## Robotics in Practice

## Management and applications of industrial robots

Joseph F. Engelberger
With a Foreword by Isaac Asimov

В	Ž	B	Ĭ,	1	(_)	Ţ	14	E	K	
inven	1	K I	~~	Ĩ	LZ	ζ	· 3	0-A-10-694		



KOGAN PAGE
in association with
Avebury Publishing Company

## **Contents**

For	List of illustrations and color plates Foreword by Isaac Asimov Author's preface	
PA	RT 1 Fundamentals and management	
1.	Robot use in manufacturing	3
	Evolution of industrial robots, 3  Near relations of the robot, 7  Robot cost versus human labor, 9  Die casting — an early success story for industrial robots, 12  Robots versus special-purpose automation, 15	
2.	Robot anatomy	19
	Robot classification, 19 Arm geometry, 30 Drive systems, 33 Dynamic performance and accuracy, 35	
3.	End effectors: hands, grippers, pickups and tools Methods of grasping, 41 Mechanical grippers, 42 Vacuum systems, 49 Magnetic pickups, 51 Tools, 55	41
4.	Matching robots to the workplace Part orientation, 59 Interlocks and sequence control, 61 Workplace layout, 67	59

5. Reliability, maintenance and safety	75
Environmental factors in robot systems, 75 Designing robots for industrial environments, 78 Reliability targets, 82 Theoretical reliability assessment, 83 Maintenance needs and economics, 85 Safety levels and precautions, 89	
6. Organizing to support robotics	93
Example of manufacturer's training system, 93 How General Electric built an in-house capability, 95 Work force acceptance of robots, 97	
7. Robot economics	110
Checklist of economic factors: costs and benefits, 101 Project appraisal by the payback method, 104 Return on investment evaluation, 107 Areas of cost exposure, 109	
8. Sociological impact of robots	111
Quality of working life, 111 Attitudes to robots, 112 Effect on employment, 115	
9. Future capabilities	117
Future attributes of robots, 117 Commentary on future attributes, 120 Priorities in attribute development, 125 Interaction with other technologies, 128 Future applications, 133	
PART II Application studies	
10. Die casting applications Outline of die casting operation, 141 Robots in die casting, 145 Further considerations for robot die casting, 155	141
11. Spot welding applications Outline of spot welding operation, 159 Robots in spot welding, 163 Planning a robot spot welding line, 164	159

12. Arc welding applications	171
Arc welding process, 171 Robots in arc welding, 174 Programming the robot, 176 Choice of robots for arc welding, 177 Case example of arc welding robot, 178 Flame cutting: a related application, 179	
13. Investment casting applications	181
The investment casting process, 181 Mold making by robot, 184 Basic programs for robot mold making, 186 Case example at Pratt & Whitney, 187	
14. Forging applications	189
Forging processes, 189 The working environment of the forging process, 192 Robots in forging, 193	
15. Press work applications	197
Press operations, 197 Current applications of robots in the press shop, 199 Outlook for further robot handling of press work, 203	
16. Spray painting applications	207
Paint behavior and the technique of painting, 207 The spray painting environment, 208 Automation in the paint spraying industry, 209 Robots in paint spraying, 210 Outlook for robot painting in the automotive industry, 212 Benefits analysis of robot painting, 214	
17. Plastic molding applications	217
Plastic molding processes, 217 Opportunities for robot applications, 220 Current robot use in plastic molding, 220	
18. Applications in foundry practice	225
The casting process, 225 Robots in the foundry, 227 Applying robots to the fettling operation, 228	
19. Machine tool loading applications	233
Development of automation in the machine shop, 233 Robot applications to machine tools, 235 Robot attributes for machine tool applications, 243	

20. Heat treatment applications	247
Heat treatment processes, 247 Robots in heat treatment, 249	
21. Applications for deburring metal parts	253
Demands of the deburring operation, 253 Robot requirements for deburring, 254	
22. Palletizing applications	257
Robot use to achieve optimal pallet loading, 257 Depalletizing by robot, 260	
23. Applications in brick manufacture	263
The brick manufacture process, 263 The robot contribution to brickmaking, 265	
24. Applications in glass manufacture	269
Outline of glass manufacturing process, 269 Robot handling of sheet glass, 271 Robot handling of fragile glass products, 273	
Appendix: List of principal robot manufacturers	277
Bibliography	279
Index	285