CHAPTER 1: GENERAL DEFINITIONS

1.1 Computer Integrated Manufacturing

Computer Integrated Manufacturing (CIM) technology concerns the developing field of automated manufacturing and materials handling. The use of computers applied to design, machining and manufacturing of products, as well as in quality and process control, is emphasized.

CIM is defined differently by different users, and can be implemented in varying an increasing degree of complexity. For many companies, improving shop-floor communications is the primary goal. Others extend the degree of integration to encompass communication between engineering and manufacturing functions. The ultimate benefit of CIM is the improvement of communication and control of information flow to all aspects of an enterprise. Integrating information and organizations will decrease the logistical size of a company, making it appear to be small again—at least from the management, administration, and information-sharing viewpoints. The goal of CIM is to provide the computer applications and communications needed to bring about the integration (with matching organization changes) that will allow a company to take advantage of these new capabilities.

1.1.1 CIM the Enterprise Wide Solution

In any manufacturing enterprise there is a unique set of business processes that is performed in order to design...produce...and market the enterprise’s products. But no matter how unique an enterprise or its set of processes, every enterprise shares the same set of high-level objectives. This is to:

• Manage manufacturing finance and accounting
• Develop enterprise directives and financial plans
• Develop and design products and manufacturing processes
• Conduct manufacturing operations
• Manage external demands

Computer Integrated Manufacturing harnesses information system technology to integrate these manufacturing and business objectives. When implemented properly, CIM can deliver increased productivity, cost-efficiency and responsiveness throughout the enterprise.

CIM accomplishes this by addressing each of the major functional areas of the manufacturing enterprise:

• Marketing
• Engineering and Research.
• Production Planning
• Plant Operations
• Physical Distribution
• Business Management

Integrating these functions and their resources requires the ability to share and exchange information about the many events that occur during the various phases of production; manufacturing systems must be able to communicate with the other information systems throughout the enterprise. There must also be the means to capture data close to its source,
and then integrate this data at a division or corporate level, as well as with external suppliers, sub-contractors and even customer

![Figure 1.1: Enterprise Functions](image)

To meet this need, the CIM environment requires a dynamic network of distributed functions. These functions may reside on independent system platforms and require data from various sources. Some may be general-purpose platforms, while others are tailored to specific environments. But the result is an environment that encompasses the total information requirements of the enterprise—from developing its business plan to shipping its products.

With this enterprise-wide emphasis, CIM can deliver its benefits to all types of manufacturing operations, from plants that operate one shift per day to processes that must flow continuously...from unit fabrication and assembly to yielded lots with by-products and co-products. These benefits can also be realized in those enter prices where flexible
manufacturing systems are being used to produce more diversified products over shorter runs, as well as by integrating the management of the CIM enterprise with automated office systems.

By creating a more efficient, more comprehensive information system environment, CIM supports management efforts to meet the challenges of competing effectively in today’s world markets.

The CIM advantage translates into a wide range of benefits. When Computer Integrated Manufacturing is implemented in an enterprise, the benefits can be felt far beyond the plant floor and its manufacturing process. They extend into each of the functional areas of the manufacturing enterprise.

In Marketing, CIM helps manage customer satisfaction by allowing electronic order entry from customers... through faster response to customer inquiries and changes...and with more accurate sales projections.

In Engineering and Research, CIM benefits include quicker design, development, prototyping and testing... faster access to current and historical product information...and a method for paperless release of products, processes and engineering changes to manufacturing. In Production Planning CIM offers more accurate, realistic production scheduling...while it requires less expediting, canceling and rescheduling of production and purchase orders.

Within Plant Operations, CIM provides the means to assist the manufacturing operations in controlling processes, optimizing inventory, improving yields, managing changes to products and processes, reducing scrap and rework. CIM also helps utilize people and equipment more effectively...and reduces crisis production demands as well as lead times and product costs.

In Physical Distribution, where external demands are satisfied with products shipped to the customer, CIM helps plan requirements...manage the flow of products...improve efficiency of shipping, vehicle and service scheduling...allocate supply to distribution centers...and expedite processing of returned goods.

For Business Management activities such as managing manufacturing finance and accounting, and developing enterprise directives and financial plans. CIM offers better product cost tracking...more accuracy in financial projections...and improved cash flow.

For the enterprise as a whole, these advantages add up to faster release of new products...shorter delivery times...optimized finished goods inventory...shorter production planning and development cycles...reduced production lead times...improved product quality, reliability and serviceability...increased responsiveness and greater competitiveness. In effect, CIM replaces an enterprise’s short-term tactical improvements with a long-term strategic solution.

Of course, the advantages of CIM aren’t just contained within the four walls of your enterprise. It can also deliver real productivity gains to those outside your enterprise. For example, suppliers will be able to plan production, schedule deliveries and track shipments more efficiently. And your customers will benefit from shorter order-to-delivery times; on-time deliveries; and less expensive higher-quality products.

As you can see, the integration and productivity gains made possible by CIM are key to maintaining a competitive edge in today’s manufacturing environment.
1.2 CIM Benefits

Computer Integrated Manufacturing have been successfully introduced into a wide variety of workplace environments and are playing an increasingly important role in maintaining the competitive edge for manufacturing organizations in global markets. Manufacturing, firms around the world have invested, and are expected to continue to invest significantly large sums of money in CIM systems. A recent survey indicates that almost 87% of US manufacturing are actively engaged in CIM or had plans to do so (Johnson and Labarre, 1993). The potential benefits of a CIM system are reduced time to market and increased flexibility and agility plus those described below:

Improvement labor productivity-More effective use of design, manufacturing, producibility and quality engineers through concurrent engineering practice and elimination of organizational barriers. CIM tools also reduce the number of drafting, model or prototype shop personnel required to accomplished the equivalent output of work with higher quality results.

Improvement Equipment productivity- Better utilization of machines and work cells is achieved through improved monitoring, control and diagnostics; the application of group technology to increase batch size and reduce set-up time. Assist the manufacturing operations in controlling processes, optimization inventory, improving yields, managing changes to products and processes.

Lower the cost of the product- Design product for producibility, faster release of new products, shorter delivery times, shorter production planning and development cycles improve quality control. Reliability and serviceability, improve product quality, resulting in reduction of scrap, rework and warranty cost due to better engineering analysis.

When Computer integrated Manufacturing is implemented in an enterprise, the benefits can be felt far beyond the plant floor and its manufacturing process. They extend into each of the functional areas of the manufacturing enterprise. Some of the benefits as experienced by IBM (1989) can be summarized as follows;

1- It helps to manage customer satisfaction by allowing electronic order entry from customers through faster response to customer inquires and changes with more accurate sales projections.

2- More accurate, realistic production scheduling while it requires less expediting, canceling and rescheduling of production.

3- For business management activities such as managing manufacturing finance and accounting and developing enterprise directives and financial plans, CIM offers better product cost tracking, more accuracy in financial projections and improved cash flow.

Many of the firms that are currently using CIM, such as Allen Bradley, Ingersoll Milling, Cone Drive, Forest and Continental Cai have reported a number of improvements including (Melnyk and Narasmhan, 1992):

- 15-30 % reduction in engineering design cost,
- 30-60 % reduction in overall lead times,
- 40-70% gain in overall production,
- 200-500 % gain in quality
- 30-60 % reduction in working progress.
1.3 Major Problem Sources

While CIM programs have reported large gains for manufacturing firms, CIM can be costly and difficult to implement. Lei and Sobol (1992) emphasizes that CIM implementation in many US firms has hindered because of the difficulties in understanding the technology and organizational impediments.

CIM programs in nine firms have been examined by Morris and Morris (1994). The most serious problems reported include lack of direction and cost justification indicating that support for CIM programs by top level management is necessary to improve the success of CIM programs.

1.4 CIM in Small and Medium Size Companies

The most widely used criterion for defining firm size is the number of employees although indicators such as turnover or value added are also found and may be more appropriate for certain purposes. Usually the following classification for firms in manufacturing is adopted:

- 0 - 99 employees small
- 100 - 499 employee medium-size
- 500 and larger

Small and medium size companies (SMEs) have gained importance. One of the reasons for this focus on SMEs is the awareness that they are a growing segment in an economy where the larger establishments have lost ground in terms of market share and employment (Young and Vesterager, 1990).

In Denmark, 98% of the discrete parts manufacturing companies employ 200 people or less. These small and medium size companies employ 52% of the people working in discrete-part manufacturing and produce 33% of the country’s value-added goods. In America 95% of discrete-parts companies employ 250 people or less, which is 43% of the people working in discrete-parts manufacturing, and produce 18% of the country’s value-added goods.

In small or medium size manufacturing the situation is completely different from mass production enterprise in that, order acceptance must be based on cost-estimation and the availability and capacity of the right type of equipment. The number of job types is much higher than large enterprises and as a consequence the amount of manufacturing data to be generated per unit of work is very high. Therefore process planning and continuity of activities, aiming at the flexible use of the manufacturing equipment and human resources is vital (Kals, 1991).

Small and medium size companies generally have customer-order driven production (Kovacs et al., 1994). Therefore they should have high level of flexibility since one order is different from another and existing facilities frequently have to be modified to meet customer needs. This type of production may even lead to one-of-aKind production.

Although most effort to date in CIM system development has focused upon large cooperation’s, the general feeling is that in the next decade small and medium size companies will be the fastest growing segment of the CIM market. This is significant, since it was originally claimed that only large organizations would benefit from CIM as they have the necessary resources.
Large enterprises developed their own methods to implement the CIM system. Experience brought success, but their solutions were not completely applicable to small and medium size enterprises as cost and availabilities of staff with experience of computerized systems have mostly been prohibitive (Hirsch et al., 1993).

Figure 1.2: CIM Facility
Figure 1.3: CIM Definition

Figure 1.4: Functions and Information Flows in CIM
Figure 1.5: CIM Activities

Figure 1.6: CIM Material and Information Flow
Figure 1.7: The Enterprise Model
Figure 1.8: Marketing Work Flow
Figure 1.9: Engineering and Research work flow
Figure 1.10: Production Planning work flow
Figure 1.11: Plant operations work flow
Figure 1.12: Physical distribution work flow
Figure 1.13: Business Management work flow
Figure 1.14: The flow/process manufacturing work flow