Design for Six Sigma^{+Lean} Toolset

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Implementing Innovations Successfully

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Foreword

Every company relies on innovation to compete globally. However, creative ideas are mostly insufficient if you want to translate an innovative spirit into commercial success. The ability to put a new product or a new process on the market as quickly as possible is becoming increasingly important.
Systematic management is necessary for developing cost-effective and successful products based on market realities and customer requirements. Especially open innovation, which is currently intensively discussed and widely implemented, requires consideration. Only a sensible interface and information management is capable of generating overall success from a variety of good ideas.

Design for Six Sigma^{+Lean} is an approach for such a systematic innovation management. This concept was developed to achieve a target-oriented realization of innovations and is strongly associated with the Six Sigma^{+Lean} methodology, currently applied globally to optimize existing processes. DFSS^{+Lean} synthesizes a number of key factors, including the active integration of employees, customer-oriented development, the reduction of complexity in products and processes, and controlling of innovation in terms of a standardized procedure.

The present toolset represents the proven approach UMS takes when putting Design for Six Sigma^{+Lean} into practice. Its individual tools are assigned to the process model Define, Measure, Analyze, Design, and Verify in a clear and manageable structure. This structure can be considered as a red thread and makes it easier to apply the tools in practice and organize an innovative product and process development that is target-oriented and efficient.

Besides the whole UMS team, I would like to thank the authors, who along with their expertise and experience have shown enormous commitment in putting this book together. My thanks also go to Mariana Winterhager for the graphic layout of the material and Astrid Schmitz for the translation work.

I wish everyone great success in implementing innovations.

Frankfurt am Main, October 2008

Stephan Lunau

Design for Six Sigma^{+Lean} Toolset

Introduction

Introduction

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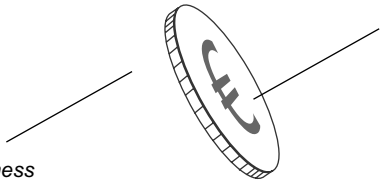
Implementing Innovation Successfully

Today innovation is one of the most important success factors for every company: according to an up-to-date benchmark study conducted by the American Productivity and Quality Control (APQC)*, companies displaying strong growth generate one-third of their turnover from products which are younger than three years. A further key observation: over the last 50 years the lifecycles of new products have shortened by 400% on average. Successful innovation is obviously not only due to good ideas, but requires quick implementation.
But the implementation step includes great difficulties for many companies: statistics show that from 100 R&D projects only every tenth generates commercial success and even an on-schedule market launch is met by only every second product.

Every innovation demands from companies a balancing act between customer requirements and internal effort / expenditure and the risks. On the one hand customer requirements are to be met exactly (effectiveness), while on the other hand low costs and a quick introduction to the market (efficiency) are to be realized.

Two sides of the coin



Effectiveness:
Complete fulfillment of customer requirements – strategic creation of the markets of tomorrow

Efficiency:
Lowering costs – ensuring competitiveness

The question is: how is a balance to be achieved between the benefits for the customer and the effort / expenditure for the company?

Implementing innovation successfully thus means making a good idea marketable in the shortest possible time while the risk for the company is minimized at the same time. This can only be achieved through systematic management of developmental work.

* *American Productivity & Quality Center (2003): Improving New Product Development Performance and Practices. Houston (TX): APQC (www.apqc.org/pubs/NPD2003)*

Such an innovation management must avoid the risks typical of product development. These are:

- Customer requirements are either not identified at all or only insufficiently; products / services unsuitable for the market are thus developed.
- Resources are deployed in line with false priorities (waste of resources).
- Features are added to products / services, which the customers don't want (Overengineering).
- Only a few members of the development team determine the process.
- Project results are not completely documented and are not understandable.
- The introduction to the market is delayed (time to market) through unplanned and time-consuming rework.

Innovation management must also be able to respond flexibly to the individual requirements of different project types.

Project Type / *Project-Characteristics*	*Breakthrough Innovation*	*Mixed Types*	*Incremental Improvement*
Complexity	High		Low
Degree of Novelty	High		Low
Variability	High		Low
Degree of Structuring	Low		High

DFSS can be used for all project types. The deployment of specific methods and tools must be calibrated and coordinated to match the respective development task. However, the logical structure remains the same.
With Design for Six Sigma (DFSS^{+Lean}) an approach has been put into practice worldwide and across many sectors in recent years that is capable of successfully implementing these requirements.

Through a structured combination of proven methods and tools from the Six Sigma, Lean Management, and system development environment, DFSS^{+Lean} offers the possibility to systematically and efficiently boost innovation in the company.

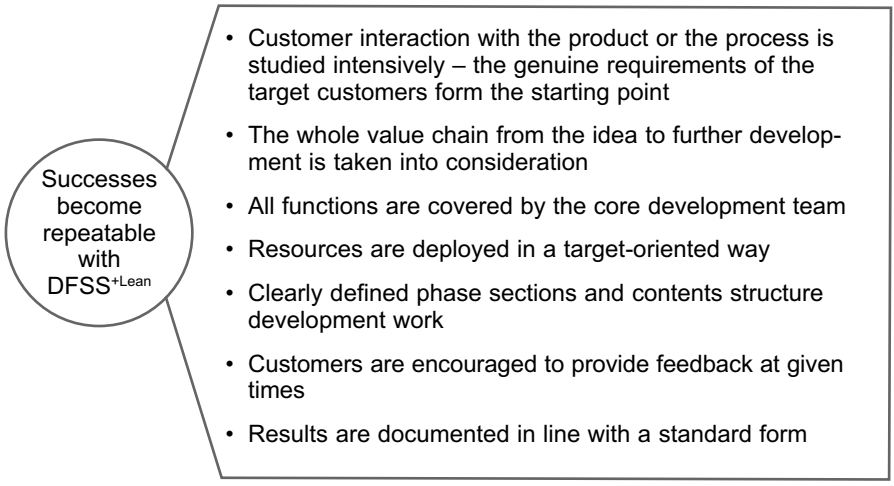
The description of the development process in terms of the DMADV phase cycle (DMADV = Define, Measure, Analyze, Design, Verify) makes it possible to apply DFSS^{+Lean} to different innovation levels and to support process and product development in equal measure.

DMADV provides methodological support on three of five innovation levels.

Innovation Levels	*Application Areas*	*Methods*
1	Process optimization	DMAIC: elimination of negative quality
2	Development of a new product based on an existing process (in line with changes in the market)	DMADV: generation of positive quality
3	Development of a new process to further develop an existing product (e.g. during production transfers)	
4	Development of a new product and a new process	
5	Basic research	

The risk of misguided development or "never ending stories" is reduced significantly. Successes become repeatable.

Example on the following page.



Design For Six Sigma^{+Lean} is a key element of the Six Sigma^{+Lean} concept and pursues the same approach. This will be briefly presented on the following pages.

The Six Sigma+Lean Approach

Six Sigma+Lean is the systematic further development and combination of proven tools and methods for improving processes. Emphasis is placed on the consistent orientation to customer requirements and a concept of quality that integrates the "benefit" for the stakeholders.

Six Sigma+Lean derives the elimination of defects and waste from a systematic analysis of processes based on facts. Implementing an integrative measurement and project systematic achieves a lasting increase in both customer satisfaction and company value. The concept mobilizes and demands the commitment of all executives and thus, when applied consistently, provides an integrated approach for changing the entire company culture.

Six Sigma+Lean is applicable in every industry and service branch and is broadly accepted on capital and labor markets.
Because of that this method also has a positive influence on the image and shareholder value of a company.

The Goal of Six Sigma+Lean

Six Sigma+Lean shows that the demand to enhance quality while reducing costs at the same time must not represent a contradiction.
If quality is determined in relation to customers, every increase in quality represents added value that the customer is prepared to pay for.
The goal of every Six Sigma+Lean project is therefore: to achieve perceivable quality through marketable products while significantly cutting costs through lean processes.

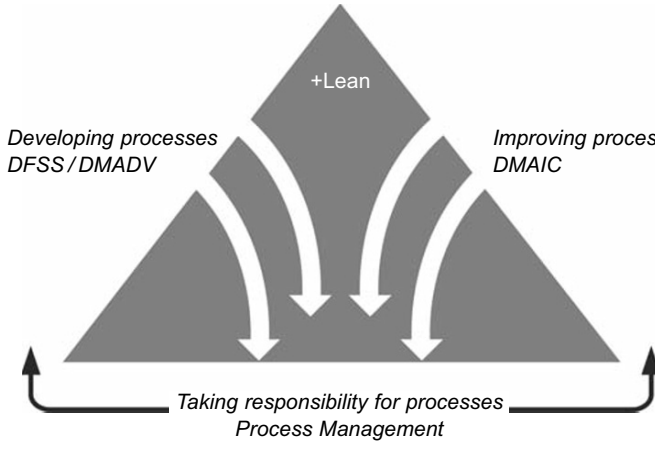
This special approach forms the basis of the special Six Sigma+Lean vision of quality, which has as its goal the benefit generated for both the customer as well as the company:

To meet
customer requirements
fully and profitably.

The Four Dimensions of Six Sigma+Lean

Six Sigma+Lean comprises four key elements or dimensions in order to realize this vision:

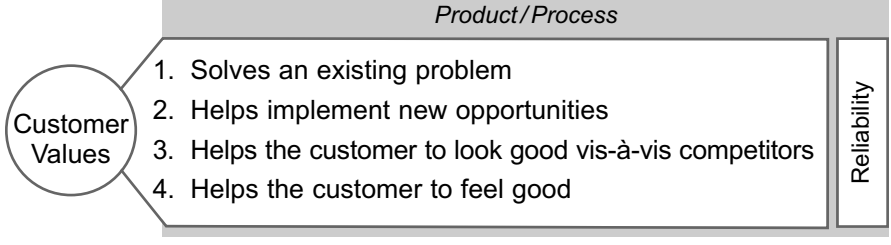
- The iterative cycle employed to optimize processes, called the DMAIC, that consists of the five phases, **D**efine, **M**easure, **A**nalyze, **I**mprove, and **C**ontrol
- The procedural model for developing processes and products, called the DMADV, that consists of the five phases, **D**efine, **M**easure, **A**nalyze, **D**esign, and **V**erify (also known as DFSS, Design for Six Sigma)
- Lean Tools applied in the two aforementioned approaches
- Process Management for ensuring sustainability



With DMAIC, Six Sigma+Lean has at its disposal tools and methods for improving products or processes, while the DMADV cycle provides an approach enabling the developedment of new products and processes.

Generating well-founded results, the DMAIC iterative cycle represents the basis for a systematic project work which is based on facts. The key goal of this improvement methodology is to decrease process lead times by reducing rework, waste, and inventories. Existing potential is realized by systematically eliminating errors and defects.

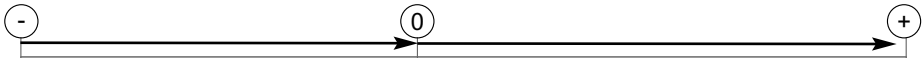
The procedural model DMADV or DFSS+Lean aims at satisfying customer needs. Based on systematic surveys new products and processes are developed which create value for the customer. The framework for developmental work is set by the following customer values.



The combination of both approaches in Six Sigma+Lean matches the insight that:

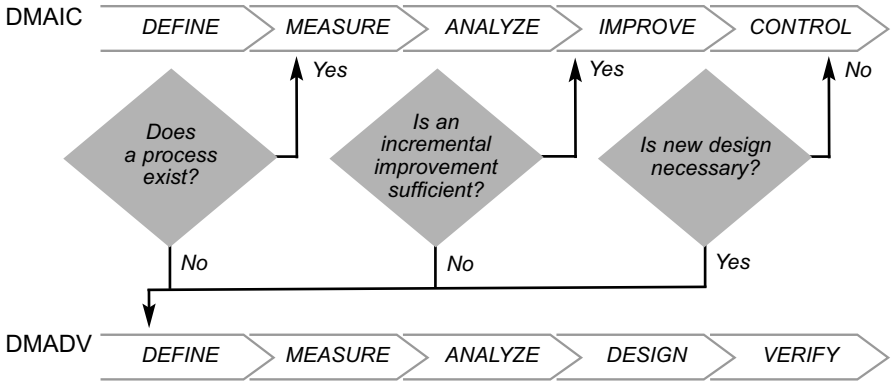
"Not doing anything wrong doesn't mean that one is doing everything right!"

This is because: DMAIC lastingly eliminates negative quality, while with DFSS+Lean new positive quality can be generated.



DMAIC	DMADV / DFSS
Elimination of negative quality	Generation of positive quality
• Quality: reduce defects • Speed: increase the speed • Costs: reduce costs	• Problem solving • Creating opportunities • Look good • Feel good

Both approaches complement one another during Six Sigma+Lean project work, so that a launched DMAIC project can at several places in the cycle be converted into or induce a DMADV/DFSS+Lean project.


DMAIC
DEFINE
MEASURE
ANALYZE
IMPROVE
CONTROL
Does a process exist?
Yes
Is an incremental improvement sufficient?
Yes
Is new design necessary?
No
No
No
Yes
DMADV
DEFINE
MEASURE
ANALYZE
DESIGN
VERIFY

Developing New Processes and/or Products with DFSS+Lean

DFSS projects concentrate on generating value for the respective target customers. A perceivable value always arises when a product/process exactly fulfills customer needs.

One necessary prerequisite for developing "valuable" products and processes is therefore the systematic identification of customer requirements. When weighted and prioritized they – and not the preferences of the developers – function as the motor of the project.
In addition, they facilitate the concentration on limited resources.

On this basis the DMADV procedural plan sketched below is suitable for the development of follow-up products and the elaboration of completely new products or processes.

Phases	*DMADV Procedural Plan*
DEFINE	• Business case • Project planning and scoping
MEASURE	• Understanding customer requirements • Transformation into specific and measurable customer requirements • Deriving target values and tolerances
ANALYZE	• Development of an optimal high-level design concept
DESIGN	• Elaboration of the design down to the smallest detail • Production and implementation planning
VERIFY	• Pilot and/or test • Complete implementation • Monitoring the KPIs

Proven tools and methods from the Six Sigma, Lean Management, and System Development environment are deployed in each phase of this DMADV cycle:

	Tools	*Goal*
Define	• Project Charter • Project Scope • Multigeneration Plan (MGP) • Gantt Chart • RACI Chart • Budget Calculation • Stakeholder Analysis Table • Communication Plan • Risk Analysis	• The project is defined. • Problem and goal are defined and complemented by a MGP. • The project is clearly scoped and its influence on other projects reviewed. • Activity, time, and resource planning is defined. • Possible project risks are identified and assessed.
Measure	• Portfolio Analysis • Kano Model • Customer Interaction Study • Survey Techniques • Affinity Diagram • Tree Diagram • Benchmarking • House of Quality • Design Scorecards	• The relevant customers are identified and segmented. • Customer requirements are collected, sorted, and prioritized. • CTQs and measurements are derived on the basis of customer requirements. • For measurements priorities are allotted, target values and quality key figures defined.
Analyze	• Function Analysis • Transfer Function • QFD 2 • Creativity Techniques • Ishikawa Diagram • TRIZ • Benchmarking • Pugh Matrix • FMEA • Anticipated Defect Detection • Design Scorecards • Process Modeling • Prototyping	• The best concept is selected from alternative high-level concepts. • Conflicts and contradictions in the selected concept are solved and the necessary resources are derived. • The remaining risk is defined, customer feedback is gathered, and the concept is finalized.

	Tools	Goal
Design	• QFD 3 • Statistical Methods (Tolerancing, Hypothesis Tests, DOE) • Design Scorecards • FMEA • QFD 4 • Radar Chart • Lean Toolbox (Value Stream Design, Pull Systems, SMED, Lot Sizing, Complexity, Poka Yoke, Process Balancing)	• The detailed concept is developed, optimized, and evaluated. • The production process is planned and optimized in line with Lean principles. • The implementation of the process design is prepared, involved employees are informed, and customer feedback was gathered.
Verify	• PDCA Cycle • Project Management • Training • SOPs	• The Pilot is carried out, analyzed, and the Roll Out planned. • The production process is implemented. • The process is handed over completely to the Process Owner, the documentation was passed on, and the project completed.

The correct use of these methods and tools contributes significantly to a successful DFSS project.

Critical Success Factors

Along with the quality of the deployed methods and tools, the success of a DFSS project also depends to a great extent on the acceptance within the company.

[SUCCESS]	=	*[ACCEPTANCE]*	x	*[QUALITY]*
Innovative new and / or further development of products and services trimmed exactly to meet requirements which can be sold to a sufficiently large pool of customers in a profitable way		• Interdisciplinary team with changing responsibilities during different phases • Disciplined project management in the frame of Six Sigma roles and responsibilities, applying DFSS^{+Lean} tools • Specific and measurable criteria to regulate the preparatory and specific work of all divisions involved in the development process • Risk management to evaluate the project environment • Active stakeholder management during the project course		• Offer the customer "valuable" products and services, i. e. identify, understand, and translate customer needs • Coherency and coordination • Innovate new and / or further development to solve problems in such a way that the customer benefits and benefit / value is generated • "Quality" as stringent orientation for company performance to customer requirements

Employee Acceptance

A successful implementation of the DFSS project contributes more than anything else to ensuring acceptance.
Forming an interdisciplinary team creates a platform covering many areas and functions. This platform enables the efficient fulfillment of the development task which is achieved by applying common tools and methods. Defects, double work, and loops are avoided, while project criteria are met more easily. The joint project work establishes a common language understood by everyone and thus improves communication across all areas.

Usually a DFSS team is made up of employees from the following areas, or is at least supported by them:

The defined team is accompanied by an internal / external coach who introduces the necessary methods and tools in the course of development work and applies them while working with the team. In this way the employees from the various areas extend their methodological skills with proven tools and methods. The learnt success becomes repeatable.
The DFSS^{+Lean} investment in human capital is thus goal-oriented and sustainable. The resultant distinctive profiles of companies applying these methods vis-à-vis their competitors cannot be offset by gaining the services of "knowing" employees.

Besides an interdisciplinary core team, the acceptance of the DFSS^{+Lean} project is promoted in the company by a number of other factors:

- Management commitment
- Providing suitable resources with sufficient know-how and prompt availability
- Team ability of the core team
- Systematic application of tools and methods
- Creativity
- Integration of DFSS tools and methods into existing development processes
- Defining and sticking to the project profile / scope
- Goal-oriented and systematic project management

The Quality of Applied Tools and Methods

In line with the success story of Six Sigma in process optimization (DMAIC), the success of the DFSS^{+Lean} concept is not based on inventing new tools and methods. On the contrary: many of the methods and tools dealt with in this toolset have proven worthwhile for a number of years in meeting the challenges of development processes. Crucial to the success of the DFSS concept is how these tools and methods are combined with one another.

A further success factor of the DFSS^{+Lean} approach is its integrated perspective of the product life cycle, from the idea to the utilization of the obsolete product under the systematic consideration of financial key figures.

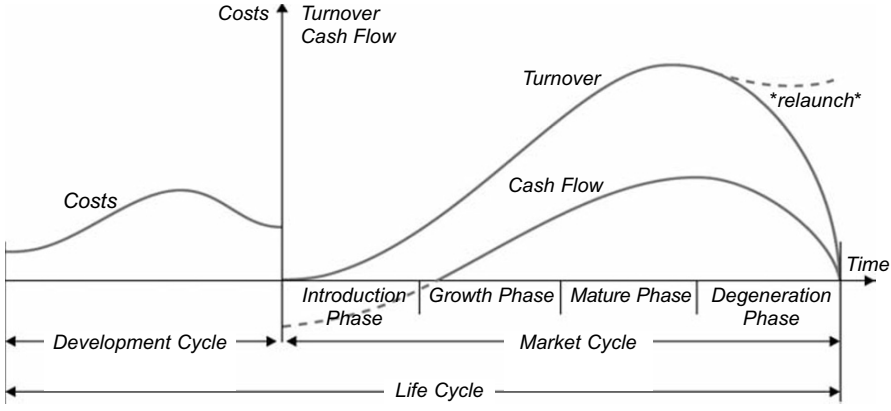


Diagram from Bea / Haas (1997): 113

A sensible combination of the Six Sigma^{+Lean} toolsets DMAIC, DFSS, and Lean Management provides quick, goal-oriented solutions for the most complex problems and ensures a flexible and customer-oriented further development of the respective product / process. The successful implementation of the tools is secured through the company's well-trained employees.

Whoever has to reach a decision on the use of a DFSS^{+Lean} approach in operative practice should consider the following aspect:

In our practical experience of DFSS^{+Lean} UMS has repeatedly observed how advantageous it is to integrate the concept into an already existing development process. In this context the quality of the deployed aids can develop its optimal potential and so guarantee the acceptance of the participating employees.

Summary: the Benefits of DFSS+Lean

Because the goal of the DFSS+Lean approach is to meet the requirements of both the customer and the company, it generates a diverse array of benefits for everyone involved in the development process:

Contents	*Company*	*Employee / Team*
• Perceivable benefit (value) • Products / processes and systems in line with requirements • Reliable products / processes and systems • Good cost-benefit ratio	• Security and risk minimization • Short time-to-market • Service and repair cost minimization • Margin security through USP • Enhanced image • Repeatable successes	• Effective tools • Common language • Security in every phase of the project (flow-up / flow-down) • Repeatable successes • Greater motivation