# TELE-OPERATION OF A MANUFACTURING SYSTEM FOR VOCATIONAL EDUCATION

**Francis H.F. Tsang and Jonathan K.F. Lee**
**Department of Manufacturing Engineering**
**Hong Kong Institute of Vocational Education (Chai Wan)**

**Index:** Distance and open learning, Education on demand

**Abstract:** A flexible manufacturing system was designed and developed to become a decentralised modular network manufacturing plant in the Hong Kong Institute of Vocational Education (Chai Wan). The system consists of a flexible machining cell, flexible assembly cell, automatic storage system, a database server, web-server and video conferencing system which are to be linked by various networks internationally with other educational institutions or manufacturing sites.

Various areas for the development such as system layout, simulation, mechanical design, hardware and software development have been carried out. The current development is to establish a web-based control and training system to the customers or students. They can view the operation of manufacturing and assembly processes as well as access system data and information globally.

The aim of this paper is to report the tele-control development of the flexible manufacturing system. The development changes the current education process. The system provides virtual and animated images on design, manufacturing attributes and supports remote training. Students, at a distant location can acquire skills, production methods and access system data and information globally. Moreover, instant feedback from students is possible, as they can make criticism at any geographical area. Delivery of knowledge can now be on-line and in real time globally to achieve better result of education.

Students using this system can communicate with the system host using Internet or ISDN leased line directly. They can submit task on various manufacturing processes and control of industrial robots through Internet or intranet. Host's feedback to students is also provided in order to enhance the learning process.

## INTRODUCTION

A Flexible Manufacturing System (FMS) [1,2] has been designed and developed in the department of manufacturing engineering, Hong Kong Institute of Vocational Education (Chai Wan) to become a decentralised virtual modular network manufacturing plant named as Tele-presence Depot (TPD). A database is designed for the TPD to be linked by Internet network with other production depots and this is called International Network (IN). This leads to the International Network Corporation (INC) enabling globalisation of manufacturing activities at any geographical location to be integrated into one system. Individual TPDs can then be integrated together to become a global partner of the multi-national corporation. Globalisation in the context of INC means that the product or different part of the product can be designed, tested, analysed, and manufactured in different TPD at different sites worldwide for a number of reasons, such as technology and resources available in a particular TPD.

An INC may have various design experts, machines and equipment located around the world. Appropriate decision has to be taken to allocate different tasks to a suitable TPD in order to maximise the utilisation of resources. In order to manage all these facilities effectively and to handle its policy making and production planning, an INC needs a communication network that interconnect its multiple manufacturing plants and sales offices as well as other facilities. Considering this, an attempt has been made to design and develop IN making use of the advanced technology in Internet and multimedia.

Effective productivity depends on time to market, product costs, market share, and quality. The IN is a systematic tool that embraces customers, suppliers; distributors, powerful information infrastructure, and effective use of modern technology leading to every success of a INC.

Globalisation of manufacturing requires efficient transfer of manufacturing information among various regions. Therefore, a technique called Telepresence Teaching and Learning (TPTL) is designed and implemented to change the current education process. Individual TPD in one part of the world can control off shore manufacturing and at the same time viewing the animated manufacturing processes on line via the IN.

This is like making products in house without going to the distance site. Similarly, students in one location will be able to control the FMS and even the robot located remotely as well as enjoying the animated presentation. The system provides web site as an interface between students and the TPD incorporated with central network server and allows students at a distant site to operate the machines through Internet.

## LITERATURE REVIEW

Video conferencing is the combination of dedicated audio, and communications networking technology for real time interaction [3]. Types of video conferencing include room based systems and desk top video conferencing. Room based systems allow groups of people in a room setting to communicate with other groups of people. Desktop video conferencing combines personal computing with audio, video, and communications technologies to provide real-time interaction from a typical personal computer, and the interaction embodies communications between groups of people.

In education, numerous researchers [4,5,6,7] have evaluated video conferencing system (VCS) to be effective and efficient as means of imparting instruction and information to geographically dispersed groups of people. It allows students to enhance interaction at distant site. Using the system for educational delivery was found to be flexible and exchange of ideas and knowledge is greatly improved and learning experience is substantially enhanced.

Coventry [8] reported that video conferencing has great potential for learning in higher education. The potential lies in creating greater opportunity for dialogue which facilitates more effective learning than working in isolation. Dialogue may be between tutors and learners or amongst learners.

In view of the development of Internet, applications of VCS are associated with the education in Internet environment. West Virginia Educational Network [9] was created to link up classes for higher education. Perrone [10] presents WebQuest, which is a system combining the WWW with the notion of an interactive quest game. Players of the game answer questions to acquire important objects needed to solve the quest.

Wong et al. [11] used the concept of dynamic documents to render on a WWW browser, a sequence of multimedia scenarios, having objects of types such as audio, image, plain text, HTML,

document and animation. It allowed the user to interactively test and compose such a presentation, using Netscape Navigator to collect multimedia resources from the WWW. A presentation database stores the presentation and serves as a convenient repository for users to access.

The current Internet is widely accepted by users for communication world-wide. The Global Internet is now being used to manage networks as well as user and application interaction in a local and international environment. The video must be integrated with the Internet/Intranet and organised to enhance information processes such as, email services,

## SET-UP OF THE TELE-OPERATION MANUFACTURING SYSTEM LABORATORY (TMSL)

The configuration of the tele-operation manufacturing system is shown in Fig. 1. The main components in this system include a web server and a database server in the host computer. The web pages in the web-sever provide an interactive interfaces to the users. The web-pages allows users to select various combination of product design, orders for product and animated images on product design. In addition, the users can view the operation of manufacturing processes and make dialogue with the local site through internet or VC system. The later features are useful for vocational training globally.

The web-pages are front-end database application, which allow users to select and submit their requests into the host computer. In the host computer, which includes a SQL database server, whenever there is a request being submitted through the Internet or Intranet, the data will be transmitted into the SQL database server and stored up automatically. A visual basic control program run on a local computer will communicate to the host computer. The local computer connects to an ABB robot controller through a robcomm software. The robcomm software is a TCP/IP communication software which set up the communication between the ABB robot and the local computer. The entire manufacturing system can be controlled and monitored by an external computer via this TCP/IP communication interface.

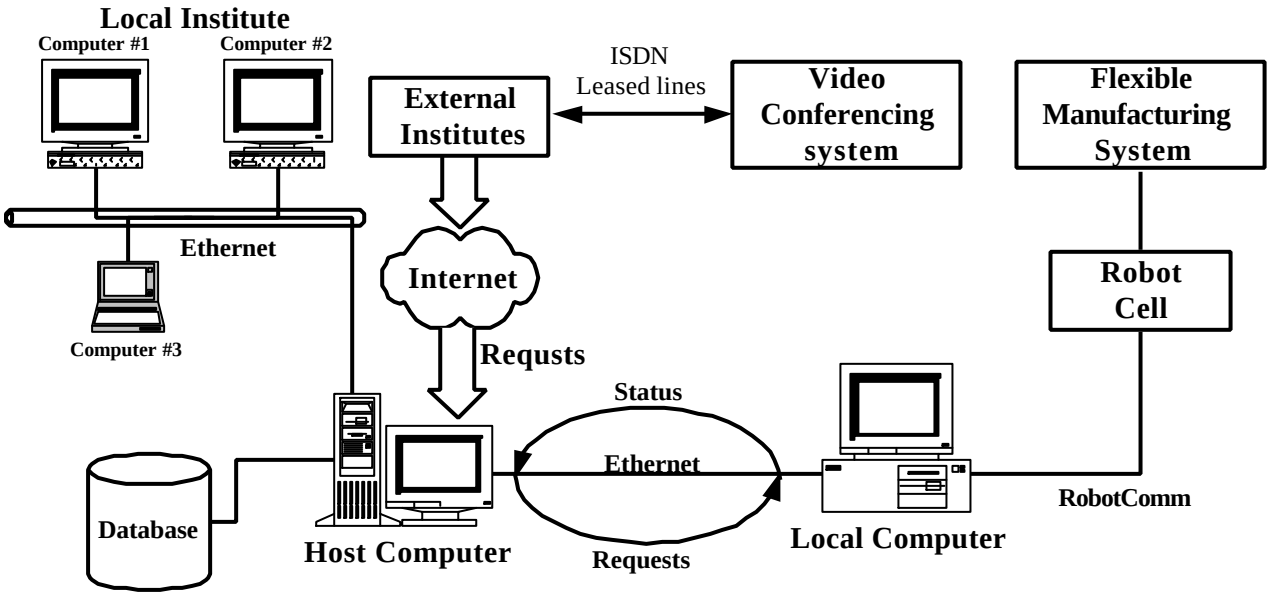


**Fig.1 Tele-operation Manufacturing System**

In addition to the control aspects, the tele-operation system also includes a monitoring system. The monitoring system is divided into two parts. The first part installs a number of web cameras to monitor the operation of the manufacturing system. The local computer can communicate with other computer via Internet or intranet using Microsoft Netmeeting. With this setting, the local computer can make a call with a remote computer and communication can be established. Both video, audio, file transfer and software sharing activities can be made. Due to band width of the existing network, this configuration performs satisfactory only in the host institute within the local area network (LAN). However, it can still provide an useful on-line training to our students. For example, staff in classrooms or laboratories can link to the TMSL for on line demonstration and discussion via the campus network.

In order to speed up the communication, a video conferencing system with three 128k ISDN leased lines is adopted to improve the speed of video and audio images. External institutes can make a call to the VC system so that they can communicate with the lecturing staff in the laboratory. With this set up, the frame rate can be up to 30 frames/second which is acceptable quality for audio-visual images.

The tele-operation manufacturing system laboratory (TMSL) uses the video conferencing system (VCS) that facilitates collaboration, interaction and information interchange among various systems. It also permits virtual meeting with voice, graphic text, and video capabilities. It is a powerful tool for effective dissemination of knowledge globally.

Students can gain experience as a result of attending the training using VC system via TMSL as well as through monitoring other depot's manufacturing processes. They can have a better insight for improving productivity with international collaboration. They can understand how multi-disciplinary teams and resources located worldwide could be managed as well as data can be shared amongst teams from different domain.

TMSL not only offers the ability to integrate audio experience directly with text, but also adds the power of interactivity. This learning system generates an active, and self-directed learning environment for students. The system not only improves the process of teaching and learning, but also provides new tools and technology that promote remote learning.

## CONCLUSION

An engineer on one side of the world will be able to control the FMS and the robot cell located remotely. He can work on a common manufacturing activity with another remote engineer collaboratively and interactively through the implemented development. Geographical barriers that defer the operations of International Network Corporation (INC) will be eliminated. With the installation of video conferencing system, photo-realistic images can be produced which provides a convincing audio and visual presentation for design selection, manufacturing and assembly processes. People can view all these virtual and animated display worldwide.

The use of telepresence teaching and learning (TPTL) improves quality of teaching by delivering knowledge globally to students. Students, at a distant site, can acquire skills and production methods on a PC and concurrently access necessary data and information (Support remote training and on line operation training to students). Students can overcome the barriers of time, distance, and costs to share information and knowledge on line as well as in real time to achieve the best value from education. Instant instructional feedback is possible, as students are able to make global criticism at any geographical location.

Use of TPTL may result in less teaching manpower and teachers can use more time to carry out research or to receiving life long training to keep abreast of latest technology.

## REFERENCES


[1] F HF Tsang and WS Lau, "Control Architecture for Flexible Manufacturing System", CAI symposium 2000, HKIE, 2000, pp 52-62.

[2] K. F. Lee and H. P. Tang, "Development of a Flexible Manufacturing Cell", 5th Guangdong-Hong Kong Symposium on Advances in Mechatronic Research and Industrial Development, 1997, pp 545-555.

[3] Adeoye, T. K. (1998). "Video Conferencing". Multimedia Telecommunication FAQ, JilTel Communications, pp. 1-9.

[4] Davis, G. (1995). "A Product Test Evaluation of Two Way Video Conferencing in Secondary and Post Secondary Institutes". University of New Brunswick.

[5] Lowery, L. (1999). "Video Conferencing for Refresher Courses". Texas A&M University, Bryan and College Station, Texas, USA.

[6] Rettinger, L. A. (1995). "Desktop Video Conferencing-Technology and Use for Remote Seminar Delivery". North Caroline State University.

[7] Sherry, L. (1996). "Issues in Distance Learning". International Journal of Distance Education, Vol. 1(4), pp. 337-365.

[8] Coventry, L. (1999). "Video Conferencing in Higher Education". Institute for Computer Based Learning, Heriot Watt Universty.

[9] Weinstein, I. M. (1999). "Video Conferencing and Multipoint Meetings at Credit Suisse First Boston". Global Media Servies, Credit Suisse First Boston.

[10] Perrone, C. Clark, D. & Repenning, A. (1996). "Webquest: Substantiating Education in Edutainment through Interactive Learning Games". (Colorado University) and (Boulder Valley Schools) in Computer Networks and ISDN Systems, Vol. 28, No. 7, pp. 1307-1319.

[11] Wong, J., Rao, S. & Ramaiah, N. (1997) "A Multimedia Presentation Toolkit for the World Wide Web". (Iowa State University) in Software -Practice and Experience, Vol. 27 No. 4, pp. 425-446


## CORRESPONDENCE


Francis H.F. Tsang and Jonathan K.F. Lee

Department of Manufacturing Engineering

Hong Kong Institute of Vocational Education (Chai Wan)

Email: francist@vtc.edu.hk and jkflee@vtc.edu.hk