
Index

Page numbers followed by *f* indicates figure and *t* indicates table

A

abandoned call rates
 regression analysis with multiple predictor variables, 254–61
 regression analysis with one predictor variable, 246–54
abstracts, 441
accounts payable cause-and-effect matrix, 195*f*
accounts receivable, days sales outstanding (DSO), 474–75
accuracy, 85, 86
Ackoff, Robert, 24, 300
adjusted *R*-squared statistic, 260
advertising, effect on sales
 business models, 233
 data over time, 51–52
 design of experiments, 273, 299–301
 experiment description, 24–27
 hypothesis, 27–28
 outcomes, 28–29
 statistical inference tools, 308–317
 statistical thinking strategy, 39–41, 42, 43
 variation reduction, 47
affinity diagrams, 125–26, 179–85
airline industry, 367
alternative hypothesis, 334–35
American Statistical Association, 450, 451
analysis of means (ANOM), 344
analysis of results, 286, 294–98
analysis of variance (ANOVA), 341–43, 346, 374, 410
analyze, DMAIC step, 128, 132–35
Anheuser-Busch, Inc., 24–29. *See also* advertising, effect on sales
ANOM (analysis of means), 342
ANOVA (analysis of variance), 341–43, 346, 374, 410
antagonistic interactions, 291
area under the curve, 375
assignable causes, 46–47
assumption, 41, 51, 107, 156, 236, 241, 244–45, 249–52, 260, 271, 308, 312–13, 320–22, 324–29, 331–32, 340–47, 357–59, 363, 370–72, 384–85, 388, 391, 393, 404, 408, 410–11

attribute data, 155
automobile accidents, 146, 147*f*
automobile industry, capability ratios, 222
Automotive Industry Action Group, 87
average and averages
 confidence intervals, 318–21, 327–28, 357
 defined, 13–14
 hypothesis tests, 340–43
 sample average, 383–86
average deviation, 14, 217, 391–92
“average of the averages,” 384

B

baby wipe flushability case study. *See* flushable wipes case study
Baggerly, Keith, 143
balance of trade, 6*f*
bank customers, average number arriving per hour, 52
banking telephone waiting time case study, 101–5, 107–8, 144, 159
bell curve, 358, 365
benchmarking, 11–12, 77–78
biased sampling, 152–53
billing process, 4–5, 59, 64, 73–75
binomial distributions, 366*f*, 368–70, 372
blending models, 234
blocking, 301–03, 303
blood glucose levels, 414–20
Borror, C. M., 87
Box, G. E. P., 51, 231, 232, 236, 270, 285
Box-Cox family of power transformations, 408
box plots, 109, 164–67
Brache, A. P., 81
brainstorming, 177–79
Brassard, M., 180–83
budgeting, for experiments, 285
Budweiser, 24–29. *See also* advertising, effect on sales
Burdick, R. K., 87
Busch, August, Jr., 24
business improvement, 3–21
 case study, 4–5
 global competition requirements, 5–7
 introduction, 3
 management approaches, 10–14, 421–23
 model for, 7–10

- business improvement (*continued*)
 - statistical thinking applications, 18–20
 - statistical thinking principles, 12–18
 - summary, 421
- business plan issues, affinity diagram
 - depicting, 180–83
- business processes, 55–89
 - analysis of, 65–78
 - dynamic nature of, 41, 51–53
 - examples, 56–62
 - identification of, 63–65
 - introduction, 55–56
 - measurement, 74–78, 82–87
 - principles of statistical thinking, 15–18
 - reengineering of, 10, 11, 122, 491–96
 - SIPOC model, 56, 62–63, 75
 - summary, 421–22
 - systems, 79–82
- C**
- call centers, 58, 66–67, 234, 301–302. *See also* abandoned call rates
- capability analysis, 140*f*, 205–7, 222–26
- casinos, 358
- causal relationships, tools for understanding
 - cause-and-effect (C&E) matrix, 194–97
 - failure mode and effects analysis (FMEA), 197–201
 - Five Whys, 125, 201–2
 - Is-is not analysis, 124–25, 202–5
 - within process improvement framework, 140*f*
 - See also* cause-and-effect diagrams
- cause-and-effect diagrams, 191–93
 - benefits, 191
 - examples, 191–92
 - limitations, 191
 - newspaper error case study, 133*f*
 - procedure, 193
 - purpose, 191
 - resin manufacturing case study, 98–99, 109, 191
 - tips, 193
 - variations, 193
- cause-and-effect (C&E) matrix, 194–97
- c* charts. *See* control charts
- C&E (cause-and-effect) matrix, 194–97
- center points, 303
- central limit theorem, 383–86
- Champy, James, 487
- characterization stage of experimentation, 280, 282
- checksheets, 106, 124, 143–46
- chemical analysis measurement, 83, 84*f*
- chemical reactions, 235
- chemical yield study, 475–78
- chi-squared test, 344–45, 366*f*, 481, 485–88
- Cicero, 483
- Clemente, Roberto, 139
- common-cause variation, 17–18, 46–50, 107–8
- communication
 - one-paragraph summaries or abstracts, 441
 - presentations, 439–41
 - of transformation results, 409–10
 - written reports, 441–43
- computer passwords, 159
- confidence intervals
 - for average, 318–21
 - defined, 308
 - for difference between two averages, 327–28, 357
 - for difference between two proportions, 328–29
 - examples, 310–11
 - general structure, 320
 - and hypothesis testing, 333–34, 337, 339
 - for proportion, 322–23
 - for regression coefficient, 325–26
 - for standard deviation, 323–25
 - vs. prediction intervals, 317–18
- confidentiality, 450
- conflict resolution, 435–36
- Consumer Price Index (CPI), 390
- continuous data, 164–71, 339–44, 365–66
- continuous probability distributions, 374–82, 484–89
- control, DMAIC step, 128, 135–36
- control charts, 207–22
 - benefits, 208
 - examples, 208–9
 - integer data, 364
 - limitations, 208
 - procedure, 209–21
 - purpose, 207
 - tips, 221–22
- Coombes, Kevin, 143
- copying documents, 66, 68*f*
- core processes, 80–81, 82*f*
- corporate tax payments, cause and effect diagram, 191–92
- corporate travel agencies, customer satisfaction survey, 148, 149*f*
- correlation coefficients, 171
- credit cards
 - account opening process, 60, 73
 - age distribution of holders, 161–62
 - collection strategies, 233
 - payment amount vs. balance, 168
- currency, 397
- customer complaint resolution, 176*f*
- customer feedback, 75
- customer order process, 58–59, 73–74, 76
- customers
 - defined, 9, 62, 66, 420–21
 - SIPOC model, 62
- cycle time

- billing example, 4–5, 59–60
 - continuous data, 365
 - continuous distribution, 374
 - credit approval example, 209*f*, 215, 357
 - customer order-to-receipt example, 162, 343
 - exponential distribution, 380–82
 - measurement, 75–76
 - mortgage approval example, 327–28, 330, 334
 - non-value-added processes, 66
 - probability distributions, 366
 - reengineering, 494
 - small business loans example, 357–58, 362
 - transformation, 408–10
- D**
- data
 - types, 363–66
 - vs. information, 10
 - data analysis, 42
 - data collection
 - for hypothesis testing, 335
 - over time, 51–52
 - subject matter knowledge, 40–41, 50–51
 - tools, 140*f*, 142–50
 - See also* sampling
 - data mining, 236–37
 - data quality, 151–54, 335
 - data quantity, 154–55, 335
 - Davis, P., 233
 - decrease the variation, 47–48
 - defectives, 212, 213
 - defects, 212
 - define, DMAIC step, 128, 130–31
 - Deming, W. Edwards, 15
 - deployment flowcharts, 175
 - descriptive statistics, 156. *See also* graphical analysis
 - design of experiments (DOE), 269–305
 - approaches to, 270–73
 - blocking, 301–2
 - center points, 303
 - defined, 109
 - examples, 273–79
 - four or more variables, 467–78
 - introduction, 269–70
 - larger experiments, 299–301
 - process, 284–86
 - randomization, 285–86, 302–03
 - statistical approach to, 270, 271–73, 279–86
 - summary, 425
 - three-factor experiments, 292–99
 - tips, 304
 - two-factor experiments, 286–92
 - df (degrees of freedom), 313
 - diabetes control case study, 414–20, 422–23
 - discrete data, 155, 344–45
 - discrete probability distributions, 367–73, 483–84, 486*t*
 - discrete variables, 164–67
 - distribution process, is-is not analysis for
 - late delivery in, 203, 204*f*
 - DMAIC (Define, Measure, Analyze, Improve and Control), 12, 128–37
 - document process flow, 105, 106*f*, 172–77
 - DOE. *See* design of experiments (DOE)
 - dot method of multivoting, 190
 - Dow Jones Industrial Average (DJIA), 45–47, 51, 395–97
 - draft, military, 151
 - Drucker, Peter F., 55
 - Duke University, 143
 - dynamic nature of business processes, 41, 51–53
- E**
- economy, global competition's impact on, 5–7
 - Edison, Thomas A., 93, 270
 - efficiency, 229
 - election polls and forecasts, 150, 152–53
 - electronics assembly, 71–72
 - empirical models, 235–36
 - Empirical Rule, 224–25, 379–80
 - employee retention case study, 311–13
 - employee satisfaction, 75
 - exercise equipment service contract sales, 330–33, 334, 335–39, 366, 368–70
 - experiments, scientific method step, 43. *See also* design of experiments (DOE)
 - exponential distribution, 366*f*, 380–82
 - exponentially weighted moving average (EWMA), 221
 - extrapolation, 254
- F**
- facilities evaluation, 63
 - factors, 292
 - failure mode and effects analysis (FMEA), 197–201
 - F*-distribution, 366*f*, 387, 398, 481, 488*t*
 - Fernandez, M. M., 76
 - finite population, sampling from, 350–52
 - finite population correction factor (FPCF), 350
 - first principle of statistical thinking, 15–16
 - fishbone diagram, 32
 - Fisher, Ronald, 387
 - Five Whys, 125, 201–2
 - flowcharts, 105, 106*f*, 172–77
 - flushable wipes case study
 - brainstorming, 178
 - description, 111–17
 - is-is not analysis, 124–25, 203
 - multivoting, 189
 - problem-solving framework, 124–25, 126

FMEA (failure mode and effects analysis), 197–201
 FPCF (finite population correction factor), 350
 fractional factorial design, 281, 467*t*
 frames, 153, 314–16
 French curve, 237
F-test, 343
 Fuller, F. T., 71
 future values, prediction interval for, 326–27

G

Gaussian distribution, 358, 365
 General Electric, 12
 global competition, economic impact, 5–7
 goodwill case study, 398–407
 Goodyear, 180–83
 Gosset, William S., 388–89
 graphical analysis, 156–71
 box plots, 109, 164–67
 histograms, 107–8, 126, 160–64
 within process improvement framework, 140*f*
 run charts, 156–58
 See also Pareto charts; scatter plots
 graphics, use in written reports, 442
 Greek letters, 318

H

Hammer, M., 81, 491
 haphazard experimentation, 270
 Hau, I., 30–39
 hidden plant, 72–74
 hidden replication, 299
 hiring process, 60
 histograms, 107–8, 126, 160–64
 homogeneity of variance, 344
 Hunter, J. S., 51, 232, 236, 270, 285
 Hunter, W. G., 51, 232, 236, 270, 285
 Huxley, Thomas, 307
 hypothesis, scientific method step, 43
 hypothesis testing
 and confidence intervals, 333–34, 337, 339
 consistency between data and null hypothesis, 335–37
 for continuous data, 339–44
 data obtainment, 335
 for discrete data, 344–45
 examples, 311–13
 formal statement of hypothesis, 334–35
 process, 330–33
 for regression analysis, 345–46
 rejecting or failing to reject, 338–39
 role of, 308–9
 sample size formulas, 346–52

I

IBM, 81*f*
 ID (interrelationship digraphs), 109, 126, 185–88
 improve, DMAIC step, 128, 135
 improvement. *See* business improvement
 Ince, D., 143
 increase the average, 47
 independence, 244, 389
 independent, 125, 188, 244, 249, 298, 308, 327, 370, 390–91
 independently, 26, 175, 180, 233, 271, 290, 328–29, 341–44
 inference. *See* statistical inference theory
 infinite population, sampling from, 347–50
 inflation, 397
 information, vs. data, 10
 information technology, 94
 in-person interviews, 448
 inputs, 15, 62
 institutionalization, 47
 insurance, 48–50
 integer data, 364–65
 interaction, 240, 289–91, 397–98
 interpretation of data, 50–51
 interrelationship digraphs (ID), 109, 126, 185–88
 interviews, 448, 449–50
 inverse transformations, 398, 407–8
 investment growth, 392–96
 is/is not analysis, 124–25, 202–5

J

JMP, 159, 169, 240–41
 Juran, Joseph M., 15

K

Kepner, C. H., 124
 KISS principle, 69–70
 knowledge-based tools, 172–205
 affinity diagrams, 125–26, 179–85
 brainstorming, 177–79
 cause-and-effect (C&E) matrix, 194–97
 failure mode and effects analysis (FMEA), 197–201
 Five Whys, 125, 201–2
 flowcharts, 105, 106*f*, 172–77
 interrelationship digraphs, 109, 126, 185–88
 is-is not analysis, 124–25, 202–5
 multivoting, 189–91
 within process improvement framework, 140*f*
 See also cause-and-effect diagrams

L

labeled scatter plots, 169
 Latin letters, 316
 Lean Six Sigma, 12, 94, 128, 130

- learning organizations, 11
- least squares, 240–46
- legal document process failures, FMEA for, 198*f*, 199
- Likert scales, 150
- linear combinations, 389–92
- linear relationship, 235
- loading, 121–22
- loan process, 357–58, 362
- logarithms, 395, 398, 407–8
- logistics, suboptimization, 79
- Lyday, R. W., 87
- M**
- machine learning, 236
- mail surveys, 448
- main effects, 294–98
- management approaches, 10–14
- manufacturing
 - benchmarking, 78
 - business process, 57–58
 - hidden plant, 72
 - interference, 357
 - process measurement, 83, 84*f*
 - Six Sigma approach, 12
 - suboptimization, 79
 - tolling operations, 62
 - See also* resin manufacturing case study
- marketing and market research personnel, 424
- mathematical French curve. *See* regression analysis
- mathematical statistics, 45
- measure, DMAIC step, 128, 131–32
- measurement process, 74–78, 82–87. *See also* sampling
- mechanistic models, 235
- media, interpretation of data, 50–51
- meetings, 434–35, 439–41
- microbrewing process, 69, 70*f*
- mixed-level factorial experiments, 474–75
- models and model building, 231–69
 - defined, 109, 231
 - examples, 232–35
 - introduction, 231–32
 - limitations of using existing process data, 264–65
 - strategies, 231–32
 - summary, 424–25
 - tips for, 265–66
 - types, 235–37
 - uses of, 237
 - verification, 461–64
 - See also* design of experiments (DOE); regression analysis
- Moen, R. D., 270
- Montgomery, D. C., 87, 233, 270, 352
- multicollinearity, 261–64
- multiple responses, trade-offs among, 459–61
- multivoting, 113, 126, 189–91
- N**
- National Institute of Standards and Technology (NIST), 86
- negative effect, 262
- newspaper accuracy case study, 130–37
- New York City rental market, 80
- New York Times*, poor quality data, 143
- Nightingale, Florence, 479
- NIST (National Institute of Standards and Technology), 86
- Nolan, T. W., 270
- “no-memory” property, 380
- nominal data, 363–64
- nonresponse bias, 152
- non-value-added work, 65–74
 - examples, 65–69
 - hidden plant, 72–74
 - process complexity increase, 69–72
- normal distributions, 358, 365, 366*f*, 374–82, 499, 501
- N over 3 method of multivoting, 190
- np* charts, 212, 213
- null hypothesis, 334, 335–39
- O**
- objectives, 284, 359
- observations, 43
- Occupational Safety and Hazards Administration (OSHA) incident rates, 218–19
- OFAAT (one-factor-at-a-time)
 - experimentation, 271
- off-list pricing, top-down flowchart for, 177*f*
- OFIs. *See* opportunities for improvements (OFIs)
- ogive, 160
- oil companies, blending models, 234
- Olympic medals, 365
- one average, hypothesis tests for, 340
- one-factor-at-a-time (OFAAT)
 - experimentation, 271
- one observation, prediction interval for, 321–22
- one-paragraph summaries, 441
- one-sided alternative, 335
- operations management personnel, 426
- opportunities for improvements (OFIs), 65–78
 - non-value-added work and complexity, 65–74
 - process measurements, 74–78
- optimization stage of experimentation, 280, 282
- order taking process, 58–59, 73–74, 76
- order-to-receipt cycle time, 162*f*
- ordinal data, 364

OSHA (Occupational Safety and Hazards Administration) incident rates, 218–19

outliers, 253, 455

output benchmarking, 78

outputs, 15, 62, 64

P

Pareto charts, 158–60

attribute data, 124

banking telephone waiting time case study, 103*f*, 104*f*

benefits, 158

common-cause variation, 108

examples, 159

limitations, 159

multivoting results, 189–90

newspaper accuracy case study, 132*f*, 134*f*

procedure, 159–60

purpose, 158

soccer team improvement case study, 32*f*, 34*f*

tips, 160

variations, 160

passwords, 159

patent filings, 173–75

p charts, 212, 213

peaking, 121–22

Peck, E. A., 233

personnel requisition process, 60

pharmaceutical industry, 5

Plackett-Burman design, 281, 467*t*

plastic parts case study, 277–79

Pohlen, Carolyn, 431, 414–20

Pohlen, Tom, 414–20

Poisson distribution, 211–12, 366*f*, 367, 370–73

polymer production process, 56, 67*f*

Porter, Cole, 467

practical significance, 338–39

precise measurements, 85, 86–87

prediction intervals

defined, 308

for future *y* values using regression equation, 326–27

for one observation, 321–22

vs. confidence intervals, 317–18

predictions, 237

presentations, 439–41

presidential elections, 152–53

probability density functions (continuous probability distributions), 374–82, 484–89

probability distributions, 366–82

continuous distributions, 374–82, 484–89

defined, 358, 366–67

discrete distributions, 367–73, 483–84, 486*t*

linear combinations, 389–92

normal distributions, 358, 365, 366*f*, 374–82, 499–501

sampling distributions, 382–89

standard deviation of, 371

transformations, 392–410

types, 358

probability mass functions (discrete probability distributions), 367–73, 483–84, 486*t*

probability theory, 358–63

problem solving, 123–27

basic framework, 123–27

case studies, 111–23

defined, 10

summary, 424

tools overview, 140

See also specific tools

process benchmarking, 78

process capability, 140*f*, 205–7, 222–26

process complexity, 69–72

processes, generally *See* business

processes

process improvement, 105–10

basic framework, 105–10

case studies, 95–102

defined, 9–10

summary, 424

tools overview, 140

See also specific tools

process measures, 74–78, 82–87

process resources, 64

process stability, 85, 106–7, 140*f*, 205–7.

See also control charts

process steps, SIPOC model, 62

product, defined, 62, 66

product development case study, 271–75, 301–302

product display, three factor experiment, 292–98

projects

business process analysis, 88–89

debriefing, 427

design of experiments, 304–5

model building, 269

process improvement and problem solving framework, 227

selection of, 53–54

statistical engineering, 137–38

statistical interference, 353, 411–12

summary, 427

proportions, confidence interval for, 322–23, 328–29

proposals, for experiments, 286

Provost, L. P., 2670

public accounting services, box plot of

hourly rates paid for, 164–65

pulse advertising, 29

Q

quadratic model, 239–40
 qualitative variables, regression analysis using, 455–59
 quality function deployment (QFD), 195

R

randomization, in experiments, 285–86, 302–3
 random sampling, 41, 150, 151
 rare occurrences, 212–13
 R charts, 210, 213, 217
Readers' Digest, 152
 realized revenue case study, 117–23
 rebates, 117–23
 reengineering, 10, 11, 122, 491–96
 regression analysis, 237–46
 abuses of, 265
 building models using, 240, 240f
 factor effects, 298
 French curve, 237
 hypothesis testing for, 343–44
 least squares, 240–46
 low adjusted *R*-squared value issue, 454–55
 model verification, 461–64
 multicollinearity, 263–66
 multiple predictor variables, 239–40, 254–61
 normal distributions as basis for, 374
 one predictor variable, 238–39, 246–54
 outliers, 455
 process overview, 238–39
 tips for, 266–67
 trade-offs among multiple responses, 459–61
 of two-level factorial design, 291–92
 when some, or all variables are qualitative, 455–59
 regression coefficients, 325–26, 345–46
 rent controls, 80
 replication, 285, 299
 reproducibility, 87
 residual analysis, 249–53. *See also* transformations
 resin manufacturing case study
 cause-and-effect diagram, 98–99, 109, 191
 control chart, 208
 description, 95–101
 scatter plots, 99f, 168
 special- vs. common-cause identification, 107, 108, 109–10
 stratification, 141
 response surface experiments, 475–78
 results, analysis of, 286, 294–98
 results benchmarking, 78
 reverse transformations, 398

rework, 66, 72–73

Ricoh, 95–101

risk priority number (RPN), 200

root causes, 125, 127

root sum of squares formula, 390

R-squared statistic, 260, 454–55

“rule of thumb” for sample size, 155, 344–45

Rummler, G. A., 81

run charts, 156–58

S

safety data, 201–2, 218–19

sales, advertising's effect on. *See* advertising, effect on sales

sales departments, suboptimization, 79–80

sample average, 383–86

sample size, 155, 344–50, 446

sample variance, 386–87

sampling

 for data quality, 151–54

 from finite population, 350–52

 from infinite population, 347–50

 random sampling, 41, 150, 151

 sample size, 154–55

 tips, 150–55

 use of, 83

sampling distributions, 382–89

 central limit theorem, 383–86

 importance of, 382

 sample average, 383–86

 sample variance, 386–87

scatter plots, 167–71

 benefits, 168

 correlation coefficients, 171

 defined, 108–9

 examples, 168

 limitations, 168

 procedure, 169

 purpose, 167–68

 resin manufacturing case study, 99f, 168

 root cause identification, 127

 tips, 169–71

 variations, 169

S charts, 210, 213

scientific method, 43

Scott Paper Company, 111–17

scrap, 66, 72

screening stage of experimentation, 280

second principle of statistical thinking, 16

self-managed work teams, 11

self-selected opinion polls, 451

semiconductor manufacturing process, 57–58

sequential nature, 40

service, defined, 62, 66

service contract sales, 330–33, 334, 335–39, 366, 368–70

- Shewhart, Walter, 216, 217
- SIPOC model, 56, 62–63, 75
- Six Sigma, 12
- small business loans, 357–58, 362
- snapshot studies, 51
- Snedecor, George W., 387
- Snee, R. D., 87
- soccer team improvement case study, 30–41, 42, 43, 52, 159
- soft drinks, 308–9
- special-cause variation
 - detection and elimination of, 46–50, 107, 207, 220
 - is-is not analysis, 203
 - vs. common-cause variation, 17–18, 107
 - See also* control charts
- square root, 398, 407–8
- stability, 85, 106–7, 140f, 205–7. *See also* control charts
- standard deviation
 - confidence interval for, 323–25
 - defined, 14
 - hypothesis tests, 342–44
 - of linear combination, 391–92
 - of probability distribution, 371
 - sample variance, 387–88
- standard normal distributions, 366f, 376–82, 499–501
- standards, 107–8, 126
- statistical engineering, 93–138
 - defined, 44, 94
 - DMAIC framework, 128–37
 - introduction, 93–94
 - principles, 94–95
 - summary, 422
 - tools overview, 140
 - See also* problem solving; process improvement
- statistical inference theory, 355–412
 - applications, 356–58
 - data types, 363–66
 - framework for, 358–63
 - introduction, 355–56
 - linear combinations, 389–92
 - probability distributions, 358, 366–82
 - sampling distributions, 382–89
 - summary, 425
 - transformations, 392–410
- statistical inference tools, 307–53
 - confidence and prediction intervals, 317–29, 479–81
 - defined, 307
 - examples, 310–13
 - hypothesis tests, 330–52, 479–81
 - introduction, 307–9
 - process of applying, 314–17
 - summary, 425
 - types, 308–9
- statistical methods, 43–45. *See also* models and model building; statistical inference tools
- statistical significance, 338–39
- statistical thinking
 - applications of, 18–20
 - for business improvement, 3–21, 421–23
 - diabetes control case study, 414–20, 422–23
 - future research, 425–27
 - history of use, 5
 - implementation steps, 13f
 - principles of, 12–18
 - review of, 420–27
 - vs. scientific method, 43
 - See also* business processes; statistical engineering
- statistical thinking strategy, 23–54
 - advertising case study, 24–29, 39–41
 - business improvement process
 - application, 41–43
 - dynamic nature of business processes, 51–53
 - introduction, 23–24
 - soccer team improvement case study, 30–41
 - summary, 421
 - synergy between data and subject matter knowledge, 50–51
 - variation in business processes, 45–50
- statistics system, 44f
- Stengel, Casey, 427
- stimulus-response relationship, 25–28
- stock market, 393–97
- straight-line model, 238–39
- strategy. *See* statistical thinking strategy
- stratification, 108, 125, 127, 141–42
- structural variation, 52, 122
- subject matter knowledge, 40–41, 42, 50–51, 127
- suboptimization, 79–80, 81–82
- subprocesses, 64–65
- summary of project, 441
- supermarket chain, three-factor
 - experiment, 292–99
- supersaturation, 25, 28–29
- suppliers, SIPOC model, 62
- surveys, 146–50
 - benefits, 148
 - confidentiality, 450
 - defined, 445–46
 - examples, 148
 - integrity issues, 450–51
 - limitations, 148
 - methods, 447–48
 - parties conducting, 447, 449–50
 - procedure, 148–50
 - purpose, 148

- questions, 448–49
 - resources, 451
 - sample size, 446
 - tips, 150
 - variations, 150
 - synergistic interactions, 291
 - synergy between data and subject matter
 - knowledge, 40–41, 50–51
 - systems of processes, 79–82
- T**
- tables, 442
 - tax payments, cause and effect diagram, 191–92
 - t* critical values, 497–98
 - t*-distribution, 366*f*, 387–89, 479
 - teams, 429–37
 - benefits of, 429–30
 - conflict resolution, 435–36
 - formation, 431
 - ingredients of successful, 432
 - meetings, 434–35
 - project selection, 431–32
 - reasons for failure, 436–37
 - stages of growth, 432–33
 - when to use, 430–31
 - telecommunications services, customer
 - measure, 76
 - telemarketing, 58, 286–92, 301–2
 - telephone interviews, 448
 - telephone repair centers, business models, 234–35
 - telephone waiting time, 101–5, 107–8, 144, 159
 - test programs, 283–84
 - theoretical models, 235–36
 - third principle of statistical thinking, 16–17
 - 3-sigma limits, 216–17
 - 3 standard deviation limits, 216–17
 - three-factor experiments, 292–99
 - time, 365
 - time plots, 156–58
 - time series model, 236
 - tolling operations, 62
 - top-down flowcharts, 175
 - total quality management (TQM), 11
 - trade-offs among multiple responses, 459–61
 - transformations, 392–410
 - communication of results, 409–10
 - defined, 397
 - examples, 395–97
 - goodwill case study, 398–407
 - inverse transformations, 398
 - logarithms, 395, 398
 - process of applying, 407–10
 - reverse transformations, 398
 - square root, 398
 - use of, 392–95
 - t*-ratio, 259, 298, 345–46
 - travel agencies, customer satisfaction
 - survey, 148
 - Tregoe, B. B., 124
 - t*-test, 340–41, 361–62, 374, 387
 - two averages, hypothesis tests for
 - comparing, 340–41
 - two-factor experiments, 286–92
 - two-level factorial design, 287, 291–92, 467*t*, 468–74
 - two-sample *t*-test, 340–41
- U**
- u* charts, 210–11
 - unapplied labor rate, 223–24
 - uncertainty, 154
- V**
- value-added work, 65–69
 - variables
 - identification in experimental design, 284–85
 - in statistical inference, 359–61
 - variance inflation factors (VIF), 263–64
 - variances, hypothesis tests for comparing, 343–44
 - variation
 - common-cause variation, 17–18, 46–50, 107–8
 - defined, 13–14
 - presence in all processes, 40, 45–50
 - special-cause variation, 17–18, 46–50, 107, 203, 207, 220
 - third principle of statistical thinking, 16–18
 - VIF (variance inflation factors), 263–64
 - Vining, C. G., 233
- W**
- wages and earnings, 6*f*
 - waste, 66
 - water absorbency case study, 310–11
 - weight gain, 233
 - Wheeler, D. J., 87
 - Wooden, John, 439
 - work teams. *See* teams
 - World Vision, 61–62
 - written reports, 441–43
- X**
- X*-bar charts, 210, 213, 217
- Y**
- Yellowstone National Park, 232, 236
- Z**
- z*-distribution, 377–79, 388, 479
 - z*-test, 345

<http://www.pbookshop.com>

<http://www.pbookshop.com>

<http://www.pbookshop.com>