# Index

Note to reader: **Bolded** page references indicate definitions and main discussions of a topic. *Italicized* page references indicate illustrations and tables.

# Numbers

2D, commenting on 2D DWF sheets, 125–127
3D fabrication from 3D models, 95 construction administration and, 217–220, 219
3D RFIs creating Adobe 3D file for field review, 199–202, 200–202 overview of, 198–199
3D technology, on-the-job education and, 300
3D viewers Navisworks, 94 Revit, 59
3D-4D Building Information Guide, from GSA, 269–270

# A

AACE (Association for the Advancement of Cost Engineering), 145-146 Acrobat Professional, Adobe advantages of, 185 Cloud tool, 190, 190 commenting in, 190-191 creating Adobe 3D file for field review, 199-202 exporting clash detection report to, 171-173, 172-173 punch lists, 225 review features in, 191 tutorial on 3D RFIs, 198-199 AGC (Associated General Contractors of America) model contracts, 41 types of contract documents available from, 43-44 AIA (American Institute of Architects) model contracts, 41 types of contract documents available from, 42 - 43AISC (American Institute of Steel Construction), 128-129

American Institute of Architects (AIA) model contracts, 41 types of contract documents available from, 42 - 43American Institute of Steel Construction (AISC), 128-129 analysis analyzing effects of BIM implementation, 33 MATs (multiple analysis test beds), 307-308 superintendent training in analysis of BIM files, 197–198 animations scheduling animations overview of, 92 updating Naviswork, animation, 163-164, 163-165 sequencing animations generating 92 updating, 164-165 Archibus, 273 ArchiCAD, 114 architects dvantages of scheduling with architect's model, 92-93 on BIM team, 4 challenges of constructability, 106-107 collaborative relationships in future of BIM, 308 in design-build delivery method, 12 IE (information exchange) responsibilities, 48-49 new roles in future of BIM, 292-293 value of LEED accreditation to, 232 as-built models, project deliverable, 267 Associated General Contractors of America (AGC) model contracts, 41 types of contract documents available from, 43 - 44Association for the Advancement of Cost Engineering (AACE), 145-146 Autodesk, focus on model sharing, 291 Autodesk Constructware construction management and, 181 overview of, 167 Autodesk Design Review. See Design Review, Revit Autodesk Navisworks. See Navisworks Autodesk Revit. See Revit Auto-Takeoff tool, Timberline estimating with, 77-79 overview of, 77-78 taking off doors, 78-79 updating costs with, 155

## B

Batch Generate tool, Innovaya Visual Estimating, 68 Beck Technology's DProfile, 57 benchmarks, integration plan and, 30 Bentham, Jeremy, 258 bidirectional model linking, 60 BIM (building information modeling). See also IPD (integrated project delivery) 10 steps in implementing, 26-35 overview of, 26-27 short version of, 34-35 Step 1: identifying BIM manager, 27-28 Step 2: estimating time/cost to implement BIM software, 28-29, 28-30 Step 3: developing integration plan, 30–31 Step 4: starting small, 30-31 Step 5: training BIM manager, 31 Step 6: supporting BIM manager by starting BIM department, 32 Step 7: balancing adherence to plan with flexibility, 32 Step 8: creating resources, 32 Step 9: analyzing effects of implementation, 33 Step10: monitoring new software and industry trends, 33-34 CM-at-risk delivery method. See CM-at-ris delivery method contractor's role, 24-25 delivery methods, 5-6 evolution during project, 143-144 example of building constructed using BIM technology, 2, 21 factors influencing use of, 5, fad or here to stay, 25-26 future of collaborative relationships and, 308-309 construction managers and, 297-298 formal education, 298-300 interoperability, 293-294 job requirements for BIM manager, 302-303 need for, 294-297, 295 new process, 306 new roles in, 292-293 on-the-job education, 300-301, 301 opportunities, 307-308 overview of, 290-292, 291 team approach and, 304-306, 305 growth in job market related to, 26 new process concept and, 23-24 primer on, 3-4 team members and, 4 value and potential of BIM technology, 2 BIM files in-field ordering and, 259 issues regarding sharing and transferring, 151

renovation and, 280 size limitations, 153 superintendent training in analysis of, 197-198 updating estimates with, 152 BIM guide. See Model Coordination Plan BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors (Eastman), 57 BIM managers, job requirements, 302-303 BIM protocol document. See Model Coordination Plan BIM servers, 291 budgets management, 176-178 updates for integrated projects, 148 Building Materials Reuse Association, 259 Building Product Models: Computer Environments Supporting Design and Construction (Eastman), 3 buildingSMART, 294

# CAD files

analyzing and overlaying, 181 facility management and, 266 limitations in facility management, 271 sharing and transferring digital information, 150-151 CAD technology BIM replacing, 290 BIM team vs. CAD team, 109, 109 delivery methods using, 6 prebid phase and, 145 shop drawings and, 111-112 trade coordination and, 127 traditional CAD process, 23-24 CAFM (computer-aided facility management), 282 CD (construction documentation) phase, 8 CFD (computational fluid dynamics), 233 clarification of information process clarification stage diagram, 152 CM-at-risk delivery method, 19 commenting on 2D DWF sheets, 125-126, 125-127 design-bid-build delivery method, 9-10 design-build delivery method, 15 IPD (integrated project delivery), 22 clash detection construction administration and, 220-223, 221-222 exporting clash detection report to Acrobat Professional, 171-173, 172-173 Navisworks creating clash detection report, 169-171, 170 testing model assumptions, 168, 168-169 updating clash detection reports, 174-176, 174 - 176

testing updates by hiding model components, 169 trade coordination and, 128-133 training, 198 updates, 165-168, 166, 168 Clash Detective, Navisworks, 128-133, 169 cleaning costs, buildings, 265 clearance clash, clash detection and, 131 Cloud tool, Acrobat Professional, 190, 190 CM-at-risk delivery method, 16-20 clarification of information process, 19 communication and collaboration methods, 18 documentation, 18-19 overview of, 16-17 preconstruction phase, 17-18 project closeout phase, 19-20 CMiC, construction management and, 181 CMMS (Computerized Maintenance Management Systems), 283 CNC (computer numerical control), plasma cutting with CNC machines, 95 code review professionals, 304 collaboration. See also communication CM-at-risk delivery method, 18 design-bid-build delivery method, 8-9 design-build delivery method, 13-14 example of learning from fabricator, 247 future of BIM and, 308-309 instead of litigation, 45 IPD (integrated project delivery), 20-21 commenting on 2D DWF sheets, 125-126, 125-127 construction administration overview of, 203-205, 203-205 Redline tags, 207-208, 207-209 Redline tool, 205-207, 205-207 RFIs (requests for information), 196-191 communication. See also collaboration. CM-at-risk delivery method, 18 design-bid-build delivery method, 8-9 design-build delivery method, 13-14 IPD (integrated project delivery), 20-21 team extranets for, 56-57 FTP for, 55 Internet for, 57 Newforma software for, 56 overview of, 55 communication hub, in job trailer, 211, 211 composite BIM, for transfer of digital information, 54-55 composite modeling benefits of, 183 overview of, 96 VDC models, 290 computational fluid dynamics (CFD), 233 computer numerical control (CNC), plasma cutting with CNC machines, 95

computer-aided facility management (CAFM), 282 Computerized Maintenance Management Systems (CMMS), 283 conference room, in job trailer, 209, 212 constructability, 106-127 commenting on 2D DWF sheets, 125-126, 125-127 construction model adding constructability information to, 117-120, 117-121 creating, 113-117, 116-117 Design Review tools, 121-122 exporting Revit model to Design Review, 122-124, 122-124 overview of, 106-111 sophistication and detail of information as construction phase approaches, 144 submittals, 111-113 construction, decrease in productivity in, 3 construction administration **3D RFIs** creating Adobe 3D file for field review, 199-202, 200-202 overview of 198-199 commenting overview of, 203-205, 203-205 Redline tags, 207-208, 207-209 Redline tool, 205-207, 205-207 conclusion, 227 fabrication, 217-220, 219 iob trailer communication hub, 211, 211 conference room, 209, 212 overview of, 209, 209 plans and specifications hub, 210 virtual job trailer, 212-215 overview of, 179-181 processes for information flow BIM approach, 183-184 existing approach, 181-183 punch lists, 223-227, 224-226 **RFIs** adding new view to, 188, 188 Adobe review features, 191-193, 192 commenting, 190-191, 190-191 creating RFI sheet, 186-187, 186-188 overview of, 184, 184-186 printing as PDF, 188-190, 189-190 sequenced clash detection reports, 220-223, 221-222 site coordination, 215, 215-217 superintendent training advanced training for model creation, 196-197, 197 BIM file analysis, 197-198 goals for basic skills, 195–196 overview of, 193-195, 195

construction documentation (CD) phase, 8 construction managers challenges of constructability, 106 future of BIM and, 297–298 trade coordination and, 127 construction model adding constructability information to, 117-120, 117-121 benefits of, 121 creating, 113-117, 116-117 construction phase case study on construction of signature bridge, 133-139, 134-137 conclusion, 139-140 constructability, 106-127 adding constructability information to construction model, 117-120, 117-121 BIM team vs. CAD team, 109 commenting on 2D DWF sheets, 125-126, 125-127 contractor using BIM in field, 110 creating construction model, 113-117, 116 - 117Design Review tools, 121–122 exporting Revit model to Design Review, 122-124, 122-124 overview of, 106-111 reviews, 107 submittals, 111-113, 112 overview of, 90 scheduling, 90-106 Navisworks. See Naviswork overview of, 90-93 saving schedule as MPX file, 94 series of tasks in, 91 software for, 93-54 updating BIM schedules, 90 trade coordination, 127–133 clash detection and reporting, 128-133, 130-132 overview of, 127, 127 construction trailers. See job trailers Constructware, Autodesk construction management and, 181 overview of, 167 contingency, AACE definition of, 145-146 contractors challenges of constructability, 106-108 collaborative relationships in future of BIM, 308 design-build delivery method, 12 IE (information exchange) responsibilities, 49 new roles in future of BIM, 292-293 role in BIM process, 24-25 sharing and transferring digital information, 150-151 trade coordination and, 127 value of LEED accreditation to, 232

contracts AGC documents, 43–44 AIA documents, 42–43, 43 collaboration not litigation, 45 DBIA documents, 44 overview of, 40, 40–41 costs assigning with Timberline estimating, 73–77 facility management, 264–265, 264–267 *Cradle to Cradle* (McDonough), 262

#### D

data management, 305 data transfer. See digital information transfer databases BIM as, 224 element-to-database linking with RFIDs, 278-279 DBIA (Design-Puild Institute of America) on design build delivery method, 11-12 model witracts, 41 types of contract documents available from, 44 DD (design development), 6 deconstruction, recycling and, 260-261 delivery methods CM-at-risk delivery method, 16-20 design-bid-build delivery method, 6-11 design-build delivery method, 11-16 IPD (integrated project delivery), 20-23 overview of, 5-6 perceived value of, 17 demolition, documentation for, 280-282 department, starting BIM department, 32 design development (DD), 6 design intent documentation, 106, 108 Design Review, Revit commenting on 2D DWF sheets, 125-126, 125 - 127exporting Revit model to, 122-124, 122-124 interoperability and, 199 overview of, 121-122 design-bid-build delivery method, 6-11 clarification of information process, 9-10 communication and collaboration methods, 8 - 9documentation, 9 information flow in, 7 overview of, 6-7 preconstruction phase, 7-8 project closeout phase, 10-11, 15-16 sharing models and, 147-148 design-build delivery method, 11-16 AGC contracts for, 44 AIA contracts for, 43 clarification of information process, 15 communication and collaboration methods, 13 - 14

contractors, 12 DBIA contracts for, 44 delivery methods. See design-build delivery method documentation, 14-15 information flow in, 13 overview of, 11-12 preconstruction phase, 12 Design-Build Institute of America. See DBIA (Design-Build Institute of America) design-builder, in design-build delivery method, 12 designers, BIM team and, 4 digital information transfer composite BIM, 54-55 overview of, 52-53, 53 parallel BIM, 53-54 sharing and, 150-151 team communication, 55-57 digitizer, for takeoff process, 8, 8-9 documentation CD (construction documentation) phase, 8 CM-at-risk delivery method, 18-19 design-bid-build delivery method, 9 design-build delivery method, 14-15 end-of-project information overload, 267 facility decommissioning, 280-282 IPD (integrated project delivery), 21-22 prebid phase and, 145 DProfile, Beck Technology's, 57 DWF files commenting on 2D DWF sheets, 125-127 DWFX files and, 123

# E

Eastman, Charles, 3 education. See also training formal, 298-300 on-the-job, 300-301, 301 efficiency, 91 Elvin, George, 20 energy costs/efficiency facility management and, 264, 282-283 job trailers and, 256-257 sustainable construction and, 248 engineered to order (ETO), 218 engineers BIM team and, 4 challenges of constructability, 106 collaborative relationships in future of BIM, 308 IE (information exchange) responsibilities, 49 new roles in future of BIM, 292-293 value of LEED accreditation to, 232 environmental agencies, 304 environmental sustainability. See sustainability e-SPECS software, linking model components to building specifications, 113

estimating documentation and, 9 Innovaya Composer for Revit exporting Innovaya file, 63 merging multiple Revit models, 63-64 overview of, 61-63 Innovaya Visual Estimating, 64-70 generating managed quantities, 68-70 interface for, 65-68 MC2 estimates and, 70 overview of, 64-65 overview of, 57, 57 Revit estimating, 58-60 Timberline estimating assigning costs, 73-77 Auto-Takeoff function, 77-79 opening existing estimates, 72-73 options for creating new estimates, 71 overview of, 71 updates comparing old and new estimates with Timberline, 137-159, 157-159 overview of, 152-156, 153-154, 156 estimators, BIM, 154 ETO (engineered to order), 218 Excel exporting Innovaya Visual Estimating file to, 69-70, 69-70 exporting Timberline Variance Report to, 158-159, 159 exporting Innovaya file, to Revit, 63 Revit files to Google SketchUp, 80 to Navisworks, 98-99 site coordination plan, to Google Earth, 86-87 extranets, for team communication, 56-57

#### F

fabrication, construction administration and, 217–220, 219 fabricators example of learning from fabricator, 247 new roles in future of BIM, 293 facility management benefit of having one source of information (one BIM), 273–276 conclusion, 286–287 costs, 264–265, 264–267 documentation for decommissioning, 280–282 implementation and use of BIM, 286–287 investment and logistics, 282, 282–284 maintaining models, 279 owners and, 267–270, 269

record BIMs deliverable process and, 274 example of, 272 information in, 273-279, 277 overview of, 270-273 training, 284-285, 285 field associates requirements for successful use of BIM, 194 training in analysis of BIM files, 197-198 File Transfer Protocol (FTP), 55 firefighters, BIM and, 304 flexibility, balancing adherence to plan with, 32 floor creating in Revit, 118 models/modeling, 120-121 FMDesktop, 273 foremen. See superintendents The Foundations of Lean Construction, 246 Freedom Viewer, HTML files and, 167 FTP (File Transfer Protocol), 55 fuel consumption, material proximity and, 241-242 future of BIM collaborative relationships and, 308-309 construction managers and, 297-298 formal education, 298-300 interoperability, 293-294 job requirements for BIM manager, 302-303 need for, 294-297, 295 new process, 306 new roles in, 292-293 on-the-job education, 300-301, opportunities, 307-308 overview of, 290-292, 291 team approach and, 304-304, 305

# G

Gallello, Dominic, 2 gatekeeper, for managing project information flow, 142 global positioning satellites (GPS), 216-217 GMP (guaranteed maximum price), 16 goal setting planning process and, 40 for sustainable construction, 248, 255 for training, 195-196 Google Earth creating placemarks for calculating material proximity distances, 242-245, 242-246 exporting site coordination plan to, 86-87, 87 importing site with, 83-86, 83-86 inserting sites into SketchUp, 82 Google SketchUp exporting from Revit to, 80, 80-81 Google Earth for inserting site into, 82 importing and exploding model in, 81

painting model in, 82, 82 starting site coordination in, 79, 79–80 Google SketchUp for Dummies (Chopra), 81 Government Services Administration (GSA), 269–270 governmental agencies, BIM and, 304 GPS (global positioning satellites), 216–217 graphics files, prebid phase and, 145 Green BIM (Krygiel and Nies), 230 Green Building Alliance, 261 green construction. See sustainability Green construction trailer, 257 GSA (Government Services Administration), 269–270 guaranteed maximum price (GMP), 16

#### H

hard bidding, BIM and, 147 hard clash, clash detection and, 131 Hardin, Sy, 45 hazardous waste, demolition and, 280–281 *How Eurldings Learn* (Brand), 308 HTI (1) files, clash detection reports and, 167

IAI (International Alliance for Interoperability), 293-294 ICC, Sustainable Building Technology Committee, 233 IE (information exchange) plan, 48, 48-50 IFC files creating Adobe 3D file for field review, 199-202 interoperability and, 294 IFD (International Framework for Dictionaries), 294 Imhotep, historic architect, 294–295, 295 importing DWF file with comments into Design Review, 125 - 126Google SketchUp models into Revit, 79, 81 Revit model into Navisworks, 99-100, 100 Revit schedule into Navisworks, 100-102, 100-102 site map into Google Earth, 83-86, 83-86 industry trends, monitoring, 32 in-field ordering, 259 information clarification process clarification stage diagram, 152 CM-at-risk delivery method, 19 commenting on 2D DWF sheets, 125-126, 125 - 127design-bid-build delivery method, 9-10 design-build delivery method, 15 IPD (integrated project delivery), 22

digital information transfer standards composite BIM, 54-55 overview of, 52-53, 53 parallel BIM, 53-54 team communication, 55-57 flow process BIM approach, 183-184 existing approach, 181-183 in record BIMs, 273-279, 277 sharing and transferring, 150-151 information director, BIM managers as, 303 Innovaya Composer exporting Innovaya file, 63 merging multiple Revit models, 63-64, 64 overview of, 61-62, 61-63 modeling with, 155 process of updating estimates, 156 updating estimate quantities with, 153 Visual Estimating, 64–70 creating new estimate in, 71 generating managed quantities, 68-70 interface for, 65-68 MC2 estimates and, 70 overview of, 64-65 preconstruction phase, 65-67, 68-70 Integrated Practice in Architecture (Elvin), 213 integrated project delivery. See IPD (integrated project delivery) integrated projects, budget updates and, 148-152 integrated service, CM-at-risk contract, 17 integration plan, developing, 30-31 International Alliance for Interoperability (IAI), 293-294 International Framework for Dictionaries (IFD), 294 Internet, for team communication, 56-5 interoperability issues in the future of BIM, 293-294 NBIMS and NIBS goals for, 60 need for, 286 transfer of information during project lifecycle and, 142 INV files. See also Innovava converting RVT (Revit) files to, 61 exporting, 63 merging multiple Revit models, 63-64 overview of, 60 synchronizing design changes in Revit models with, 64 investment BIM as, 34 facility management and, 282, 282-284 IPD (integrated project delivery), 20-23 AIA contracts for, 42 clarification of information process, 22 communication and collaboration methods, 20 - 21

documentation, 21–22 getting/sharing models, 148 information flow in, 22 overview of, 20 preconstruction phase, 20 project closeout phase, 23

#### J

iob sites coordination, 215, 215-217 Google Earth exporting site coordination plan to, 86-87 importing site with, 83-86 Google SketchUp exporting from Revit to, 80 Google Earth for inserting site into, 82 importing and exploding model in, 81 painting model in, 82 starting site coordination in, 79-80 sustainability surveillance, 255-256, 258 job trailers communication h.b, 211, 211 conference room, 209, 212 green trailer for sustainability, 256-257 overview of, 209, 209 plans and specifications hub, 210 virtuat job trailer, 212-215

Kenig, Michael, 25

# L

landfills, lean construction to reduce impact on, 246 Leadership in Energy and Environmental Design. See LEED (Leadership in Energy and Environmental Design) lean construction, 246 LEED (Leadership in Energy and Environmental Design) green preconstruction, 233-235 material proximity as requirement of, 241, 245 standards for sustainability, 231-233, 232 sustainability goals based on, 248 level of detail (LOD) defining responsibilities and, 47 in models/modeling, 111 life cycle, of buildings costs over, 264-265 facility managers and, 281 maintenance and repair costs over, 269 salvaging/recycling buildings and, 259 Lines tool, Navisworks Collaboration Software, 119 litigation, collaboration instead of, 45

Living Building Challenge (LBC-Cascadia Green Building Council), 230 LOD (level of detail) defining responsibilities and, 47 in models/modeling, 111 logistics, facility management, 282–284

#### Μ

management facility management benefit of having one source of information (one BIM), 273-276 conclusion, 286-287 costs, 264-265, 264-267 documentation for decommissioning, 280-282 implementation and use of BIM, 286-287 investment and logistics, 282, 282-284 maintaining models, 279 owners and, 267-270, 269 record BIMs, 270-279, 272, 274, 277 training, 284-285, 285 identifying BIM manager, 27-28 supporting BIM manager by starting BIM department, 32 training BIM manager, 31 manufacturing, BIM opportunities, 307 Masdar Headquarters sustainability case study 249, 249-255, 251-252, 254 background of Masdar City, 250 cost/budget models, 254-255 integrated approach to Masdar City goals, 250-251 overview of, 249 paperless process, 255 phases/schedules, 253-254 sustainable construction and, 252-253 sustainable content goals, 254 materials managing for sustainability, 258-259 proximity to job site creating placemarks for finding distances, 242-245, 242-246 overview of, 241-242 replacement costs as factor in facility management, 264 selection in green construction, 234-235 MATs (multiple analysis test beds), 307–308 MC2 estimates, 70 means and methods. See constructability MEP format, Revit, 130 metrics, integration plan and, 30 Microsoft Project, 93, 164 Microsoft XPS Viewer, 123 Model Coordination Plan as constructability submittal, 111

overview of, 50-52 schematic of, 51 models/modeling advanced training in, 196-197 advantages of scheduling with architect's model, 92-93 as-built models as project deliverable, 267 bidirectional model linking vs. exporting, 60 composite models, 96 construction models, 113-117 coordination of, 114 design models evolving into fabrication or construction models, 110-111 exporting Revit model to Design Review, 122-124 fabricating from 3D models, 95 getting/sharing models, 147-148 linking models, 114 LOD (level of detail) in, 111 maintaining models, 279 planning strategy for, 109 superintendent training in, 196-197, 197 testing model assumption using Navisworks, 168, 168-169 training in, 195 updates Navisworks and, 163-164, 163-165 overview of, 159-161 Revit and, 161-162, 161-162 VDC (Virtual Design and Construction) models, 107 MPX (Microsoft Project) files importing Revit schedule into Navisworks, 100 - 102saving schedule as, 94 MQ (managed quantities) assigning costs in Timberline, 73-76 Innovaya Visual Estimating, 68-70 multiple analysis test beds (MATs), 307-308

#### Ν

National Building Information Modeling Standards (NBIMS), 60, 285, 294 National Institute of Building Sciences (NIBS), 60, 273 natural resources demands of construction on, 234 sustainability and, 230 Navisworks assigning components to schedule, **104–106**, *105–106* clash detection updates creating clash detection reports, 169–171, 170 testing model assumptions, *168*, 168–169 updating clash detection reports, 174–176, *174–176* 

Clash Detective, 128–133 commenting overview of, 203-205 Redline tags, 207-208, 207-209 Redline tool, 205-207, 205-207 export file in Revit for, 98, 98-99, 99 importing Revit models, 99-100, 100 importing Revit schedules, 100-102, 100-102 interoperability and, 199 linking tasks to model components, 102, 102 - 103model updates, 163-164, 163-165 overview of, 94-98 punch lists and, 225-226 search sets in, 103-104, 104 sequenced clash detection reports, 220-223 TimeLiner in, 100 user interface, 97 NBIMS (National Building Information Modeling Standards), 60, 285, 294 Newforma software, for team communication, 56 NIBS (National Institute of Building Sciences), 60,273 NWC files, 98–100 NWD files Navisworks file format, 97 saving NWC file as, 100 NWF files, 97

# 0

O&M (operations and maintenance) manual digital, 16 submitted at project closeout, 10, 15 on-the-job education, future of BIM and, 301 Onuma Planning System (OPS), 273 open source, BIM facility management and, 273 operations and maintenance manual digital, 16 submitted at project closeout, 10, 15 opportunities, future of BIM, 307-308 OPS (Onuma Planning System), 273 outsourcing, constructability models and, 108 owners collaborative relationships in future of BIM, 308 facility management and, 267-270, 269 looking for BIM enabled companies, 297 ownership of responsibility. See responsibilities, defining

## P

painting model, in Google SketchUp, 82 Pan tool, Innovaya Visual Estimating, 67 panopticon concept (Bentham), 258 parallel BIM, 53–54

parametric modeling, in aerospace industry, 295-296 PDF files advantages of Acrobat Professional, 185 prebid phase and, 145 printing RFIs as, 188-190 shop drawings and, 111 people, basis of BIM success, 34 Pick Wall tool, Revit, 118 PlanetReuse, 260 planning balancing adherence to plan with flexibility, 32 preconstruction phase and, 38-39, 38-40 plans and specifications hub, in job trailer, 210 polylines, 266 prebid phase hard bidding during, 147 integrated project and, 148-152 overview of, 145-147, 146 preconstruction phase CM-at-risk delivery method 17–18 conclusion, 88 contracts AGC documents 43-44 AIA documents, 42-43, 43 collaboration not litigation, 45 DBIA documents, 44 overview of, 40, 40-41 defining responsibilities, 45-48, 46 design-bid-build delivery method, 7–8 design-build delivery method, 12 digital information transfer standards composite BIM, 54-55 overview of, 52-53, 53 parallel BIM, 53-54 team communication, 55-57 estimating, 57, 57 Google Earth exporting site coordination plan to, 86-87,87 importing site with, 83-86, 83-86 Google SketchUp exporting from Revit to, 80, 80-81 Google Earth for inserting site into, 82 importing and exploding model in, 81 painting model in, 82, 82 starting site coordination in, 79, 79-80 IE (information exchange) plan, 48, 48-50 Innovaya Composer for Revit exporting Innovaya file, 63 merging multiple Revit models, 63-64, 64 overview of, 61-62, 61-63 Innovaya Visual Estimating, 64-70 generating managed quantities, 68-70, 68-70 interface for, 65-67, 65-68 MC2 estimates and, 70 overview of, 64-65

IPD (integrated project delivery), 20 Model Coordination Plan, 50-52, 51 overview of, 37 planning projects, 38-39, 38-40 Revit estimating, 58-60, 59-60 site coordination, 79 sustainability and, 233 Timberline estimating assigning costs, 73-76, 73-77 Auto-Takeoff function, 77-78, 77-79 opening existing estimates, 72, 72-73 options for creating new estimates, 71 overview of, 71 preconstruction services, CM-at-risk delivery method and, 16 Primavera exporting Primavera schedule for use in Navisworks, 93-95 scheduling software, 93 process future of BIM and, 306 new process concept in BIM, 23-24 programming languages, open source, 273 project closeout phase CM-at-risk delivery method, 19-20 design-bid-build delivery method, 10-11, 15 - 16IPD (integrated project delivery), 23 project construction feasibility. See constructability Prolog, 181 punch lists, construction administration, 223-227, 224-226

# R

Radio Frequency Identification (RFID) tags element-to-database linking, 278-279 field use of, 213 site coordination and, 216-217 record BIMs benefit as facility investment, 268-269 deliverable process and, 274 example of, 272 how to create, 271-272 information in, 273-279, 277 overview of, 270-271 record model, 196 recycling. See also salvaging schedule with field for recycled content calculating volume of recycled content, 239-241 creating, 235-239 sustainability and, 262 Redline tags, commenting, 207-208, 207-209 Redlining tool, commenting, 205-207, 205-207 renovation, BIM files and, 280 reporting, trade coordination, 128-133

resources, creating, 32 responsibilities, defining IE (information exchange) plan, 48, 48-50 Model Coordination Plan, 50-52, 51 overview of, 45-48, 46 review features, Adobe, 191-193, 192 Review Tracker, Adobe advantages of Acrobat Professional, 185 punch lists and, 225 setting up clash reports, 173 Revit 3D view, 59 construction model, 113-114 custom schedules, 235-239 estimating, 58-60, 59-60 exporting to Design Review, 122-124 to Navisworks, 98, 98-99 to SketchUp, 80 importing DWF file with comments into Design Review, 125–126 Google SketchUp models, 79 importing Revit model into Navisworks, 99-100 importing Revit schedule into Navisworks, 100-102 Innovaya Composer plug-in. See Innovaya, Composer Innovaya Visual Estimating as connector between Revit and Timberline, 64 MEP format, 130 merging multiple Revit models with Innovaya Composer, 63-64 model updates, 161–162, 161–162 RFIs (requests for information) adding new view to RFI sheet, 188, 188 creating RFI sheet, 186-187, 186-188 printing as PDF, 188-190, 189-190 user interface, 59 RFID (Radio Frequency Identification) tags element-to-database linking, 278-279 field use of, 213 site coordination and, 216-217 RFIs (requests for information) **3D RFIs** creating Adobe 3D file for field review, 199-202, 200-202 overview of, 198-199 adding new view to RFI sheet, 188, 188 Adobe review features, 191-193, 192 BIM and, 292 commenting, 190-191, 190-191 creating RFI sheet in Revit, 186-187, 186-188 overview of, 184, 184-186 printing as PDF, 188-190, 189-190 roles, new role in BIM, 292-293 RVT files, converting to INV files, 61

# S

safety, job site surveillance and, 255-256 salvaging, 259-261, 260. See also recycling scheduling, 90-106. See also Navisworks custom schedule with field for recycled content calculating volume of recycled content, 239-241, 240-241 creating, 235-239, 235-239 material delivery and waste management, 258 overview of, 90-93 software for, 93-94 training in updates, 198 scheduling animations overview of, 92 updating Navisworks animation, 163-164, 163-165 SD (schematic design) design-bid-build delivery method and, 7 Model Coordination Plan, 51 search sets creating in Navisworks, 103-104 vs. selection sets, 103 security, job site surveillance and, 255-256 selection sets, in Navisworks, 103 Selection Tree, Navisworks, 106, 106 sequencing animations generating, 92 updating, 164-165 servers, BIM, 291 sharing Autodesk focus on model sharing, 291 defining responsibilities and, 45 digital information, 150-151 models and, 147-148 shop drawings, constructability models and, 111 side-by-side estimates, with Timberline, 157 simulation, clash detection reports tied to, 220 single-purpose entity method of very, 42 sites. See job sites SketchUp. See Google SketchUp smart pass chips, 278-279 software estimating time/cost to implement BIM software, 28-30 monitoring new, 33-34 Solibri Model Checker, 94 specifications, end-of-project information overload, 267 specifications hub, in job trailer, 210 stakeholders BIM, 277 defining responsibilities and, 46 starting small, BIM 10 step implementation, 30-31 subcontractors. See contractors submittals, constructability, 111-113

superintendents task performed using BIM, 180 training advanced training for model creation, 196-197, 197 BIM file analysis, 197-198 goals for basic skills, 195-196 overview of, 193-195, 195 sustainability conclusion, 262 custom schedule with field for recycled content calculating volume of recycled content, 239-241, 240-241 creating, 235-239, 235-239 goal setting for, 248, 255 Green construction trailer, 256-257, 257 job site surveillance, 255-256, 258 lean construction, 246 Masdar Headquarters case study, 249, 249-255, 251-252, 254 material management, 258-259 material proximity creating placemerks for finding distances, 242-245 242-246 overview of 241-242 overview of 229-231 preconstruction phase and, 233 recycling, 262 salvaging, 259-261, 260 USGBC and LEED standards, 231–233, 232 Sustainable Building Technology Committee, ICC, 233

# T

tablet PCs, value to field personnel, 213 takeoff process, in design-bid-build method, 8 team BIM planning process and, 39-40 BIM team members, 4 communication, 55-57 extranets for, 56-57 FTP for. 55 Internet for, 57 Newforma software for, 56 overview of, 55 future of BIM and, 304-306, 305 new roles in future of BIM, 293 technology, threats to project success, 26 tenant occupancy rates, facility management and, 264 testing models by hiding model components, 169 MATs (multiple analysis test beds), 307-308 testing model assumption using Navisworks, 168, 168-169

Timberline assigning costs, 73-76, 73-77 Auto-Takeoff function, 77–78, 77–79 creating estimate variance report with, 157-158, 157-158 estimate updates and, 153 exporting variance report to Excel, 158-159, 159 Innovaya Visual Estimating as connector between Revit and Timberline, 64 opening existing estimates, 72, 72-73 options for creating new estimates, 71 overview of, 71 time, threats to project success, 26 time/cost estimates, for implementing BIM software, 28-30 TimeLiner, Navisworks, 100–102 trade coordination, 127-133 clash detection and reporting, 128-133, 130-132 overview of, 127, 127 training facility managers, 284-285, 285 future of BIM requiring formal education, 298-300 on-the-job education, 300-301, 301 starting with BIM manager, 30 superintendents advanced training for model creation 196-197 BIM file analysis, 197-198 goals for basic skills, 195-196 The Triple Bottom Line (Savitz), 22

## U

United States Green Building Council (USGBC) environmental awarness and, 230 standards for sestainability, **231–233**, 232 updates clash detection creating clash detection report, 169–171, 170 exporting detection report to Acrobat Professional, 171–173, 172–173 overview of, **165–168**, 166, 168

testing by hiding model components, 169 testing using Navisworks, 168-169 updating clash detection reports, 174-176, 174 - 176estimates comparing old and new estimates with Timberline, 157-159 overview of, 152-156, 153-154, 156 models Navisworks and, 163-164, 163-165 overview of, 159-161 Revit and, 161-162, 161-162 overview of, 142-144 user interface Innovaya Visual Estimating, 65-68 Revit, 59 USGBC (United States Green Building Council) environmental awareness and, 230 standards for sustainability, 231-233, 232

# V

value engineering, 17 Variance Report, Timberline creating, 157-158, 157-158 exporting to Excel, 158–159, 159 VDC (Virtual Design and Construction) future of BIM and, 290 job requirements for VDC coordinators, 302-303 models, 107 Vico Software, for estimating, 57 virtual construction managers, 302-303 Virtual Design and Construction. See VDC (Virtual Design and Construction) Virtual Design and Construction: New Opportunities for Leadership (Bedrick), 273 virtual job trailer, 212-215 visibility graphics, Revit, 161, 161-162

#### W

Walk tool, Innovaya Visual Estimating, 67 waste, material management and, 258 WBS (work breakdown structure), 93