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# An Investigation on the Skill Requirements of a Manufacturing Engineer in a Computer Integrated Manufacturing Environment

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## Abstract

The problem for this study centers on these questions:

What skills will a manufacturing company's manufacturing engineers require to : 1) Implement successfully computer integrated manufacturing. 2) How will they obtain these skills?

# AN INVESTIGATION ON THE SKILL REQUIREMENTS OF A MANUFACTURING ENGINEER IN A COMPUTER INTEGRATED MANUFACTURING ENVIRONMENT

A Research Proposal for Presentation
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by

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# CHAPTER I

## Introduction

Computer Integrated Manufacturing (CIM) was a term coined by Dr. Joe Harrington in 1973 in his book Computer Integrated Manufacturing (Harrington, 1973). Since that time it has come to mean many things to many different people. Often attributed to CIM is the development of new technologies. However, CIM goes beyond this technological aspect to encompass a complete philosophy. CIM does not just happen in a company, it needs to be developed. This research study looks at some of the problems in making CIM a reality.

### Problem Statement

The problem for this study centers on these questions:

What skills will a manufacturing company's manufacturing engineers require to: 1) Implement successfully computer integrated manufacturing. 2) How will they obtain these skills?

### Purpose

The United States' manufacturers want to be the most competitive industries in the world. The

continued improvement in technology relates to higher profitability. The successful use of CIM means that personnel must be able to respond to change and to adapt effectively. Effective use of CIM requires manufacturing engineers (MEs) to have a broad range of working skills. From this increase in knowledge and skills, MEs are able to make intelligent, productive, and creative decisions about CIM in their manufacturing setting. By identifying the components that contribute to effective use of CIM, information may be provided for meaningful training plans. The information will be useful to developers of in-service training and school educational programs.

Statement of Need

The need for the study is based on the following factors: MEs who are not trained to use CIM in their work place have been asked to incorporate this into their work process. As a result there is a tremendous need to identify and implement ways of training MEs to use CIM as a work tool. According to Vasilash (1991) factors which caused this demand were the rapid growth in technology and the increased competition being faced from Japanese and European manufacturers. With the competitiveness in the marketplace, manufacturing

companies must be more innovative and automate or in a few years will find themselves out of business (Merfield, 1988). One of the major problems with being competitive is the risk involved (Bergstrom, 1991). One area most associated with risk and being competitive is in automation. The United States has not kept up to many of the other industrialized nations in this respect. One of the major drivers towards automation is the need for flexibility to handle a wide variety of products. As automation increases, the amount of education and training also must increase. The Japanese and Europeans spend more time in this area than do U.S. companies (Vasilash 1991). Bergstrom (1991) suggests the flexibility and competitiveness come from establishing outstanding manufacturing bases through use of skilled personnel. These include both the interpersonal and technical skills.

All of America needs to wake up to the competitiveness in today's marketplace (Vasilash 1991). If this does not happen, other countries will be owning what was once ours. Already many companies that were in business twenty years ago are either gone or have been bought out by foreign interests. According to a summary of the Society of Manufacturing Engineers (SME)

Profile 21 study (Koska and Romano 1988) most MEs are not ready for the responsibilities of integrating CIM. Future successes of CIM depend a great deal on the attitudes of working with and through people. To handle these changes educational programs will need to be devised broadening MEs' knowledge base and providing on-going training. This involves dealing with others and technical skills. The Profile 21 study did not identify where current MEs perceived their skills to be. According to Favre (1988) in his computer based subject matter study, there is a need in our educational system to identify the manufacturing skills that future graduates will be required to have in their curriculum. Rothwell (1991) stated that the technology is available to make CIM work. To do this the people who design, operate, and maintain these systems must get ready. To be efficient, MEs will need to understand the total company from incoming material to customer needs. Failure of CIM in the past often occurred due to the environment not being ready for its acceptance or success. MEs need to be able to work within teams of varying disciplines for CIM to be successful (Ciampa, 1988). Koska and Romano (1988) recommend the total reconstruction of training for MEs.

According to Rothwell (1988) it's important for MEs to have an understanding of the basic rules of free enterprise and how the economic system works. Training programs for CIM should be well planned continuing features of a comprehensive program. In the past training programs have often been isolated one-time events. Shrensker (1990) stated the amount of education and training will need to be increased to effectively use CIM. After being on a job for 6 to 12 months, MEs will need to go back to school to update and expand their skills. The manufacturing companies need to be involved in the on-going training of both in-house and outside programs. Koska and Romano (1988) maintain the human skills training must be improved so MEs can deal effectively with customers, top management, and factory workers, as well as their counterparts in other areas. Rothwell (1991) advises that the U.S. needs schools and industry to teach leadership skills and encourage people to become leaders in their field. This requires more emphasis on management and public relation skills.

Computer aided manufacturing (CAM) is a major component of CIM. When discussing CAM Kruppa and Gollajesse (1991) noted that computer numerical control

(CNC) machines are often the major topic. However, the attention paid to CNC training needs has often been inadequate. When the automation of processes occurs CAM training becomes critical.

The government needs to provide incentives for money to be spent on education and training. A wide variety of programs have been initiated by manufacturing companies to improve the skills of MEs. However, results have not been shared with other groups nor documented. Profitability within a company is a by-product of various elements. These elements include marketing, purchasing, and efficient production techniques. As a result, there is little basis for judging the merits of a CIM training program. Rothwell (1988) stated that management executives have had to make educational decisions based upon limited personal experiences or the experiences and knowledge of others. Little has been done to determine what makes an effective CIM training program or how to assist in improving an existing program. For efficiency, MEs need to understand the total company from incoming material to customer needs and use the latest technology available to them. By doing so they are better equipped to make decisions concerning production

requirements. Kruppa and Gollajesse (1991) stated that many companies have initiated their own training programs for MEs in specific areas like CAD and NC programming. However, depending on the scope of the training, it may need to be redone if the ME changes responsibilities. This entails the broadening of MEs' skills and more in-depth training.

Implementation of CIM techniques involves the incorporation of new ideas into industries. These include areas such as diagnostic problem solving, statistical process control, project management, and teamwork (Ciampa, 1988). One common theme within the study is that one person alone has no chance of integrating the CIM technologies. Management and the shop floor personnel within the company also must advance their skills. The focus includes everyone from the top down to the shop floor. The skills utilized will continue to include the usual technical areas. To go along with these are non-technical skills in effective communication and teamwork. Koska and Romano (1988) in their study included the skills of speaking foreign languages and the ability to deal with broader business issues. The availability of powerful computers provides numerous data bases of information.

To use this knowledge requires an understanding of production, cost, and efficiency reports relating to both U.S. data and foreign countries. According to Rothwell (1988) it is important for MEs to have an understanding of the basic rules of free enterprise and how the economic system works. This involves courses in economics and accounting. Every action taken by MEs impact industry's profitability. For the positive reinforcement of the need for these skills Ciampa (1988) suggests the personal measurement system and rewards need to change to reflect this. It is human nature at whatever your level in an organization to work towards personal growth and personal rewards.

Conkol (1990) noted people as one of the biggest issues within CIM. The people need the know how to integrate the technology. An overall knowledge in technology can be more important than specific product knowledge. Those involved must have good understanding of what they are trying to do. According to Slesinski (1990) for information flow it is important to get people involved in idea sharing and the exchanging of problems. One way of achieving this is for schools to stress the fundamentals associated with CIM. According to Conkol (1990) industry must in the future re-examine

how they are going to do things. Early CIM attempts stalled by using yesterday's standards for measuring performance. CIM requires input and feedback from all areas of a manufacturing concern. This means good communication channels must exist that can move information. Lozeau (1990) noted a major problem with CIM is educating faculty of colleges and universities. For the accurate development of new programs companies using the latest technology need to work with the school systems. One of the biggest problems with school programs is providing students with flexibility. Programs confined to specific systems in schools limit flexibility.

Schreiber (1989) noted the need for cross-training of personnel. For MEs the success of a company can be greatly impacted by programs of cross-training the design engineers and MEs. Up to twenty percent of the engineers in Japan have a combination of design and manufacturing experience as compared to four percent in the United States. Through cross-training a better understanding of the competitiveness of the marketplace can be learned. Also, it is a good way to learn who is your customer. The customer in a manufacturing company in the next person to receive the product. Only with

the completion of the product does the final customer receive it. Along with this it gives MEs a broader range of skills and provides greater flexibility for their future. If the U.S. is going to compete in a global market, they will need every advantage possible. Ciampa (1988) recognizes the need for MEs to have a broader range of skills such as individual initiative and innovation. For this to happen, increases of in-house training programs by industries are essential. The in-house program should permit participants to learn, practice, master, and apply skills.

Lozeau (1990) noted that through certification programs management has a way of determining their best MEs. Certification also provides educational systems with a means of evaluating their performance. It also can be used objectively to determine the skill levels of MEs. For MEs it is a means of professional development. Several certification programs may need development to handle the variety of jobs. Certification serves as a motivational method for MEs in terms of accomplishment and a path for their professional development.

Barcus (1991), President of the Society of Manufacturing Engineers, commented on the need for

lifelong learning and career development. This aspect is one of the most critical to manufacturing remaining competitive. MEs in the work place have the responsibility for more expensive and complex equipment. To handle this requires a new learning process, a part of which is learning how to learn. For CIM to work, it must include all the disciplines of people within the company.

Ciampa (1988) noted that to put an educational program together, there has to be some sense of common vision. When MEs are able to understand the complete picture, they are more willing to learn new skills and continue their education. To meet the challenges of the future, MEs need expanded educational offerings (Barcus, 1991). Colleges and universities must channel their efforts to meet these needs. Ciampa (1988) feels that colleges and universities typically do a good job of providing the basic technical skills that MEs require. However, often the skills needed in CIM environments are those in problem solving, decision making, and planning. These are skills that take time to develop. Other skills that are helpful are the interpersonal skills like influencing and negotiating. This may mean the organization of seminars and

workshops instead of formal programs. These types of programs can be on an as needed basis. These types of programs require strong relationships between the schools and the manufacturing sector. With adult programs it is possible to shift the physical environment to more informal settings to enhance the program. Within this partnership in education a continuous assessment must be made of the needs of all involved to evaluate successes and failures.

Ciampa (1988) identified several considerations in terms of integrated technology in manufacturing. Among these are innovations where people need to be willing to meet challenges and come up with new solutions to problems. Both management and MEs need to be willing to change if this to become reality. A serious internal look must be taken to see what the organization has done well and what it can change to make it better. This includes such things as a revamped educational system with a shift in government emphasis to support education and manufacturing.

Training is very important at all levels, not only do MEs need it but also management (Lozeau, 1990). With management receiving training, they can better understand the needs of MEs. The need exists for two

types of education. The first is in skills training, and the second is in concepts and theory. One way of providing training is joint programs with industry and universities. Management must understand the tools that they have available to them within their MEs. Coordination needs to exist for training programs between industry and schools. This way the development of courses meets the users' requirements. The restructuring of educational programs for MEs returning to school is also very important (Ciampa, 1988). People returning to school after working often have different attitudes towards learning and have different motivational needs. This means the tailoring of programs to the learner in such a way that they become partners. The programs must not only prepare them for the future, but how to do their present job more efficently as well.

Ciampa (1988) noted that often people become bored and complacent with their jobs. When this happens the innovation and competitiveness of a job diminish. However, the competition is not idle while this is taking place. Barcus (1991) reported that of the MEs who will be working in the 21st century, two-thirds of them have employment in industry already. Due to this

any development of an educational program needs to focus on today's employees. Of the MEs in employment today, 20-30% of them lack the technical and personal skills to do their current jobs well, let alone have concerns about tomorrow's problems. According to Ciampa (1988) MEs in a CIM environment have to be willing to take responsibility. From a company standpoint rewards must be offered before the risks of responsibility taking will be assumed by the employee.

Within a business the push for training must come from top management. Without this support the benefits from CIM diminish (Rothwell 1991). The integration of CIM technologies into an industry's infrastructure will require 5 to 10 years to develop fully. The long range plan needs to consider technological improvements, organizational changes, and human resources (Shrensker, 1990). The technology of CIM has been around for many years; however, the integration of it has been the challenge (Ciampa, 1988).

Summary

The future successes of industry depend on how we utilize our resources. The people are the most important resource available to companies. The statement of need has shown the skill requirements that

MEs require when working in a computer integrated manufacturing environment. However, none of the literature reviewed for the study discussed what the skill levels of MEs were. Nor did they identify the amounts of training MEs currently take. The review of literature shows a need for improvement within company training programs and university classes to meet the skill requirements of MEs. The establishment of partnerships between the schools and industries for the development of joint programs is also a concern. The implementation plans to make the best use of people must be long range with commitment from top management. The plan must include both industry and government participation to make it effective.

The rapid growth in technology and the increased competition from overseas created a demand for highly skilled MEs. The amount of time spent in pursuit of education is lower in the United States than in Europe or Japan. Broad based training programs require people to learn to work as team members. The skill requirements are both technical and non-technical in nature. With the rapid changing technology comes the need for flexibility. MEs require adaptability to the changing CIM environment. Two of the major concepts

associated with CIM are computer aided manufacturing and computer numerical control.

Schools need to be aware of the new requirements taking place in industry through improved communication channels. The new programs generated must reflect the standards of a competitive industry. Management needs to work with the schools in program development to ensure the courses meet the users' requirements. They need to be concerned with educating the complete workforce. Programs developed for working MEs need a different structure due to the differences in attitudes and motivation. Included in a training program should be diversification through cross-training programs with design engineers. This provides a better overall understanding and greater flexibility. The government also needs to recognize the importance of manufacturing and provide support for education. One educational direction is through professional certification programs. Certification is both a means of evaluation and development. The mental outlook of MEs must change in regard to education to one of lifelong learning and career development. Many of tomorrow's MEs are already working in today's industries and are lacking in the necessary skills.

Research Questions

This study will address the following research questions:

1. What are the skill levels of MEs working in a CIM environment as they perceive them to be?

2. Are training programs for these skills offered by colleges and universities?

3. Do employers provide ample opportunities to access additional training and education programs?

4. What can management and the government do to enhance training and education?

5. What are the different ways of providing training and who should be responsible for it?

6. What is the number of hours spent by MEs each year in pursuit of continued professional development?

Assumptions

The following assumptions will be made in pursuit of this study:

1) The manufacturing engineers in the states of Iowa, Minnesota, Wisconsin, Michigan, and Illinois are appropriate for this study.

2) The areas of need of CIM are similar across the United States based on earlier research.

3) The skill requirements of CIM are comparable within a variety of manufacturing industries based on earlier research.

4) There is a lack of empirical research to determine the components of effective CIM training based on earlier research.

## Delimitations

The study will be conducted in view of the following delimitations:

1. The survey will be conducted over five mid-western states.
2. The survey will be sent only to MEs who are members of SME.
3. A total of 300 MEs will receive the survey.

## Statement of Procedures

The procedure for the study is as follows:

Questionnaire development

1. Question content
2. Number of questions
3. Rating scale
4. Target population
5. Sample size

Determination of subjects

1. Manufacturing company listings
2. Procure addresses of subjects

Instrumentation validation

1. Survey sent to five MEs for evaluation
2. Compile evaluations of instrument validation

Modification of questionnaire

1. Revise the questionnaire according to the feedback from the five MEs

Data collection

1. Send out questionnaires
2. Compile the returned questionnaire information

Data Analysis

1. Evaluation by the use of descriptive statistics for all questions
2. Create distribution charts for all questions using the Likert scale
3. Percentage calculations for continuing education questions

Follow up

1. Written report of questionnaire findings
2. Report sent to subjects participating in the study (when requested)

Time Line

The time line of the study is as follows:

1. Questionnaires to be mailed by October 28, 1991

2. Questionnaires to be returned by November 18, 1991

3. Compilation of data November 18-25, 1991

4. Analysis of data November 25-30, 1991

5. Written report of the findings November 30 to December 7, 1991

6. Report sent to subjects participating in the study (when requested) January 6, 1992

7. Submit the research study to the advisor and reader January 22, 1992

Definition of Terms

The following terms will be defined to clarify their use in the study: computer integrated manufacturing, manufacturing engineer, in-service training programs, and outside training programs.

1. Computer integrated manufacturing (CIM) - refers to the total manufacturing system. CIM is the integration of a total manufacturing enterprise that uses a system of data communications together with new managerial philosophies that improve organizational and personal efficiency. A broad variety of technologies

make-up CIM which form an overall strategy. Their use depends upon the management approach, the products produced, and the customer. CIM uses many computer software applications along with communication networks that provide the infrastructure to achieve business objectives (Shrensker, 1990).

2. The manufacturing engineer (ME) - develops the manufacturing plans to produce the products the company offers. The MEs' traditional role starts with a product design and sees it through to finished production. This entails equipment purchases, negotiations with suppliers, production implementation, human resources, strategic planning, and facilities planning (Koska and Romano, 1988).

3. In-service training - involves the education undertaken by professionals in conjunction with service. Often in-service training refers to internal staff development. In-service training takes place after initial training or pre-training has occurred. The primary objectives of in-service training include professional growth, personal growth, and program development. The in-service training could be college or university designed workshops and courses or

individualized activities. The in-service training is usually a part of a company sponsored formal or informal program plan.

4. Outside training - refers to education undertaken by professionals outside of their job service. Outside training ranges from initial degree programs to doctoral programs. The objectives of the training include personal satisfaction, job enrichment, job advancements, and job placement. Outside training could be college or university degree programs and is usually formal in structure.

## Summary of Chapters to be Developed in the Final Study

In the final study the problem and purpose will be reviewed along with the methodology followed in utilizing the questionnaire. A compilation of the questionnaire results will be documented along with observations concerning the study. In the conclusions the research questions will be analyzed with respect to the study. Additional facts the study brings out will also be noted. Recommendations will be made based upon the facts borne out within the study.

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