Teaching Flexible Manufacturing System in University Education for Future Engineers

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ABSTRACT

Flexible Manufacturing System (FMS) typically possesses multiple automated stations and is capable of variable routings among stations. Human resource development, equipment operator skills, manufacture of processing tools, products, processes & machinery, research and development are some of the issues resulting from higher level of technology implementation. Industry needs universities to respond with increase emphasis on design and manufacturing skills. With FMS teaching and training in the university laboratories, the increasing capability of engineers provides a distinct advantage for future industries.

Key Words: Flexible, products, manufacturing, industry, training, university

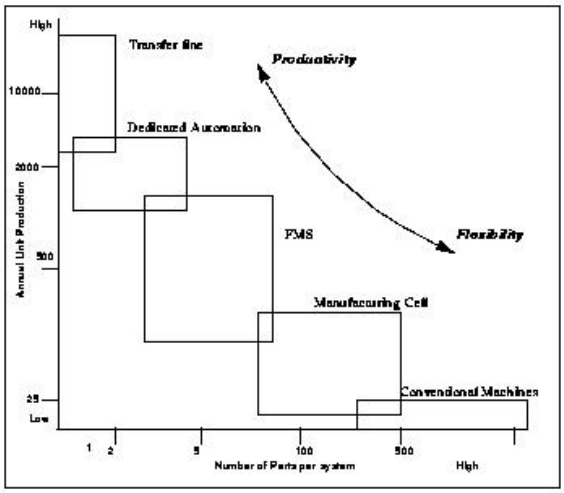
(1) INTRODUCTION

Flexible Manufacturing System (FMS) typically possesses multiple automated stations and is capable of variable routings among stations. Its flexibility allows it to operate as a mixed model system. The FMS integrates into one highly automated manufacturing system many of the concepts and technologies, including: flexible automation, CNC machines, distributed computer control, robotics, automated material handling and storage. The FMS requires a significantly greater capital investment because new equipment is being installed rather than existing equipment being rearranged.

(2) TRENDS IN MANUFACTURING INDUSTRIES

A flexible manufacturing system (FMS) is an arrangement of machines.... interconnected by a transport system. The transporter carries work to the machines on pallets or other interface units so that work-machine registration is accurate, rapid and automatic. A central computer controls both machines and transport system... [1]

The FMS is technologically more sophisticated for the industries and the human resources who must make it work. Flexible Manufacturing Systems (FMS), as they were called, became a great focus of attention in industry and in academic research for a number of years. The advantages of a well-run FMS were clear; short lead-times, low inventory and a step towards the factory of the future.



"Fig. 1" *The Mode of Operation and Strength of FMS [2]*

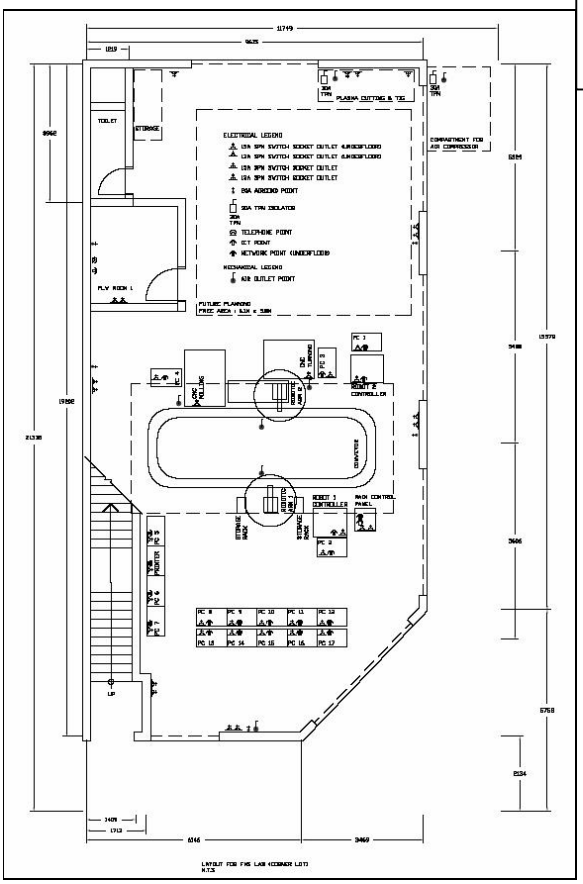
(3) MANPOWER REQUIREMENTS

Human resource development, equipment operator skills, manufacture of processing tools, products, processes & machinery, research and development are some of the issues resulting from higher level of technology implementation. In this situation, a contingency strategy for training engineers and other specialists with FMS should be considered in university learning with engineering education. These evolving trends in industry must be applied back into

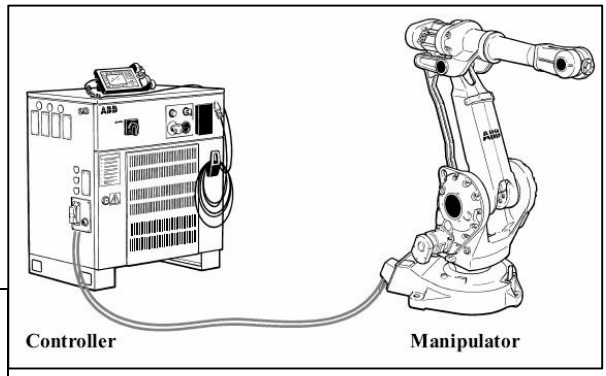
the engineering curriculum. Industry needs universities to respond with increase emphasis on design and manufacturing skills.

(4) TEACHING COMPETENT ENGINEERS

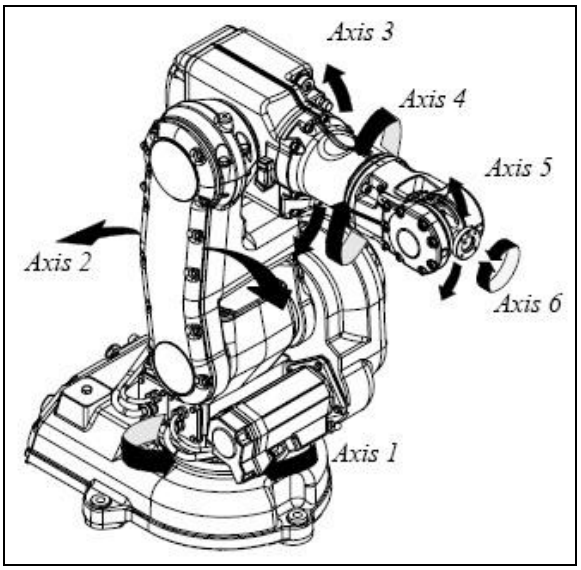
FMS teaching in the university laboratories, increases the capability of engineers provides a distinct advantage for manufacturing industries.



"Fig. 2" *The FMS Layout for Teaching and Training Manufacturing Engineers in UNIMAP.*



"Fig. 3" *The Robotic Controller and Manipulator*

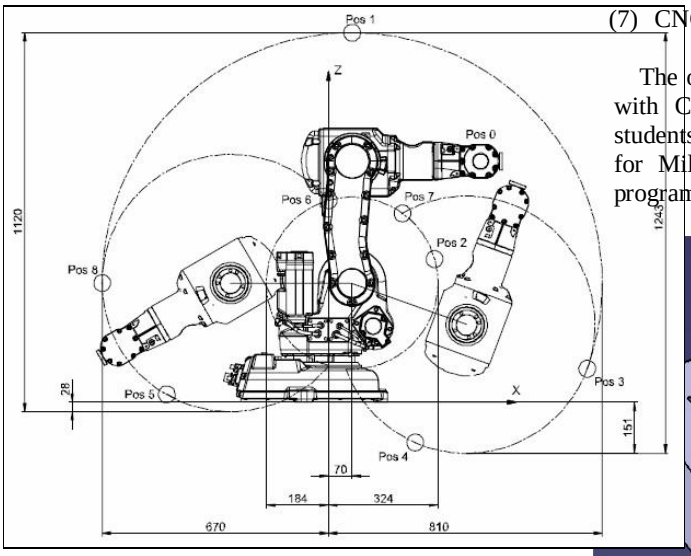


"Fig. 4" *The 6 Axes Manipulator*

In this exercise, the engineers are trained how to open a station, navigate the graphic window. They are trained to get a feed of the interface function and learn the basic interface function. The engineers learn how to create targets, create paths, how to jump to targets, how to move along paths and make the robot move back to home.

(5) TEACHING WITH ROBOTIC CONTROLLERS

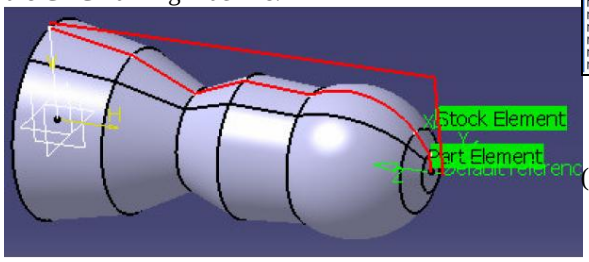
The objectives of this teaching are to expose the Robotic System in manufacturing and to expose the robotics software for program and design.



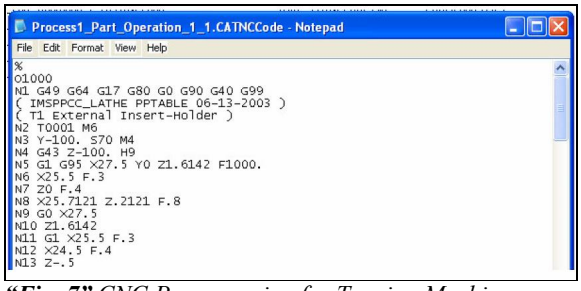
"Fig. 5" *The Working Envelope for the Manipulator*

(6) CNC TURNING

The objective of this exercise is to expose students with CAD/CAM for CNC Turning Machine. The students learn how to use the programming software for Turning Machine. The students generate CNC programming and work on the CNC Turning Machine.



"Fig. 6" *Sample Component for CNC Turning*



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N3 Y-100. S70 M4
N4 G43 Z-100. H9
N5 G1 G95 X27.5 Y0 Z1.6142 F1000.
N6 X25.5 F.3
N7 Z0 F.4
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N9 G0 X27.5
N10 Z1.6142
N11 G1 X25.5 F.3
N12 X24.5 F.4
N13 Z-.5
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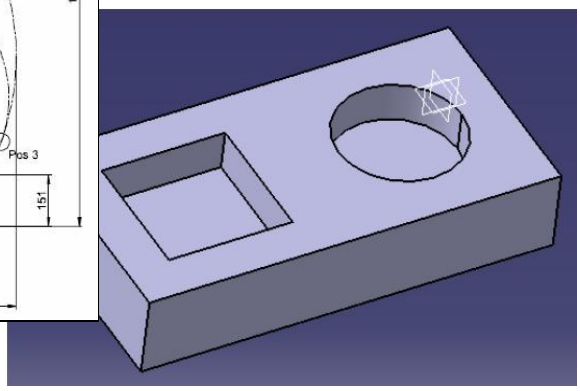
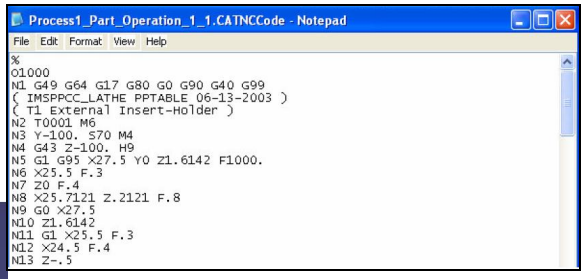
"Fig. 7" *CNC Programming for Turning Machine*

(7) CNC MILLING

The objective of this exercise is to expose students with CAD/CAM for CNC Milling Machine. The students learn how to use the programming software for Milling Machine. The students generate CNC programming and work on the CNC Milling Machine.



"Fig. 8" *Sample Workpiece for CNC Milling*



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N7 Z0 F.4
N8 X25.7121 Z.2121 F.8
N9 G0 X27.5
N10 Z1.6142
N11 G1 X25.5 F.3
N12 X24.5 F.4
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"Fig. 9" *CNC Programming for Milling Machine*

(8) ADVANTAGES AND LIMITATIONS OF FMS IMPLEMENTATION

- ❖ It is important to emphasize that the Flexible Manufacturing System is a straightforward engineering solution to the problem of industrial automated manufacturing activities with the application of engineering and computer-science techniques rather than from a forced economic or anthropomorphic analogy.
- ❖ Reduced inventory, due to the planning and programming precision.
- ❖ Faster, lower- cost changes from one part to another which will improve capital utilization.
- ❖ Consistent and better quality, due to the automated control.
- ❖ Savings from the indirect labor, from reduced errors, rework, repairs and rejects

The FMS have following limitations;

- Sophisticated manufacturing systems.
- Limited ability to adapt to changes in product or product mix.
- Substantial pre-planning activity.
- FMS complexity and cost are reasons for their slow acceptance by industry.
- Expensive, costing millions of Ringgit Malaysia

(9) CONCLUSIONS

With FMS teaching in the university laboratories, the increasing capability of engineers provides a distinct advantage for future industries. If the desired experience exists inside the university and the experience level of the teaching staff with the technological approach is high, its use should be considered and /or projects involving the proposed approach should be developed and implemented early.

In this situation, a contingency strategy for teaching and training engineers and other specialists with FMS should be considered in university learning with engineering education.

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