

Table of Contents

Preface	ix
Chapter 1. Authentication of FEM in Metal	
Cutting	1
Viktor P. ASTAKHOV	
1.1. Introduction	2
1.2. What seems to be the problem?	3
1.2.1. Practical use of metal cutting theories and the FEM	4
1.2.2. Need for proper simulations in metal cutting	5
1.3. FEM in metal cutting: issues that need to be addressed	9
1.3.1. Clear objectives of FEM simulations	9
1.3.2. Proper definition of the metal-cutting process and physically sound model	11
1.3.3. Work material model	15
1.4. Verification of the FEM in metal cutting	31
1.4.1. Common sense verification	33
1.4.2. Geometrical and metallographical similarities	34
1.4.3. Deformation similarity	36
1.4.4. Thermodynamic similarity	39
1.5. Bibliography	40

Chapter 2. Finite Element Modeling of HSM with Coated Tools	45
Muhammad FAHAD, Paul T. MATIVENGA and Mohammad A. SHEIKH	
2.1. Introduction	46
2.2. Metal cutting	47
2.2.1. Orthogonal cutting model	47
2.2.2. HSM	48
2.3. Cutting tools and coatings	51
2.3.1. Properties of hard coatings	53
2.3.2. Restricted contact length	55
2.4. Heat generation and distribution in machining	59
2.4.1. Estimation of heat source on the rake face	61
2.5. Finite element analysis (FEA) of the machining process	62
2.6. Experimental details	67
2.6.1. Temperature measurement	68
2.7. FE transient heat transfer analysis	70
2.8. Results and discussion	73
2.8.1. Cutting forces	73
2.8.2. Chip compression ratio	74
2.8.3. Tool-chip contact area and phenomena	75
2.9. Heat partition into the cutting tool	78
2.10. Conclusions	84
2.11. Bibliography	85
Chapter 3. Experimental and Numerical Modeling of Tube End-Forming Processes	93
Pedro A. R. ROSA, Luis M. ALVES and Paulo A. F. MARTINS	
3.1. Introduction	93
3.2. Theoretical background	96
3.2.1. Cold forming of metals and polymers	96
3.2.2. Extended finite element flow formulation	98
3.3. Experimentation	101
3.3.1. Stress-strain curve	101
3.3.2. Density	102
3.3.3. Critical instability load	104
3.4. Mechanics of deformation	105

3.4.1. Invert forming	105
3.4.2. Expansion and reduction.	113
3.4.3. Compression beading and nosing	117
3.4.4. End forming of PVC tubes	120
3.5. Innovative applications	126
3.6. Conclusions	131
3.7. Bibliography	133
Chapter 4. Finite Element Modeling of Rolling Processes	137
Uday Shankar DIXIT	
4.1. Introduction	137
4.2. Background on the FEM	140
4.3. Flow formulation of the cold rolling processes.	142
4.4. Updated Lagrangian formulation of cold rolling processes	154
4.5. Formulation for hot rolling processes.	161
4.5.1. Heat transfer equations	162
4.5.2. Material behavior.	164
4.6. Conclusions	168
4.7. Bibliography	169
Chapter 5. Finite Element Modeling of Ball-Burnishing Surface Treatments	173
Ainhoa CELAYA, Luis Norberto LÓPEZ DE LACALLE, Joseba ALBIZURI, Adrian RODRIGUEZ and Aitzol LAMIKIZ	
5.1. Introduction	173
5.2. Modeling of the ball-burnishing process.	177
5.2.1. Preliminary considerations	179
5.2.2. Simulation of the ball movement	183
5.2.3. Simulation results	186
5.3. Model validation	193
5.3.1. Experimental set up	193
5.3.2. Results and discussion	194
5.4. Summary and conclusions	196
5.5. Acknowledgments	197
5.6. Bibliography	198

Chapter 6. Combining the Finite Element Method and Artificial Intelligence in Manufacturing Modeling and Optimization	201
Ramón QUIZA and J. Paulo DAVIM	
6.1. Introduction	201
6.2. A brief overview on AI techniques.	203
6.2.1. AI techniques for modeling	203
6.2.2. AI techniques for optimizing	211
6.3. Approaches for combining the FEM and AI in machining research	214
6.3.1. Approaches for combining the FEM and AI in machining modeling	214
6.3.2. Approaches for combining FEM and AI in machining optimization.	219
6.4. An application sample	221
6.4.1. Problem definition	221
6.4.2. Simulation	223
6.4.3. Neural network-based modeling	226
6.4.4. Genetic algorithm-based optimization	230
6.4.5. Experimental validation	235
6.5. Concluding remarks	235
6.6. Bibliography	236
List of Authors	241
Index	245