

IMPLEMENTATION OF INTEGRATED MANUFACTURING SYSTEM

2-25/00

Thesis submitted in partial fulfillment of the requirements for the award of the
degree of

MASTER OF ENGINEERING IN MECHANICAL ENGINEERING

(INDUSTRIAL ENGINEERING)

of BHARATHIAR UNIVERSITY

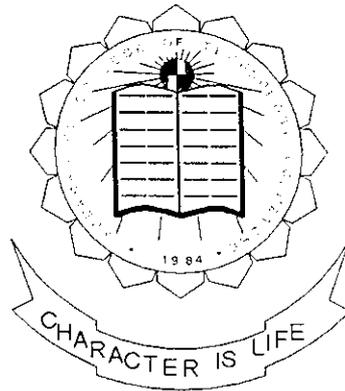
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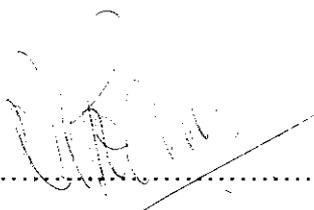
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During the year 1999 – 2000


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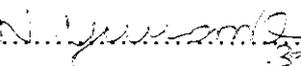
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CERTIFICATE

This is to certify that Mr.G.Venkatachalapathy, a post graduate student specialising in Industrial Engineerig of Kumaraguru College of Technology, Coimbatore 641 006, Undertook a project work "Implementation of Integrated Manufacturing System" as a part of his academic requirement from June 2000 to December 2000 in our organisation.

It requires an efficient like approach of the existing system which is taken for the project work to find the solution. I find his work is systematic and very useful to the organisation.

This project was partialy completed and the performance was good. His project results have been implemented in stores and purchase which yields a remarkable result.

for **STATEX ENGINEERING (P) LTD.,****(K.SUBRAMANIAM)
MANAGING DIRECTOR.***All Correspondence to Administrative Office*

The author wants to thank the dignitaries, whose efforts provided this opportunity to him with the entire boost. These dignitaries were **Dr.K.Padmanaban**, Principal, KCT, Coimbatore, **Dr.A.Mohanakrishnan**, HOD, Mechanical Department, KCT, Coimbatore, **Dr.E.Vallinayagam**, Professor, Post Graduate Studies Mechanical, KCT, Coimbatore, **Mr.K.Subramaniam** M.D, Statex Group of Companies, **Mr.V.Duraiswamy** Vice President (Tech), Statex Electronics, Coimbatore.

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Prof.N.Gunasekaran, M.E., MISTE, MIIIE, Asst.Prof (Mech), K.C.T, Coimbatore, the guide provided the author with the time, inspiration, guidance and support that brought this thesis to completion.

Mr.V.Shanmugam, Manager, Production, Statex Electronics, Coimbatore, the external guide gave the author his great time and suggestions which built him confident to go on with this project.

Then there was the Group of people that the author called upon for clarification **Mr.D.Senthil Kumar**, G.M.Sales, Statex Electronics, Coimbatore, **Mr.Yuvanathan**, Manager, Accounts, Statex Electronics, **Mr.Selvaraj** Asst. Manager, Production, Statex Engg. Company.

The author thanks the family members who gave mental support to complete this Project.

The author will try his best to hold his feelings for the above for ever

G.VENKATACHALAPATHY

The corporate pursued the route of custom development to meet their Information Technology requirement, till the mid 1980's.

Continuous changes in market, Organization, and technology along with evolving business needs forced many companies to reevaluate and modify their business processes through Business Process Re-Engineering.

Gradually increasing cost and complexity of maintenance, modification and enhancement of custom-built applications forced corporate to adopt packaged applications as the solution of late 1980's.

The cost and effort involved in integrating different best breed solutions from multiple vendors (various departments in the organization) led companies look for an entire integrated suite of applications from a single vendor.

To achieve low-cost producer status, companies also started seeking for some form of global supply chain management through some software that integrates order-taking, design, resource management, manufacturing, distribution, logistics and finance.

An attempt has been made in this thesis to Integrate the various quality data captured as a part of daily management such as inspection records, Product non conformities and site feed back. The data thus captured will be integrated into a common database for effective analysis and identification of corrective and preventive actions to prevent recurrence of problems.

This thesis would logically adopt the standard Computer languages and statistical techniques to process the data leading to meaningful information that can be fed back into the process for improvement. It is felt that such integration of quality would help in identifying and prioritising the improvement efforts for effective results.

DC	-	Delivery Challan
MM	-	Materials Management
PM	-	Personnel Management
QA	-	Quality Assurance
ABC	-	Always Better Control
BOM	-	Bill of Material
GIN	-	Goods Inward Note
Mfg.	-	Manufacturing
MIS	-	Management Information System
MPS	-	Master Production Planning Schedule
MRP	-	Manufacturing Resource Planning
PPC	-	Production Planning and Control
ROL	-	Re Order Level
SOP	-	Sale Order Process
WIP	-	Workorder In Process
CENVAT	-	Central Value Added Tax
R.R.A	-	Resource requirement Planning
S.F.P.C	-	Shop Floor Productivity Control
S.F.S.C	-	Shop Floor Scheduling & Control

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Today people have satisfaction with the Product / Services only when they assure high quality product at competitive price. Customer's awareness about the products and services are growing very rapidly. Nowadays people have compared the quality of the products with the global quality.

Quality as the name implies is an important characteristic associated with any product or service. The simple definitions for "Quality" are "Fitness for Purpose", "Conformance to specified requirements" etc. However the American Society for Quality Control (ASQC) defines Quality as:

The totality of features and characteristics of a product / service that bears on its ability to satisfy the stated or implied needs.

Quality is all-pervasive. It must be built into the design, selection and production processes, if they are to deliver the required performance. Doing the right things is the most effective course of action.

Quality is therefore a strategic issue in all organization and provides a business ethos, which encompass customer satisfaction, profitability and efficiency. Quality is achieved through a committed and motivated work force supported by an enabling management framework.

Quality conscious of the people working in all levels of organization is very essential to achieve Total Quality. The Indian scenario changes drastically because of competition in the global market. Hence Total Quality Management (TQM) has become a part of every company's strategic planning activities.

To achieve TQM, it is necessary that each and every department of the organization have to have quality conscious. A small deviation of quality in a sub system of an organization may lead a big problem in the final product. Hence the quality is everybody's concern.

A revolution is taking place in many countries on the management of quality aspects with the introduction of formal quality systems such as ISO 9000 & 14000. Hence the companies are planning to win over the customers by delivering defect free products and services. The people are talking about world class quality in every product / service in India.

Hence, the management has to identify and take preventive steps in order to achieve, Total Quality. The decisions made should continuously improve the quality. Commonly in all manufacturing systems, they are having their own system of quality and data recording. The decision for quality problem will be made based on the data captured in the stages of manufacturing. The data thus captured will be integrated into a common database for effective analysis with the help of statistical tools and a standard computer language. This study aims at such a kind of integration to identify the corrective and preventive measures to avoid the recurrence of the quality problems.

The quality system is studied and the above thesis is carried out at STATEX ENGINEERING COMPANY, COIMBATORE.

Statex Engineering Company (p) Ltd., is a Small Scale Industry located at Sidco Industrial Estate, Coimbatore. It has been established twelve years ago to produce just three testing Instruments required for textile Mills.

To day, it has grown up in such a way that, it is one of the two companies which produce complete range of testing equipment's from Wrap block to the High volume instrument required for textile mills. Some of the products, produced from Statex Engineering Company with their uses in the mills are explained below: -

- 1) **Trash Separator:** It is used to determine the trash contents of the cotton.
- 2) **Nep Counting Template:** This instrument is used to find the Nep content in the Card Sliver.
- 3) **High Volume Instrument:** It tests and analyzes the fiber characteristics of cotton like span length and its uniformity, strength, Elongation, Maturity, Ratio and its percentage, Micronaire and fineness.
- 4) **CSP System:** It gives print out results of cotton which contains count, statistical value of Mean, Minimum and standard deviation, confidence limit with corrected values for temperature and humidity.
- 5) **Tensostate:** It is the instrument used to measure the elongation of the cotton.

Now Statex Engineering has the capacity to produce more than 62 types of testing instrument.

R & D Wing: It has a very strong R&D base with a group of young dynamic and innovation engineers.

Service Wing: It has an excellent servicing wing with effective after-sale network, manned by highly qualified technical personnel for best maintenance and spare support for customers. At present it has four service centers at Coimbatore, Mumbai, Ahmedabad, and New Delhi in India.

Pilot Mill: The installation of a Pilot Mill with 6100 spindles capacity having latest technology machines of good combination has facilitated to use our R & D team for conducting field trials with in house but customer environment.

Human Resource: Statex Engineering Company at present has 82 employees including staffs.

It has two-sister concerns to feed the component for the machines produced at Statex Engineering Company. Sister concerns are: -

- 1) State engineering (P) Ltd. with the Manpower of 110 employees.
- 2) Dhansu Engineering (p) Ltd. with the manpower of 27 employees.

3.1 QUALITY SYSTEM

The quality system comprises the “organisational structure, procedures, processes and resources needed to implement quality management”.

The purpose of a quality system is to enable an enterprise to achieve, sustain and improve quality economically. Quality does not happen by change: it has to be managed. Quality systems organise resources so as to achieve certain objectives by laying down rules and an infrastructure which, if followed and maintained, will yield the desired results.

The quality system is perceived by many as nothing but a large collection of documents leading to the ultimate bureaucracy. Most elements of the ISO 9001 standard refer to documents that need to be in place, but the extent and complexity of documentation is left to the professional judgement of the persons creating the system. The most important documents to be developed for a quality system are documents on situations where control has been lacking.

The quality system typically provide the basis for integration of organisational information processing. Individual applications within the system are developed for and diverse sets of users. If there are no integrating processes and mechanisms, the individual applications may be inconsistent and incompatible.

Data items may be specified differently and may not be compatible across applications that use the same data. There may be redundant development of separate applications that use the same data. There may be redundant development of separate applications when actually a single application could more than one need. A user wanting to perform analysis-using data from two different applications may find the task very difficult and sometimes impossible.

The first step in integration of diverse information system applications is an overall information system plan. Even though application systems are implemented one at a time, their design can be guided by the overall plan, which determines how they fit in with other functions. In essence, the information system is designed as a planned federation of small systems.

Information system integration is also achieved through standards, guidelines, and procedures set by the MIS function. The enforcement of such standards and procedures permits diverse applications to share data, meet audit and control requirements, and be shared by multiple users. For instance, an application may be developed to run on a particular small computer. Standards for integration may dictate that the equipment selected be compatible with existing computers and that the application be designed for communication with the centralised database.

The trend in information system design is toward separate application processing from the data used to support it. The separate database is the mechanism by which data items are integrated across many applications and made consistently available to a variety of users.

3.2 FUNCTIONS OF ORGANIZATIONAL SUBSYSTEMS

Because organisational functions are somewhat separable in terms of activities and are defined managerially as separate responsibilities, MIS may be viewed as a federation of information systems-one for each organisation. There may be common support systems used by more than one subsystem, but each functional system is unique in its procedures, programs, models, etc. Typical major subsystems for a business organisation engaged in manufacturing are shown in Table 1.

Table No: 1 **MAJOR SUBSYSTEMS FOR A BUSINESS ORGANISATION**

S.No.	Major functional subsystem	Some typical uses
1.	Marketing	Sales forecasting, Sales Planning, Customer and Sales analysis.
2.	Manufacturing	Production planning and Scheduling, Cost control analysis.
3.	Logistics	Planning and control of Purchasing, Inventories, distribution.
4.	Personnel	Planning personnel requirements, analysing performance, salary administration.
5.	Finance and accounting	Financial analysis, cost analysis, capital requirements planning, Income measurement.
6.	Information processing	Information system planning, cost-effectiveness analysis.
7.	Top Management	Strategic planning, resource allocation.

The database is the primary means of integration of the various subsystems. A data item that is stored or updated by one subsystem is then available to the other subsystems. For instance, the sales and inventory information used by the marketing subsystem is supplied through the logistics subsystem; the same data is used by the manufacturing subsystem for production planning and scheduling.

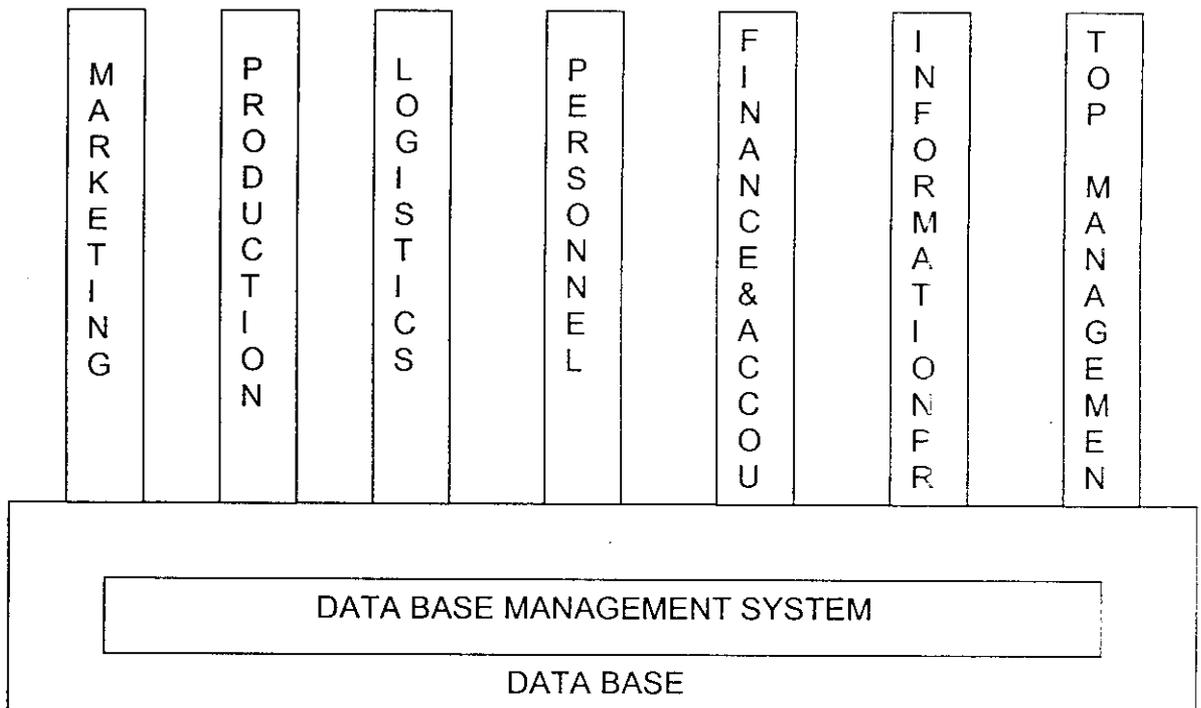


Fig 1. DBMS OF THE BUSINESS ORGANISATION

3.3 FUNCTION OF EACH SUBSYSTEM IN THE INTEGRATED MANUFACTURING SYSTEM

3.3.1 Material requirement planning (MRP I)

Material Requirement Planning is often considered to be subset of inventory control. It is also useful in production scheduling and purchasing of materials.

3.3.2 Manufacturing (MRP II - Manufacturing Resource Planning)

Manufacturing Resource Planning is computerized integrated Production, Material Planning and Control System.

It has got facilities for accepting feed back and carrying out corrections and rescheduling the production and material requirements.

BASIC MANUFACTURING DATA:

Bills of Materials:

Bills of Materials are created for each manufacturing item and list the components that are part of them. The quantity required and the materials are to be defined.

The functions of Bills of Material include: -

- a) It will log the engineering changes.
- b) Material quantity to be calculated.
- c) Effective date
- d) References
- e) Variants
- f) Single / Multi level Bills of Material

Routing:

There is a description of the process that the item has to go through to be completed in the operation file. Each operation is connected to additional information, to fully describe the procedures, with options for:

- Ultimate operation list
- Connected tool numbers
- Overlapping operations
- Yield
- Lead time calculation and critical time

Work Center information:

All available production resources are maintained in a master file, where each resource is defined.

The file holds information needed for capacity management and loading.

The data stored in this file includes normal capacity, number of machines /operators per job and time costs.

- Capacity (number of resources (machines), shifts, hours per shift, degree of utilisation.
- Work center calendar (hours per day)
- Number of machines / operations per job
- Fixed and variable cost
- General queue and waiting time,
- Sequencing options
- Production statistics (down time, waste and scrap etc.)

Cost Code:

Production costs are stored in a master file, for easy updates. The file defines the cost per hour for work, machines and tools.

- Salary costs and salary related costs
- Machine costs
- Material cost
- Tool cost

Tool Information:

In most cases it is important to manage and control tools. Each tool can define the information such as

- status of the tool
- stock position
- costs
- check up internals
- degree of utilisation

Integration:

This module can be integrated with Stock control, Purchase control and Sales Order.

3.3.3 Costing

Product costing / actual cost

Knowing the Production cost is critical. This module gives more capabilities of calculating costs for manufactured items and the ability to analyse the same.

The costing module is the tool for standard cost calculations as well as for issuing quotation for individual order.

Cost Elements:

The following are the elements of calculating the cost: -

- Direct material
- Salary cost for set up time and run time
- Machine cost for set up time and run time
- Tool cost
- Subcontractors cost
- Cost of building
- Cost of power

Standard cost:

The system can calculate the standard cost, based on the costing model connected to each item.

We can simulate different versions and save values for the current, previous or next year.

What if scenarios are easy to perform, by changing bills of material and operation steps for each simulation?

Quotations:

It is very easy to make quotations with module. The quotation function lets you use any costing model, enter the required quantity and adjust materials or operations to meet the customer's demands.

The total cost of each quotation will be presented on screen, or can be printed out, while separating material and operations for easy analysis.

Actual Cost System:

The benefit of the Actual cost system is that it shows what it actually cost to produce certain item. It is excellent tool for analysing the costs for the items produced. We can compare the actual cost with standard cost and analyse the variance.

Input for Actual cost calculations is:

- Actual time taken by the operator
- And materials used.

Accounting:

Each reported event (material usage time spent and completed work order) creates an accounting transaction.

This accountability can be used for analyzing purpose.

Integration:

This module requires stock control, Integrated with purchase, Manufacturing data and Sales Order.

3.3.4 Master Planning

It translates demand forecasting into Master Production Schedule (MPS).
MPS helps the Management in the following areas: -

- a) To authorize and control work force level.
- b) Inventory investment.
- c) Capacity planning.
- d) Cash flow.
- e) Customer Service Planning
- f) Capital Investment Planning
- g) To calculate profitability
- h) Material requirement Planning

Inputs for Master Production Scheduling are:

- i) forecasting
- ii) inventory
- iii) safety stock level

The purpose of Master Planning is to evaluate and to prepare material and capacity requirements based on forecasts and actual sales order backlog.

Forecasts:

Forecasts are calculated for individual items. Distribution over time is done with user defined distribution curve.

Forecast can be calculated based on the following data: -

- i) Quantity consumed for products.
- ii) Quantity consumed for spares.
- iii) Quantity consumed for services.

Material requirements:

In MRP II system, computer calculates the gross material requirements for purchased or manufactured items based on forecast (or) customer orders in hand. This is a rough purchase and manufacturing schedule, which is the basis for long time plans.

Capacity requirements:

Based on the forecast quantity, machine hour requirement, manpower and subcontractor resources are calculated by the computer. Computer calculates the current requirements for changed capacity in each work center, by changing degree of utilisation or adding another shift.

3.3.5 Materials Requirement Planning

Forecast quantity, customer orders Physical stock available in stores, WIP and order pending with purchase are to be integrated for MRP.

This function helps to survey the future needs for purchased raw materials and manufactured sub assemblies. For example, we can calculate the material requirements needed to realise a complete production plan.

Gross Requirements planning:

Based on forecast or customer orders the gross requirements of raw materials, components and sub assembly are to be planned. At this stage current stock at stores or planned receipts are not considered.

Summarized list of Materials:

This analysis will show you the amount of material needed to realise specific production program, such as forecast or customer order on hand. The stores stock and expected receipts are shown. From this we can deduct the materials required to complete the pending orders. Thereafter we can sum up the final material required for any length of time.

MRP stage by stage:

Considering the physical stock at stores, forecast quantity, reserved materials and customer orders and production level, the system will indicate the shortage items over a period of time. The planner will, in dialogue with the system creates a work order for further processing.

MRP Total:

The total MRP calculation automatically gives a suggestion for work and purchase orders (planned). The result of the MRP is presented in the following ways:

Order planned with suggestion about what is to be produced or purchased. The list can be sorted from shop capacity and the total MRP.

Load:

An additional output from MRP calculation is the loading chart. It displays the capacity needed to realise the planned work orders.

Releasing work order and Purchase proposals: In the work order-planning module, planned orders can be released according to production schedule. The system will provide to change the ordering quantity or cancel the orders according to the actual movement. Purchase proposals also given from this module and based on this necessary purchase order will print from purchase module.

Integration:

This MRP requires integration of forecast quantity, (based on sales proposals) stock quantity, shop capacity, purchase control.

3.3.6 Work Order Planning / Production Activity Control

This module helps to manage

- a) progress of work orders from creation to completion
- b) Work orders are entered from either Sale order module or Forecasting module.
- c) In a make to order environment, we can modify the expanded bills of material and the work order routing. (to be computerise)
- d) Possibility to schedule forward or backward.
- e) Last minute analysis of activity / load and material is available on line.
- f) As a result we can make reschedule or priority the work order

Once production resources are well defined in terms of staff, machines, tools and Bill of Materials, we have to use these resources to their limit. Production activity control helps to plan, follow up and analyse the work orders. Work order can be released from the requirement-planning module. When a work order is released necessary materials are reserved and available capacities of the work centers are automatically reduced.

Creating a Work Order:

Work orders can be created automatically from the requirement calculations.

When entering a work order, we can change the materials needed and alter the operations to suit the present requirements.

The work order contains the following information:

- a) Work Order No.
- b) Component Drawing No.
- c) Description
- d) Raw material required
- e) Quantity - Machine
- f) Sequence of operations involved with necessary work centers.
- g) Time required (set-up time and process time) for each operations.

3.3.7 Material Requirement Planning

It translates MPS in to manufacturing and purchasing plan factors to be considered are:

- a) lead time
- b) lot size
- c) shop calendar
- d) planned engineering changes
- e) inventory status

3.3.8 Capacity Requirement Planning

This function combines:

- a) planned load from the MRP process with
- b) the released work orders from production control

It merges to needs and compares them with the available capacity in terms of daily or weekly load per work center.

3.3.9 Shop Floor Control

It manages the execution of work orders by providing tools to balance the flow of resources, raw materials and sub assemblies.

Major functions of Shop Floor control: -

- a) Assigning priority to each work order.
- b) Despatching the materials to the next workstation or Assembly.
- c) Print out of work order documents. (this to be transferred to planning)
- d) Provide work in process information.
- e) Updating order status.

Shop floor supervisor will be aware of production changes and special operating instructions by simply consulting the screens.

3.3.10 Statistics

It saves all the information from where you can get the information.

Present on lists or in graphical format.

It gives information about: -

- a) work orders
- b) quantities
- c) Down time with reasons.

3.3.11 Integration

It integrates the following:-

- a) Stock control
- b) Purchase
- c) Sales order

3.3.12 System Requirement

Files to be generated and integrated:

- a) Bill of Material
- b) Items master
- c) Process Master with process time
- d) Machinery's file

3.3.13 Sales Order and Invoicing

Quotations:

First entry to a particular sale may be the quotation.

This function allow for three different customers per quotation namely

- a) Ordered – by
- b) Invoice – to and
- c) Delivery to the customer

When the customer accepts the quotation, it can be automatically convert in to an order.

Orders:

Either quotation can be converted in to order or direct order can be booked.

Delivery date to be mentioned in the order.

Delivery planning system alerts you if deadlines can not be met.

Order includes variants and other, manufacturing details.

Order can be directly copied from quotation file or from current order backlog to make entry easy.

Deliveries:

Based on a delivery proposal, the system will produce all the necessary Documentation, which includes:

- i) Invoice
- ii) DC
- iii) Number of cases and so on

Reports:

The sale order module gives you a number of reports where you can select and sort and sort the information you need.

If we linked to the stock reports and stock control module, this report helps to improve the flow of goods.

Integration:

The sale order module requires sale ledger, which integrated with

- a) Manufacturing
- b) Purchase Control and
- c) Stock Control.

3.3.14 Sales Ledger

Customer master file:

The customer master file contains the general information about the Customer. Generally it contains the following data:

- a) Customer code
- b) Customer name
- c) Address for delivering
- d) Address for communication

We can group the customer in several divisions for example we can group the customers on area wise to have a good marketing activities.

Using a simple template can enter new customers.

Invoicing:

- a) Invoice data's are automatically transferred to the Sales Ledger.
- b) As you print the invoice journal (every day), which contains a summary of all invoicing for a particular period, the accounts in the general ledger are updated.
- c) A single invoice can be made for more than one order.
- d) The legal aspects and sales tax handling are catered by the Invoice Journal.

Balance Summary Report:

- a) The most important report in Sales ledger is the Balance Summary Report.
- b) This will indicate the age of the order.
- c) This will give consolidated items to be supplied.
- d) Total value pending
- e) Based on balance item, the system will print letter with extending dates.

Payments:

The system can provide with payment forecasts, by taking the customers payment habits into consideration. All Invoices are stored in the invoice ledger and system will propose and print reminders to the customers.

Reports:

Facilitate payment collection, sales ledger assists with a number of reports. These include balance summary report with up-to-date balance summaries, commission reports.

Sales tax and CentVAT Reporting:

Based on the transactions during a certain period, system can produce all the necessary CENVAT and Sales Tax report on time. The system can provide this facility to Accounts Department.

Integration:

Sales ledger can be integrated with General ledger and the sales data can be used for Project management, Production planning (for forecast), Service management (to find the variants), Accounts, Engineering, etc.

Files to be generated and maintain: -

- a) Customer master
- b) Instrument master with variant details.

The same procedure can be adopted for Spares Sales also.

3.3.15 Service Management

Service Contracts:

System can provide flexibility to have unlimited number of service contracts. On each contract type we can specify response time, rates for changeable items and payment terms. Each previously invoiced product will be available in the system. Information relating to serial numbers, modification and contract terms will be readily available in the system.

Service order:

For each service a service order to be released. Complaints and service did to be entered in the system for future verification. If the same complaints repeat, without expects, problems can be solved.

Spares changed during services also to be computerised for calculating forecast quantity and future workload planning.

Logistics:

Service is a process flow. To be efficient, system should follow the flow of activities including ones outside the domain (p.o.pending, quantity pending with sub contractors). With service management, we can identify spare orders pending, items pending, value etc. The spare orders might have separate order number for easy traceability.

Files to be referred:

- a) Customer master
- b) Component price mater
- c) Machine details with variant.

3.3.16 Purchase Control

Purchase Planning:

Based on purchase lead-time, reordering levels, expected sales, the system will indicate the quantities to purchase at any given time.

Creation of purchase orders through system

System can create the purchase orders automatically through the purchase order proposal routine. Old orders can be copied. As soon as an order is released, it is included in stock planning and accounted for purchase commitments. Physical delivered update the stock balance.

Quality control

Goods received can be allocated the location number. A separate tag is provided to identify the part code, description, suppliers' name and quantity received, components received at receipt area will move to stock after passed quality control inspection.

Goods in transit

Goods ordered but not yet delivered are visible both in General ledger as purchase module. Total purchase pending quantities given the value of committed costs and how much of the purchase budget is stock available.

Invoices

All invoices that correspond to purchase orders are routed through purchase department. This ensures that purchase costs are accounted.

Integration

Purchase department can be integrated with general ledger and inventory module.

3.3.17 Purchase Ledger

Purchase ledger gives full information about suppliers and payment flow. Purchase ledger gives details about payment pending, VAT and sales tax rates. This module can be used as a separate one or in conjunction with General Ledger.

Supplier master file.

Supplier master file holds the information about the suppliers. Adding the address and supplied code for all the suppliers can create supplier master

Centralised purchase function.

We can easily centralising the purchase activities without losing the control over it. After, collecting the requirements from all the sister companies, purchasing can be done as a common to all the companies. This will reduce the purchasing cost as well as the component cost.

Invoice processing.

Incoming invoices are accounted through general ledger. GIN reports and purchases order to be matched with the incoming invoices. If all the relevant documents are o.k. then the invoice can be passed for payments.

Automatic payments.

Based on the payment terms, the module will provide a payment proposal. Based on this proposal the necessary cheques for the invoices are automatically generated.

4.1 EXISTING SYSTEM FOLLOWED BY STATEX ENGINEERING COMPANY

Statex Engineering Company is a Small Scale Industry, which is evaluating to medium Scale Company. Hence it is necessary to reorient the existing activities of the company. Eventhough all the existing functions are computerised at present, departments are functioned as a separate module. There is no integration of activities between the departments.

Lack of Integration leads to:

- a) Higher Material cost.
- b) Higher Inventory
- c) Lower quality service from approved suppliers
- d) Higher expenditure on inspection, administration and paper work –no-value-added activities.
- e) Data redundancy.
- f) Longer Delivery time.

For integration, it is necessary to study the data flow of all the departments in the Production system.

Cycle of Production system:

The production system cycle is shown in fig 2.

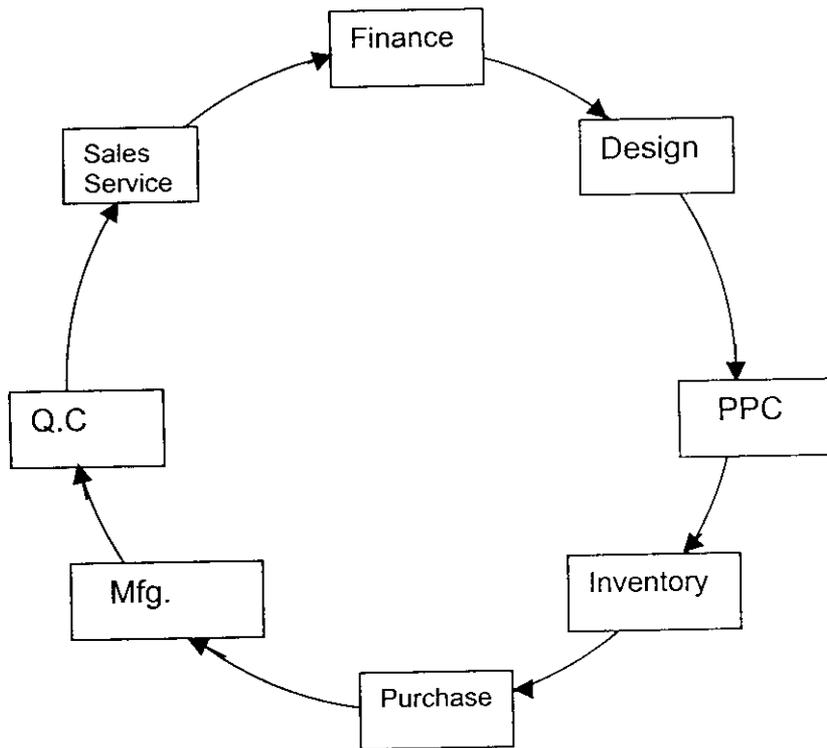


Fig 2. **PRODUCTION SYSTEM CYCLE**

4.2 EXISTING SYSTEM FOLLOWED IN DESIGN

4.2.1 Bill of Material

Even though BOM is the design document, it is not available with the design department in Statex Engineering Company.

Instead of maintaining by design department, BOM is maintained by Stores department, where only clerical staffs are working. Since, there is no updated BOM list, stores people will issue the material to assembly as per available list.

If the components are not suited for assembly whatever be the problem assembly people just return the same to stores and get another one, which is available in stores.

Based on the latest issue, BOM is corrected by stores people. Because of the above activity, the following Non-conformity will occur:

- a) There is no consistency of BOM list.
- b) No assurance on quality of material at stock.
- c) BOM list is not coincident with the drawing available at design department.
- d) Correction made in the BOM list at stores is not updated in the drawings at design.
- e) If any sub assembly component is added in the drawing, the stores department just adds the new one and not deleted the old component, which result in issue of both the components to assembly.
- f) The above problem leads to unnecessary purchasing and inventory of obsolete items.



4.2.2 Lack of Record for action taken against Customer Complaints

Normally Customer complaints are received and registered by service department. After registering the complaints, it should be transferred to design department for necessary corrective action.

Here service department receives the complaints. Service people directly followed with concern department for necessary correction and after correction they directly despatch the corrected material to the customer.

Since service department directly follows the complaints, there is no statistical evidence available at design department. Also drawings are not updated as per the corrective action taken.

If the problem recurring there is no consistency in the corrective action taken for the second time.

4.2.3 Complicated Procedure is followed for the movement of Drawings

If there is any amendment in the existing drawing, rough sketch for modification will draw by design department and this will be handed over to user department.

After receipt of rough sketch, user department will now has two drawings.

Design department again draws the drawing as per scale and handed over this drawing also to the user department.

After receipt of this drawing, user department now has three drawings for the same component. This system does not ensure that user department produces the component only for amended drawing. There may be a change of producing the component for old drawing also.

4.2.4 Addition and Omission memo.

If there any addition or omission in the existing component list design department does not consider the stock and work in progress quantity.

This procedure allows the stores to keep the component for old design also.

There is no consideration for WIP quantity.

Because of the stock of obsolete components inventory in stores increases.

4.3 EXISTING SYSTEM FOLLOWED BY PRODUCTION PLANNING AND CONTROL DEPARTMENT

4.3.1 No Planning for Raw Material:

There is no advance planning for raw materials. Based on sales order or Instruction from management, PPC department will calculate the necessary materials required completing the production and informing stores department, to raise necessary indents.

Similarly, no Planning for brought out items. Instead of PPC department, Stores department will raise the indent for Purchase components.

For the above indents purchase department will procure raw materials as well as components from the necessary suppliers.

At present if sales department confirms any sale order. PPC department will extract the manufacturing items from BOM list (which may have obsolete items also).

Based on this list, PPC will calculate the necessary raw material required meeting the production. The calculated raw material list now handed over to stores department to raise the necessary indent.

Based on the indent received from stores, purchase department will procure the required raw materials.

4.3.2 No Production master at PPC department.

There is no mater for Production items at PPC department. Production master file for all the items (including obsolete items as well as purchase items) are to be maintained by PPC department.

At present BOM file is used for planning activities. BOM file which may have obsolete item also.

4.3.3 No process sheets for manufacturing components.

Process planning also to be done by PPC department.

Each manufacturing component should have separate process sheet. Process sheet explains the process to be carried out for each component and the time required for each process. Process sheet help for routing and scheduling for the manufacturing components.

Here PPC department uses the BOM file for locating the manufacturing item. No routing and scheduling is followed.

4.4 EXISTING SYSTEM FOLLOWED BY STORES

4.4.1 GIN Preparation for Incoming materials.

For all the incoming materials are checked for quantity and Purchase Orders by stores. After verifying the quality and purchase order Goods Inward Note has been prepared by stores.

GIN with materials is moved to Quality Assurance department for Inspection. After completing the Inspection again material and GIN are moved to stores for closing the GIN and stock accounting.

4.4.2 Receipt entry.

After receiving the materials from QA department, stores people again counting the material and make receipt entry for individual components. This leads to duplication of work.

4.4.3 DC preparation.

Based on the advice from Vendor development department, DC's are prepared by stores department for outgoing materials. Here Vendor development department making advice. The same data is converted in to DC. Here also duplication of work involved.

4.4.4 BOM list correction.

If there is any correction in the BOM file, requests with the correction details are given to stores. Based on the request, stores department, make necessary correction on the BOM. This correction is not reflected to design data file. No action taken for deleting the obsolete item from BOM file. This leads to issuing of unwanted materials to assembly and the inventory is stores gets increased.

4.4.5 Issues to Assembly and other departments.

Based on the instruction from Assembly department components are issued from stores to assembly. Each machine may have 70 to 200 components. After issuing the components, stores people make necessary entry on the computer. This will take 4 hours/day approximately. After making entry pending list prepares by stores for Manufacturing, Vendor development and Purchase department separately and distribute the same to the concerned departments for further follow up.

4.4.6 Indent Preparation.

Planning department, after calculating the material requirements, they advice the stores to raise the indent for raw material. Similarly for purchase components stores department prepare the indent for further procurement of necessary components. After preparing the indents, they will hand over to purchase department and have regular follow up with purchase for receiving the components.

4.4.7 Urgent items follow up:

After releasing the indents to purchase components, stores have close follow up with purchase for receiving the same. Similarly for manufacturing components they follow with production people to manufacture the same. After receipt of the same, they will issue the components to Assembly department for finishing the product. Here stores is not responsible for follow with purchase as well as production to get the component. This can be avoided.

4.4.8 Packing list preparation:

Assembly department after completing Assembly work, they request stores to prepare the necessary packing list. Stores after preparing the packing list handed over to assembly. They verify the component and arrange for packing.

If there is any modification in the list; again they approach stores department for necessary correction. Even though it is assembly department function, here stores has prepared the packing list.

4.4.9 Work order generation

After getting information from Sales or from Management, stores department generates work orders. Based on the work orders necessary issue list is prepared by stores and issues the components to assembly for assembly work. Here work orders are to be generated by Planning and based on work order, materials have to be issued to assembly.

4.5 EXISTING SYSTEM FOLLOWED BY PURCHASE DEPARTMENT

4.5.1 Receipt of indent from Stores:

As per the present system, whenever production department needs component, they advice the stores department to raise the indent. In turn stores department raise the indent for the component, which needs urgently.

The above procedure, does not give purchase lead-time (to get the quotation and rate finalisation) to procure the component. Hence purchase department may procure the component which is easily available in the local source without comparing the rates with outstation suppliers. Hence the rates of the purchased components may be at the higher side.

4.5.2 Releasing the Purchase Order:

In the present system, whenever purchase department receives the indent they release the purchase order and procure the component. For the same component and for the same supplier five purchase orders have been released for a particular month. As per the present system number of orders released in the last year from purchase department touches 1440 number which increases the ordering cost, frequency of placing the orders to be reduced to reduce the purchasing cost.

5.1 SOLUTIONS FOR THE APPEARED PROBLEMS IN DESIGN

5.1.1 Bill of Material file

It is now handed over to design department after updating the file as per the present requirement. Now after changes, stores department issues the material to assembly as per updated file.

If there is any modification in the file, the necessary changes to be recommended to design department.

Design department will analyse the feasibility of the changes. After analysis, if the design department has accepted the recommended changes, first they will make necessary corrections in the drawing. Finally they will update the BOM file.

The above system ensures that only updated material will be issued to user departments.

Before making necessary correction in the drawings, design department will take care of material available at store and WIP. This system avoids the inventory of obsolete stock.

Assembly department ensured only updated material will be issued from stores. This automatically increases the production.

5.1.2 Customer Complaints

Now customer complaints are received directly from customers by service department. After receipt they prepare corrective Action Request (CAR) form.

One copy of the above form sent to Design department Another copy will be sent to Manufacturing / Purchase department. Design department gets the feed back from Manufacturing / Purchase department.

Accordingly Design department makes necessary corrections in the drawing and informs the Manufacturing or Purchase department to manufacture or procure the material for the updated drawings.

The material received for updated drawing is handed over to Service for despatching the same to the customer.

Since customer complaints are one of the design input, now system has modified in such a way that complaint are recorded and updated in design file also.

The above system ensures that after receipt of a complaint from customer and after updating only trouble free components are to be manufactured and despatched from our end.

5.1.3 Movement of Altered Drawing.

Existing system have been modified such that any alteration in the existing drawing, design department alter the existing drawing.

After alteration, the altered drawing will be handed over to user department, only after the receipt of old drawing.

The above system ensures that at any point of time, user department will have only one updated drawing for a particular component.

Before making necessary correction in the drawings, design department will arrange for doing necessary rework on the component available in stores. Also they will correct WIP drawing also.

The above procedure ensures that stock quantity as well as WIP quantity will adhere the latest drawing dimensions.

5.1.4 Addition and Omission Memo

Addition and Omission memo format has been modified such that the pending quantity at stores and WIP quantity are entered in the format.

Before making necessary addition or omission, the decision is to be taken for the quantity at stores and WIP quantity. After making necessary rework on the existing quantity, addition or omission is implemented. Same way necessary corrections are made in the WIP drawing also.

This system ensures that quantity pending at stores as well as at WIP gets corrected before making addition or omission from the current level.

If the existing quantity is beyond the rework condition, the current stock to be rejected and the system ensure that there is no component at stores for old design. As far as possible design department will try to liquidate the current stock available at stores as well as at WIP.

5.2 SOLUTIONS FOR THE PROBLEMS APPEARED IN PRODUCTION PLANNING AND CONTROL DEPARTMENT

5.2.1 No advance planning for Raw Material

HOD's from Sales, Production and Managing Director finalised the schedule up to Mar 2001. Based on this projected schedule, PPC will plan for Raw Materials for two months in advance.

Because of the above planning, raw materials for all the components are available at shop in advance. Waiting times in assembly have reduced considerably.

Production department easily reaches the target fixed by the management.

5.2.2 No production master at PPC

Already arranged for taking time study for all the manufacturing components. While making time study process sheets as well as master card will be generated by PPC department.

5.2.3 No Process sheets at PPC

Process sheets are required to maintain the sequence of processes and time for each process. After completing the time study, process sheets with timings for each operation is to be prepared.

This process sheet enables to calculate capacity planning and find the utilisation factor of the machines at Production department.

Routing and scheduling also to be done after completing the time study.

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5.3 SOLUTIONS FOR THE PROBLEMS APPEARED IN STORES DEPARTMENT

5.3.1 GIN Preparation and Closing

After preparing the GIN, material and GIN copy is now moved to Inspection area. After completing the inspection, Inspection department people close the GIN and they will enter the accepted quantity in the computer.

Based on the GIN copy received from Inspection stores make necessary receipts against that item. In future, program to be done such a way that when the inspection people close the GIN, the accepted quantity should automatically transfer to stores as receipt entry. This will avoid individual entry for receipts of components from Inspection.

5.3.2 Generation of DC cum Advice by Company

Now DC's for outgoing materials are prepared manually by stores department Progress is under study that whenever work order is raised by production planning department, necessary D.C. cum advice are to be generated by Production Planning through computer.

This DC cum advice's are to be handed over to stores by vendor development department after necessary verification. Stores department after making entries at their end they will send the material to the sub-contractors.

This system will avoid preparation of advice by vendor development department and preparation of D.C. at stores department.

5.3.3 BOM file correction

At present stores department corrects Bill of Material. If any correction in the existing BOM file, user department will intimate to stores to make the correction. Based on the request from user department, stores correct the BOM Material file.

There is no action for correcting the necessary drawing based on the BOM correction. Hence BOM file and the relevant drawings are not matched after making correction at BOM file.

To avoid the above problem, BOM file is transferred to design department. Now the requisition to be forwarded to design department. Design department makes necessary correction both in the BOM file as well as in the relevant drawing.

This system ensures that at any point of time BOM file and drawing file will always match with each other.

5.3.4 Computerisation of issue entries

At present issues to assembly are done individually. This took more time to make entries in the computer for the items already issued.

New computer system is under study such that, based on requisition from assembly, stores department instructs the computer to issue the necessary components for a particular product. Computer automatically issues the components, which is having sufficient stock.

After issuing, computer will give two separate lists. One is issued list and another one is pending list. Based on issued list materials can be issued from stores to assembly. Based on pending list pending items for a particular work order can be followed from purchase or vendor development department.

This system saves major manual work done at present in stores.

5.3.5 Cancellation of Indent preparation for Purchase components

At present based on Sales order from sales, stores prepares indent for the procurement of purchase components. Before preparing the indent, they have to calculate purchase components required meeting the sale order.

After finalising the required components, stores has to prepare indent by entering each component in the computer. This leads to major manual work.

To avoid the above work, ABC analysis has been done for purchase components (Xerox copy enclosed). Based on the analysis level for each component has fixed by the management as follows:

- For 'A' Class items - Based on the purchase lead time maximum One-month stock can be maintained. For costlier items which is having no purchase lead time, can be procured whenever sale order is confirmed.

For 'B' Class items - Minimum 1 ½ month stock can be maintained. Whenever the stock reaches 1 ½ months stock. Order can be released for another two months. Hence maximum level for 'B' class items may be 3 ½ months requirement.

For 'C' Class items - Minimum 1 ½ month stock can be maintained. Whenever stock reaches 1½ months stock, order can be released for another 3 months quantity. Hence maximum level for 'C' class items may be 5 ½ months.

Out of 1192 bought out items,

CLASS	NO. OF ITEMS	% BY QUANTITY	ANNUAL CONSUMPTION VALUE (Lakhs)	% BY VALUE
A	120	10.07	53.81	80.07
B	240	20.13	9.73	14.48
C	832	69.8	3.66	5.45
TOTAL	1192	100	67.2	100

After fixing the level for all the purchase components, total value now purchase department has advised to release Purchase order whenever they reach the R.O.L. and get the components whenever they reach Minimum Level.

Because of the above system major work from stores has been eliminated. Also stock level at stores are under control. There is no need for stores department to follow the shortage components. Because purchase will take care of the components whenever it reaches ROL, Production can be increased with less follow up work.

5.3.6 Packing list preparation by Assembly Department

At present after completing the assembly operation, they request stores to prepare required packing list. Solution has been given such that the necessary packing list to be prepared by Assembly department. They need not request stores to prepare the same. This avoids unnecessary movement of people as well as papers from one department to other.

5.3.7 Work Order generation by Production Planning Department

After getting information either from Sales or from Management, production-planning department will release necessary work order to manufacture the ordered quantity. Before releasing the work orders, Planning department will ensure that the BOM components are currently usable. No obsolete items are available. Based on the work order, stores department will issue the components to assembly department for assembly operation. The above system ensures that only BOM material components are released in work order system since work order file is generated based on latest BOM file.

5.4 SOLUTION GIVEN TO PURCHASE DEPARTMENT

5.4.1 Introduced Departmental Planning

Stores have been requested to stop raising the indents for purchase components. Purchase department will release the Purchase order based on the ROL fixed by the Production Planning Department.

As per the new system Purchase department need not wait for the stores indent. Whenever the components touches ROL, purchase department can take action independently. This system gives sufficient lead-time to purchase department to procure the components. At the same time, eliminating the indent has eliminated major work from stores department

5.4.2 Reduction in number of Purchase Orders

As per the existing system, number of orders released from purchased department goes to 2440 nos. This shows that most of the purchasing time consumes in the order releasing activity. Cost per Purchase Order in the Statex Engineering Calculated as Rs.130/-

Cost per Purchase Order is	=	Rs.130/-
No. Orders released in the last year	=	2440 Nos.
Therefore Last year Ordering cost	=	130 x 2440
	=	Rs.3, 17,200/-

As per the new system Purchase Orders are to be released based on ROL.

Whenever the component reaches ROL, 2-month quantity will be released for 'B' class item and 4 months quantity for 'C' class items. This process reduces the numbers or orders to $\frac{1}{4}$ of the existing one.

i.e. In future No. of Orders to be released	=	610 Nos.
Therefore Order cost per year	=	610 x 130
	=	RS. 79,300/-

Cost saving as per the new system	=	3,17,200	-
79,300			
	=	Rs.2.37.900	

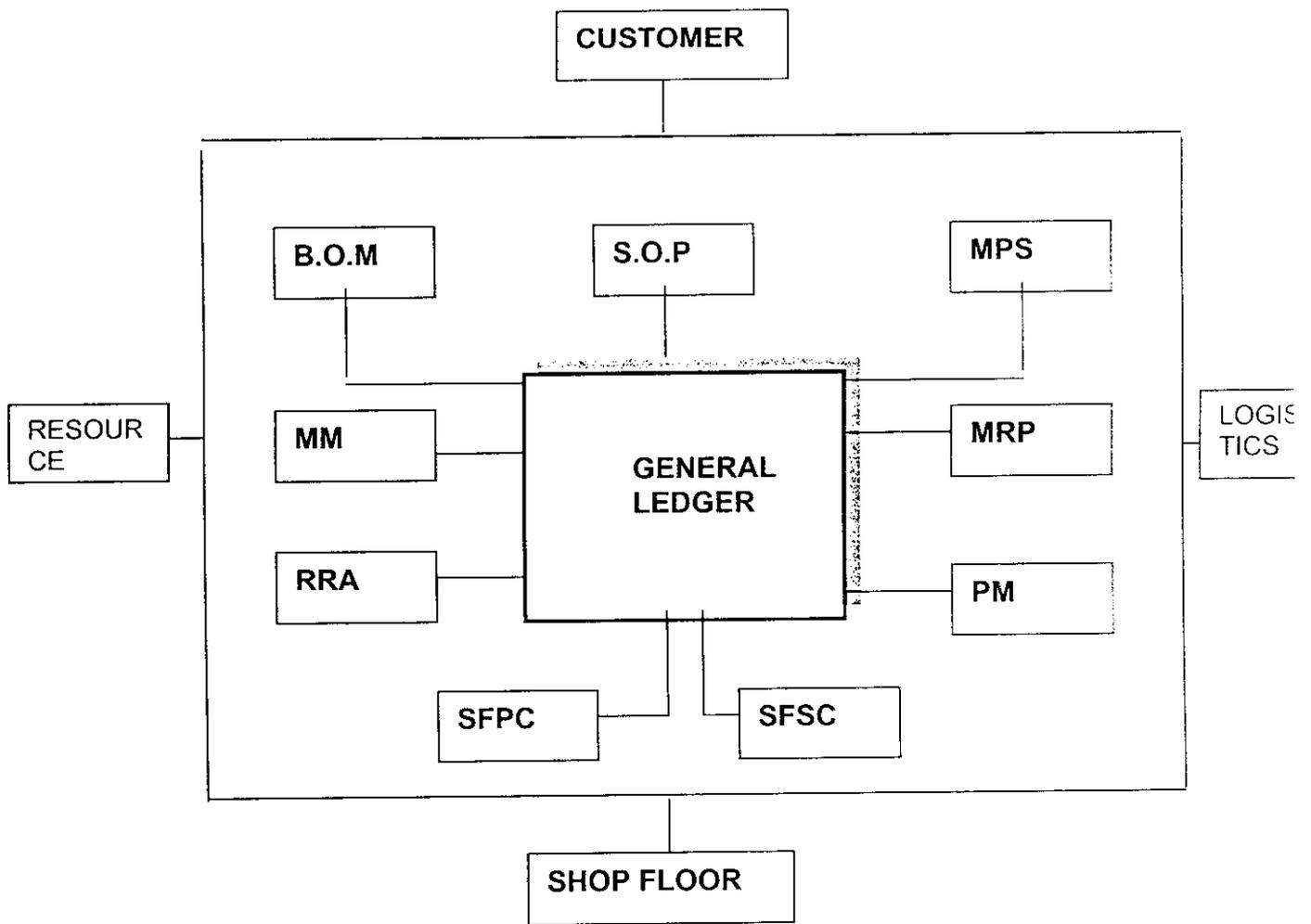


Fig 3. PROPOSED SCHEMATIC VIEW OF INTEGRATED MANUFACTURING SYSTEM

6.1 REDUCTION IN INVENTORY

Inventory values has decreased from 37.64 lakhs to 26.54 lakhs.

Reductions of inventory by 11 lakhs during 4 months have been achieved by liquidating the existing inventory. This has been achieved by

- a) reducing the Purchase
- b) by removing obsolete items from the stores.
- c) Further action is taken to reduce the inventory value to 17 lakhs by reducing the stock quantity.

6.2 REDUCTION IN NUMBER OF PURCHASE ORDERS RELEASED

Number of Purchase orders have been reduced to 620 for 6 months from 2440 orders released during the last year.

Cost of Order is estimated as		Rs.130/-
Last year Ordering Cost	=	2440 x 130
	=	Rs.3, 17,200
This year it is proposed to limit to		1000 nos.
Therefore this year orders cost will be	=	1000 x 130
	=	Rs.1, 30,000
Cost saving by reducing ordering cost	=	Rs.1, 87,200

This has been achieved by releasing the orders for 3 months quantity and providing the schedule for the above quantity (Spread over the quantity for 3 months).

6.3 REDUCTION IN PURCHASE VALUE

Purchased items values have been reduced from 16.07 lakhs to 4.24 lakhs. This has been achieved by stopping the indents released from stores.

Based on the Sales instruction, stores department has released the indent without considering the quantity at stock. This leads to over inventory at stores.

Now by eliminating the indents from stores and fixing ROL for purchase components, over inventory has been reduced to 4.24 lakhs.

6.4 INCREASE IN SALES VALUE

Sales value is expected to be increased from 0.85 crores during first half of the financial year to 4.3 crores in the next half of the year.

This can be achieved by providing proper planning for Raw material as well as purchased components. Also the management has fixed 6 months target. Hence every month the Production Department is trying to achieve the target.

Books:

1. David D. Bedworth and James E. Baily, *Integrated production control systems- (Operations and Management)*, Standard Publishers Distributors, Sixth edition, 1997
2. Donald J. Bowersox, David J. Closs and Omar K. Hufferich, *Logistical Management – A systems integration of Physical Distribution, Manufacturing Support and Materials Procurement*, Macmillan Publishing Company, Third edition, New York, 1986.
3. Gopalakrishnan. P, Sundaresan. M, *Materials Management – An integrated approach*, EEE, Prentice-Hall of India private limited, 1999.
4. Gordon B. Davis and Margrethe H. Olson, *Management Information System – Conceptual Foundations, Structure and development*, Second edition, McGraw-Hill International editions, 1994.
5. James L Riggs, *Production System*, Fourth edition, John Wiley & sons, New York, 1974.

Manuals:

1. CAFIMS (Computer Aided Factory Integration and Management), IIT Bombay & Delhi
2. Applying ISO 9000 Quality Management System, International Trade centers Geneva
3. BaaN Software System
4. Scala 5 Business Management Software

APPENDIX

CHARTS

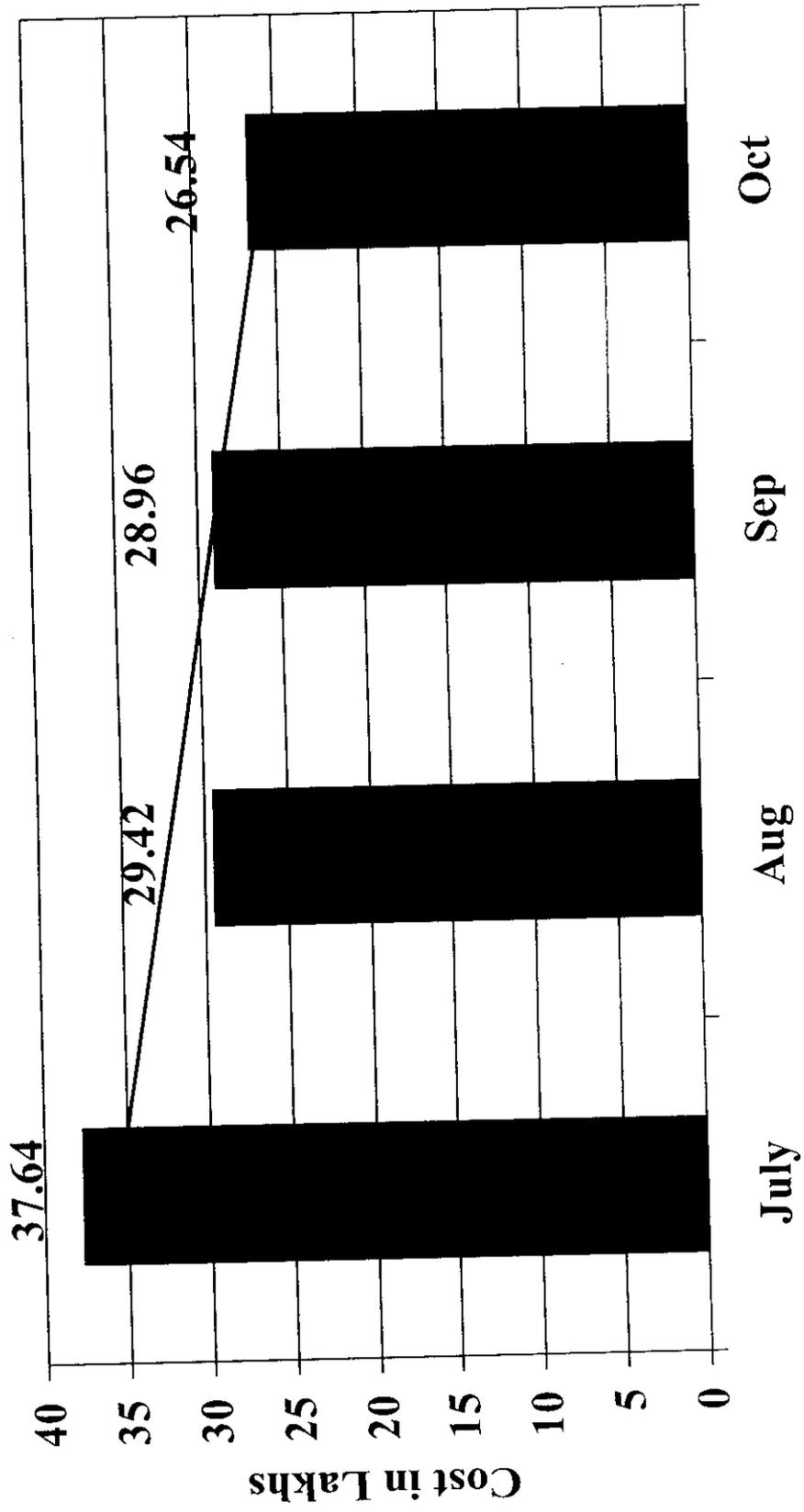


Fig 4. INVENTORY VALUE

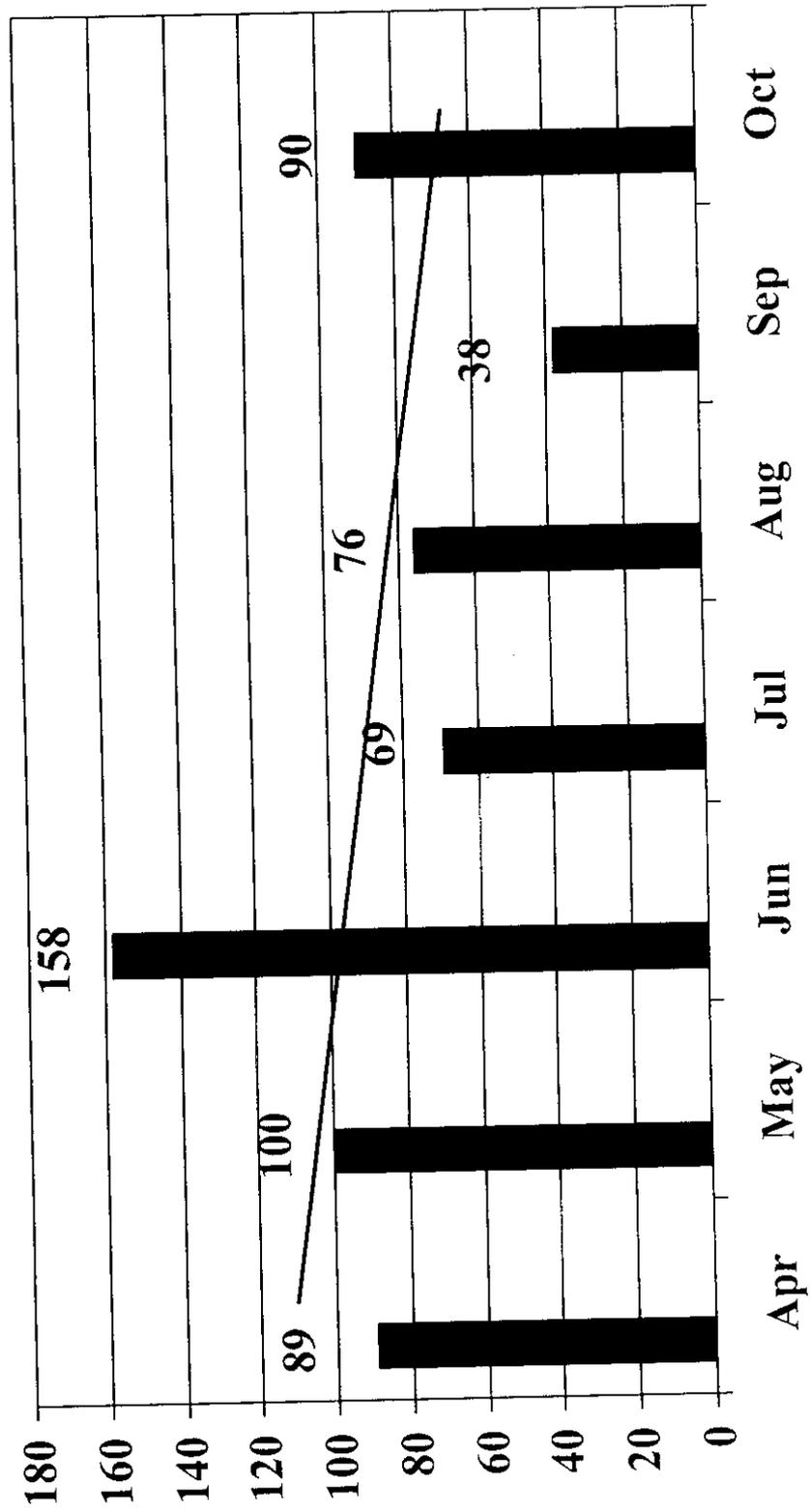


Fig 5. NUMBER OF PURCHASE ORDERS RELEASED

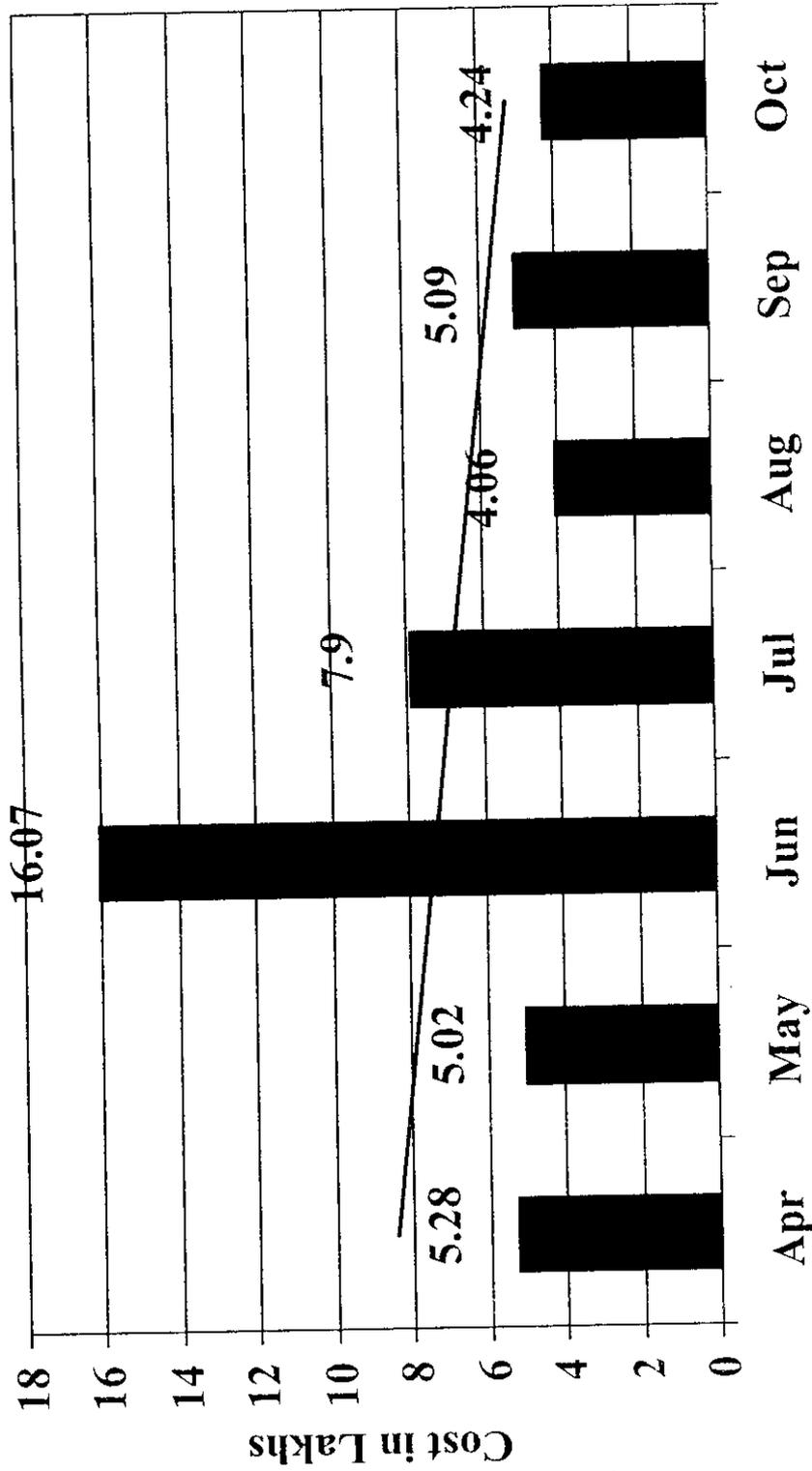


Fig 6. PURCHASED VALUE

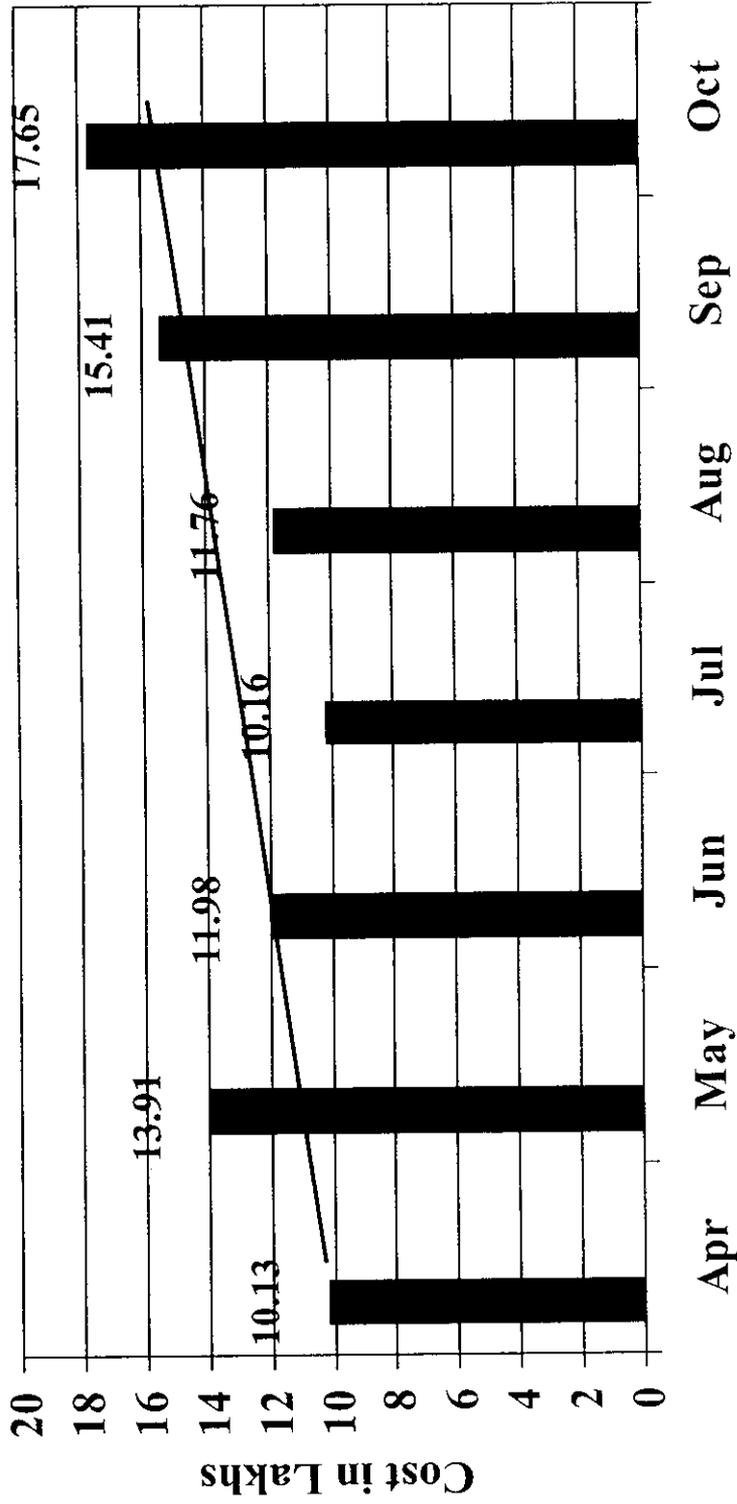


Fig 7. SALES VALUE