Six Sigma$^{+\text{Lean}}$ Toolset

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Six Sigma$^{+\text{Lean}}$ Toolset

Executing Improvement Projects Successfully

Translated by Astrid Schmitz

Springer

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Foreword

Six Sigma has established itself globally over the last 20 years as a best practice concept for optimizing processes. Many renowned companies from a diverse array of business branches successfully deploy Six Sigma and profit from the benefits of Six Sigma-inspired projects, significantly improving their net income. Focusing on customer needs and measurability is at the forefront of this approach.
In the course of its long history the Six Sigma approach has undergone many developments and upgrades and these have been incorporated into the original concept. One very important step is the integration of Lean Management tools into the classical Six Sigma concept. Along with reducing process variation – which is achieved through classical quality tools and statistical analysis, these tools contribute decisively to achieving a significant acceleration in process speed and a reduction of inventories and lead times.
As practiced by UMS GmbH, in its applications, the Six Sigma^{+Lean} approach thus combines the tried-and-tested tools of both worlds, which are linked together systematically in the proven DMAIC process model. Effective tools exist for every problem, ensuring that excellent and sustainable project results are achieved.
We took the chance to update the book with respect to the latest developments of the method and incorporated the customer feedback of the last years.
Here we focused especially on an improved Define phase, the incorporation of the OEE measurement in the Measure phase and a revised Lean Toolset.

The present Six Sigma^{+Lean} Toolset takes into account the described developments by serving as a practice-oriented reference book for trained Master Black Belts, Black Belts, and Green Belts. It contains all key Six Sigma^{+Lean} tools, which are depicted in clearly structured graphs, charts and highlighted with examples. The book follows the successive phases of a project and deals with the tools according to their respective place in the Define, Measure, Analyze, Improve, and Control phases. This enables the expert to work through his projects chronologically, with the Toolset acting as a guideline.

I am indebted to members of the UMS team; their detailed expertise and rich wealth of experience contributed to realizing this Toolset. In particular my co-authors Alexander John, Renata Meran, Olin Roenpage, and Christian Staudter. I would like to thank Astrid Schmitz for her effort in the translation and adaptation process. Finally, my thanks go to Mariana Winterhager for her continuous effort in incorporating all the changes and the improvements into the Toolset.

I wish readers good luck with their projects.
Frankfurt am Main, July 2008
Stephan Lunau

Six Sigma+Lean Toolset

Introduction

Introduction

Contents:

The Formula for Success
– The core elements for a successful implementation of Six Sigma^{+Lean}

Quality as Success Factor
– The foundations and dimensions of Six Sigma^{+Lean}
– What is Six Sigma^{+Lean}?
– Six Sigma^{+Lean} puts benefit first
– What does the term Six Sigma^{+Lean} mean?
– The dimensions of project success in Six Sigma^{+Lean}
– Improving processes (DMAIC)
– Developing new processes or products (DFSS)

Acceptance as Success Factor
– Roles and responsibilities in the Six Sigma^{+Lean} concept
– Modular and practice-oriented training and coaching concept

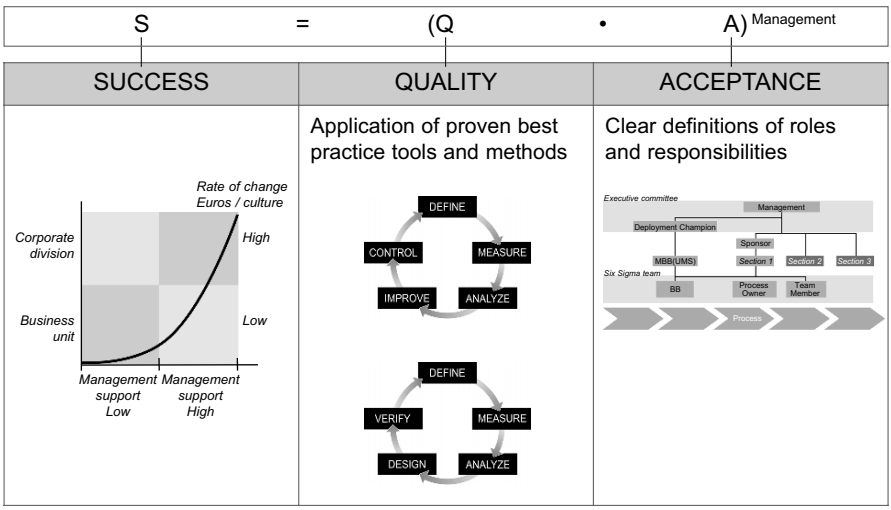
Management Commitment as Success Factor
– On the road to business excellence
– Implementation concepts
– Methodological Six Sigma^{+Lean} generations

Result: Measurable, Sustainable Success
– What is "Critical to Quality" when implementing Six Sigma^{+Lean}?

The Formula for Success: Core Elements of Successful Six Sigma+Lean Implementation

The Success Formula for Six Sigma+Lean Implementation

For over nine years now, UMS has implemented Six Sigma+Lean in a diverse array of corporate structures and cultures. The experience we have gained shows that certain core elements are crucial for achieving measurable and sustainable results. These core elements can be defined as success factors and presented in the following compact formula:



Quality describes the consistent and sensible application of proven best practice tools and methods for optimizing existing processes and developing new processes and products. The sum of this work on processes and products is an important contribution to achieving process excellence in the corporation – methodologically advanced and supported by the Six Sigma+Lean concept.

The application of the methods takes place in the framework of clearly defined roles and responsibilities for employees and managers in the corporation. In the course of this application, an extensive knowledge of methods is built up amongst employees in a short time. This knowledge creates an independence from external

support when faced with solving upcoming problems. In turn, this employee competence decides primarily about the **acceptanc**e of the concept in the corporation and influences significantly the implementation. Dedicated resources which are given the relevant freedom to do their project work in the framework of Six Sigma^{+Lean} deliver quick and measurable results.
Intensive training in methods for employees in combination with practical project work generates both a direct transfer of knowledge as well as benefits and palpable progress for one's own projects. The combined training and coaching in the frame of the Six Sigma^{+Lean} project work positively influences project culture, provides adequate support through all project phases, and thus represents a key element for achieving people excellence.

How can quality and acceptance be secured and strengthened when implementing Six Sigma^{+Lean}? With adequate **management** commitment clear and measurable goals, connected to the current corporate strategy, focus existing resources on the important themes. These are to be defined through a value-based project selection. Here, top management takes on a key role model function. On the one hand, the goals to be achieved with Six Sigma^{+Lean} in project works are to be integrated into existing incentive structures, on the other, the aspiration must be to achieve the trans-sectoral application of the concept in the sense of a common language to change corporate culture.

In their overall effect, the listed elements of the success formula result in a quick, measurable **success** that, along with a noticeable generation of net benefit, also achieves a considerable contribution to business excellence in the sum of the selected success factors.

The following section will present and explain the individual core elements of the formula:
$Success = (Quality \bullet Acceptance)^{Management}$.

Quality as Success Factor: The Foundations and Dimensions of Six Sigma^{+Lean}

What is Six Sigma^{+Lean}?

Six Sigma^{+Lean} is the consistent further development and systematic interlinking of proven tools and methods. When combined coherently and applied consistently, they can also be considered and employed as an integrated approach for changing corporate culture.

The following table visualizes the differences to other approaches and methods:

Six Sigma^{+Lean}	**=**	**the creation of lean processes free of variation as well as customer-oriented products.**
Product development	=	develop processes and products.
Lean management	=	cut process cost.
TQM	=	optimize / manage processes.
ISO	=	standardize / optimize processes.

Six Sigma+Lean Puts Benefit First

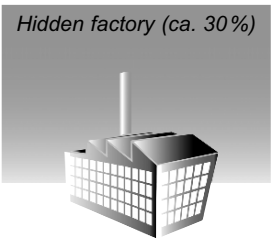
Six Sigma+Lean shows that a demand for raising quality while simultaneously reducing costs must not be a contradiction. Instead, the task set in every project is to consider and realize both sides of the "Six Sigma" coin.

Because only misunderstood quality costs money: putting quality into the product independent of customer requirements generates higher costs, and these can add up to a significant share of turnover. For example, with a three Sigma process poor quality accounts for up to 30 % of turnover (cost of poor quality), a factor that is also known as the "hidden factory". If quality is understood correctly, then it generates financial gain: because quality is what the customer is willing to pay for. For the customer this means that perceivable quality is produced through lean processes at significantly lower costs.

From this key consideration we can derive the special vision of quality that is the hallmark of Six Sigma+Lean and always puts benefit first:
The requirements of our customers are to be met completely and profitably.

Waste frequently represents the largest cost driver (called the "hidden factory" in industrial corporations). Starting points for optimization are to be found in the following areas:

- Rework
- Duplication of work
- Rejects / defects
- Inventories and warehousing

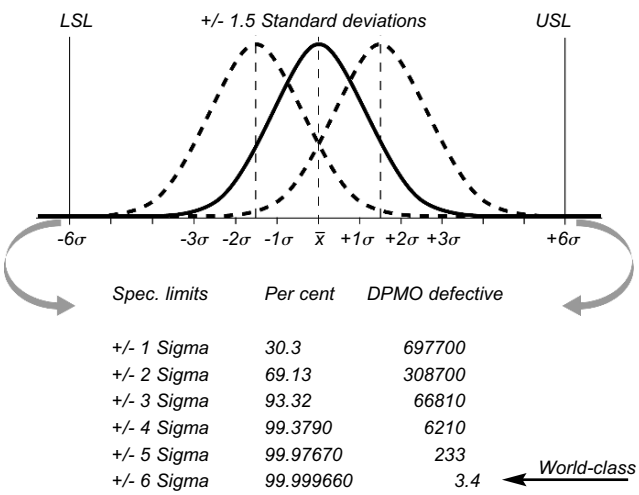


Here a cost reduction of up to 30 % can be generated. In addition, increasing quality creates the preconditions necessary for raising turnover. Overall, the following levers emerge for net benefit:

- Increasing quality – customer loyalty and realizing greater turnover levels
- Cost reductions – greater competitive potential
- Higher process speed – less stock
- Greater customer loyalty – realization of new business fields

What Does the Term Six Sigma^{+Lean} Mean?

Six Sigma^{+Lean} means "six standard deviations". The Six Sigma^{+Lean} vision means that the standard deviation of a normal distribution fits +/- six times between the specification limits defined by the customer (upper specification limit = USL and lower specification limit = LSL). The located value corresponds to a quality level of 99.9999998 %. Practical experience shows that processes fluctuate over time – by at least +/-1.5 Sigma, this means that in the end a quality level of 99.9997 % is achieved and this corresponds to an error rate of 3.4 defects per million opportunities (DPMO).



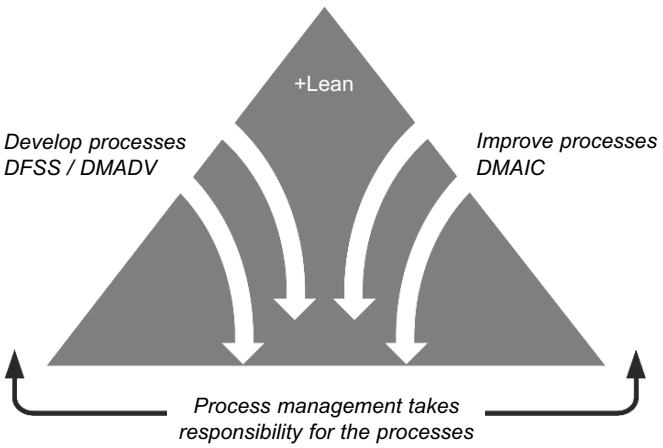
Spec. limits	Per cent	DPMO defective	
+/- 1 Sigma	30.3	697700	
+/- 2 Sigma	69.13	308700	
+/- 3 Sigma	93.32	66810	
+/- 4 Sigma	99.3790	6210	
+/- 5 Sigma	99.97670	233	
+/- 6 Sigma	99.999660	3.4	World-class

Six Sigma+Lean stands for a customer-driven maximization of quality that provides measurability and a data-driven procedure based on a statistically secured analytic ("whatever cannot be measured cannot be improved"). Numbers, data, and facts accompany every project and support both the description of the current situation as well as the systematic analysis of causes.

The Dimensions of Project Success in Six Sigma+Lean

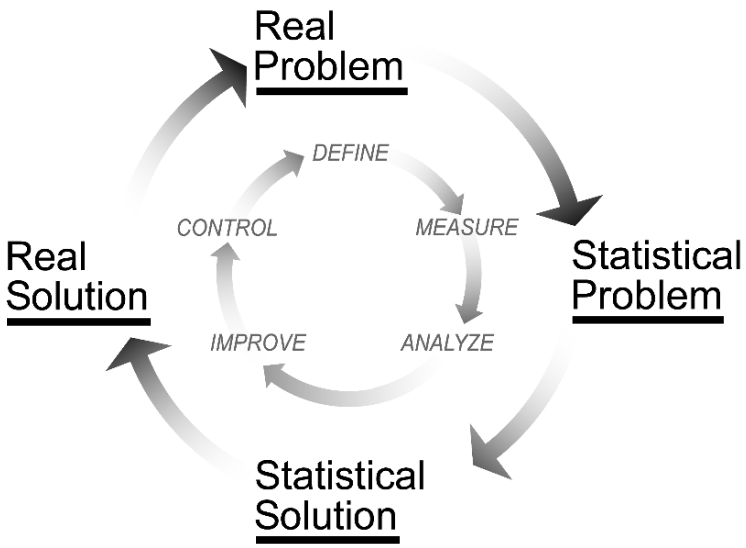
Six Sigma+Lean is made up of four important modules or dimensions that secure project success

- The iterative cycle employed to optimize processes, called the DMAIC, that is made up 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 is made up of the five phases, **D**efine, **M**easure, **A**nalyze, **D**esign, and **V**erifiy – (also known as DFSS, Design for Six Sigma+Lean)
- Lean tools applied in the two aforementioned approaches
- Process management for securing sustainability



Improving Processes (DMAIC)

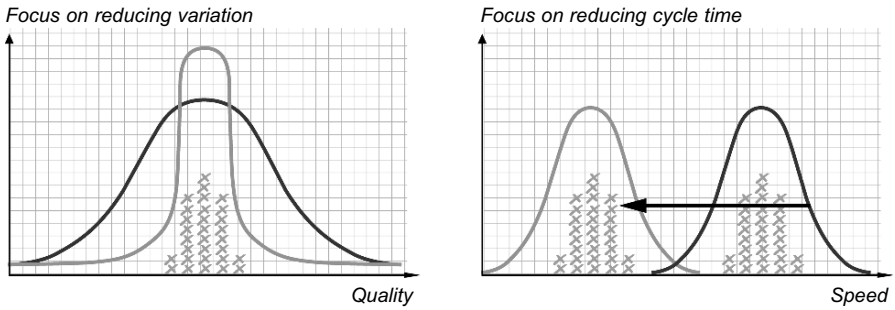
The DMAIC iterative cycle employed to optimize existing processes forms the basis for systematic and fact-based project work that achieves sustainable and measurable results. The aim of DMAIC is to raise quality (by reducing rework and scrap) and reduce stocks as well as cutting cycle times through inventory controls and adjusting capacity.
When applying the DMAIC cycle, the following mindset is used to solve the identified, complex problems:



The following chart lists the main activities and aligns the tools employed to the respective phase:

	Tools	*Mission*
Define	• Project Charter • SIPOC • CTQ Matrix • Stakeholder Analysis	• The project is defined. • Current state and target state are depicted and the process to be improved is marked off. • Customer and business requirements are clearly defined.
Measure	• Measurement Matrix • Operational Definition • Measurement System Analysis • Sample Size and Strategy • Charts and Diagrams • Quality Key Figures	• The starting situation is captured. • Key figures and an operational definition are developed, the measurement system analysis is completed, and the data collected.
Analyze	• Cause & Effect Diagram • FMEA • Process Analysis • Value Stream Map • Hypothesis Tests • Regression • DOE	• The causes for the problem are identified. • All possible causes are collected and summarized into the decisive key figures through process and data analysis.
Improve	• Brainstorming • "Must" Criteria • Effort-Benefit Matrix • Criteria-based Selection • Piloting • Roll out Planning	• The solution is implemented. • Possible solutions are generated on the basis of core causes, systematically selected, and prepared for implementation.
Control	• Documentation • Procedural Instructions • Control and Run Charts • Reaction Plan and Process Management Diagrams	• The sustainability of the result is secured. • The implemented solutions are documented and will be monitored using key figures. • A reaction plan secures prompt intervention.

Special tools and methods taken from lean management have complemented and extended the DMAIC toolbox over the last few years – the result is the Six Sigma^{+Lean} concept. This development was undertaken on the basis of an important insight: that, along with reducing process variation through proven quality tools and statistical analyses, the relevant levers for achieving significant cuts in cycle time and inventories are also of great importance. This fundamental prevention or avoidance of waste will be a continuous focus of our considerations.



Quality	+	*Speed*
Customer requirements are met completely		**Customer requirements are met profitably**
Tools of quality management		Tools of lean management

The following lean tools have proven worthwhile and are integrated into the DMAIC iterative cycle:

	Lean tools	*Mission*
Analyze	• Value Stream Map • Identification of the Sources of Waste • Little's Law • Process Efficiency • Constraints Analysis (takt rates and takt time analysis)	• The root causes are identified. • The causes for constraints, high stock inventories and long cycle times are identified and summarized into root causes by using lean tools.
Improve	• Theory of Constraints (TOC) • 5 S • Setup Time Reduction • Generic Pull System • Replenishment Pull System • Poka Yoke • Total Productive Maintenance (TPM) • Lean for Service	• The solutions are implemented. • Based on the core causes and using lean tools the solutions are developed, evaluated, and prepared for implementation.

Exemplary depiction of relevant project topics in the frame of Six Sigma^{+Lean}:

Quality-related topics = variation reduction	*Speed-related topics = increasing process speed*
• Reducing rework / scrap • Optimizing quality reviews • Optimizing output (less waste) • Reducing customer complaints • Systematic optimization of machinery parameters through Design of Experiments (DOE) • Reducing complexity: one component serves several applications	• Significant inventory reduction • Minimize trans-sectoral cycle times, e.g. reduce order to cash • Improve process efficiency by reducing waste • Raise capacity by balancing out processes and improving availability of machines • Optimize setup times to reduce batch sizes and the necessary inventories

The DMAIC methodology helps to effectively reduce or even eliminate the so-called negative quality. Negative quality arises when defined customer requirements are not met profitably.
The DMADV procedural model for process and product development generates positive quality in the sense of a strongly customer- and market-oriented development of products and processes. In this way, DMADV maximizes potential by generating value for the customer.

"Not doing anything wrong does not mean you're doing everything right!"

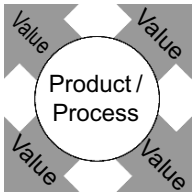
DMAIC	DMADV / DFSS
Eliminating negative quality	Generating positive quality
• Quality / reduce defects • Speed / increase speed • Costs / reduce costs	• Problem solving • Creating opportunities • Look good • Feel good

Project work with the DMADV model focuses on the effort to offer customers products and processes, which have value for them, i.e. to recognize, understand, and implement customer needs. Innovative work on the new or further development of products and of processes is pressed ahead with by taking into account the prerequisite for solving problems from a customer viewpoint, for demonstrating new opportunities, and for feeling good, and / or looking good.

Developing New Processes or Products (DFSS)

In DFSS value for the customer is created by using the DMADV methodology and recognizing the relevant value drivers:

1.
Problem solving:
Helps the customer to **solve** an existing **problem**



2.
Creating opportunities:
Helps the customer to create new **opportunities** that do not yet exist

4.
Feel good:
Helps the customer to **feel good** about themselves

3.
Look good:
Helps the customer to **look good** in comparison to competitors

The prerequisite for this is a systematic elaboration of "true" customer needs and their prioritization. The aim of developmental work is not the development of a product based on the latest technology (running the risk of "over engineering"), but rather the best possible implementation of customer needs in solutions that create products and processes with value for the customer.

The following table lists the main tasks and aligns the tools to the respective DMADV phase.

	Tools	*Mission*
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 complimented by a Multigeneration Plan. • The project is clearly marked off and the influence on other projects examined. • The activity, time, and resources planning are defined. Possible project risks assessed.
Measure	• Portfolio Analysis • Kano Model • Customer Interaction Study • Survey Techniques • Affinity Diagram • Tree Diagram • Benchmarking • House of Quality • Design Scorecard	• The relevant customers are identified and segmented. • Customer needs are collected, sorted, and prioritized. • CTQs and measurements are deduced on the basis of customer needs. • Priorities are set for measurements and the target values, specifications, and quality key figures are defined.
Analyze	• Function Analysis • Transfer Function • Creativity Techniques • Ishikawa Diagram • TRIZ • Benchmarking • Pugh Matrix • FMEA • Anticipated Error Detection • Design Scorecard • Process Modeling • Prototyping	• The best concept is selected from the alternative high-level concepts. • Conflicts and contradictions in the selected concept are resolved and the requirements to the necessary resources are derived. • The remaining risk is defined, customer feedback was obtained, and the concept finalized.
Design	• Statistical Procedures (tolerancing, hypothesis tests, DOE) • Design Scorecard • FMEA • Radar Chart • Lean Toolbox (Value Stream Design, Pull Systems, SMED / Quick Changeover, Lot Sizing, Complexity, Poka Yoke, Process Balancing)	• The detailed design is developed, optimized, and evaluated. • The production process is planned and optimized based on lean specifications. • The implementation of the process design is prepared, involved employees are informed, and customer feedback was obtained.

	Tools	*Mission*
Verify	• PDCA Cycle • Project Management • Training • SOPs • KDI Monitoring	• The pilot is carried out, analyzed, and the roll out planned. • The production process is implemented. • The process is completely handed over to the process owner, the documentation was handed over, and the project concluded.

This Toolset doesn't take into account the DFSS concept. DFSS is covered by the DFSS^{+Lean} Toolset we published in 2007.

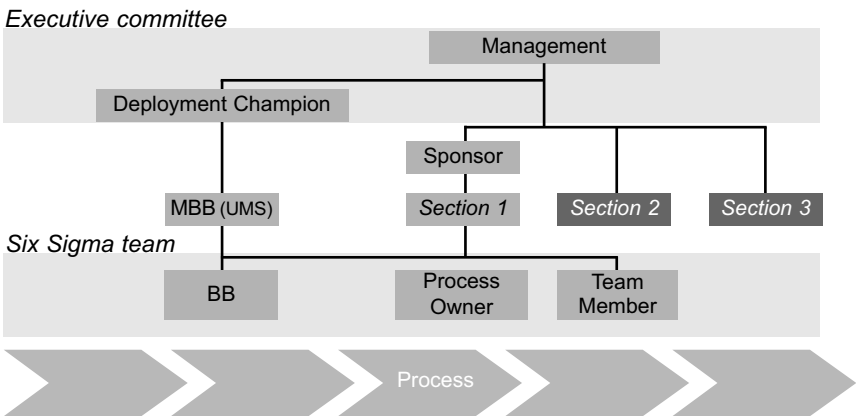
Acceptance as Success Factor

Roles and Responsibilities in the Six Sigma+Lean Concept

The key aspects that need to be put into place for a universal acceptance of Six Sigma+Lean are clearly defined roles and responsibilities for employees and executives, intensive method training, and coaching accompanying the improvement projects.

Along with a corporate-specific customization and definition of the roles, their systematic implementation in everyday practice is an important task and challenge in Six Sigma+Lean deployments.

The chart below shows the typical roles (followed by a detailed description).



Executive committee

- Defines the strategic orientation of Six Sigma+Lean
- Prioritizes and decides on the projects and sets the project mission
- Chooses the Project Sponsor for each project
- Carries out regular reviews

Deployment Champion
- Steers and drives forward the Six Sigma^{+Lean} initiative
- Defines unified standards used in Six Sigma^{+Lean}
- Guides and instructs the Master Black Belts
- Ensures the support of top management
- Identifies and shows the benefits of Six Sigma^{+Lean}

Project Sponsor (also called the Champion in some organizations)
- Guarantees that the required resources are available and assembles the project team
- Is responsible for the project's monetary results
- Reports to the executive committee
- Carries out regular gate reviews (sign offs) together with the Black Belt and Master Black Belt

Master Black Belt (MBB)
- Is engaged full-time in the Six Sigma^{+Lean} initiative and coaches the Black Belts and Green Belts
- Carries out the regular gate reviews for the project phases
- Coordinates projects and project proposals
- Identifies training needs and carries out further training measures
- Is assigned to specific core processes (and Process Owners)

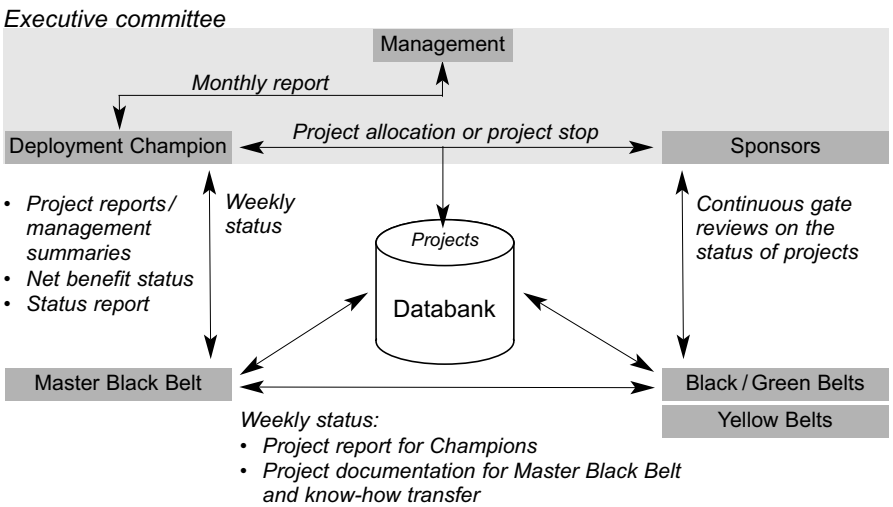
Black Belt (BB)
- Is engaged full-time in the Six Sigma^{+Lean} initiative
- Guides the Six Sigma^{+Lean} projects, contributes his / her methodological competence, and leads the team to success
- Is responsible for both the management of the project as well as its documentation
- Regularly informs the Project Sponsor and organizes the gate reviews
- Along with direct involvement in project work performs other tasks in the scope of the Six Sigma^{+Lean} initiative (work packages)

Green Belt (GB)
- Is engaged part-time in the Six Sigma^{+Lean} initiative
- Guides smaller Six Sigma^{+Lean} improvement projects in his / her section or supports a Black Belt, contributes his / her methodological competence, and leads the team to success
- Is responsible for project management and its documentation together with a Black Belt
- Regularly informs the Project Sponsor

Team Member (Yellow Belt)
- Works constructively both within and outside the team meetings on the work packages and contributes his / her professional competence
- Supports the implementation of the project and acts as a multiplier of the initiative

Process Owner
- Implements the results generated by the improvement project
- Ensures the long-term sustainability of the project results
- Communicates early on and regularly with the Black Belt and Sponsor

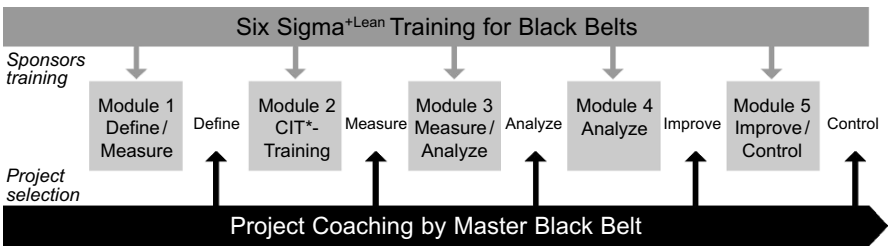
Along with the deployment of DMAIC / DMADV tools and methods and the accompanying support of project work with the aid of defined roles, reporting progress is crucial for monitoring and presenting achieved results. The graph below is an excellent example of a reporting structure and is typical of a Six Sigma^{+Lean} organization. This kind of structure supports the translation of the defined roles into actual work and so guarantees its successful completion.



A Modular and Practice-oriented Training and Coaching Concept

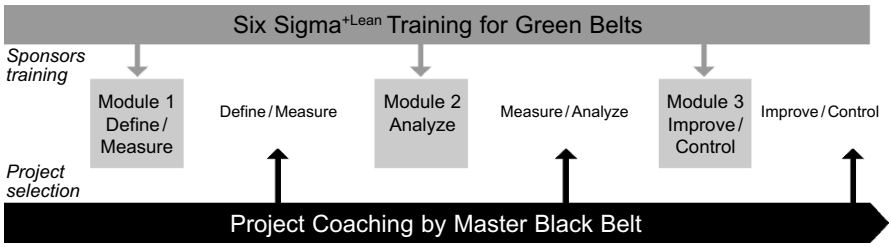
A modular-based training and coaching of Black and Green Belts guarantees that project work remains practically relevant, if it is combined with continuous references to the specific improvement projects between the modules. The Master Black Belts act as direct coaches for the Black and Green Belts. In this way they ensure an intensive knowledge transfer of the Six Sigma^{+Lean} methodology and its tools from the training into their own project work and that their application is suitable for dealing with specific problems and tasks.
For this reason, tools and methods are taught in concentrated form and can be applied to the projects in flexible combinations. When structured in this way, the Master Black Belt is the key contact partner for training and coaching – this secures maximum effectiveness for the whole course of the project.
Group coaching sessions – where several participants come together to discuss the project – can further intensify know-how transfer because they provide insights into comprehensive problems and how they may be approached.

Combined method training for Six Sigma^{+Lean} Black Belts:

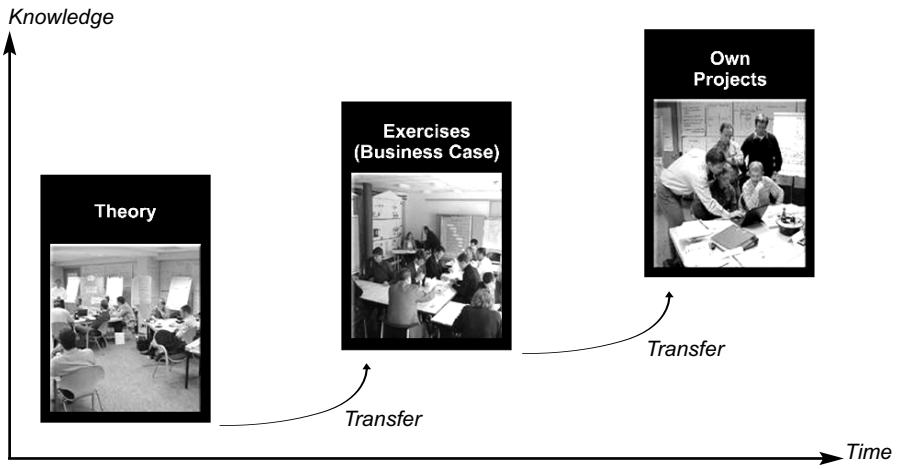


*CIT = *Change implementation tools, a concept for accompanying and steering the changes being made to a process*

Combined method training for Six Sigma^{+Lean} Green Belts:



Each of the modules is characterized by a didactic "triple jump". The first stage is the teaching of theoretical content. In the second stage this theory is applied to simulations and exercises, modeled on actual business cases enabling participants to practice transferring their knowledge to practically relevant situations. The third stage is devoted to working on one's own projects, guaranteeing that knowledge is transferred directly to specific problems in project work.

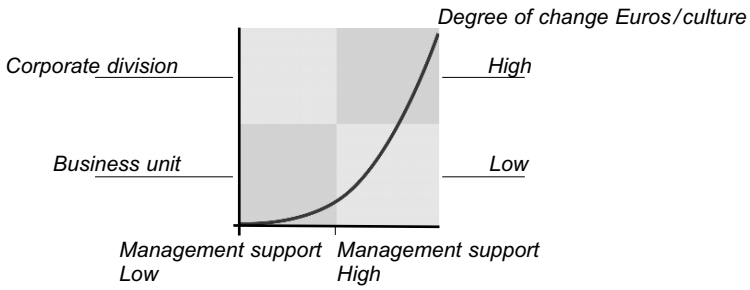


This approach allows training to be conducted flexibly, responsive to the specific requirements and needs of the participants. Project-related problems can be integrated into the training and coaching at all times. Controls are carried out at the completion to monitor learning success; they provide both the participants as well as the responsible Master Black Belt with feedback on the strengths and weaknesses of each participant.

Management Commitment as Success Factor

On the Road to Business Excellence

A consistent management support is the key to success – irrespective of the scope of Six Sigma^{+Lean} in the organization at its launch.
Six Sigma^{+Lean} unfolds its full effect when the concept's core elements are applied across and permeate through the entire organization – such a complete and systematic approach is the motor of success.
Six Sigma^{+Lean} is ideally suited to support a corporation on the road to achieving business excellence. Process excellence is created along with the application of proven tools. Employees are integrated and empowered in the sense of people excellence. The greatest benefit of Six Sigma^{+Lean} lies in the creation of a conceptual, fact-based framework that enables performance to be measured, improved, and managed. This generates in turn the transparency necessary for management to make the right decisions. In this way Six Sigma^{+Lean} actively supports the implementation of corporate strategy.



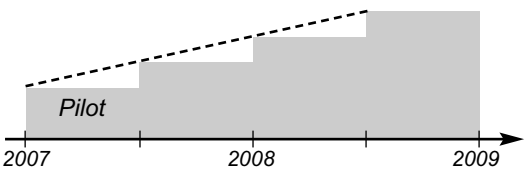
Consistent management support means measurable monetary results which as a rule already surpass the cumulative expenses in the first year of the Six Sigma^{+Lean} application. Practice shows that a consistent application of the Six Sigma^{+Lean} concept can lead to a cost/effort-benefit ratio of 1:7 and more.

"Do it right the first time" describes the general aspiration of business excellence – but it especially covers the **methodological** and **scheduled development phases** of a Six Sigma^{+Lean} implementation.

Implementation Approaches

In terms of timing, progress when implementing Six Sigma^{+Lean} can be achieved either through a step-by-step approach or in one quick step, known as a break-through approach. Both approaches have their own strengths and weaknesses.

Step by step:
- Phased build up of Six Sigma^{+Lean} resources
- Lower net benefits at the start of the initiative
- The implementation is manageable and controllable
- Continuous build up of knowledge and permanent refining of expertise
- Continuous change of corporate culture
- Acceptance of the Six Sigma^{+Lean} program is generated and extended continually



Break through:
- Training for numerous Six Sigma^{+Lean} resources at the very start of the initiative
- Quicker generation of benefit in the projects at the start of the implementation
- Considerable cost and effort required to manage and coordinate
- High risk of identifying and implementing the wrong resources and projects
- Danger of increasing resistance due to the excessive demands made on the organization by carrying out numerous projects in the implementation phase
- A rapid change of culture in the corporation is necessary