Computer integrated manufacturing

Computer Integrated Manufacturing, known as CIM, is the phrase used to describe the complete automation of a manufacturing plant, with all processes functioning under computer control and digital information tying them together. CIM is an example of the implementation of information and communication technologies (ICTs) in manufacturing. This starts with computer aided design, followed by computer aided manufacture, followed by automated storage and distribution. One integrated computer system controls all that happens.

Through the integration of computers, manufacturing can be faster and less error-prone, although the main advantage is the ability to create automated manufacturing processes. In a CIM system functional areas such as design, analysis, planning, purchasing, cost accounting, inventory control, and distribution are linked through the computer with factory floor functions such as materials handling and management, providing direct control and monitoring of all the operations. It was promoted by machine tool manufacturers in the 1980’s and the Society for Manufacturing Engineers (CASA/SME).

PRINCIPLE OF CIM :

CIM relies on closed-loop control processes, based on real-time input from sensors. It is also known as flexible design and manufacturing. The output of the system is fed back through a sensor measurement to the reference value. The controller then takes the error between the reference and the output to change the inputs u to the system under control. This kind of controller is a closed-loop controller or feedback controller. This is called a

single-input-single-output (SISO) control system. Part of the system involves flexible manufacturing, where the factory can be quickly modified to produce different products, or where the volume of products can be changed quickly with the aid of computers. In the CIM system some processes will be different.

Data entry will now be stored in hard drives. This will allow for the manipulation and the retrieval of the data with a simple keystroke. The means by which the processing of data into the production of products will also be streamlined within hardware and software. This will allow operators to alter and enhance programs in order to improve products. The CIM system will also provide the necessary algorithms to bring all the data together. The data will then be able to intermingle with the sensor and modification components of the system.

COMPONENTS OF CIM :

CIMOSA (Computer Integrated Manufacturing Open System Architecture), is a 1990s European proposal for an open system architecture for CIM developed by the AMICE Consortium as a series of ESPRIT projects. The goal of CIMOSA was to help companies to manage change and integrate their facilities and operations to face world wide competition. It provides a consistent architectural framework for both enterprise modelling and enterprise integration as required in CIM environments. The heart of computer integrated manufacturing is CAD/CAM. Computer-aided design(CAD) and computer-aided manufacturing(CAM) systems are essential

to reducing cycle times in the organization. CAD/CAM is a high technology integrating tool between design and manufacturing.

CAD techniques make use of group technology to create similar geometries for quick retrieval. Electronic files replace drawing rooms. CAD/CAM integrated systems provide design/drafting, planning and scheduling, and fabrication capabilities. CAD provides the electronic part images, and CAM provides the facility for toolpath cutters to take on the raw piece. The main components of a CIM system are:

1. CAD/CAM, computer-aided design/computer-aided manufacturing

2. CAPP, computer-aided process planning

3. CNC, computer numerical control machine tools

4. DNC, direct numerical control machine tools

5. FMS, flexible machining systems

6. ASRS, automated storage and retrieval systems

7. AGV, automated guided vehicles

8. Use of robotics and automated conveyance

9. Computerized scheduling and production control

Business system integrated by a common data base.

OPERATING PROCESS :

A computer-integrated manufacturing system is not the same as a “ lights-out” factory, which would run completely independent of human intervention, although it is a big step in that direction. Part of the system involves flexible manufacturing, where the factory can be quickly modified to produce different products, or where the volume of products can be changed quickly with the aid of computers. The heart of computer integrated manufacturing is CAD/CAM. Computer-aided design(CAD) and computer-aided manufacturing(CAM) systems are essential to reducing cycle times in the organization. CAD/CAM is a high technology integrating tool between design and manufacturing. CAD techniques make use of group technology to create similar geometries for quick retrieval. Electronic files replace drawing rooms.

CAD/CAM integrated systems provide design/drafting, planning and scheduling, and fabrication capabilities. CAD provides the electronic part images, and CAM provides the facility for toolpath cutters to take on the raw piece. The computer graphics that CAD provides allows designers to create electronic images which can be portrayed in two dimensions, or as a three dimensional solid component or assembly which can be rotated as it is viewed. Advanced software programs can analyze and test designs before a prototype is made. Finite element analysis programs allow engineers to predict stress points on a part, and the effects of loading. Once a part has been designed, the graphics can be used to program the tool path to machine the part.

When integrated with an NC postprocessor, the NC program that can be used in a CNC machine is produced. The design graphics can also be used to

design tools and fixtures, and for inspections by coordinate measuring machines. The more downstream use that is made of CAD, the more time that is saved in the overall process. Generative process planning is an advanced generation of CAD/CAM. This uses a more powerful software program to develop a process plan based on the part geometry, the number of parts to be made, and information about facilities in the plant. It can select the best tool and fixture, and it can calculate cost and time. Flexible machining systems (FMS) are extensions of group technology and cellular manufacturing concepts.

Using integrated CAD/CAM, parts can be designed and programmed in half the time it would normally take to do the engineering. The part programs can be downloaded to a CNC machining center under the control of an FMS host computer. The FMS host can schedule the CNC and the parts needed to perform the work. In the CIM system some processes will be different. Data entry will now be stored in hard drives. This will allow for the manipulation and the retrieval of the data with a simple keystroke. The means by which the processing of data into the production of products will also be streamlined within hardware and software. This will allow operators to alter and enhance programs in order to improve products. The CIM system will also provide the necessary algorithms to bring all the data together. The data will then be able to intermingle with the sensor and modification components of the system.

In general various CIM processes or functions can be classified into the following stages:

STAGE-1 : Computer Aided Design. A product is designed totally on computer. When complete it is tested or its functions simulated on screen before even a prototype is made. If a circuit is involved it is designed by using software and tested on screen. Improvements / alterations are made to the design using the same CAD software.

STAGE-2 : Prototype Manufacture. Prototypes are manufactured on machines such as 3D printers which produce an accurate 3D model. CNC routers and laser cutters may also be used to produce a realistic model. Sometimes working models are manufactured.

STAGE-3 : The computer system controlling the plant works out the most efficient method of manufacture. It calculates costs, production methods, numbers to be manufactured, storage and distribution.

STAGE-4 : The computer system orders the necessary materials to manufacture the product. Keeping costs to a minimum. The ‘ just in time’ philosophy is applied. This means that materials / components are ordered as needed. Very little is stored at the factory. Usually only enough materials are stored to keep the factory going for a small number of days. Materials are automatically reordered when required, to keep the factory working smoothly and continuously.

STAGE-5 : Manufacturing begins with the product being made using CAM (Computer Aided Manufacture). Computers control CNC machines such as laser cutters, CNC routers and CNC lathes.

STAGE-6 : Quality control is applied at every stage. The product is tested using computer control inspections. For instance, the accuracy of manufacture is tested automatically. This ensures that the product is manufactured to the correct sizes.

STAGE-7 : The product is assembled by robots. This is automated (controlled) by the computer system.

STAGE-8 : The product is quality checked before being stored for distribution to the customer. All storage is automated. This means that computer controlled vehicles move the finished product from the manufacturing area to storage. The computer systems keep track of every individual product. Products are bar coded which are constantly scanned and recorded by the computer system.

STAGE-9 : The product is automatically moved from store to awaiting lorries / trucks for distribution to the customer.

STAGE-10 : Financial accounts are updated, bills chased up and paid by the computer system.

Computer integrated manufacturing can include different combinations of the tools listed above.

FIELDS OF APPLICATION :

It might be more prudent for a company to begin the process of computer integration with CAD/CAM and an integrated business data base. There are many reliable and proven CAD/CAM software packages available, as there

are integrated business software systems. Taking small steps instead of a wholesale CIM approach is advisable. Various fields of application wher CIM is very instrumental in shaping up the organizational value’s are:

1. Automotive sectors where rate of production is an important aspect.

2. Aerospace segment where high precisional & accurate products are desirable.

3. Those sectors where complex & sophisticated products are required which cannot be produced through traditional manufacturing unit.

4. Those areas where manufacturing through human effort is a very cumbersome process.

5. Those fields of operation where high-end technology is desired which are easy through CIM system.

BENEFITS :

The goal of the CIM system is to eliminate the waste within the manufacturing process. This is done by taking the design, analysis, planning, purchasing, cost accounting, inventory control and distribution departments and interlink them with the factory floor, material handling, and management departments. The CIM system will have an impact on every system within the factory.

The CIM system, which is sometimes referred to as the integrated computer aided manufacturing system, operates on both hard and software. Simply put, the software is what runs the factory, or the brains. The hardware is

what makes the machines run, or the muscles. The CIM system runs on an efficient output process. This means that the whole factory works together, not as separate parts. As a unified unit, it operates for the peak benefit of the whole factory.

Simply put, the CIM system does not backload or store up work. It does not warehouse products. The CIM system keeps work flowing through computer integration in order to keep all the parts of the system constantly functioning. It registers all the raw material received by the factory. It then walks the material through the factory and the production process.

The CIM system fractions every individual “ center” of the factory into work cells. As work cells, they are then divided into individual stations. The stations are then broke down to the individual processes, and the processes are what metamorphosizes the raw materials into actual products. This may seem complicated, but it streamlines the whole manufacturing process. With each division of the factory broken down in such a manner, it allows operators to make any necessary changes to the system without shutting down the whole system.

CIM is a very interactive, hands on system. If it is applied correctly, it will enhance the productivity of the whole factory. It will link several departments and functions together. It is simple to install. It usually is installed through a LAN, or local area network, connection.

CHALLENGES :

While the CIM system is the optimal choice to aid in the manufacturing process, it does come with a unique set of challenges. The greatest challenge is to get all the different machines within the factory to work on the same system. In the typical factory, there are a variety of machines that perform different tasks, that are made by a variety of suppliers. The issue is to get every one of these machines to accept the programming, and tasks from one mainframe computer.

The challenge of the CIM system is encapsulated within the data itself. While many operators may be lost on the actual production floor, there will be a need for operators to maintain the integrity of the data that is transmitted to the machines. The challenge is in acquiring competent individuals who can assure that all the data within the system is at its optimum operating integrity.

The challenge that has been encountered in the use of the CIM system is process control. This entails assuring that the whole process runs smoothly. This particular challenge ties the data entry people, the programmers, and the production operators together. The factory will need to assure that the individuals working with the system throughout the factory are competent and knowledgeable. These individuals will need to be well trained, and probably need to update their training periodically.

Another key issue is data integrity. Machines react clumsily to bad data, and the costs of data upkeep as well as general information systems departmental costs is higher than in a non-CIM facility. Another issue is the attempt to program extensive logic to produce schedules and optimize part

sequence. There is no substitute for the human mind in reacting to a dynamic day-to-day manufacturing schedule and changing priorities.

CONCLUSION :

One of the keys to success in the manufacturing business is to lessen errors and to enhance productivity. The more one can produce with fewer flaws, the more one can make at the bottom line. CIM is a very interactive, hands on system. If applied correctly, it will enhance the productivity of the whole factory by quickly introducing new customerized high quality products and delivering them with unprecedented lead times, swift decisions, and manufacturing products with high velocity. So undoubtedly, CIM system is here to stay in the near future and rule the world of manufacturing industry.