# C O N T E N T S

1	THE MADE AND THE BORN 6 Neo-biological civilization 6 The triumph of the bio-logic 7 Learning to surrender our creations 8
2	HIVE MIND 9 Bees do it: distributed governance 9 The collective intelligence of a mob 11 Asymmetrical invisible hands 13 Decentralized remembering as an act of perception 15 More is more than more, it's different 20 Advantages and disadvantages of swarms 21 The network is the icon of the 21st century 25
3	MACHINES WITH AN ATTITUDE 28 Entertaining machines with bodies 28 Fast, cheap and out of control 37 Getting smart from dumb things 41 The virtues of nested hierarchies 44 Using the real world to communicate 46 No intelligence without bodies 48 Mind/body black patch psychosis 49
4	ASSEMBLING COMPLEXITY 55 Biology: the future of machines 55 Restoring a prairie with fire and oozy seeds 58 Random paths to a stable ecosystem 60 How to do everything at once 62 The Humpty Dumpty challenge 65
5	COEVOLUTION 67 What color is a chameleon on a mirror? 67 The unreasonable point of life 70 Poised in the persistent state of almost falling 73 Rocks are slow life 75 Cooperation without friendship or foresight 78
6	THE NATURAL FLUX 83 Equilibrium is death 83 What came first, stability or diversity? 86 Ecosystems: between a superorganism and an identity workshop 89 The origins of variation 90 Life immortal, ineradicable 92 Negentropy 95 The fourth discontinuity: the circle of becoming 97

7	EMERGENCE OF CONTROL 99 In ancient Greece the first artificial self 99 Maturing of mechanical selfhood 102 The toilet: archetype of tautology 104 Self-causing agencies 108
8	CLOSED SYSTEMS 112 Bottled life, sealed with clasp 112 Mail-order Gaia 115 Man breathes into algae, algae breathes into man 118 The very big ecotechnic terrarium 120 An experiment in sustained chaos 123 Another synthetic ecosystem, like California 130
9	POP GOES THE BIOSPHERE 133 Co-pilots of the 100 million dollar glass ark 133 Migrating to urban weed 136 The deployment of intentional seasons 138 A cyclotron for the life sciences 143 The ultimate technology 145
10	INDUSTRUAL ECOLOGY 147 Pervasive round-the-clock plug in 147 Invisible intelligence 149 Bad-dog rooms vs. nice-dog rooms 151 Programming a commonwealth 154 Closed-loop manufacturing 155 Technologies of adaptation 158
11	NETWORK ECONOMICS 161 Having your everything amputated 161 Instead of crunching, connecting 162 Factories of information 165 Your job: managing error 169 Connecting everything to everything 173
12	E-MONEY 176 Crypto-anarchy: encryption always wins 176 The fax effect and the law of increasing returns 182 Superdistribution 184 Anything holding an electric charge will hold a fiscal charge 189 Peer-to-peer finance with nanobucks 195 Fear of underwire economies 196
13	GOD GAMES 198 Electronic godhood 198 Theories with an interface 199 A god descends into his polygonal creationTo 203 The transmission of simulacra 208 Memorex warfare 209

Seamless distributed armies 213
A 10,000 piece hyperreality 215
The consensual ascii superorganism 216
Letting go to win 219

#### 14 IN THE LIBRARY OF FORM 221

An outing to the universal library 221
The space of all possible pictures 225
Travels in biomorph land 228
Harnessing the mutator 231
Sex in the library 233
Breeding art masterpieces in three easy steps
Tunnelling through randomness 239

236

#### 15 ARTIFICIAL EVOLUTION 241

Tom Ray's electric-powered evolution machine What you can't engineer, evolution can 245
Mindless acts performed in parallel 247
Computational arms race 251
Taming wild evolution 253
Stupid scientists evolving smart molecules 254
Death is the best teacher 258
The algorithmic genius of ants 261
The end of engineering's hegemony 264

#### 16 THE FUTURE OF CONTROL 267

Cartoon physics in toy worlds 267
Birthing a synthespian 269
Robots without hard bodies 272
The agents of ethnological architecture 275
Imposing destiny upon free will 276
Mickey Mouse rebooted after clobbering Donald 278
Searching for co-control 281

## 17 AN OPEN UNIVERSE 283

To enlarge the space of being 283
Primitives of visual possibilities 284
How to program happy accidents 285
All survive by hacking the rules 288
The handy-dandy tool of evolution 290
Hang-gliding into the game of life 292
Life verbs 294
Homesteading hyperlife territory 296

# 18 THE STRUCTURE OF ORGANIZED CHANGE 300

The revolution of daily evolution 300
Bypassing the central dogma 302
The difference, if any, between learning and evolution 304
The evolution of evolution 307
The explanation of everything 309

## 19 POSTDARWINISM 310

The incompleteness of Darwinian theory 310
Natural selection is not enough 312
Intersecting lines on the tree of life 314
The premise of non-random mutations 315
Even monsters follow rules 318
When the abstract is embodied 320
The essential clustering of life 321
DNA can't code for everything 322
An uncertain density of biological search space 32
Mathematics of natural selection 325

#### 20 THE BUTTERFLY SLEEPS 328

Order for free 328

Net math: A counter-intuitive style of math 329 Lap games, jets, and auto-catalytic sets 331 A question worth asking 333 Self-tuning vivisystems 337

# 21 RISING FLOW 340

A 4 billion year ponzi scheme 340 What evolution wants 343 Seven trends of hyper-evolution 346 Coyote trickster self-evolver 350

## 22 PREDICTION MACHINERY 352

Brains that catch baseballs 352
The flip side of chaos 355
Positive myopia 357
Making a fortune from the pockets of predictability 358
Varieties of prediction 366
Change in the service of non-change 369
Telling the future is what the systems are for 370
The many problems with global models 370
We are all steering 375

# 23 WHOLES, HOLES, AND SPACES 377

What ever happened to cybernetics? 377
The holes in the web of scientific knowledge 380
To be astonished by the trivial 382
Hypertext: the end of authority 385
A new thinking space 389

# 24 THE NINE LAWS OF GOD 392

How to make something from nothing 395