Index

abstract representations of concrete systems, 88
Académie Royale des Sciences, 36
accelerations
  interactions between, 340
  non-environmental, 340
action
  narrative theory of, 227
activation network, 189
  shape or topology, 186
  spreading, 186
activation networks, 448
activation over relaxation, 186
adaptability, 302
adaptation, 20
adaptive capacity, 135
adaptive changes create other risks, 177
adolescence, 125
advertising, 378
  drives changes, 368
  meets mass-production, 363
affordances, 84, 446
agency
  role of, 107
aggregation, 296
  statistical, 93
aggregations, 139
aging, 309, 318
agriculture, 68
  agriculture depends on drainage, 162
  plantation, 176
AI (Artificial Intelligence)
  degree of alignment, 450
  general cross-task, 381
  narrow task specific, 381
alignment, 140–141, 270
  degree of, 70
  of disciplines, 61
  educational, 22
  social, 22
  of societies’ values, 369
alliance structures
  unstable, 280
all knowledge is incomplete, 115
alternatives, 65, 131
  future, 64
alternative scenarios
  multiple, 178
analogue approach relating past and present, 81
Anthropocene, 266, 336
anthropogenic, 26, 68
  action, 73
anthropology economic
  formalist, 374
anticipate, 12, 80, 360
anticipation, 97, 99
a “place” out of a “space”
  humans create, 347
approach
  additive, 134
  extended evolution, 354
  flow structure, 145
  generative, 221
approach (cont.)
  positivist, 217
  reductive, 134
  trial-and-error, 220
archaeology, xiii, 45, 56, 124
ARCHAEMODES, 32, 72, 100, 177
architectures
  modular, 96
Arthur, 98, 221, 227, 261, 413, 420
artifact making
  emergent stabilization, 229
artifact making reconstruction, 229
artifacts
  as information-processing tools, 157, 259
  inform substance and substantiate information, 342
  took over much information processing, 259
artificial intelligence, 451
  Atlan machine learning, 59, 356, 380, 433
  focus on training, 382
  narrow and general, 381
  predicts suicidal tendencies, 387
  use of information external to humans, 382–383
assessment models
  integrated, 90
assimilation
  stepwise, 140
asymmetrical trees
  garbling and loss of signal, 196
attitude, III, 38
  fatalist, 72
attactor
  aperiodic, 113
  limit-cycle, 111
  point-, 111
  strange- or chaotic, 113
  torus-, 112
attractors
  low-dimensional strange, 113
attributions, 226
  invention as generation of, 226
Augé, 347
authority
  central hierachical, 193
  supraregional, 175
autocatalytic, 145, 155, 281
  reaction, 146
automation, 381, 451
  machine learning in, 380
  and outsourcing require education, 324
  people replaced by, 309
  from production to distribution society, 382
autonomy, 381
  limited, 194
  machine, 381
back-casting, 85, 98
Bacon, 35
balance of power, 450–451
barriers
  administrative, 62
  in hierarchies, 205
  to information flow, 352
  to innovation, 231
  to interdisciplinarity, 54
  to transdisciplinarity, 58
basic hierarchies
  create, 131
basic sequence
  rotating around vertical axis, 254
battle against water
  drainage ditches, 158
Beckert, 97
  Imagined Futures, 395
bee’s eye view, 56
behavior
  average, 60
  collective, 106
  cyclical of economy, 219
  of distributed systems, 208
  economic, ecological, and social, 63
  future, 80
  idiosyncratic, 107
  individual, 106
  near-chaotic, 16
  no long-term predictions of, 111
  non-equilibrium, 106
  of spreading activation net, 187
  stable, 210
behavioral
  skeletons, 261
behaviors
  diverse, 60
Bénard convection, 270
bias
  in category formation, 59
  neutralized, 147
  none, 147
toward dissimilarity, 147
toward similarity, 147
bifurcation
  Hopf, 281
  points, 74
  second
    separation hierarchical and distributed communication, 268
  third
    preurban smouldering, 269
bifurcations
  and dampenings, 209
  period-doubling, 282
  render chaos transient, 200
big bang
  financial, 324
big data, 11
  algorithm-based analysis, 380
  capability to automate, 379
  cheaper sensors, 351
  cloud memory, 351
  concentration of information, 378
  concentration of power, 379
  customized advertising, 378
detailed analysis of patterns, 378
enhanced resolution, 379
increased processing capacity, 351
mobilization of relevant voters, 378
novel approaches, 405
revolution, 451
  socially (de)constructive uses, 380
big men, 190, 267
biodiversity
  loss of, 15
biosocial nature
  of humans, 124
birth and death rates
  different parts of the world, 309
birth of world system
  commerce and banking spread, 291
  continental information gathering networks, 292
  heterarchical structures, 291
  heyday of city power, 292
  increasing information-processing capacity, 292
  industrial expansion, 292
  rural emigration to towns, 292
  from rural to urban, 291
rural–urban interaction increase, 292
  trading houses, 292
  voyages to other continents, 292
birth rate, 309
  crude, 307
Black Death, 33, 74, 290, 296–297
black soils, 68
blade tools, 127
bonds, 169
to fund water infrastructure, 169
bootstrapping, 222, 224
  drivers, 138
  process, 122
Borges, 109
bottom-up
top-down vs., 421
boundaries
  planetary, 93
boundary
  between signal and noise, 450
  conditions, 82–83
  phenomena taking over, 270
bourgeoisie, 42
brain
  biological capacity of, 142
  to body weight ratio, 125
  short-term working memory, 58
brain capacity
  learning to exploit, 124
  short-term working memory, 58
BRICS countries
  rise of, 330
buffer, 302
burden
  sharing, 94
business
  community, 19
  control handed over, 391
  driven, 22
  encapsulated by, 12
butterfly
  effect, 111, 301
capability
  cognitive, 49
  to enhance dimensionality, 179
capacity
  cognitive, 124
capital
  human and natural
  overexploitation, 359
Index

capitalism
  increased competition, 363
capitalist dynamics
  role of constitutive fictions, 395
career structures, 61, 408, 436
carrying capacity, 134
Cartesian, 34
categories
  open and closed, 232
categories to observations
  relating, 232
categorization, 147
categorize, 131
category
definition, 98
category formation, 27, 147
causal chains
  to explain the present, 178
cells, 103, 142, 204
  Bénard convection, 103
technology, 103
  organized around central concept, 103, 222
central axis
  rotating vessel around, 249
centuries, 8
  eighteenth and nineteenth, 39
eleventh and twelfth, 290
nineteenth and twentieth, 36
seven to eleventh, 270
thirteenth and fourteenth, 291
chaîne opératoire, 229
challenges
  environmental, 10, 444
  societal, 20, 135
  sustainability, 305
chance origins
  improbability of, 40
change
  design for, 27
  global, 15
  heredity linked to, 40
  second order, 73
change and stability, 448
change is hard, 356
changes
  anthropogenic, 67
  second order, 17, 26
  state, 105
  structural, 331
changing identity
  challenge of, 59
channel
  capacity, 155, 193
channel
  capacity
    drops below or exceeds, 184
channel capacity
  sufficient, 269
channels
  multiple alternative, 185
chaos, 146
  deterministic, 110
  enhancing resilience, 108
  potential of, 340
  promotes flexibility and diversity, 108
  responsible for enhancing resilience, 108
  true, 72
chaotic, 111
chaotic oscillation
  causes bifurcation
  and dampening, 209
chieftdoms
  unstable transitional organizations, 189
chimpanzee
  STWM, 125
chip, 127
choice
  has central role, 231
choices
  determined emotionally, 59
  circular economy, 27
climate change, 10–11, 49, 175
  mitigate, 94
  clocks, 349–350
  atomic, 349
clusters, 110
  hierarchy of, 110
  small, 188
  urban systems in, 189
coarse-graining, 197, 201
codesign
  of models, 94
  of research questions, 94
coevolutionary transitions
  depend on temporal rhythms, 264
coevolution of human cognition
  very long-term, 121
coexist
  predictability and unpredictability, 105
cognition
coevolution of, 447
universal interface between humans and environment, 123
of a wider range of scales, 134
cognitive capacity
and infant growth, 126
cognitive dimensions
reduced number, 184
cognitive spheres
certainty sphere, 233
possibility sphere, 233
problem sphere, 233
coherence, 153
dissolution of nation-states, 365
internal, 194
self-referential, 217
Cold War, 365
collaboration, 175
emergence of, 159
between stakeholders, 58
transdisciplinary, 58
collapse, 72, 141, 274–275
structural, 72
collective action
in water management, 160
collective behavior
unpredictable, 105
colonial, 296
colonial empires
dismantling of, 300
colonial powers
western in China, 348
colonies
business and government working together, 298
commodities
overdependency on, 316
commodity production
intrinsic rate, 281
Commons
Tragedy of the, 175
communication
common actualization of meaning, 48
contributing to migration, 310
increased dependency on, 142
multichannel, 182
self-referential, 25
stress, 137
syntactic aspect of, 151
written
transcends space and time, 185
communication channels
limited capacity, 151
longer, 184
communication, collaboration, competition
anchored within value space, 354
communities
disciplinary, 22
early farming, 265
gated, 372
globalization destroys, 374
mutual dependency, 368
The New World
value space of communities, 439
of scholars and scientists, 41
scientific and non-scientific, 49
specialized, 137
urban
designing for change, 401
competence networks, 226
competencies
five transdisciplinary, 63
key, 63
competition
and cooperation, 199
reduced by innovation, 202
shifts to economy, 366
Complex Adaptive Systems, 100, 102, 105
Adaptive, 444
complexity
characterization of, 104
Earth system vs. human perception, 333
embrace, 405
high degree of, 275
increasing, 77
information diffusion capacity, 196
reduced
of hierarchical self-organizing systems, 202
complex systems, 80, 100, 102, 105
adaptive, III, 444
behaviors, 83
resilience in, 107
self-organizing, 104
structure, 193
compulsive sequences, 221
computer
exceed human information processing capacity, 433
games, 31, 85, 368, 451
computer (cont.)
models, 85
processing power, 344
simulation, 86
reliability, 89
computing
high performance, 379
power
increasing model complexity, 98
Comtat, 82, 177
conceive objects
as three-dimensional, 131
conception of objects
closed categories, 234
partonomy, 234
sequence, 234
topology, 234
conceptual models
beyond, 90
conditions
of enhancement, 109
extant, 96
favoring risk taking, 223
initial, 73
of natural selection, 40
operational, 208
configuration
divine, 33
societal, 300
spatiotemporal, 145
conflict
arbitrage, 139, 365
increases in, 184
intergroup, 138
intrasocietal, 450
low incidence of, 182
Congress of Vienna, 364
connectedness, 70
is information, 70
connectivity
gradual improvements
 discontinuous effect, 276
rapid increase in, 351
conscious
knowledge
 limited by the unknown, 231
consequences
for health
of wealth differentials, 322
unanticipated, 85
unexpected, 99

unforeseen and unwanted, 86
unintended, 10, 12, 96, 176, 300
conservation, 71
law of, 24, 123
principle, 445
constraint
communication as, 137
cultural, 248
disciplinary, 51
energy, 138, 142, 296
external, 452
hierarchy as, 184
on hierarchy capacity, 196
intellectual, 61
internal, 452
constraints
communication and energy as, 139
energy and resources, 142
construction problems
control of shape, 247
control speed and rhythm, 248
ensure access, 248
maintain fixed position, 248
range of shapes required, 248
vessel collapses or deformation, 248
consumerism, 352
contact
face-to-face, 182
contingencies, 83
contingent structurations
history as, 108
continuity, 188
institutional, 422
control
central, 198
loss of control over information,
391, 450
no government, 451
no individual in, 185
controller
central, 208
controlling
ecological dynamic, 68
cooperation
 reduces group stability, 191
cooptation, 36
corn production
in N. America, 74
correct wealth discrepancies, 452
coupled systems
hierarchies and market systems, 195
creation
cultural context of, 229
between mind and matter, 232
creative choices
not random or unlimited, 235
creativity
role of, 98

crises of the twentieth century
abolition of gold standard, 300
big bang, 301
collapse of the USSR, 301
dust bowl, 300
emergent fields of tension, 299
Great Depression, 300
restructuring of the developed world, 300
revolution of rising expectations in ex-colonies, 301
shift toward consumerism, 300
subsuming regional risks under global ones, 301
World War I, 299
World War II, 300
crisis, 72
accumulation of unintended consequences, 386
societal, 25
temporary information-processing insufficiency, 334
cross-scale dynamics
in modeling tools, 94
crowdsourcing, 66
cultivation
requires drainage, 159
cultural
constructs, 10
Culture
Nature as subcategory of, 52
current tipping point
one of three most consequential in history, 339
curricula, 42
cybernetics, 101
cyberwarfare, 347
cyclical lows
not coinciding, 176
Daly, 411
argument value-based, 412
back-casting from new ideas, 414
critiques role of science and technology, 413
energy- and matter-related arguments, 412
need for dematerialization, 414
no-growth economics, 414
political economics of scarcity, 412
replace more is better with enough is best, 412
science contributed to conundrum, 413
steady state economics, 413
technological adaptation, 414
Darwinian model, 40
debt level
high, 317
debt system
is fiduciary, 316
decision-making, 98
anticipation can flip negatively, 396
based on imagined futures, 395
confidence in imagined future, 396
decisions
constrained by social networks, 259
decolonization
cut information flow, 298
separates business and government, 298
dedicated authority
water-, 162
defined channel
of communication, 151
delta, 158
dematerialization
of our value systems, 11
democracies
from enabling to controlling, 391
democracy
alternative truths, 371
and consumerism, 370
distinguishing political parties, 371
distinguishing fiction and reality, 372
fracturing alignment, 371
hybrid, 371
hybrid regime, 378
information bubbles, 372
institutional challenges, 371
participate actively, 391
populist organizations, 371
and sustainability, 370
think-out-of-the-box, 391
Index

demographic tendencies
projected, 306
Demographic Transition Theory, 308
demography
  elephant in the room, 413
  inviolability of human life, 414
denominator
  common, 359
  lowest common, 352
Descartes, 35
designing for change, 452
Desmond Tutu
  let us pray, 391
destruction and creation
  cascades of, 224
deterministic and stochastic processes
  interplay between, 108
developing countries
  computer literacy, 377
  ICT important after 2000, 376
  ICT lagging, 377
  ICT potential underexploited, 377
  insufficient ability to use ICT, 377
  investment lagging, 377
  poverty reduction, 377
  use of Internet, 377
development
  vs. mechanics, 39
development pathways
  alternative, 93
development proxies
  demography, 288
  density and extent of transport, 288
  innovativeness, 288
  spatial extent, 288
  trade flows, 288
  wealth accumulation, 288
differences between cultures
  becoming source of friction, 352
differential payoffs
  increase success, 200
digital revolution
  accelerated existing dynamics, 363
Dilthey, 37
dimensionality
  curse of, 26
  difference between perception and action, 333
  increases in, 114
dimensions
  enhance the number of, 178
  fractal, 113
  of reality
    removed, 369
directness
  aligned, 226
  mutual, 226
disaggregation, 35, 77
disciplinary communities
  need for fusion, 305
  reinforced, 60
disciplines, 41
discontinuity, 274
  history of, 107
disintegration
  edge of, 122
dissipative flow structure, 214
dissipative flow structures, 446
distinction
  markets and market societies, 373
distinction between information and noise
  blurring or disappearing, 353
distributed processing
  longdistance corridors, 269
distributed systems
  allocation of finite resources, 197
  cooperation and competition, 197
  environment and payoff, 199
  imperfect knowledge, suboptimal behavior, 198
  independence of participants, 197
  knowledge slow and incomplete, 197
  power-law of learning, 197
  satisfaction, 198
distribution economy
  criteria for policies, 383
  politics over economics, 383
diversification
  economic, 136
DIVERSITAS, 18
diversity
  enhances stability, 209
domestic and international dynamics
  interdependency, 366
dominance of individual centers
  unstable, 278
Doppler effect, 116
downslope, 93
dualism
  between abstract and concrete, 35
  great wall of, 33, 74
  reason and experience, 35
Dupuy, 44
dynamics
at multiple scales, 94
second order, 264

Earth system, 16
Earth System Science Partnership, 19
ecology
definition, 40
human, 41
economic
growth
and population growth, 309
models
dynamic equilibrium, 360
vulnerability of LDCs, 319
economic and political web
transnational, 364
economic anthropology
substantivist, 373
economics
behavioral, 99
complex systems thinking, 99
emphasis on continuity, 360
evolutionary thinking, 99
macro-, 60
separate from politics, 373
value-driven behavior, 373
economy
prestige goods, 268
from production to distribution, 383
ecosystem, 41
edges, 110
education
differentiates earning capacity, 319
education systems
discipline-based and -focused, 22
egalitarian processing
group too large for, 183
elections
non-participation, 390
empires, 139
Empiricism, 34–35
encephalization
quotient, 125
energy
efficiency improvement, 312
infinitesimal additional cost, 351
mastery of, 339
rapid increase of use, 311
renewable, 314
stranded assets, 312
engagement
stakeholder, 65
entities
administrative in Holland, 159
entrepreneurship
US decline of, 320
entropy
dissipates, 146
Shannonian relative, 145
statistical–mechanical, 145
environment, 40
as non-organism, 40
perspective, 20
environmental dynamics
slow change, 264
environmental risk
control, 135
epistemological
differences
between disciplines, 60
epistemologies, 22
e-residency
Estonian, 348
ethno-archaeology, 247
European expansion and retraction, 288
European Union, 173
evaluate choices made
against options not chosen, 228
events
unforeseen, 106
Evernden, 32
evolution
extended, 230
ontogenetic vs. phylogenetic, 40
evolutionary
drive, 108
many pathways, 283
evolutionary approach
relating past and present, 81
evolving structure
merges functions and simplifies, 357
ex-ante, 84
and ex-post, 178
ex-ante perspective, 443
exchange and trade, 136
ex-colonies
gain independence, 329
executive manufacturing functions
tools, techniques to instantiate conceptions, 234
existence
emergence over, 104
expansion keeps trouble away, 154
explanation, 55
proximate, 24
ultimate, 24
explanation and prediction are asymmetrical, 115
exploitation, 70
explosion, innovation, 132
extended evolution, 448

factoids, 333
facts
status of, 216
farmers
moved to towns, 163
feedback

cognitive, 155
feedforward

tools available, 254
finance
productive vs. speculative, 314
first stirrings
Hanseatic League, 289
new (feudal) social structure, 289
new spatial structure, 289
peasants provide surplus, 289
protection for peasants, 289
twelfth-century Renaissance, 289
flood of 1953, 173
flows
as dynamic structures, 103
dissipative, 103
flow structures
around towns, 138
dissipative, 103
fluctuations
aperiodic, 110
focus
on contexts and relationships, 102
on Information Theory, 443
Fondaco, 348
footprints, 142
forecasting and backcasting, 85

foreign lands
past and future as, 81
fourth bifurcation
city states, 270
framework
static allocation, 60
free market
creation of governments, 373
disembedded financial logic, 373
From Being to Becoming, 102
fuel
peat as, 163
functions
new cognitive, 134
funds for repairs
towns loan, 169
fusion
intellectual, 23
future
ontologically uncertain, 85, 393
thinking about, 11, 79
future driver
exchange between present and imagined futures, 395
Future Earth, 19
futures
desirable, 84, 97
plausible, 84
futuring, 96
gatherer-hunter-fisher societies, 190
General Systems Theory, 41
generative potential
assessing, 226
theory of, 227
Geosphere-Biosphere Program, 18
global economic interdependence, 366
globalization, 329
cheap transportation, 375
cost of moving people, 375
dimensionality of other cultures, 302
diversity buffers against hyper-connectedness, 302
expansion of markets, 375
explosion of unanticipated consequences, 302
is not new, 297
local growth of industry, 375
outsourcing, 375
reduced dimensionality of value spaces worldwide, 302
Index

reduces dimensionality, 358
separation of production and consumption, 375
shrinking value space, 358
telecontrol, 376
transformations in, 375
undermines diversity in values, 302
value chain revolution, 375
globalized world system
more accident-prone, 342
Global Systems Science’, 302
governance
international, 397
governments
used by, 12
grain prices
increase in, 165
great acceleration, 444
speeded up by information processing, 343
great men, 190, 267
Greco-Roman culture
around the Mediterranean, 140
green growth, 11
bottom-up, 420
distribution economy, 420
economy of opportunity, 420
enlarge our global value space, 421
global environmental footprint, 412
global governance impossible, 422
ill defined, 411
interpretation of, 410
is growth necessary?, 411
less work, more creativity, 419
local autonomy, 420
multipolar world, 422
opportunity for change, 411
power of new technologies, 415
reduce differences in wealth and wellbeing, 411
reduce humans’ environmental reduce impact, 411
reevaluation, reduction, and relocalization, 421
role of free market ideology, 413
role of progress, 411
small communities, 422
small-scale agriculture, 421
statistical approach ignores detail, 422
strengthening bottom-up awareness, 423
greenhouse gas emissions
ignore ultimate causes of unsustainability, 304
group meetings
periodic, 267
group size
highly variable, 183
limited, 182
growth
density-dependent, 108
growth of structure
causes loss of dimensionality, 357
Gunderson & Holling, 70
Haarlemmermeer, 170
habitus, 106
Haeckel, 40
Harvard model, 41
Helbing, 106, 423
distributed networks take over, 423
Heraclitus of Ephesus, 100
hermeneutic circle, 37
heterarchical systems
adaptability, 202
advantage, 203
efficiency, 202
large sluggish adaptation, 271
reduction of error-making, 201
stability, 202
heterarchies, 195, 200
hierarchical, 71
hierarchies, 193
diffusion time limit, 196
emergence statistically probable, 191
emergence of, 266
multilevel, 194
optimizing resources, 194
hierarchization
bottom up, 201
hierarchy
adaptability, 197
adaptable and adapted, 197
asymmetrical, 207
fixed-point attractor, 267
growing and strengthening, 268
overall complexity, 196
reduced adaptiveness, 268
symmetry and diffusion speed, 196
Index

human wellbeing
  reduction in dimensionality of, 330
hyper-coherent, 67
hypermodernity
  anthropology of, 347

ICT
  individuation, 368
  role of, 367
ICT acceleration
  must it run its course?, 403
  power concentration, 402
  wide societal adaptation, 403
ICT revolution, 12
  Alpha-Go approach, 405
  architecture, 404
  artificial intelligence development, 423
  assisted self-organization, 426
  barriers to managing society, 425
  Big Brother society, 424
  causing unemployment, 413
  changes in perception, 383
  changing societal dynamics, 347
  collection of microdata, 385
  collective control, 403
  collective science, 384
  combinatoric complexity greater than
    ICT capacity, 426
  complexification, 384
  computational thinking, 404
  computers control society, 423
  computing power always insufficient, 426
  context, 362
  continues existing trends, 364
  coordination capacity, 423
  decreasing cost of moving information, 375
  democracy, 370
  desirability adapted to system dynamics, 426
  disconnect technology-society, 390
  explosion of small companies, 386
  facilitating globalization, 367
  focus on relationships, 384
  free market development, 423
  human-machine interaction, 403
  increasing dimensionality, 405
  information society thinking, 404
  instability of hyper-coherent systems, 427
  learning for the future, 405
  limits to cooperation, 428

hierarchy (cont.)
  tangled, 43
  vertically asymmetrical, 257
historical myopia, 360
history
  natural, 10
  and Natural History, 39
  not inevitable, 297
Hogg, 197
holistic approach, 57
  to the future, 81
holistic perspective, 444
Holland
  emerged from interaction between people
    and water, 175
Hollandsche Maatschappij van
  Wetenschappen, 36
Hoogheemraadschap, 162
hotspots
  regional players compete, 366
Huberman, 197
human
  dynamic
    faster change, 264
  information processing, 122
  learning
    autocatalytic reaction, 146
  societies
    information processing, 124
human agency
  absence of, 34
human beings
  dual nature, 32
  organize, 24
human brain
  36, 43
  biological evolution of, 125
  growth of, 124
  as natural phenomenon, 30
human capability
  to innovate, 135
human cognition and organization
  constrain information processing, 344
Human Dimensions of Global
  Environmental Change, 18
humanity
  is active, 28
  is passive, 28
human-machine teaming, 381
human-produced commodities
  knowledge determinant, 149
humans
  eating their future, 310
Index

management of politics, 386
massive data gathering, 406
modeling, 384
network approaches, 384
overcoming cognitive limitations, 404
(over)simplification, 385
predictive policing, 424
problem-based, change-focused tools, 405
science overtaken?, 385
serious games, 405
simplification, 384
slowing it down, 403
society uncontrollable, 426
statics to dynamics, 384
statistical basis of insurance, 386
steering economy, 386
synthesis 2.0 tools, 404
transparency in science, 384
we’re all connected, 426
wise king cannot control society, 424
ideas
ideas outlive objects, 217
ideas behind technology
skeleton of society’s choices, 261
immaterial domain
part of technology, 215
immigration
and xenophobia, 309
imperfect matches
between past and present, 82
income inequality
rising in the USA, 324
increase in knowledge
but loss of control, 334
individualism, 70
individuals
independence from context, 394
individuals and groups
align values, 355
industrial revolution, 42
changing status of colonies, 295
Europe mass producer, 294
improved political control, 295
multipolar world, 295
new technologies, 295
plentiful (fossil) energy, 294
social movements, 295
society dependent on innovation, 296
industry
-driven, 22
infomercials, 368
information
control of, 184
disembedding of, 342
everyone source for everyone, 369
links ideal and real realms, 152
is shared, 123
as potential meaning, 148
reaches everyone instantly, 352
as reduction of uncertainty, 151
sharing of, 24
information brokers, 269
information diffusion
speed of, 195
information diversity
increase, 344
information flow
volume processed, 186
information loss
outside context, 152
information pool
heterogeneous, 184
heterogenous, 183
homogeneous, 181
inhomogeneities in, 267
information processing
acceleration of, 340
capacity
increased density, 135
clusters grow indefinitely, 188
collective, 133, 142
digital, 343
disembedding of, 340
distributed, 192, 207
efficiency, 194
electronic, 11
feedback loop, 343
heterarchical and directional, 271
information as flow, 150
expanding stable clusters, 187
knowledge as stock, 150
long distance activation, 188
no control, 352
organization of, 11
replaced energy as the main constraint, 341
short-lived finite clusters, 187
temporally stable
finite clusters, 187
information-processing landscape
spatial clumpiness, 189
information society, 445
information sources
multiplication, 369
information-theoretical approaches
limitations, 151
inferred
everyone partly, 184
infrastructure maintenance
reductions in, 317
initial conditions
of the present, 67
sensitivity to, 111
innovation
acceleration of, 45, 50
as ex novo investment, 219
in business, 42
cascade, 139
cost of, 45
directed to sustainability, 415
increasingly costly, 322
in industry, 42
introduction of novelty in society, 215
requires energy for implementation, 320
requires ex-ante perspective, 215
role of
in society and economy, 219
societies depend on, 154
innovations
appear as clusters, 219
new, 137
innovative culture
how to acquire, 228
instability
and discontinuity, 105
fundamental, 107
local, 113
intellectual fusion, 57
absence of, 56
interaction
between niche and perception, 235
interactive, 19
interdisciplinary, 53
Intergovernmental Panel on Climate Change, 23, 97
International Energy Agency, 312
Internet
of Things, 45
invariant elements
determine tradition, 254
invention
creation of novelty, 215
determined by context, 220
improve understanding, 392
interaction between ideas and things, 216
invention and innovation, 447
inventor
studies options for actions ex-ante, 218
thinks possibilities, probabilities, 218
inversion society-economy, 449
investigate
choices made and not made, 244
investment
in environment, 136
private, 169
Iron Age, 45, 272
European, 68
issues
epistemological, 83
real-world, 65
John Seely Brown, 430
Jonas, 33
judgment
constrained, 147
Kennemerland, 160
knowing
self-referentially construed, 52
knowledge
formalized categorizations, 148
not specialized, 182
societal coherence, 150
through critical observation, 34
through identification, 34
knowledge and information
interaction between, 148
Krause, 247
lakes
drained, 165
Lamarck, 40
land
reclamation, 170
surface below water level, 162
tax, 164
landscapes
disturbance dependent, 68
Lane, 45
Lane and Maxfield
the innovator’s perspective, 225
last seventy years
  balance of power shifts, 299
extraction-to-waste economy, 299
multipolar and information-flow
  structure emerging, 299
Latouche, 419
learn how to learn, 24
learning
  group-, 133
  machine
    of large datasets, 381
  problem- and project based, 65
  student-centered, self-directed, and
  collaborative, 65
lemniscate, 70
lenders of last resort, 317
Leroi-Gourhan, 25, 220
levees
  natural, 158
  level of abstraction, 153
Lewis, 32
life expectancy
  differences, 307
life sciences
  assume long-term irreversibility, 38
Limits to Growth, 86
lineages and chiefdoms
  segmentary, 191
Little Ice Age, 68
long-distance distributed communications
  emergence of, 270
long term, 26
long-term evolutions
  endogenous and exogenous, 69
long-term perspective, 444
long-term societal dynamics
  independent of matter/energy constraints, 150
long-term study of invention and
  innovation, 443
LonWorks, 45
lowest common denominator, 56
Luhmann, 48

department of

  manufacture
    invariant elements, 254
    staged or chunked, 240
    variable elements, 254
manufacturing
  dimensions involved, 126
  sequences inverted, 134
manufacturing tradition
  Negros Oriental, Philippines, 249
marketing
  enabled creation of demand, 341
markets
  shaped by governments, 324
market systems, 193
  are non-optimizing, 194
  equal access to partial information, 193
  flexible and diverse, 194
  no central control, 193
marsh, 158
mass marketing, 363
mass-production, 363
material and energetic constraints
  temporary, 150
material aspects of technology
  seen as facts, 216
material conditions
  articulate with inventor’s perception, 230
materials
  new, 134
materials and artifacts
  relational systemic outlook on, 229
material wealth
  growing differentials in, 322
mathematical model
  dynamic, 86
mathematics of discontinuous change
  need for, 360
matter
  mastery of, 339
  primordial state of, 39
matter, energy and information
  not exchanged in the same way, 149
Maxfield, 45
means of communication
  improvements in, 137
mechanism
  regulatory, 258
mechanisms
  self-reinforcing, 109
mechanization, 363
media
  enabling escape, 367
memory
  loss of, 152
metadata
  extending, 90
Michoacan, Mexico, 255
middle classes
  squeeze on, 324
migration
  challenges, 310
  changing regional demographies, 309
milieu
  perspective, 20
mobile societies
  do not invest, 265
  uncertainty, no risk, 265
modeling
  agent-based, 179
  component-based, 96
  safe operating spaces, 93
model of transitions, 448
models
  agent-based, 114
  dynamic equilibrium, 80
  evaluate theories, 89
  kinds of, 90
  position in argument, 96
  process, 88
  and questions, 90
  support, 88
modern world
  changing roles of government and business, 298
molding
  invariant elements, 257
  pottery, 255
  variations, 257
money
  dominance of, 45
monism
  materialistic, 36, 43
Moore’s law, 344
multidimensional communal value sets
  populism and defence of, 330
multidisciplinary, 53
multinational corporations
  the size of nations, 364
multinationals
  growth of, 341
multiple attractors
  coexistence of, 108
multi-scalarity, 113
narratives
  allow backing into the future, 226
Natura
  is ambiguous, 32
natural environment
  disturbance-dependent, 264
naturalization of Man, 36
nature, 10
  appropriation of, 158
  objectification of, 32
network
  amplification, 116
networks
  heterarchical, 186
  processes occur in, 110
  prone to transformation or collapse, 109
network size and stability
  very large fluctuations, 188
news cycle
  twenty-four hour, 368
new solutions
  create challenges, 357
  grafted on existing structures, 356
Newtonian physics, 37
The New World
  anti-disciplinary approaches, 440
  capabilities determined by networks, 438
  change in risk calculus, 434
  change is the norm, 434
  collective information processing, 429
  compasses and maps, 431
  computer
    games, 437
  crowd know more than individuals, 438
  dimensionality and potential, 439
  diversity and ability, 437
  emergence and authority, 428
  emergent democracy, 429
  entities and patterns, 437
  exploration and exploitation, 432
  failures and learning opportunities, 436
  freeing animal spirits 432
  a fundamentally new information-processing structure, 435
  Heraclitan approach, 433
  intellectual property rights?, 438
  Kuhn’s essential tension, 435
learning and teaching, 433, 436
learning by doing, 436
machine and human co-processing, 433
need-based innovation, 430
power over and power to, 429
Practice and theory, 436
pull and push, 430
pull-over-push, 437
real life patterns are complex, 440
the role of disobedience, 435
safety and risk, 433
stability rather than change as the challenge, 434
Systems and objects, 439
vision and plan, 431
nexus
cognitive, 35
NGOs
major international, 366
niche
combines possibility and problem spaces, 237
generalizable external model, 237
niche construction, 228, 230
nineteenth-century international relations
sovereignty and balance of power, 365
nodes, 110
noise, 147
nominal debt
global, 316
non-communicable diseases
increases in, 319
nonoptimal strategies
persistence in distributed systems, 202
nouns and verbs
role of, 109
novelties
product of group in context, 219
novelty
emergence of, 12
not perceived without stability, 217
objectification, 36
objectivity
in the study of nature, 34
objectivity or neutrality
scientific, 48
observations
overdetermined by past experience, 217
Occam’s Razor, 114
ontological uncertainty
allows and limits inventions, 225
ontology to ontology
moving from, 229
open systems
societies as, 155
open water
threatens land, 164
operating space
safe, 15
operation
multiple modes of, 110
order and disorder
relationship between, 104
order through fluctuation, 106
organization perspective, 374
organizations
(proto-)urban, 185
oscillations
aperiodic, 107
Ostrom, 10
other participants
no-one knows all, 184
out of the box, 97
parsimony
rule of, 114
Participatory Anthropic Principle, 49
partnerships
ad hoc, 169
partonomies, 131
pasture
agricultural land reverts to, 163
Patent Office
United States, 47
path dependency, 74
pathways
development, 93
pattern recognition, 147
Pax Americana
favors multinationals, 298
peat, 158
tax on, 165
peer polity interaction, 270
peer review, 31, 36, 61
pension and healthcare systems
challenge for, 319
people
live partly in fantasy world, 368
people immobilized
by indecision, 353
perception
  dimensions of
    select or suppress, 147
percolation
  phenomenon, 122
percolation perspective, 446
period
  colonial, 74
  industrial, 74
  precolonial, 74
perspective
  cyclical, 33
  dissipative flow, 301
  linear, 33
  organization, 110
  systemic and evolutionary, 82
perspectives
  environment and milieu, 27
phase space, 111
phase transitions, 105
phenomena
  dead, ahistorical, 37
  poly-interpretable, 217
phenomena and ideas
  relative lifespans of, 217
phenomenology
  invention and innovation, 227
physics
  mechanistic, 33
planetary boundaries
  societal, 306
planetary boundary
  societal, 324
  ICT acceleration, 402
  wealth discrepancy, 326
plantations
  in East Indies, 172
plausible and desirable futures, 452
Polanyi, 373
political entities
  indigenous, 140
political organization, 159
possibility space
  multiple domains of attraction, 108
potential
  is energy, 70
pottery-making, 237
power
  predictive, 80
principle
  precautionary, 27
printing, 342
proactive, 20
problem formulation
  indeterminacy in, 21
problems
  multidimensional, 58
  wicked, 22, 58, 102
  wicked or hairy, 54
problems of construction
  constrain techniques, 247
processes
  reversible, cyclical, or repeatable, 37
processing
  partial control, 183
  under partial control, 446
  universal control, 446
  without central control, 184, 446
  without central control, 184–186
Processing
  under universal control, 181
processing of information
  semi-independent machine, 343
processing strategy
  divide and rule, 201
  pipe-lining, 201
production economy
  wage differentials, 382
productivity
  increase not rewarded, 325
  increasing emphasis on, 359
profits through growth ideology
  driver since Industrial Revolution, 320
promotion and tenure, 31
properties
  emergent, 93
proto-urban centers
  emergence of, 269
pumps
  steam, 173
quasi-periodic, 113
Rationalism, 35
raw materials
  choice of, 234
reactive, 20
reality from conception
  distinguish, 131
reality shows, 368
real life and fantasy
  distance between, 369
Index

reason conform to experience, 35
rebuilding cities autonomy, 401
  circular economy, 401
designing multiple scenarios, 402
different business models, 401
ergy-information balance, 399
ICT favors distributed settlement, 400
ICT undermines need for cities, 400
integrating top-down and bottom-up, 401
longevity of infrastructure, 399
long time horizon, 400
societal risks increased, 400
urban planning, 401
vulnerability, 400
rebuilding communities, 452
building resilience, 398
chaos, 397
codependency of individuals, 398
collective creativity, 398
contribution of IT, 397
growths initiatives, 397
humility of scientists, 399
multidimensional value spaces, 397
organic agriculture, 398
rebuilding trust, 399
revitalization, 398
transition towns, 397
recombinant innovations
increase in, 351
reductionist, 12
redundancy
potential, 352
reengaging, 452
reestablished stability after World War II, 365
regulation
social, 137
relationship
change and stability, 217
invert between data and interpretations, 258
society–environment reciprocal, 135
subject–object, 115
relationship society–environment reciprocal, 135
release, 72
Renaissance, 33
  emergence of bourgeoisie, 291
era of opportunity, 290
Italian, 290
long distance trade, 291
population and wealth aggregation, 290
reevaluation of religion, etc., 290
urban and rural population growth, 290
urban trading centers in Low Counties, 291
reorganization, 72
institutional, 72
reproduction as identical recreation, 40
research
institutional contexts of, 48
validation, 22
research diversity
reduction of, 62
reset
relation society–environment, 334
resets nature of shift toward society, 335
resilience community, 70
Resilience Alliance, 10
resources
integral part of society, 216
scarce allocation of, 61
unavailable, 330
retransform water into land, 169
return on invested capital decrease in US, 320
reversal economy and technology, 261
Rhine, 158
Rijnland, 158, 160
rising expectations revolution of, 324
risk barriers planetary, 306
risk spectrum shift in, 177
shifts, 26
Rockström, 15
Roggema, 402
role as scientists, 453
role of scientists
acknowledge limits of science, 408
role of scientists (cont.)
adopt CAS, 407
anticipation, 407
are we experts?, 407
behave as citizens, 407
humility, 407
intellectual leaders, 408
links with government and industry, 406
listen more, talk less, 406
loss of trust, 406
role of scientific facts, 408
social and political engagement, 406
too far from public, 406
transparent relationship with society, 406
Royal Society, 36
rural dynamics
governed by environment, 264
rural land
urban control, 169

safe operating space, 306
Saijo, 391
sanctuaries
liminally placed, 269
savings and investments
decrease in, 319
scaffolding structures, 226
theory of, 227
scales
interaction spatial and temporal, 176
scaling
allometric, 46, 139, 327
scenario
building, 97
Schumpeter, 219
science
cognitive, 98–99
cognitive and social, 49
is conditional, 49
critical attitude to, 47
history of, 32
institutionalization of, 50
multidimensional, 50
societal context of, 44
trust in, 31
science losing trust, 444
sciences
mistrust of, 47
natural
partnership with industry, 46
scientific ethic
Mertonian, 47
scientist
explains results of actions ex-post, 218
scientists
productivity of, 61
scientists must engage, 453
SDGs
adopt progress ideology, 417
against
western liberal capitalism, 417
end poverty and hunger, 416
global mandate, 418
globalization and countermovements, 418
no one left behind, 417
peaceful, just and inclusive societies, 416
prosperous and fulfilling lives for all, 416
protect the planet from degradation, 416
risks of the project, 417
top-down direction and bottom-up
innovation, 419
search engines, 351
search time
reduction, 137
second order change, 445
sedentary societies
humans engage with environment, 265
invest, 265
reduced range of resources, 265
sequences of action
remember and reproduce, 131
stretching and chunking, 134
shaping technology
collective knowledge, 231
conscious knowledge (know that), 231
tacit knowledge (know-how), 231
shift
from government-funded fundamental to
industry-funded applied research, 47
shift from exploiting to exploring, 449
short hierarchies
domain-specific, 267
short-term working memory, 125, 445
shrinking dimensionality
reducing innovation?, 360
signal, 146
signal and noise
distinction between, 353
signal-to-noise ratio
stronger, 184
similarity, dissimilarity
not absolutes, 147
social stresses
increasing, 137
size of information flow
related to time perception, 350
slow and rapid dynamics
interaction between, 280
slow dynamics
importance of, 69
small face-to-face groups
fission frequent, 191
social beings
humans are, 149
social dislocation, 373
social interaction
holistic basis reduced, 359
social networks, 351
social science
researching societal dynamics, 305
societal coherence, 355
dependent on innovation, 214
societal collapse
scientific theory of, 332
societal dynamics
interactions between, 331
societal structure
transitions in, 180
societal systems
are open, 145
genesis of, 145
societies
egalitarian, 182
small-scale, 182
value spaces, 355
societies’ capability
to absorb change, 346
society
self-organizing communications system, 48
society’s focus
shift from stability to change, 320
society’s interaction with the material world
artifacts determine, 260
society’s perspective
shift from past to future, 320
socioenvironmental dynamics, 10
second order, 10
socioenvironmental systems
integrated, 102
software evolution
algorithmic, 344
solutions
create unforeseen challenges, 48
solutions and challenges
interaction between, 122
space and time
changing relationship with, 347
specialized relationship, 184
spectacularization
of experience, 367–369
spectacularization of experience, 451
speculative capital
mobility of, 315
spillovers, 221
stability
global, 113
needs to be explained, 217
organizational, 194
research device, 116
stages of invention
critical revision, 220
insight, 220
perception of a problem, 220
setting the stage, 220
stakeholders
from civil society, 58
state of our planet, 72
states and empires, 192
Steffen, 15, 305
stochastic information webs, 269
stone tools
shaping, 126
three-dimensional conceptualization of, 127
stories
just-so, 82
strategies
error-making, 108
strategy
multi-resource, 134
structure
flow is the, 103
hierarchical, 183
scaffolding, 23
structuring
spontaneous, 106
study of invention
combines inside- and outside perspective, 218
STWM
modern human, 125
subject and referent, 27
comparing, 147
subjectivity
of observer recognized, 115
subsistence strategies
different, 135
sustainability, 9
pills of, 24
a societal challenge, 306
sustainability conundrum
societal, not environmental, 443
Sustainable Development Goals, 415
swarm planning, 402
understanding
passes through human cognition, 51
system behavior
long-term, 103
systems
Complex Adaptive, 443
education, 22
homeostatic, 101
morphogenetic, 101
open, 146
open or closed, 101
tangled hierarchy, 229
technical systems
neither societal nor environmental, 157
technique
Levallois, 131
techniques anchored
at minimally three levels, 233
technological imbalances, 221
technological innovation, 444
technological tradition
articulated between ideal and real realms, 218
coevolution between material conditions
and cultural knowledge, 230
technologies
capturing unknown phenomena, 222
information-processing role of, 157
mindful and full of intent, 231
new solutions within, 222
novel, 223
recombination of existing ones, 222
technology
construct to capture phenomena, 221
mediates between mind and matter, 213
new domains of, 223
part of multilevel recursive structure, 222
shapes economy, 225
of a society, 224
ways to do things, 215
technology and economics
interface of, 98
techno-sphere, 230
temporal continuity of ideas, 447
temporal intervals
subdivision of, 350
temporal overlaps
cause problems, 176
tendencies
fissionary, 184
tendency
in invention sequences, 220
territorially
in constant redefinition, 270
territorial states
colonies under military control, 293
growing wealth gap, 293
hybrid systems, 293
improvement of the road systems, 293
independence, 293
territorial integration, 292
Treaty of Westphalia, 293
territories
reliance on
undermined, 347
smaller, 135
The World in 2050, 97
theories
dynamic
formalization, 87
overdetermined by past experiences, 356
underdetermined by observations, 59, 356
Thermodynamics
Second Law of, 116
thinking
critical, 65
overdetermined by the past, 26
path-dependent, 26
underdetermined by observations, 26
thinking and managing
long-term strategic to short term tactical, 360
threats and institutions
bootstrapped to create The Netherlands, 176
time-bomb
or crisis, 177
time delays
introduce oscillations, 198
time management
reducing unit size, 350
time perception
relative, 116
societal management of, 349
subjective and individual, 349
tipping point, 11, 27
tipping points, 107, 448
ultimate endogenous causes, 332
topologies
new, 134
towns, 137
trade
long distance, 163
longer distance, 138
trade barriers
protectionism and national security, 315
trade goods
industrial production of, 163
trading centers
specialized periodic, 269
trajectories
future, 84
transactions
legal coverage
organization instead of territory, 348
transdisciplinarity, 12, 57
transdisciplinary, 17, 53
transformation
structural, 103
transformations
in information processing structures, 180
long-term, 78
transition
first organizational, 265
transition toward globalized society
elites vs. others, 330
transmission of information
electrical, 342
treasure
conquered, 141
Treaty of Westphalia, 364
tribes, 191
trust
scientists regain, 48
truths or realities
there are none, 48
turbulence, 113
turves, 163
ultimate causes, 445
ultradiffusion, 192
uncertainty
ontological, 102
slows down investments, 316
understanding
vs. knowledge, 37
underwater peat exploitation
limited, 169
undisciplined, 53
unexpected consequences
accumulation of, 50, 332
tragedy of, 10
unintended consequences, 449
accumulation of, 77, 342
universe
inanimate, 33
unlimited cheap energy
lifted constraint on innovation, 363
upscale, 93
urban dynamics
governed by humans, 264
urbanites
buy land, 165
urbanization
affected by I, 329
changes in governance structure, 327
due to enhanced information processing,
327
expansion of, 163
high institutional vulnerability, 327
major stresses, 329
rapid increase of, 326
rising transport costs with climate change,
327
and rural depopulation, 329
urbanization trend
business as usual?, 329
urban mode of life
gradual strengthening, 288
US
tax system
biased toward rich, 325
USA, Russia, and China
readjustments, 366
use personal opinions
to elaborate alternative truths, 353
Usher, 219
US military
globally dominant, 366
value
social creation of, 374
values
determined by socioenvironmental
networks, 354
and identities, 355
instantiations of information processing
structures, 354
play an essential role, 354
value space, 46, 451
enlarging the, 138
expands during societal growth, 356
reduction of, 332
variation and natural selection, 40
view
systemic evolutionary, 83
villages, 135
vitalist, 30
von Bertalanffy, 100
water into land
land into water, 175
water management
reorganization of, 165
watermills, 163
way out
change behaviors, 389
choice is important, 393
desires in decision-making, 394
focus on generation of the new, 392
future studies, 392
increased multidimensionality, 394
individual or community success?, 393
ontological uncertainty, 396
progress not inevitable, 392
question of free will, 394
redirect behavior, 390
rethink all behavior, 389
role of emotional desires, 394
stop digging!, 390
weal differences
major societal adjustments, 324
so-called elephant curve, 325
societal planetary boundary, 296
wellbeing
indicators of, 46
we only think that we think, 36
western value space
has it reached a limit?, 322
Why model?, 86
wicked
problems, 21
Wiener, 100
World Climate
Research Program, 18
world economy
multipolar, 319
The World in 2050, 418
worldview
fragmentation, 369
vitalist, 32
World War II
diplomatic rules breaking down, 365