Evolution and Contents of FMS

FMS: Definition and Description

- In many cases it depends on the user’s rather than the equipment manufacturer’s point of view.
- FMS technology, originating in Europe, has evolved over the last two decades primarily to meet the requirements of the mid-volume, mid-variety world of part manufacturing.
- This focus has occurred because part manufacturing is one of the most costly and unprofitable areas in industry.
- However, FMS is not limited to part manufacturing operations.
- Depends on the user’s definition of FMS and the type of industry, FMS has been and will continue to be utilized in process- and assembly-related industries as well as part manufacturing.
- Many of the principle and practices apply regardless of industry type, business objectives, or definition of FMS.

Evolution

- The concept of flexible manufacturing systems was born in London in the 1960s when David Williamson came up with both the name and the concept. At the time he was thinking in terms of a flexible machining system, and it was in a machine shop that the first FMS was installed.
- His concept was called System 24 because it was scheduled to operate on the 24 hours a day under the control of a computer, but otherwise unmanned on the 16-hour night shift.
- This simple concept of decentralized computer control of machine tools, combined with the idea of using machine tools for 24 hours per day (16 unmanned on night shift), was the beginning of FMS.

Williamson’s planning

- To use NC (numerically controlled) machines to work out a series of machining operation on a wide range of detail parts.
- Workpieces would be loaded manually on pallets, which would then be delivered to the machines and loaded automatically when needed.
- Each machine would be equipped with a magazine from which tools could be selected systematically to perform a variety of different operations.
- Included in this overall process were systems for removing chips and cleaning workpieces.
- This system combined the versatility of computer-controlled machine with very low manning levels.
- With the growth in computer-controlled equipment and broader applications developing from metal forming to assembly, the concept of “flexible machining systems” was broadened to become what is known today as “flexible manufacturing systems,” or FMS.
- As the first FMS systems were installed in Europe, and users quickly discovered that the principles would be idea for the manufacturing of low-volume, high-variety products.
- The addition of refinements to an FMS to detect and compensate for tool wear were then added to further aid unattended FMS operations.
These first FMS on the market had dual computers: DNC (direct numerical control) for cell control functions and a separate computer to monitor the traffic and management information systems.

Since the 1970s there has been an explosion in system controls and operational enhancements. The programmable controller appeared in the late 1970s, and the personal computer emerged utilizing distributed logic control with many levels of intelligent decision-making capabilities.

What will be the next steps?
- The FMS has evolved rapidly and will continue to evolve because technology continues to evolve, global competition intensified, and the concept of flexible projected to increase steadily in the years ahead.
- In 1990s, 50+% of all FMSs were used for manufacturing machinery and 40+% for manufacturing transportation components. Construction and material-handling industries will comprise around 10+% of the user market.
- Flexible automation is presently feasible for machining operations. Development efforts continue to expand the FMS’s capabilities in the areas of improved diagnostics and sensors, high speed none-contact on-line inspection, multifunction or quick spindle head changing machine tools, and extending flexible automation to include forming, heat treating, and assemble.

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General FMS considerations

- Identify some common problems associated with conventional manufacturing.
  - Many manufacturing industries are currently dedicated to manual and conventional production methods or high-speed fixed automation. And many are ill suited to accommodate faster product and process changes in an increasingly globalize and competitive market place.

- Flexible manufacturing affords users the opportunity to react quickly to changing product types, mixes, and volumes while providing increased utilization and predictable control over hard assets.

- Although FMS provides users with many benefits, they are not easy to justify. Limitation and alternatives must be weighed and compared to determine if FMS is the best or even the right approach to productivity and profitability improvements.

- The once traditional accounting and cost justification practices have become outdated and have lost their applicability to many factory automation programs and projects. The rules for staying competitive have change. The measurements must also change.

Manufacturing cells

- The concept of processing parts in a manufacturing cell is usually developed around NC machine as the core equipment.

- Machining and manufacturing cells can range in size and complexity from an automated stand-alone turning or machining center to a full-scale FMS.

- The terms “cell” and “FMS” are sometimes used interchangeably; however, many differences exist depending on system size, complexity, and the extent of the application, along with how a particular company views and uses its system.

- Machining cells are generally based on clustering of two or more redundant CNC machines by part family.

- Part loading and unloading within the cell are usually handled by means of an integrated, compute-controlled robot or some other partially automated or manual means.

- Many companies are overcoming their apprehension of cells and unattended machining problems by seeing the extra production, they can get from grouping their machine and setting them up to run during lunch hours and for a few hours after quitting time.

- Many industrial managers have come to recognize and accept the need for greater automation coupled with greater flexible in their manufacturing operation through the use of unattended or lightly attended cells – and for a fraction of the cost of a full-scale FMS.

Physical planning of FMS

- Understand the value of detailed planning to a successful factory automation project.

- Physical planning for FMS or any automation project can involve hundreds of people. All through the planning, implementation, and installation phases, the problem becomes one of structured focus on evaluation, communication, coordination, and resolution.

- An automation project such as FMS cannot be developed, controlled, and implemented by informal, haphazard committees assembled irregularly on a “catch as catch can” basis. Strong individuals must be appointed to the project team, from
competent project manager to capable, authoritative, and decision-making functional managers. These individuals must be prepared to stay on the project until completion.

**Fundamental FMS physical planning**
- Fundamental FMS physical planning involves close teamwork between user and supplier, along with researching, analysis, information gathering, compiling, and coordinating a vast amount of complex technical issues and data.
- This includes targeting the specific parts or part families to be produced and extends through facility modification, system layout, configuration, and sizing, to operating and organization consideration, and compatibility and integratability with existing operations and computer system.

**Human Resources**
- Understand the importance of human resource considerations to a successful FMS installation.
  - Issues relative to retraining, redeployment, job security, loyalty, new job assignments, seniority, experience, and many others.
  - FMS equipment must obtain higher utilization rates in order to reduce costs, improve productivity, and increase profitability.
  - A successful people-automation connection is built on teamwork, communication, and employee involvement in an environment where openness, honesty, and sincerity prevail.

**Quality: manufacturing's driving force**
- Quality is the most important factor to the survival of any business. It directly supports the other factors of cost, productivity, on-time delivery, and market share.
- In a free enterprise system, quality standards are set by the customer. Therefore, all quality standards needed to produce the components of a product and perform its assembly must be specified in a manner such that customer expectation are met.

**Improve the quality of quality: goal in any business**
- To improve quality and meeting customer expectation, manufacturers are coming to realize that they must have better control over difficult to control manufacturing processes.
- Flexible cells and systems are a means of improving and controlling the manufacturing process, but only after the process itself is under control and all the required upfront planning and preparation work is completed.
- Pressure in the manufacturing industries continues to mount to “get it right the first time” – to design products correctly and to make them of higher quality, more quickly, and less expensively than ever before.
- FMC and FMS afford users an opportunity to accomplish these goals.

**Just-in-Time Manufacturing**
- The stockless production concept of just-in-time (JIT) manufacturing, originally pioneered by the Japanese, is about inventory, but it is much more than inventory reduction.
- It is about organizing he production process so that usable parts, both purchased and manufactured, are available on the shop floor when they are needed – not too late and not
JIT in FMS

- Although inventory reduction is one of the benefits of JIT, frequently it is not the major benefit. JIT has helped many companies reduce quality defects by as much as 60 percent, decrease production time by as much as 90 percent, and cut capital expenditures by as much as 30 percent when the technique is applied to the full circle of procurement (obtain), manufacturing, and delivery.
- Ignoring the JIT concept is ignoring an opportunity and a chance to make invisible problems visible where they can be squarely faced and resolved.
- Therefore, planning and implementing and FMS can and should be a driver for changing a company’s total manufacturing approach to one of just-in-time.

Group Technology (GT)

- GT is not simply the formation of machinery into manufacturing cells, although cellular arrangement is a logical consequence of group technology application.
- It involves bringing together and organizing (grouping) common concepts, principles, problems, tasks, and technology to improve productivity.
- GT, like JIT, is a journey, not a destination. It involves continuous improvement and structured discipline and must be a fundamental building block of a cell or system if the real benefits of automation are to be achieved.

Processing and Quality Assurance Equipment

- Turning centers
- Machining centers
  - Known in the 1960s as ATCs, or automatic tool changed.
- Cleaning and deburring equipment
  - Cleaning and deburring equipment do perform ho-hum postmachining operations, but the automated processes add value, save time, and free employees to perform more meaningful full work elsewhere.
  - Fixtures and pallets must be cleaned in order to accurately locate succeeding parts.
- Coordinate measuring machines (CMM)
  - Inspecting parts faster and add value to the part manufacturing process
  - When statistical process control is applied to the inspection process, these data can be used to virtually eliminate bad parts.

Automated material movement and Storage systems

- With respect to cells and systems, cover more than traditional workpiece flow and movement; they also include tool, fixture, and pallet movement and storage to and from the processing stations and queue areas along with chip collection and removal.
- In small cells and systems, robots interfaced with machine tools, continue to gain wider acceptance and use. In many cases a robot interfaced with one or more machine tools is a company’s first attempt at a cell.
- Continue to be developed and improved is focused on the timely and reliable delivery, storage, and retrieval of all type of material and system support equipment.

Cutting tools and Tool management
Some of the most cumbersome and difficult issues to deal with relative to FMS are managing, coordinating, and controlling the wide variety of cutting tools.

This includes not only having and maintaining the required number of cutting tools to process the required parts through the FMS, but also managing the coordinating requirements, tool storage, reconditioning and preset considerations, tool life monitoring, broken tool detection, and a host of other factors.

**How to manage cutting tools?**

- In many cases, too much variety exists; the number of different tools required to machine the identified parts has proliferated (increased) because of a lack of basic tool control prior to FMS.
- Through careful and astute manufacturing analysis of each workpiece, minimal design engineering changes and/or optimized part programming routines may reduce or eliminate unnecessary tools.
- Analysis of this type for each part can have a considerable effect on reducing overall cutting tool requirement for parts run through the FMS.

**Workholding considerations**

- An FMS is only as successful as the amount of detail designed and built into each component or element of the system. Fixtures are one of those important elements.
- Poorly designed fixtures, sloppy manufacturing methods, and “make it fit” fixture guild and assembly practices are problems, even in a stand-alone NC environment.
- Fixture problems hold up production, cause scrap and rework, interfere with delivery schedules, and cause extra delays.

**System hardware and general functionality**

- FMS computer hardware is the visible computing element in a system installation. Overall computer hardware includes the central FMS computer, its related peripheral equipment, programmable controllers, and a backup computer, in some cases, for traffic and/or material management.
- The computer can do nothing, however, without the required application software, people, and the necessary communication links to the various workstation.
- The computer requires proven application software, competent and trained personnel, and backup resources in order for the entire system to perform at acceptable levels.

**FMS software: structure, functions, and description**

- FMS consist of a variety of processing, quality assurance, computer hardware, and system support equipment, all of which are visible and tangible.
- Software is an invisible element and is the essential glue that binds the visible FMS equipment together and forms a system.
- Without these highly developed and sophisticated computer routines, and FMS is a mere collection of individually automated equipment on the factory floor.

**FMS Installation**

- During the FMS installation phase, the system must physically be assembled started, and debugged. Also during this period, some training will occur while the system is being installed, and some usually occurs after the system is installed and in complete operation.
Problems and delays are sure to be encountered during this final but critical stage of the project. However, these can be resolved with well-prepared contingency plans, a teamwork “can-do” attitude, and project leadership as well as project ownership.

**FMS Implementation**

- Implementation involves making all the installed components work and functions as a system.
- It involves optimizing and fine tuning each FMS component, including computer hardware and software, to obtain peak performance. And it means making sure all personnel across all shifts are adequately trained and functioning as a team.