Effective Innovation

The Development of Winning Technologies

By Don Clausing Victor Fey

Table of Contents

Preface	x i
Chapter 1: INTRODUCTION	1
Chester Carlson—an Outstanding Innovator 3	
There are Inventions and Then There Are Inventions 5	
The Story of Television—Success With Innovation 6	
Summary: Effective Innovation 7	
Chapter 2: STEPS FOR SUCCESSFUL INNOVATION	9
The Enterprise Context 11	
The Product-Acquisition Context 12	
Effective Innovation Process 14	
Interactive Activities for Effective Innovation 15	
What Latent Needs are Unsatisfied 17 What Technology Integrations Are Important? 19 What Are the Important Market Segments? 20	
Barriers to Beware of 20	
Watt and the Steam Engine 21 Carlson and Xerography 21 Canon Copier Introduction Into the United States 22 Cylinder-Valve Paving Breaker 22 Lessons Learned 23	

Summary

Summary 75

Chapter 3: TECHNOLOGY STRATEGEY:

25

CHOOSING DIRECTIONS

The Challenge of Technology Innovation 27
Market Needs—Opportunities for Innovation 28
Launch Innovations; Market Needs 29 Growth Innovations; Market Needs 30
High-Potential Technologies to Satisfy Market Needs 31
Delphi method 31 Mathematical modeling 31 Scenario analysis 32 Morphological analysis 32
Introduction to TRIZ—Invention on Demand 33
A Periodic Table for Technology 35
Guiding Technology Evolution 38
Phase 1: Analysis of the Past System's Evolution 40 Phase 2: Determination of Strategic Opportunities (High-Potential Inventions) 45 Law of Increasing Degree of Ideality 47 Law of Non-Uniform Evolution of Sub-Systems 48 System Conflicts and Architectural Innovations 52 Law of Transition to a Higher-Level System 55 Law of Increasing Flexibility 59 Law of Transition to Micro-Level 62 Law of Completeness 64 Law of Shortening of Energy Flow Path 66 Law of Harmonization of Rhythms 69
Applying the Laws and Lines of Technological System Evolution 70
Science, Technology, and the Market 74

Chapter 4: CONCEPT DEVELOPMENT	
Functions 81	
Actions 83	
The Ideal Technological System 84	
System-Conflict Diagrams 84	
Resolving System Conflicts 85	
Resolving System Conflicts: Elimination of the Conflicting Components 85	
Ideality Tactic 1 86 Ideality Tactic 2 88 Ideality Tactic 3 92	
Resolving System Conflicts: Changing the Conflicting Components 93	
Separation of Opposite States In Time—Soldering 95 Separation of Opposite Properties In Time—Paper Feeder Separation of Opposite Properties In Space 97 Separation of Opposite Properties Between the Whole and Its Parts 99	96
Resolving System Conflict: Eliminating the Harmful Actions Resolving System Conflicts—Conclusion 103	100
The Basic Technological System: the Substance-Field Model 104	
Sufield—Basic Concept 104 Sufields—Further Development 107 Using Sufields to Innovate 107	
Structural Changes to Sufield Diagram 108 Changes to Fields 109 Changes to Substances 110 Types of Applications or Objectives 110	
Standards For Sufield Transformation 111	
Retard Roll 111 Take-away Rolls 112	
Summary of Sufields 113	

Problem formulation

Combining the powers of various tools of TRIZ 116	
Putting It All Together: an Example 121	
Log Debarking—Resolving a System Conflict 123 Novel Peristaltic Pump—Identifying a New Physics 126	
Summary 131	
Chapter 5: CONCEPT SELECTION	133
Pugh Concept Selection (and Generation) 135	
Step 1—Choose Criteria 136 Step 2—Form the Matrix 138 Step 3—Clarify the Concepts 138 Step 4—Choose the Datum Concept 139 Step 5—Run the Matrix 140 Step 6—Evaluate the Ratings 142 Step 7—Attack the Negatives and Enhance the Positives 143 Step 8—New Datum—Rerun the Matrix 143 Step 9—Plan Further Work 143 Step 10—Iterate to the Winning Concept 144 Applications of the Pugh Concept Selection Process 144	
Chapter 6: ROBUST NEW CONCEPTS	147
Challenge: Make the Innovation Work Well for Customers	149
Noises—Challenges to the Innovation 150	
Environmental Variations 150 Variations in Production 152 Variations as the Result of Time and Use 152 Variations in Product Characteristics 152 Functional Noises 153	
Failure modes 153 Failure Mode Measurement Method 1 156	

Failure Mode Measurement Method 2 157

The Algorithm for Inventive Problem Solving 114

114

Breaking psychological inertia 115

Failure Mode Measurement Method	3	157
Secondary and Tertiary Failure Mode	S	158
Conclusion About Failure Modes 1	58	

Shortcomings of Traditional Development Approach 158

Case Study 159
Problem Reaction 159
Limits of Problem Reaction 161
Traditional Culture 163
Valid Role for Problem Solving 164

Operating Window—Key for Reliability 165

Robustness—Development Process 166

Step 1—Identification of the Critical Functional
Variables 166
Step 2—Resources for Robustness 167
Step 3—Identification of Failure Modes and the Noises
that Cause Them 168

Failure Modes 168 Noises 169

Step 4—P Diagram 171
Step 5—Operating Window Determination 172
Step 6—Improving the Operating Window 173
Step 7—Completion 175
All Failure Modes 177
Critical-Parameter Drawing 178

Operating Window and Physical Contradictions 179

Case Studies—Success in Practice 180

Case Study 1 180 Case Study 2 180

Introduction to Taguchi Methods 181

Dynamic Methods 181 S/N Ratio 183 Two-Step Optimization 185 Comparison of Operating Window and S/N Ratio 185

Benefits 186

CHAPTER 7: TECHNOLOGY-READINESS ADULT

187

Why You Want to Do a Technology-Readiness Audit 189

Technology-Readiness Event 191

Readiness Criteria 192

Robustness 192 Critical Parameter Management 193

Ideal Function/Failure Modes 196
Failure Modes/Critical Functional Parameters 196
Critical Function Parameters/Critical Specifications 197
Critical Specification/Critical Production and Field-Service
Quality 197
Summary of CPM 197

Other Readiness Criteria 198
Other Readiness Criteria—Technical 198
Other Readiness Criteria—Total Value Chain 199

Readiness in the Corporate Culture 199

Conclusion 200

CHAPTER 8: TECHNOLOGY TRANSFER AND INTEGRATION

201

Technology Selection 203

Pugh Selection Process 204 Selection Team 204 Selection Criteria 204

Readiness 204
Cost/Performance Superiority 205
Integration 206
Non-Technical Criteria 206

Selection Completion 208

Effective Transfer 208

Cultural Barrier 208 Transfer People 209

Commercialization 210

4
ix

CHAPTER 9: MANAGEMENT OF EFI	FECTIVE INNOVATION	211
Leadership of Effective Innovation	213	

Managing the EI Process Successfully 214
Integrate EI Into Product Acquisition 215
Integrate With the Enterprise 218

Xerox PARC and the Personal Computer 219 3M Corporation 219 Barrier Summary 220 New Business 220

Spend the Right Amount 221 Get the Right People 222 Successful Management Summary 224

Transition to Effective Innovation 225

Getting the Right People 225
Transition to the Effective Innovation Process 225

JIT Training 226 LUTI 226

Funding 227 Integrate 227 Cultural Change 228

Management Summary 228

CHAPTER 10: EFFECTIVE INNOVATION—BENEFITS

231

New Products 233

Types of New Products 233

Blockbuster Products 234
Technologically Improved Products 234
Revenue 235

Keeping Ahead of the Competition 236

239

INDEX

BIBLIOGRAPHY