Introduction to FMS

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.

From System Point of View
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.

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

Basic FMS Elements

Hardware elements are visible and tangible:
1. CNC machine tools
2. Pallet queuing carrousels (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
True FMS

*True FMS can handle a wide variety of dissimilar parts, producing them one at a time, in any order, as needed (very few so-called FMSs meet this strict definition). It needs the flexibility to adapt to varying volume requirements and changing part mixes, to accept new parts, and to accommodate design and engineering modifications.

*FMS also requires the flexibility to cope with unforeseen and unpredictable disturbances such as machine downtime problems or last minute schedule changes; and the ability to grow with the times through system expansion and configuration, improvements, and alterations.

*FMS is a business-driven solution to mid-volume, mid-variety manufacturers; it offers the opportunity of predictable control to the manufacturing process. A full FMS installation is one in which a process is put under total computer control to produce a variety of products with the system’s defined capability and with a pre-determined schedule.

*In the long range, FMS is the natural partner for CAD (Computer Aided Manufacturing) and CIM (Computer Integrated Manufacturing) which ultimately all serve to bring a product from design to reality by the most efficient and cost effective means.
Is there an optimum size of FMS?

*At the present time the answer is no; size depends on user needs and resources. The number of NC machines in a system can be as low as one or two. Generally, the number of processing machines or machine tools is three to ten. Thus, the cost and effort involved for planning, project engineering, installing, implementing, and managing an FMS is high.

Need for FMS

*The objective in manufacturing is to get the right raw materials or parts to the right machines at the right time. Too much or too soon creates backed up excess in-process inventory. Too little or tool late caused delayed work schedules and idle machines. The result in many cases is a poor use of capital, in the form of excess in-process inventory and/or under utilization of equipment.

The analysis of 8760 available hours in a calendar year to a manufacturing operation breakdown of the time spent by an average part in the shop.

Common day-to-day disturbances within the overall manufacturing process consisting of:

1. Priority (scheduling) changes
2. Engineering design changes
3. Tooling difficulties
4. Machine breakdowns
5. Processing problems
6. Lost, misplaced, and scrapped parts
7. Vendor lateness

Today's environment to meet customer requirements:

1. There should be minimum delay between order placement and order delivery.
2. Quality and reliability should be high
3. Operating costs should be predictable and under control.
4. Replacement parts should be available an accessible on a quick turnaround basis.

The principle objectives of FMS

1. Improve operational control through:
● Reduction in the number of uncontrollable variables
● Providing tools to recognize and react quickly to deviations in the manufacturing plan
● Reducing dependence on human communication

2. Reduce direct labor through:
● Removing operators from the machining site (their responsibilities and activities can be broadened)
● Eliminating dependence on highly skilled machinists (their manufacturing skills can be better utilized in manufacturing engineering functions)
● Providing a catalyst to introduce and support unattended or lightly attended machine operation

3. Improve short-run responsiveness consisting of:
● Engineering changes
● Processing changes
● Machine downtime or unavailability
● Cutting tool failure
● Late material delivery

4. Improve long-run accommodations through quicker and easier assimilation of:
● Changing product volumes
● New product additions and introductions
● Different part mixes

5. Increase machine utilization by:
● Eliminating machine setup
● Utilizing automated features to replace manual intervention
● Providing quick transfer devices to keep machine in the cutting cycle

6. Reduce inventory by:
● Reducing lot sizes
● Improving inventory turnovers
● Providing the planning tools for just-in-time manufacturing

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
Conventional Approaches to Manufacturing

Conventional approaches to manufacturing have generally centered around machines laid out in logical arrangements in a manufacturing facility. These machine layouts are classified by:

1. Function - Machines organized by function will typically perform the same function, and the location of these departments relative to each other is normally arranged so as to minimize interdepartmental material handling. Workpiece produced in functional layout departments and factories are generally manufactured in small batches up to fifty pieces (a great variety of parts).

2. Line or flow layout - the arrangement of machines in the part processing order or sequence required. A transfer line is an example of a line layout. Parts progressively move from one machine to another in a line or flow layout by means of a roller conveyor or through manual material handling. Typically, one or very few different parts are produced on a line or flow type of layout, as all parts processed require the same processing sequence of operations. All machining is performed in one department, thereby minimizing interdepartmental material handling.

3. Cell - It combines the efficiencies of both layouts into a single multi-functional unit. It referred to as a group technology cell, each individual cell or department is comprised of different machines that may not be identical or even similar. Each cell is essentially a factory within a factory, and parts are grouped or arranged into families requiring the same type of processes, regardless of processing order. Cellular layouts are highly advantageous over both function and line machine layouts because they can eliminate complex material flow patterns and consolidate...
material movement from machine to machine within the cell.

Benefits and Limitations 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.

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.

- FMS limitations
1. FMS is not a cure-all for productivity and profitability problems. It cannot make order out of confusion, but it can make a major contribution after manufacturing chaos is resolved first. New automated techniques, including FMS, should be applied only to a successful non-automated activity. Information flow must be efficient before computers are introduced. Material flow must be efficient before automated guided vehicles (AGV) are acquired.

2. Applying FMS may not be as productive as efforts to outsource or subcontract component manufacturing or to maximize the efficiency of existing workers and processes. Increased machine utilization, improved quality and part throughput, and reduced inventory are the goals. FMS may result from efforts to obtain these goals.

3. The high cost of FMS may be prohibitive. Perhaps the purchase of a machining center equipped with pallet shuttle or with an automatic work changer would be sufficient. To coupled with an 8- to 16-hour queue of work to operate unattended during the night, numerous automated features, such as sensing and probing capability, adaptive control, tool monitoring, and advanced diagnostics is required.

4. Purchase of an FMS is not the same as that of a standard machine tool. It is an ongoing partnership venture between supplier and user that can take in some cases 2 years from initial facility preparation to complete system implementation and operation.

5. Most FMSs are being promoted by machine tool manufacturers who are concerned with metal-removal processes. Closer study of individual component's functional requirements and design criteria may provide a more practical and economical solution.

6. Purchase of an FMS without consideration as to how the system can integrate (hardware and software) with existing machinery, computer systems, and operations causes automation isolation.

7. FMS is for the workpiece not the workpiece for FMS.