Change management	Goal of LD	Overall strategy	Process improvement	…	
	Initiation	Board of management	Project leader	…	Developer
	Degree of urgency	High	Medium	Low	
	Level of Self-Reflexion	High	Medium	Low	
Size of pilot project	Duration	3 months	6 months	…	5 years
	Relation pilot project/ major project	Fictive pilot project	Project as part of major project, common start	…	Project as part of major project, common end
	No. employees within pilot	5	10	…	> 50
	Involvement of further employees	Yes	No		
Stage of pilot project	Stage of pilot project	Early design phase	Evaluation phase	…	Market launch
Course of the project	Involvement of employees	Kick off	Different responsibilities	…	
	Level of autonomy	High	Medium	Low	
	Level of detail of waste analysis	Process steps	Activities	…	
	Level of detail of measures	Methods	Forms	…	Procedures
	No. of areas of measures	1	2-5	…	>10
	Quick wins	Yes	No		
Project responsibilities	Project leader named	Yes	No		
	Staff function available	Yes	No		
	Change agent available	Yes	No		
Involved hierarchical levels	No. of levels	1	2-3	…	>8
	Positions	CEO	Managing director	…	Developer
	Departments	Product development	Design	…	Sales
	Implementation strategy (Vahs (X))	Top-Down	Bottom-Up	…	Multiple Nucleus
Experiences with process and product modeling etc.	Experience with process analysis (departmental level)	High	Medium	Low	
	Experience with process analysis (individual level)	High	Medium	Low	
	CIP-Tools	Excel files	Software	…	Suggestion system
Transferability	Ratio day-to-day business/ project work	100/0	70/30	…	0/100
	Representative constellation	Yes	No		
Implementation	Possible connections to process	Training	CIP	…	Personnel development
	Persistency of pilot team	High	Medium	Low	
Etc.					

Pilot responsibilities

Even in SMEs without staff functions, several persons must take the lead for the implementation. In some cases, this could be the project leader of the major project in which the pilot is embedded. Besides the question of staff functions, the identification of possible change agents is important. Change needs certain characters, e.g. visionary people and people articulating resistance, see section 2.2.

Involved hierarchical levels
Even if literature always focuses on the involvement of top managers and CEOs in the process, it is hardly shown what that should look like. As discussed before, the implementation of LD might lead to measures on different hierarchical levels and different responsibilities. To show some relevance of LD, the pilot project needs the involvement of different departments, especially since communication and synchronization are main waste drivers. Potential departments are product development (different departments or teams), sales, construction and testing. This correlates to the decision regarding how many hierarchical levels are to be addressed. Discussions in large groups can be helpful, but could also inhibit people naming their problems with the process development process. Furthermore, the implementation strategy needs a discussion. Most appropriate, especially within the SME context, seems to be the "center out" or "multiple nucleus" strategy according to Vahs, see section 2.2.
Experience with process modeling and process improvement
Crucial for any change in development processes is the capability to model processes and to control their examination. Therefore, the pilot project has to consider the level of process modeling on a generic level (i.e. departmental level) as well as on an individual level. In addition, it has to be discussed to what extent an analysis has already been conducted or needs to be implemented – again on both levels. In order to incorporate as many former initiatives as possible, it is relevant to consider all the tools and results of a Continuous Improvement Process (CIP) that have already been implemented in a particular company.
Transferability
The success of a pilot project will only last if the results and the analyzed wastes are representative of the everyday development work. Therefore, the ratio of the project work to the everyday work is taken into account. Also important is whether the pilot project is representative of other projects (i.e. degree of novelty, customer specifications, etc.) as well as the team composition and structure. Finally the implementation possibilities to other improvement initiatives are of relevance.
Implementation
In the long run, important measures as well as trainings, workshops, etc. need to be addressed and assessed during the pilot phase. The core team could possibly support further projects while certain training measures can already be started during the initial pilot project.

In order to understand the importance and the character of a good pilot project, the history within the research project is monitored (see varyingly grey colored cells in table 2). In addition, the modifications in the pilot project setting are commented in detail, i.e. for example if new hierarchical levels are addressed or the limits of the pilot are expanded. The first project months have already shown that modifications are necessary. Moreover, it is interesting to see how differently pilot projects are designed in different companies. It emphasizes the need for company categorization and corner cases as shown above.

4.4 Discussion of future steps
Apart from the discussion regarding measures, the execution phase needs to be planned appropriately. It is of utmost importance that people apply the measures. Having executed the measures, the developers can give a more detailed feedback. Particularly important is that failures be assessed in order to learn for further steps. Therefore, a plan is designed, naming responsibilities, report forms and dates. The execution phase is monitored by the academic partners, i.e. by interviews and workshops as well as an observation sheet. After the execution phase, an evaluation phase lasting several months is planned. In that time, a guideline will be formulated that specially focuses on future implementation. In order to make changes and improvements visible, different performance measures are generated for this specific context.

5 CONCLUSION AND OUTLOOK
Changes such as the implementation of LD require a company have experience with specific examples and lessons learned to have lasting success. In addition to a successful method application, the implementation of a philosophy needs a deeper anchoring within the product development process and the entire company. Therefore large-scale companies often name a certain department or a team that is solely responsible for change projects. SMEs (which are in the focus of the ongoing project) cannot

afford such departments and are structures differently organizationally, executing development processes differently as well. This makes it hardly possible to adapt the lean literature to their circumstances. Literature often suggests the use of pilot projects to push a change with the help of concrete challenges to make people acclimatizes themselves to the change faster. This paper presents a framework that enables SMEs to characterize themselves and to design an appropriate pilot project with the help of a set of guidelines. These guidelines will include information about necessary steps, people, conditions, etc. The characterization bases on three different aspects – company context, waste analysis and measures. Furthermore, this paper presents a categorization for the development context in light of LD.

The first project months have proven the utmost importance of dialogue with employees of different hierarchical levels about waste and measures. The procedure within the research project can be described with the help of a cyclic model with the elements “design of measures”, “design of performance figures” and “comparison with wastes”. These discussions are already part of the change process towards LD themselves. Based on first findings, the paper finally presents a scheme with influencing factors for the design of pilot projects. The categorization captures general aspects such as change management (goal and initiation, degree of urgency, etc.) but also aspects regarding the stage and the course of the project (design phase, level of detail, etc.). In addition, former experiences of the employees with process and product modeling as well as optimization are addressed and possible ways of transfer and implementation.

For the ongoing research, the history of the pilot projects is monitored as seen in 4.3. Afterwards, the results must be compared to the findings of the company categorization, the waste analysis and the measure design. The context has to be assessed for causalities that enable the formulation of the framework. To increase the scope of the research, several workshops and interviews will be conducted with further SMEs. In addition, the framework will be discussed with representatives of large-scale companies to gain insights in the main differences. Probably, the findings for the pilot design can be partly applied also in that context. In general, pilot projects are just a part of the whole implementation process. Therefore the connectivity of a pilot project to further possibilities of staff training or the like needs further research as mentioned also in table 2.

REFERENCES

[1] Womack, J.P., Jones, D.T. and Roos, D. The Machine that Changed the World - Based On The Massachusetts Institute of Technology 5-Million-Dollar 5-Year Study On The Future Of The Automobile. (Macmillan, New York, 1990).

[2] Bauch, C. Lean Product Development: Making waste transparent. 2004).

[3] Oehmen, J. and Rebentisch, E. Waste in Lean Product Development. *LAI Paper Series “Lean Product Development for Practitioners”* (Massachusetts Institute of Technology, Cambridge, US, 2010).

[4] McManus, H.L. Product Development Value Stream Mapping (PDVSM) Manual. Cambridge, US, 2005).

[5] Rother, M. and Shook, J. *Learning to See - Value-Stream Mapping to Create Value and Eliminate Muda*. (The Lean Enterprise Institute, Inc., 2003).

[6] Graebsch, M., Roelofsen, J. and Lindemann, U. Lean development in the automotive industry - the snap-shot approach. *World Automotive Congress 2008* (GWV Fachverlage GmbH, Munich, 2008).

[7] Shook, J. Managing to learn - Using the A3 management process to solve problems, gain agreement, mentor, and lead. Cambridge, 2008).

[8] Katyal, A. Enterprise Transformation and Lean Implementation in a Globally Dispersed Organization *Leaders for Global Operations Program* (Massachusetts Institute of Technology, Cambridge, US, 2010).

[9] Loch, C.H., Sting, F.J., Bauer, N. and Mauermann, H. How BMW Is Defusing the Demographic Time Bomb. *Harvard Business Review*, 2010, 88(3), 99-102.

[10] Graebsch, M., Lindemann, U. and Weiß, S. Lean Development in Deutschland - Eine Studie über Begriffe, Verschwendung und Wirkung. In Hut, D., edMunich, 2007).

[11] Kotter, J. Leading Change: Why Transformation Efforts Fail. *Harvard Business Review*, 1995, 73(2), 59-67.

[12] Lewin, K. *Field theory in social sciences*. (Tavistock Publications Ltd., 1952).

[13] Vahs, D. Organisation. Einführung in die Organisationstheorie und -praxis. (Schäffer-Poeschel Verlag, Stuttgart, 2003).
[14] Fellbaum, K.-R. *Telekommunikation von A-Z*. (VDE-Verlag, Berlin, 1981/82).
[15] Ehrlenspiel, K. Integrierte Produktentwicklung - Denkabläufe, Methodeneinsatz, Zusammenarbeit. (Hanser, Munich, 2007).
[16] Filson, A. and Lewis, A. Cultural issues in implementing changes to new product development process in a small to medium sized enterprise (SME). *Journal of Engineering Design*, 2000, 11(2), 9.
[17] European Commission. Definition of SME (96/280/EG), Official Journal L107. 1996).
[18] Wolter, H.-J. and Hauser, H.-E. Die Bedeutung des Eigentümerunternehmens in Deutschland - Eine Auseinandersetzung mit der qualitativen und quantitativen Definition des Mittelstands. *Jahrbuch zur Mittelstandsforschung 1/2001* (Deutscher Universitätsverlag, Wiesbaden, 2001).
[19] Vossen, R.W. Relative strengths and weaknesses of small firms in innovation. *International Small Business Journal*, 1998, 16(88).
[20] Braun, T.E. Methodische Unterstützung der strategischen Produktplanung in einem mittelständisch geprägten Umfeld. (Dr. Hut, Munich, 2005).
[21] Schmidt-Kretschmer, M., Gericke, K. and Blessing, L. Managing Requirements or Being Managed by Requirements - Results of an Empirical Study. *International Conference on Engineering Design*Paris, 2007).
[22] Millward, H. and Lewis, A. Barriers to successful new product development within small manufacturing companies. *Journal of Small Business and Enterprise Development*, 2005, 12(3), 379-394.
[23] Lövquist, L. Prouct and Process Novelty in Small Companies´ Design Processes. *Creativity and Innovation Management*, 2010.
[24] Ottosson, S. Research on dynamic systems - some considerations. *Technovation*, 2004, 24, 863-869.
[25] Haque, B.J.-m., Mike. Applying lean thinking to new product introduction. *Journal of Engineering Design*, 2004, 15(1), 1-31.
[26] Ward, A.C. *Lean product and process development*. (The Lean Enterprise Institute, Cambridge, US, 2007).

Contact: Katharina Helten
Technische Universität München
Institute of Product Development
Boltzmannstraße 15
85748 Garching
Germany
Tel: +49 89 289 15150
Fax: +49 89 289 1544
Email: helten@pe.mw.tum.de
http://www.pe.mw.tum.de

Katharina Helten graduated as a mechanical engineer at RWTH Aachen University, Germany, in 2008. She now works as a research assistant at the Institute of Product Development at the Technische Universität München in Germany. Her research focuses on PD processes, and mainly on lean development and its implementation in industry.

Katharina G.M. Eben graduated as mechanical engineer at the Technische Universität München in 2008. Her studies focused on automotive engineering. She now works as scientific assistant at the Institute of Product Development at the Technische Universität München, Germany. Her research research interests lie in Lean Product Development and management of product variety.

Udo Lindemann is a full professor at the Technische Universität München, Germany, and has been the head of the Institute of Product Development since 1995, having published several books and papers on engineering design. He is committed in multiple institutions, among others as Vice President of the Design Society and as an active member of the German Academy of Science and Engineering.