

Contents

1	Totality of Science	1
	Introduction	1
	Illustration: Rutherford’s Experiment on the Structure of the Atom	2
	Methodology and Organization in Rutherford’s Experiment	5
	Activities of Science	8
	Illustration: Fire Ant Society	10
	Scientific Paradigms	11
	Illustration: National Science Foundation	13
	Two Levels of Procedures in Science	17
	Summary	18
	Notes	19
2	Origin of Scientific Method	21
	Introduction	21
	Scientific Method	22
	Nicolaus Copernicus	22
	Tycho Brahe	23
	Johannes Kepler	24
	Galileo Galilei	25
	Rene Descartes	26
	Isaac Newton	28
	Scientific Method as Empirically Grounded Theory	30
	Vienna Circle’s Logical Positivism	32
	Illustration: Inference in Newton’s Gravitational Solar Model	36
	Circularity Between Empiricism and Theory in Scientific Method	39
	Summary	41
	Notes	41
3	Research Funding	43
	Introduction	43
	Illustration: US National Institutes of Health	43
	Focus of Government Research Programs	45

Government Research Programs.....	46
Research Planning in NIH	47
Building Blocks, Biological Pathways, and Networks	48
Molecular Libraries and Molecular Imaging	48
Structural Biology	50
Bioinformatics and Computational Biology	50
Nanomedicine	51
Science “Roadmaps” in Research Planning.....	52
Peer-Review in Research-Funding Procedures.....	53
Illustration: Empirical Evidence for the Theory of Plate Tectonics: Tharp and Heezen	55
Format of Research Proposals	59
University Procedures in Research-Proposal Writing and Submission	60
Summary	63
4 Research Techniques.....	65
Introduction.....	65
Research Techniques.....	65
Illustration: Discovery and Modeling of DNA	67
Empirical and Theoretical Research Techniques.....	85
Experiment.....	85
Instrument	86
Measurement.....	87
Perceptual Space	87
Analysis.....	87
Laws	87
Model	88
Theory	88
Scientific Inquiry as Both Inductive and Deductive	88
Summary	90
Notes	91
5 Communities of Scientists	93
Introduction.....	93
Illustration: The Royal Society	93
Scientific Societies and Peer Review	95
Illustration: Origin of European Research Universities.....	97
Research Universities.....	101
Illustration: Discovery of Nuclear Fission.....	101
Scientific Communities and University Professorships.....	103
Illustration (Continued): Discovery of Nuclear Fission.....	104
Research Teams	106
Illustration (Continued): Discovery of Nuclear Fission.....	107
Complexity of Nature and Research	109
Illustration (Continued): Discovery of Nuclear Fission.....	109

Scientific Competition	113
Illustration (Concluded): Discovery of Nuclear Fission (and Then the Atomic Bomb)	115
Summary	118
Notes	119
6 Science and Society	121
Introduction	121
Illustration: Recombinant DNA Technique	121
Innovation Process	123
Illustration: Origin of the Biotechnology Industry	126
Science Bases for Technology	128
National Innovation System	129
Illustration: US R&D Infrastructure	130
Illustration: Innovation of the Internet	133
Economic Long-waves	136
Performance of National Innovation Systems	142
Summary	144
Notes	144
7 Paradigms and Perceptual Spaces	145
Introduction	145
Illustration: Center in Neuromorphic Systems Engineering	146
Scientific Paradigm	149
Illustration: Kant's Critique of Pure Reason	150
Modern Scientific Paradigms	152
Matter and Mind	153
Matter and World: Scientific Paradigm of Mechanism	154
Matter and Self: Scientific Paradigm of Function	154
Mind and Self: Scientific Paradigm of Logic	155
Mind and World: Scientific Paradigm of System	155
Paradigms and Scientific Disciplines	156
Inanimate: Physical Sciences	157
Animate: Biological Sciences	157
Cognitive: Mathematics and Computer Sciences	158
Societal: Social Sciences and Management	159
Perceptual Spaces	159
Perceptual Space for Observing Physical Nature	160
Illustration: Jung's Personality Types	161
Perceptual Spaces in the Social Sciences	164
Summary	164
8 Paradigms of Mechanism and Function	165
Introduction	165
Illustration: Ontology of Physics and Chemistry	165

Scales of Nature as Mechanisms.....	166
Illustration: Einstein's Special Relativity.....	167
Scientific Paradigm of Mechanism.....	169
Kinematics in Mechanism.....	169
Dynamics in Mechanism.....	171
Prediction in Mechanism	172
Illustration: Darwin's Theory of the Evolution of Species	173
Scientific Paradigm of Function	174
Function and Behavior	176
Function and Will.....	177
Illustration: Human Brain	178
Reason and Information Processing.....	179
Functional Model of Intelligence.....	180
Stimulus–Response Model: Perception of the World and Action in the World.....	180
Pure Reason: A Priori Capabilities of Mind	182
Consciousness: Cognitive Processes.....	183
Sub-conscious: Cognitive Functions beneath the Conscious Level of the Mind.....	183
Will: Decisions of Action	186
Summary	188
Notes	189
9 Objectivity in Social Sciences.....	191
Introduction.....	191
Illustration: Max Weber on Social Science Methodology	192
Empirical Observation in Social Science.....	193
Illustration: Modern Economic Theory and the Global Financial Collapse of 2007–2008	194
Flyvbjerg on Idealism and Realism in Political Science.....	198
Illustration (Continued): Economic Theory and Global Financial Collapse 2007–2008.....	200
Idealism and Realism in the Social Sciences.....	203
Social Theory and Practice	203
Social Science Empiricism and Practice.....	205
Relationship of Physical Science to Technology	206
Relationship of Social Science to Practice.....	207
Illustration: US Academics and Consulting.....	209
Social Science Consulting and Normative Judgments.....	209
Universality in Social Science as Empiricism/Practice	210
Summary	212
Note.....	213

10 Paradigms of Systems and Logic	215
Introduction	215
Illustration: Energy Systems	215
Systems Paradigm	217
Systems Theory	218
Illustration: Enterprise Systems	220
Kinds of Systems	221
Logic as the Language for a Language: Linguistic	
Meta-regression	223
Illustration: Fortran – The First Programming Language	225
Types of Languages Developed in Science	226
Illustration: Specialized Languages in Information Systems	228
Illustration: Logic in the Computer	231
Logic in the Computer	235
Logic in the Modern University	237
Logic in Ordinary Languages	237
Logic in Philosophy	237
Logic in Mathematics	238
Logic in Computer Science	238
Logic in Science	238
Logic in Management Science	239
Logic in Engineering	239
Logic as a Scientific Paradigm	240
Summary	240
Notes	241
 11 Theory in the Social Sciences	 243
Introduction	243
Illustration: History of Political Reason in the US Constitution	244
Societal Phenomenological Laws	246
Ideal-Type Social Theory	248
Illustration: Ideal-Type Theory of Societal Systems	251
Principles of Social Order	255
Reasoning in Social Structures	256
Political Rationality	257
Cultural Rationality	258
Economic Rationality in Society	259
Technical Rationality in Society	260
Societal Systems Model as Ideal-Type Theory	261
Illustration: Nuremberg Trials	262
Universality in Societal Reasoning	267
Summary	268
Notes	268

12 Models	269
Introduction	269
Illustration: Heisenberg and “Adequate Concepts”	270
Illustration: Quantum Theory: Max Planck	273
Illustration: Quantum Theory – Balmer and Rydberg	275
Illustration: Quantum Theory of the Atom – Einstein	278
Motion in Physical Perceptual Space	280
Particle Motion	280
Wave Motion	281
Illustration: Quantum Theory – Bohr	284
Bohr’s Model	289
Quantum Mechanical Theory	290
Scientific Objects and Models	291
Summary	292
Notes	293
 13 Models in the Social Sciences	 295
Introduction	295
Use of Social Science Models	296
Topological and Flow Models	297
Matrices and Topological Graphs	299
Illustration: Input–Output Economic Model	300
Explanation in Social Science Models	301
Illustration: Failure in the Context of Oil Drilling	302
Modeling Organizational Systems	304
Illustration: Modeling a Manufacturing Organization	306
Transformation Plane Activities	307
Support Plane Activities	308
Control Plane Activities	310
Control Models: Dynamics and Optimization	310
Summary	311
 14 Multidisciplinary Research	 313
Introduction	313
Illustration: MIT Biotechnology Process Engineering Center	313
Multidisciplinary Research Strategy	315
Illustration (Continued): MIT Biotechnology Process Engineering Center	317
Organizing and Planning Multidisciplinary Research	319
University/Industry Cooperation in Multidisciplinary Research	320
University Science to Industrial Technology	322
Illustration: Center for Biofilm Engineering at Montana State University	323
Multidisciplinary Research Strategy	326

Illustration (Continued): Center for Biofilm Engineering at Montana State University	327
Multidisciplinary-Research Center Grants	330
Role of a Multidisciplinary Research Center Director	331
Critical Mass of Research	332
Summary	333
15 Measurement	335
Introduction	335
Quality and Quantity	336
Quality: Mathematical Set Theory	337
Illustration: Set Notation in Defining Natural Objects	338
Quantity: Counting	339
Quantity: Mathematical Operations	340
Mathematical Group	341
Addition Group	341
Multiplication Group	342
Algebra	342
Vectors	343
Differential Algebra (Calculus)	344
Analytic Geometry	345
Illustration: Quantitative Sentences and Deductive Inference	347
Measurement: Random Variables	349
Illustration: Measurement Histogram	350
Probability	351
Sum of Probabilities: Either-Or	352
Product of Probabilities: Both-And	352
Complete Set of Events	353
Sampling Theory	353
Bernoulli's Formula	353
Mean Value and Squared-Dispersion of a Random Variable	357
Shape of the Distribution of a Random Variable	357
Bayes' Rule	357
Multiple Means in a Distribution	361
Correlation Between Two Random Variables X and Y	361
Least-Squares Fit to a Straight-Line Function	361
Correlation Estimation	362
Summary	363
16 Handbook of Research Methods	365
Introduction	365
How Does One View Science As a Whole?	365
What Are the Intellectual Frameworks of Science?	366
What Is Scientific Method?	367
What Role Does Modeling Play in Scientific Method?	369

How Does Methodology Differ Between Social and Physical Sciences?	370
How Does One Manage a Research Project in a University?	371
How Can One Identify a Research Issue?	372
How Can One Write a Persuasive Research Proposal?	373
How Should One Manage a Research Center in a University?	373
How Can Science Research Be Effectively Transferred to Technology Research?	375
How Should a Research Agency Plan a Research-Funding Program?	375
How Should Officers in a Research Agency Manage a Research-Funding Program?	376
References	379
Index	383



<http://www.springer.com/978-1-4419-7487-7>

Managing Science
Methodology and Organization of Research
Betz, F.
2011, XXX, 388 p., Hardcover
ISBN: 978-1-4419-7487-7