Complexity Management
Journal
Issue 3/2010

More Innovation, Less Waste –

The Secret of Efficient Development Processes (Part 2)

Schuh & Company
Complexity Management

Content

Editorial

Sometimes unexpected events can disrupt whole industries. Take the gulf oil spill for example. In its aftermath it is stalling the fishing and tourism industries and even caused a moratorium for drilling and exploration companies. Chaos is always guaranteed when higher forces strike. Entrepreneurs try and scramble to deal with the results.

Chaos is not always bad. Creative chaos is sometimes a prerequisite for change and when applied at the right time and at the correct place, can even have positive consequences. Innovation always requires some chaos, but knowing when chaos is necessary and when order and organization are benefical, can help turn weaknesses into strengths.

This issue of the Complexity Management Journal introduces methods and approaches that help you manage your research & development processes more proactively. For example, our Lean Innovation audit can reveal within a short time period where your company stands and where it still has room for improvement.

Define your starting point to the Lean Journey!

Best regards,

Jörg Starkmann
CEO, Schuh Complexity Management, Inc.

Stephan Krumm
CEO, Schuh Group

More Innovation, Less Waste – The Secret of Efficient Development Processes (Part 2)

Stephan U. Schittny/Michael Lenders (WZL)

Lean Innovation, Lean Development and Lean Engineering are common topics of conversation. The joint goal is the improvement of the impact and efficiency of innovation and development processes. These are not surprising goals since the R&D process sets the course for the ability of the company to comply with Lean principles as products move along the value stream. Even future products, their marketability and manufacturability are determined at this stage. For the company, it is especially important to be able to differentiate itself from the global competition through innovation and at the same time offer compelling product benefits to its customers. Short development times and reduced R&D efforts move increasingly into the foreground.

The last issue of the Complexity Management Journal discussed the evolution of Lean Thinking, from the origin of Lean Production theory to Lean Administration to Lean Innovation. To develop the Lean Innovation principles, the University of Aachen and Schuh & Company have invested many research resources over the past years. Several analysis and implementation projects proved the twelve Lean Innovation principles to be viable. A condensed version of the approach will be presented in this article.

"The 12 Lean Innovation principles represent the results of our analysis about what differentiates the innovation management of Lean Champions from the average."

Michael Lenders, Ph.D.

The idea of Lean is extended to the R&D area to include the increase of R&D impact in terms of truly successful and innovative development output. The Lean focus on efficiency increases, as it has become so well known for manufacturing environments, does not reach far enough for development processes. Therefore, the R&D specific approach referred to as Lean Innovation should be applied. In our experience, 40 % of today's innovation projects cannot be realized because of a lack resources. Any gain in efficiency, productivity and output that can be achieved because of Lean Innovation is therefore even more important.

Lean Innovation: A holistic approach that fulfills the specific demands of innovation and development management.

The Lean Innovation approach combines the design of development processes and new products without waste. It improves the R&D impact in terms of output of successful and innovative products and services. The approach is based on the five principles of Lean Management, which were described in detail in the previous journal. Several basic methods are available to implement these principles in production and administrative processes (Fig. 1).

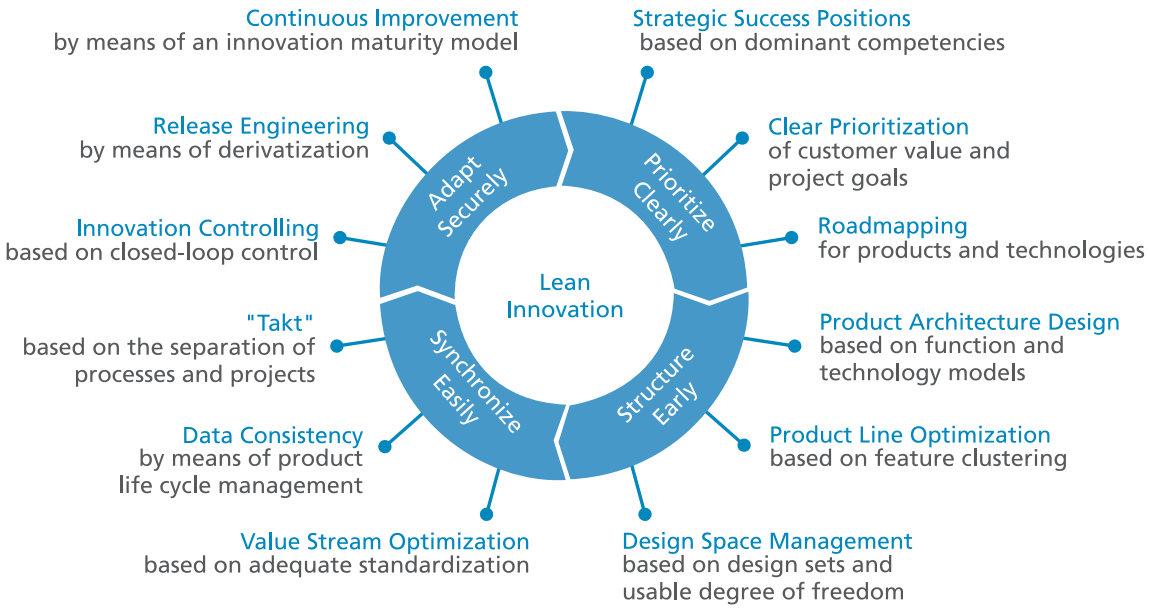

Figure 1: 12 Principles of Lean Innovation

Overall, Lean Thinking proposes three procedures:

- Eliminate waste
- Reduce unavoidable non-value adding activities
- Optimize value adding activities

Therefore, the goal of innovation and development without waste is to embrace the nature of product development as a creative process, while at the same time increasing the development efficiency.

To transfer the Lean principles to the innovation and development areas, twelve central principles were defined. These principles produce a long-term and sustainable increase of innovation opportunities for a company (Fig. 1). The twelve principles can be divided into the following four groups:

- Prioritize Clearly
- Structure Early
- Synchronize Easily
- Adapt Securely

Prioritize Clearly

Prioritizing clearly is the "incarnation" of a value orientation within innovation management. If innovation resources are strategically incorrectly prioritized, success in the market is at best incidental; regardless of how efficient the processes are.

1. Strategic Success Positions: An effective innovation strategy provides for a proactive composition of strategic success positions (SSP) through innovation management. An SSP addresses the intentional creation of important and dominant competencies. Strategic success positions form the requirements to achieve true market dominance and above-average results over the long-term. Figure 2 illustrates the systematic approach to determine strategic success positions.

2. Clear Prioritization: The starting point of an innovation is the easy and clear communication of product advantages. The value system captures the ideas of the stakeholders and structures them transparently. Often, conflicts between goals, hidden in the specification sheet, lead to waste of development output. Therefore, project goals are clearly classified to recognize conflicts of goals early on. Objectives that are not goal-oriented and contradictory are recognized by the system and resolved in a strategically correct manner.

3. Roadmapping: Technology and product planning occur in a long-term roadmapping process. The planning has to be consistent and independent from the short-term cycles of the market. By applying a system to detect technologies early, new areas are tapped soon after discovery and in a customer-oriented manner. Technology planning focuses the technology resources on few, yet important activities. This way, waste through unfocused technology developments can be avoided. Product planning is the result of a systematically performed idea generation and evaluation process that is synchronized closely with the technology planning.

Structure Early

Structuring early implements effective frontloading by defining guidelines for value-oriented product planning. It is essential to eliminate the causes of waste early on during projects, but particularly during the subsequent value-adding steps.

4. Product Architecture Design: The systematic design of the product architecture is the prerequisite for the development of scale effects despite increasingly individual products. Synergies on the product and process level are tapped by modeling functions and technologies. A current product architecture comprises such function and technology models and makes commonalities across the entire product range and across different levels accessible. Examples are common parts, design standards or fixed production process sequences. A consequent application of these principles aids in avoiding waste through missed opportunities to utilize scale effects.

A deciding factor is to not only determine physical equalities of a product, but to also realize functional, technical or technological opportunities for standardization. Because of the strong cross-product integration on those three levels, single modules do not have to be developed for specific product types anymore. In order to manage the associated increased complexity,

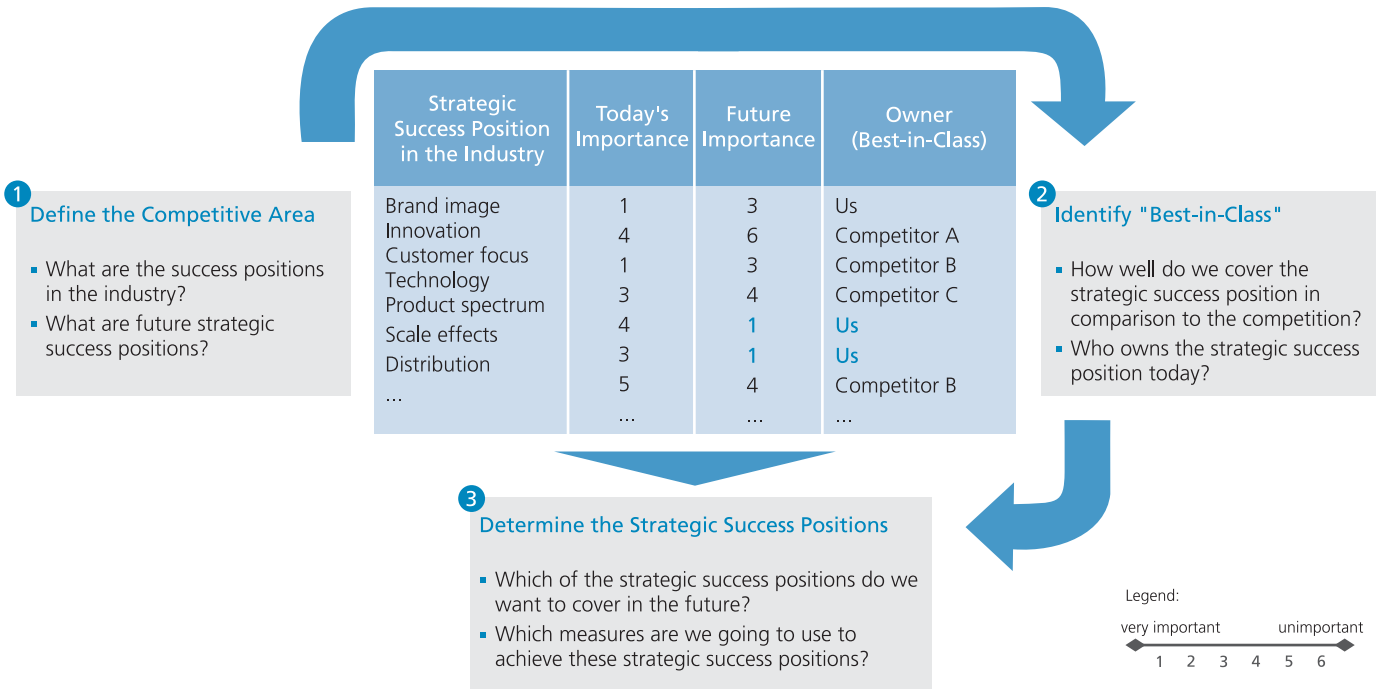

Figure 2: Approach to Determine the Strategic Success Position of Innovation Management

the product functions are defined with degrees of freedom in a function model (Fig. 3). These define which freedoms are allowed for the design based on the interdependencies across products. Larger degrees of freedom produce more options to configure the product until the functionality is achieved to the point of product specific component development. When designing the product structure and sub-assemblies, the technology model forms the basis to ensure that the product can be produced within the desired structure.

"Early structuring is the basis for successful complexity management in product development."

Stephan U. Schittny, Ph.D.

5. Product Line Optimization: Increasing product variety causes waste because of a lack of transparency about costs and benefits of product-related complexity. By classifying product features by customer benefit and cause-fair complexity costs, product variance caused by the market can easily be evaluated with regards to waste caused by excessive complexity without adequate customer value.

6. Design Space Management : The management of design space is important to ensure significant product success with short time-to-market and avoid iterations. Effective design space management defines transparent degrees of freedom for each innovation task. All solutions have to be evaluated properly in such a manner. Groups of alternative solutions, so-called "Design Sets", are pursued even if they are redundant until a definitive decision is made.

The goal of design space management is to create a broad range of solutions and to eliminate options at set milestones based on the set degrees of freedom. Solutions are only eliminated when they are deemed to be poor based on sufficient information.

Synchronize Easily

The interaction of each discipline involved in the innovation project is comparable to a symphony. Many experts and artists work simultaneously together, yet only through perfect synchronization is a piece of art created. The ability to easily synchronize everyone involved is of utmost importance.

7. Value Stream Optimization: Wait times and rework are the biggest interruptions to a continuous value stream for innovation processes. The optimization of the value stream distinguishes between creative and repetitive processes. Administrative processes are stan-

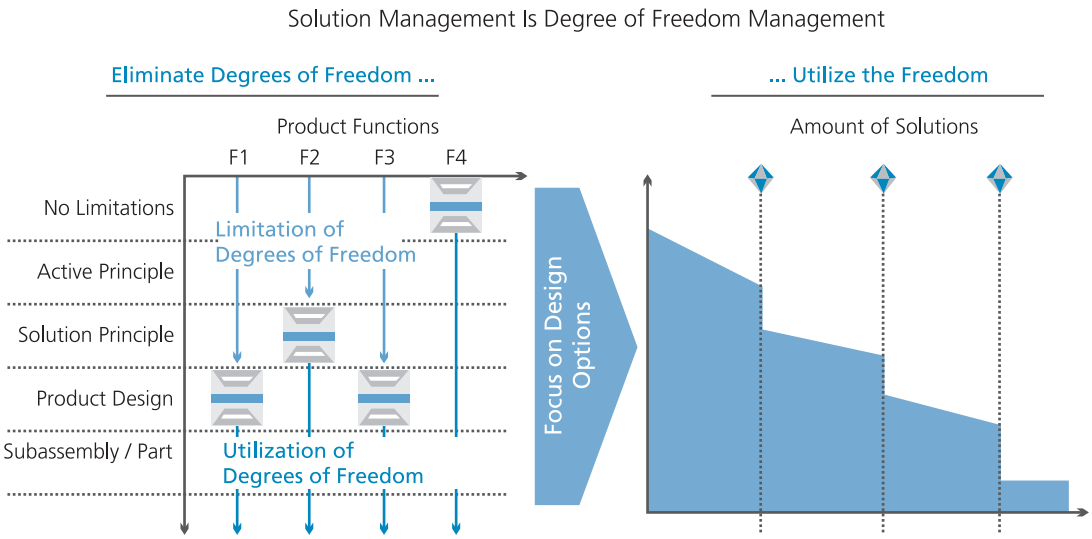

Figure 3: Degree of Freedom Management

dardized with a "successful practice" approach, while the creative processes need defined transparent goals and an exact scope of actions. The key to avoid waste is to adapt standardization for such processes.

8. Data Consistency: The basis for synchronized innovation processes is consistent data. Waste of development capacity through incomplete or wrong information should be avoided and waste through non-value adding support activities such as searching and adaption should be significantly reduced. Product life cycle management provides processes, methods and tools to ensure that product information is available at the right times, with the correct quality, and at the right location.

9. Takt: Because of the consistent separation of project and process management, the adherence to planning and delivery dates is increased significantly and capacity peaks are successfully leveled out. Proper project management ensures the transparent implementation of project structure, resources and milestone planning. Project management follows standardized processes, which are easily planned and synchronized because of demand-oriented takt.

Adapt securely

Lean Innovation demands adaptability from innovation management. Adapting securely describes the goal-oriented enhancements of products and processes with regard to identified chances for improvement.

10. Innovation Controlling: Innovation controlling empowers the employees involved in the innovation process to perform improvements independently. Therefore, transparent goals and short feedback loops about achieved results within the process are necessary. Waste of innovation resources through ambiguity and by missing goals are avoided.

11. Release Engineering: Complex products often exhibit functionalities and modules with highly variable life cycles. Without product releases it is almost impossible to keep products current in the mind of the customer over the long term, especially when they have long life cycles. Unplanned release cycles, however, quickly lead to waste because of unnecessarily high complexity along the whole process chain. The goal of release engineering is to steer the life cycles of single product

functions in such a direction, that the product always appears new to the customer. Release planning is a methodical interface between product structuring and life cycle management.

12. Continuous Improvement: For Lean Innovation, continuous improvement is described in five steps along the innovation maturity model. The model describes how changes in structures and behavior can continuously improve the effectiveness of the lean innovation principles. Ideal and target states serve as orientation to all employees and are especially important to enable continuous improvements.

Conclusion

Increasing competitive pressures require companies to adopt innovative and creative approaches to position themselves against the competition. The consistent transformation of lean ideas into the creative processes of R&D, increase a company's competitiveness in the global markets.

Once the Lean philosophy is consistently implemented in the areas of innovation and R&D, effectiveness and efficiency increase over the long term. Our research shows that when Lean Innovation is successfully implemented, innovation productivity can increase by up to 200%. The output of product and process innovation increases, while resource consumption remains constant. Internally, as well as externally a high degree of innovation is perceived, making the company more interesting to consumers, investors and (potential) employees.

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Am I a Lean Innovation Champion or Laggard? – A Short Discussion of the Lean Innovation Audit

Stephan U. Schittny/Michael Lenders (WZL)

Nobody needs much convincing to realize the importance of successful innovations. They ensure the sustainability of a company by setting them apart from the competition. Even at higher prices, innovative products can achieve market success and guarantee a company's growth. However, with more than half of all innovation projects failing, many enterprises are less and less successful at achieving uniqueness through innovation. Each failure causes exorbitant costs!

Lean Innovation: An Innovation Offensive despite Limited Resources

Examples of successful companies show that innovation projects that abide by certain principles and rules have a much higher probability of succeeding. According to studies, Lean Innovation champions are able to create concurrent and sustainable innovations despite resource constraints. For these results, it is necessary to focus on the value created by innovations and to identify and eliminate typical types of waste that occur in innovation management and R&D.

> "To recognize waste is the first step to have successful and efficient innovation projects."
>
> Michael Lenders, Ph.D.

Companies that can avoid the following waste are on their way to becoming Lean Innovation champions:

- Lacking customer orientation and vague project goals
- Idle resources in research and development
- Unnecessarily long time-to-market because of interrupted value streams
- Costly products because of uncontrolled creation of product complexity and unused scale effects
- Further inquiries and iterations because of insufficient standards
- Avoidable defects and revisions during the prototype phase

Where and How Does Lean Innovation Start?

Lean Management sets the scope to focus activities on value creation, while reducing unnecessary waste. The utilization of Lean tools, which has already become the norm in the manufacturing field, is drastically underutilized in the R&D and innovation management field. Only few companies have started the systematic identification of waste in R&D and innovation management.

Schuh & Company offers the Lean Innovation audit as a diagnostic tool. It gives companies an effective way of assessing their state of affairs before or during the implementation of Lean efforts within the R&D departments. Unnecessary efforts can be eliminated, saving upfront costs, and resources can be directed to areas where they become most effective.

A workshop brings together the company's employees and focuses on clarifying the Lean Innovation principles. In consequent steps, the processes are analyzed and the types of waste for R&D and innovation management at the company identified. For each of the twelve Lean Innovation principles, the currently achieved degree of maturity is transparently assessed. An effective and sustainable action plan is developed in coordination with the employees to implement Lean Innovation based on the company's achieved understanding and situation.

The Different Steps of the Lean Innovation Audit

The Lean Innovation audit is unique in that it can be completed within a short time period. Audit results are available after a few workshops and about ten interviews. The detailed proceedings (Fig 1.) are aligned according to the company structure, goals and guidelines. While the Lean Innovation audit's duration and efforts are quite manageable, its results can help companies achieve major breakthroughs in managing its limited R&D resources.

The first step for a successful project, no matter in which area, is always to be on the same page. Therefore, each audit starts with a management alignment. This serves as an introduction to the Lean Innovation topic and is a forum to discuss project goals from the viewpoint of management. Not only is the stage set by providing the background knowledge via presentations, simulations and games, we also introduce the significant tools of the Lean Innovation method. Together with the management team we determine the focal points of the audit and select the methods for the in-depth analysis, e.g. R&D value stream analysis. Based on the developed Lean Innovation understanding and the outcomes of the analysis, the plan for the following implementation of Lean Innovation within the company is defined in this phase.

Part 1: Understanding Lean Innovation. Value orientation in R&D and innovation management.

Lean Innovation: What is that? This question is answered in the first part of the audit. The theoretical foundations of Lean Innovation are described and the types of waste in R&D and innovation management are pointed out. A significant part of this phase is the

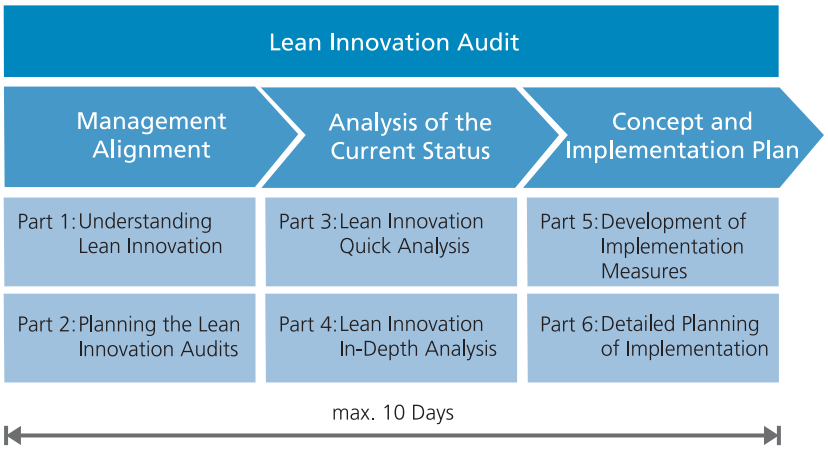

Figure 1: Overview of the Audit Steps

instruction in the twelve Lean Innovation principles (for more information, please read the article "More Innovation, Less Waste – The Secret of Efficient Development Processes" Part 2, p. 4-9).

Actions are defined and the method kit, including the analysis of the Lean Innovation audit is introduced. Additionally, practical exercises by means of simulation games clarify the impact of actions (e.g. value stream optimization).

Part 2: Planning the Lean Innovation Audit. Defining a concept (vision) for Lean Innovation in the company and creating a detailed plan of the audit.

Discussions and adjustments of precise goals for Lean Innovation in the company are necessary in order to achieve a vision.

The detailed plan of the Lean Innovation audit comprises a comprehensive and collective selection of the processes that are going to be examined during the value stream analysis as well as the coordination of workshop and interview partners within the company. An additional part of this audit phase is the preparation of the internal communication about Lean Innovation efforts.

A summary of the management alignment concludes this part of the Lean Innovation audit.

Part 3: Lean Innovation Quick Analysis. The quick analysis is based on the Lean Innovation degree of maturity model.

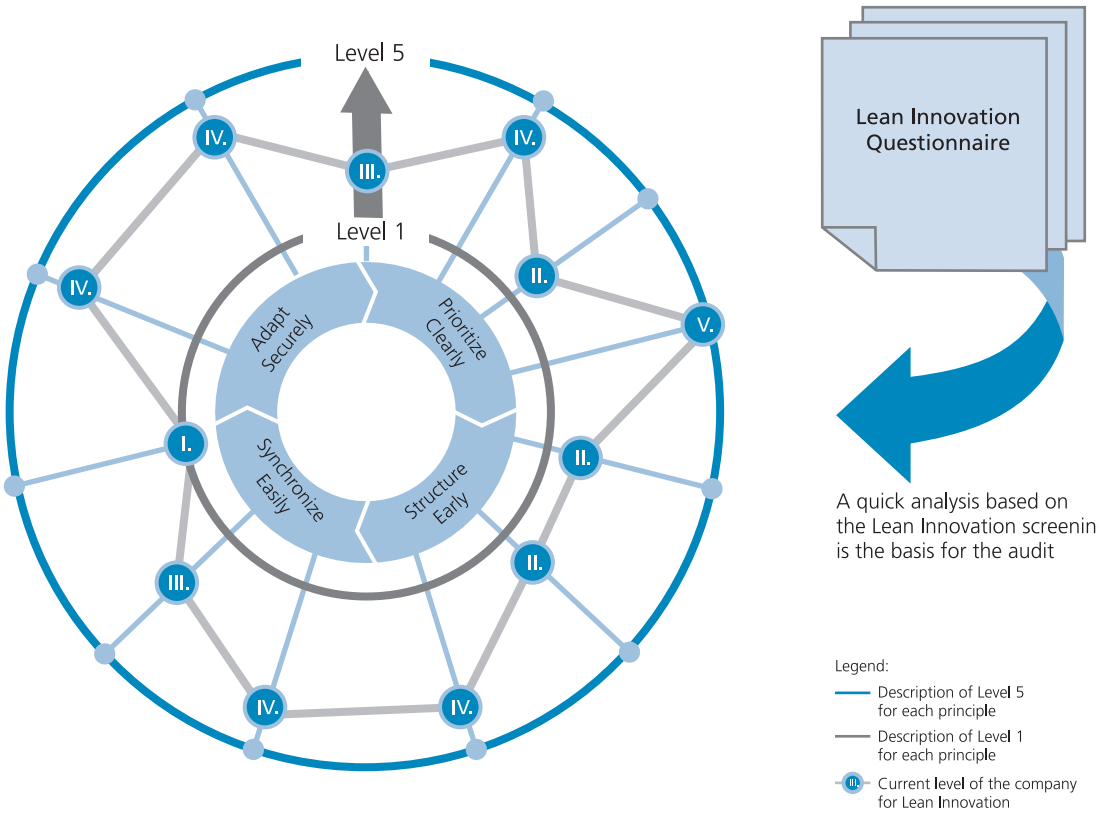

Figure 2: The Radar Chart Pictures the Achieved Level of Lean Innovation within the Company for Each Principle

The quick analysis is a screening, which comprises questionnaires, a moderated workshop and interviews with several employee groups of the company to assess the status quo of Lean Innovation.

The next step is an anonymous evaluation and clear overview of the current state of the company in adherence to each of the twelve Lean Innovation principles.

"The Lean Innovation Audit gives a quick overview about measures that can sustain your companies business success."

Stephan U. Schittny, Ph.D.

A radar chart (Fig. 2) depicts the achieved level of Lean Innovation within the company for each of the principles.

Part 4: Lean Innovation In-Depth Analysis. A typical in-depth analysis for selected innovation and R&D processes.

During workshops, we perform value stream analyses for the processes that were selected during the management alignment. An essential component is to convey the special characteristics of value stream optimization for creative R&D and innovation processes. Together with company management and employees, a target value stream is developed for each process.

As an option, activity and organizational structure analyses can also be performed for selected R&D groups. Muda-workshops on-site, meaning at the desks of R&D employees, or the 5S method are additional approaches to identify improvement opportunities.

In the last phase, the management team approves implementation measures to ensure the successful implementation in the future.

Part 5: Development of Implementation Measures. Deduction and prioritization of improvement based on the analysis of the as-is state, the defined goals and development of implementation concepts.

For any project to be successful it is important that the developed improvements are feasible. Lean Innovation projects are no different. Therefore, the action items are prioritized depending on importance in a first step. The joint development of approaches helps to foster the acceptance of the measures by the employees. Project outlines serve as aids to document the results. They also assess the obtainable improvement opportunities.

The management team has the final say in approving all measures, because it will be responsible for the outcome of the measures.

Part 6: Detailed Implementation Planning. A detailed plan of the opportunities based on a pilot study and short, mid, and long-term improvement projects.

Further ideas for pilot projects are planned and developed. In addition, improvement projects are prioritized and assigned to a person responsible for their implementation. The development of a monitoring system helps to track the progress and achievement of goals.

It should not be forgotten that Lean Innovation also has to be communicated to the employees of the company. The development of a communication concept is an important part and ensures the success of the overall project.

Conclusion

The probability to achieve innovation success despite limited resources is increased by concentrating on the value creation of innovations and the minimization of typical, avoidable waste in R&D and innovation management. Translating the Lean philosophy from manufacturing to R&D requires, as described in the first article, a conversion of the principles to satisfy the creativity of R&D processes.

With the help of the Lean Innovation audit, a quick and easy evaluation of the current improvement activities of R&D departments and innovation management becomes possible. The company is measured against the degree of maturity model. Depending on the recorded degree of conformance with the model, actions and measures are derived to assist the implementation of Lean Innovation.

Therefore, the Lean Innovation audit is an invaluable tool in assessing the company's efforts in the beginning or during the introduction of Lean Innovation. It also ensures a sustainable and successful implementation.

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Value and It's Importance:
Value Stream Mapping in R&D Departments, a Case Study

Stephan U. Schittny/Marcus Rauhut (WZL)

Every year companies invest large sums of their marketing budget not only on measures that increase their sales, but also increasingly on market and consumer behavior studies. Consumer goods companies are a prime example of this trend. The intention is to understand and satisfy the consumer's needs and desires adequately. The value stream begins here, with the customer. It then continues on to the development of the products, passing the production itself and ending with the distribution of products and after-sales services. The methods and tools of Lean Production and Lean Administration have been successfully applied to the manufacturing section of the value stream over the past years. Unfortunately, the explicit challenges of product development, especially where the processes are characterized by their creativity and uniqueness, have not been addressed. Here, the value stream analysis tailored to the R&D needs can fill the gap.

Value and Waste in R&D

A successful innovation relies on the ability to easily communicate the advantages of a new product. Only when transparent development targets are in line with the customer's understanding of value, can the processes and product features be developed in a way that is value-driven and waste-free. When improving production processes, the focus lies on the most efficient production of a product that is already completely defined. That is a fundamentally different concept from improvements in innovation processes, where the product is still under development and the improvement can only come in the form of a more efficient design process and a better result (i.e. end product).

Thus, project teams that analyze the innovation processes, should not only be on the lookout for the seven types of waste as defined by Womack and Jones, but also for waste that is specific to product development such as idle time, hand-offs, stop-and-go activities etc. Additional deficits in customer orientation, the degree of innovation and the utilization of common parts in a product should be identified (Figure 1). This aspect is of essential importance because the product specifications, product architecture or complete service concept, once approved, determine the degree of freedom to which subsequent activities can later on be optimized. Therefore, the results of development activities determine the amount of inevitable waste in the subsequent steps of assembly, quality assurance or service.

Similar to the classic value stream analysis, a value stream analysis specific to R&D activities distinguishes between value-adding activities, necessary support activities and waste. Identifying the types of waste, as described above, is much easier than determining the value of a particular product development activity. For example, how should the creation of a prototype by an automotive manufacturer's design team be valued? None of the three to five thousand physical prototypes that are often more expensive to develop than a series-production vehicle, will ever reach the customer. However, much of the accumulated know-how gained through designing and testing is transferred into each of the final models.

This brings up the question: "What is the optimal amount of prototypes, by model or amount of cars sold, before there are noticeable quality differences?" The difficulty of answering this question is due to the value drivers of the innovation process chain that are not always apparent. Value drivers represent factors that can be influenced and are relevant to the financial performance of a company or a company unit. The value drivers of the innovation process are derived from the customer value and product strategy, both of which are

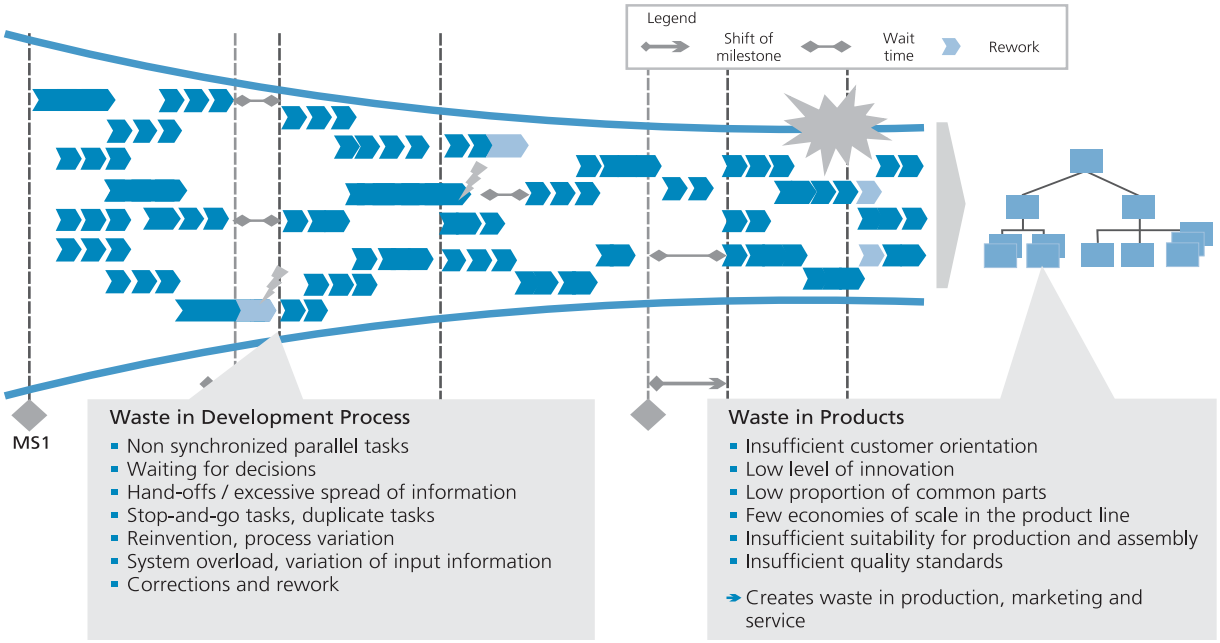

Figure 1: Waste in the Development Process and in the Product

combined in the value system. This value system collects and clearly structures the stakeholder's perceptions about the value stream. Only by defining the actual value drivers of each particular stage of the innovation process, does it become possible to evaluate the degree of added value in the value stream analysis (see figure 2).

R&D Value Stream Mapping: A Case Study

Using the example of the R&D department of a consumer goods company, the value stream analysis approach will be explained in more detail. The company's strategic excellence position (SEP) consists of delivering technologies and design-trends in new, demand-oriented solutions to their customers. The goal of the value stream analysis project was to increase the efficiency and effectiveness of the product development processes for two selected product lines.

The concept phase and the early phase of the prototype development were defined as the relevant process steps prior to initial workshops. Afterwards a development project was selected as a representative example. The process was analyzed and the relevant stakeholders from marketing, design, development and testing laboratories were selected and brought together in a first workshop served to prepare the value stream analysis.

As part of this step, the stakeholders had reviewed the selected development project and identified characteristic deficits. Additionally, the strategic top-down perspective of the development manager was defined. In the second workshop, the swimlane design was used to document the value stream. Lean Administration projects commonly rely upon the swim lane method. Each process stakeholder is assigned a swim lane, where a change of the swimlane indicate a transfer point or hand over of responsibility (see figure 3).

Depending on the size and the complexity of the corresponding process, the level of detail of the value stream map needs to vary. This should be defined prior to mapping the process. The process analyzed in this project had a typical lead time of six to nine months, therefore only process steps lasting one to two weeks had a reasonable level of detail. The coordination between concept design and architecture was very important. In this case, a more detailed level was chosen in order to display the flow of information correctly. For the different process elements, the process inputs and outputs were recorded. Individual process elements were characterized by task, degree of added value and degree of standardization. Other process parameters that were used to detail the process are cycle time, process time, tools used and scrap rates. To determine the degree of added value, the normal process view was amended

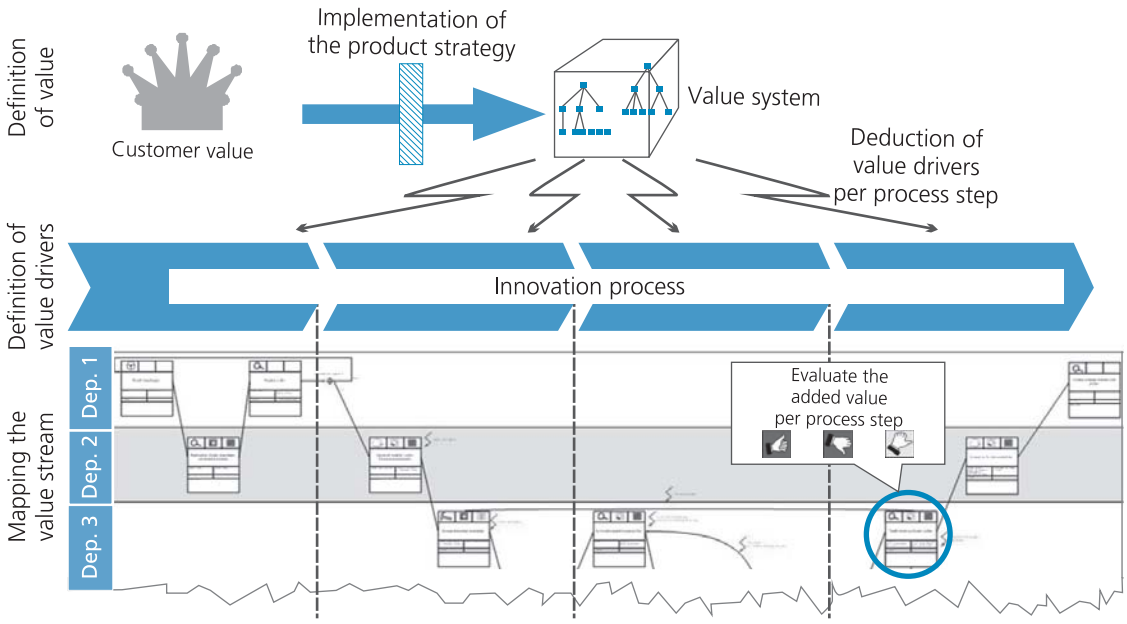

Figure 2: Value System and Value Drivers in the Innovation Process

with a "value view". This value view included the value drivers of each stakeholder at the different development stages. Because of the above-mentioned difficulty to define value in innovation processes, this additional step is necessary. The discussion about the value drivers during the workshop enabled the participants to identify how their development efforts add to creating customer values and revealed the interdependencies between the different departments.

In our case, participants of the workshop identified major deficits. Besides the known offenders of cycle time and repetitive loops, also inconsistent communication of the customer value by marketing, insufficient validation of the initial design concepts through focus groups using design prototypes and rushed agreements on the final product concept were named on the list of major deficits. The latter point has been observed many times in other development projects. When a prototype fails a customer acceptance test, there are neither alternative product concepts available nor enough time for a complete redesign to adjust the product. As a result, the complete project should be abandoned and deemed a failure. In most cases, however, the product is launched anyway, because of impending penalties from arrangements with the retailers.

After completing the documentation of the current processes, improvements for the identified shortfalls were defined. In a subsequent workshop the target process was designed. One of the most radical changes built into the new target process was the creation of an alternative development design in terms of a set-based design. Going forward, several different solutions will be systematically designed and developed. Concepts will only be eliminated at certain milestones based on the results of market studies and customer feedback.

Projects with a particularly high-risk profile will always have a fallback design right until the end of the development phase. A new approach to communicate customer values to the design and development departments, the early use of quality design prototypes and an adjustment of testing methods were implemented as additional measures to improve the target value stream. Lastly, the identified changes were broken down by the workshop team and then ranked in a benefit vs. cost portfolio. The results were documented in a roadmap that defines the timing of measures and most importantly, the person responsible. This ensures that the momentum of the value stream mapping project is carried forward and embedded into the day-to-day activities of everyone involved.

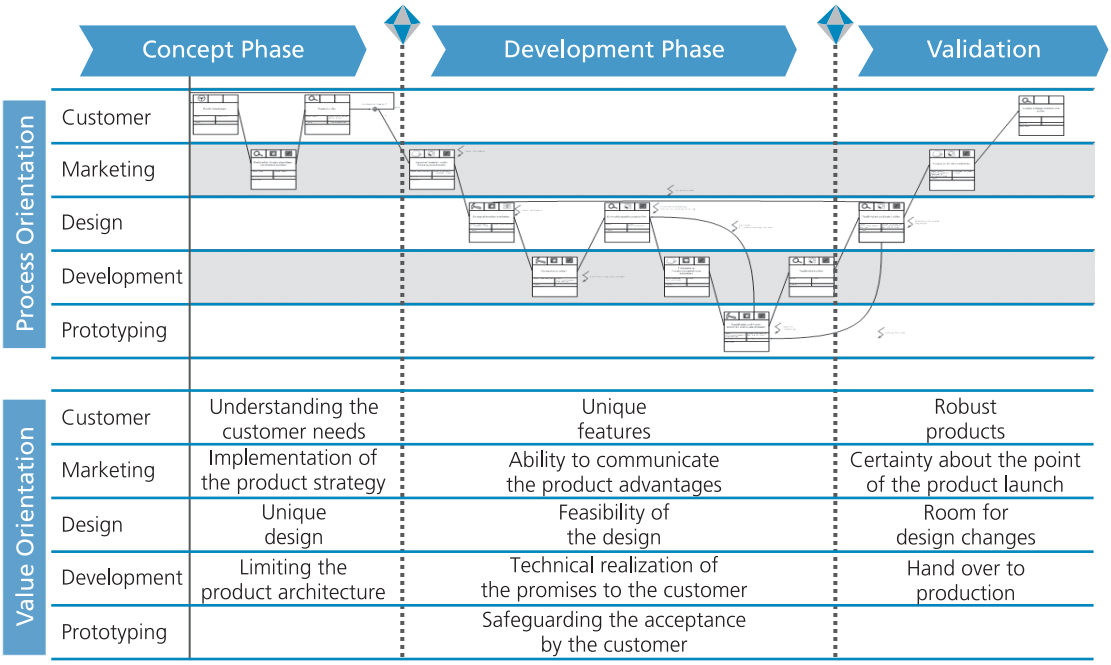

Figure 3: Exemplary illustration of the current value stream.

Using the value stream map as a tool helped to visualize the interdependencies of the different sub-processes for the participants. At the same time, day-to-day problems of the process were easily located in the map and were discussed objectively. Besides offering a solely structural optimization to the process, the value stream analysis also supports the necessary integration of different departments into a collective value stream.

A Look Ahead: Creating Flowing Processes!

Creating value-oriented processes in product development relying on value stream analysis, as described in the example above, is a central part of every Lean Innovation initiative. In addition to optimizing complete development processes, the value stream analysis is also helpful when redesigning repetitive standard processes in product development, such as change, purchasing or testing processes. In order to realize flowing processes however, the essential method of Lean Production systems, takt time, is still needed. Takt time touches on one of the basic principles of industrial production, the separation of planning and execution. However, in almost every project this principle is violated, because it is difficult to completely and accurately plan complex development projects in advance. The results are continuous changes and rework of plans. For the takt time within product development, it is essential to find a consistent timing structure of the workflow and to create manageable time measurement units separated by explicit planning steps. For these planning steps, the product development orders are to be prioritized according to the current knowledge and customer values and then to be dispatched to the next cycle in accordance with available resources. Additionally, Visual Management methods have to be integrated into the planning and controlling processes of the project management and the responsibilities of the project manager and project teams have to be redefined. By introducing a specific takt time to the R&D department, a better synchronization of the processes and an increased transparency of performance are achieved.

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„Lean Innovation Requires Creativity and Consistency“

Klaus Broichhausen and Stephan U. Schittny talk to the editorial staff of the Complexity Management Journal about innovation, modern management, creativity and consistency.

Mr. Schittny, Mr. Broichhausen, why “Lean Innovation”?

Schittny: The original underlying demand of the Lean Management approach is to consistently improve sustainable value creation in production. This approach can also be transferred to the development of products and services. So it only seems logical to us to apply the same methods and tools to the innovation process that have already proved valuable in other areas.

Broichhausen: …and for this application there is still a high demand and need even in well organized companies. Politicians demand innovation, whether it is in Europe or the USA, in order to create high quality jobs. Surveys show that a majority of companies view innovation as a major factor for success, even more important than cost reduction, globalization and increase of customer satisfaction or quality. The direction should therefore be set! However, this is not a no-brainer; based on industry interviews the orientation towards “value creation through innovation” is only consistently implemented in few of the questioned companies.

How can you explain the missing consequence?

Broichhausen: Some deficits are clearly addressed in the surveys. The main causes of problems with innovative products are stated as lacking evaluations of market opportunities, subjective decision making processes and ambiguous portfolio control during the development process. Additional critical areas are the control of resources and priorities. Especially in smaller companies, financing problems add additional complications.

Schittny: Here again, connections to Lean Management exist. The most important factor of creating value without waste is the firm’s customer orientation. When aligning processes with customer value, it is of crucial importance how the product portfolio is controlled!

Broichhausen: Of course we as external consultants cannot design the product that is in line with the market from the ivory tower. Creating value for the customer, that is to launch the right product, at the right time and for the right market, is part of the original entrepreneurial task. With our systematic approach we can, however, directly support the development of products and services on site.

> “The orientation towards value creation through innovation is only consistently implemented in few companies.”
>
> Prof. Klaus Broichhausen, Ph.D.

We can check the processes that lead to product decisions for consistency and consequence, question content and methods critically and adjust them together with the company’s experts. This alignment is extremely critical during the early phase of product development because on average 80 % of a product’s value is defined at this stage. We also provide the tools, sometimes specifically adjusted to the company’s needs, that such a process requires.

Schittny: …and all development activities should be measured against this standard. On average, they could be designed 15-20 % more efficiently.

Broichhausen: In practice, quite a number of problems can be observed. It starts with the realistic planning of performance, budget and timing of development activities. Furthermore, the structure of the project and the collaboration with partners and suppliers cause problems to the point of questions about differentiated product functions, accuracy and tolerances. After all, these functions extremely influence the production costs. This synchronization of technology, development, ramp-up of production and marketing is, in my experience, decisive for the economic success of a new product.

Schittny: Our research and project work clearly indicates that the topic of aligning the development of technology and products with the value orientation of the markets is definitely not standard. This starts with minor topics, such as lacking value orientation in team meetings and extends to more difficult topics of responsibilities and company structure. Together with the company's experts, we can achieve progress here. This progress will be decisive for success and an important factor of differentiation in the future, especially considering the international competition.

Both of you demand a very rigorous process during the development of products and services. Is there any room left to address the creativity and motivation mentioned?

Broichhausen: First of all, the orientation towards the customer benefit is a very creative and motivating task. In practice, this is not that easy. Each challenging development has enough problems and only creative solutions help. Moreover, it is not the sole focus of the systematization to increase efficiency. It is also important to implement well targeted creativity within the overall pressure for profitability. Here creative ideas must be combined with clear goals in a very focused manner.

Schittny: We have enhanced the methodical approach of the innovation pipeline. Given the dynamic markets today, a company cannot implement all good ideas for technology developments at the beginning. Therefore, we suggest the use of rigorous "roadmaps" that at

About:

Klaus Broichhausen brings his extensive experience in the machine, tooling, aerospace and transportation industries to the Schuh Group.

His expertise covers a broad range of the development of innovative product strategies as well as the technical and commercial operative implementations. He assists our clients in the development of new pragmatic solutions for their respective industrial environment and their implementation.

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certain phases open up towards creativity and new ideas. However, our experience shows that only very specific questions should be asked, according to the project progress, in order to not endanger the goal.

Broichhausen: During this phase the problem of human "shifting" often crops up. For a specialist, who works with high precision and quality, it is difficult to switch to creative conclusions, especially if they are combined with attributes such as "maybe" or "possibly". Here a two-pronged approach would lead to inefficiencies again. Who doesn't know the results of brain storming sessions that lead to nothing or last forever? Therefore, external support is helpful if not necessary. Because of our cooperations, we have several options in the area of change management. It becomes possible to find the right balance between the creativity and stringent development work that is anchored in the process and implement it into the daily work. It is possible! A simple example for me is a successful design studio. During the generation of ideas they are extremely creative, but during the selection and development phase they are absolutely goal oriented.

Thank you for your time.

About:

Stephan U. Schittny is a manager at Schuh & Company. He has extensive consulting and industry experience in process optimization as well as strategic and organizational development. His special focus lies on Lean Management. He manages the advancement of the topics Lean Innovation and Development.

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Lean Innovation to Improve Embedded Software Design and Development

Hans R. Tanner

The continuing integration and miniaturization in microcontroller design along with improved computing power allows for an ever increasing number of new and innovative product functions to be implemented in embedded software. Because of these changes, manufacturers need to prepare themselves to meet new and more complex customer requirements. Unfortunately, the development of embedded software is rarely treated with the same importance as the development of the other product components. Quite often available potentials of modularity, portability, state of the art design techniques, and release management are not exploited to the full extent possible. The techniques introduced by the Lean Innovation methodology can help to achieve significantly better results in this area.

Embedded Software Development Is often Treated with Lower Priority

Good product design must follow some generally accepted principles: It should start with an in-depth knowledge of the relevant customer requirements, implement a modular design that allows for reuse of modules, meet all applicable regulatory requirements, and comply with applicable technical standards and state of the art practices. The product should be configurable to allow for user configuration or mass customization and meet principles of complexity management, i.e. minimization of the diversity of used parts and variants in both, products and production and logistics processes. Finally, each new product design should be the well thought out result of a higher level, strategy based system architecture and product roadmap.

While significant improvements have been achieved over the last decade in implementing these principles in the tangible parts of products, embedded software development is clearly lagging behind in many cases. Many companies' development processes show the following weaknesses in particular:

- Too often, the development of firmware is treated as an individual project for each device. Opportunities to use commonalities on the level of hardware standardization as well as design tool standardization are not exploited.

Examples of devices using embedded software:

- A large and constantly growing number of microcontrollers in cars cover all functions.
- 'Ordinary' products like washers, dryers and vacuum cleaners rely on microcontrollers to not only control the user interface, but also the core functions of the product.
- Production equipment like machining centers or injection molders come with built-in web servers that allow for control of the equipment functionality, as well as the analysis of performance data.
- Devices that used to be 'stand-alone' e.g. medical diagnostics devices now have a communication infrastructure that allow to visualize the data on the user's PC and to share it automatically with the doctor.

This list could go on indefinitely, as new devices with improved functionality become available daily.

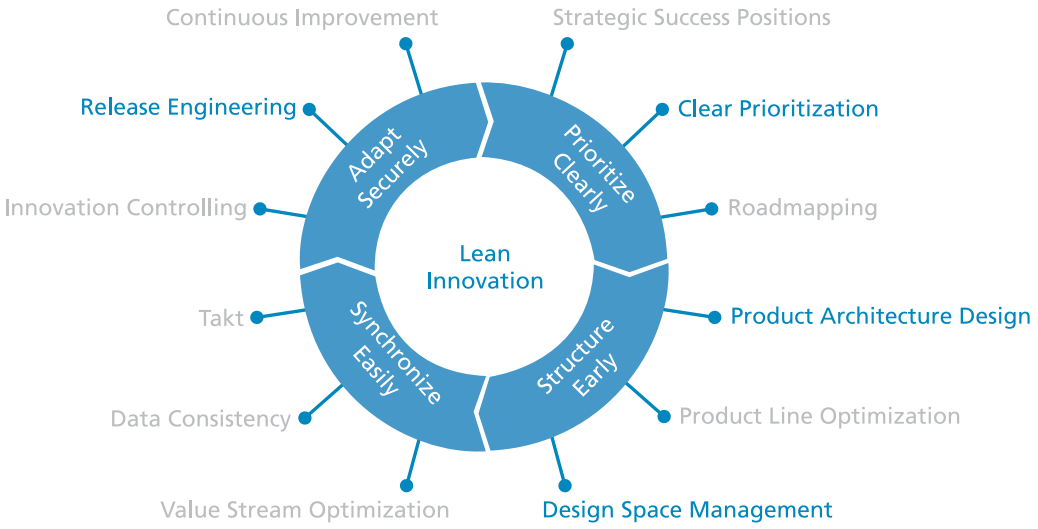

Figure 1: By Simply Focusing on 4 of the 12 Lean Innovation Principles, Embedded Software Design and Development Can Be Improved Signifcantly

- Modularization is in the best case understood as the availability of function libraries that can be reused. However, an understanding of modularity in the sense of grouping the code along the product functions, even in combination with the related hardware using a proper hardware abstraction and then reusing it in the next product, is rarely done.

- System architectures and product roadmaps rarely treat the development and evolution of low-level software as an individual topic. Technology steps, new technologies and their implementation are seldom identified along a timeline. This is an important topic during the planning stage as there are still frequent technology changes in IT, requiring thorough market observation and technology succession planning.

- Consequently, there is also no harmonization of technologies between a product roadmap and software roadmap. This topic is of particular importance because both worlds typically have very different product life cycles.

Lean Innovation as introduced in the current and past issues of the Complexity Management Journal provides several mechanisms that help to better integrate the development of embedded software with the development of the overall product; a first step to overcome the above-mentioned problems. In particular, addressing the Value System and Target Hierarchy, Technology Management and Roadmapping, Design Space Management, Product Architecture Design, and Release Engineering can reveal the biggest improvements.

Value System and Target Hierarchy

Normally in an engineering driven development environment, not enough time is spent on carefully identifying all aspects of user requirements. This is particularly true regarding embedded software. Even though smart software functionality, e.g. standardized cross-device user interface and menu systems or functions that increase the ergonomics of a device, can greatly contribute to the overall value of the device to a customer. However, the methods that are generally used to recognize customer requirements, such as focus groups, do not help to clearly identify the true requirements. Focus group members think linear and along the options of the sample device. Most likely, their input provides insights into current deficits of a product and ideas for incremental improvements, but rarely will it generate break-through ideas.

As Lean Innovation emphasizes the need to carefully define a clear target hierarchy, additional methods such as the definition of Use Cases, the identification of com-

peting Use Cases, thorough QFD analysis and prioritization should be introduced to break down walls in the design process of embedded software as well.

Furthermore, Lean Innovation promotes the provision of roadmaps as a planning tool for several generations of products, starting with basic technology roadmaps and module roadmaps and ending with product roadmaps. Embedded software should be part of the module roadmap to show the availability of individual versions with specific product features along the product life cycle.

Design Space Management

In every product development process, there is a significant risk of ruling out potential solutions too early in the process. In many instances, this results of having to reintroduce them again at high costs late in the process. From the embedded software point of view, it is important to keep future expansions alive as long as possible. For example, when implementing a communication interface, it makes absolute sense to use a communication stack that later can be expanded to support additional communication protocols, such as adding wireless communications to a wired device. Furthermore, the design space should also be kept open regarding the attached hardware. This could be achieved by standardizing certain control signals from the outside to the processes that allow for adding new input-based functionality later on in the product life cycle. For example, when implementing a motor drive circuit to set the motor speed of a software or hardware knob, adding a tachometer signal from the motor back to the controller would keep the design space open. In that case, it would be possible later to add a PID feedback loop to create an autonomous control loop in the software without additional hardware changes.

Product Architecture Design

Just like in mechanical engineering, modularity should be used as a design principle for embedded software as well. Modularity is more than just separating source code in individual units or libraries, e.g. math libraries, but stands for functional separation. Functional modules such as user interfaces, core device functions like control loop implementations or communications protocol implementation should be kept and treated as individual modules with clearly defined interfaces. They offer the opportunity for improvements and releases on the module level as well as making the hardware-independent fraction of the code portable between devices. Furthermore, functional modules that have the potential to be reused on additional devices should be separated from the target hardware in order to facilitate the transfer. Examples for such modules are database elements or the structural part of user interfaces and menu systems.

Release Engineering

The Lean Innovation methodology suggests shortening release cycles to maintain an image of being an innovative solutions provider. Software can facilitate short release cycles to a great degree, as improvements to the product can be implemented at relatively low cost. Therefore, it is important to overcome the 'hotfix' mentality, carefully plan and make use of short release cycles and upgrades made available by embedded software.

When carefully planned, a company can introduce a new device using a standard hardware where not all hardware functions are supported by software at the beginning. By providing software releases, most often installable by the user through Internet-based distribution, functionality can be added to the device over time, thereby increasing the value for the customer.

Conclusion

In our experience, the design of embedded software is often treated as a topic of minor importance in the design process of typical hardware devices or machinery. As a result, available potentials of smart and elaborate software functionality are not fully exploited. Applying the Lean Innovation principles to the design process of embedded software can help to overcome these weaknesses, turning embedded software from a necessity to a core contributor of product success.

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Schuh & Company focuses on providing solutions and methods for managing the ever increasing complexity of today's enterprises, products and processes. With this approach the company established itself as an implementation-oriented problem solver in the industry. Today the company consists of about 40 people committed to ensure your company's success through their work as strategy and organizational consultants, as well as management coaches.

Schuh & Company is headquartered in Aachen, Germany, with subsidiaries in St. Gallen, Switzerland (since 1991), and Atlanta, GA, USA (since 1997).

In 1999 Schuh & Company started the Complexity Academy initiative. The program provides valuable hands-on knowledge through its conferences and workshop events.

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Editorial Board:
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Photos:
Pages 1, 7: ©istockphoto.com/gilles lougassi