Experiment No 15

Objective: Introduction of CIM , PLC and CNC.

Introduction of CIM: To stay competitive, factories are increasingly automating their production lines with Computer Integrated Manufacturing (CIM) systems. A CIM cell is an automated assembly line that uses a network of computers to control robots, production machines, and quality control devices. The CIM cell can be programmed to produce custom parts and products. CIM provides many advantages:

- Computer integration of information gives all departments of a factory rapid access to the same production data.
- Accessibility of production data results in faster response to change, which in turn shortens lead times, increases the company's responsiveness to customer demands and competition, and improves due-date reliability.
- Computer aided scheduling optimizes the use of the shop floor. This improves the utilization of machine tools and reduces work-in-progress and lead times.
- Real-time production data can be used to optimize the production processes to improve quality, using techniques such as statistical process control.
- Computer analysis and prediction of material requirements for production can reduce inventory levels and lead times. Integration with suppliers and customers can provide even greater benefits.

CIM cells are composed of the following basic elements:

1. **Conveyor**: Device that transports parts from station to station.
2. **Production Stations**: Locations around the cell where parts are processed and stored by machines and robots. Robots move parts between the conveyor and station machines.
3. **CIM Manger:** The PC that contains the CIM Manager software which coordinates the functioning of all devices in the cell using a Local Area Network (LAN).
4. **Station Manager**: A PC that controls the different devices at a station and has a communication link with the CIM manager. Device Control is performed by OpenCIM device drivers that run on this PC. A device driver controls the operation of a device at the station in response to commands from the CIM manager and other CIM elements.

1-1-1 Stations

The Open CIM cell is composed of a set of stations located around a conveyor as shown in the figure 1-2. Each station is controlled by a Station Manager PC. A CIM Manager PC coordinates the activities

of all stations. Production commands are sent from the CIM Manager computer to the device drivers via the Station Manager PC. Status messages generated by devices are interpreted by the device driver and sent back to the CIM Manager. Generally, the major stations are:

- **ASRS Station:** Automatic warehouse which supplies raw materials to the Open CIM cell and holds finished products.
- **Machine Station:** Station where Materials are shaped, formed, or otherwise processed (e.g. using a CNC machine)
- **Assembly Station:** A station where parts are put together. The resulting new part is called an assembly.
- **QC Station:** Quality Control. Inspection of parts using machine vision.

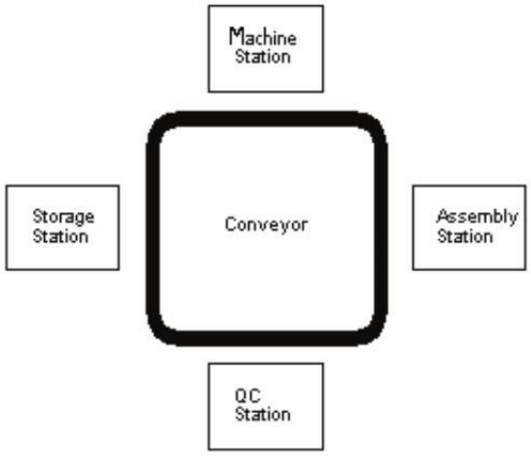

Figure 1-2 Schematic example of Stations at CIM

Stations contain devices that perform production activities such as material processing or inspection. The following elements are generally present at a station:

- **Robot:** A device which moves parts around a station (e.g. inserts parts into a CNC machine) and/or performs assembly operations.
- **Robot Controller:** An ACL controller which controls the robot
- **Station Manager PC:** A Station Manager PC where the device drivers are located that:

a. Translate Open CIM production messages and commands to/from each station device (e.g. the ACL controller commands).

b. Provide a user interface for controlling station devices by manually sending

Open CIM commands (e.g. to CNC machines or an ACL controller)

c. Function as a terminal for devices that use an RS232[1] interface for setup and programming (such as the ACL controller).

 Machine: A device that processes parts at a station. CNC machines such as lathes and mills process parts according to user-supplied G-code programs

Material Flow

Material handling tasks can be divided into two groups:

- **Primary Material Handling:** These tasks perform the transportation of parts between stations.
- **Secondary Material Handling:** These tasks perform the handling of parts within a station, such as placing a template on the conveyor, inserting a part in a CNC machine, assembling parts and so on.

In Open CIM cell, the primary material handling tasks are usually performed by the conveyor. A robot performs the secondary material handling tasks at each station. When a robot removes a template from the conveyor, it typically places it on a buffer. (A buffer is a tray designed to hold a template when it is removed from the conveyor. The buffer is attached to the outer rim of the conveyor.) Once the template is on the buffer, the robot can remove apart from the template and take it to a station device.

Templates

Templates are plastic trays which can hold various types of parts (Figure 1-3). They allow parts to be transported on the conveyor. A template contains a matrix of holes in which pins are placed to fit the dimensions of a part. Each arrangement of pins defines a unique template type. Each part may only be held by its assigned template.

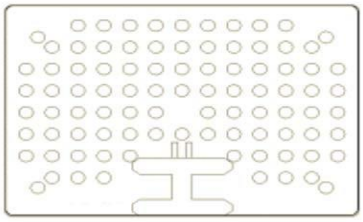

Figure 1-3: An empty template

Storage

An ASRS station (Figure 1-4) is typically used as the main source of raw material storage for the cell. The ASRS can also serve as a warehouse for parts in various stages of production. Storage cells in the ASRS contain templates, either empty or loaded with parts. Part feeders can also be used to supply raw materials at various stations around the cell.

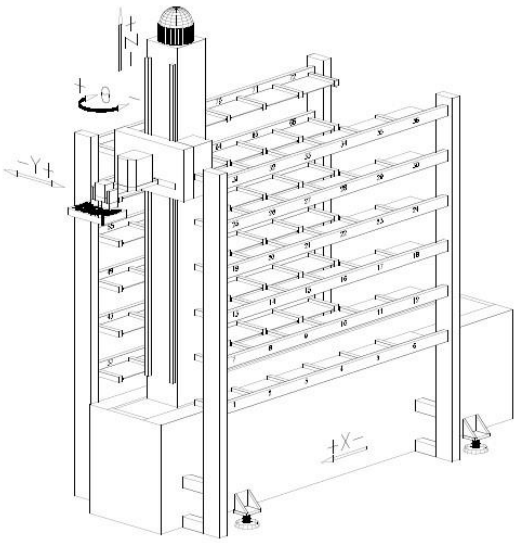

Figure 1-4 Automatic System Retrieval Storage

Conveyor and pallets

A pallet is a tray which travels on the CIM conveyor and is designed to carry a template (Figure 1-5). To transport a part to another station, a robot places the template carrying the part on a pallet on the conveyor. The OpenCIM conveyor carries pallets in a continuous circuit from station to station.

PLC: The conveyor is controlled by a PLC (programmable logic controller). Each pallet has an ID number which is magnetically encoded in a bar on the pallet. Each pallet is stopped briefly when it arrives at a station so that its magnetic code can be read. If the PLC determines that the pallet is needed at this station, it informs the CIM Manager. The pallet remains at this station until the CIM Manager sends a release command. While a pallet is stopped, the conveyor continues to transport other pallets which are moving between stations. The location at which a pallet is stopped is called a conveyor station. Each OpenCIM station has its own conveyor station, which contains two pneumatically operated pallet stops, a magnetic pallet-arrival sensor, a magnetic sensor

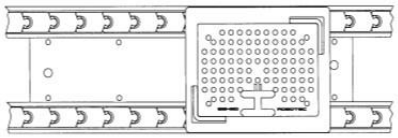

Figure 1-5 Pallet at Conveyor Station

The CIM Manager keeps track of pallets which are empty and those which are carrying parts. It sends the destination station of each pallet to the PLC. Magnetic code readers at each station enable the PLC to identify the pallet ID numbers. If the part carried by the pallet does not require processing at the station, the pallet is allowed to continue on the conveyor. Even though a pallet may be needed at a station, the CIM Manager may direct the PLC to release it if the robot that handles templates at this station is busy.

Robot and Controller

CIM robots (Figure 1-6) move parts within a station (secondary material handling) and perform assembly operations. Robots vary in speed, payload, accuracy, range of movements (degrees of freedom), working envelope (horizontally or vertically articulated), and drive mechanism (DC servo, AC servo or pneumatic).

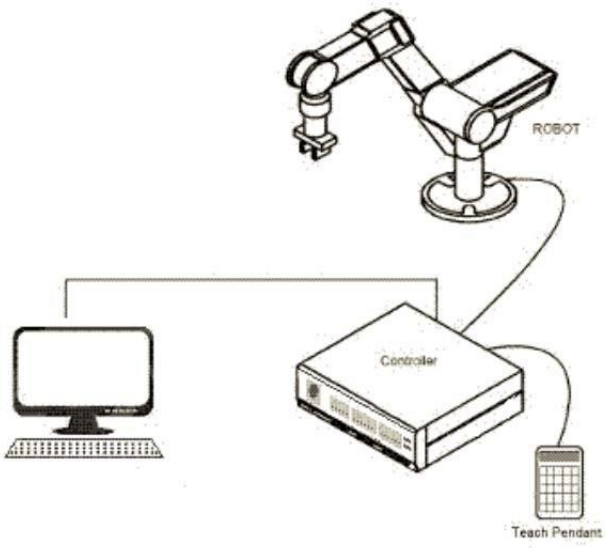

Figure 1-6 Robot Controller, Teach pendant and station manager

Robotic programming language uses a device driver in order to communicate with the Open CIM manager software. Robotic programs inform the robot what path to follow and what task to perform once it reaches a destination. The controller (ACL) provides the power supply to the robot and moves the robot by controlling the power to the motors inside the robot.

CNC: CNC stand for computer numeric control.

CNC Lathe

CNC Lathes have at the very least the ability to drive the cutting tool under g-code control over 2 axes, referred to as X and Z. With CNC lathe machines, the material being worked is slowly sheared away. The result is a beautifully finished product or intricate part.

CNC Mill

CNC milling is a specific form of computer numerical controlled (CNC) machining. Milling itself is a machining process like both drilling and cutting, and able to achieve many of the operations performed by cutting and drilling machines. Like drilling, milling uses a rotating cylindrical cutting tool. However, the cutter in a milling machine can move along multiple axes, and can create a variety of shapes, slots and holes. In addition, the workpiece is often moved across the milling tool in different directions, unlike the single axis motion of a drill.