# 363 ■ INDEX

# Index

Note to the Reader: Throughout this index boldfaced page numbers indicate primary discussions of a topic. *Italicized* page numbers indicate illustrations.

# NUMBERS

3D BIM, 15, 50–52 3D printers, 30–31, 116 4D BIM. *see* model-based scheduling 5D BIM. *see* model-based estimating

# A

accuracy, installation, 234 activity tracking, construction, 234, 235 addenda BIM. see BIM addenda definition of, 65 AE (architectural and engineering) models, 52, 55 AGC (Associated General Contractors of America), 64, 65 AIA (American Institute of Architects), 64, 65,66 Alberti, Leon Battista, 46 analysis building codes for, 179, 179 building rating systems for, 177–178. 178concrete CO<sub>2</sub> emissions 179–180 data. 27-29 model-based, 74-75 multiple, 358 Sefaira for, 182-187, 182-188 software for, 175-176 sustainability, 180-181, 181 animation, scheduling, 221-226, 221-226 Apple Watch, 22 AR (augmented reality) simulations, 115, 115 architect-controlled record models, 264 architects in ConsensusDocs 301, 65 DB delivery method and, 59-60 new responsibilities of, 344 uses of BIM by, 351 architectural and engineering (AE) models, 52, 55 Architecture 2030, 176-177

artifact deliverables CAD files, 314-315 constant deliverables and, 315-316 hybrid approach to, 316, 317 overview of, 310-311, 311 PDFs, 311-312, 313 As-builts—Problems & Proposed Solutions (Pettee), 310 Assemble Systems, intuition and, 286–287, 287-288 Assemble tool, for cost trending, 172–175, 173-175 Associated General Contractors of America (ACC), 64, 65 attention span statistics, 41 augmented intelligence, 359 accemented reality (AR) simulations, 115, 115 Autodesk BIM 360 Field barcodes/QR codes in, 297-298, 298 commissioning in, 326, 327 equipment database in, 301 features of, 291 mapping equipment to, 291-295, 292-295 mobile application, 297 to status material, 299-301, 300 uploading information into, 295-297, 296 visualizing equipment in, 301-303, 302-303 Autodesk BIM 360 Glue email invitation, 159 real-time clash alert, 27, 28 sharing models, 291-292, 292 uploading models to, 159-160, 160-163 Autodesk Communication Specification, 75-77, 79, 83 Autodesk Navisworks clash detection in, 205-207, 205-208 Comments tool in, 243-246, 244-246 default units in, 219 features of, 198 field information via, 242-243 importing search sets into, 288–290, 288-290 NWD/NWF file formats, 198, 217, 219

Autodesk Navisworks (continued) opening files in, 219 overview of, 196–198, 197 punch list coordination in, 328, 329 Redline Tags in, 248-249, 248-249 Redlining tool in, 246-247, 247-248 schedule simulation in, 221-226, 221-226 scheduling software and, 217-221, 218-220 search set exercise, 199-205, 200-204 sequencing clash analysis in, 211–213, 212–213 Autodesk Navisworks Manage, 301-303, 301-303 Autodesk Revit CO<sub>2</sub> emissions and, 179–180 creating doors in, 284-286, 285-286 for estimations, 164-169, 165-169 export formats, 80-81, 81 fabrication in, 342, 342-343 schedule discrepancies in, 170-171, 171 showing design intent, 61 AutoMark 2.0, 272

#### B

Ballard, Glen, 125 barcodes, 297-298, 298-299, 299 Batch Link, for digital plan room, 272 behaviors, in successful BIM, 7-8 Bentley Navigator, punch lists in, 327, 328 Big BIM, little bim (Jernigan), 8 Big Data analysis, 27–29 BIM (building information modeling) analyzing data in, 27-29 battle for, 258-261, 259, 261 as catalyst, 340 in closeout procedures, 38-39 in CMAR delivery method, 55–56 constructability and, 25-26, 25-27 in construction, 192-193. see also construction construction management and, 15 controlling schedules with, 33-34, 34 cost controls, **34–35**, *35* cost estimation, 23-24, 23-24 current adoption cycle of, 12 in DBB delivery method, 50-52, 51 design for prefabrication, 29-31, 30 developing intuition in, 284 education and, 350-351 enabling behaviors in, 7-8 equipment tracking with, 38

facilities management and, 39-40, 40 factors effecting use of, 12, 13 future of. see future of BIM growth trends of, 9 improving world situation, 360-361 increased adoption of, 10, 16 increasing benefits of, 12, 14 as informational database, 15 keys to speaking, 97 knowledge management and, 41, 41-42 leadership buy-in, 42-43 logistics in, 22, 22-23 managing changes, 35-36 managing punch lists, 39, 39 planning for success of, 19 prefabrication and, 342-343, 342-343 primary uses of, 69-75 processes in, 4-5 356-357 project pursuit and, 16-19, 18 results/savings of, 43, 44 scheduling and, 20-22, 21 successful platform of, 4 team engagement in, 16, 17 technologies in, 5–7 training. see training unification of model data for, 334-337 value of, 2-4, 8-9 widespread impact of, 354-356 BIM addenda agency documents, 65-66 comparison of, 64 development of, 63-64 optimum approach to, 65 summary of, 66-67 unique intent of, 67 BIM and Integrated Design (Deutsch), 83, 148 BIM execution plan communication in, 77-79, 78-79 defining expectations in, 83-85 history of, 75-77, 76 information exchange plan in, 81-83, 82 organizing, 85-88 overview of, 75 software and, 79-81, 80-82 summary of, 89 BIM file maintenance, 329–330 BIM guides, 108 BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, 209

BIM kickoff meeting bad start to, 137 collecting right people for, 136-137 communication/expectation bias at, 139 creating visions at, 138-139 BIM manager creating record BIM files, 318 evolving role of, 43 future role of, 351–352 job requirements of, 352-354 BIM-washing, 93, 93, 99 Bluebeam Revu eXtreme. see digital plan room Bricklaying System (Gilbreth), 128 Brilliant: The Evolution of Artificial Light (Brox), 176 Brooks Act (1972), 47 building codes and sustainability, 179, 179 building information modeling. see BIM (building information modeling) building rating systems, 177–178, 178 Building the Empire State (Willis), 126 buildingSMART alliance, 345

# С

CAD (computer-aided design) files, 314-315 340 California Commissioning Collaborative change(s) cost of, 51, 51 management of, 35-36 resistance to, 258-261 clash detection exercise in, 205-207, 205-208 limitations of, 4–5 macro to micro focus, 197, 197-198, 208 model coordination and, 196 Navisworks and, 196-198, 197 search set exercise in, 199-205, 200-204 sequencing conflict in, 211-213, 212-213 clearance objects, 26 client alignment importance of, 117-118 in marketing BIM, 104-105, 106 closeout. see project closeout cloud-based model collaboration benefits of, 27, 208 coordinating construction and, 31, 32 cost estimation via, 24

CMAR (Construction Manager at Risk) delivery method advantages/challenges of, 54-55 BIM in, 55-56 process of, 52-54, 53 collaboration BIM-related savings and, 44 with DB delivery method, 58-59 education fostering, 350 Empire State Building and, 126 IPD method promoting, 62 via web meetings, 236 co-location, for conflict resolution, 27 color coding systems in construction, 228 project status by, 301-303, 303 Comments, field information in, 243-246, 244 - 246The Commercial Real Estate Revolution (Miller, Strombom, Iammarino & Black), 2, 20, 55, 134 commissioning definition/value of, 325 features of, 326-327, 327 process of, 326 munication jobsite offices and, 255 at kickoff, 139 between people, 77-79, 78-79 software systems and, 79-81, 80-81 comparison, of BIM-enabled projects, 351-352 composite modeling, 198-199 computer monitor, for conference room, 253 computer-aided design (CAD) files, 314-315, 340 concrete CO<sub>2</sub> emissions, calculating, 179-180 conference room features, 252-254, 253 conflict detection/resolution, 26, 26-27 conflict resolution path, 197 ConsensusDocs 301, 64, 65 constant deliverables, 315, 315-317, 316 constructability, 25-26, 25-27 constructability review Autodesk BIM 360 Glue in, 159-160, 159 - 163details leveraged in, 153-158, 154-157 overview of, 149–150, 150 plans leveraged in, 150-153, 151-153 constructible models, in DB delivery, 60-62

construction activity tracking in, 234, 235 better field information for, 238–239 BIM in, 192-193 changes in, 95 color coding systems in, 228 design and, 139-140, 140 fabrication and, 208-211, 210 feedback loops in, 226-227 field information in, 243-246, 244-246 future trends in, 340-341, 341 installation management in, 228-229 installation verification in, 232-233, 233 managing field issues in, 235-236 model coordination and, 194 safety in, 236-238, 237-238 schedules for, 213-217, 214-215 sequence simulation for, 221-226, 221-226 site coordination and, 194, 194-196 time predictability in, 281 virtual walk-throughs and, 346-349 construction management BIM and, 15 BIM manager role in, 43 changes and, 35-36 coordination activities in, 31 equipment tracking in, 37-38 future role of. 351–352 history of BIM in, 9–11, 10, 11, 13–1 knowledge management in, 40-42, 41 leadership buy-in of BIM, 42-43 managing facilities, 39–40,70 materials and, 37 project pursuit in, 16-19, 18 resolving punch lists, 39 scheduling in, 20-22, 21 utilizing mobile devices in, 32, 32-33 value of technology in, 2-4, 9 Construction Manager at Risk method. see CMAR (Construction Manager at Risk) delivery method construction-ready models, 343-345 contact sheets, 79 contractors BIM adoption by, 10–11, 10–11, 351 responsibilities of, 344 contracts. see also BIM addenda design, 319-320 in planning, 19-20

controlled environment, for prefabrication, 29 coordination in construction, 31 model-based, 69-71, 70-71 site, 194, 194-196 Core Collaboration Team, 79, 83 core deliverables, in marketing BIM, 105-107, 107Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry (Gallaher, O'Connor, Dettbarn & Gilday), 331 costs analyzing qualitative, 74-75 BIM-derived estimates of, 23-24, 23-24 controlling, 34-35, 35 of facilities operations, 308, 308-310 of mobile-enabled construction, 33 model-based estimates of. see model-based estimating of project changes, 51, 51 sharing history of, 171-172, 172 CPM (Critical Path Method) scheduling ineffectiveness of, 33 model-based scheduling and, 282-283 predictability in, 281-282 cross-platform integration, 7 customer-centric service importance of, 117-118 in marketing BIM, 104–105, 106 customized solution development, 6-7 Cyberwalk omnidirectional treadmill, 346-347

#### D

data analysis, in BIM, 27–29. see also analysis daylighting analysis, 184, 186 DB (Design-Build) delivery method advantages/challenges of, 60 BIM in, 60–62, 61 E-BIMWD addendum for, 65–66 process/features of, 56, 56–60, 59 DBB (Design-Bid-Build) delivery method advantages/challenges of, 50 BIM in, 50–52, 51 process/features of, 47–50, 48 for record BIM files, 320 DBIA (Design-Build Institute of America), 64, 65–66 DD (Design Development) phase incremental information for, 140-142, 141 - 142timing of information in, 143-145, 144 default settings custom settings vs., 206 in Navisworks, 219, 222, 222 Defining BIM—What Do Owners Really Want? (Reed), 119 delivery methods comparison of, 58 Construction Manager at Risk, 52-56 definition of, 46 Design-Bid-Build, 47-52, 48, 51 Design-Build, 56, 56-61, 59, 61 development of, 46-47 expected change in use of, 57, 95 Integrated Project Delivery, 62, 62-63 for record BIM files, 320 team selection and, 96 dependencies, DSM Matrix and, 145-148, 146 - 148design contracts, 319-320 estimating during, 171-175, 172-175 future developments in, 358–359 prioritizing information for, 145-148, 146 - 148scheduling, 139-145, 140-142, 144 time predictability in, 281 Design Development phase. see DD (Design Development) phase Design Development Quality Management Phase Checklist (AIA), 141 Design Management Guide for the Design-Build Environment (Pankow Foundation), 149 Design Structure Matrix. see DSM (Design Structure Matrix) Design-Bid-Build delivery method. see DBB (Design-Bid-Build) delivery method Design-Build delivery method. see DB (Design-Build) delivery method Design-Build Institute of America E-BIMWD, 64,65-66 Detailed Analysis Plan, 83 details in constructability review, 153-158, 154-157 developing tool, BIM as, 99-101 digital documents, in construction, 32

digital plan room extracting files in, 274-275, 275 hyperlinking documents in, 275–276, 276 hyperlinking RFIs in, 277-278, 277-278 page labels for, 272-274, 273-274 slip-sheeting in, 278-279, 279-280 tool belt for, 272 direct replacement strategy in selecting technologies, 7 document control 2D information and, 270-272, 271 digital plan room for. see digital plan room document coordination, 69-71 documents, artifact deliverables as, 310-311, 311 doors, creating Assemble Systems and, 286-287, 287-288 importing search sets for, 288-290 intuition in, 234-286, 285-286 material status for, 299-301, 300 summary of process, 304, 304 uploading information/barcodes for, 295-298, 296-298 visualizing equipment status for, 301–303, 301-303 Draft Day (movie), 94-95 drones, for safer construction, 237-238 DSM (Design Structure Matrix) dependency sequence and, 147–148 elements/mapping in, 146 utilizing, 145-148 Dubler, Craig, 84, 139, 259

#### Ε

E-BIMWD documents (DBIA), 64, 65–66
education, future of BIM and, 349–351
EERE (Office of Energy Efficiency & Renewable Energy), 180
efficiency in scheduling, 215
Empire State Building builders of, 125
collaboration and, 126
innovations and, 126–129, 127–128
planning/prefabrication of, 129–132, 130–131
Empire State Building: The Making of a Landmark (Tauranac), 125
enabling behaviors, in successful BIM, 7–8 energy analysis. see also sustainability Sefaira for, 182-187, 182-188 team input into, 84-85 engineered-to-order (ETO) components, 209 Engineering Drawing: Practice and Theory, 2nd Edition (Carter & Thompson), 135-136 Entering the Brave, New World (Larson & Golden), 63 environmental delays, 29 equipment mapping to BIM 360 Field, 291-295, 292-295 tracking, 37-38 estimating Assemble Systems in, 286-287, 287-288 during design, 171-175, 172-175 discrepancies in, 170-171, 171 model-based, 164-169, 164-169 traditional methods, 163-164 ETO (engineered-to-order) components, 209 Evans, Richard L., 176 expectation bias, 83, 139 expectations, 83-85 extracting files by label, 274-275, 275

# F

fabrication with BIM, 208-211, 210 facilities management, 39-40, 40 artifact deliverables in, 310-311, 311, 313, 314-315 benefits of BIM in, 323-325 BIM training for, 332-333 defining LOD in, 321 details, 300, 300 hybrid approach to, 315-317 information management for, 316 life cycle logistics in, 330–332 maintaining BIM files in, 329-330 model maintenance in, 333-334 model-based, 73, 73-74 uploading information for, 295-297, 296-297 facility operating costs, 308, 308-310 fast delivery, via DB delivery method, 58 feedback loops, 226-227 field issue management better information for, 238-239 overview of, 235-236, 291

field personnel, BIM training for, 261-262, 263 field-controlled record models, 264–265 file extraction by label, 274-275, 275 file links generating, 296, 296 for video embedding, 250-251, 250-252 file naming conventions, 87-88 five-dimensional BIM. see model-based estimating flat-panel television, for conference room, 253 flow-line schedule, 282, 283 folder structure, 86-87 Ford, Henry, 124, 128, 132 four-dimensional BIM. see model-based scheduling Friedman, Thomas L., 258 Fuller, George A., 126 future of BIM BIM teamwork and, 354–356, 355 construction manager role in, 351-354 education and, 349-351 industry trends and, 340-341, 341 interoperability in, 345 new process in, 356-357 opportunities in, 97, 357-358, 357-359 past predictions and, 340 prefabrication and, 342-343, 342-343 relationships in, 359-360 roles/responsibilities in, 343-345 virtual walk-throughs and, 346-349, 346-349 future owner challenges, 322, 323

# G

G201/G202 documents, 66
Gantt bar scheduling method, 21, 34
Gates, Bill, 240
GBXML (Green Building XML Schema), communication via, 80
glazing, energy analysis of, 182–184, 183–184
Gleason, Duane, 171
Glue application. see Autodesk BIM 360 Glue
GMP (guaranteed maximum price), CMAR delivery and, 53
Goals and Use/Objectives chart, 76, 76
Golden, Kate, 63
Gourley, Sean, 359 *Green BIM* (Krygiel & Nies), 181
guides, for BIM planning, 19

# Η

hard bid jobs, integrated projects vs., 96 hardhat barcoding, 37–38 Hardin, Sy, 67 Hoffer, Eric, 7 *How Buildings Learn: What Happens After They're Built* (Brand), 359 Howell, Greg, 125 hyperlinked documents, **275–276**, 276 hyperlinked RFIs, **277–278**, 277–278

iMRI (intraoperative magnetic resonance imaging) installation, 265-270 incremental dilemma, 143-145 increments, design DD checklist for, 142 information for, 140–142 schedule, 141 timing of information for, 143-145, 144 in-field videos, 236 information amount/compilation of, 331-332 chaos, 144 Comments for, 243-246, 244-246 delivery of needed, 336–337 early exchange of, 17 future processing of, 359-360 increased sharing of, 15 potential methods for, 242, 243 for record BIM files, 320-321 Redline Tags for, 248-249.248-249 Redlining tool for, 246–247, 247–248 required for DD, 140-142, 141-142 risk of too much, 15 timing of, 143–145, 144 traditional relaying of, 239-240 information analytics, 27-29 information backbone, 335, 335 information exchange plan adoption of, 332 in BIM execution plan, 81-83, 82 informational database, BIM as, 15 information-centric innovations, 94 innovation at AEC Hackathon, 100, 100 BIM as tool for, 99-101 challenge of, 101 creating change, 5

Empire State Building and, 126–129, 127 - 128growing need for, 352 importance of, 18-19 The Innovation Paradox (Phillips), 260 installation accuracy in, 234 coordination, 69-71 management, 228-229 installation verification in construction, 210 laser scanning for, 265-270 methods for, 232-233, 233 instance properties, 166-167, 167 Integrated Practice in Architecture (Elvin), 2, 254 Integrated Project Delivery method. see IPD (Integrated Project Delivery) method integrated projects BIM for fabrication as, 210 George A. Fuller Company and, 126 hard bid jobs vs., 96 integrated teams in **C**<sup>M</sup> construction management, 2–3 in DB delivery method, 61–62 importance of, 95–96 interoperability future role of, 345 of model data, 334-337 of technologies, 10, 12 interrelationships, data, 359-360 intraoperative magnetic resonance imaging (iMRI) installation, 265-270 intuition in BIM Assemble Systems and, 286-287, 287-288 creating doors and. see doors, creating development of, 284 mapping equipment and, 291-295, 292-295 in visualizing equipment status, 301-303, 301-303 inventory management, 37 IPD (Integrated Project Delivery) method advantages/challenges of, 62-63 BIM in, 63 process/features of, 62, 62

#### J

Jackson, Barbara J., 46–47 JIT (just-in-time) approach to material management, 37 job trailer as communication hub, 255 conference room in, 252–254, 253 plans/specifications hub in, 254 as server, 254–255 setting up, 255–256 Jordani, David, 322 JVs (joint ventures), 8

#### Κ

kaizen, in creating change, 5 kickoff meeting. *see* Bim kickoff meeting knowledge gap, bridging, 261, 261 knowledge management platforms, 40–42, 41

# L

labels, page creating, 272-274, 273-274 extracting files by, 274-275, 275 large computer monitor, for conference room, 253 Larson, Dwight, 63 laser scanning BIM overlay and, 35 installation verification with, 232-23 265 - 270phased for quality control, 31 lateral brace frame, 70 LBS (location-based scheduling) features of, 282, 283 lean practices and, 229-231 model-based scheduling and, 282-283 LCI (Lean Construction Institute), 125 Leading Change (Kotter), 138 lean practices Empire State Building and. see Empire State Building features of, 124, 124-125 LBSs and, 229-231 LED/LCD flat-panel screen, for conference room, 253 LEED (Leadership in Energy and Environmental Design), 178, 178 Leroy Lettering tool, 134–135, 135 life-cycle building costs, 73, 73 life-cycle information for doors, 76 line-of-balance schedule view, 21

Links tool, 250–251, 250–252 location-based scheduling. see LBS (location-based scheduling) LOD (level of development) analysis and, 74-75 in BIM addenda, 64, 64 coordination and, 69-70 cost estimation and, 72 dangers of undefined, 70-71 definition of, 68 facilities management and, 73-74, 321 level descriptions, 68-69, 70 matrix, 71 scheduling, 72, 148-149, 149 logistics BIM and, 22–23 for facilities management, 330-332 The Long Term Costs of Owning and Using Buildings (Evans, Haryott, Haste & Jones), 308 Looking a. Type: The Fundamentals (Martin), 284 Luckey, Palmer, 347

# M

MacLeamy curve, 51, 51, 141 manufacturing industry, 36, 358 marketing BIM client alignment in, 104-105, 106, 117-118 core deliverables in, 105-107, 107 demonstrating value, 98-99 evolution of, 92-94, 93 guidelines/tips for, 118-120 innovative proposals in, 118 key factors in, 97-98 showing results, 102, 103 stage of adoption and, 99-101, 100-101 summary of, 121 team selection in, 94-96 material management overview of, 37 process of, 228-229, 231-232 Vico Office for, 232 MATs (multiple analysis test beds), future implemention, 358-359 Max Planck Institute, 346-347 Mazria, Ed, 176 McConahey, Erin, 360 media richness theory, 78 memorandum of understanding (MOU), 20

metrics, justifying ROI, 102, 103 Microsoft Word, 79–80, 80 Miller Act (1935), 47 mobile-enabled construction benefits of, 32, 32-33 controlling schedules with, 33-34 model coordination review, 25 model links, managing field issues, 236 model maintenance, 333-334 model origin, 86 model storage, 86 model-based analysis, 74-75 model-based coordination, 69-71, 70-71 model-based estimating discrepancies in, 170-171, 171 evolution of, 164 overview of, 72 process of, 164-169, 165-169 model-based facilities management, 73, 73 - 74model-based scheduling overview of, 21-23, 72 simulations, 116, 116-117, 118 value of, 281, 281-283, 283 modeling advanced training, 263-265 basic training, 263 composite, 198-199 models evolution of, 341 fabrication of, 208-209 record, 263-265 uploading to Glue, 159-160, 159-163 Moore, Rex, 229-231 MOU (memorandum of understanding), 20 multiple analysis test beds (MATs), future implementation, 358-359 Musk, Elon, 35

# Ν

Navisworks. see Autodesk Navisworks Navisworks Manage, 301–303, 301–303 The New Quotable Einstein (Calaprice), 310 NIBS (National Institute of Building Sciences), 336 Notes on the Construction of the Empire State, 126–128 NRCA (National Roofing Contractors Association), 153 The NRCA Roofing Manual: Membrane Roof Systems, 153, 158

# 0

object-based parametric modeling technologies, 9-10, 51, 341 OCR (optical character recognition), 272 Oculus Rift AR headset, 115, 347-349 Office of Energy Efficiency & Renewable Energy (EERE), 180 omnidirectional treadmills, 346-348, 346-349 Onuma System, 24, 24 open source programming, 335 opportunities, for BIM, 357-358, 357-359 organizational behaviors, in successful BIM, 8 origin, model, 86 overlays installation verification with, 232-233, 2.3.3 phased for quality control, 319 owners benefits of BIM, 317-318, 323-325 BIM performance and, 260 challenges for future, 322, 323 record BIM files for, 318-320, 319 The Owner's Dilemma: Driving Success and Innovation in the Design and Construction Industry (Bryson), 117-118

#### Ρ

page labels creating, 272–274, 273–274 extracting files by, 274–275, 275
parametric modeling, 11, 51, 341
Parkinson, Robynne Thaxton, 65–66
PDF (Portable Document Format) files as artifact deliverables, 311–312, 313 smart, 116
Penn State BIM Project Execution Planning Guide, 75–77, 84
people, communication between, 77–79
phone calls, 79
photogrammetry, 237–238, 320
pile on method in selecting technologies, 5–6, 10

plan views, 150-153, 151-153 plans job trailer for specifications and, 254 site logistics and, 188, 188-190, 194, 194-195 using contracts in, 19-20 preconstruction analysis and. see analysis BIM kickoff for, 136–139 constructability and. see constructability review DSM and, 145-148, 146-148 estimates and. see estimating lean practices and, 124, 124-125 meetings, 136 new technology and, 132-134, 133 scheduling design in, 139-145, 140-142, 144 scheduling LOD in, 148-149, 149 site logistic plans in, 188, 188-190 use of BIM in, 134-136, 135 predictability, in construction, 281, 281-282 prefabrication with BIM, 29-31, 342-343, 342-343 for Empire State Building, **129–132**, *130–131* leveraging models for, 357, 357 "The Stack" project, 30 preinstallation meetings, 137 The Principles of Scientific Management (Taylor), 282, 305 process first strategy in selecting technologies, processes future, 356-357 in successful BIM, 4-5, 5 professionals, value of, 360 Profitable Partnering for Lean Construction (Cain), 31 project closeout artifact/constant deliverables in, 329 commissioning in, 325-327, 326-327 overview of, 39-40 punch lists in, 327-329, 328-329 project construction feasibility, 149-150 project management schedules, 20-22 project pursuit augmented reality simulations, 115, 115 images, in RFP response, 110, 111-112 virtual reality simulations, 113-114 project schedule, team selection and, 96 project visualization, 16, 18 proven tool, BIM as, 99-101 Pull Plan software, 34, 234, 235

punch lists BIM and, **327–329**, 329 managing, **39** model callout, 39 purpose of, **327** in technology comparison, 103

# Q

QR codes BIM 360 Field and, **297–298**, 298 comparison of, 299 potential of, 341

#### R

radio-frequency identification tags. see RFID (radio-frequency identification) tag Raskob, John, 125 rating systems, building, 177-178, 178 Real Time Analysis, 182, 183 record BIM files creating, 318 features of, 318 integrating, 320-321 part of design contract, 319-320 record models architect-controlled, 264 creating, 263-264 field-controlled, 264-265 third party-controlled, 265 Redline Tags, 248-249, 248-249 Redlining tool, 246–247, 247-248 relationships, future, 359-360 Relentless Innovation: What Works, What Doesn't—And What That Means for Your Business (Phillips), 258 remodeling facilities, future, 359-360 The Republic of Technology: Reflections on Our Future Community (Boorstin), 15 request for proposal response. see RFP (request for proposal) response requests for information. see RFIs (requests for information) resource-loaded schedule view, 21

responsibilities contractor/architect, 344 subcontractors, 344-345 results, of implementing BIM, 102, 103 return on investment (ROI), 102, 107 Revit. see Autodesk Revit Rex Moore's production system, 229–231 RFID (radio-frequency identification) tags comparison of, 299 in construction, 195, 324 in facilities management, 324 **RFIs** (requests for information) DBB method and, 49–50 document control of, 270-272, 271 hyperlinking, 277-278, 277-278 limitations of, 239-240 technology comparison, 102, 103 RFP (request for proposal) response BIM-derived images in, 110, 111–112 other marketing tools in, 116 showing BIM capabilities in, 108-110, 109 simulations in, 112-113, 114 tailor-fit proposals in, 116, 116-117 virtual/augmented reality simulations in, 113-115, 115 RIBA (Royal Institute of British Architects), 345 risk-reducing strategies, 101, 101 ROI (return on investment), 102, 103

# S

safety hardhat barcoding for, 37-38 improving with BIM, 22-23, 236-238, 2.37 - 2.38Santa Maria Novella, 46, 46 schedule(s) BIM and, 20-22, 21 clash detection with, 211-213, 212-213 collaborative, 34 controlling with BIM/mobile tools, 33-34, 34 creating, 172-175, 172-175 exporting to text file, 171-172, 172 simulations. see simulations team selection and, 96 scheduling. see also model-based scheduling animation, 221-226, 221-226 construction, 213-217, 214-215

design, 139-145, 140-142, 144 LOD, 148-149, 149 search sets creating/attaching, 223-224, 223-224 creating/saving, 286-287, 287-288 importing, 288-290, 288-290 intuitive uses of, 290 Navisworks exercise with, 199–205, 200-204 security cameras, 195-196 Sefaira, for sustainability analysis, 182–187, 182-188 selection bias, 83 The Selection of Communication Media as an Executive Skill (Lengel & Daft), 77-79 selection sets, 199 sequenced clash detection, 211-213, 212-213 sequencing simulations in construction scheduling, 216-217 Navisworks creating, 221-226, 221-226 server, job trailer as, 254-255 The 7 Habits of Highly Effective People (Covey), 138 Shreve, Lamb & Harmon, 126 Simuson, Scott, 7 simulations clash detection with, 211-213, 212-213 in RFP response, 112–113, 114 sequencing, 216-217, 221-226, 221-226 virtual/augmented reality, 113-115, 115 site coordination, 194, 194–196 site logistics BIM and, 22, 22–23 plans, 188, 188-190, 194, 194-195 Skyscrapers and the Men Who Build Them (Starrett), 129, 135 slip-sheeting, digital, 278-279, 279-280 smart PDFs, 116 SmartMarket reports, 33 BIM use, 150 lean practices, 124-125 Project Delivery Systems, 56 Smith, Al, 125 software systems communication via, 79-81, 80-81 construction scheduling, 217-221, 218-220 information via, 336 integration/consolidation, 345 learning about, 350 new BIM process and, 356-358

The Spirit of Kaizen: Creating Lasting Excellence One Small Step at a Time (Maurer), 5 The Stack project, 30 Starrett Brothers & Eken collaboration of, 126 Empire State Building and, 125 innovations of, 126–129 planning/prefabrication of, 129-132 Sterner, Carl, 188 Steward, Don, 145 storage, model, 86 subcontractors BIM performance and, 260 CAD fabrication model by, 61 new responsibilities of, 344-345 sustainability analysis of, 180-181, 181 building codes and, 179, 179 building rating systems and, 177-178, 178 Sefaira analysis of, 182-187, 182-188 swap out method in selecting technologies, 6

# T

tablet devices, in construction, 32, 32 takeoff, model-based estimating as, 72 Taylor, Frederick Winslow, 281-282 team engagement, 16, 17 team integration in BIM construction management, 2 - 3in DB delivery method, 61-62 importance of, 95–96 team selection future importance of, 351, 354-356 for marketing BIM, 94-96 technical expertise, 96 technology(ies) adopting new, 132-134, 133 client's requirements, 96 in construction management, 2-4 contractors adopting, 10-11, 10-12, 13 innovators, 352 selecting proper, 17-18 in successful BIM, 5-7 wearable, 22 templates, in BIM planning, 19

third party-controlled record models, 265 three-dimensional BIM, 15, 50-52 three-dimensional printers, 30-31, 116 three-dimensional tools, 15 three-legged stool of BIM, 4 time predictability in construction, 281 To Sell Is Human (Pink), 117 Today and Tomorrow (Ford), 124, 128, 132 tool belt, for digital plan room, 272 tools, for BIM planning, 19-20 touch-screen LED TV, in conference room, 253 The Toyota Way (Liker), 133-134 TPS (Toyota Production System), 133-134 training advanced, 263-264 basic, 263 facility managers, 332-333 field personnel, 261-262, 263 uses of BIM, 265 trending, cost, 172-175, 173-175 Triumph of the Lean Production System (Krafcik), 124 trust, DB delivery method and, 58-59, 59 2010 Buildings Energy Data Book (Dept. of Energy), 176, 177 The 2030 Challenge, 176-177 type properties, in Revit schedules, 165-167, 166-167

# U

Umstot, David, 104–105, 108 USGBC (United States Green Building Council), 178, 178

# V

value, demonstrable, 98–99 VDC (virtual design and construction) BIM, 209–210, 210 VDE (virtual desktop environment) solutions, 341 video embedding, links for, 250–251, 250–252 Virtual Builders certification, 360–361, 361

- virtual construction manager. see BIM manager Virtual Design and Construction: New Opportunities for Leadership (Bedrick), 319 virtual modeling, 68–69 virtual walk-throughs, 346–349, 346–349 Virtuix Omni's omnidirectional treadmill, 348, 348–349 visions, creating, 138–139
- VR (virtual reality) simulations, 113-115, 115

#### W

- waterproofing details in design, 153–158, 154–157 WBS (work breakdown structure),
  - 230
- The World Is Flat: A Brief History of the Twenty-first Century (Friedman), 159
- worry-free owners, in DB delivery method, 57–58