

Contents

1	Introduction	1
1.1	Cost reduction – an issue in product development	1
1.2	Aims of the book	2
1.3	Structure of the book	2
1.4	For an easier use of the book	3
2	Cost Responsibility of the Product Developers.....	5
2.1	What are costs?	5
2.2	Who affects costs in a company?	8
2.3	Examples of the effect of product development on costs.....	13
3	Cost Management for Product Development	17
3.1	What is cost management?	17
3.1.1	Developing market-driven products	19
3.1.2	Developing cost-driven products.....	20
3.1.3	Realizing cost-efficient product development processes	20
3.2	Problems of cost management in product development.....	21
3.2.1	Management.....	22
3.2.2	Information availability	25
3.2.3	Applying methods and tools.....	26
3.3	Adapting cost management.....	27
3.3.1	Type of product and product program	27
3.3.2	Types of production.....	29
3.3.3	Aim and scope of cost management	30
4	Methodology and Organization of Cost Management for Product Development.....	31
4.1	Elements of cost management.....	31
4.2	Processes in the product lifecycle	33
4.3	The human being in the organization	37
4.3.1	The individual and the work within the team.....	37
4.3.2	Integrative forms of organization	39

4.4	Methods of cost management in product development.....	40
4.4.1	Solving problems with the procedure cycle	41
4.4.2	Strategic organization of the procedure	43
4.5	Integration of methods for target-cost oriented development.....	46
4.5.1	Task clarification: Requirements clarification, target costs establishment and their distribution.....	46
4.5.1.1	Clarify the requirements	47
4.5.1.2	Function analysis.....	47
4.5.1.3	Establish the total target costs	49
4.5.1.4	Dividing the total target costs into partial target costs	54
4.5.2	Solution search: How are low-cost solution approaches developed?	56
4.5.2.1	Search for available solutions	57
4.5.2.2	Solution search by using physical effects	57
4.5.2.3	Variation of shape	59
4.5.2.4	Solution search with the help of creativity techniques	60
4.5.2.5	Concept development with the morphological matrix.....	61
4.5.3	Solution selection: How can the best solution be selected?	61
4.5.3.1	Analysis of product properties	61
4.5.3.2	Evaluation and decision.....	62
4.5.3.3	Summary of the methodical procedure.....	63
4.6	Resources and means for supporting cost management.....	65
4.6.1	Advising on production and cost in design	67
4.6.2	Cost structures.....	68
4.6.3	Relative costs	73
4.6.4	Rules.....	74
4.6.5	Checklists.....	75
4.6.6	Portfolio analysis.....	76
4.7	An example of the methodical procedure: A marking laser.....	76
4.7.1	Task clarification.....	76
4.7.2	Solution search	78
4.7.3	Solution selection	82
4.8	The practice of cost management.....	85
4.8.1	Introduction to cost management	85
4.8.2	How much effort is justified for cost reduction?.....	87
4.8.3	Implementing cost management.....	90
4.8.3.1	Interdisciplinary work methodology	90
4.8.3.2	Planning, operation and control of cost reduction projects.....	92
4.8.3.3	Company-internal prerequisites	103
4.8.3.4	Information and continuing education.....	104

4.9	Other well-known cost management methods	104
4.9.1	Overview	105
4.9.2	Value analysis	105
5	Influencing the Lifecycle Costs.....	109
5.1	What are lifecycle costs?	109
5.2	What influences the lifecycle costs?.....	114
5.3	How to develop a product to a lifecycle cost target?	118
5.4	Extending service life to lower lifecycle costs	121
5.5	Examples of reducing lifecycle costs	122
6	Influencing the Total Costs.....	125
6.1	Total costs in the company	125
6.2	Reducing product development costs	127
6.2.1	Establishing focal points of product development activities	129
6.2.2	Increasing the efficiency of product development.....	129
6.2.3	Capabilities regarding in-house product development.....	135
6.3	Product development creates complexity in the company.....	136
6.3.1	Costs of complexity.....	137
6.3.2	Costs of part variety and technology complexity	137
6.3.3	Cost of product variants.....	139
7	Factors that influence Manufacturing Costs and Procedures for Cost Reduction.....	143
7.1	Overview of the influences and their importance.....	143
7.2	Influence of the task statement.....	146
7.3	Influence of the concept	148
7.4	Influence of shape	152
7.5	Influence of the production quantity	153
7.5.1	Processes associated with the production quantity	154
7.5.2	Why costs come down with increasing production quantity.....	156
7.6	Influence of size and dimensions	159
7.6.1	Overall growth laws for costs.....	160
7.6.2	Influence of the geometrical relationships of active surfaces.....	164
7.7	Combined influence of size and the production quantity.....	166
7.7.1	Formal relationships	167
7.7.2	Calculation example.....	168
7.7.3	Example of spur gears, other parts, and rules.....	170
7.8	Influence of the loading.....	174

7.9	Influence of material	176
7.9.1	Significance of material costs	176
7.9.2	Reducing raw material costs	178
7.9.2.1	Overview	178
7.9.2.2	Reduction of material volume.....	180
7.9.2.3	Reduction in material costs per unit volume.....	183
7.10	Decision between in-house development and production, versus outsourcing.....	187
7.10.1	Overview	187
7.10.2	Advantages and disadvantages of outsourcing.....	187
7.10.3	Decision between in-house production and purchasing (make or buy decision)	188
7.10.4	Cost-driven design for cases of uncertain manufacturing facilities and inadequate cost transparency	190
7.11	Influence of the production process.....	195
7.11.1	Overview	195
7.11.2	Primary production processes	203
7.11.2.1	Most important casting processes.....	203
7.11.2.2	Factors affecting the costs of cast parts	203
7.11.2.3	Cost reduction by using full-mold casting processes	207
7.11.2.4	Rules for low-cost form design of castings.....	207
7.11.2.5	Examples of form design of castings.....	212
7.11.2.6	Low-cost form design of polymer parts.....	212
7.11.2.7	Low-cost design of sintered parts.....	216
7.11.3	Deformation processes.....	218
7.11.3.1	Most important deformation processes.....	218
7.11.3.2	Form design rules.....	220
7.11.4	Separation processes.....	224
7.11.4.1	The most important separation processes	224
7.11.4.2	Parameters that affect costs in machining processes	226
7.11.4.3	Form design rules for machining processes	227
7.11.4.4	High-speed milling and grinding.....	234
7.11.4.5	Stamping and nibbling.....	234
7.11.4.6	Gas, laser, plasma and water-jet cutting	235
7.11.5	Connections (joints).....	237
7.11.5.1	Most important fixed connections.....	238
7.11.5.2	Low-cost design of welded assemblies (conventional arc welding)	240
7.11.5.3	Laser and electron beam welding.....	245
7.11.5.4	Adhesion.....	246
7.11.5.5	Screws, bolts and other connection elements....	246
7.11.6	Dimensional tolerances and roughness	249
7.11.7	Assembly	252
7.11.7.1	Importance of the design-for-assembly	252
7.11.7.2	Parameters affecting the assembly costs.....	254

	7.11.7.3	Rules for low-cost assembly	255
	7.11.7.4	Examples of assembly-oriented design.....	261
	7.11.8	Quality costs, measuring and testing	262
7.12		Management of product variants.....	264
	7.12.1	Causes and consequences of product and part variety	269
	7.12.1.1	External causes of the growth of variants	269
	7.12.1.2	Internal causes of the growth of variants	270
	7.12.2	Advantages and disadvantages of variant variety.....	272
	7.12.2.1	Advantages of a high variant variety	272
	7.12.2.2	Disadvantages of a high variant variety.....	272
	7.12.3	Steps in analyzing the variant situation.....	275
	7.12.3.1	Analysis of the product and part variety	276
	7.12.3.2	Interface analysis.....	285
	7.12.4	Decreasing the product and part variety.....	286
	7.12.4.1	Standardization	287
	7.12.4.2	Forming design part families	292
	7.12.4.3	Favor integral design.....	295
	7.12.4.4	Employing measures to reduce the set-up costs.....	300
	7.12.4.5	Organizational measures for reducing the part variety	302
	7.12.5	Design in size ranges	302
	7.12.5.1	Definition, purpose and effect.....	302
	7.12.5.2	Preferred number series to facilitate designing in size ranges.....	306
	7.12.5.3	Similarity laws	310
	7.12.5.4	Limits for geometrically similar size ranges	313
	7.12.5.5	Example of a size range.....	314
	7.12.6	Modular design	317
	7.12.6.1	Definition, purpose and effect.....	317
	7.12.6.2	Design (morphology) of modular products.....	321
	7.12.6.3	Developing modular designs.....	325
	7.12.6.4	Modularization.....	329
	7.12.6.5	Use of platforms.....	330
	7.12.6.6	Basic solutions, standardization	331
	7.12.6.7	Parametrics, design logic	332
	7.12.6.8	Example of a modular design in the storage and handling area	333
	7.12.6.9	Example of modular design for sports cars.....	337
	7.12.6.10	Example of a modular design / size-range system for tractors	339
	7.12.7	Summary.....	343
7.13		Results of a cost benchmarking project	344
	7.13.1	Overview and procedure	344
	7.13.2	Costs benchmarking in the gear transmission industry	345
	7.13.3	Gears.....	349
	7.13.4	Comparison of welded and cast gear housings.....	352

7.13.5	Heat treatment and hardening procedures	360
7.13.6	Shaft-hub connections	362
7.13.7	Assembly of gear drives	366
7.13.8	The complete gear drive, and a cost reduction example	369
7.14	Influence of product disposal on manufacturing costs.....	376
7.14.1	Motivation for disposal-oriented product development	376
7.14.2	Product development procedure for lowering disposal costs	378
7.14.3	Example of an adaptive design for lowering disposal costs	379
7.14.4	Some simple rules for lowering the disposal costs	384
8	Fundamentals of Cost Accounting for Product Development.....	385
8.1	The origination of manufacturing costs	385
8.2	Cost terms for product manufacture	386
8.2.1	Definition and organization of the costs	387
8.2.2	The terms sales price, total (factory) costs and manufacturing costs	388
8.3	Cost accounting in a company	389
8.3.1	Cost type accounting	390
8.3.2	Cost center accounting.....	390
8.3.3	Cost unit accounting	394
8.4	Cost calculation procedures	394
8.4.1	Summary overhead costing	395
8.4.2	Differentiating overhead costing	396
8.4.3	Examples of real cost generation and overhead costing	400
8.4.4	Disadvantages of overhead costing	408
8.4.5	Workstation costing.....	410
8.4.6	Process costing	412
8.5	Direct costing.....	414
8.5.1	Application of direct costing.....	414
8.5.2	Marginal costing.....	416
8.5.3	Limit costing.....	421
9	Early Identification of Costs during Product Development – Development-Concurrent Cost Calculations.....	423
9.1	Overview	423
9.1.1	Aims of cost calculation concurrent with product development.....	423
9.1.2	Progress of cost calculation concurrent with product development.....	427
9.1.3	Procedure for quick cost calculation.....	427
9.1.4	Possibilities for reducing the effort.....	428
9.2	Cost estimation.....	429

9.3	Quick cost calculation	430
9.3.1	Search calculation; similarity calculation	431
9.3.2	Determination of costs based on one parameter	432
9.3.2.1	Weight-based costing	432
9.3.2.2	Material cost method.....	433
9.3.2.3	Quick cost calculation with performance governing parameters.....	434
9.3.3	Design equations	434
9.3.4	Quick cost calculation formulas with several parameters.....	435
9.3.4.1	Development of quick cost calculation formulas with regression analysis	436
9.3.4.2	Example of a quick cost calculation with several independent variables.....	437
9.3.4.3	Development of quick cost calculation formulas with optimization processes	439
9.3.4.4	Use of neural networks for determining cost	441
9.3.4.5	Use of fuzzy logic for determining cost.....	443
9.3.5	Quick cost calculation with cost growth laws	443
9.3.6	Procedure for performing the quick cost calculation	448
9.3.7	Accuracy of quick cost calculations	450
9.3.7.1	In-house accuracy of preliminary calculation ...	451
9.3.7.2	Industry-wide accuracy of the preliminary calculation.....	452
9.3.7.3	Compensation of random errors.....	453
9.3.7.4	Keeping current.....	456
9.4	Computer-integrated cost calculation	456
9.4.1	Computer integration of work scheduling and cost calculation	458
9.4.2	Computer integration of CAD, work scheduling and cost calculation	460
10	Examples	465
10.1	Example “Concrete mixer”	466
10.1.1	Goal of the example.....	466
10.1.2	Problem description.....	467
10.1.3	Description of the competing products	467
10.1.4	Steps in the cost reduction project	468
10.1.5	Summary and conclusions of the example.....	481
10.2	Example “Centrifuge base”	483
10.2.1	Introduction.....	483
10.2.2	Clarify the task	483
10.2.3	Summary and conclusions of the example.....	489

10.3	Example for the application and comparison of quick cost calculation procedures: "Bearing pedestal"	490
10.3.1	Introduction.....	490
10.3.2	Determination of costs in production planning and preliminary calculation.....	492
10.3.3	Weight cost calculation for welded design; lot size = 1.....	495
10.3.4	Cost calculation with Cost Growth Laws: Welded design, size ratio $\varphi_L = 0.5$ and 2.....	496
Appendix: Help for Cost Reduction.....		499
A 1	Overview: Introduction.....	499
A 2	Guidelines for Cost Reduction	500
A 2.1	I Clarify the task and the procedure.....	500
A 2.2	II Search for solutions.....	501
A 2.3	III Select solution	504
A 2.4	Project follow-through, evaluation	504
A 3	Important Figures and Rules.....	504
A 3.1	Cost calculation (origins of costs)	504
A 3.2	Cost structures; cost targets; concurrent calculation.....	505
A 3.3	Material costs.....	509
A 3.4	Production costs	509
A 3.5	Assembly costs.....	509
A 3.6	Reduction of variants.....	509
Literature.....		515
Index		537