STEPHAN LUNAU (Ed.)

CHRISTIAN STAUDTER
JENS-PETER MOLLENHAUER
RENATA MERAN
OLIN ROENPAGE
CLEMENS VON HUGO
ALEXIS HAMALIDES

# Design for Six Sigma<sup>+Lean</sup> Toolset

Implementing Innovations Successfully





### Design for Six Sigma<sup>+Lean</sup> Toolset

#### Stephan Lunau (Ed.)

Christian Staudter
Jens-Peter Mollenhauer
Renata Meran
Olin Roenpage
Clemens von Hugo
Alexis Hamalides

## Design for Six Sigma<sup>+Lean</sup> Toolset

Implementing Innovations Successfully



Editor:
Dipl.-Kfm. Stephan Lunau
UMS GmbH Consulting
Hanauer Landstraße 291B
60314 Frankfurt
Germany
stephan.lunau@ums.gmbh.com

Authors:

Dipl.-Bw. Christian Staudter
Dipl.-Wirt.-Ing., Dipl.-Ing. Jens-Peter Mollenhauer
Dipl.-Vw. Renata Meran
Mag. Olin Roenpage
Clemens von Hugo
Dipl.-Wirt.-Ing. Alexis Hamalides

UMS GmbH Consulting Hanauer Landstraße 291B 60314 Frankfurt Germany

ISBN 978-3-540-89513-8

e-ISBN 978-3-540-89514-5

DOI 10.1007/978-3-540-89514-5

Library of Congress Control Number: 2008940146

© 2009 Springer-Verlag Berlin Heidelberg

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permissions for use must always be obtained from Springer-Verlag. Violations are liable for prosecution under the German Copyright Law.

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Cover design: WMXDesign GmbH, Heidelberg, Germany

Printed on acid-free paper

987654321

springer.com

#### **Table of Contents**

Fo	reword	1
Int	roduction Design for Six Sigma <sup>+Lean</sup>	3
_	Implementing Innovation Successfully	5
_	The Six Sigma <sup>+Lean</sup> Approach	9
	- The Goal of Six Sigma <sup>+Lean</sup>	9
	- The Four Dimensions of Six Sigma <sup>+Lean</sup>	10
_	Developing New Processes and/or Products with DFSS <sup>+Lean</sup>	13
_	Critical Success Factors	16
	- Employee Acceptance	16
	- The Quality of Applied Tools and Methods	18
-	Summary: the Benefits of DFSS <sup>+Lean</sup>	20
Р	hase 1: DEFINE	21
lni	itiating the Project	24
_	Project Charter	24
_	Business Case	26
_	Redesign	28
_	New Design	30
_	Project Benefit	31
_	Project Team	33

Scoping the Project	34
- Project Scope	34
Multigeneration Plan	36
- Project Mapping	38
Managing the Project	40
- Project Management	40
Activities, Time and Resource Planning	41
- RACI Chart	46
- Project Budgeting	48
Stakeholder Analysis	50
Change Management	52
- Risk Assessment	54
Kick-off Meeting	56
Define Gate Review	57
Phase 2: MEASURE	59
Selecting Customers	62
Identifying Customers	63
ABC Classification	65
- Portfolio Analysis	66
- 5W1H Table	67
Collecting Customer Voices	68
<ul> <li>Selecting and Carrying out Research Methods</li> </ul>	69

_	Internal Research	71
_	External Research	72
_	Customer Interaction Study	73
_	1-to-1 Interview	76
_	Focus Group Interview	77
_	Survey	78
_	Target Costing	82
Sp	pecifying Customer Needs	84
_	Identifying Customer Needs	85
_	Customer Needs Table	86
_	Structuring Customer Needs	88
_	Affinity Diagram	89
_	Tree Diagram	90
_	Kano Model	92
_	Prioritizing Customer Needs	94
_	Analytic Hierarchy Process	95
_	Deriving CTQs and Key Output Measurements	98
-	Benchmarking	100
_	Quality Function Deployment (QFD)	102
_	House of Quality (QFD 1)	104
_	Design Scorecard	116
_	Risk Evaluation	117
_	Quality Key Figures	119

-	Parts per Million (ppm)	120
_	Defects per Unit (DPU)	121
_	Yield	122
_	C <sub>p</sub> and C <sub>pk</sub> -values	124
_	Process Sigma	127
_	Z-Method for Calculating Sigma	128
-	Measure Gate Review	130
Ρ	hase 3: ANALYZE	133
ld	entifying Design Concept	136
_	Analyzing Functions	138
_	Depicting Functions	140
_	Deriving Requirements to Functions	142
_	Developing Alternative Concepts	145
_	Brainstorming	146
_	Brain Writing	148
_	Mind Mapping	149
_	SCAMPER	150
_	Morphological Box	151
_	Benchmarking	153
_	Selecting the Best Concept	155
_	Selection Procedure Based on Pugh (Pugh Matrix)	156
_	Conjoint Analysis	160

	- Conjoint Analysis with Minitab®	163
O	ptimizing Design Concept	168
_	TRIZ – Resolving Conflicts in the Selected Concept	169
_	Engineering Contradictions	171
_	TRIZ Contradiction Matrix	184
_	Physical Contradictions	188
	- Separating the Contradictory Requirements	190
	- Fulfilling the Contradictory Requirements	193
	- Avoiding the Contradiction	193
_	Sufield Analysis – Incomplete Functional Structures	194
_	76 Standard Solutions	199
_	Trimming – Complexity Reduction	204
_	Evolution of Technological Systems	208
	- Nine Laws of Evolution for Technological Systems	209
_	Deriving Requirements to Necessary Resources	216
Re	eviewing the Capability of the Concept	217
_	Risk Evaluation	218
_	Failure Mode and Effect Analysis (FMEA)	219
_	Anticipatory Failure Detection	224
_	Getting Customer and Stakeholder Feedback	226
_	Finalizing the Concept	227
_	Preparing Market Launch	230
_	Analyze Gate Review	233

P	hase 4: DESIGN	235
De	evelop, Test and Optimize Detailed Design	_ 238
_	Drawing up Transfer Function	_240
_	Zigzag Diagram	242
_	QFD 3	_ 243
_	Generating Alternative Characteristics of Design Elements	244
_	Tolerance Design	246
_	Design for X	248
_	Developing a Design Scorecard for the Detailed Design	250
_	Testing Detailed Design	252
_	Implementing Prototype	253
_	Comparing Alternative Designs	254
_	Hypothesis Testing	255
_	Design of Experiments (DOE)	264
_	Selecting Detailed Design	274
_	Adjusting Design Scorecards	275
_	Risk Evaluation	276
_	Avoiding Risks	_277
R	eviewing the Performance Capability for the Target Production_	282
_	QFD4	283
_	Evaluating the Current Process Performance	_ 284
De	eveloping and Optimizing Lean Process	288
_	SIPOC	289

_	Process Diagram	290
_	Value Stream Map	291
_	Developing Standard Operating Procedures	296
_	Minimizing Process Lead Time	298
_	Facility Layout Planning	306
_	Spaghetti Diagram	307
_	5 S Concept	308
_	Planning the Equipment	310
_	Planning Material Procurement	311
_	Making Employees Available	312
_	Providing IT	314
_	Optimizing Lean Process Design	315
-	Design Gate Review	316
Ρ	hase 5: VERIFY	319
Pr	eparing Implementation	322
_	Setting up KPI System	326
_	Setting up Process Monitoring	330
_	Drawing up Process Management Diagram	333
_	Piloting the Process	335
lm	plementing the Process	338
_	Drawing up Final SOPs and Process Documentation	338
_	Carrying out Implementation	339

Handing over the Process	341
Handing over Process Documentation	341
Carrying out Project Closure	342
Verify Gate Review	344
APPENDIX	
- Abbreviations	347
- Index	350
- Sigma Table	363
<ul> <li>TRIZ Contradiction Matrix</li> </ul>	
- QFD Matrix	

#### **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<sup>+Lean</sup> 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<sup>+Lean</sup> methodology, currently applied globally to optimize existing processes. DFSS<sup>+Lean</sup> 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<sup>+Lean</sup> 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<sup>+Lean</sup> Toolset

Introduction



#### Introduction

#### Content:

Implementing innovation successfully

#### The Six Sigma<sup>+Lean</sup> Approach

- The goal of Six Sigma<sup>+Lean</sup>
- The four dimensions of Six Sigma+Lean

Developing new processes and/or products with DFSS+Lean

#### **Critical Success Factors**

- Employee acceptance
- The quality of the applied tools and methods

Summary: Benefits of DFSS+Lean