MANUFACTURING, AUTOMATION SYSTEMS AND CIM FACTORIES

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CHAPMAN & HALL
London · Glasgow · New York · Tokyo · Melbourne · Madras

Published by Chapman & Hall, 2–6 Boundary Row, London SE1 8HN

Chapman & Hall, 2–6 Boundary Row, London SE1 8HN, UK

Blackie Academic & Professional, Wester Cleddens Road, Bishopbriggs, Glasgow G64 2NZ, UK

Chapman & Hall Inc., One Penn Plaza, 41st Floor, New York NY10119, USA

Chapman & Hall Japan, Thomson Publishing Japan, Hirakawacho Nemoto Building, 6F, 1-7-11 Hirakawa-cho, Chiyoda-ku, Tokyo 102, Japan

Chapman & Hall Australia, Thomas Nelson Australia, 102 Dodds Street, South Melbourne, Victoria 3205, Australia

Chapman & Hall India, R. Seshadri, 32 Second Main Road, CIT East, Madras 600 035, India

Co-published in 1994 by Ohmsha Ltd, 3–1 Kanda Nishiki-cho, Chiyoda-ku, Tokyo 101, Japan and Chapman & Hall, 2–6 Boundary Row, London SE1 8HN, UK

Typeset in 10/12 pt Palatino by Best-set Typesetter Ltd., Hong Kong
Printed in Great Britain by **Clays Ltd, St. Ives plc, Bungay, Suffolk**

ISBN 0 412 48230 4

A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication data available

♾ Printed on permanent acid-free text paper, manufactured in accordance with ANSI/NISO Z 39.48-1992 and ANSI/NISO Z39.48-1984 (Permanence of Paper).

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Preface

This book describes the current state of automation of the Japanese manufacturing industry. When read from a Western-world point of view, it clearly identifies some of the cultural difference between Japanese and Western manufacturing industries, and identifies some of the reasons why Japanese manufactured goods have achieved a competitive edge.

One of the key issues is that Japanese manufacturing companies are more receptive to the philosophies and benefits of automation. Large-scale factory automation is by definition a high-cost activity which is highly disruptive to the roles of the existing workforce. It is also unreasonable to expect a short-term return on investment. These factors make such automation prohibitively expensive to smaller organizations unless they have assistance.

The Japanese Ministry of International Trade and Industry (MITI) and other government bodies actively encourage smaller manufacturing industries to invest in automation. Examples of this are the use of lease robots, special low-interest rate loans for investing in automation, and tax incentives for users of computer-controlled machines. The corresponding Western organizations such as the British Department of Trade and Industry (DTI) do not approach this level of support.

Japan also has a shortage of skilled labour which can be alleviated by the introduction of automation. In addition Japan has company unions, as opposed to the Western trade unions, which means that changing job specifications are viewed from a different perspective. These factors combine to minimize the workforce mistrust and opposition to automation which is prevalent in the West.

One of the great benefits of automation is the ability to manufacture small batches of a wide variety of products. This gives a competitive edge over the mass production of a small number of products used by traditional manufacturing companies.

When considering the automation of factories the approach of using the simplest equipment which can adequately perform a task is emphasized in this book. Thus the problems of inaccuracy, support and maintenance costs are kept to a minimum.

To summarize, the methods described in this book are applicable to a wide range of manufacturing companies worldwide. All of the examples quoted refer to actual implementations and thus there is concrete evidence of their viability. Hence, given the necessary funding, there is no reason why automation on the scale adopted by Japan cannot be adopted by all other industrialized nations.

Dr Phillip R. Edwards

List of abbreviations

ADCIMS	autonomous distributed/decentralized control integrated manufacturing system
AE	assemblability evaluation
AEM	assemblability evaluation method
AGV	automatic guided vehicle
AI	artificial intelligence
AI/AO	analogue input/analogue output
AMRF	automated manufacture research facilities
APT	automatically programmed tools
ARCLE	assembly robot control language
ARL	assembly robot language
ARTRA	advanced robot technology research association
AS/RS	automatic storage and retrieval system
ASAR	automatic storage and retrieval
ATM	automatic transfer machines
CAA	computer-aided assembly
CAD	computer-aided design
CAE	computer-aided engineering
CAI	computer-aided inspection
CAM	computer-aided manufacture
CAQC	computer-aided quality control
CAST	computer-aided stress test
CAT	computer-aided testing
CFM	continuous flow manufacturing
CG	computer graphics
CIA	computer-integrated assembly
CIT	computer-integrated testing
CNC	computer numerical control
CPU	central processing unit
CTS	conformance test specification

DASD	direct access storage device
DI/DO	digital input/digital output
DNC	direct numerical control
DPMM	discrete parts manufacturing model
DSS	decision support system
EC	engineering change
EDM	electric discharge machines
ESPRIT	European Strategic Programme for Research and Development in Information Technology
FA	factory automation
FGCS	fifth-generation computer system
FMC	flexible manufacturing cell
FMS	flexible manufacturing system
FTL	flexible transfer line
GPSS	general-purpose simulation system
HIM	human-integrated manufacturing
HMS	horizontal machining centre
I/O	input/output
ICAM	integrated computer-aided manufacturing
ICAR	International Conference on Advanced Robotics
INGCT	Institute for New Generation Computer Technology
IE	industrial engineering
IEC	International Electro-technical Commission
IFR	International Federation of Robotics
IIMM	integrated intelligent management manufacturing
IMM	intelligent management and manufacturing
IMS	intelligent manufacturing system
IR	industrial robot
IROFA	International Robotics and Factory Automation Centre
ISIR	International Symposium on Industrial Robots
ISO	International Standards Organization
IT	information technology
IUT	implementation under test
JCF	Joint Coordinating Forum
JETRO	Japanese External Trade Organization
JIRAS	Japanese Industrial Robot Association Standards
JIS	Japanese Industrial Standards
JIT	just in time
JMTBA	Japanese Machine Tool Builders' Association
LAN	local area network
LUNA	language for users' needs and aims
MAGVR	manufacturing automatically guided vehicle robot
MAP	manufacturing automation protocol
MC	machining centre

MELFA	MEL for factory robot language
MIR	manipulating industrial robot
MITI	Ministry of International Trade and Industry (Japan)
MMS	manufacturing message specification
MOF	Ministry of Finance (Japan)
MRP	material requirement planning
MTBF	mean time between failures
MTC	MAP test centre
MUM	methodology for unmanned manufacturing
MC	numerical control
NIST	National Institute of Standards and Technology (USA)
OA	office automation
OSA	open systems architecture
OSI	open systems interconnection
PASLA	programmable assembly robot language
PC	personal computer
PCB	printed circuit board
PLAW	programming language for welding
PCL	programmable logic controller
PSIM	personal sequential inference machine
PTP	point-to-point
QC	quality control
SCARA	selective compliance assembly robot arm
SCOL	symbolic code language (for robots)
SE	systems engineering
SERF	Sankyo easy robot formula
SI	system integration
SIMPOS	sequential inference machine programming and operating system
SME	shape memory effect
SME	Society of Mechanical Engineers (USA)
SMR	soft motion robot
SPEL	Suwa Seiko production equipment language
SQC	statistical quality control
ST	standard time
SUT	system under test
TQC	total quality control
VTR	video tape recorder
WAN	wide area network
WFMUG	World Federation of MAP/TOP Users Groups
WIP	work in process

Introduction

This book has been compiled to address the expanding fields of factory automation (FA) and the large-scale application of computers, computer-integrated manufacture (CIM). It examines these areas in terms of their significance, situation, perspective and basic system technologies with respect to the current situation in Japan.

The current automation technologies, current situation, and technology of computer-integrated manufacture is examined.

In order to provide a foundation for later chapters, each technology is examined with respect to the reasons for its usage and growth. Factory automation is examined as an automated production technology. Computer-integrated manufacture is examined as a computerized production technology. The systems engineering involved in the introduction of factory automation and CIM systems is outlined, and the growing use of numerical control (NC) machines and the development of robot management operations in Japan are described.

Chapter 2 deals with system networks, software databases, artificial intelligence, standardization and other recent technologies necessary for factory automation and CIM. Chapter 3 is a case study which illustrates IBM's successful introduction of CIM into the company. Chapter 4 identifies the risks accompanying the introduction of factory automation and CIM. Safety measures are suggested to counter these risks, and the effectiveness of the methods are evaluated. Chapters 5 through 13 describe actual examples. They show the introduction of factory automation and CIM into ten factories belonging to major Japanese companies. These experiences are related to the preceding four chapters.

Kiyoji Asai

Contents

PART ONE

The Current Status of Automation and CIM