CONTENTS

Prologue | ix

- 1. The World Is Not a Machine | 1

 The Nonergodic Universe above the Level of Atoms | 2

 Beyond the Second Law | 4

 Why Do Human Hearts Exist? | 6

 What Is an Organism? | 8

 The World as Machine | 11
- 2. The Function of Function | 13
- 3. Propagating Organization | 17

 Work | 19

 Boundary Conditions, Work, and Entropy | 20

 The Constraint Work Cycle | 21

 Nonpropagating and Propagating Work | 23

 Constraint Closure—and More | 27

 Two Closures | 29

Potential for Self-Reproduction: Three Closures | 29

Nonmystical Holism | 30

The Genericity of Physics and Specificity of Biology | 30

Propagating Organization of Process | 31

4. Demystifying Life | 33

The RNA World | 35

The Lipid World | 39

The Connectivity of Random Graphs | 40

From the Computer to the Lab | 47

Three Closures of Life | 50

Life as the Daughter of Molecular Diversity | 51

The "Life Force" | 52

5. How to Make a Metabolism | 55

CHNOPS | 62

Beginning Guesses about Reaction Graphs | 64

Into the Laboratory | 67

Joining a Metabolism to a Collectively Autocatalytic Set | 72

6. Protocells | 77

The Damer–Deamer Scenario | 78

Onward to Protocells | 81

Entropy and Persistent Self-Construction | 84

Things Not Said | 85

- 7. Heritable Variation | 87
- 8. The Games We Play | 91
 Sensing, Evaluating, Responding to the World | 92
 Moving | 93

From Matter to Mattering | 93

Instrumental Ought | 94

The Filigreed Games We Play | 95

Interlude: The Surprising True Story of Patrick S. "The First,"
Rupert R., Sly S., and Gus G., Protocells in Their Very Early
Years | 97

The Story of Patrick! | 97

The Story of Rupert! | 101

The Amazing Story of Sly Protocell | 104

The Story of Gus | 105

- 9. The Stage Is Set | 109

 The Biosphere Explodes in Diversity | 110

 We Cannot Mathematize This Becoming | 111

 Context-Dependent Information | 112
- 10. Exaptations and Screwdrivers | 115

 Preadaptations and Exaptations | 115

 The Many Uses of Screwdrivers | 118

 Jury-Rigging and Whatnot | 120
- 11. A World Beyond Physics | 123

 Entropy and Evolution | 123

 Niche Creation Is Self-Amplifying | 124

 Beyond Law: Biology Cannot Be Reduced to Physics | 125

 No Laws Entail the Becoming of the Biosphere | 127

 Reductionism Fails | 127

Epilogue: The Evolution of the Economy | 129

What Is an Economic Web? | 130

Two Senses of "Need" | 130

A Brief Look at the Evolution of the IT Industry | 131

The Adjacent Possible of the Economic Web | 133

The Algorithmic Adjacent Possible | 133

The Non-Algorithmic, Unprestatable, Adjacent Possible of the Economy | 134

The Diversity of Contexts and Diversity of Uses | 136

The Growing Web Is the Growing Context for Its Own
Further Growth | 137

A Brief Comment on Standard Economic Growth Models | 137

An Early Statistical Model of the Adjacent Possible | 138

REFERENCES | 141 INDEX | 145