COMPUTERIZATION AND ITS IMPACT ON POLYTECHNIC EDUCATION

P. K. SINGLA *

SYNOPSIS

Industries, world over, are facing a number of challenges, in terms of production efficiency and quality parameters, due to globalization and competitiveness. The problems are more complicated today because many changes are occuring not only simultaneously but also more rapidly than in the past. These changes are occuring in all sectors of industries whether these are manufacturing, service or agriculture/mining sector industries. Applications of CAD/ CAM/CNC/AUTO CAD and other Computer Integrated Manufacturing (CIM) techniques have come to stay in the Indian industrial scenario. Despite the benefits which automation and computerization can bring, the decisions for investment in "Advanced Manufacturing Services" mainly depend on the specialized technical/skilled personnel required for manning these enterprises. Technician Engineers being the backbone of any industry, are mainly responsible for executing and managing all types of activities starting right from raw material, processing, marketing, managing and controlling at shop floor, have therefore to be equipped with CIM techniques if they have to sustain in the industry. It is here that role of polytechnic level institutions comes into play to produce matching manpower as per the requirements/ developments of the world of work.

Though efforts have been made by Curriculum Development Centres (CDCs) of Technical Teachers' Training Institutes and states in different regions of the country to include these CIM techniques in various engineering/vocational/art base curricula, there exists a large gap between curricula and its implementation. In order to fill-up this gap it is absolutely necessary to i) provide training and develop competency in each teacher, working in the polytechnic, to handle various computer softwares available for designing, drafting, testing, processing, managing etc., irrespective of the courses/subjects the teacher is handling ii) develop/procure various engineering/vocational/art application computer software packages iii) develop infrastructure and environment to ensure use of CAL/CAI and other multimedia for better

*** Assistant Professor, Curriculum Development Centre, TTTI, Chandigarh.**

comprehension, understanding and skill development in the students. An integrated approach is essential to bridge the gaps between industry, curriculum and polytechnics.

***(Keywords :** CAD / CAM / CIMS / NC / CNC / DNC / IT / CAL / CAI / VR / VL / CPM / PERT / GERT / CAPP / GT / CAQC / MRP / FMS / EDM / BDPS / Micro-factory / Advance Manufacturing Services explained in Appendix)*

1. INTRODUCTION :

The industrial revolution which took place about two centuries ago, brought with it the technology and during the past few decades scholars and scientists have turned their attention to the rapid technological innovations and developments which accompany industrialization. In the present context of globalization and breaking of the trade barriers it is neecessary that Indian industry is able to compete the world market. Besides competitiveness, other factors of neeed for quality manufacturing/ services due to increased consumer awareness; short lead times and short product lives; complexity and variety in products / services and uncertainty in demand made it increasingly important for the industry to initiate automation steps to achieve all these. Because of its merits, like great speed, accuracy, consistency and efficiency in storage, retrieval, computation and analysis, cost-effectiveness, versatality and compactness, computers have formed a permanent niche in every walk of life whether it is complex system of office administration and managemeent; education/ training / research and development; banking / commercial / accounting activities; business / industry; communication / information / network; legal; medicine / health care; meterology; power; transportation; tourism; defence; agriculture; art / music / sports; space/ nuclear research; mining operation or it is a system of as simple as house keeping.

Computers have a long association with business and industry in all sectors whether it is primary (agriculture / mining), secondary (manufacturing) or tertiary (service) sector. Its applications in the industry start right from accounts/ management, raw material management, production planning control and scheduling, marketing to project management through network planning. In planning large products where large number of related activities having strict precedence relationships, i.e. some activities cannot start unless some other activities are first completed and whereas some other activities can go in parallel, can be computerized by making use of modern project planning and scheduling methods like Critical Path Method (CPM); Programme Evaluation and Review Techniques (PERT) and Graphical Evaluation and Review Techniques (GERT), to improve the efficiency in handling the projects. Computer-Aided Design (CAD)/ Computer Aided Manufacturing (CAM), Computer Numerical Control (CNC), Direct Numerical Control (DNC), Robot Technology, Computer-Aided Process

Planning (CAPP), Group Technology (GT), Computer-Aided Quality Control (CAQC) and Computer Integrated Manufacturing System (CIMS) are now a reality in most of the large, medium and small scale industries in India.

The curricula of various disciplines/ programmes being offered by technician level institutions, will have to integrate these "Advanced Manufacturing / Services" systems to remain relevant with the industry so that the manpower being developed and produced in these institutions fit into the job requirements of present industrial scenario. Further the applications of computer and multimedia have a great potential to give educational technology a "technology push" by which a "teacher-leading instructional" style can be replaced with "student-leading learning" style in the polytechnics.

2. COMPUTER INTEGRATED MANUFACTURING SYSTEM :

Computer Integrated Manufacturing System (CIMS) stands for a global methodological approach in the enterprise in order to improve the industrial performance. In a way, CIMS is concerned with providing computer assistance, control and high-level-integrated-automation at all levels of manufacturing industries, by linking islands of automation into a distributed processing system. Manufacturing system, particularly for a small to medium batch manufacturing system with a large variety of discrete components such as automobile industry needs enormous information and any of the conventional methods of handling such data invariably cause delays in identifying the problems and suggesting remedial measures. Solutions offered by CIMS in such cases are available at sufficiently low cost and have enough processing capacity required. CIMS covers all activities related to the manufacturing business such as : evaluating and developing appropriate product strategies; market analysis and forecasting; product/market characteristics analysis and identifying/ generating possible manufacturing systems; designing components for process of manufacturing (i.e. machining, inspection, assembly, maintenance and all other processes of the component or product, such as welding, cutting, press work, painting etc.); evaluating/determining batch sizes, manufacturing capacity, scheduling and control strategies relating to the design and fabrication process involved in a particular product; analysing and feedback of certain selected parameters related to the manufacturing process; evaluation status report from the Direct Numerical Control (DNC); analysing system disturbances and economic factors in CIM at component as well as total system level; analysing and providing data at the appropriate level, time and in the appropriate format.

2.1 TRAINING REQUIREMENT FOR CIMS :

The polytechnics, developing and providing skilled manpower-technician engineers, for the industries using CIMS, should set up a 'micro-factory' in an institutional training environment so that this facility can become an incubating chamber for training students of polytechnics in CIMS and experimenting with various alternatives in advanced manufacturing systems such as CAD/CAM/CNC/DNC/Rapid Prototyping Flexible Manufacturing Systems (FMS)/Concurrent Engineering Designs, Robotics, Artificial Intelligence, Group Technology (GT) and CIMS etc. Curricula in polytechnics should include large number of well structured modules on specific topics of relevance to manufacturing/services involving applications of computerized systems. A number of modular courses on these topics are to be developed to train the students of polytechnics and technical personnel from the industry. After successful completion of a certain number of such modules, a certificate or diploma can be awarded or alternatively there could be a well planned post diploma/advance diploma in "Advanced Manufacturing". Following are broad areas of training to be offered through these modules :

- Operation of advanced manufacturing machines
- Use of CAD/CAM
- Simulation of factory environment
- Integration
- Communications
- Factory operation
- Back-up facilities
- Management and decision making

2.2 POLYTECHNIC - INDUSTRY INTERFACE :

Once 'micro-factory' environment for advance manufacturing / services is created, polytechnics can offer following consultancy services to industry to generate internal revenue in order to make CIMS self-sustaining:

- Product design using CAD/AUTO-CAD and training to industry personnel to work in CAD/AUTO-CAD environment
- Process planning, tooling, selection and part programme development
- Creating and managing environment involving use of CNC/ DNC/ CAD/CAM/CIMS at work places
- Development of operational principles such as Material Requirements Planning (MRP), Capacity Planning, Production Planing, Computer-Aided Quality Control (CAQC), Engineerinig Data Management (EDM), Group Technology (GT), Business Data Processing System (BDPS) and Flexible Manufacturing Systems (FMS) etc.
- Other specialized services required by the industry in the area of manufacturing/services using computer application systems.

3. COMPUTER AND MULTIMEDIA IN TEACHING - LEARNING PROCESS IN POLYTECHNICS :

Use of computer and multimedia in Engineering / Technology / Vocation / art based programmes being offered by polytechnics have far reaching effects. Applications of Computer not only makes the teaching of courses interesting, meaningful, purposeful, accurate and productive but also influence teaching-learning process efficiently and effectively in developing computational problem-solving, visualization, designing, drafting abilities through simulations in the students.

Computer and multimedia help in changing the concept of education and training in the minds of those who are managing the educational institutions from 'teaching' and 'instructing' to those of 'assisting' and 'watching' thereby encouraging the learners with lowest readiness and interest to get involved in the teaching-learning process through individualized instruction and independent study especially through use of Computer-Aided Learning (CAL)/ Computer-Aided Instruction (CAI)/ Multimedia packages.

The use of CAL/CAI/multimedia should be made only after making what can be called as 'educational design' based on the requirements of the desired learning outcomes, the nature of the subject matter, the charactetistics / traits of the student / learner and the availability of facilities/environinent. Beyond these, effective communication (in oral and writing) and team skills are also essential which are the abilities to cooperatively work, negotiate, persuade others to accomplish group objectives which should be tabulated in such a way that these form part of 'Trait-profile' of the learner while developing 'educational design'.

4. VIRTUAL LABORATORY (VL) :

VL is based on the innovation in Virtual Reality (VR) which creates an incredibly realistic three dimensional environment on a computer screen. The success of VR/ VL depends on the extent to which one can interact with computer. On a practical plane VR/VL is used as an effective tool for highly accurate measurements. Today many chemical heavy industries, ship building companies, automobile manufacturing industries, road/rail/air/water transportation network design organizations are making use of the potentials of VR/VL for cutting down costs and obtaining superior results. In the area of aviation and aeronautics VR/ VL can be used for a precise flight stimulation accurate/instrumntation control and safety procedures. VR/VL has also been used to simulate the Russian orbital complex Mir to finest details. On the other hand VR/VL enables us to bring a safe but fine cycling experience directly into work places, canteens and staff quarters.

Virtual laboratory, which is an off shoot of CAL/CAI, allows the learner to understand laboratory equipments, how to handle them, how to set up experiments, take precautions, play with variables, draw graphics, verify laws and everything a laboratory can offer except for the real sensory experience e.g. a student of science/ technology/vocation/ art can scroll into the virtual laboratory to interact with the IC engine or any other topic of a particular course/ programme to find solutions to the problems chasing him/her. In this way, VL in foreseeable future can change the present approach of 'examination oriented' education/training in polytechnics to 'problem-solving'. Niemiec et al reviewed the results of more than 250 research studies, done on CAL/CAI/VL and concluded that CAL/ CAI/VL is not only effective but as much as three times as cost effective as tutoring/ actual laboratory. Additionally, VL is able to take the students to certain situations which are impossible to achieve in the laboratory such as extremely hazardous, time consuming, expensive or difficult to establish in an educational institute. In the absence of real situation, VL can atleast offer the development of lowest level of psychomotor skills, that is, imitation. Here the prime goal is not to promote muscular coordination, but to establish cognitive control over muscular involvement. From the example of established practice of training of car drivers or pilots in simulated conditions, it will not be unwise to expect some tangible learning outcomes, though not structured and qualified, in manipulations - precision articulation - naturalization through VL.

Over the past two years a series of hydraulic simulations have been developed to provide the students VL environmnt where the students can perform the experiments and acquire the knowledge/skills regarding equipment, procedure, analysis and graphical representation of experimental results. Even if actual experimentation is not performed, VL provides a fairly accurate representation of the experiments and help in developing valuable experimental skills in the students. These sitnulalion techniques in VL are being used to educate and train technician engineers all over the world with a verv high degree of successful outcomes and need to be developed and popularized in Indian polytechnic education system to improve quality of laboratory work in the system.

5. AN INTEGRATED APPROACH FOR IMPACT OF COMPUTERIZATION IN POLYTECHNIC EDUCATION :

With the financial support received through the World Bank Assisted Project many polytechnics have procured computers and many of them have erected buildings to accommodate these computers but the desired impact of computerization is not being realized due to certain gaps existing in the system. Some of the main reasons for non-visibility of this impact are: out-dated curriculam lack of trained teachers, non-availability of appropriate application and educational computer softwares, lack of interface between world of work and polytechnics etc.

Somewhere a misunderstanding among the teachers and others stakeholders of polytechnic education seems to exist that by providing just one or two programmers/computer professionals and by creating an isolated computer engineering/science department with, some -hardware resources, these gaps, can be bridged. In fact, developing and using any application/educational computer - software require a team work consisting of computer professionals, subject experts and personnel dealing with pedagogy. In order to fill-up the existing gaps and to remain relevant to the present day, rapid automation in the industry an integrated approach consisting of following components will have to be followed if some tangible impact is to be realized :

- Inclusion of contents of computer applications appropriate to various courses/subjects in all the programmes/disciplines being offered by the polytechnics and integration of computerization in the 'core-curricula
- Teacher being the key to success of any educational project/programme, both inservice and preservice teachers, irrespective of type of course(s) he/ she is teaching whether the course(s) are in applied sciences; -drawing; engineering/technology sciences; engineering /technology applications, humanities or management should be trained and re-trained in relevant hardware and software packages being used in the field to enable him/her "teach with and teach about" various industrial applications of computers including applications of computers in teaching-learning process
- Specially designed, through the involvement of concerned teachers, flexible and appropriate CAL/CAI packages should be made available to every teacher in the polytechnics.
- Development of computer, multimedia and other infra-structure to create an environment to practice systems like CAD/CAM/ CNC/DNC/CIM/ CAL/CAI/VR/VL etc., in a polytechnic set-up
- Autonomy to polytechnic to develop interface between higher level institutions/organizations and industries to exchange expertise and offer consultancy services to make the system self-supporting
- Setting up 'micro-factory' environment in the technician level institutions to create situations where students and teachers can get a feel of practices being followed in the world of work.
- Organised effort in the development of VR/VL courseware is the need of the hour, considering that not much laboratory and workshop facilities exist in technician level institutions, to improve teaching-learning process

6. CONCLUSION :

The current state of art-technology-information technology (IT) using computer simulations can provide what is believed to be a viable and flexible learner interactive framework to allow learning strategies-based on the learning outcomes from the learner, contents to be covered and characteristics of learner himself. Rapid advances are occurring in computer technology and its utilization for automation in industry. Automation and advance manufactufing/ services have become a reality in the world of work, with computer applications of systems like CIMS/CAD/ CAM/CNC etc. 'Micro-factory' concept is very useful and necessary for providing a test bed and training ground for the technician engineers, and industrial personnel. These 'Micro-factories' set-up in cojunction with higher level technical institutions and other organizations can become self-sustained by offering consultancy and training services to industries. An integrated approach comprising inclusion of components of computer applications in various curricula, teacher training/re-training, development of appropriate software packages and providing necessary infrastructur/environment suggested in the paper will go a long way in necessary desired impact of computerization in polytechnic education system.

7. REFERENCES :

i) R.P.Niemiec, M.F.Sikorski, H.J.Nalberg; Comparing the Cost Effectiveness of Tutoring and Computer - Based Instruction, Journal of Educational Computing Research, 1989

ii) A.Romiszowski; Producing Instructional System: Lesson Planning for individualized and Group Learning Activities, London, 1984

iii) G.Jerry Page- A.Quentin; Aspects of Educational Technology, Nichols Publishing Companvl 1979

iv) M. Radhakrishna et al; Proceedings of First International Conference on Educational Computing "EDUCOMP' 1996", TTTI, Chandigarh 1996.

APPENDIX :

1. **Computer aided design (CAD) :** It can be defined as the use of computer systems to assist in the creation, modification, analysis, or optimization of a design.

2. **Computer-aided manufacturing (CAM) :** It is the use of computer systems to plan, manage and control the operations of manufacturing plant through either direct on indirect computer interface with the plant's production resources

   - Direct application =

     computer monitorin & control

   - Indirect applications =

     manufacture support applications

3. **Numerical control (NC) :** It is a form of programmable automation in which the process is controlled by numbers, letters and symbol.

4. **Computer numerical control (CNC) :** It is a nc system that utilizes a dedicated, stored programme computer to perform some or all of the basic numerical control functions. With CNC the programme is entered once and then stored in the computer memory. Thus tape reader is used only for the original loading of the part programme and

part programme and data. Compared to NC, CNC offers additional flexibility and computational capabilities.

5. **Direct numerical control (DNC) :** It is manufacturing system in which number of machines are controlled by a computer through direct connection and in real time. The tape reader is omitted in DNC, thus relieving the system of its least reliable component. Instead of using tape reader, the part programe is transmitted to the machine tool directly from the computer memory. One large computer can control more than 100 separate machines.

6. **Robot technology:** An industrial robot is a general - purpose, progrmable machine possessing certain anthropomorphic characteristics. The most anthropo-morpric or human - like, characteristics of a robot is its arm.

7. **Group technology (GT) :** It is a manufacturing philosophy in which similar parts are identified and grouped together to take advantage of their similarities in manufacturing and design - leading to efficiency in manufacturing through reduced set-up times, lower in-process inventories, better scheduling, improved tool controi, and use of standardized process plans.

8. **Material requirement planning (MRP) :** It involves determining when to order raw materials and components for assembled products. It can also be used to reschedule orders in response to changing production priorities and demand conditions. The term priority planning is now widely used in describing computer-based systems for time-phased planning of raw materials, work-in-progress and finished goods.

9. **Capacity planning :** It is concerned with determining the labour and equipment resources needed to meet the production schedule.

10. **Direct digital control (DDC) :** It involves the replacement of the conventional analog control devices with the digital computer. With DDC, the computer calculates the desired values of the input variables, and then these calculated values are applied directly to the process. The direct link between computer and process is the reason for the name "direct digital control".

11. **Computer-aided quality control (CAQC) :** It is used:

- To improve product quality
- To increase productivity in the inspection process
- To increase productivity and reduce lead times in manufacturing

12. **Coordinate measuring machine (CMM) :** It Consist of a table which holds the part in a fixed, registered position and a moveable head which holds a sensing probe. The probe can be moved in three directions-x,y & z- coordinates. During operation,

the probe is brought into contact with the part surface to be measured and the three coordinate positions are indicated to a high level o accuracy,upto±0.0002 in (o.005imm)

13. **Computer-integrated manufacturing (CM) :** It is a term used to describe complete automation with all processes functioning under computer control it uses the database and communication techniques to integrate the design, manufacturing and business function that combine the automated segment of factory or facility. In such a methodology approach economic, social and human aspects have the same importance as technical aspects.

14. **Flexible manufacturing system (FMS) :** It is an integrated approach to automating a production operation. The primary characteristics of FMS is that it is a computer-controlled manufacturing system that ties together automated production machines and material handling equipments. The FMS is designated to be flexible so that it can fabricate a variety of different products of relatively low volumes. A FMS consists of more than one complementary or supplementary machine, many of which are of the CNC type, served by compatible, common and preferably automatic tool and work piece supply systems under the supervision of an integrated computer control.

★