

Index

a

- AA6061 aluminum alloy face milling
 - 88
 - ABAQUS Standard software 26
 - ABC optimization method 205
 - abrasive water jet center Omax 2626
 - 119
 - abrasive water jet cutting (AWJC) 113
 - cutting head working principle 113
 - effect of machining parameters on
 - quality characteristics 126–127
 - experimental setup 118–120
 - main components 113
 - material machinability 114
 - mathematical modeling 120–126
 - parameters 113
 - process optimization 127–129
 - purpose and methods 115–117
 - quality parameters 113
 - surface quality coefficient 115
 - tapper error 114
 - traverse feed rate 114
 - absorption mechanisms, laser 133
 - acetone 227
 - adaptive fuzzy logic system 228
 - adaptive neuro fuzzy inference system (ANFIS) 101, 102
 - addendum surfaces 34–36
 - additive manufacturing (AM)
 - technology 8, 10, 194
 - architectural and structural design
 - 265
 - art and fashion 265
 - CAD creation 263
 - development 9
 - electron beam 263
 - 4th industrial revolution 266
 - fuel cells 265
 - laser-based AM process 263–264
 - medical field 265
 - methods 304
 - modeling 267
 - robotics 265–266
- adhesion phenomena 85
 - adjoint state variable method 33
 - advanced manufacturing (AM)
 - technology 262–264, 295
 - challenges in 288–294
 - dynamic programming 283
 - game theory 281–282
 - mathematical methods for
 - 279–280
 - simulation and Monte Carlo
 - technique 282–283
 - sustainability
 - of applications 275–276
 - comparative advantages 277–279
 - of process and equipment 273–275
 - waiting line theory 281

- aircraft cabin door casting simulation
 - 63–64
 - AISI 1019 steel 88
 - AISI 1023 steel plates 201
 - α -Al₂O₃ 226
 - aluminum 6061 114
 - aluminum alloys 85
 - aluminum alloy 6082T6 101
 - aluminum composite coatings 222
 - Amontons and Coulomb friction law
 - 243
 - analysis of variance (ANOVA) 86, 91, 229
 - Anisimov model 143
 - anisotropy parameter 28
 - area-concentrated search (ACS) strategy
 - 197
 - artificial bee colony (ABC) algorithm
 - 241
 - artificial bee colony optimization
 - (ABCO) algorithm 195,
 - 198–199
 - artificial intelligence 288
 - artificial neural network (ANN) 86, 194, 241
 - aspects defects 43
 - ASP YSZ coatings 222
 - atmosphere control HIP treatment
 - 170
 - atmospheric plasma spray (APS) 217
 - coated Al₂O₃ 229
 - process optimization and modeling 228–230
 - austenitic stainless-steel 116
 - AutoCAST 50
 - automatic tractor mounted ESAB CPRA
 - 800S SAW machine 202
 - automation 2
 - AWJC. *See* abrasive water jet cutting (AWJC)
 - AZ61A magnesium alloy parts
 - 89–98
- b**
- bending and unbending problem
 - 29–30
 - bending moments 27–29
 - biofouling effect 261
 - bio-polymer polylactic acid (PLA) 278
 - blank shape optimization procedure
 - 34
 - bond enthalpy 133
 - Box-Behnken design 88
 - of experiment 39
 - buildup edge 85
- c**
- carbon fiber reinforced plastics (CFRP)
 - 115, 119
 - carrier gas 222–223
 - casting
 - AutoCAST 50
 - computer-aided design 49
 - computer aided engineering 49
 - Flow-3D 50
 - fluid flow model 53
 - FT-Star 50
 - heat transfer model 50
 - initial and boundary conditions 61
 - MAGMA 50
 - microstructure simulation model
 - 58, 74
 - mold filling simulation 62
 - ProCAST 50
 - simulation-based 49
 - stress simulation model 56, 70
 - cellular automaton (CA) 59
 - cemented carbide tools 85
 - central composite design (CCD) 88, 89, 118
 - centrifugal casting 63, 64
 - chemical free energy density 60
 - chemical vapor deposition (CVD) 138
 - cladding and diffusion bonding
 - 174–175

- classical bacterial foraging optimization (CBFO) 195–197
- classical nucleation theory (CNT) 58
- coal-fueled steam motor 4
- Coble creep 177
- CO₂ laser 133
- CO₂ laser-welding process 116
- composite materials 115
- computational fluid dynamics 54
- computer aided design (CAD)/computer aided manufacture (CAM) 134
- computer numerically controlled (CNC) machine 263
- container/canister size optimization, HIP
 - macroscopic approach 179–182
 - microscopic approach 182–183
 - soft computing 183–184
- continuity equation 54
- control theory 260
- convective heat transfer coefficient 51
- conventional manufacturing 262
- Coulomb friction law 244
- Cryptographic methods 260
- cubic B-spline parametrization 33
- cumulative strains 22
- cutting temperature 85
- Cyber-Enabled Manufacturing system 6
- cylinder head cover filling simulation 62–63
- d**
- deep drawing 44
- “defect-free” workpiece 44
- DEFORM2 245
- deformation path prediction 27
- defuzzification 100
- Demeri cylindrical cup 24–26
- Demeri Springback benchmark 38
- dendrite microstructures simulation 76–79
- Densal HIP process 170–171
- densification of product 172–173
- density function method 34
- Design Expert 2019 software 127
- design of experiment (DoE) 116
- diamond-like-carbon (DLC) 246
- difficult-to-cut material Inconel-800 194
- diffusion interface 59
- diode laser 133
- directional solidification 67
- Direct Metal Deposition technique 7
- Dirichlet boundary conditions 61
- discrete mathematics 260
- dispersed porosities 64
- DMG LASERTEC 60 HSC Q-switched Nd:YAG 148, 152
- drawbead restraining forces 36–38
- duplex stainless steel UNS 318 03 173
- dynamic programming 283
- DZ466 nickel-based superalloy 74
- e**
- elastic strain 57
- elastoplastic bending 29
- elastoplastic stiffness matrix 58
- electron beam 263
- electron energy loss spectroscopy (EELS) 153
- element-free Galerkin method 240
- enthalpy of the plasma 222
- equivalent plastic strain 22
- Eulerian volume of solid (VOS) 240
- evaporation-induced recoil momentum 143
- evolutionary algorithms 194
 - artificial bee colony optimization 198–199
 - classical bacteria foraging optimization 196–197

- evolutionary algorithms (*contd.*)
 - invasive weed optimization 198
 - particle swarm optimization 195–196
 - self-adaptive bacteria foraging optimization 197–198
- evolutionary neuro-fuzzy system 101
- evolutionary structural optimization (ESO) 34
- excimer laser 133
- explicit dynamics algorithm 16
- explosive boiling 136
- extended product life 274

- f**
- face milling 83
- factor analysis method 51
- factorial design 86
- Factory Act 3
- fast nonlinear procedures, in stamping and hydroforming 16–20
- FASTSTAMP© 33
- finite difference method (FDM) 52–53, 55
- finite element method (FEM) 57
- flameless cold/kinetic spray 217
- flame spraying process parameters 229
- flank buildup 85
- Flow-3D 50
- fluid flow model
 - continuity equation 54
 - free surface track 55–56
 - Navier–Stokes equations 54
 - numerical algorithm 54–55
- fluidized carrier gas 219
- fly ash-Al₂O₃ coating 226
- fly ash–aluminum coatings 221
- fly ash-quartz-ilmenite composite coatings 223
- fly ash-SiC composite coatings 230
- forced convection 51
- forming limit diagram (FLD) 40, 242
- forming process 237
- 4D printing technology 290
- Fourier's law 50
- fourth industrial revolution (4IR) 257, 266
- free surface track 55–56
- friction 243–245
 - coefficient 243
 - evolution 243
- FT-Star 50
- furnaces 164–165
- fused deposition modeling (FDM) 256
 - optimization model 200–201
 - optimization of parameters 206–207
 - technical specifications 200
- fuzzification 99
- fuzzy inference systems (FIS) 99
- fuzzy logic 86
 - internal structure of FIS 100
 - machining 101
 - membership functions 99
 - surface roughness in magnesium milling 102–106
- fuzzy-nets-based adaptive control system 101
- fuzzy technique 194

- g**
- game theory 281–282
- gas handling 165
- gas hole defects 64
- gas impregnation equipment 168, 169
- gas laser 255
- gas pressure bonding 157
- Gaussian integration formula 58
- gbest 195
- genetic algorithm (GA) 241
- geometrical defects 43
- geometrical mapping algorithm 17, 18
- geometric stiffness matrix 57

- Ginzburg-Landau free energy
 functional 60
- global diffuse response surface
 approximation 43
- grain boundary diffusion 177
- graphite 138
- graphite heating elements 164
- Grashof number 51
- gravity acceleration 51
- gravity casting process 63, 64
- gray relational analysis 230
- green process 273
- grey-fuzzy logic 98–106
- h***
- hadfield steel 116
- hardened AISI 4140 steel 88
- hardening coefficients 28
- heat affected zone (HAZ) 135
- heat conduction 50–51
- heat conduction partial differential
 equation 52
- heat convection 51
- heat flux density 51
- heat radiation 51–52
- heat transfer model
 finite difference method 52–53
 heat conduction 50–51
 heat conduction partial differential
 equation 52
 heat convection 51
 heat radiation 51–52
- Hencky integrated law 17
- heterogeneous nucleation 58
- heuristic techniques 284
- high-level waste (HLW) 170
- high-rate solidification (HRS) 67
- Hill anisotropic plasticity criterion 22
- HIPed duplex stainless steel 174
- hollow bar stress simulation 71
- homogeneous nucleation 58
- homogenization method 34
- hoop strain 25
- hoop stress 28
- hot isostatic pressing (HIP)
 atmosphere control HIP treatment
 170
 cladding and diffusion bonding
 174–175
 Densal HIP process 170–171
 densification of product 172–173
 gas ipregagnation equipment 168
 higher size equipment 167
 liquid HIP 171
 near net shape (NNS) parts 173–174
 nuclear waste treatment 169–170
 optimization 176–184
 powder metallurgy 159–166
 preheating equipment 170
 Sinter HIP 168–169
 technology positioning 159
 typical installations 175–176
 uniform rapid cooling 167
 uniform rapid quenching 168
- household-based manufacturing 2
- human-robot interaction (HRI) 266
- hybrid simulation 267
- hydroforming 44
- i***
- implicit Newton-Raphson algorithm
 16
- implicit statics algorithm 16
- improved inverse method 27–31
- improved resource efficiency 274
- Inconel-800 202–203
 difficult-to-cut material 194
 turning of 202–203
- industrial stamped parts 20
- inlet boundary conditions 62
- Integrated Manufacturing Technology
 road mapping project (IMTR)
 267
- interfacial energy density 60

internet of things (IoT) 253
 invasive weed optimization (IWO)
 195, 198
 IWO search algorithm 205

j

JFE Intelligent Multistage Forming
 (JIM-FORM) 246

k

kerf geometry 116
 kerf taper angle 116, 126
 kinematic hardening 29
 kinematic viscosity 51
 kinetic energy 223
 Kistler 9272 dynamometer 89
 Kurz–Giovanola–Trivedi (KGT) kinetic
 equation 59
 Kuznetsov data equation 143

l

Lankford anisotropy coefficient 39, 40
 laser ablation 135
 laser additive manufacturing (LAM)
 304
 aerospace applications 268–270, 294
 biofouling effect 261
 challenges in 290–293
 classification of 254, 261
 convolutional neural network models
 (CNN) 256
 3-D computer-aided design (CAD)
 model 256
 detection and correction methods
 260
 economic competitiveness 259
 economic sustainability and social
 sustainability 257
 environmental sustainability 257
 fine arts applications 271–273, 294
 fused deposition modeling (FDM)
 256

graphical classification of 303
 investment and applications
 258
 laser solid freeform fabrication
 (LSFF) technology 255
 linear programming 260
 mathematical methods 259
 medicinal applications 270–271,
 294
 modeling and simulation of
 284–288
 planning and production 259
 stochastic modeling 260
 technology improvement 259
 trends and benefits 257
 laser assisted chemical vapor deposition
 134
 laser attenuation 142
 laser cleaning 272
 laser energy density/flux 141
 laser micro machining
 complex 3D freeform surfaces
 144–151
 process parameters 135–137
 recoil pressure in the evaporation
 stage 140–144
 topographical modeling 137–140
 laser solid freeform fabrication (LSFF)
 255
 laser source selection 133
 lattice diffusion 177
 LAVA-P code 229
 laws of thermodynamics 4
 lightweight alloys machining 85
 liquid expansion coefficient 51
 liquid HIP (LHIP) 171
 liquid-metal cooling (LMC) 67
 liquid-vapor phase forming bubbles
 136
 liquid velocity 51
 Lobatto integration scheme 28
 Lobatto points 29

- local free energy density 60
- Lotfi A. Zadeh theory of fuzzy sets 98
- m**
- machining 88
- machining parameter effect on quality
 - characteristics 126–127
- MAGMA 50
- magnesium 85
- magnesium based alloys 85
- marker-and-cell (MAC) algorithm 55
- material elastic modulus matrix 57
- material machinability 114
- material reflection factor 142
- mathematical methods 259, 279–284, 294, 303
- mathematical models 279
- mathematical optimization problem 33
- Maxwellian velocity distribution 142
- mean absolute percentage error (MAPE) 106
- melt expulsion 136
- melting index (MI) 226
- Merchant's model for the cutting force 86
- metal artefacts 272
- metal/ceramic/cermets coating 217
- metal forming
 - artificial bee colony algorithm 241
 - artificial neural network 241
 - AutoForm 239
 - coatings 246–247
 - Deform 239
 - element-free Galerkin method 240
 - Eulerian volume of solid 240
 - forming limit diagram 242
 - friction 243–245
 - genetic algorithm 241
 - materials used in 238–239
 - micro-mechanics 247
 - overview of parameters 237
- Pam-Stamp 239
- QForm 239
- sheet manufacturing 239
- spring-back 241
- tool wear 245–246
- wrinkles defect 240
- metallic sheet profile 21
- methyl alcohol 227
- micro-mechanics 247
- microstructure of coating 221
- microstructure simulation model
 - cellular automaton 59
 - nucleation model 58–59
 - phase-field method 59–61
- mild steel weld wire 201
- milling
 - chip geometry 83
 - cutting edge angle 83
 - face milling 83
 - fuzzy logic 98–106
 - lightweight alloys 85
 - response surface methodology 87–98
 - surface quality 84
 - surface roughness 86
- minimum quantity lubrication (MQL) 202
- MINITAB V statistic tool 229
- modeling and simulation (M&S) 267–288
- modified cell capture and decentered square growth algorithm 59
- mold filling simulation
 - aircraft cabin door casting simulation 63–64
 - cylinder head cover filling simulation 62–63
- molybdenum coatings on MS substrate 229
- molybdenum heating elements 164
- Mo-NiCrBSi coatings 225
- Monte Carlo method 283

multistage inverse method (MIM)
20–26

n

Nabarro–Herring mechanism (or Coble
creep) 177

nanolaminated TiHfN/CrN + CrN
coating 247

nanosecond/femtosecond pulses
135

natural convection 51

Navier–Stokes equations 54

Nd:YAG laser 133

near net shape (NNS) parts 173–174

Neumann boundary condition 62

Newton's law of cooling 51

nickel-based single crystal superalloy
blade 74

NiCrAlY coatings 231

non-linear modulation index 198

no-slip boundary condition 62

nuclear waste treatment 169–170

nucleation model 58–59

nucleation rate 59

nucleus density 59

Numisheet93 30–31

conference 30

Nusselt number 51

o

optimization

of addendum surfaces 34–36

of drawbead restraining forces
36–38

of hydroforming process parameters
41–43

of material parameters 39–41

of tools geometry 38–39

organic solvents 227

orthogonal length unfolding algorithm
17–20

outlet boundary conditions 62

oxygen resistant Kanthal heating
elements 164

p

parameter optimization 69–70

parameters initialization 203–206

particle swarm optimization (PSO)
195

pbest 195

phase-field kinetic equation 61

phase-field method 59–61

plasma gas 222

plasma power 221

plasma spray ceramic/metal/cermet
coatings 220

plasma spray coatings

angle of powder injection 225

APS process optimization and
modeling 228–230

arrangement of 218–219

case study 230–231

mass flow rate of powder 223–224

plasma gas 222

plasma power 221

powder feeder 219

powder related variables 225–227

power supply module 219

schematic diagram of 218

schematic layout of plasma spray
setup 220

spraying angle 225

stand-off distance 224–225

substrate-related variables 227–228

water supply unit 219

plasma sprayed Al_2O_3 221

plasma sprayed fly ash 222

plasma sprayed fly ash-quartz-ilmenite
composite coatings 223

plasma sprayed YSZ coatings 221

plasma spray gun 218–219

plastic bending 29

plastic integration algorithm 22

- plasticity criterion 22
 - plastic strain 22, 57
 - plastic yield 177
 - PM HIP NNS offshore deep-sea manifold 173
 - Polyamide-6 200
 - polycrystalline cubic boron nitride (PCBN) 154
 - polycrystalline diamond (PCD) 85, 138, 140
 - powder metallurgy, HIP
 - auxiliary systems 166
 - canning 161–163
 - control system 165–166
 - furnaces 164–165
 - gas handling 165
 - melting and atomization 160
 - post processing 166
 - pressure vessel 164
 - stages 159–160
 - powder-related variables 225–228
 - power law creep 177
 - Prandtl number 51
 - preheating HIP equipment 170
 - pressure-dependent variable friction model 245
 - pressure vessel 164
 - primary gases 222
 - principal component analysis 230
 - ProCAST 50
 - prosumers 278
 - pulse-by-pulse evaluation approach 137
 - pulsed laser deposition 134
 - pulse laser ablation (PLA) 137
- r**
- radial basis function neural network-fuzzy logic (RBFNN-FL) 101
 - radial length development algorithm 17, 18
 - radial stresses 26
 - random fields 261
 - rapid prototyping process 194
 - rare-earth-doped laser 255
 - recoil pressure, in the evaporation stage 140–144
 - regression analysis 194
 - response surface methodology (RSM) 116, 194
 - AZ61A magnesium alloy parts 89–98
 - chi squared (χ^2) distribution 87
 - machining 88–89
 - null hypothesis 87
 - regression coefficients 87
 - Reynolds number 51, 223, 224
 - Robin boundary condition 62
 - robotics 265–266
 - root mean square error (RMSE) 106
 - RSM-based particle swarm optimization (PSO) technique 88
- S**
- scalar fields 59
 - secondary gases 222
 - self-adaptive bacterial foraging optimization (SBFO) 195, 197–198
 - Sequential Quadratic Programming algorithm 33, 39, 42
 - shape optimization 33–34
 - shear flow stress 244
 - shear friction model 244
 - shear friction stress 244
 - sheet hydroforming process 13
 - sheet manufacturing 239
 - sheet metal forming processes 13, 15
 - σ_{mises} stress distribution 72
 - signal-to-noise (S/N) ratio 194, 229
 - SIMPLE algorithm 55
 - simulated shrinkage distribution 64
 - simulation-based casting 49

- simulation models 260
- single crystal aero-engine blade 67
- single mode SPI pulsed Yb-doped fibre laser 144
- single-step inverse method 20
- Sinter HIP 168–169
- Small Medium Enterprises (SMEs) 289
- small shrinkage cavities 64
- solidification simulation 64–70
 - directional solidification 67
 - parameter optimization 69–70
- solid-state laser 133, 255
- SPI-H3 HM fibre laser 140
- SPI pulsed Yb-doped fibre laser 150
- Splats 217
- spraying angle 225
- springback optimization problem 39
- stainless steel 114
- stamping and hydroforming processes
 - aspects defects 43
 - design and optimization 14
 - direct methods 14–15
 - explicit dynamics 15
 - geometrical defects 43
 - geometrical mapping algorithm 17
 - implicit statics 15
 - improved inverse method 27–31
 - inverse methods 15
 - mathematical optimization problem 33
 - multistage inverse method (MIM) 20–26
 - numerical simulation 14
 - optimization of addendum surfaces 34–36
 - optimization of drawbead restraining forces 36–38
 - optimization of hydroforming process parameters 41–43
 - optimization of material parameters 39–41
 - optimization of tools geometry 38–39
 - orthogonal length unfolding algorithm 17–20
 - radial length development algorithm 17
 - shape optimization 33–34
- stand-off-distance 224–225
- statistical techniques 284
- statistical tools 253
- statistical variability 260
- stochastic modeling 260
- stress simulation model
 - dendrite microstructures simulation 76–79
 - finite element method 57
 - hollow bar 71
 - thermal elastoplastic model 57
 - turbine blade 71–74
- stress state integration 22
- submerged arc welding (SAW)
 - direct parameters 201
 - indirect parameters 201
 - optimization 207–209
 - optimization model 202
 - technical specifications 201
 - weldment properties 201
- subtractive manufacturing processes 194
- Sugeno inference method 102
- Surface properties, of engineering materials 217
- surface quality 85
 - coefficient 115
- surface roughness 86, 88
- swarm intelligent method 196
- Swift-Voce hardening law 42
- Swift-Voce law 39
- Synroc waste treatment plant (SyMo) 169

t

Taguchi and Design of Experiments (DoE) 228–230

Taguchi and grey relation 86

Taguchi design, of experiment 150

Taguchi L12 orthogonal array 150

Taguchi orthogonal design 194

Taguchi's L9 DoE 230

tapper error 114–116

Taylor's equation for tool life 86

TC11 titanium alloy 88

Televox robot 4

temperature coefficient 51

theory of elastoplastic bending 27

thermal conductivity 51

thermal elastic model 57

thermal elastoplastic model 57

thermal strain 57

thermal viscoelasticity model 57

thermal viscoelastic plastic model 57

thin-walled structure 63

3D computer-aided design (CAD) model 256

3D freeform surfaces
channels/grooves-like structures 144–147
experimental optimization 147–151
subsurface integrity 151–154

3D printing technology 7, 8, 255, 261, 262, 264

3D technology 261

Ti6Al4V alloy 88

TianJin Motor Dies Company Limited (TQM) 242

titanium alloy castings 63

titanium 6Al-4V 114

tool durability 84

tool steel 114

tool vibration 88

tool wear 88, 245–246

Toyota Motor Corporation 3

traditional/advanced manufacturing
consumer products 3
economic importance of 7–8
environmental impact and significance 6–7
Industrial Revolution 2, 5
joining of materials 2
metallic and non-metallic materials 2
sustainability of 9–10
utensils and decorations 2

transient γ -Al₂O₃ 226

transmission coefficient 142

tube hydroforming 41

turbine blade stress simulation 71–74

turning of Inconel-800 alloy
optimization 209–210
optimization model 203
surface integrity 202–203
surface roughness 203
technical specifications 203

Twingo car dashpot cup 33, 34

2D beams 27
bending 28

two factor interaction model (2FI) 121

u

unbending 29

uniaxial pressing 157

uniform rapid cooling (URC) 167

uniform rapid quenching (URQ) 168

uniform stretching 29

unit manufacturing process (UMP) 10

v

vacuum plasma spray (VPS) 217

vaporization 136

volume of fluid (VOF) method 55

W

waiting line theory 281
waste-free additive manufacturing
(AM) 194
water jet 113
water supply unit 219
wear, erosion and corrosion resistances
220–221
wear/erosion/corrosion/thermal
deteriorations 220
welding process 194
Westinghouse Electric Corporation 4

workpiece material machinability 84
wrinkle defect 240
wrought duplex stainless steel 174

Y

yield stress 22
Young modulus 28
Yttria-stabilized zirconia 228

Z

Zadeh theory 98
ZEISS ECLIPSE 550 equipment 120

