PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Mid-term Examination: Semester 1 Academic Year: 2005
Date: August 3, 2005 Time: 9:00-12:00 hr.
Subject: 226-501 Manufacturing Systems & Tech. Room: R300

Instructions

- Answer all 6 questions in the **answer** book.
- Open-book exam., Any materials, books, papers, calculators and dictionaries are allowed.
- Total score is 100

Questions	Full Score	Assigned Score
Q1	15	
Q2	15	
Q3	15	
Q4	15	
Q5	20	
Q6	20	
Total	**100**	

Asst. Prof. Somchai Chuchom

Question 1 (15 marks)

For the "Minimum structure" MS Block diagram supplied in Figure 1,

1.1 Link the in-and outputs (x_{ij},y_{ij})

1.2 Draw the corresponding "Basic MS Structure Matrix"

Question 2 (15 marks)

Explain in detail the 3 kinds of flows supporting effective manufacturing.

Question 3 (15 marks)

There are three aspects of manufacturing systems, structural, transformation, and procedural aspects. Explain in detail what you understand on each aspect.

Question 4 (15 marks)

Summarize what you have learned from studying each sub-system for manufacturing systems, show only ONE sub-system like you provided it in the submitted report.

Question 5 (20 marks)

5.1 What is GT? Describe the typical advantages to be gained by implementing GT.

5.2 Design a coding scheme for the set of parts describe below. The code is to be used by process planning and manufacturing. The code is to cover all sheet metal parts. Raw stock ranges between 1/32 and ½ inches in thickness (light and heavy gauge). Raw sheet alloys of various hardnesses are used. The combination of stock thickness and hardness determine the force needed to perform and operation and hence, which machines are permissible. Additionally, the demand rate for the part is important because high-volume parts justify specialized multi-operation dies and punch presses. For most machine types, a high-power and/or large-dimension part would be made on a different machine than a low-power and/or small part.

Raw sheet is available in many sizes and, hence, larger parts often require only shearing (on a shearing machine) to obtain the individual piece raw material. Other items can have the basic part raw material formed by slitting the sheet stock (on a slitting machine) and then shearing. Part with irregular shapes undergo trimming early in their production process. Smaller and nonrectangular parts require an initial blanking operation to produce the basic input material for individual piece.

Most bending operations are performed on punch presses. These presses vary in power and part dimension capabilities. Hole punching machines provide an inexpensive method for individual punching asymmetrical holes on small volume parts. Press brakes are used for forming long grooves and flanges near the edge of parts.

State any assumptions you make and explain how your code will be useful.

Question 6 (20 marks)

With the regard to present international development in manufacturing engineering,

6.1 Read the attached case study material on “FMS suitable for small companies”.

6.2 Summarize what you think are its 10 main points.

6.3 Comment on the suitability of this type and size of “FMS” for Thai manufacturing industry.

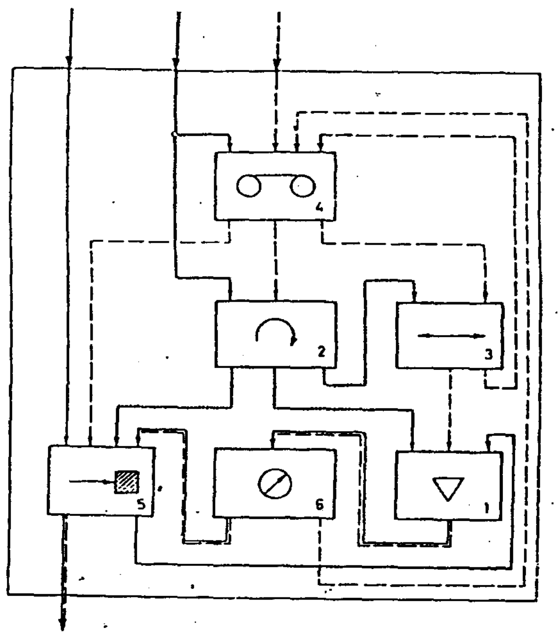


Figure 1 (For Question 1)

FMS suitable for small companies

Working for 16 hours overnight, the single-robot multi-machine system is a good example of a small-type FMS

Hanshin Kiki, Kobe, unveiled a "Single-robot Multi-machine System" in July, 1985. The system attracted attention as an FMS line designed for and developed by medium and small enterprises. The main feature of this system is that one robot provides workpieces for plural machine tools, and thus, complete unmanned night operation is achieved. The company plans to not only utilize the system in house but also sell its hardware and software extensively outside.

In the Hanshin Kiki Single-robot Multi-machine system, three NC machine tools and work tables are arranged around a robot with one-axis traveling track. Since the robot performs a series of works from unloading to setting workpieces, a completely unmanned line has been realized.

The company built a new unmanned model plant where the said system was introduced, and inaugurated the operation of the system in the spring of 1985 for test purposes. In July, 1985, the company announced the development of the system. In the machining operation of this unmanned line, "the machines operate for 16 hours during the night and man proceeds with set-up and other preparations for eight hours during the day." As stated by Mr. Koichi Yamada, president of the company. This new system has realized considerable increases in productivity.

The company developed the system on its own by receiving a development fund from the Hyogo Prefecture's Scientific Technology Promotion Foundation. It is very rear that a small company has developed such system technology. Mr. Yamada stated, "We wish we could be the first instance of small-sized companies to develop such a system." The system is likely to become a topic as a rationalized production system for small enterprises.

Coexistence of man and robot

The company was established in 1925 and started with manufacture and sales of bolts and nuts. Presently, in addition to those products, the company was engaged in integrated production of transmission line controller and re-oriented positioning units such cross tables. Among them, control equipment presently cover approximately 75% of the total sales. The sales of the March 1984 term were ¥1.57 billion and those of the March 1985 term increased to ¥2.05 billion. In fiscal 1986, the company aims at ¥2.3 billion.

Under such circumstances, the company has set its goal on the revival and growth of the machine category including bolts and nuts, with which the company has been dealing from the beginning and examined how to proceed with the revival and growth. For this reason, it determined to aim at the stream-lining of production and expansion of machining operation by the application of NC to the production facilities. However, because the company came behind others in the application of NC, it considered adding something "new". As a result, they constructed a new production system which includes a robot.

The basic concepts of development are the pursuit and achievement of: (1) coexistence of man and robot; (2) effective utilization of man power, machines, and equipment, and (3) space saving. On the basis of such basic concepts, the company completed the system; pursuing the idea of how to substitute the robot for man.

Own system control technologies

The hardware element of the system, presently operating at the company, includes three machine tools, Hitachi Seiki's vertical-spindle machining center VA45 and also 5NE-1100, and ASEA's robot IRB-60/2, a tract motion, a rotary table, various operation panels, and a printer.

Mitsubishi Electric's FA Factory Land C-1 controls the whole system, and Mitsubishi Electric's K series sequencer are used in the centralized control panel, a guided vehicle and rotary tables. ASEA's controller and Fanuc's controllers are also used for the robot and machine tools, respectively. The company did not standardize the controllers but combined the interfaces of each controllers into one. This is because the company is aiming towards the accumulation of such knowhow.

The functions and operations of the above described system are explained below. First, data, such as machine numbers, part table numbers, robot operation numbers, part numbers, and a machining quantity, are entered into the Factory Land C-1. Also, operation data are entered into the robot and each machine controller.

After the completion of the above, by the operation of Factory Land C-1, the robot supplies a workpiece to each machine, machining operation is initiated, and the robot stands by at its home position. When a report of machining completion is given to the host controller C-1 from a machine, the controller gives an instruction to the robot to reverse or change the workpiece. Further, the robot supplies a workpiece to the machine in order of the receipt of machining completion message.

Upon completion of the scheduled machining the host controller instructs the robot to stop supplying workpieces. When a problem occurs in a certain machine, the supply of a work to the machine is stopped. Further, in case that a problem related to robot operation occurs, the robot and the corresponding machine stop immediately and the other machines are also stopped upon completion of the ongoing machining.

Then, the host controller records the star-and-completion time of the robot operation and of each machine as well as the number of finished parts.

Controllable up to 7 units

One of the greatest features of this system is that a robot supplies and unloads workpieces to and from plural machines. That is achieved by the rail-guided robot. The rail is 10 m in overall length, on which a robot runs. When a robot is fixed at one place, the working range is limited only in 2 m. But it expands approximately 13 times to 27 m by this rail-guided system.

This system called track motion has been developed on the basis of the technologies of the X-Y tables which had been developed previously by the company. The company set up an engineering department in April, 1983, and at the same time, started the development of an X-Y table, and has developed X-Y, X-Y-Z tables, and so on for plasma cutting machines and laser cutting machines as FA-oriented positioning units. The microcomputerbased motor control technologies acquired through development of the X-Y tables have been utilized for the track motion, which is designed to stop at an optional position with high accuracy. The positioning repeatability of the track motion is ±0.02 mm.

In addition to the achievement of such high accuracy, another point to note is the fact that the track motion makes it possible for small business to have a compact flexible production line. Although three machines are installed in the line operating at the company, a maximum of 7 machines are said to be acceptable in the line.

Further, the improvement of machining accuracy and completely unmanned operation have been attained by control systems for the automatic compensation of chucking errors and automatic chip disposal in intermittent cutting.

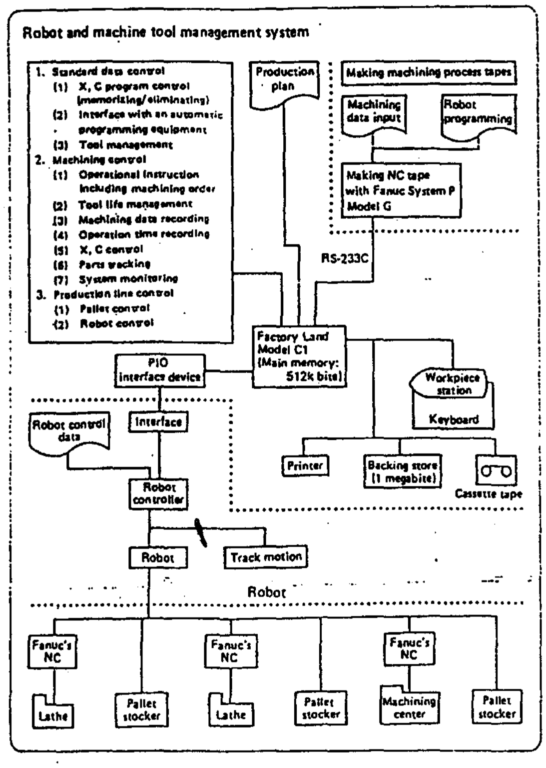
Pay-off higher twice than usual

In this system, approximately 20 types of workpieces are machined presently. Needless to say, that number is further extended by increasing machining data. Large lot consists of 200 to 300 workpieces and small lot sizes are 30 to 50 workpieces. Currently, the system is used for machining new couplings. Since the system most often performs the turning of rotary parts which is followed by drilling operation, it consists of 2 NC lathes and one vertical-spindle machining center.

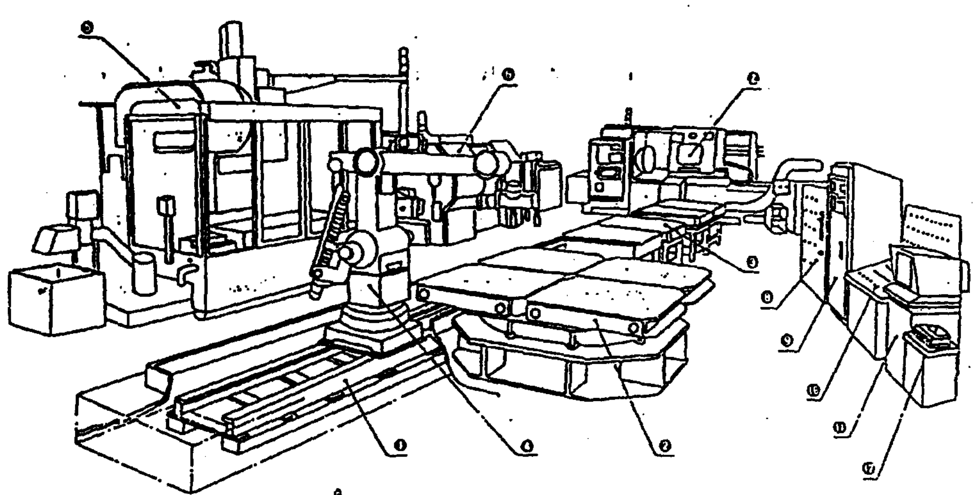
The system is operated around the clock including 16-hour completely unmanned operation during the night. Man attends the system during the eight daytime hours. However, the number of operators has been reduced from the previous two to one who does only set-up workpieces and other preparation. The other operator is now engaged in, for example, R&D or assists in another department.

In terms of operation time, the investment can pay off at a double pace as compared to the previous system by a simple calculation. Further, if the effects of labor saving, etc. are also considered, that ratio will still be higher, resulting in a high economical efficiency. "Even it operators work 2.5 times slower than now during the daytime, a robot can fully make up the loss during the night," stated Mr. Yamada.

Presently, two engineers are continuously engaged in the development of software for the above described system. Mr. Yamada said, "We plan to accumulate knowhow for the age when robot will be more frequently used". The company is enthusiastic for developing a new system technology for the customers service as well as for its own use.



A compact FMS "One-robot multi-machine system"



1. Track motion 2. Rotary table 3. Fixed table 4. Robot
5. Machining center 6. NC lathe 7. NC lathe 8. Track motion controller
9. Robot controller 10. Centralized control panel 11. FA controller
12. Printer