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The Effectiveness of System Integration in CIMS of Japanese Companies

Takaya Ichimura, Takenori Aoki and Guo Fang Song *

* Department of Management,
School of Business & Commerce, Nihon University
2–1, Kinuta 5–chome, Setagaya–ku, Tokyo 157 Japan

Abstract

Under the present situation of diversification of users' needs, rapid technological innovation and internationalization, most Japanese manufacturers are required, as a management strategy, to develop an effective production system with small lot size and short production lead time. In order to meet these requirements, CIMS(computer–integrated manufacturing system) has been developed and introduced for practical use as a new computer–based production system. CIMS is characterized as an integrated system of software and hardware for production management with the purpose of meeting market requirements and counteracting fluctuations in users' demand by maintaining effective production planning and control. The style of CIMS varies with conditions of production and goals of system design. The purpose of this study is to investigate its effectiveness and examine future problems of system integration of CIMS in terms of production management in Japanese manufacturing companies.

Key Words: CIMS (computer integrated manufacturing system), System Integration, Production Management

1 Introduction

Existing conditions such as economic recession, trade friction and high value of the yen, as well as severe market competition, diversification and fluctuation of demand and market segmentation, have forced Japanese manufacturers to develop a new production control system to meet market demand and to maintain efficient production for survival in a highly competitive market.

Conventional production systems cannot cope with such severe situations, and thus the development of a new production control system is desired as a countermeasure. [1],[2] Such changes of existing conditions add pressure to conventional production systems to meet the needs of the present situation. For instance, market segmentation leads to smaller lot size, fluctuation in users' needs leads to diversification of product specifications, short production lead time and rapid technological innovation lead to short product life cycle, and intensive market competition leads to extensive cost–cutting and shortening of production lead time.

As countermeasures, factory automation, FMS, CAD/CAM/CAT, integrated production management systems and networks have been introduced; in particular, CIMS (computer integrated manufacturing system) has been increasingly applied the past few years. [3]

CIMS mainly focuses on the "integration of sub–systems." Its effectiveness and usefulness depend on the system, type of integration, and the purpose of design of CIMS.

When CIMS was first applied, many technological, organizational, and managerial problems could not be solved. In recent years, however, many styles of CIMS have been developed and it has been proven that CIMS is very useful in coping with the present demand of Japanese manufacturers due to the rapid development of computer technology and communication networks.

The purpose of this study is to classify the styles of system integration, to clarify the effectiveness of CIMS and to present future perspectives of CIMS in modern factories in Japan.

2 Objectives of CIMS

The main objectives for introducing CIMS into the manufacturing industry as a countermeasure to changes in existing conditions are as follows: [4]

(1) To shorten the time (lead time) for product development, and quicken the response to customers for the purpose of meeting users' needs.
(2) To establish more flexible production planning and control systems for the purpose of achieving dynamic and quick response to meet a variety of users' needs and to counteract fluctuations of demand.
(3) To rationalize and integrate a planning and instruction system for the purpose of reducing direct and indirect costs of production, inventory and administration.
(4) To standardize and improve the processes of product development, design and manufacturing for the purpose of achieving quality improvement and cost reduction of finished products.

Flexibility and effectiveness of response to the market are the main characteristics of CIMS. Introduction of CIMS leads to a change in the focus of manufacturers from efficiency- and product-oriented manufacturing to a user- and sales-oriented management system.

Based on an investigation of expected results from CIMS, the most desirable intentions are listed below: [5]

(a) Reduction of production lead time
(b) Reduction of order-to-delivery time
(c) Restructuring of factory management
(d) Establishment of closer relationships among production, sales, and product design departments
(e) Improvement of employee morale
(f) Decrease of in-process inventory
(g) Direct and indirect cost reductions
(h) Improvement of customer service
(i) Reduction of the lead time required for product development
(j) Establishment of small lot size production system
(k) Improvement of product quality
(l) Restructuring of organization and effective performance of duties
(m) Establishment of intimate partnership with sub-contractors

According to the investigation [5], it has been clarified that the expectation of the effectiveness of CIMS has gradually changed with time. The highest ranked goals were "reduction of production lead time" in 1988-1990; "closer relationship between production and sales departments" in 1991-1992; and "restructuring of factory management" in 1993.

3 Styles of System Integration

System integration is classified into the following patterns in this study.

(1) Automated machine group level (Pattern A)

A large-scale automated machine group consists of direct numerical control machines, individual robots, programmable logic controllers or work stations with a flexible manufacturing system.

(2) Integrated manufacturing system level (Pattern B)

The basic functions of production are divided into four stages of product design, process design, manufacturing and production control, and computer-aided systems such as CAE, CAD, CAM, CAT support and connect one stage to the other. [6]

CIM is constructed as a basic network to transmit technical information in all stages.

(3) Factory automation level (Pattern C)

A FA system realizes flexibility in automation, and it consists of a control system and a manufacturing system. It enables flexible process arrangement; thus, the flow of materials, inventory and products is totally controlled along with storage of parts, processing, material handling, inspection and delivery.

(4) Hierarchical level (Pattern D)

According to the hierarchical model, a manufacturing company can be divided into business level (administration, finance, marketing, sales, R&D), factory level (product design, production technology, production control, supply, delivery, resource management, plant management), and workshop level (equipment, station, cell, section). CIM is an automated system which integrates those activities and functions. [7]

(5) Computer-integrated manufacturing system level (Pattern E)

Every subsystem such as order entry, producing a bill of materials, resource requirement planning, inventory control, capacity planning, and shop management is integrated into CIMS through a common data base and on-line network. CIMS is designed to adjust to fluctuations of demand and existing conditions, leading to quick and appropriate action. [8]

4 Effectiveness of CIMS

4.1 The effectiveness of CIM based on different styles of system integration

The results of introducing CIM into different patterns of system integration are listed in **Table-1**.

Table-1. Effectiveness of CIMS

Style of CIM	Expected result from the intro uction of CIMS												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Pattern-A (FMS level)	◎	−	−	−	−	−	−	−	−	○	◎	−	−
Pattern-B (IMS level)	△	○	−	○	△	−	−	△	◎	◎	○	−	−
Pattern-C (FA level)	○	○	−	△	△	○	△	△	△	○	○	△	△
Pattern-D (BFW level)	△	○	○	○	○	○	○	△	−	○	○	○	○
Pattern-E (CIMS level)	△	△	◎	◎	○	○	○	○	△	△	△	○	◎

Note:

a: reduction of production LT
b: reduction of order-to delivery time
c: restructuring of factory mgm't
d: coordination of departments
e: improvement of morale
f: decrease of in-process inventory
g: direct & indirect cost reduction
h: improvement of customer service
i: short product development LT
j: small lot production system
k: improvement of product quality
l: restructuring of duties & organization
m: close partnership with subcontractors

◎ : very effective
○ : useful
△ : indirectly effective
− : not clarified

4.2 The cases of actual application of CIMS in terms of the type of production

(1) Factory A

(OA equipment manufacturer: assembly line production type) [9]

1) Information lead time was reduced by use of computer and communication systems and value-added network (VAN). Manufacturing lead time was

also reduced greatly by introducing automated material handling equipment.

2) It enabled the realization of the just-in-time (JIT) system which consequently caused decrease of inventory and required storage space.
3) A flexible and quick response system was established to cope with fluctuations of demand and frequent change of customer specifications.
4) Flexibility of the assembly line markedly increased.

(2) Factory B

(sheetmetal machine manufacturer: job shop production type) [11]

1) Optimum timing among all processes was achieved.
2) Mistakes in writing tags and time lag of information transfer were eliminated through use of an automatic report collector.
3) Accurate scheduling system was established; consequently, the sense of reliability increased in the workshop.
4) Order selection and estimation of delivery date became more accurate at the time of order placement.
5) Man hours required during the inspection process decreased by half.

(3) Factory C

(steel wire manufacturer: lot production type) [10]

Actual countermeasures and results are summarized in **Table-2.**

Table-2. Case study of company C

Target of CIMS	Actual Countermeasures	Effects
Engineering Integration	On-line real-time control of cutting line	CAD/CAM
Process Integration	Line deployment by indivisual line	Process integration
	Unit lot size: 10t coil → 2t coil	Small lot size
	Close partnership among workers in process	Mobile worker system
	Data collection by bar-code tag and machine	POP•LAN
	Weekly production plan → Daily dispatch	Flexible scheduling
	Direct delivery date included in bar-code tag	Visible management
Manufacturing & Sales Integration	Production based on order placement	Decrease of inventory
	Monthly requirement →Direction by each order	Small lot production
	Delivery of order entry sheet → 5 times/day	On-line order entry
QA & Inspection Integration	On-line real-time display of the results of testing and inspection	On-line data base on quality

Note: Masayoshi Fuse and Hisahiro Miyake, "The framework of strategic integrated production and case studies," IE Review 159 Vol.30,No.1, 1989.3 p.22

4.3 Results from a questionnaire regarding effectiveness of CIMS

From the results of actual use of CIMS, the degree of satisfaction in terms of the objectives listed in section 2 is arranged in decreasing order. (Numbers on the left and right in parentheses show rankings of objectives given in section 2 and effectiveness from actual use of CIMS, respectively.) [5]

1) Restructuring of factory management (3 - 1)
2) Establishment of closer relationships among production, sales, and product design departments (4 - 2)
3) Improvement of employees' morale (5 - 3)
4) Improvement of customer service (8 - 4)
5) Reduction of production lead time (1 - 5)
6) Reduction of order-to-delivery time (2 - 6)

From these results it is proven that CIMS is more effective for improving problems on the managerial level and for restructuring the company. The main effect of CIMS is to increase flexibility of the production system.

On the other hand, reduction of production lead time had already been achieved by CIMS, but coordination of company strategy and CIMS can be improved further.

4.4 Other results

The introduction of CIMS leads to highly effective results not only in terms of actual manufacturing activities, but also in terms of restructuring management, improvement of morale of the employees.

The following are the main effects of CIMS based on a field investigation. [5]

1) Increase in the creativity of employees due to an increase in free time.
2) Sense of partnership among employees resulting from the possession of common information.
3) Recognition of individual jobs and roles based on the entire system.
4) Increase in the quality of job performance increased on the whole.

5 Other Issues

5.1 Future tasks

1) Arrangement and expansion of network
2) Understanding between and coordination with related sections for the integration of systems
3) Improvement of technical level of production control
4) Availability and development of individual sub-systems
5) Improvement of the ability of system engineer
6) Increased reliability of data base

5.2 Reasons for failure of CIMS

1) Steering organization was insufficient
2) Lack of basic consensus for adopting CIMS in the company
3) Lack of an able leader
4) Estimated investment was too high
5) Insufficient coordination of related sections
6) Data base was poorly structured

6 Conclusions and Future Perspectives

This study clarifies the basic conditions and motivations of CIMS development such as fluctuations of demand, diversification of users' needs, rapid technological innovation and development of computer-related technology.

Under such circumstances, CIMS must be developed in order to establish a flexible and overall production control system, which is expected to overcome problems in management.

The establishment of CIMS is proven to be effective mainly to:

(a) meet users' needs,
(b) reduce total cost,
(c) shorten lead time and realize quick response to orders,
(d) promote the JIT system and decrease inventory, and
(e) improve quality of products.

As for the future development of CIMS, a more extensive management system will be developed, and a strategic information system (SIS) will be investigated further. [11],[12]

A vertical network system including subcontractors and vendors will be formulated, then the flow of production control information and technological information will be transferred through the network. Thus, all related companies will be involved in the network.

The importance of SIS will be emphasized as a management tool in order to overcome severe competition in the market.

Flexibility and adaptability will improve with the introduction of SIS, and based on this, the probability of forming new business opportunities and gaining market share will become important strategies of management.

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