CIM HANDBOOK

EDITED BY
M. MESINA
W. J. BARTZ
E. WIPPLER

TRANSLATED BY
A. MORRIS

CIM Handbook

The opportunities for
rationalisation opened up by the acquisition
and integration of computer automation

Edited by

Dr. Ing. M. Mesina
Prof. Dr. Ing. Wilfried J. Bartz
Dipl. Ing. Elmar Wippler

Translated by

Adrian Morris, FIL, MGesInf

for

M J Shields, FIInfSc, MITI
(Literary & Technical Language Services)

BUTTERWORTH
HEINEMANN

Butterworth-Heinemann Ltd
Linacre House, Jordan Hill, Oxford OX2 8DP

A member of the Reed Elsevier group

OXFORD LONDON BOSTON
MUNICH NEW DELHI SINGAPORE SYDNEY
TOKYO TORONTO WELLINGTON

First published by Expert Verlag 1990

First published in Great Britain by Butterworth-Heinemann Ltd 1993

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN 0 7506 0820 X

Library of Congress Cataloguing in Publication Data
A catalogue record for this book is available from the Libary of Congress

Printed and bound in Great Britain by
Biddles Ltd, Guildford and King's Lynn

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Editors' Introduction

The subject of Computer Integrated Manufacturing (CIM) is dealt with in a number of original papers, based on practical experience. The choice of CIM as a subject for this book reflects industry's increasing need for information about computer-based technologies and their integration into the manufacturing process.

The introduction of new technology presents new opportunities, but it also brings with it new risks. Computer Automation (CA) technologies are very complex. They call for relatively long periods of introduction. They are in general very expensive. The savings made by their use are not always directly demonstrable and they lead to far-reaching organisational changes within the companies concerned. Within the CIM concept, a variety of CA elements have to be integrated, usually coming from several different suppliers. The packages in use evolve very quickly: good solutions are soon replaced by even better ones. There is a great danger of either being on the wrong track or getting into a blind alley.

A successful introduction of the new technologies at first provides only limited advantage in competition - you can still manage without them. Thus far, it might be said that CIM is undoubtedly of interest, but not strictly necessary.

However, as soon as a technology has been successfully implemented in a large number of companies, it represents not only an advantage in competition between companies, but as well as that, it actually becomes a necessary condition for being able to maintain one's current market position. The far-reaching introduction of CAD/CAM into the car industry, for example, has had the effect of forcing all suppliers to make use of CAD systems, since they have to supply not only products, but also CAD models. The successful steps made by large companies both in Germany and throughout the world in introducing CIM are forcing medium-sized firms to react as quickly as they can in to seeking out and building up their own CIM solutions.

The stiff competition in the market place puts all companies into the position of having to use their own resources in an optimal way, by lowering their production costs, by meeting customer demands more quickly and by supplying not only standard products but increasingly, having to offer specially designed products. The fact that even countries with low to medium wage and salary levels have begun to produce high-tech, will intensify competition not merely on the world market, but also on the home front. Every opportunity to rationalise and optimise production must be grasped. In the medium term no company can do without CIM.

Statistical research shows that very many medium-sized companies are only now beginning to introduce the individual components of computer automation technology. These companies, for reasons of cost and also because of lack of know-how, are not in a position to do any more than this.

The main concern of this book is to help everyone who is responsible for structuring CIM concepts and for procuring and selecting CIM components, to find the solutions which meet their requirements in an optimal way, as well as having scope for future development. The significance of the most important individual CIM packages, their function, the increase in efficiency to be obtained by their implementation and the prerequisites for their integration in a total CIM concept will all be clearly set out in this book.

The whole is more than the sum of the individual parts: this fact was recognised even by the ancient Greeks. The interplay of components inside a higher functional unity and the emergence of complex working structures is the subject of investigations being carried out in many branches of modern sciences such as biology, physics and synergy studies as well as in the context of research being done into the organisation and structure of future production facilities. Contrasting with traditional ways of thinking, the importance of information in this area can be clearly shown here - particularly as far as the factory of the future is concerned. The fundamental innovations in technology are not those that come about by random changes to the existing state of things, or by natural selection.

For a company to develop CIM concepts, it must have a comprehensive understanding of the existing operating structures, the materials flow, the information flow as well as the processing steps in the product manufacture. Essential computer aids for simulating the current position are available here and now. Even during this phase it is both possible and often advisable to improve the existing flow of information by properly implementing computer methods, to rationalise the flow of materials by using logistics programs as well as by making use of additional new transport methods and stock control systems. The analysis of the activities taking place within the manufacturing operation is an important basis for selecting CA technology and using it effectively.

To merely rationalise current processes with the aid of computerised techniques would not be to make the most of the opportunities for implementing CIM. Consideration must also be given to making organisational changes within the company which have only now become possible thanks to the new technology. Thus, for example, the design engineer can be incorporated directly into the sales department, where he or she can react immediately to special customer requests. Integrating CAD/CAM programmes into the CIM environment makes it possible in principle not only to represent the customised product on the drawing board but also, within a relatively short time, to make definite statements as to lead times and production costs.

The technical basis for introducing CIM is available here and now. The necessary CA packages are in an affordable price range even for the typical smaller company. Numerous positive examples can be cited. Today, the key to success in introducing CIM lies at the level of the information, in the know-how possessed by the managers and their staff who are faced with taking the strategic decisions. Just as vital, however, is the know-how possessed by all those who will be working with the new CA technologies. Thus, training for decision makers and their staff becomes more and more important. The aim of the training is not only to provide technical know-how but also to reinforce people's willingness to accept the organisational changes within the business which are necessary for CIM to be implemented successfully.

Ostfildern, September 1989

The translator wishes to record his appreciation for the help given by IBM, as well as by ICL, in providing information on Computer Integrated Manufacture to help in the translation.

List of abbreviations

APPC	Advanced program to program communication
ACSE	Association control service element
AI	Artificial intelligence
ASCII	American standard code for information interchange
AWF	Ausschuss für Wirtschaftliche Fertigung (German organisation dealing with efficient manufacturing)
BEM	Boundary element method
BGU	Business graphics utility
CA	Computer automation
CAA	Computer-aided administration/accounting
CAD	Computer-aided design
CAE	Computer-aided engineering
CAIM	Computer-aided integrated manufacturing
CAM	Computer-aided manufacturing
CAP	Computer-aided planning
CAPP	Computer-aided process planning
CAQ	Computer-aided quality management
CASE	Computer-aided software engineering
CAT	Computer-aided typesetting
CIL	Computer-integrated logistics
CIM	Computer-integrated manufacturing
CIQ	Computer-integrated quality management
CNC	Computer numeric control
CPU	Central processing unit
CSMA	Carrier sense multiple access
CSMA/CD	Carrier sense multiple access with collision detection
DB	Database
DB/DC	Database/data communications
DBMS	Database management system
dDBMS	Distributed database management system
DNC	Direct numeric control
DOS	Disc operating system
DTP	Desktop publishing
DTS	Driverless transport system
EBNF	Extended Backus-Naur form
EDP	Electronic data processing
FCS	Floor control system
FDM	Finite difference method
FEM	Finite element method
FIFO	First in, first out
FMEA	Failure mode and effects analysis
FMU	Flexible manufacturing unit

FMS	Flexible manufacturing system
FTAM	File transfer access manipulation
GPSS	General-purpose simulation system
GRIPI	Graphical interactive programming interface
HIFO	Highest in, first out
ICS	Inspection control system
IDA	Industry data administration
IPM	Information process matrix
ISO	International standards organisation
JIT	Just in time
KE	Knowledge-based engineering
LALR	Look ahead linear right
LAN	Local area network
LIFO	Last in, first out
MAP	Manufacturing automation protocol
MAS	Middle-order application system
MDC	Machine data collection
MFD	Materials flow de-centralised/Materials fine tuning/disposition
MIPS	Million instructions per second
MLS	Materials logistics system
MM	Materials management
MMS	Manufacturing message standard
MMFS	Manufacturing message format standard
MRP	Materials requirements processing
MTBF	Mean time between failures
MTBR	Mean time between repairs
NC	Numerical control
NCC	National Computer Conference (USA)
OC	Office communication
OCR	Optical character reader
ODA	Office document architecture
OPT	Optimised production technology
OS	Office systems
PC	Personal computer, process controller
PCB	Printed circuit board
PDM	Product definition model
PLC	Party line controller/Program logic controller
QA	Quality assurance
QC	Quality control
QS	Quality standard
RC	Robot controller
RDA	Remote data access
RdB	Real-time relational database
RIP	Raster image processor
RISC	Reduced instruction set chip/computer

SFCS	Shop-floor control system
SFDC	Shop-floor data collection
SGML	Standardised generalised markup language
SMC	Store management computer
SMD	Surface-mounted devices
SMS	Store management system
SNA	Systems network architecture
SPC	Statistical process control
SQL	Structured query language
TOMS	Tool management system
TOP	Technical and office protocol
TP	Transaction processing
TQC	Total quality control
UAS	Universal analysis system
VDA	German motor industry data interface
VDU	Visual display unit
VLSI	Very large-scale integration
VTP	Virtual terminals protocol
WAN	Wide area network
WIS	Workshop information system
WYSIWYG	What you see is what you get
YACC	Yet another compiler compiler

Contents

1 CIM - A challenge even for middle-order firms

H. J. Warnecke

1.1 Introduction

Every industrial nation is seeing itself exposed to ever-increasing competition, both national and international. The reasons for this can be found in:

- saturation of the market at the same time as inadequate levels of innovation,
- a larger number of international competitors,
- many companies diversifying their production programmes,
- the emergence of excess capacities,
- economic influences.

The mounting excess of supply leads to a considerable pressure on price and thus to the need for cutting costs by the most varied means or for increasing the value of the product to the customer. Increasing competition makes it necessary to comply with customer wishes much more than in the past. This all leads to an almost explosive increase in the variety of products and components, to small batch sizes, short lead times, variable production runs as well as to increased demands on the quality of the product and on customer service. The problem for a company in this changing situation is how to remain competitive.

1.2 Industry in West Germany

As well as the effects of changes in buying patterns, a number of factors specific to Germany make life more difficult for the (West) German firm. These are principally:

- a worsening competitive position *vis-à-vis* countries whose currencies are linked to the dollar exchange rate,
- a slackening of demand from oil-exporting countries,
- after Switzerland, the highest labour costs in the world - see figure 1.1,
- a high level of taxation on business profits, totalling around 70%.

The fact of this situation leads to a very considerable pressure to rationalise. A measure of this is the amount of money available for automation of the work-place, see figure 1.2. On the other hand, if one considers that the cost of processing information is becoming less - according to figures drawn up by the Philips company, the relative cost per bit of computer storage reduced by a factor of 1:50,000 during the years 1970 to 1985 - it is clear that more and more jobs can be automated.

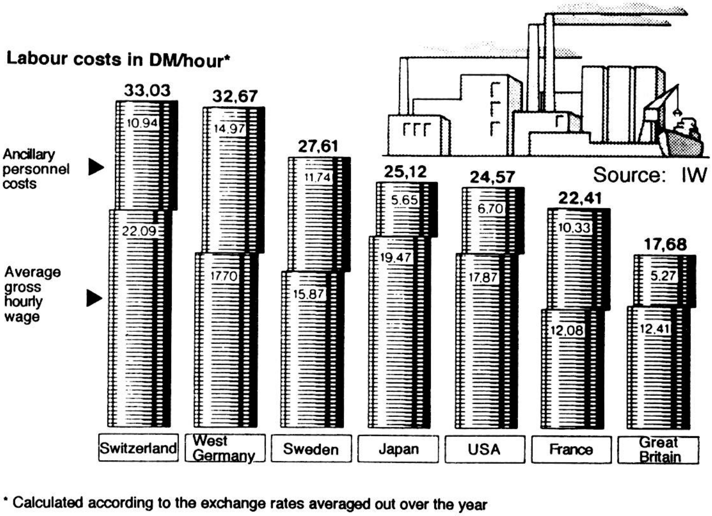


Figure 1.1: Comparison of industry expenditure on wages for 1987, seen internationally

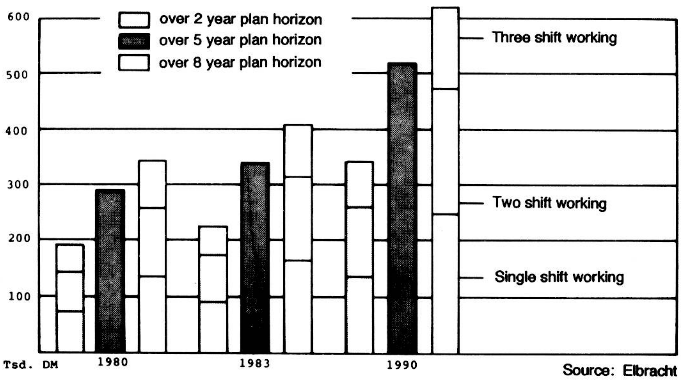


Figure 1.2: Marginal capital cost of automating one job in West Germany

1.3 Strategies for maintaining competitiveness

An advantage gained by continual innovation of products and processes cannot be maintained for ever. In the course of time, the knowledge gained becomes collective knowledge and it diffuses out to competitive firms and other countries. The consequence is that the production of simple products which can be made using traditional methods shifts to less sophisticated countries because of their lower wage levels. As far as companies in industrialised countries are concerned, even taking into account the competitive position between companies, the only logical step is for them to step up technological progress. There are two strategies for doing this; see figure 1.3:

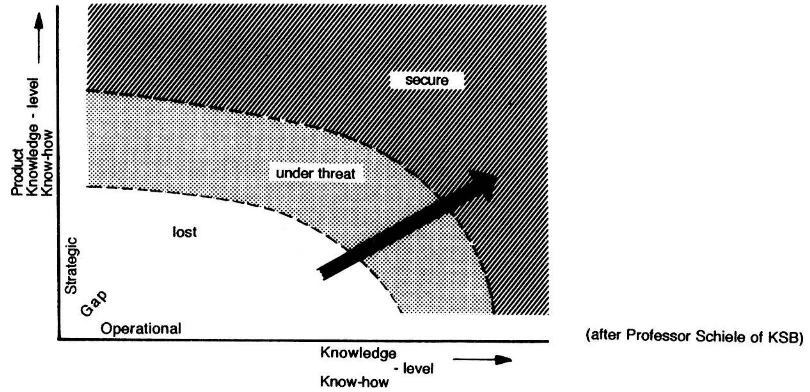


Figure 1.3: Gain in competitiveness to be had from products and production processes which make use of high levels of know-how

- The services or products on offer contain so much knowledge and know-how which is not generally available, that the competition can be kept at bay either by means of trade-mark rights and the necessary licence fee payments, or by the high research and development costs necessary to produce them. This is the way in which market leaders or companies which cover market niches can be seen to proceed.

- Products, that are simple to make, which can be easily copied, can only be produced in industrialised countries if the production process itself contains a large amount of specialist know-how. That means two things:

- The production process must be made so flexible, that it can be quickly adapted to changes in the market.

- Production costs must be kept constantly as low as possible, by utilising all available reserves of rationalisation and automation.

Branches of industry which are not successful in creating and maintaining the necessary advances in usage of know-how with regard to products and production will in future not be able to survive. The disastrous developments in the sectors of consumer electronics, watches and photography during the past 20 years in West Germany serve as sufficient warning. One very promising way of securing a know-how advantage in production is by making full use of any potential for rationalisation through the use of CIM, by integrating computers into the process of maintaining efficiency (1).

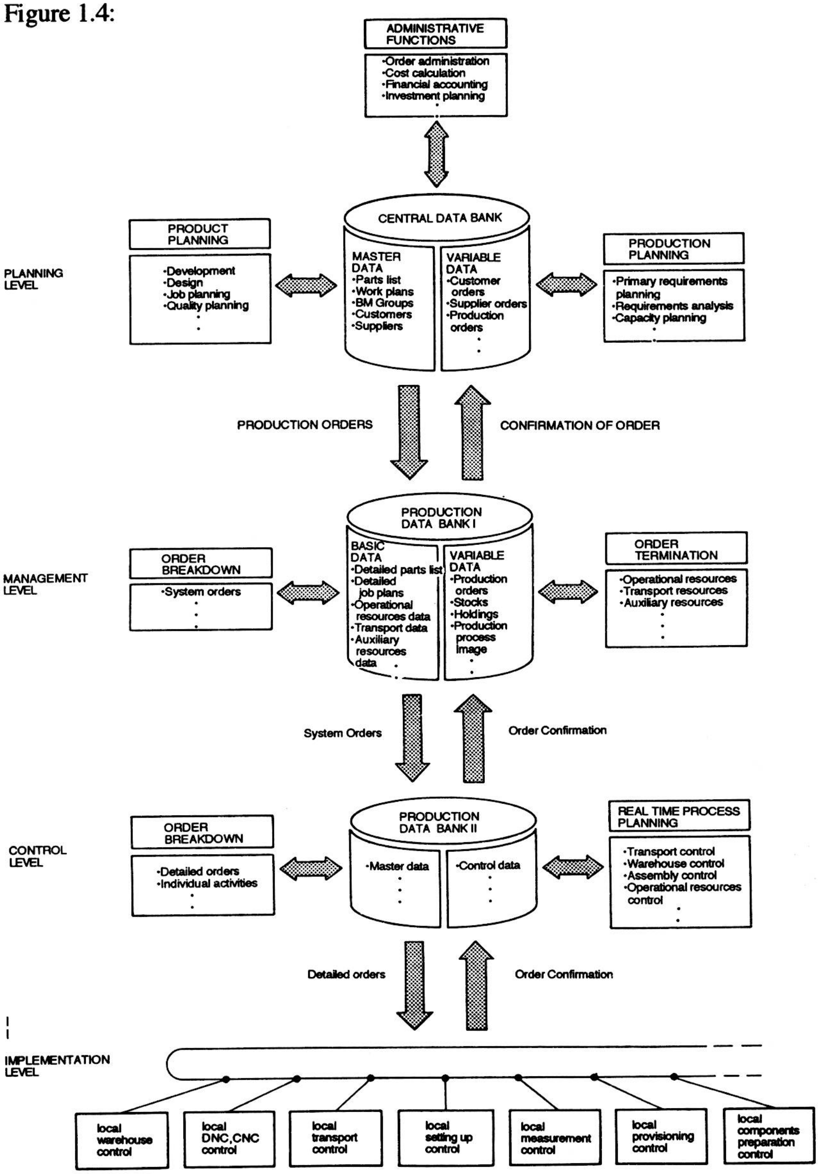
1.4 Factory 2000

Nowadays, smaller and medium-sized businesses obtain counsel and information almost exclusively from computer manufacturers and software-houses. In doing this, the users do not receive objective advice, because the computer manufacturer can only offer "business non-specific" concepts, specific to their computer, and not solutions tailored to the individual company. Comprehensive measures to provide demonstrations and training are required in order to create sufficient know-how for companies that want to introduce CIM in a step by step way. However, those concerned, in all areas of operation, are at present not yet ready for this technology. It is important for users of CIM that the problems, advantages and potential CIM solutions are all clearly demonstrated in situations as close as possible to real life and that they are told about promising solutions to their specific problems, technologies and industry sectors.

Thus, the aim of the CIM demonstration called "Fabrik 2000" (Factory 2000) produced by the Frauenhofer Institute for Production Technology and Automation (IPA) is to provide real-life and easy to understand examples of possible technical solutions in computer integrated manufacturing, as well as their specific advantages for users. CIM demonstrations, seminars and training are all going to be carried out on the basis of a demonstration production cycle which shows an example of how the areas of mechanical and electronic production are linked together. Using production and computer systems kept deliberately heterogenerous, experience can be gained which makes it possible for middle-order companies to be supported effectively, when CIM concepts are put into practice. Figure 1.4 shows the planning and control hierarchy of "Fabrik 2000".

The experience gained so far with the project can be summarised as follows - under two main headings:

Figure 1.4:


ADMINISTRATIVE FUNCTIONS
·Order administration
·Cost calculation
·Financial accounting
·Investment planning
CENTRAL DATA BANK
MASTER DATA
·Parts list
·Work plans
·BM Groups
·Customers
·Suppliers
VARIABLE DATA
·Customer orders
·Supplier orders
·Production orders
PLANNING LEVEL
PRODUCT PLANNING
·Development
·Design
·Job planning
·Quality planning
PRODUCTION PLANNING
·Primary requirements planning
·Requirements analysis
·Capacity planning
PRODUCTION ORDERS
CONFIRMATION OF ORDER
PRODUCTION DATA BANK I
BASIC DATA
·Detailed parts list
·Detailed job plans
·Operational resources data
·Transport data
·Auxiliary resources data
VARIABLE DATA
·Production orders
·Stocks
·Holdings
·Production process image
MANAGEMENT LEVEL
ORDER BREAKDOWN
·System orders
ORDER TERMINATION
·Operational resources
·Transport resources
·Auxiliary resources
System Orders
Order Confirmation
PRODUCTION DATA BANK II
·Master data
·Control data
CONTROL LEVEL
ORDER BREAKDOWN
·Detailed orders
·Individual activities
REAL TIME PROCESS PLANNING
·Transport control
·Warehouse control
·Assembly control
·Operational resources control
Detailed orders
Order Confirmation
IMPLEMENTATION LEVEL
local warehouse control
local DNC,CNC control
local transport control
local setting up control
local measurement control
local provisioning control
local components preparation control