Index

Note to reader: Bold page numbers refer to main discussions and definitions. *Italicized* page numbers refer to illustrations.

**Numbers**

- 20th Century, history of construction industry in, 8–9
- 3D modeling
  - perspective drawing, 96, 362
  - use in presenting design intent, 95
  - using BIM for, 330
- 4D models
  - scheduling and sequencing with BIM, 334–335
  - use in presenting design intent, 95
- 5D models, cost estimating using BIM, 335

**A**

- accident prevention, 303–304
- accreditation, professional, 34–37
- acronyms, used in construction, 341
- activities, in scheduling
  - determining durations of, 250–251
  - flow based on relationships between, 249, 249–250
  - as fundamental building block of schedules, 244–245
  - level of detail in, 245
  - sample activity list, 253
  - types of, 247–248
- activity-on-arrow (AOA) method, 242, 362
- activity-on-node (AON) method, 242, 362
- add-ons
  - defined, 359
  - general overhead as, 168
  - overview of, 166
  - profit as, 168
  - taxes as, 167–168
- addendum
  - to contract document, 101
  - defined, 359
- administration of the contract section, of general conditions document, 102
- administrative activities, scheduling, 247–248, 248
- advertisement for bids
  - in bidding documents, 100
  - defined, 359
  - sources of information for finding work, 73–74, 74
- agencies, coordination with local, 206
- agency CM project delivery
  - competition criteria and, 76–77
  - defined, 359
  - overview of, 48–49, 49
- agreement forms, in bidding documents, 101
- AIA (American Institute of Architects)
  - application for payment, 189
  - pay request continuation sheets, 188
- AIC (American Institute of Constructors), 35
- Alberti, Leone Battista, 7
- alcohol
  - policies in employee relations, 232–233
  - substance abuse aspect of safety management, 305
- American Institute of Architects (AIA)
  - application for payment, 189
  - pay request continuation sheets, 188
- American Institute of Constructors (AIC), 35
- American Society for Testing and Materials (ASTM), 293–294
- AOA (activity-on-arrow) method, 242, 362
- AON (activity-on-node) method, 242, 362
- application for payment, 187–190, 189
- aptitude test, for construction management, 64–66
- arbitration, of disputes, 198
- architects
  - change orders initiated by, 194
  - in commercial building, 13
  - as primary players in construction industry, 22–23
  - quality expectations and, 287–288
  - architectural drawings, in contract, 97
  - architectural programming
    - defined, 359
    - as owners responsibility, 44
  - architectural technicians, 22–23
  - area superintendents, job description of, 62
  - as-built drawings
    - defined, 359
    - final documentation in project closeout, 135
- Associated Builders and Contractors (ABC)
  - ABCares program, 28
  - accreditation and certification and, 35
Associated General Contractors (AGC) accreditation and certification and, 35
Construction Futures campaign, 28 embracing partnering approach, 176
Associated Schools of Construction (ASC) educational offerings, 34 founded in 1965, 8
ASTM (American Society for Testing and Materials), 293–294 at-risk CM project delivery competition criteria and, 76–77 construction management, 49 defined, 359 overview of, 49–50 awareness training, 196


C CA (contract administration). See contract administration (CA)
CAD (computer-aided drafting). See computer-aided drafting (CAD)
calculations in estimating, 156–157
callbacks – construction details

counting general conditions, 159–160
quantifying labor and equipment, 158–159
quantifying materials, 157–158
in scheduling, 251–255, 252, 254
callbacks, 286, 359
career opportunities, 33–34
career track, for construction managers, 61, 61
cast iron, Industrial Revolution and, 7
CDC (Center for Disease Control), 19
CDs (contract documents). See contract documents (CDs)
Center for Disease Control (CDC), 19
central repository approach
defined, 359
to implementing BIM, 336–337, 337
certificate of occupancy, in project closeout, 134
certification, professional, 34–37
change management
change orders, 193–195
changes in scope, 195
overview of, 193
time extensions, 195–196
change orders
changes in contracts and, 111–112
defined, 359
factors impacting project performance, 263
process of, 193–195, 194
changes in work section, of general conditions document, 102
chief estimators, 63
CII (Construction Industry Institute), 289
civil drawings, 96
civil engineers
functions of, 23
in heavy civil construction, 15
claims
defined, 360
unresolved issues and, 196
clash detection
BIM for performing, 335
defined, 360
cleanup, in construction operations, 215–216
client. See owners
closed bids
defined, 360
private projects and, 72
CM/GC. See at-risk CM project delivery
CMAA (Construction Management Association of America)
accreditation and certification and, 35
on agency CM, 48
CMRA (Construction Materials Recycling Association), 216
Code of Hammurabi, 5
codes, building. See building codes
cofferdams
defined, 360
techniques in commercial building, 14
collaboration, in construction industry, 31–32
Collaborative Process Institute (CPI), 42
commercial building, 13–15
characteristics of, 15
means and methods in, 14
overview of, 13
primary materials in, 14
commissioning
defined, 360
in project closeout, 134
communication
as key to relationships, 198
of schedules, 255–256
company image and publicity, 234–235
competition
changes in competitive environment, 71
in finding work, 75
competitive bidding process, 75–76
best-value selection, 85–88
low-bid as selection criteria. See low-bid selection
defined, 50, 360
price and qualifications as competition criteria, 76–77
in project design stage, 120
qualifications-based selection, 88–89
selection methods used by owners, 77–78, 79
compliances issues, in project design stage, 120
computer-aided drafting (CAD)
BIM model extending, 331
electronic management of drawings with, 96
overview of, 330–331
computers, impact of technology on construction, 9
conceptual estimates, 148–149
concrete, early version invented by Romans, 6
concrete washout stations
defined, 360
environmental protections in construction operations, 212
conflict resolution, 176
constructability reviews
defined, 50, 360
in design review process, 29
using BIM for, 334
construction by owner section, of general conditions document, 102
construction contract. See contracts
Construction: Craft to Industry (Sebestyén), 9
construction details, coordinating
information flow and, 183–184
overview of, 180

codes, building. See building codes
cofferdams
defined, 360
techniques in commercial building, 14
collaboration, in construction industry, 31–32
Collaborative Process Institute (CPI), 42
commercial building, 13–15
characteristics of, 15
means and methods in, 14
overview of, 13
primary materials in, 14
commissioning
defined, 360
in project closeout, 134
communication
as key to relationships, 198
of schedules, 255–256
company image and publicity, 234–235
competition
changes in competitive environment, 71
in finding work, 75
competitive bidding process, 75–76
best-value selection, 85–88
low-bid as selection criteria. See low-bid selection
defined, 50, 360
price and qualifications as competition criteria, 76–77
in project design stage, 120
qualifications-based selection, 88–89
selection methods used by owners, 77–78, 79
compliances issues, in project design stage, 120
computer-aided drafting (CAD)
BIM model extending, 331
electronic management of drawings with, 96
overview of, 330–331
computers, impact of technology on construction, 9
conceptual estimates, 148–149
concrete, early version invented by Romans, 6
concrete washout stations
defined, 360
environmental protections in construction operations, 212
conflict resolution, 176
constructability reviews
defined, 50, 360
in design review process, 29
using BIM for, 334
construction by owner section, of general conditions document, 102
construction contract. See contracts
Construction: Craft to Industry (Sebestyén), 9
construction details, coordinating
information flow and, 183–184
overview of, 180
construction details (continued)
request for information (RFI), 181
shop drawings, 182–183
submittals, 182
Construction Exchange, 32
construction field software, 236
Construction Futures campaign, of AGC, 28
construction industry
acronyms used in, 341
architects in, 22–23
building trades, 25–26
career opportunities, 33–34
collaboration in, 31–32
commercial building, 13–15
construction professionals (constructors), 24–25
contractors and managers, 25
contribution to society, 3
design professionals in, 21–22
diversity in, 31
educational offerings, 34
efficiency of, 31
engineers in, 23–24
environmental construction, 17–19
globalization and, 30
heavy civil construction, 15–16
history of, 4–9
impact of technology on, 9
industrial construction, 16–17
industry image, 27–28
interior designers, 24
landscape architects in, 24
making a difference, 32–33
overview of, 1
owners in, 20–21
primary players in, 20
professional accreditation and certification, 34–37
residential building, 11–13
review answers, 343–344
review questions, 37–38
scope of, 2–3
secondary players in, 26, 26–27
sectors of, 9–10, 10
statistics regarding size of, 4
sustainability and, 30–31
technology and, 29
transitions in, 28–29
Construction Industry Institute (CII), 289
construction-intent models, 333
Construction Management Association of America (CMAA)
accreditation and certification and, 35
on agency CM, 48
construction management (CM)
agency CM project delivery, 48–49, 49
aptitude test, 64–66
assessing project risks, 58–59, 58–59
at-risk CM project delivery, 49, 49–50
BIM for, 332–333
career track for construction managers, 61, 61
collection management delivery method, 48
construction projects and, 41
contract administration, 56–57
defined, 360
design-bid-build project delivery method, 47–48, 48
design-build project delivery method, 50–51, 50–52
estimating, 56
factors impacting costs in estimating, 148
functions of construction managers, 55–56
integrated project delivery, 52–53
job descriptions, 61–64
job site and construction operations, 57
managing project quality, 57–58
managing project safety, 58
monitoring project performance, 57
overview of, 39–40
owners and, 44–45
planning and scheduling, 57
problem solving and decision making, 59
project delivery methods, 46–47
project values, 42, 42–43
reports documenting project performance, 279–280, 280
review answers, 344–345
review questions, 67
scope of work, 45
selecting project delivery method, 55
trends in project delivery, 53–55, 54
construction management delivery method
agency CM project delivery, 48–49, 49
at-risk CM project delivery, 49, 49–50
overview of, 48
construction managers
assessing project risks, 58–59
career track for, 61
contract administration, 56–57
estimating, 56
functions of, 25, 55–56
general requirements for, 59–60
job site and construction operations, 57
managing project quality, 57–58
managing project safety, 58
monitoring project performance, 57
planning and scheduling, 57
problem solving and decision making, 59
Construction Materials Recycling Association (CMRA), 216
construction models. See also building information modeling (BIM)
defined, 333, 360
types of, 95–96
construction operations, 130–131
beginning in best-value selection process, 88
beginning in low-bid selection process, 84
building the project, 202
cleanup and trash removal, 215–216
company image and publicity, 234–235
coordination meetings, 203
coordination with local agents, 206
correspondence, 230–231
daily field reports, 228
diaries, 228
documenting, 226
dust and mud control, 210–212
employee parking, 223
employee relations, 232–233
environmental protections, 212–215
field offices, 218–219
job site safety, 206–207
job site security, 222–223
labor records, 229, 229
list of, 131
locating cranes and other facilities, 224
logs, 227
managing impacts of, 208–209
material and equipment deliveries, 204
material storage and handling, 221–222
noise control, 209
organizing job site, 220–221, 221
overview of, 130, 201
owner relations, 231–232
pedestrian safety, 224
portable facilities, 219–220
productivity in, 204–205
project meetings, 226–227
public relations, 231
quality control, 208
recycling, 216–217
review answers, 350–352
review questions, 236–237
site access, 223
subcontractor coordination, 202–203
subcontractor relations, 233
superintendent function, 217–218, 218
technology applied to, 235–236
temporary utilities, 219
traffic control, 223–224
using BIM for, 336
visual records, 229–230
Webcams records, 230
work hours, 224–225
construction operations management, 57
construction professionals (constructors), 24–25
construction risks, identifying, 314–316
Construction Specification Institute (CSI)
MasterFormat 2004. See CSI MasterFormat 2004
numbering system of, 104–105
overview of, 104–105
construction stages, 128–131
construction operations, 130–131
mobilization process, 129
overview of, 128–129
staging and layout plans, 130
contacts list, as tool in contract administration, 178–179
contingencies
defined, 360
for risk factors, 311
continual improvement, objectives of quality management plan, 288–289
contract administration (CA)
application for payment, 187–190, 189
carrot and stick techniques for influencing contractor performance, 191
change management, 193
change orders, 193–195, 194
changes in scope, 195
construction manager functions, 56–57
contacts list and responsibility matrix as tools in, 178–179
coordinating construction details, 180
disagreements and problems and, 196–197
dispute resolution, 197–198
final payments, 190–191
function of, 175–176
getting paid in timely manner, 184–186, 185
information flow and, 183
information flow and approval chain, 183–184
liquidated damages, 192
overview of, 173
partnering as team building technique, 176–177
pay request continuation sheets, 187–188, 188
preconstruction conference, 174–175
project incentives, 192–193
relationships and, 198–199
request for information (RFI), 180–182, 181
review answers, 349–350
review questions, 200
contract administration (CA) (continued)
schedule issues, 191
schedule of values in payment process, 186–187
setting tone for project, 176
shop drawings, 182–183
submittals, 182
technology applied to, 199–200
time extensions, 195–196
contract administrator, assigning project team, 123
contract documents (CDs)
bidding documents, 100–101
drawings, 94–95
general conditions, 101–103
organization of drawings in, 96–97
overview of, 94, 94
producing drawings, 94–95
in project design stage, 119–120
project manual, 100
size of drawings, 95–96
supplemental conditions, 103
technical specifications, 103–104
types of drawings in, 98–99
contract indemnification
defined, 360
risk mitigation strategies, 323
contractors
carrot and stick techniques for influencing performance, 191
change orders initiated by, 194
consequences of errors/omissions in estimates, 140
liquidated damages and. See liquidated damages partnership with designers in design-build approach, 51
quality expectations and, 287–288
responsibilities, in general conditions document, 101
time extensions requested by, 195–196
contracts
awarding for best-value selection, 87
awarding for low-bid selection, 82–83
bidding documents, 100–101
cost-plus-fee contracts, 112–113, 113
CSI and. See Construction Specification Institute (CSI) documents. See contract documents (CDs)
drawings in, 94–95
general conditions, 101–103
Guaranteed maximum price (GMP) contracts, 113, 113–114
lump-sum contracts, 111–112, 112
organization of drawings in, 96–97
overview of, 93
producing drawings, 95
project manual, 100
review answers, 346–347
review questions, 115
size of drawings in, 95–96
supplemental conditions, 103
technical specifications, 103–104
types of, 111
types of drawings in, 98–99
unit-price contracts, 114–115, 114–115
warranty periods in, 135–136
coordination meetings, 203
correspondence, documenting construction operations, 230–231
cost codes
defined, 267, 360
spot checking, 268
cost controls
defined, 266, 360
overview of, 267–268
cost overruns
change orders and, 270
corrective actions for, 271
labor risks and, 272–273
quantity errors as cause of, 272
subcontractors as cause of, 271–272
who is to blame, 140
cost-plus-fee contracts
overview of, 112–113, 113
time and materials in, 364
costs
analyzing discrepancies between actual and estimated costs, 268–270
cost controls, 267–268
labor risks to overruns, 272–273
monitoring project performance and, 57
project values and, 42
in time, cost, and quality triad, 41
tracking, 266–267
costs, estimating
5D cost estimating with BIM, 335
direct costs, 150
factors impacting, 143
indirect costs, 150–151
management, 148
market conditions, 147–148
project complexity, 144–145
project size, 143
quality of work, 146–147
site location, 146
time of construction, 146–147
CPI (Collaborative Process Institute), 42
CPM (critical path method). See critical path method (CPM)
craft guilds, in Middle Ages, 6
craftsmen
  in ancient Greece, 5
  quality expectations and, 287–288
cranes, locating at job sites, 224
crashing the schedule
  corrective actions for delays, 274
  defined, 360
crew. See work crew
critical path
  changing during duration of project, 255
  defined, 251, 360
critical path method (CPM). See also network diagrams
  network diagrams and, 362
  overview of, 242
CSI (Construction Specification Institute).
  See Construction Specification Institute (CSI)
CSI MasterFormat 2004
  building estimates by working through divisions of, 154
  facility construction subgroup, 106–107
  facility services subgroup, 107–108
  general requirements subgroup, 106
  numbering system of, 109–111
  overview of, 105
  process equipment subgroup, 109
  site and infrastructure subgroup, 108
cultural artifacts, environmental protections for, 215
curtain walls
  in commercial building, 14
  defined, 360
custom builders, residential, 11
cut sheets, 292

D
daily field reports, documenting construction operations, 228
dangers, in construction business, 300–301
DBIA (The Design-Build Institute of America), 36
debriefing meetings, evaluating project performance, 280–281
decision making, by construction managers, 59
defective materials, factors impacting project performance, 263–264
deliveries
  late delivery as factor impacting project performance, 264
  logging, 227
  of material and equipment to job site, 204
Deming, Edward, 288
design architects, 22–23
design assistance, using BIM for, 334
design-bid-build project delivery method
  competition criteria and, 76–77
  in construction management, 48
  defined, 360
  overview of, 47–48
design-build project delivery method
  competition criteria and, 76–77
  in construction management, 50–51
  defined, 360
  overview of, 50–52
design development (DD), 119
design-intent models, 333, 360
design professionals (designers)
  architects, 22–23
  engineers, 23–24
  functions as primary player in construction, 21–22
  interior designers, 24
  landscape architects, 24
  partnership with contractors in design-build approach, 51
design risks
  latent design defects, 314
  risk identification, 313–314
design stage, 118
  beginning in best-value selection process, 88
  BIM for, 330–331
  code and compliances issues in, 120
  competitive bidding process in, 120
  overview of, 118–120
design visualization, using BIM for, 333–334
detailed drawings, 98–99, 99
detailed estimates, 149, 149
detailed schedules, 243
diaries, documenting construction operations, 228
digitizers
  for automating takeoff, 171
  defined, 361
direct costs, in estimating, 150
direct selection. See qualifications-based selection (QBS)
Disabled Veteran Business Enterprise (DVBE), 316
disagreements and problems
  dispute resolution, 197–198
  overview of, 196–197
  relationships and, 198–199
  dispute resolution, 197–198
distributed repository approach
  defined, 361
  to implementing BIM, 337, 337
diversity, transitions in construction industry, 31
documenting construction activity
  correspondence, 230–231
daily field reports, 228
diaries, 228
  labor records, 229
logs, 227
overview of, 226
project meetings, 226–227
visual records, 229–230
Webcams records, 230
documenting project performance
  management reports, 279–280
overview of, 279
documents, contract. See contract documents (CDs)
doing it right the first time, objectives of quality
  management plan, 286–287
drawings, in contracts
  organization of, 96–97
overview of, 94–95
producing, 95
size of, 95–96
types of, 98–99
drug policies, 232–233
drug testing, 305–306
drugs, safety management an, 305
dry shacks
  defined, 361
  setting up portable facilities at job site, 219
due diligence
  getting burned by bad information, 126
in pre-construction stage, 124–125
dust and mud control, in construction operations, 210–212
DVBE (Disabled Veteran Business Enterprise), 316

e
early finish (EF), in calculating schedules, 251–254
early start (ES), in calculating schedules, 251–254
earned value analysis
  for assessing project status, 278–279
defined, 361
economics
  economies of scale, 143
  of quality and safety, 307
education. See also training programs
  offerings, 34
  systems developed in 20th Century, 8–9
efficiency, transitions in construction industry, 31
Egypt, 5
electrical drawings, in contract, 97
electrical engineers, 23
elevation drawings, 98, 99
employees
  employee relations in construction operations, 232–233
  managing employee parking at job site, 223
  quality assurance incentives, 291
endangered species, environmental protections for, 213–214
engineers
  electrical, 23
  field, 61–62, 123–124
  mechanical and structural, 23
overview of, 23–24
project, 62
environmental construction, 17–19
  characteristics of, 19
  costs of recycling, 151
  environmental protections, 212–215
  identifying risks to environment, 318–320
  means and methods in, 18
overview of, 17–18
  primary materials in, 18–19
Environmental Protection Agency (EPA)
  environmental construction and, 19
  keys in erosion and sediment control, 213
EPA (Environmental Protection Agency)
  environmental construction and, 19
  keys in erosion and sediment control, 213
equipment
  deliveries to job sites, 204
  inadequate equipment as factor impacting project
  performance, 264
for personal protection, 303
quantifying in estimating process, 158–159
erosion control
  keys in erosion and sediment control, 213
SWPPP and, 364
escalation clause
  defined, 361
  price escalation causing cost overrun, 271
estimating
  5D cost estimating with BIM, 335
  analyzing bids, 163–164
  building estimates, 154, 154
  calculating quantities in, 156–157
  characteristics of good estimators, 142–143
  characteristics of high-quality estimates, 169
  choosing bids, 164
conceptual estimates, 148–149
construction manager functions, 56
estimators – forecasts

detailed estimates, 149
direct costs, 150
factors impacting costs, 143
general overhead in, 168
getting started, 151
indirect costs, 150–151
management factors affecting, 148
market conditions affecting, 147–148
obtaining subcontractor and vendor bids, 161–162
organizing work needed for, 154–155
overview of, 139
prebid meeting, 152
preliminary estimates, 149
preparing estimate for low-bid selection, 80
pricing the work, 160, 160–161
profit in, 168
project complexity in, 144, 144–145
project size in, 143
putting it all together, 166–167
quality of work in, 146–147
quantifying general conditions, 159–160
quantifying labor and equipment, 158–159
quantifying materials, 157–158, 158
receiving bids, 163
review answers, 348–349
review questions, 172
reviewing plans and specs, 152
site location in, 146
site visit, 153, 153–154
skills in competitive bidding, 91
soliciting bids, 162–163
taxes in, 167–168
technology applied to, 169–171
time of construction in, 146–147
types of estimates, 149
what an estimate is, 141–142
winning and losing in game of, 171–172
work breakdown structure (WBS), 155–156
estimators
characteristics of good, 142–143
job description for, 63
query list, 152
responsibility of, 140
exterior finishes, in residential building, 12

F

facilities
locating at job sites, 224
project complexity and, 144
setting up portable facilities at job site, 219–220
facility construction subgroup, CSI MasterFormat 2004, 106–107
facility services subgroup, CSI MasterFormat 2004, 107–108
fair value estimating, 156
fast tracking, 50, 361
feasibility, programming and, 119
feedback loop, for project control, 261–262
field engineers
assigning project team, 123–124
job description for, 61–62
field observation reports (FOR)
declared, 361
monitoring safety of job conditions and work practices, 300
quality control (QC) and, 299
field offices
overview of, 218–219
portable facilities, 219–220
temporary utilities for, 219
fieldwork, using BIM for, 336
final documentation, of project closeout phase, 135
final payments, 190–191
financing, in commercial building, 13
financing risks, identifying, 317–318
finding work
best-value selection, 85–88
competition in, 75
competitive bidding process, 75–76
estimating skills and, 91
low-bid as selection criteria. See low-bid selection
making bid/no bid decision, 89–91
marketing, 70–71
overview of, 69–70
price and qualifications as competition criteria, 76–77
private projects, 72
public-private partnerships, 72–73
public projects, 71–72
qualifications-based selection, 88–89
review answers, 345–346
review questions, 92
selection methods used by owners, 77–78
sources of information, 73–75
float (F)
calculating, 253–254
declared, 251, 361
in scheduling, 251–252
FOR (field observation reports). See field observation reports (FOR)
forecasts
declared, 361
management reports documenting project performance, 279
forward pass
  in calculating schedules, 253–254
  defined, 361
framing, in commercial building, 14
full-service design-build firms, 52
function, project values, 43
funding, in commercial building, 13

G
Gantt charts
  advantages/disadvantages of, 241–242
  defined, 240, 361
  for scheduling, 241
  when to use, 241
Gehry, Frank, 2
general conditions
  indirect costs, 150
  in project manual, 101–103
  quantifying in estimating process, 159–160
general contractors, 25
general overhead, in estimating, 168
general provisions, in general conditions document, 101
general requirements, for construction managers, 59–60
general requirements subgroup,
  CSI MasterFormat 2004, 106
GFE (good faith effort), for awarding contracts to
disabled veterans, 316
glass cladding, in commercial building, 14
global positioning systems (GPS), 9
globalization, transitions in construction industry, 30
GMP (guaranteed maximum price) contracts, 113, 113–114, 361
good faith effort (GFE), for awarding contracts to
disabled veterans, 316
Gothic Cathedrals, 6
GPS (global positioning systems), 9
Greece, 5
Green Building Council Rating System, by LEED, 30
  guaranteed maximum price (GMP) contracts, 113, 113–114, 361

H
hazard mitigation plan, 304, 304
hazard prevention and control, 302
health training, 302
heavy civil construction, 15–16
hiring practices, quality assurance (QA) and, 290
historical artifacts, environmental protections for, 215
history of construction industry, 4–9
Home Builders Care campaign, of NAHB, 28
horizontal construction. See heavy civil construction

I
impact potential, quantifying risk, 320
incentives
  quality assurance (QA) and, 291
  techniques for influencing contractor performance, 192–193
independent testing and inspections, quality control (QC)and, 295
indirect costs, in estimating, 150–151
industrial construction, 16–17
Industrial Revolution, 7
information flow, for RFIs, submittals, and shop
drawings, 183, 183–184
information sources, for finding work, 73–75
infrastructure, 8, 361
inspection reports, final documentation in project
closeout, 135
inspections
  building code inspections and, 295–296
  independent testing and inspections and, 295
  permitting and inspection process in pre-construction
  stage, 126–127
  preparatory inspections, 287, 298
  supervisory inspections, 296–298
instructor to bidders, in bidding documents, 100
insurance bonds section, of general conditions
document, 102
integrated project delivery (IPD)
  at-risk CM. See at-risk CM project delivery
  defined, 361
  design-build. See design-build project delivery method
  overview of, 52–53
interior designers, 24
interior partitions, in commercial building, 14
Internet, collaboration facilitated by, 31–32
interoperability
  BIM and, 337
  defined, 361
invitation for bids (IVBs)
  defined, 361
  low-bid as selection approach and, 77
  private projects and, 72
  as selection instrument, 78
IPD (integrated project delivery). See integrated project delivery (IPD)
IVBs (invitation for bids). See invitation for bids (IVBs)

J
job descriptions, in construction management, 61–64
job overhead, quantifying, 159–160
job site management. See also construction operations
access, 223
accident prevention, 303
construction manager functions, 57
employee parking, 223
locating cranes and other facilities, 224
material storage and handling, 221–222
overview of, 220–221
pedestrian safety, 224
safety, 206–207, 302
security, 222–223
traffic control, 223–224
using BIM for, 334
job sites
due diligence investigation in pre-construction stage, 124–126
estimators visiting, 153
layout plans for creating staging strategy, 130
location impacting costs in estimating, 146
overcrowding as factor impacting project performance, 263
visiting in estimating process, 153, 153–154
job-specific overhead, 150
joint ventures
defined, 362
in design-build approach, 52
sharing resources and spreading risks, 313

L
labor
documenting construction operations and, 229, 229
quantifying in estimating process, 158–159
site location impacting cost of, 146
labor and material payment bond (payment bond),
required of contractors, 71–72
labor burden (payroll taxes), 167
landscape architects, 24
late finish (LF), in calculating schedules, 251–254
late start (LS), in calculating schedules, 251–254
latent design defects, 314, 362
laydown areas
defined, 362
for material storage and handling, 221
layout of materials
staging strategy for, 130
using BIM for, 336
LCI (Lean Construction Institute), 31, 37
lead estimators, 63
lead time
defined, 145, 362
flagging items with long lead time, 145
Leadership on Energy and Environmental Design (LEED), 13, 30–31
Lean Construction Institute (LCI), 31, 37
lean principles
defined, 362
efficiency and, 31
LEED (Leadership on Energy and Environmental Design), 13, 30–31
legal risks, identifying, 316–317
light framing, in residential building, 12
liquidated damages
clause in project manual, 152
defined, 145, 362
techniques for influencing contractor performance, 192
local agents, coordination with, 206
logs, documenting construction operations and, 227
long-lead-time items, 362
look-ahead schedules, 243, 364
low-bid selection, 79
awarding contract, 82–83
beginning construction, 84
comparing selection methods, 78
notice to proceed, 83–84
obtaining plans and specs, 79–80
opening bids and announcing winner, 82
overview of, 78
preparing estimate, 80
reviewing plans and specs, 80
tabulating and submitting bid, 81
lump-sum contracts, 111–112, 112

M
maintenance, using BIM for, 336
management
change. See change management
construction management. See construction management (CM)
job site. See job site management
management (continued)
project risk. See project risk management
quality. See quality management plan
safety. See safety management plan
market conditions, factors impacting costs in estimating, 147–148
marketing, finding work and, 70–71
master builder, in history of construction, 5
material safety data sheets (MSDS), 306, 362
materials
defective materials as factor impacting project
performance, 263–264
deliveries, 204
price escalation causing cost overrun, 271
quantifying in estimating process, 157–158
storage and handling, 221–222
uniqueness influencing project complexity, 145
using BIM for layout of, 336
mathematical functions, in calculating quantities, 156
McGraw-Hill Dodge Reports, 73
mechanical drawings, 97
mechanical engineers, 23
mediation, 197, 235
Middle Ages, 6
mini-schedules, 243
minitrial, dispute resolution via, 197–198
mitigating risks, 321
mobilization process, in construction stage, 129
mock-ups
of construction details, 182
defined, 362
quality control (QC) and, 293
monitoring project performance, 268–270
analyzing delays in schedules, 274
analyzing discrepancies between actual and estimated
costs, 268–270
assessing overall project status, 278–279
construction manager functions, 57
corrective actions for schedule delays, 274–277
cost controls, 267–268
documenting project performance, 279
evaluating project performance, 280–281
factors impacting performance, 262–264
feedback loop, 261–262
labor risks to cost overruns, 272–273
management reports, 279–280, 280
overview of, 259
project control cycle, 260–261, 261
review answers, 353–354
review questions, 282
schedule controls, 273–274
technology applied to, 281–282
tracking cost, 266–267
tracking quality, 266
tracking time, 273
tracking tools, 265
MSDS (material safety data sheets), 306, 362
mud control, in construction operations, 210–212
multi-family dwellings, 11
multiple prime contracts, 49, 362

N
National Association of Home Builders (NAHB)
accreditation and certification and, 36
Home Builders Care campaign, 28
National Association of Minority Contractors (NAMC), 36
National Association of Women in Construction (NAWIC), 35–36
National Building Code, 296
network diagrams
critical path in, 251
defined, 240, 362
developing precedence diagram, 248–249
for scheduling, 242–243
techniques in, 242
used in sequencing stage of scheduling process, 248
when to use, 241
network logic. See also sequencing stage, in scheduling
defined, 248, 362
post-it notes for working out, 250
noise control, in construction operations, 209
nonresidential construction, 54
notice to proceed
in best-value selection process, 88
defined, 362
in low-bid selection process, 79, 83–84
numbering system, CSI, 109–111

O
Occupational Safety and Health Administration (OSHA)
on components of safety management plan, 302
defined, 362
material safety data sheets (MSDS), 306
safety standards of, 300–301
office engineers, 62
online publications, sources of information for finding
work, 73
Onuma, Kimon, 332
Onuma Planning System (OPS), 332
open bid
defined, 362
process for public projects, 71
operation manuals, final documentation in project
closeout, 135
operations, construction. See construction operations
OPS (Onuma Planning System), 332
Otis, E.G., 7
overhead
general, 168
job-specific, 150
quantifying, 159–160
overtime, 275
owner occupancy, as end stage of construction projects, 135
owners
collection management and, 44–45
defined, 44
as primary player in construction, 20–21
quality expectations and, 287–288
relations with, 231–232
responsibilities, in general conditions document, 101

P
partnering
defined, 362
as team building technique, 176–177
pay request continuation sheets, 187–188, 188
payment
application for, 187–190, 189
final, 190–191
overview of, 184–186, 185
pay request continuation sheets, 187–188, 188
schedule of values in, 186–187, 187
payments and completion section, of general conditions
document, 102
payroll taxes, 167
pedestrian safety, at job site, 224
performance bond, required of contractors, 71–72
performance monitoring. See monitoring project
performance
permits
coordination with local agents, 206
permitting and inspection process in pre-construction
stage, 126–127
personal protections
in safety management plan, 302–303
section outlining in general conditions document, 102
perspective drawing
defined, 362
organization of drawings in contracts, 96
Peters, Tom, 288
phone logs, tracking day to day activities at job sites, 227
planning and scheduling
administrative activities, 247–248, 248
calculations in, 251–255, 252, 254
communicating and updating, 255–256
construction manager functions, 57
determining activity durations, 250–251
flow based on relationships between activities, 249,
249–250
Gantt charts for, 241, 241
network (precedence) diagrams for, 242, 242–243
notifying subcontractors of schedules, 256–257
overview of, 239
planning stage, 244–245
precedence diagrams used in sequencing stage, 248,
248–249
review answers, 352–353
review questions, 258
schedule issues in contract administration, 191
scheduling stage, 250
sequencing stage, 248–250
steps in building schedules, 244
subcontractor coordination and, 203
technology applied to, 257
time is money, 240
types of, 240–241
types of activities in, 247–248
uses of schedules, 243–244
using BIM for, 334–335
work breakdown structure (WBS) used in, 245–246, 246
planning stage, in scheduling
overview of, 244–245
types of activities in, 247–248
work breakdown structure (WBS) used in, 245–246
plans
obtaining for low-bid selection, 79–80
quality management. See quality management plan
reviewing for low-bid selection, 80
safety management. See safety management plan
types of drawings, 98, 99
PM (project manager)
assigning project team, 122–123
job descriptions, 62–63
PMI (Project Management Institute), 36–37
political risks, identifying, 316–317
Pollio, Marcus Vitruvius, 6
portable facilities, setting up at job site, 219–220
post-construction stage, 132–135
  overview of, 132
  project closeout, 132–135
  project evaluation, 136
post-it notes, 250
PPP (public-private partnerships)
  bidding process for, 72–73
  defined, 363
pre-construction stage, 121–127
  assigning project team, 121–124, 122
  due diligence in, 124–125
  overview of, 121
  permitting and inspection process in, 126–127
  value engineering in, 125
prebid meetings, in estimating process, 152
prebid risks, identifying, 311–313
precedence diagrams. See also network diagrams
  defined, 242, 363
  developing, 248–249
preconstruction conference
  overview of, 174–175
  setting project tone at, 176
prefabrication, using BIM for, 336
preinspection. See preparatory inspections
preliminary estimates, 149
preparatory inspections
  defined, 363
  overview of, 287
  quality control (QC) and, 298
prequalification
  defined, 363
  public projects and, 72
price/pricing
  applying unit costs to quantities in estimating, 160, 160
  as competition criteria, 76–77
  differences based on quality, 286
  price escalation causing cost overrun, 271
  site location impacting, 146
  sources of information for, 161
price proposals
  in best-value selection process, 86
  defined, 363
primary players, in construction industry
  architects, 22–23
  building trades, 25–26
  construction professionals (constructors), 24–25
  contractors and managers, 25
  design professionals, 21–22
  engineers, 23–24
  interior designers, 24
landscape architects, 24
  overview of, 20
owners, 20–21
prime contractor. See general contractors
private projects, bidding process for, 72
probability index, in quantifying risk, 320
problem prevention, objectives of quality management plan, 287
problem solving, functions of construction managers, 59
process equipment subgroup, CSI MasterFormat 2004, 109
procurement
  of construction services, 75
  quality assurance (QA) and, 291
  types of activities in schedules, 247–248
procurement stage, 127–128
  overview of, 127
  purchase orders, 128
  subcontracting, 127–128
production activities, scheduling, 247
production builders, 11
productivity, in construction operations, 204–205
professional accreditation and certification, 34–37
profit, in estimating, 168
programming, in project design stage, 119
programs
  defined, 359, 363
  owners role in developing, 20
project closeout, 132–135
  final documentation, 135
  overview of, 132
  project punchout, 133
  substantial completion, 134
project complexity
  in estimating, 144
  factors impacting costs in estimating, 144–145
project control cycle
  feedback loop for, 261–262
  overview of, 260–261, 261
project delivery
  agency CM project delivery, 48–49
  at-risk CM project delivery, 49–50
  in commercial building, 15
  defined, 363
design-bid-build project delivery method, 47–48
design-build project delivery method, 50–52
integrated project delivery, 52–53
methods, 78–79, 79
  overview of, 46–47
selecting project delivery method, 55
trends in project delivery, 53–55
project engineer, 62
project evaluation, in post-construction stage, 136
project incentives, techniques for influencing contractor performance, 192–193
Project Management Institute (PMI), 36–37
project manager (PM)
assigning project team, 122–123
job descriptions, 62–63
project manual
bidding documents, 100–101
general conditions, 101–103
liquidated damages clause, 152
overview of, 100
supplemental conditions, 103
technical specifications, 103–104
project meetings, documenting construction operations and, 226–227
project punchout
for punch list, 133
warranty compared with, 136
project risk management
construction risks, 314–316
design risks, 313–314
environmental risks, 318–320
financing risks, 317–318
mitigating risks, 321
overview of, 309
political/legal/regulatory risks, 316–317
prebid risks, 311–313
quantifying risks, 320–321, 321
review answers, 355–356
review questions, 327
risk analysis, 324–325
risk assessment, 58–59
risk identification, 310
risk management team, 326
risk mitigation plan, 324–326
risk mitigation strategies, 322, 322–324
systematic approach to, 310
project stages
construction stage, 128–131
design stage, 118–120
measuring project success, 137
overview of, 117–118
owner occupancy, 135
post-construction stage, 132–135
pre-construction stage, 121–127
procurement stage, 127–128
review answers, 347–348
review questions, 138
warranty periods and, 135–136
project superintendent, 62
project team, 121–124
project values, 42, 42–43
projects
delivery in. See project delivery
monitoring performance of. See monitoring project performance
overview of, 41
planning and scheduling. See planning and scheduling project values, 42, 42–43
quality management, 57–58
risk assessment, 58–59, 58–59
safety management, 58
setting tone for, 176
size impacting costs in estimating, 143
staging, 220
protection of persons and property section, of general conditions document, 102
public-private partnerships (PPP)
bidding process for, 72–73
defined, 363
public projects, bidding process for, 71–72
public relations
construction operations and, 231
employee relations, 232–233
overview of, 231
owner relations, 231–232
subcontractor relations, 233
publicity, 234–235
punch list
defined, 363
for project punchout, 133, 133
purchase orders, issuing in procurement stage, 128
pyramids, in ancient Egypt, 5

Q
QBS (qualifications-based selection), 78, 88–89
qualifications, as competition criteria, 76–77
qualifications-based selection (QBS), 78, 88–89
quality
construction managers responsible for, 57–58
continual improvement, 288–289
defining quality, 285–286
doing it right the first time, 286–287
economics of, 307
extra efforts in, 298–299
factors in achieving, 284
mandated controls, 292–298
objectives of, 286
quality (continued)
overview of, 283
preventing problems, 287
project values, 43
quality assurance (QA), 289–291
quality control (QC), 292
quality management plan, 284–285
review answers, 354–355
review questions, 308
safety as component of, 299–300
of supervision, 263
in time, cost, and quality triad, 41
tracking, 266
work quality impacting costs in estimating, 146–147
of workforce, 262–263
quality assurance (QA), 289–291
defined, 363
overview of, 289
practices in, 290–291
quality control (QC), 292–298
in construction operations, 208
defined, 363
extra efforts, 298–299
mandated controls, 292–298
overview of, 292
quality management plan
continual improvement, 288–289
defining quality, 285–286
doing it right the first time, 286–287
objectives, 286
overview of, 284–285
preventing problems, 287
quantifying materials, 158
quantifying risks, 320–321, 321
quantity errors, cost overruns due to, 272
quantity surveyors
calculating quantities in estimates, 156
defined, 363
job description for, 62
query list
defined, 363
questions compiled by estimators, 152

R
R. S. Means, 146
racial harassment, 232–233
RCM (reinforced concrete masonry), 14
record drawings, final documentation in project
closeout, 135
record keeping. See documenting construction activity
recycling
in construction operations, 216–217
estimating cost of, 151
Reed Construction Data, 73
regulatory risks, identifying, 316–317
reinforced concrete masonry (RCM), 14
relationships, dispute resolution and, 198–199
Renaissance, 6–7
request for information (RFI)
BIM reducing, 335
defined, 363
overview of, 180–182, 181
RFI logs, 227
request for qualifications (RFQs)
defined, 363
as selection instrument, 78
requests for proposals (RFPs)
defined, 363
overview of, 77
releasing, 86
as selection instrument, 78
residential building, 11–13
characteristics of, 12–13
means and methods in, 11–12
overview of, 11
primary materials in, 12
responsibility matrix, as tool in contract administration,
178–179
responsive bid
defined, 363
in low-bid selection process, 78–79
retainage, 189–190, 363
reviewing plans and specs, in estimating process, 152
rework, 286, 363
RFI (request for information). See request for information
(RFI)
RFPs (requests for proposals). See requests for proposals
(RFPs)
RFQs (request for qualifications)
defined, 77, 363
releasing, 85
as selection instrument, 78
risk abatement, 323
risk allocation, 323
risk analysis, 324–325
risk assessment, 58–59, 58–59
risk avoidance, 322–323
risk identification
construction risks, 314–316
design risks, 313–314
environmental risks, 318–320
financing risks, 317–318
overview of, 310
political/legal/regulatory risks, 316–317
prebid risks, 311–313
risk management. See project risk management
risk management team, 326
risk mitigation plan, 324–326
risk mitigation strategies, 322, 322–324
risk retention, 322
risk transfer, 323
ROM (rough order of magnitude) estimates, 148
Roman Empire, 6
roofing materials, 14
rough order of magnitude (ROM) estimates, 148

S

safety
accident prevention, 303–304
as component of quality, 299–300
construction managers responsible for, 58
dangers of construction business, 300–301
developing safety management plan, 301–302
economics of, 307
hazardous materials, 306
at job site, 206–207
pedestrian safety at job sites, 224
personal protections, 302–303
project values, 43
review answers, 354–355
review questions, 308
role of safety manager, 300
substance abuse and, 305–306
tailgate safety meetings, 304–305
training, 302
safety management plan
accident prevention, 303–304
overview of, 301–302
personal protections, 302–303
substance abuse, 305–306
tailgate safety meetings, 304–305
safety manager, 300
safety manuals, 301. See also safety management plan
schedule of values
defined, 363
payment and, 186–187, 187
schedules. See also planning and scheduling
4D scheduling and sequencing with BIM, 334–335
activities as fundamental building block of, 244–245
activities in, 247–248
analyzing delays in, 274
calculations in, 251–255
controls, 273–274
corrective actions for delays, 274–277
notifying subcontractors regarding, 256–257
schedule issues in contract administration, 191
steps in building, 244
technology for, 257
types of, 243
will-calls impacting, 205
work breakdown structure (WBS) for, 245–246
scheduling stage
calculations in, 251–255
determining activity durations, 250–251
overview of, 250
schematic design, in project design stage, 119
scope of work
changes in project scope, 195
defined, 364
defining, 45
owners role in setting, 44
scope, project values, 43
scope sheet
bid analysis and, 165
defined, 364
Sebestyén, Gyula, 9
secondary players, in construction industry, 26, 26–27
section drawings, 98, 99
sectors, of construction industry, 10
commercial building, 13–15
environmental construction, 17–19
heavy civil construction, 15–16
industrial construction, 16–17
overview of, 9–10
residential building, 11–13
security, job site, 222–223
self-performed work
defined, 364
vs. subcontracted work, 25
senior estimators, 63
sequencing stage, in scheduling
developing precedence diagram, 248–249
factors impacting project performance, 263
flow based on relationships between activities, 249–250
overview of, 248–250
sexual harassment, 232–233
shop drawings
defined, 364
overview of, 182–183
quality control (QC) and, 293
short-interval schedules, 243, 364
shortlisting
  in best-value selection process, 85–86
defined, 364
signage, at job site, 234
single-family dwelling, 11
single-source project delivery. See design-build project
delivery method
site and infrastructure subgroup,
  CSI MasterFormat 2004, 108
site logistics plan, 220, 364
sites. See job sites
skyscrapers, 7–8
slip forms
  defined, 364
techniques in commercial building, 14
small-volume builders, 11
software
  for construction operations, 236
  for contract administration, 199
  for estimating, 169–170
  for scheduling, 255, 257
soil tests and engineering, in pre-construction stage, 125
special-purpose schedules, 243
specialty contractors (subcontractors), 25
specification writers, 23
specifications
  defined, 8, 364
  obtaining for low-bid selection, 79–80
  quality expectations in, 287–288
  reviewing for low-bid selection, 80
staging strategy, in construction stage, 130
Standard Building Code, 296
standards
  safety standards, 300–301
  testing standards, 293–294, 294
steel, 7
stereoscopic projection
  defined, 364
  generating virtual environments, 333–334
Stone Age, 4
storage and handling, of materials at job site, 221–222
storm water pollution, 212–213
storm water pollution prevention plans (SWPPP),
  212–213, 364
straw wattles
  defined, 364
  environmental protections in construction operations, 213
structural drawings, 97
structural engineers, 23
subcontractor bids, in estimating process
  analyzing, 163–164
  choosing, 164
overview of, 161–162
receiving, 163
soliciting, 162–163
subcontractors
  bids vs. contractual agreements, 165
  coordination meetings with, 203
  coordination of, 202–203
  cost overruns due to, 271–272
  integrating subcontractor and supplier data using
    BIM, 335
  notifying regarding schedules, 256–257
  quality assurance (QA) and, 290–291
  relations with, 233
subcontracts
  issuing in procurement stage, 127–128
  section of general conditions document, 102
submittals
  defined, 364
  overview of, 182
  quality control (QC) and, 292
substance abuse, 305–306
substantial completion
  defined, 364
  project closeout phases, 134
summary schedules, 243
superintendent, of construction operation, 217–218, 218
supervision, in project performance, 263
supervisory inspections, 296–298, 297
supplemental conditions, in project manual, 103
suppliers. See vendors
sustainability, 30–31
SWPPP (storm water pollution prevention plans),
  212–213, 364
systems coordination, using BIM for, 335

T
tailgate safety meetings
  defined, 364
  in safety management plan, 304–305
takeoff
  calculating quantities in estimates, 156
  defined, 364
digitizers for automating, 171
taxes, in estimating, 167–168
team building, 176–177
technical proposals
  in best-value selection process, 86
  defined, 364
  weighted criteria method for scoring, 87
technical specifications, in project manual, 103–104

technology
age of, 9
in construction operations, 235–236
in contract administration, 199–200
in estimating, 169–171
in monitoring project performance, 281–282
in scheduling, 257
transitions in construction industry, 29
termination or suspension of contract, section of general conditions document, 102

test reports, final documentation in project closeout, 135
testing
independent testing and inspections and, 295
standards, 293–294, 294
The Design-Build Institute of America (DBIA), 36
time. See also planning and scheduling
monitoring project performance and, 57
project values, 43
scheduling and, 239–240
in time, cost, and quality triad, 41
tracking, 273
time and materials, 112, 364. See also cost-plus-fee contracts
time and scheduling section, of general conditions document, 102
time extensions, contractors requesting, 195–196
time of construction, impacting costs in estimating, 146–147

toolbox safety meeting, 364
tools, impact of inadequate, 264
Total Quality Management (TQM), 288–289, 364
Toyota Production System (TPS), 31, 362
tract builders, 11
traffic control, at job site, 223–224
training programs. See also education
quality assurance (QA) and, 290
safety and health, 302
transmittals
in construction correspondence, 230
defined, 364
logging, 227
trash removal, in construction operations, 215–216

U
UL (Underwriters Laboratories Inc.), 294–295
uncovering and correction of work, section of general conditions document, 102
Underwriters Laboratories Inc. (UL), 294–295

unforeseen conditions, due diligence uncovering, 124–125
Uniform Building Code, 296
unions, drug testing and, 306
unit costs, 160–161
unit-price contracts, 114–115, 114–115
updating schedules, 255–256
U.S. Green Building Council (USGBC)
accreditation and certification and, 37
sustainability and, 30
utilities, setting up temporary utilities at job site, 219

V
value engineering
defined, 50
in pre-construction stage, 125
variance
analyzing discrepancies between actual and estimated costs, 268–270
defined, 269
vegetation, environmental protections for, 214
vendor bids, in estimating process
analyzing, 163–164
choosing, 164
overview of, 161–162
receiving, 163
soliciting, 162–163
vendors
integrating subcontractor and supplier data using BIM, 335
as valuable resource in problem-solving, 179
virtual construction, BIM and, 332–333
visual records, documenting construction operations, 229–230

W
warranties
final documentation in project closeout, 135
project punchout compared with, 136
warranty periods, in construction contracts, 135–136
WBS (work breakdown structure). See work breakdown structure (WBS)
weather conditions, impacting project performance, 262
Webcams records, documenting construction operations, 230
weighted criteria method, for scoring technical proposals, 87
wetlands, environmental protections for, 214–215
will-call
  factors in scheduling, 205
  material and equipment deliveries, 204
wood frame construction, 12
work breakdown structure (WBS)
  estimators use of, 155–156
  for scheduling, 245–246, 246
work crew
  increasing size to correct schedule delays, 275–276
  quality of workforce as factor in project performance, 262–263
working overtime to correct schedule delays, 275–276
working two shifts per day to correct schedule delays, 276–277
work hours, 224–225
work packages, 155–156
working drawings (contract documents), 119–120
wrought iron, 7

Z
zero-punch list, 298–299