

Introduction to Computer Integrated Manufacturing Environment

I. What are the problems facing manufacturing industries today?

External pressures:

- *Technological advancements
- *Increased cost, quality, and delivery pressure as a result of intensifying worldwide competition
- *Fluctuating exchange rate (closer scrutiny of make versus buy decisions)
- *Uncertainty and instability of economic conditions
- *Declining percentage of individuals choosing careers in manufacturing

Internal problems and inefficiencies:

- *High levels of work-in-process inventories
- *Complex material flow patterns
- *Extremely long lead times
- *Increasing product complexities
- *Excessive material handling and damaged parts
- *Complex scheduling and machine capacity loading
- *Low capital asset utilization
- *Shop floor engineering changes
- *Bottlenecked machine groups as a result of multiple parts competing for the same work center
- *Aging capital equipment and inadequate allocation of replacement funds
- *Excessive expediting as a result of front-loaded lateness
- *Excessive move, queue, and part setup time
- *Misplaced parts resulting from part movement to unofficial queue areas
- *Out of control scrap and rework costs

Order-Winning Criteria Model

<i>Corporate goals</i>	<i>Marketing strategy</i>	<i>Manufacturing order-winning criteria</i>	<i>Manufacturing strategies</i>	
			<i>Structure</i>	<i>Infrastructure</i>
What the company is going to do: <ul style="list-style-type: none"> • Growth • Profit margin • Other financial measures 	How the company will reach desired goals: <ul style="list-style-type: none"> • Product markets and segments • Mix • Volumes • Standardization versus customization • Level of innovation • Leader versus follower 	<ul style="list-style-type: none"> • Price • Quality • Lead time • Delivery/reliability • Flexibility • Innovation/ability • Size • Design Leadership 	<ul style="list-style-type: none"> • Capacity • Facilities • Technology (processes used) • Vertical Integration (degree to which all parts are produced internally) 	<ul style="list-style-type: none"> • Work force (pay, skill level) • Quality achievement process • Manufacturing, planning, and control system • Organization (control, measurement, motivation)
<i>External Focus</i>		<i>Common Language</i>		<i>Internal Focus</i>

II. What is FMS?

United States Government - A series of automatic machine tools or items of fabrication equipment

linked together with an automatic material handling system, a common hierarchical digital preprogrammed computer control, and provision for random fabrication of parts or assemblies that fall within predetermined families.

Kearney and Trecker - A FMS is a group of NC machine tools that can randomly process a group of parts, having automated material handling and central computer control to dynamically balance resource utilization so that the system can adapt automatically to changes in parts production, mixes, and levels of output.

FMS is a randomly loaded automated system based on group technology manufacturing linking integrated computer control and a group of machines to automatically produce and handle parts for continuous serial processing.

FMS combines microelectronics and mechanical engineering to bring the economics of scale to batch work. A central on-line computer controls the machine tools, other workstations, and the transfer of components and tooling. The computer also provides monitoring and information control. This combination of flexibility and overall control makes possible the production of a wide range of products in small numbers.

- ⊙ A process under control to produce varieties of components or products within its stated capability and to a predetermined schedule.
- ⊙ A technology which will help achieve learner factories with better response times, lower unit costs, and higher quality under an improved level of management and capital control.

III. Basic FMS Elements

Hardware elements are visible and tangible:

1. CNC machine tools
2. Pallet queuing carrousel (part parking lots)
3. Material handling equipment (robots or automatic guided vehicles)
4. Central chip removal and coolant systems
5. Tooling systems
6. Coordinate measuring machines (CMM)
7. Part cleaning stations
8. Computer hardware equipment

Software elements are invisible and intangible:

1. NC programs
2. Traffic management software
3. Tooling information
4. CMM program work-order files
5. Sophisticated FMS software

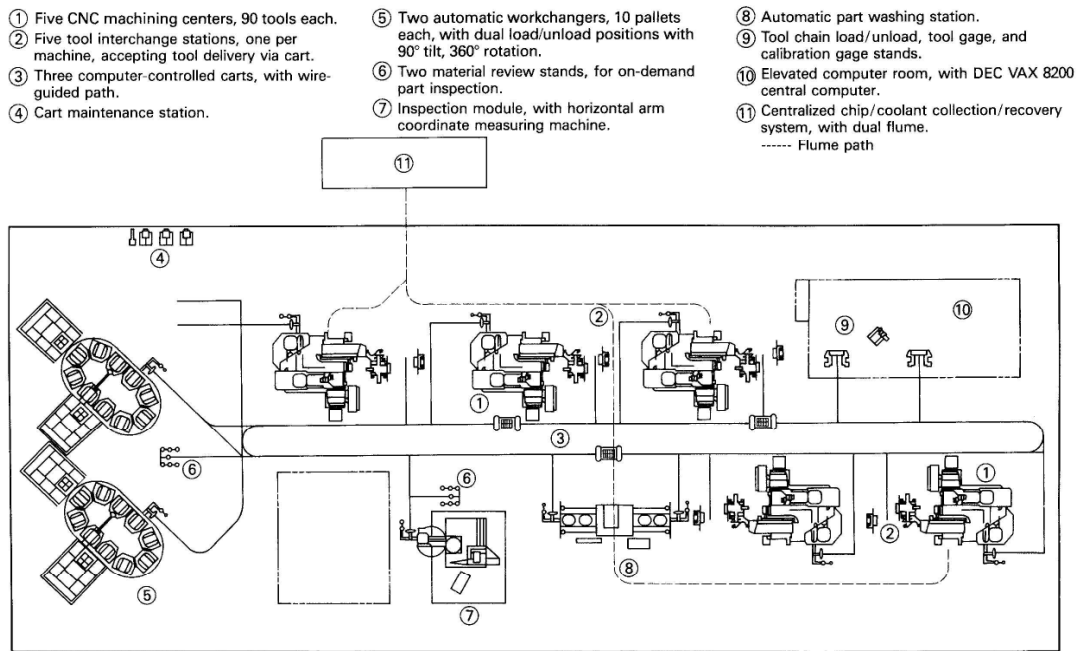


Figure 1-1 Typical FMS and its major identifiable components. (Courtesy of Cincinnati Milacron)

IV. Benefits of Invest in Flexible Manufacturing

1. Inventory reduction of 60 to 80 percent - a key benefit because parts do not sit around 95 percent of the time waiting to be used. FMS provides the capability for increased part throughput, thus reducing the opportunity for parts to sit around as work in process and finished inventory.
2. Direct labor savings of 30 to 50 percent - low staffing levels leading to a very few people in direct manufacturing jobs, such as operating machines and assembly. The whole key to FMS is that it offers flexibility an unattended or lightly attended operation as setups and workpieces are fixtured and made off-line while machine tools are cutting metal.
3. Increased asset utilization approaching 80 to 90 percent - Asset utilization is increased because equipment can operate lightly staffed for three shifts a day, seven days a week, depending on certain operating conditions and correct equipment balance. The computer controlled, automated of FMS give the prospect of operation for 24 hours per day.
4. Floor space reduction of 40 to 50 - The floor space can be reduced and thus the actual size and cost of a new plant can be much smaller, perhaps even one-third the size of a conventional plant. Additionally, the space required for work in process and finished inventory reduces.

V. FMS Limitations

-FMS is not without its inherent limitations. Many of these limitations originate from unrealistic expectations as to what FMS is and what it can do and misunderstanding about the need for flexibility in manufacturing. The flexibility means different things to different manufacturers, and flexibility requirements in manufacturing do not always translate into FMS.

Generally, flexibility refers to:

1. **Variety of mix:** the combination of different parts the system can make at a time and the various subsets of part types that can be make simultaneously.
2. **Adaptability to design, production, or routing changes:** this refers to ease of accommodating engineering changes, expansion of the total universe of part productable on the system, and the variety of routes or machines that can process the same part type.
3. **Machine changeover:** the ease with which a machine within the system can automatically change from making one part type to another.

VI. Unattended Machining

- The concept of unattended machining implies running an NC machine tool with no operator in attendance for extended periods of time, usually eight or more hours. The parts, tools, and NC programs are considered to be loaded and available at each machine station or are delivered on as needed basis to each machine.
- Unattended machining begins by making sure an adequate supply of parts and cutting tools is available to keep the machine in operation for an extended period.

Usually the following questions need to be cleared:

- What type of material to be produced? Steel? Cast iron? Aluminum? or A combination?
- How long will the machine continue to operate unattended?
- What provisions are available to keep it running?
- What assurance is there that the machine will continue to run and not cause damage to itself, the parts, or the tooling?
- How many different types of parts can be run unattended on the machine or in the cell?
- How much extra process preparation work is required ahead of time to process each type of unattended part (part programs, fixtures, tooling, or material-handling changes)?

New multi-machine cells should include features

- Extended part queuing and tool-changing capabilities
- Torque and force sensing of the metal-cutting process
- Automatic fault detection
- Probing capabilities - greatly contributes to accuracy, repeatability, and quality of unattended machine

Example of unattended machining center features and requirements

1. Palletized queuing of workpieces by means of a carrousel or in-line part setup arrangement.
2. Detection of missing, miss-aligned, or wrong parts using the probe and part program branching to bypass the problem area.
3. Determination of excess or insufficient stock with the probe.
4. Detection of broken tools through the use of a fixed probe with a spindle probe to determine whether the workpiece stock has been removed.
5. Avoiding erroneous probe data, such as touching on a chip with a reasonableness test on the probe data.
6. Avoid wrecks by spindle torque measurement and predetermined shutdown limits.
7. Clear chips from tools for probing cycles through high pressure coolant flushing and air blasts.

Example of unattended turning center features and requirements

1. Part size must be controlled through probe measurement of the part, automated in process or post process gauging, and automatic compensation of the machine for changes.
2. Parts must be automatically delivered, loaded, and unloaded, usually by means of an integrated floor- or machine- mounted robot arm along with part queuing by palletized conveyor.
3. Specific part identification can occur by probing unique dimensions to distinguish random parts within a given family and calling up the proper NC program as required.
4. Wrecks can be avoided through spindle torque and slide force sensing and shutting the machine down safely before part, tool, or machine damage occurs (due to exceeded machine horsepower limits, dull tools, or excess workpiece stock).
5. Chips can be cleared from the chuck by the quick rotation of an empty chuck and applying air blast before loading the next part (long unattended applications can create a problem with disposal of the volume of chips produced).
6. Parts must be easily turned end for end and accurately located for part completion.
7. A fixed probe for automatic tool length setting avoids the time-consuming manual or deal of tool setting for broken tool detection.

VII. What is Computer Integrated Manufacturing?

CIM is a conceptual approach to helping manufacturing organizations respond to the difficult environment in which they operate.

CIM is not a product that can be purchased and installed. CIM is a way of thinking about and solving problems. The emphasis is on understanding how to create effective manufacturing enterprises. The determination to apply this understanding must come from personal commitment.

CIM is thus taken here to involve the design or redesign of an entire manufacturing enterprise so that all aspects of the system work together effectively. In most cases of interest, integrated information flow, the widespread application of computers, and high levels of automation result from such design efforts. However, these technologies are identified here as a means to an end; the emphasis is on understanding how to most appropriately use all available resources to achieve enterprise objectives.

The advantages of conversion to CIM-oriented operations for companies were found as:

Reduction in engineering design cost	25 - 30 percent
Reduction in overall lead time	30 - 60 percent
Increase in product quality	2 -5 times
Increase in capability of engineers	3 - 35 times
Increase in productivity of production operations	40 - 70 percent
Increase in productivity of capital equipment	2 -3 times
Reduction in work-in-progress	30 - 60 percent
Reduction in personnel costs	5 - 20 percent

Toward Competitive Manufacturing Systems:

The management of a manufacturing system to best use all resources, and the management of technology to best achieve system objective, are both essential aspects of problem solving.

Skilled management is required to make the best use of available resources. In today's manufacturing setting, technology must be viewed as a potential resource. Thus, the management of technology - including selection of the most appropriate technology for use and its optimum application - is an essential management task.

VIII. STRATEGY DEVELOPMENT FOR CIM IMPLEMENTATION

The implementation of CIM would result in getting all "islands of automation" in the factory to work together as one functioning unit.

The range of benefits include:

- Inventory reduction
- Manufacturing cost reduction
- Product quality improvement
- Increased manufacturing flexibility
- Improved On-time delivery
- Allowance for dynamic market management

Typical problems in CIM strategy development include:

Lack of management commitment

-The driving force must come from a top management committed to this new way of doing business is necessary.

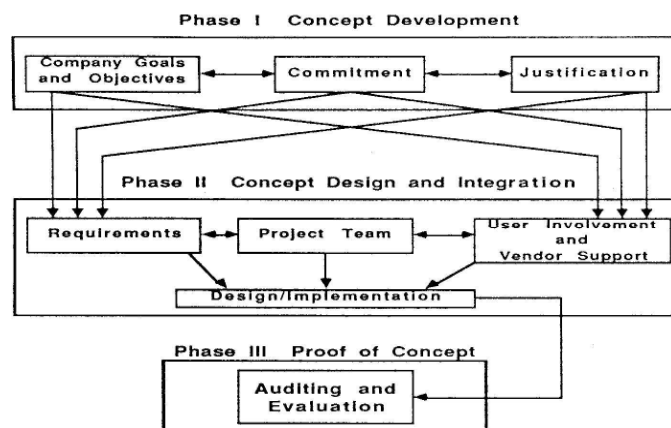
Lack of knowledge of long term business goals

-All levels of management and workers should involve, otherwise the wrong type of process being implemented or the wrong type of process being installed

Lack of in-house expertise of current systems

-Multi-background teams with many skills, ranging from software, hardware, to business management expertise are needed.

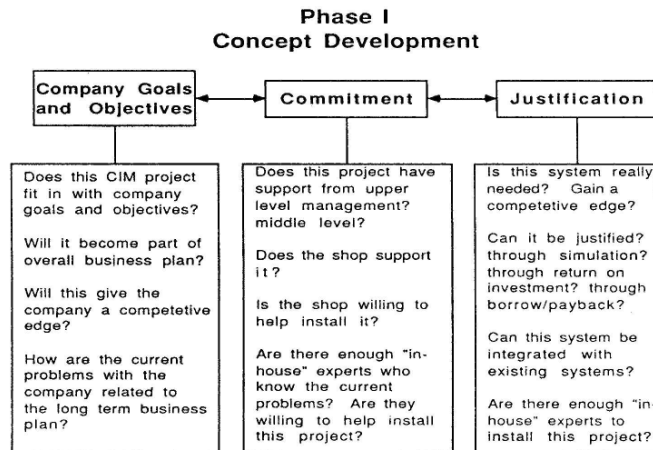
METHODOLOGY



Phase I: Concept Development

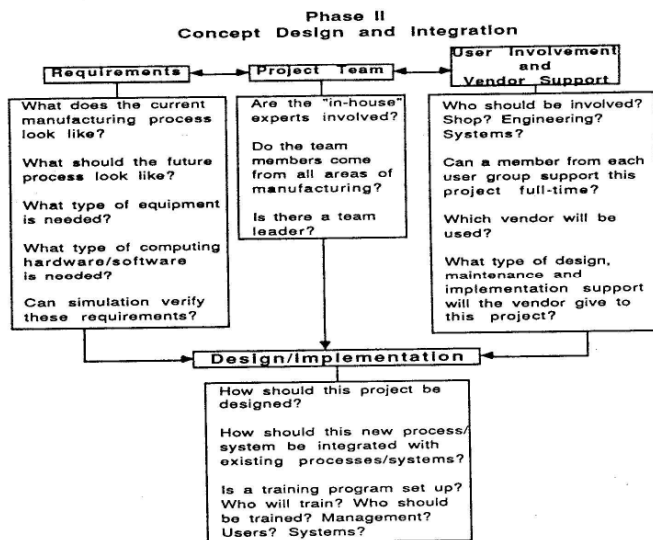
- Company goals and objectives
- Commitment

-Justification

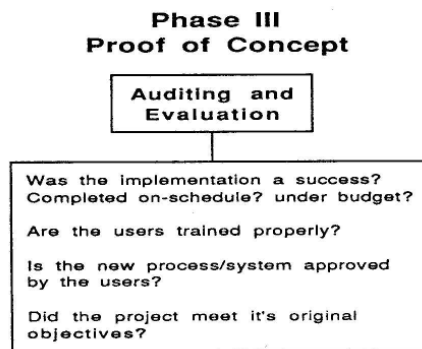


Phase II: Concept Design and Integration

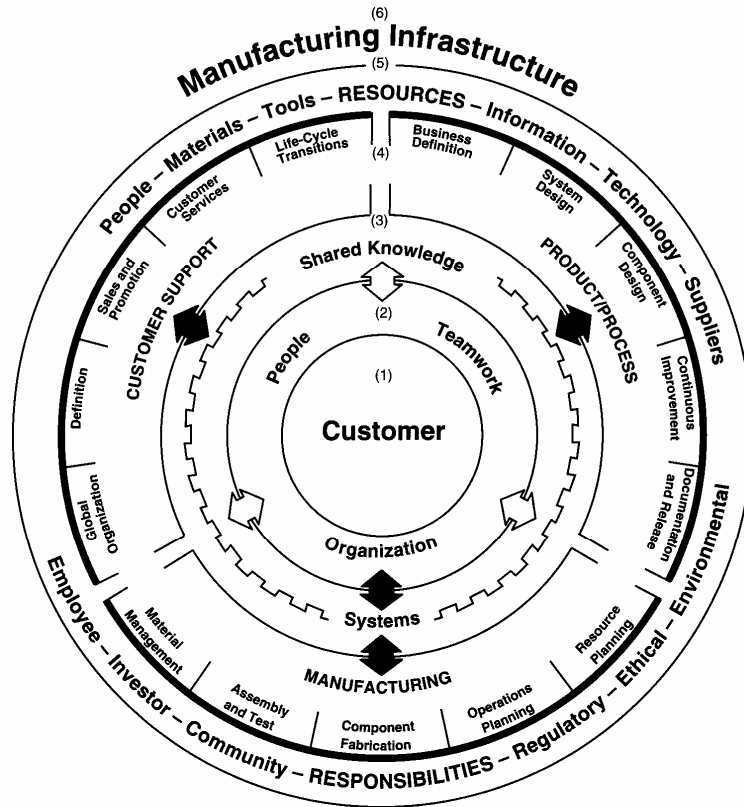
- Project team
- Requirements
- User involvement and vendor support
- Design/Implementation



Phase III: Proof of Concept



New Manufacturing Enterprise Wheel



- Customer, is the primary target for all marketing, design, manufacturing, and support efforts in the enterprise. Only with a clear understanding of the marketplace and the customer can the enterprise be successful.
- The 2nd layer on the wheel focuses on the means of organizing, hiring, training, motivating, measuring, and communicating to ensure teamwork and cooperation in the enterprise. The techniques used to achieve this goal include self-directed teams, teams of teams, organizational learning, leadership, standards, rewards, quality circles, and a corporate culture.
- The section 3 focuses on the shared corporate knowledge, systems, and common data used to support people and processes. The resources used include manual and computer tools to aid research, analysis, innovation, documentation, decision making, and control of every process in the enterprise.
- The 4th layer, three main categories of processes, product/process definition, manufacturing, and customer support, make up this section of the wheel. Included in this group are fifteen key processes that form the product life cycle.
- The 5th layer, enterprise has resources that include capital, people, materials, management, information, technology, and suppliers. It also has responsibilities to employees, investors, and the community, as well as regulatory, ethical, and environmental obligations.
- The final part of the wheel is the manufacturing infrastructure. This infrastructure includes customers and their needs, suppliers, competitors, prospective workers, distributors, natural resources, financial markets, communities, governments, and educational and research institutions.