

## Table of Contents

<b>Preface . . . . .</b>	<b>ix</b>
<b>Chapter 1. Environmental Impact in Micro-device Manufacturing . . . . .</b>	<b>1</b>
<b>Jong-Leng LIOW</b>	
1.1. Introduction . . . . .	2
1.1.1. Sustainability in micro-manufacturing . . . . .	5
1.2. Role of LCA . . . . .	7
1.2.1. Energy considerations in micro-device manufacturing methods. . . . .	10
1.3. Energy consideration in micro-manufacturing . .	14
1.3.1. Mass and energy balance . . . . .	14
1.3.2. Minimum work . . . . .	17
1.4. Energy consideration in micro-end-milling manufacturing . . . . .	22
1.4.1. Energy consumption with spindle and slide speed variation . . . . .	23
1.4.2. Efficiency of the machining process . . . . .	27
1.5. Conclusions . . . . .	28
1.6. References . . . . .	29
<b>Chapter 2. Cutting Tool Sustainability . . . . .</b>	<b>33</b>
<b>Viktor P. ASTAKHOV</b>	
2.1. Introduction . . . . .	33

2.2. Statistical reliability of cutting tools as quantification of their sustainability . . . . .	37
2.2.1. State of the art . . . . .	37
2.2.2. Cutting tool reliability concept . . . . .	38
2.2.3. Practical evaluation of tool reliability under invariable cutting conditions . . . . .	41
2.3. Construction of the probability density function of the tool flank wear distribution with tool test results . . . . .	50
2.3.1. Simplified method . . . . .	50
2.3.2. Statistical analysis of tool wear curves . . . . .	52
2.4. Tool quality and the variance of tool life . . . . .	58
2.5. The Bernstein distribution. . . . .	59
2.6. Concept of physical resources of the cutting tool. . . . .	67
2.7. References . . . . .	76
<b>Chapter 3. Minimum Quantity Lubrication in Machining</b> 79	
Vinayak N. GAITONDE, Ramesh S. KARNIK and J. Paulo DAVIM	
3.1. Introduction . . . . .	79
3.1.1. Cutting fluids and problems related to cutting fluids . . . . .	80
3.1.2. Dry cutting and its limitations . . . . .	81
3.1.3. MQL and its performance in machining . . . . .	81
3.1.4. Limitations of MQL . . . . .	83
3.2. The state-of-the-art research for MQL in machining . . . . .	84
3.2.1. Experimental studies on MQL in drilling . . . . .	84
3.2.2. Experimental studies on MQL in milling . . . . .	86
3.2.3. Experimental studies on MQL in turning . . . . .	87
3.2.4. Experimental studies on MQL in other machining processes . . . . .	89
3.3. Case studies on MQL in machining . . . . .	90
3.3.1. Case study 1: analysis of the effect of MQL on machinability of brass during turning – ANN modeling approach . . . . .	91

3.3.2. Case study 2: selection of optimal MQL on machinability of brass during turning – Taguchi approach . . . . .	99
3.4. Summary . . . . .	104
3.5. Acknowledgments . . . . .	105
3.6. References . . . . .	105
<b>Chapter 4. Application of Minimum Quantity Lubrication in Grinding . . . . .</b>	<b>111</b>
Eduardo Carlos BIANCHI, Paulo Roberto de AGUIAR, Leonardo Roberto da SILVA and Rubens Chinali CANARIM	
4.1. Introduction . . . . .	111
4.1.1. Concern about cutting fluids . . . . .	113
4.2. Minimum quantity lubrication . . . . .	114
4.2.1. Classification and design of MQL systems . .	116
4.2.2. MQL application in grinding . . . . .	118
4.3. Results . . . . .	122
4.3.1. Plunge external cylindrical grinding. . . . .	122
4.3.2. Internal plunge grinding. . . . .	146
4.3.3. Surface grinding. . . . .	154
4.4. Conclusions . . . . .	169
4.5. Acknowledgments . . . . .	170
4.6. References . . . . .	170
<b>Chapter 5. Single-Point Incremental Forming . . . . .</b>	<b>173</b>
Maria Beatriz SILVA, Niels BAY and Paulo A.F. MARTINS	
5.1. Introduction . . . . .	173
5.2. Incremental sheet forming processes . . . . .	174
5.2.1. Single-point incremental forming. . . . .	174
5.2.2. Incremental forming with counter tool . . . .	176
5.2.3. Two-point incremental forming . . . . .	177
5.3. Analytical framework . . . . .	179
5.3.1. Membrane analysis . . . . .	181
5.3.2. State of stress and strain . . . . .	182
5.3.3. Formability limits . . . . .	185
5.4. FE background . . . . .	187
5.4.1. Modeling conditions . . . . .	188

5.4.2. Post-processing of results . . . . .	189
5.5. Experimental . . . . .	191
5.5.1. Forming and fracture forming limit diagrams	191
5.5.2. SPIF experiments . . . . .	194
5.6. Results and discussion. . . . .	195
5.6.1. Stress and strain fields. . . . .	196
5.6.2. Formability limits . . . . .	199
5.7. Examples of applications . . . . .	203
5.7.1. Sector shower tray . . . . .	203
5.8. Conclusions . . . . .	206
5.9. References . . . . .	206
<b>Chapter 6. Molding of Spent Rubber from Tire Recycling</b>	<b>211</b>
Fabrizio QUADRINI, Alessandro GUGLIELMOTTI,	
Carmine LUCIGNANO and Vincenzo TAGLIAFERRI	
6.1. Introduction . . . . .	212
6.2. State of the art of tire recycling . . . . .	215
6.3. Direct molding of rubber particles. . . . .	221
6.4. Experimental results. . . . .	225
6.5. Concluding remarks . . . . .	233
6.6. References . . . . .	234
<b>List of Authors</b> . . . . .	<b>241</b>
<b>Index</b> . . . . .	<b>245</b>