MULTIMEDIA APPLICATIONS IN PRODUCTION INFORMATION MANAGEMENT

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ABSTRACT

To make effective decisions, the production managers of manufacturing firms have to access and interpret an enormous amount of production information. To be successful in the global market place, they need to collect, transmit and interpret these information quickly. Effective and efficient management of production information will therefore be essential.

It is the author's view that multimedia technology can improve production information management because multimedia technology will enable quicker collection, transmission and interpretation of production information and will enhance communication between man and computer as well as man and man through a computer.

This project explores the application of the multimedia technology in production information management. Based on the findings of the literature review and interviews conducted, the author concludes that multimedia technology can not only enhance existing production information management systems in the short run but also change the way products are manufactured in the long run. The benefits will be improved product quality, reduced cost and shortened lead time.

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CHAPTER I

INTRODUCTION

Background

In order to satisfy customer demand and meet competition, a manufacturing firm has to address a number of issues such as how to operate the manufacturing plants efficiently, how to keep the inventory levels at a minimum without disrupting the production schedule and affecting customer service, how to ensure sufficient capacity to meet peak and anticipated demands etc. Particularly, the managers of the firm have to decide on matters such as when to release job shop orders, what / when / how much to purchase, how to layout a factory, when new facility is required etc.

To make effective decisions, the production managers need to access and interpret an enormous amount of information such as the planned and anticipated demand, the product structure and the current utilization of production resources. To be successful in the global market place, they must be able to collect, transmit and interpret these information quickly. Effective and efficient management of production information would therefore be essential.

It is the author's view that production information management can be improved with the introduction of

multimedia technology. The reason is that multimedia technology should allow quicker and easier information collection / retrieval and better information presentation. The intermediate results will be improved understanding and quicker interpretation of the information and the end result will be more effective decision making.

Objective

The objective of this study is to verify the author's view on the role of the multimedia technology in production information management.

Report Organization

The report is organized into seven chapters. Chapter I introduces the background and the objective of the study and the organization of the report. Chapter II presents the methodology employed. Chapter III and IV give an overview of the current state and the future trend of multimedia technology and production information management respectively. Chapter V presents the results of the interviews conducted. Chapter VI presents the author's view on the role of multimedia technology in production information management. Chapter VII presents the conclusions and recommendations on future work.

CHAPTER II

RESEARCH METHODOLOGY

Methodology

The methodology used in this study follows that of a typical business research, i.e., problem definition, information needs identification, information collection, analysis and conclusion.

Problem Definition

Multimedia technology has been around for some time. Recently it has become more affordable and has found applications in areas such as training, marketing and information retrieval. This study aims at:

1. Identifying the role and application areas, if any, of the multimedia technology in production information management.
2. Identifying any future work that can further our understanding on the subject.

Information Needs

The information needed to address the defined problems are:

1. Information on multimedia technology, its benefits, current state, existing applications and future trends.

2. Information on production information management, its current state and future trends.

Information Collection

Information is collected from the following sources:

1. Literature review. Information from journal, magazine, text books, product catalogues/brochures provides the background information required for this study.

2. Interviews. Interviews with selected firms will be conducted to provide a sample of the practical problems and considerations in production information management.

Analysis and Conclusion

With the information collected, opportunities of applying multimedia technology to solve the problems or enhance the process of production information management can be identified and the role of multimedia technology in production information management can be determined.

CHAPTER III

MULTIMEDIA TECHNOLOGY - AN OVERVIEW

Definition

Multimedia can be defined as the combination of two or more media in an integrated manner. The emphasis on "integrated manner" excludes cases where the two or more media are just used in a parallel but not synchronized fashion, which should be at most defined as "multiple" media. [Grimes and Potel, 1991].

Although in the literature the media usually refers to text, graphics (which includes pointers, touch screens and mice), animation, sound and video [Grimes and Potel, 1991], for the purpose of this study, input devices such as bar coder, optical character reader etc are also considered as part of multimedia.

Multimedia is a technology for communication, not a product. Though not explicitly defined, multimedia technology is usually employed in communication between man and computer or man and man through a computer. Since multiple media is used, the communication is through multiple senses, i.e., seeing, hearing, feeling etc.

Besides the use of multiple media, interactivity is another key element in multimedia technology. A multimedia system allows the user to interact with the

computer to navigate freely through the system at his own way and own pace. [Grimes & Potel, 1991; Waterworth, 1991; Strothman, 1991]

Benefits

Since a multimedia system presents information through multiple senses, the communication process resembles the natural human face to face communication (e.g. the use of different tones together with facial expressions and gestures). It is believed that this will speed up and enhance understanding. As a result, the performance of the computer user in intellectual tasks such as decision making will be improved. [Donovan, 1991; Yager, 1991; Fox, 1991]

Another benefit of using multimedia is that information can flow in parallel through different channels. This will speed up the communication process and will also be useful in situations where one communication channel is occupied. For instance, a worker inspecting a piece of work with his hands occupied can input the result into the computer through voice recognition equipment.

Major Components of Multimedia Systems

A typical multimedia system consists of a computer, storage, input/output devices and associated software. These major components are further described in the remaining paragraphs. The descriptions emphasize on the audio and visual (i.e. image and video) media since these media have drawn the most attention in the multimedia

arena.

The Computer

The hub of a multimedia system is the computer. This is usually a personal computer similar to the conventional ones but with faster Central Processing Unit (CPU) because of the demanding processing need to process visual data.

Input / Output Devices

Apart from the conventional input / output devices such as display and keyboard, multimedia systems use other devices to interface to the outside world, e.g., speakers, touch screens, cameras, video recorders, high resolution colour monitors, high resolution scanners and facsimile machines [Price, 1991; Yager, 1991].

Before a multimedia system can work on multimedia data such as images, full motion video and sound, these data must be captured and stored in the system in the form of audio (sound) and video (images, full motion video) signals.

Various input devices are available to capture audio / video (A/V) signals. For instance, there are add-in cards to the computer that can freeze and capture video images into a disk graphics file [Yager, 1991].

Storage

A/V signals captured can be stored in the multimedia system in either analogue or digital form. In the analogue form, the A/V signal varies according to the

intensity of the images captured. In the digital form, the A/V signal is represented by a stream of numbers, each of which represents the light intensity value of the image at a certain time. [Serra, 1991]

Analogue storage includes videotapes and videodiscs and digital storage includes magnetic disk and CD-ROM. These are discussed below.

Videotapes

Videotapes in various formats such as VHS, Video 8 and Hi8 provide a very convenient and affordable form of magnetic storage. With special purpose video-cassette recorder (VCR), the computer can control the playback sequence of the videotapes and thus enhance interactivity between the user and the system. The major drawbacks of videotapes are the sequential access and the difficulty in searching due to frame accuracy problem. [Serra, 1991; Yager, 1991]

Videodiscs

Analogue laserdisks, or videodiscs, were introduced in the 1970s. These laserdisks are 12 inches in diameter and carry analogue A/V information recorded optically using a laser beam on both sides of the disks. Each side of these disks holds 54,000 frames, or 30 minutes of motion video with a playback rate of 30 frames per second.

Since the information is stored in concentric circles on the disk, frame-by-frame access and other special effects such as freeze frames, slow motion and fast forward are possible. This overcomes the drawbacks

of the videotapes and allows the viewer to access information on the disk at a random manner with seek time of around one second.

Since the preparation of videodiscs is an expensive process, the application of videodiscs is mainly in publication such as education, books, manuals and visual database.

Another disadvantage is its read only nature, which means that ordinary users cannot prepare their own disks. This problem has been partially overcome with the introduction of write-once laserdisks, however these laserdisks and their recorders are more expensive. [Serra, 1991; Fox, 1991]

Magnetic Disks

Magnetic disks of large capacity are available and can be used to store digitized A/V information. However magnetic disks are relatively costly, not removable (for disks with high capacity) and not suitable for mass replication. [Yager, 1991; Fox, 1991].

CD-ROM

Introduced in 1985, CD-ROM (Compact Disc Read-Only Memory) can hold more than 600 MB of data with data transfer rate of 1.5 Megabits per second and access time below one second.

With a manufacturing cost of under a dollar, CD-ROM is a very suitable media for distributing large quantities of A/V data, however it cannot replace magnetic disk due to its read-only nature. There are WORM (Write Once Read Many) and erasable disks available,

but the disk capacity is lower (about 200 MB) and the disk drives are much more expensive. [Serra, 1991; Fox, 1991; Robinson, 1990]

Issues with Digital A/V Storage

Digital storage of A/V information has several advantages over analogue storage, e.g., variable rate playback and integration with other digital data in computers. The greatest problems of storing digitized information are the storage required and the vast amount of data transmitted between the storage and the computer. To display a smooth full motion video it is necessary to display 30 images per second. With each digitized image occupies around half a megabyte of storage, a second of full motion video will need at least 15 Megabytes (MB). It is obvious that the storage and bandwidth requirements are very demanding.

The problem of bandwidth is partially solved by advances in the networking technology such as the FDDI technology (Fibre Distributed Data Interface) which runs at 100 Megabits per second (Mbps) [Fox 1991]. Another solution is compression. By reducing the amount of data required to represent a piece of A/V information, both the storage and the time required to store and transmit that piece of A/V information is reduced.

Compression approaches can be divided into two main classes: lossless and lossy schemes. Lossless schemes remove redundancy in the original information and include techniques such as Huffman and Run Length. Lossy schemes encode the original information in a form that takes up

relatively small space which when decoded results in a representation that is similar but not exactly equal to the original. Under the lossy schemes are techniques such as JPEG, MPEG and px64, which are commonly used in multimedia systems [Fox, 1991; Quinnel, 1993]. These schemes will be discussed in more details under the section on "Multimedia Standards".

Software

Apart from conventional software such as operating system that are required for the basic operation of the computer, the multimedia system requires a number of supporting software in order to run and develop multimedia applications. Some of these software are discussed below. [Semich, 1992]

Multimedia Authoring Tools

These tools integrate various multimedia elements together into multimedia applications.

Multimedia Database Management System

A multimedia database management system allows the users to index and retrieve multimedia data types. There are commercially available multimedia database management systems, e.g., Lenel Systems International Inc.'s MediaOrganizer and MPCorganizer.

Sound Recording, Editing and Mixing Software

This software allows the user to store digitized audio signals onto disk and modify them.

Video Overlay Software

This software allows mixing of graphics files,

animation files and digitized video into the same application.

Animation Development Tools

These tools allow multimedia application developers to manipulate animated objects.

Clip Media

This software contains ready to use sound track for development of multimedia applications.

Typical Multimedia Systems

This section describes some typical multimedia systems that are available on the market, namely NeXT computers, Compact Disc Interactive, Digital Video Interactive, IBM's Ultimedia, Microsoft's Multimedia PC and Apple's Macintosh.

NeXT Computers

The NeXTdimension board introduced by NeXT computers is a graphics board which includes an i860 processor for graphics and a JPEG compression chip for compression. Together with the NeXT computer, the board compresses incoming video signal and transfers it to the hard disk and also performs real-time playback with moderate quality. To support multimedia, a digital multimedia communication software system called MediaView has been built to handle graphics, video, audio and animations etc. [Fox, 1991; Serra, 1991]

Compact Disc Interactive

Compact Disc Interactive (CD-I) is a CD-ROM based

proprietary technology launched by Sony and Philips for the consumer and low-end education/training markets. The system consists of a compact disc player, a Motorola M68000 family processor, an audio processing unit, decoders for A/V signals, a pointing device and a real-time operating system called CD-RTOS (Compact Disk Real Time Operating System). [Fox, 1991; Serra, 1991; Robinson, 1990]

Digital Video Interactive

Digital Video Interactive (DVI) is a technology developed by Intel. Unlike CD-I, which is a standalone proprietary system, DVI is a more open system and serves as an extension to a computer system. The current technology uses the 82750 PB pixel processor and the 82750 DB display processor. The software used is the Audio-Video Kernel (AVK), which is modelled on a production studio. AVK has been designed to support various platforms such as Microsoft Windows, OS/2 and Unix and can interface with multimedia programming interfaces such as IBM's Media Control Interface and Apple's QuickTime. An implementation of the AVK architecture is the ActionMedia II boards that support full motion digital video for Micro Channel and ISA based systems. [Fox 1991; Serra 1991; Donovan 1991]

IBM PS/2 Ultimedia

The IBM PS/2 Ultimedia Model M57 SLC is IBM's answer to multimedia computing. The system is based on the 386 SLC CPU chip which is as much as 88 percent faster than

the 386SX at the same clock rate of 20 MHz. The system comes with 4MB of RAM, four Micro Channel bus slots, a 2.88 MB floppy drive, an 80 MB SCSI hard drive, a PS/2 mouse, a 101-key Enhanced keyboard, DOS 5.0, Windows 3.0 with Multimedia Extensions and OS/2 2.0. The system also includes a CD-ROM drive, an XGA graphics card, an M-Audio Capture and Playback Adapter providing 16 bit A/D and D/A conversion, a MIDI port and musical sound. Add on boards will provide other functions such as video-capture and digital video support. [Reinhardt, 1991; Ross, 1991]

Multimedia PC

The Multimedia PC (MPC) standard proposed by Microsoft is a set of minimum performance and capability specification for CD-ROM, sound and display graphics. It specifies a minimum of 286 CPU; 2 MB of memory; 1.44 MB floppy disk drive; 30 MB of hard disk; VGA video display; digital audio subsystem consisting of 8 bit sampling music synthesizer, MIDI interface and onboard analog audio mixer, CD-ROM drive with CD-Digital Audio and system software compatible with Microsoft's Window 3.0 with multimedia extensions.

A number of vendors provide hardware and software products conforming to the standard. An example is the Tandy's Multimedia 4033 LX, which conforms to the MPC specifications on audio, optical storage and software but features 33 MHz 386 CPU, 4 MB memory, 105 MB hard disk and super VGA. [Raskin, 1991; Ross, 1991; Strothman, 1991]

Apple Computer's Macintosh

The Macintosh computer produced by Apple computers already has basic multimedia capabilities. It can support 8 bit or 24 bit colour with add-in video-adapter boards. It also has a MIDI output option that attaches to a serial port. On the software side, HyperCard, a program supplied free with the Macintosh, can be used to develop, modify and run multimedia production. Peripherals such as optical scanners, CD-ROM drives and videodiscs can be accessed via direct links within a HyperCard program. The Macintosh operating system System 7.0 together with the QuickTime extension provides various functions to display, compress, decompress, cut, copy and pass multimedia data such as colour images and sound. [Robinson, 1990; Wayner, 1991]

Multimedia Standards

There was no standard at the early stage of development of multimedia systems. This leads to incompatibility problem and hinders further development. Recently international standards have been set up to address this issue. This section describes some of these standards.

JPEG Standard

The JPEG (Joint Photographic Experts Group) standard deals with compression of still images. It supports progressive encoding, where more and more details are included in multiple scans of the image, and hierarchical encoding, where lower resolution images are accessed

before higher resolution ones. Both encoding schemes are useful for browsing and low-resolution displays. JPEG also includes a lossless encoding technique.

CCITT Recommendation H.261

The CCITT Recommendation H.261, also referred as p x 64, is a standard for producing compressed video streams at rates of p x 64 Kilobits per second, where p can be from 1 to 30. When p is low (1 or 2), the compressed stream can only be used for videophone application. For higher p, use for video conferencing is feasible.

MPEG Standard

The MPEG (Motion Picture Experts Group) standard is divided into three parts: MPEG-Video, MPEG-Audio and MPEG-System. MPEG-Video is for compressing video signals of 360x240 pixels down to 1.2 Megabits per second, which is suitable for use in CD-ROM, digital audio tape and T1 communication channels. MPEG-Audio deals with compression of audio channels of CD quality, which require 2 x 706 Kilobits per second, to 2 x 128 Kilobits per seconds or even lower. MPEG-System aims at encoding television-quality audio and video signals into a single stream at 1.5 Megabits per second.

Existing Multimedia Applications

Multimedia as a more natural man-computer interface can be used in the front end of almost any computer application. Existing applications are mainly in the areas of public access, kiosk merchandising, training and

business communications [IBM, no date].

Public Access

The user friendliness of multimedia system is ideal for providing information for the public. Examples of applications in this area include kiosks that provide vehicle registration renewals via touch screen transaction and a multimedia imaging system that provides teachers conducting tours to the Louvre museum with information about the location of paintings.

Kiosk Merchandising

The audiovisual and interactive capabilities of multimedia systems allow customers to learn and experiment with a product and thus increase the chance of a successful deal. For instance, customers in a flooring showroom can renovate their rooms themselves via a multimedia equipped kiosk. With credit card reading devices and communication capability, a kiosk can be turned into a point of sales location.

Education Training

A multimedia system is superb for education training due to its capability in presenting information in a mixture of media and in allowing the users to interactively explore through the information. An example of such application can be found in Boeing Company, which used interactive desktop systems to train 7,500 airline flight and maintenance personnel each year [Strothman, 1991].

Business Communications

Multimedia technology has important application in business presentations because it enhances communication beyond conventional text and graphics and gives the audience a professional feeling. Its interactive capability also enables the presenter to switch to different parts of the presentation according to the response of the audience.

Another application of the multimedia technology in the business arena is video conferencing, which allows people thousand miles apart to communicate as if they were face to face.

The Trend

Further Technological Advances

Multimedia technology will develop further to overcome the problems encountered today. Faster CPU chips specially designed with multimedia functions such as image and audio data manipulation are under development to provide more processing power for the demanding multimedia applications. CD-ROM that has transfer rate of 300-350 Kilobytes per second allows image of better quality to be delivered. Local-area networking protocols will be enhanced to support multimedia to allow the sharing of multimedia data and applications. Standards will be further developed to permit interoperability of multimedia applications across platforms. [Cole, 1993]

New Applications

Existing applications will be further developed and new applications will come up. An example is the use of multimedia for communication between work groups that are geographically separated. An experiment in this area was conducted in a Xerox Palo Alto Research Centre experiment in the mid-1980s [Bly, Harrison & Irwin; 1993]. People in two research laboratories in Palo Alto, California and Portland, Oregon were linked together via a "media space", which is defined as "an electronic setting in which groups of people can work together, even when they are not resident in the same place or present at the same time". In this particular experiment, the media space consisted of audio/video links connecting the two sites and the researchers' offices. The result of the experiment revealed that the media space could be used for informal communication among work groups of different geographical locations. Another similar experiment [Fish, Kraut, Root and Rice; 1993] also had similar result. However it was also found that communication through A/V channel was not able to replace face to face communication for situations where sharing of work objects (e.g. computer terminal) was required.

Virtual Reality

Most of the existing applications emphasize on enhancing the communication from computer to man, e.g., better presentation of business information. Relatively few applications address communication in the other

direction, i.e., from man to computer. This situation will change with the development of "Virtual Reality" (VR).

Virtual reality may be defined as a synthetic representation of reality [MacNicol, 1990]. VR participants can explore the synthesized reality, the Cyberspace, at their own will. In order to make the synthesized reality more realistic, new user interface devices are required for the VR participant to communicate with the computer. These include devices such as sensor-laden gloves that allow the participant to manipulate the objects in the Cyperspace; goggles that deliver 3D graphics and earphones that deliver 3D sound [Hamilton et al, 1992].

VR applications stretch the limits of the current multimedia technology. A lot of computational and networking capacity is required to process and transfer the vast amount of data needed for the synthesized reality. New user interfaces require new technological advances. For instance, how to accurately simulate the pressure when a VR participant grasps an object in the Cyperspace using a VR glove [MacNicol 1990]. The current technology is probably not adequate to cope with all the requirements of VR, but it is hoped that they will be met as the technology develops.

Summary

Multimedia technology is a technology for communication. It is well suited for applications

involving presentation of complex information on different media and requiring extensive user interaction. The application of multimedia technology will speed up and enhance the communication process through parallel use of different communication channels and more effective presentation of information.

Currently multimedia technology has applications in areas such as public information access, kiosk merchandising, business presentation and training.

The technology is reasonably developed and multimedia systems are commercially available. However there are still a number of technical issues need to be resolved before the full potential of the technology can be realized.

CHAPTER IV

PRODUCTION MANAGEMENT - AN OVERVIEW

Definition

Production management can be defined as "the management of the conversion process, which converts land, labour, capital and management inputs into desired output of goods and services" [Adam and Ebert, 1992].

Major Production Management Activities

The major activities in production management can be grouped into three areas, namely planning activities, organizing activities and controlling activities.

Planning activities include processes such as forecasting, product and sales planning, product and process design, capacity planning, location planning, layout planning, master production scheduling etc. Organizing activities include job design, work measurement, standard establishment and project management. Controlling activities include inventory control, material requirements planning etc.

Selected activities that are more relevant to this study are briefly described below. Readers may refer to the literature [Adam & Ebert, 1992; Fogarity et al, 1991] for detailed description of all activities.

Forecasting

Forecasting determines the aggregate demand anticipated by product groups after considering factors such as political, social, economic, technological, demographic and competitive conditions [Fogarty et al, 1991]. Forecasting can be performed at different time horizon to suit different needs. For instance long range forecasting (five years or more) provides input to long range capacity planning process while short term forecasting drives the master production scheduling process.

Product and Sales Planning

Product and Sales Planning determines at a macro level the product lines a manufacturing firm is to produce and the markets it is to serve. The Product and Sales Plans provide answers to questions such as what / where / to whom the firm is going to produce / sell and at what quality and price levels.

Product and Process Design

Product Design gives a detailed specification of the product such as its components, materials etc. Process design determines how the product is to be manufactured, e.g., whether it should be manufactured in a job shop technology or batch technology.

Capacity Planning

Capacity Planning is carried out to ensure that adequate production facilities are in place to meet the

demand anticipated by forecasting. If there is insufficient production facilities present, then new production facilities should be planned.

Location Planning and Layout Planning

During the detailed planning stage for new facilities, activities such as Location Planning, which produces plans for the location of production facilities, and Layout Planning, which produces plans for the layout of production facilities within a plant, are involved.

Production Planning

Production Planning produces plans for providing sufficient finished goods by period and meeting the sales plan objectives while staying within financial and production capacity constraints. Based on the output of the forecasting and other inputs such as management strategy and policy, manufacturing processes, efficiency and capacity of workcenters etc, a production plan stating the quantity of each product group to be manufactured in the planning periods is produced.

Resource Requirement Planning

Resource Requirement Planning (RRP) performs initial validation on the production plan to make sure that the resources required to carry out the plan such as labour, materials, facilities and equipment, and funds are available. These set the constraints of the Master Production Scheduling.

Master Scheduling

Master Scheduling produces a more refined plan on manufacture of specific items within a planning period based on the production plan. The refined plan is called the Master Schedule and includes information on Project On Hand (POH) inventory, Available To Promise (ATP) inventory and the Master Production Schedule (MPS).

Rough Cut Capacity Planning

Rough Cut Capacity Planning (RCCP) is the process to roughly determine if the capacity available can meet the demand of the MPS. If not then management has to take appropriate action such as arranging overtime.

Material Requirements Planning

Once the MPS is finalized, purchase and production plans for lower level items specifying what/when/how much to order and when to deliver etc can be produced based on the MPS, the inventory status and the Bills of Material. This process is referred to as Material Requirements Planning and is sometimes denoted as "little MRP" (mrp) or MRP I in order to distinguish it with Manufacturing Resources Planning to be covered later.

Capacity Requirement Planning

Capacity Requirement Planning (CRP) uses the output of mrp as input to compute the machine loading for each work station to verify that there is sufficient capacity to process all orders planned.

Shop Floor Control

The Shop Floor Control (SFC) function executes the planned shop floor activities, reports on the operating results and amend plans as need to ensure that desired results are achieved. The main functions of SFC are scheduling (assigning start and end times to orders), sequencing (assigning sequence in which orders are processed), priority control, queue length management (controlling lead time and work in progress and achieving full utilization of bottleneck work centres) and input/output planning and control (setting the acceptable performance level, measuring actual inputs and outputs and correcting out-of-control situations).

Inventory and Order Management

The function of Inventory and Order Management (IOM) is to control the actual execution of the plan produced by mrp. Tasks under the management of IOM include period or cycle counts, issue of documents for transfer of goods and inspections on goods received.

Manufacturing Resource Planning

Manufacturing Resource Planning, also referred to as MRP II or "closed loop mrp", is an integrated production information system that coordinates the production function with other areas in a manufacturing firm such as sales, purchasing, finance, and engineering by sharing data among and synchronizing the activities of these areas.

A MRP II system includes functions such as Business Planning, Production Planning, Master Production Scheduling, Material Requirements Planning, Rough-cut Capacity Planning, Detailed Capacity Planning, Shop Floor Control and Purchase Control.

Besides the production function, MRP II interfaces with the engineering function by sharing the engineering data database, the marketing function by accepting sales orders and providing delivery date projections, the finance function by providing data for estimating capital and working capital requirements, and the accounting function by providing information on accounts payables and receivables. [Adam & Ebert, 1991]

Just-in-time Manufacturing

Just-in-time (JIT) is a philosophy as well as a set of methods for manufacturing. Its emphasis is on reduction of waste, total quality control and devotion to customers. Shigeo Shingo of Toyota identified seven causes of wastes, namely, overproduction, waiting, transportation, unnecessary processing, stocks, unnecessary motion and defective products. By attending to these seven wastes, improvements can be achieved. [Adam & Ebert, 1991]

JIT is a 'pull' system. Products are manufactured only when orders are received from customers or when it is necessary to replace those products consumed by workcenters downstream in the production line. Such a system results in reduced inventory.

The 'pull' system is formalized by the Kanban system. Kanban, which literally means 'visual record', is a method to control the material flow within a JIT manufacturing system by using cards to authorize a work station'to transfer or produce materials. There are two types of Kanban systems. The Two Card Kanban system has a 'conveyance kanban' which authorizes transfer of materials and a 'production kanban' which authorizes the production of materials. The Single Card Kanban system has only a 'conveyance kanban' and no 'production kanban'. [Adam & Ebert, 1991]

The adoption of JIT has implications in many areas in a manufacturing firm. For instance, facility layout is affected since a JIT system usually employs a U-shape layout plan to reduce the movements of the workers between workstations so as to reduce the number of workers required to attend a given number of machines; the machines should be more flexible in manufacturing different product models and machine set up times need to be minimized; workers need to trained in handling different tasks and suppliers need to shorten their delivery time etc.

Computerized Production Information Systems

Definition

As mentioned previously, effective and efficient management of production information is essential for success in managing a manufacturing firm. Computers have been used to implement computerized manufacturing

information system (or production information system) for some time.

For the purpose of this study, a production information system can be viewed as a computer based system that helps production personnel to make decisions, carry out simulations and optimize factory operations [Sartori, 1988].

Benefits

The potential benefits of a production information system are many. For instance,

- Faster and better simulation leading to better quality decisions
- Better communication among different parts of the manufacturing firm via the system leading to more unified actions
- Better sharing of information through shared database
- More up to date information through real time update of the database
- Extension of order policies to all parts instead of the more expensive items is now possible due to the fast processing speed of computer.

Typical Production Information System

A typical production information system consists of functional components that corresponds to the production management activities described in the previous sections.

A detailed description can be found in the literature [Sartori, 1988; IBM, 1972].

An example of a commercially available production information system is the Manufacturing PM II (MPM II) is an online MRP II system supplied by Software PM. The system can run on a number of hardware platforms including IBM AS/400, AS/ENTRY, System/36, PS/2 and RISC System/6000 and is consisted of a number of software modules such as Standard Product Costing, Product Data Base, Master Production Scheduling, Material Requirements Planning, Capacity Requirements Planning, Customer Order Management, Stock Locator, Inventory Control, Physical Inventory Management, Shop Floor Control, Shop and Inventory Costing, Purchasing, Job Accounting and Financials.

Implementation Issues

Although computerized production information systems have been around for some time, there are still a number of implementation issues. For instance, Maloney [Maloney, 1990] stated two fundamental problems with the MRP II system, namely, the inconsistency between the MRP II system and the business requirement, and insufficient analysis or customization inventory requirements and policies.

To make the MRP II more effective, he suggested that one should (i) ensure that the system strategy is appropriate to the business, e.g., a distribution business will require a distribution requirements planning system; (ii) produce separate plans for

different products' inventory requirements; (iii) ensure that basic data such as BOM, routings etc are accurate; (iv) develop operating plans that are within the operation's capacity; and (v) ensure that conflicts within the firm will not become obstacles for delivering goods from manufacturer to consumer. The information supplied to the computer system must be of high quality to avoid the "garbage in, garbage out" situation.

Clipp [Clipp, 1990] also stressed the need of high quality data in successful MRP implementation and emphasized the importance of management commitment, training and education, and data integrity.

Lubar [Lubar, 1990] identified several technical deficiencies of many existing MRP II packages which he believed should be improved in the next generation of MRP II systems: (i) obsolete user interface. The user interface of some of today's MRP systems is still based on keyboard input which is not user friendly (by today's standard) and time consuming. Also screen navigation is not as convenient as possible since user has to exit the current screen in order to enter into the next screen. (ii) non-integrated system. This leads to a number of problems such as unsynchronized product releases, sub-optimal interfaces among system components, no real time updating because of redundant data in database, redundant data entry, difficulty in using the system due to different user interfaces for different system components. (iii) hardware platform dependent.

On the functional side, Lubar suggested that (i)

more functionality should be provided in shop floor management area; (ii) more JIT related features should be provided; and (iii) rather than just providing a all purpose package that requires every details to be entered, the new systems should allow experienced users to skip the irrelevant details in order to expedite transaction processing.

The Trend

The Introduction of New Tools

As the production environment becomes more complex, more production information will need to be managed. New tools will be introduced to perform this task. For instance, Northern Telecom has employed an expert system called Engineering Change Manager to reduce the cycle time and documentation required to process product design changes. Campbell's Soup has used similar technology to analyze process control data to ensure that their products can meet the regulatory requirements. [Taramina, 1990]

Convergence of MRP II and JIT

Previously there was a misconception that MRP II and JIT were mutually exclusive and that MRP II systems should be migrated to JIT because the latter was superior. A more recent view is that the two can co-exist and support each other. Shankle believed that the manufacturing environment is a continuous spectrum with the pure job shop at one end and a repetitive production

line at the other. Most shops that fall in between can benefit from a mixture of MRP II and JIT [Shankle 1992]. Louis also described the implementation of the Material Acquisition System, which combined Material Requirements Planning, Kanban concepts, bar coding and electronic data interchange [Louis 1991].

Further Integration in the Manufacturing Firm

Further integration of various functional areas within a manufacturing firm will also occur. Norman envisioned that as simulation tools are becoming more and more user friendly, managers as well as workers will use simulation to a greater extent and eventually the simulation tool will contain all the production rules of the manufacturing plant under simulation and effectively becomes the control system linking up various areas of the production [Norman, 1992].

This further integration will help to achieve Computer-integrated Manufacturing (CIM), which is defined as "computer information systems utilizing a shared manufacturing database for engineering design, manufacturing engineering, factory production, and information management" [Adam & Ebert, 1992].

In the longer term, Jain believed that MRP II, CIM and EIS (Executive Information System) will form an "enterprise solution" that further integrates the management, planning and operation functions of a manufacturing firm [Jain 1991].

Summary

Production management consists of many activities, each of which requires a lot of decision making. Production managers have to access and interpret a lot of information in order to make effective decisions.

To cope with the situation, computerized production information systems have been used. However there are still a number of issues. Some of these issues are directly related to the systems, such as obsolete user interface and poor screen navigation. The others are related to implementation, such as poor data accuracy.

CHAPTER V

INTERVIEW REPORT

Two interviews have been conducted: one with the MIS Manager of the Rototech Group and one with the Corporate Development Manager of the Kitty & Kettie Supermarket Limited. The Rototech case is reported in greater detail because of its relevance in the manufacturing environment.

Rototech

Rototech is a US based firm owned by Chinese and American Jews. It has three major product lines: electrical hardware such as power strip, electrical appliances such as chopper, and devices such as circuit breakers. It has offices in US and Hong Kong and production facilities in Shen Zhen, PRC. About 500 workers are employed in PRC.

The firm is implementing a MRP II system which is developed by Singapore and runs on a SUN Microsystem with UNIX operating system. The first phase of implementation is inventory control. Production planning and control will be addressed later.

Under the current implementation, workers are requested to input the inventory data at the PRC site. The data is then transferred to Hong Kong through a 2400 bits per second telephone wire and finally input manually

into the system.

The major problem encountered at present is poor data accuracy, which is due to a number of reasons such as frequently changing part numbers, human errors in reading and typing, resistance from PRC workers as they see the inventory data entry as an extra task, and inadequate experience in material control in PRC site. Due to this problem, the implementation is still at the data validation stage at the time of the interview.

Kitty & Kettie Supermarket Limited

Kitty & Kettie is a local supermarket chain. It has an in-house developed inventory control system which keeps track of the inventory status at the central stores. Inventory is classified into three categories according to their price and volume. Similar to Rototech, one problem that they have encountered in implementing the inventory control system is inaccurate inventory data caused by reasons such as data input error.

Summary

Though Rototech and K & K Supermarket Limited are of different business nature, they have encountered similar problems in production information management, namely, data accuracy.

CHAPTER VI

MULTIMEDIA TECHNOLOGY IN PRODUCTION INFORMATION MANAGEMENT

The Role of Multimedia Technology in Production Information Management

Based on the information in previous chapters, the author believes that multimedia technology should have an important role in production information management.

In the short term, it can help to resolve issues of existing production information systems by providing better user interface for quicker and easier information collection / retrieval and better information presentation. This will reduce the resistance of users, decrease the chance of input errors and enable better and quicker comprehension / interpretation of information. The results will be better data quality (more up to date, accurate, consistent data) and more effective decision making. In fact there are already some multimedia applications in production information management on an adhoc basis. Some of these applications are described in the next section.

In the longer term, as multimedia technology develops, the author believes that it can change the way products are designed and manufactured. The section

following next describes some of the opportunities that exist.

Existing Applications

Training

A common application of multimedia technology is training and such application has also been found in the production environment. Bethlehem Steel, a Pennsylvania company, offers more than 60 interactive video courses in various technical areas [Strothman, 1991]. CDT Micrographics has built a simulation and training application for a paper mill factory which allows the trainees to learn how to run a plant without the risk of running into real trouble [Semich, 1992].

User Interface

As reported previously, the user interfaces of some existing production information systems are obsolete. Obsolete user interface will lengthen the data entry time as well as create resistance from users. The result will be outdated and inaccurate data, which is one of the major problems encountered in implementation of production information systems.

Multimedia technology can solve this problem by providing better user interface to speed up data entry time and reduce user resistance. Actually work has already begun in this area. For instance, Eloranta [Eloranta, 1988] described how techniques such as interactive graphics and hierarchical representation of

objects (e.g. the product structure as documented by the Bills of Materials) could be employed in production information system user interface to enhance the data representation.

Data Collection

Poor data quality is a major problem in the implementation of production information systems. A number of data collection technologies such as bar coding, magnetic stripe, radio frequency data communication, voice recognition and optical character recognition allow data to be input into the production information system more effectively and result in better data quality. Production areas such as inspection and inventory will benefit most from these technologies. [Moore 1990; AIM-USA 1992]

Production Information Retrieval

Production personnel such as technicians and engineers need to access production information such as specifications, drawings, figures and process descriptions in order to perform their tasks. With the increasingly complicated production environment, there is an information overload situation and the conventional way of storing and retrieving these data is no longer effective. Hosni and Okraski [Hosni & Okraski 1992] has developed a hypermedia system (one form of multimedia system) to store and retrieve production information for the Orbiter Processing Facility at Kennedy Space Centre.

Order Processing

Order processing can be considered as a multimedia application in production information management that combines enhanced data collection, improved user interface and better information retreivel.

For large manufacturing firms, it is not uncommon to have hundreds of products, each having its own product structure with thousands of parts. It would be very difficult to visualize the product structure from a BOM presented in the conventional form. It would also be very tedious and error prone to handle such a large number of products and parts by using the part number alone. Through the examples below, it can be seen that multimedia technology can help to reduce the input error, speed up the input process and provide a better user interface.

Italian motorcycle manufacturer Ducati has developed a computerised parts catalogue based on the Apple Macintosh that demonstrates the potential of multimedia technology in this area. Ducati's dealers can display drawings of the motorcycle and look for further details of a particular part by clicking on the part in the drawing displayed. When a dealer points to specific parts the system will prompt the dealer with part name and number and automatically build an order form, which will be downloaded to the host for further processing at the end of the day.

A similar system was used by the office furniture manufacturer Steelcase Strafor to build order forms and

to train the distributors. Like the Ducati's system, Steelcase Strafor's dealers can complete an order form by selecting products from the electronic multi-media catalogue. This eliminates the trouble of finding the correct order codes from the printed brochures, which could be a difficult task given the over 200,000 product combinations. In addition, the Steelcase's system uses animation and voice to train its distributors how to install its furniture. [Meiklejohn, 1990]

The Opportunities

Continual Enhancements to Production Information Systems

As technology develops, multimedia technology will continue to enhance existing and new production information management systems. For instance, the emerging use of expert systems for production information management [Taramina 1990; Biegel & Wink 1989] will be further enhanced by the use of multimedia technology for better knowledge presentation [Sipior & Garrity 1992]. The application of multimedia technology such as superb animation and voice technology in simulation tools will greatly enhance the user-friendliness of such tools and will allow untrained personnel such as managers and workers to operate such system as well as to build simulation models. This will ultimately result in the integration of the whole factory via the simulation tool [Norman, 1992]. The use of virtual reality in training will allow the trainees to have more realistic experience

of the subjects being trained without the need for on the job experience. [Norman, 1992; Hamilton et al, 1992]

Inter-Workgroup Communication

With further development of video conferencing, engineers / design personnel at different geographical locations can meet together via the communication network to perform tasks such as joint product design and prototype development. This will greatly reduce the travelling time and allow the best personnel in different locations to work together. The result will be reduced cost, shortened design lead time and better design quality. [Norman, 1992]

Product Design

The use of tools such as simulation and 3-D graphics has greatly improved the quality of product design and reduced the design cost. The use of virtual reality in product design will allow faults in the design to be spotted at the early design stage without the need of expensive prototypes. The result is reduced cost, shortened lead time and improved quality.

In fact there are already experiments in using virtual reality to this area. For instance Chrysler has worked together with IBM to use a VR system to design a 1997 Chrysler and Northrop Corp. has used the same technology for the redesign of the F-18 fighter jet. [Hamilton et al, 1992]

Remotely Controlled Manufacturing

An interesting application of VR in production is the "Telepresence", a VR tool that performs remote equipment manipulation. With this tool, an operator can perform industrial tasks through a robot located at a remote site. [Hamilton et al, 1992] This allows cheap / experienced labour to operate a plant located remotely. The result will be reduced manufacturing cost and / or better product quality.

Summary

In the short and medium term, multimedia technology can enhance existing and new production information systems to resolve some existing implementation issues such as poor data quality and user resistance.

In the long term, multimedia technology will change the manufacturing process itself. Products are designed by designers worldwide, making best use of these scared talents. Decisions are made quicker and better through the improved user interface of production information systems. Communication within the firm is greatly enhanced with new communication technology. Factory operations become more coherent through the improved simulation tool. Workers are trained more effectively through multimedia training applications. Manufacturing can be performed remotely to make best use of well trained operators. All these will result in reduced costs, shortened time and improved quality and will enable a manufacturing firm to operate at a global scale.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

While multimedia applications in areas such as training and marketing have received a lot of attention, the application of multimedia technology in production information management is still in its infancy and not much effort has been spent on this subject, as reflected by the small number of related works in the literature.

Having said that, multimedia applications in production information management do exist today, albeit on an adhoc basis in customized and specific applications. In an effort to explore the potential opportunities of multimedia in production information management, the author has collectively identified areas in which the multimedia technology can contribute. In the short and medium term, these include areas such as user interfaces, data collection, production information retrieval and training. In the long term, opportunities exist in areas such as product design, inter-workgroup communication and remotely controlled manufacturing.

Multimedia technology should in the shorter term help to enhance existing and new production information management systems. In the long term, it will change the way products are designed and manufactured and will enable manufacturing firms to make best use of resources

at separate geographical locations. The benefits are reduced cost, reduced lead time and better product quality.

The author hence concludes that multimedia technology should have an important role in production information management. However there are still a number of technical issues to be solved in order to realize the full potential of multimedia technology. These include technological advances in faster CPU, bigger and faster storage, faster networking technology, improved data compression algorithm, internationally accepted standards, and improved input / output devices.

In this report, the author has identified the role of multimedia technology in production information management. To further the understanding on the subject, the author recommends that further studies should be performed in the following areas:

1. Local (HK) specific issues and characteristics. Most materials presented in this report are based on literatures published in foreign countries. Study in this area will bring the subject into the local environment of Hong Kong.
2. Feasibility on generalized software packages. Most applications described in this report are customized solutions. Manufacturing firms that do not have the resources to build customized solutions will have to rely on software vendors to build multimedia capabilities into their packages in order to benefit from the technology. The current

offerings and trends of the software vendors in the market and the demand of the users should be studied.

3. Cost-effectiveness studies. Multimedia technology will benefit the production information management, but there is a cost associated with it. The situations under which the use of multimedia technology is cost justified should be covered.

These studies will focus the issue more on the Hong kong environment. They will also help the suppliers of multimedia products and production information systems in Hong Kong to plan their products and make the Hong Kong manufacturers aware of the opportunities brought along with the multimedia technology and help them justify the investment.

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Interview

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