DEVELOPMENT OF SOFTWARE FOR EVALUATING CAPACITY BUILD - UP OF A MACHINE TOOL INDUSTRY.

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MEE/99/3527

A THESIS SUBMITTED TO THE DEPARTMENT OF MECHANICAL ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY AKURE, IN PARTIAL FUFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTERS OF ENGINEERING.

FEBRUARY, 2007

CERTIFICATION

I certify that this research work was carried out by OLANIYAN, Olawale Oludare of the Department of Mechanical Engineering, Federal University of Technology, Akure and has been approved to have met the requirements for the award of M.Eng. Degree in Mechanical Engineering (Production Option) of the Federal University of Technology, Akure, Ondo State, Nigeria.

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07/08/07
Date

DEDICATION

This project work is dedicated to the Almighty God who created the universe.

ACKNOWLEDGEMENT

I give thanks to God Almighty for sparing my life and granting me the grace and inspiration to complete this course successfully despite all odds.

I would like to acknowledge and appreciate the academic contribution rendered by my supervisor and the Head of Department, Dr. S. B Adejuyigbe whose patience and academic excellence has led me to the completion of this project. My sincere appreciation goes to Professor A.A Aderoba, my co-supervisor, Dr. O.P Fapetu, The former Head of Department and the entire staff of Mechanical Engineering Department for their support towards the success of this course.

My sincere thanks to my big boss Professor O.O. Adewoye, the Director General, National Agency for Science and Engineering Infrastructure, Abuja, whose support both morally and in kind can not be quantified.

I am very grateful to my boss Dr. Niyi Babatope, The Director and Engr.B.A Olunlade, Deputy Director, of Engineering Materials Development Institute, Akure for their significant contribution towards the pursuit of this course.

I am grateful to my parents; Elder & Mrs S. A. Olaniyan and my family members for their advice and supports. And also grateful to my colleagues; The G5, R.D.O'S ,Engineers of E.M.D.I Akure and my friends; sir K & family, Tope Elemeje &family, Tunde Ajayi &family, Ganiyu Deji & family, Joke, Odi, Seun, Seyi Awe,Niyi Egbemode for their love and cooperation in making this program a reality.

My sincere appreciation to my only love; Olaniyan Yewande and my lovely daughter; Olaniyan Abisola for their understanding during the course of this program.

I thank you all.

ABSRACT

In the conventional manufacturing cycle practiced for so many years in industry, engineering drawings were prepared by design draftsmen and then used by manufacturing engineers to develop the process plan. The activities involved in designing the product were separated from the activities associated with process planning. These were both time consuming and involved duplication of effort by design and manufacturing personnel.

Computer – Aided Design is finding increasing use in industries today due to its productivity, quality of design , better communication, consistent quality of engineering drawings and creation of a database for design modifications.

In the cause of this project, an interactive software known as **CADDMT 2006** was developed using a Visual Basic Program. The database is restricted to only engineering and production department of the industry so as to reduce the complexity of the design structure. The visual basic program developed shows the database of the standard facilities that are suppose to be in existence in a standard machine tool industry and existing facilities available in the case study Nigeria Machine Tool Limited in Osogbo.

The software developed shows the database of the difference in the standard and existing facilities. The database of the operation of each section in production and manufacturing department of the industry was also developed using the software.

It also links all the sections in the company and network all the department in the company thereby making it interactive. The computer-Aided Design system in database design permits automation in some certain phases of design and manufacturing. This software permits proper communication with the user (user-friendliness) having a common input/output language familiar to them. The software generates accurate engineering facilities data in Machine Tools Industry and gives the name quantity and technical specification of each facility. The software developed will successfully enhance the efficiency of any design and manufacturing processes.

The introduction of CAD system in database design is to give fast and easy modification of design.

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CHAPTER ONE

1.0 INTRODUCTION

The first industrial revolution was experienced eighteenth century when attempts were made to substitute power by mechanical energy. The world is passing through second industrial revolution with the advances occurring continuously in the fields of electronics and computer sciences, and the computer substituting human brain in the control of machines and industrial processes.

The manufacturing scene today is undergoing a revolution. In fact the technology that had the greatest impact on the production system over the last decades is computer technology. Computers have important role to play in job shop and batch production manufacturing plants, which constitute an important portion of the total manufacturing activity. It may be remembered that traditional batch manufacturing suffers from drawbacks like low equipment utilization, long lead times, inflexibility to market needs, high inventory, high dependence on skill of operators, poor quality control, and increased indirect cost. It is estimated that in conventional batch production methods, only 5 to 10% time is utilized on machines and the rest is spent on moving and waiting. Out of the total time on the machine only 30% is on machining, the rest being on positioning, loading, gauging and idling. All these drawbacks can be overcome by introducing automation in machine tools, material handling equipment and assembly machines, using computers for process control and for data collection, planning and decision making to support manufacturing activities (Jain 2001).

For any meaningful technological, or industrial design, or manufacturing breakthrough in developing countries like Nigeria, it is time to embrace computer aided design (CAD) as a manufacturing tool so that accurate data, drawings and manufactured products can be correctly obtained in good time.

Computer aided design (CAD) involve any type of design activity which makes use of computer to develop, analyze, or modify an engineering design. CAD system offers the opportunity to develop the database needed to manufacture the product. In the conventional manufacturing cycle practiced for so many years in industry, engineering drawings were prepared by design draftsmen and then used by

manufacturing engineers to develop the process plan. The activities involved in designing the product were separated from the activities associated with process planning. These were both time consuming and involved duplication of efforts by design and manufacturing personnel.

In an integrated CAD/CAM system, a direct link is established between product design and manufacturing. It is the goal of CAD/CAM not only to automate certain phases of design and certain phases of manufacturing, but also to automate the transition from design to manufacturing. Computer – based system have been developed which create much of the data and documentation required to plan and manage the manufacturing operations for the product (Groover1994).

The manufacturing database is an integrated CAD/CAM database. It includes all the data on the product generated during design (geometry data, bill of materials and parts list, material specifications, e.t.c) as well as additional data required for manufacturing, much of which is based on the product design.

1.1 OBJECTIVES OF THE RESEARCH PROJECT

The objectives of this research project are to:

(a) evaluate the capacity build-up of a local machine tool industry;

(b) formulate the investment strategy for getting the industry fully operational;

(c) generate software that not only create database but also provide a day to day evaluation of capacity build –up; and

(d) prescribe a layout for networking the different departments in the machine tool industry.

1.2 CONTRIBUTION TO KNOWLEDGE

The introduction of the CAD system in database design is to give fast and easy access to the information in the databank thereby giving fast and easy modification in design. This also permits prototypes to be quickly designed, made and supplied to the potential customer for evaluation by direct feeding of these data to a CAM system.

The CAD system in database design also permits automation in certain phases of design and manufacturing. This can be achieved via Advanced Manufacturing

Technology which is a sure tool for the needed development in Computer Aided Design and Computer Aided Manufacturing (CAD/CAM) using Pro/E software

1.3 RESEARCH METHODOLOGY

An inventory survey of the case study of Machine Tools Industry, Osogbo, Nigeria was undertaken. Personal interviews and oral discussions with the engineers and workers in the case study industry were undertaken to collect relevant information needed to develop the database software for a viable Machine Tool Industry in Nigeria. The facilities, equipment and machines available for the purpose of developing and creating a viable database for the day to day activities of the case study industry were analyzed and considered in the development of the software.

The software for evaluating the capacity building of the case study industry was therefore developed. The software proposed the investment strategy for getting the industry fully operational, since the present capacity utilization of the industry is at minimum level.

The software developed shows the quantity of the equipment, the equipment description and the technical specification and capacity of the equipment. This software was restricted to only Engineering Department (Production Planning, Store, Quality Control, Research and Design) and Production Department (Manufacturing and Foundry) so as to reduce the complexity of the design structure. The inventory of the equipment, facilities and machines of both the engineering and production departments were taken into consideration.

The coefficient of correlation which is the linear relationship between the present capacity utilization and the projected utilization of a viable Machine Tool Industry was determined.

CHAPTER TWO

2.0 LITERATURE REVIEW

Computer-aided Design (CAD) can be described as any designed activity that involves the effective use of computers to create or modify an engineering design (Jain, 2001).

The two basic reasons for using the computer in the design of a product (Jain, 2001)

i. To increase the productivity of the designer; and

ii. To create a database for manufacturing

CAD is a process in which the user and the computer interact to get the best design of a product by exploiting the intellectual capabilities of the user and the processing capabilities of the computer. Modern CAD system are based on Interactive Computer Graphics (ICG), which the computer employed to create, transform and display data in the form of pictures or symbols. These pictures can be modified, enlarged, reduced in size, moved to another location on the screen, rotated and transformed.

2.1 INTRODUCTION TO COMPUTER- AIDED DESIGN

Computer – Aided Design (CAD) was defined by Farag (1987) as the use of computer systems to assist in the creation, modification, analysis, optimization, storing and communication of design information. The CAD system allows design modifications to be performed easily and efficiently. The analysis and optimization phases of the design are accurately performed by the computer while the designer will find these tasks time consuming and tedious without the use of computer. The CAD system in this case shall enable the designer to make decisions based on the analytical calculations performed by the computer.

The use of computers and the development of Computer – Aided Design techniques have resulted in signification reductions in design project costs, working hours, inconsistencies and mistakes. The introduction of CAD to engineering design has yielded economics benefits. Farag (1987) reported a case in which work of 32 draftsmen working without a CAD system may be done by 8 draftsmen with the CAD system in the same time. Indeed, CAD systems can increase productivity in the drafting function by roughly five times over manual drafting.

Computer – Aided Design is finding increasing use in industries today due to its productivity, improved quality of design and communication.This is done through better communication, more consistent quality of engineering drawings and creation of a database for design modifications.

2.1.1 DESIGN

The process of design is an iterative procedure, which consists of six steps as shown below in Fig. 2.1

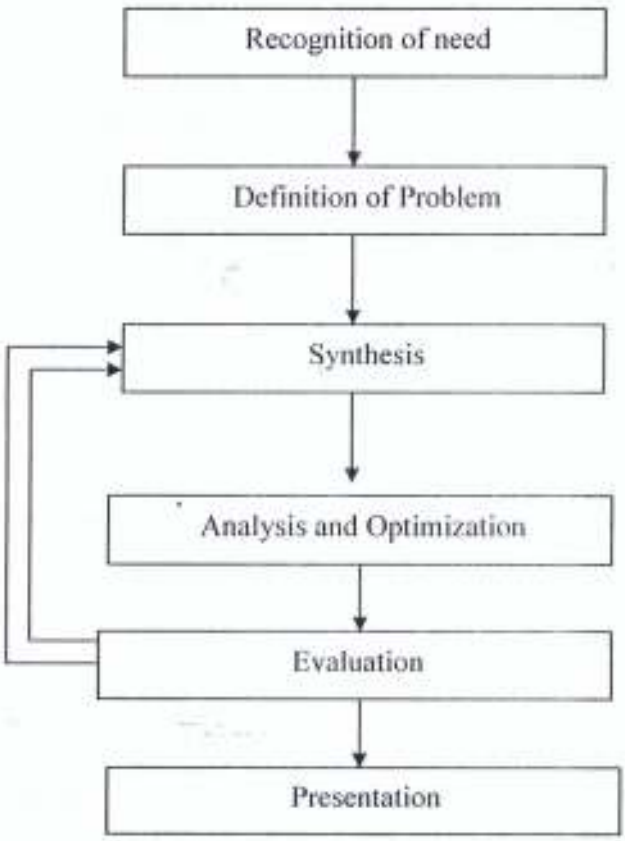

Fig. 2.1 The general design process.

Source: Groover and Zimmers (1984)

2.1.2 THE DESIGN PROCESS

The General design processes according to Singh (1997) are the following;

(i)Recognition of need: It involved the realization by someone that a problem exists for which some corrective action should be taken. This might be the identification of some defect in a current machine designed by an engineer or the perception of a new product marketing opportunity by a salesperson.

(ii)Definition of the problem: It involves a thorough specification of the item to be designed. This specification includes physical and functional characteristics, cost, quality, and operating performance.

(iii)Synthesis and Analysis: These are closely related and highly iterative in the design process. A certain component or subsystem of the overall system is conceptualized by the designer, subjected to analysis, improved through this analysis and redesigned. The process is repeated until the design has been optimized within subsystems and synthesized into the final overall system in a similar iterative manner.

(iv)Evaluation: It is concerned with measuring the design against the specification established in the problem definition phase. This evaluation often requires the fabrication and testing of a prototype model to assess operating performance, quality reliability, and other criteria.

(v) Presentation of design: This is the final phase in the design process. This includes documentation of the design through drawings, material specifications, assembly lists, and so on. Essentially the documentation requires that a design database be created.

2.2 COMPUTER-AIDED DESIGN

Computer-aided design (CAD) can be defined according to Singh (1997), as the use of the digital computer to assist the designer in the

- Creation
- Development
- Modification
- Analysis
- Optimization of a design activity

The various design related tasks which are performed by a modern CAD system which can be grouped into four functional areas.

i. Geometric modeling
ii. Engineering analysis
iii. Design review and evaluation
iv. Automated drafting

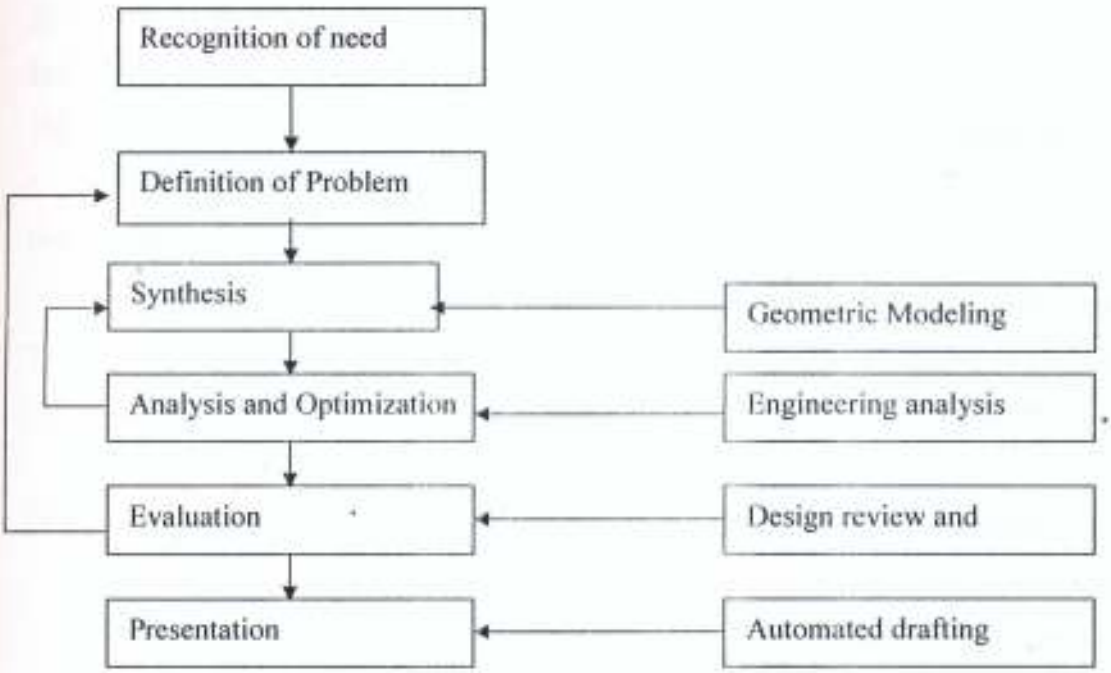

Fig 2.2 Conventional design process: Computer-aided Design
Source: Groover and Zimmers (1984)

2.2.1 Computer-Aided Design Process

The various tasks performed by a modern CAD system can be grouped into the following four functional areas:

(a) Geometric modeling: It is concerned with the computer-compatible mathematical description of the geometry of an object. The mathematical

description allows the image of the object to be displayed and manipulated on a graphics terminal through signals from the Central Processing Unit (CPU) of the CAD SYSTEM. The software that provides geometric modeling capabilities must be designed. There are several different methods of representing the object in geometric modeling. The basic form uses wire frames to represent the object. In this form, the objective is displayed by interconnecting lines.

Wire-frame geometric modeling is classified into three types, depending on the capabilities of the ICG system.

According to Groover and Zimmers (1984), the three types are;

(i) 2D. Two dimensional representations are used for a flat object.

(ii) 2½D. This goes somewhat beyond the 2D capability.

(iii) 3D. This allows full three-dimensional modeling of a more complex geometry.

(b). Engineering Analysis: In any engineering design project, some type of analysis is required. The analysis may involve stress-strain calculation, heat transfer computations, or the use of differential equation to describe the dynamic behaviors of the system being designed. The computer can be used to ajd in this analysis work.

(c). Design Review and Evaluation: This involves checking the accuracy of the design, dimensioning and tolerancing routine which assign size specification to surfaces indicated by the user help to reduce the possibility of dimensioning errors. Checking the accuracy of the design can be accomplished conveniently on the graphic terminal.

(d) Automated drafting: Automated drafting involves the creation of hard copy engineering drawings directly from the CAD database.

2.3. COMPUTER-AIDED DATABASE DESIGN

2.3.1 DATABASE

Data refer to information on some facts enabling us to draw certain conclusions. Interrelated data are often called a data system. A set of related attribute contents is referred to as a data record. The ordered collection of data records is called a data file or a data set (Koryachko et al, 1990).

A database refers to a set of specially arranged data to be used in many application programmes. A database is called a set of files operated by a special application programme package i.e. a database management system, for the purpose of creating and updating data arrays and fetching reference data (Jeffrey et.al, 2000).

A database is a set of data representing status of object and their interrelation in a given data domain. A database refers to the whole set of data processed by more than one programme (programme module). A data file has a number of purposes but a unified representation of the data stored. Database has also a number of purposes but feature different representation of the data stored.

The major requirements for database according to Koryachko et al (1990)

(i) Data integrity, their consistency and reliability

(ii) The database arrangement should afford a match between the time of data access by the application programmes and the rate of their usage by the CAD application programmes.

(iii) Versatility: The database should contain all necessary data and provide access to them in the course of design problem solution.

(iv) Openness of database: the possibility of loading new information in the database.

(v) Availability of high level language to organize interaction between the database and the user

(vi) Security: Prevention of unauthorized access to or modification of the database.

(vii) Optimum database arrangement, i.e. minimization of data redundancy.

The engineering and manufacturing database comprises of all the information needed to fabricate the components and assemble the product. It includes the bill of

material (assembly cost), part design data (either as engineering drawings or some other suitable formats), process route sheets, and so on.

Software segments and algorithms for managing the database constitute a database management system (DBMS). A database manager or Database management system (DBMS) is a software package used to set up, or structure, a database at can also be used to retrieve information from a database.

The principal features of database managing software for microcomputers are as follows:

- locate and display – It has the capability to locate record in file quickly and then display the records on the screen for viewing, updating or editing.
- Soft: - It is easy to change the order of records in a file
- Calculate and Format:-The database programs contain built mathematical formula and other features that can be used.

2.3.2 TYPES OF DATABASES

There are four major types of databases according to Riley (1994), they are:

(i) The individual database: - It can also be called microcomputer database. This is collection of integrated files primarily used by just one person.

(ii) The company or shared database: - The common operational database and common user database.

(iii) The distributed database: - When data in a company is not just stored in one location but in several locations and made accessible through a variety of communication networks, this is referred to as distributed database.

(iv) The proprietary database: - This is an enormous database that an organization develops to cover certain particular subjects. It can be extended to some public or outside individuals for a free. It is also possible to call it information utilities or databanks.

2.3.3 DATABASE DESIGN

Development of a database structure according to user requirements is referred to as database design. Database design outcome is a database structure consisting of logical and physical component, as well as an application programmer's manual (Teorey, 1990).

Database system is broken down into the analysis, design and operation phases.

The first phase involves the stages of formation and analysis of requirement, conceptual design, implementation planning, and, and physical design. The requirement analysis is an absolutely unformalized stage.

The design phase includes the stages of a database implementation, performance analysis and support, modification and adaptation. The conceptual design chooses the types of information arrangement by way of integrating information demands of the user.

The implementation design (logical design) is divided into two parts: database design and software design. The first part yields a database logical structure. The second part is functional description of programme modules and sets of requests to the database.

The physical design is broken into two parts choosing the database physical structure and debugging the programme modules produced in the course of software design.

Database design process starts with creation of a conceptual model. The conceptual model includes descriptions of objects and their interrelations with no indication of the methods of their physical storage. Conceptual model creation begins with analysis of the fact concerning the objects and their interrelations in existing and potential application programme, so conceptual model is a model of an application domain (Jeffrey et al 2000).

2.3.4 COMPUTER-AIDED DATABASE DESIGN

The Computer-Aided Design (CAD) database contain the application models drawings, designs, assemblies and alphanumeric information such as bills of materials

and that it also involves the interactive graphic software system commands, function menus, and plotter output routines. Nearly all of the functions of a CAD system depend on its database (Groover, 1984).

The graphic software used in computer-aided design can be divided into modules thus:

(i) The graphics packages

(ii) The application program

(iii) The application database

The software configuration is shown in the Fig 2.3 below:

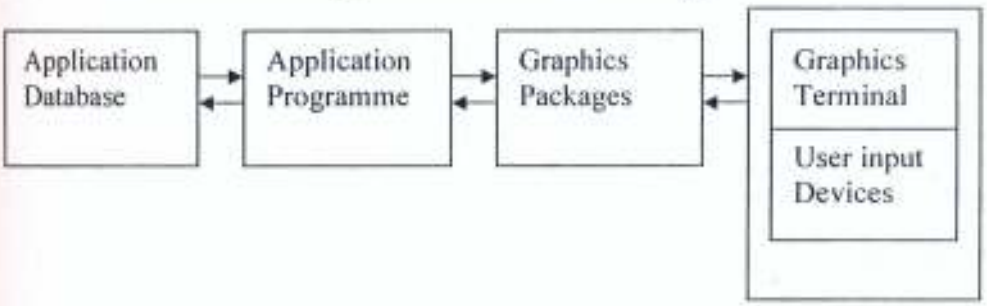

Fig.2.3 Model of graphics software configuration

Source: Groover and Zimmers (1984)

The application program controls the storage of data into and retrieves data out of the application database. The application program is driven by the user through the graphic package. The graphics are viewed on the screen. The commands entered into CAD will automatically update the information describing the current drawing. This data is held in a file called a CAD database and is accessible to other software packages including other CAD system on the network. The database holds both graphics and non-graphic data. Non-graphic data are – standard parts.

2.4 MACHINE TOOLS

A machine tool is a power driven device in which energy is utilized in deformation of material for shaping, sizing or processing a product to a desired accuracy by removing the excess material in the form of chips (Edward, 2000).

The machine tools are generally used for two purposes:

(i) To produce certain form

(ii) To produce finished surfaces

The form of surface produce depends upon the shape of the cutting tools and the relative motion between the cutter and the work-piece. The relative motion, also known as working motion between the cutter and work-piece can be obtained either by the motion of work-piece of cutting tool, or by a combination of the two (Jain,2001).

The working motions are of two types:

(i) Primary cutting motion (drive motion)

(ii) Feed motion

Working motion is powered by external source of energy. In addition to working motion, auxiliary motion such as for clamping/unclamping of workplace, tool holder, idle travel, changing speed, engaging/disengaging of working motions ,etc are also provided on machine tools (Chernov,1984).

2.4.1 Classification of Machine Tools

Machine Tools can be classified according to Adejuyigbe (2002) based on the surface and purpose or specialization as enumerated below;

According to the type of surface generated, the machine tools can be classified as

(a) **Machine tools for cylindrical work:** - In this case, the work piece is rotated about an axis, or alternatively the work may be at rest and the tool is rotated as well as traversed. Various machines used for this type of working are lathe, boring machine, cylindrical grinder and surface grinder.

(b) **Machine tools for flat surface work:** For generating a straight-cut plane surface, the work piece is moved past the cutting tool in a straight path and the tool is traversed in perpendicular direction or alternatively tool is moved in a straight path and work is traversed in perpendicular direction. In both cases, the tool or the work in traversed in perpendicular direction only after one cut has been completed. The machines doing this type of operation are planning,

shaping, slotting and broaching machine. The flat surface could also be produced by having rotary motion of multi-cutting edged tool and translatory motion of job. The examples of machines employing such motion are milling and surface grinding machines. Holes are produced in work pieces by drilling operation.

According to the specialization or purpose, machine tools can be classified as;

(a) **General purpose or basic machine tools**: - These are used for performing all metal cutting operations within their range. These include lathes, shapers, drilling machines, milling machines, grinding machines, planning machine etc.

(b) **Production machine Tools:** These are used to reduce the manufacturing cost and to increase the rate of production. These are generally multi-station tooling machines and designed to do one type of job at a time. These include capstan and turret lathes, semi automatic lathes production milling machines, multiple head drilling machine etc.

(c) **Special purpose or single purpose machine tools:** These are used for mass production and generally one machine is capable of producing only one type of job. These include gear generation, camshaft grinders, piston turning lathes, thread rolling machine etc.

(d) **Flexible manufacturing system:** These are the latest machines which can be used to machines which can be used to machines any jobs and these are designed to achieve the following objectives; less machining time per part: reduced loading, tool changing and other non cutting time; more flexibility; greater compatibility with systems; reduced operator involvement; improved safety and less noise.

Machine tools can be classified into several other ways, viz as per weight, and as per degree of automation (Nagpal,1986).

2.5 HISTORICAL ASPECT OF NIGERIA MACHINE TOOLS

Nigeria machine tools limited are the leading industrial equipment manufacturing in sub-Sahara Africa (NMT, 1992). It came to being as 85 to 15

percent equity ventures between the federal government of Nigeria and the India government – owned Hindustan machine tools (International) limited. The agreement was signed in the year 1979. The company is located on a 102.3-hectare parcel of land at kilometer 8, New Ikirun road in Osogbo, the capital of Osun State of Nigeria.

Nigeria machine tools limited commenced operations in January 1983 with machinery and equipment assembly, and went into effective manufacturing in September 1987. The complex is now developed which has an array of modern conventional as well as computer-aided machinery and equipments manned by competent professionals.

2.5.1 PRODUCTION SECTION

Production section of Nigeria machine tools limited (NMT,1992) has two sub units. They are, manufacturing unit and foundry units of the industry. These are the units where the major production of machinery, equipments and spare parts are made. The chart in fig 2.4 shows various divisions in production section.

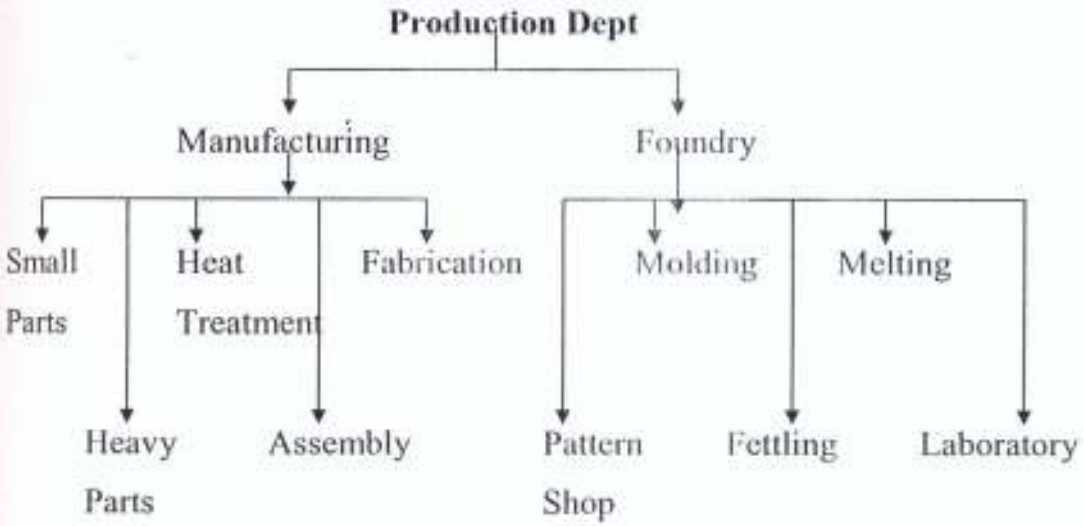

Fig.2.4 Production Department of NMT Ltd. Osogbo

Source: NMT(1992)

2.5.2 ENGINEERING SECTION

Engineering section of Nigeria machine tools limited (NMT) has five sub units. They are production planning, store, quality control, research and design. These are the unit where the proper planning seeks to deploy the facilities of the company in such a manner that the required quantity of the product is manufactured to the right quality at the required time by the best and cheapest method. The chart in fig 2.5 shows various divisions in engineering section.

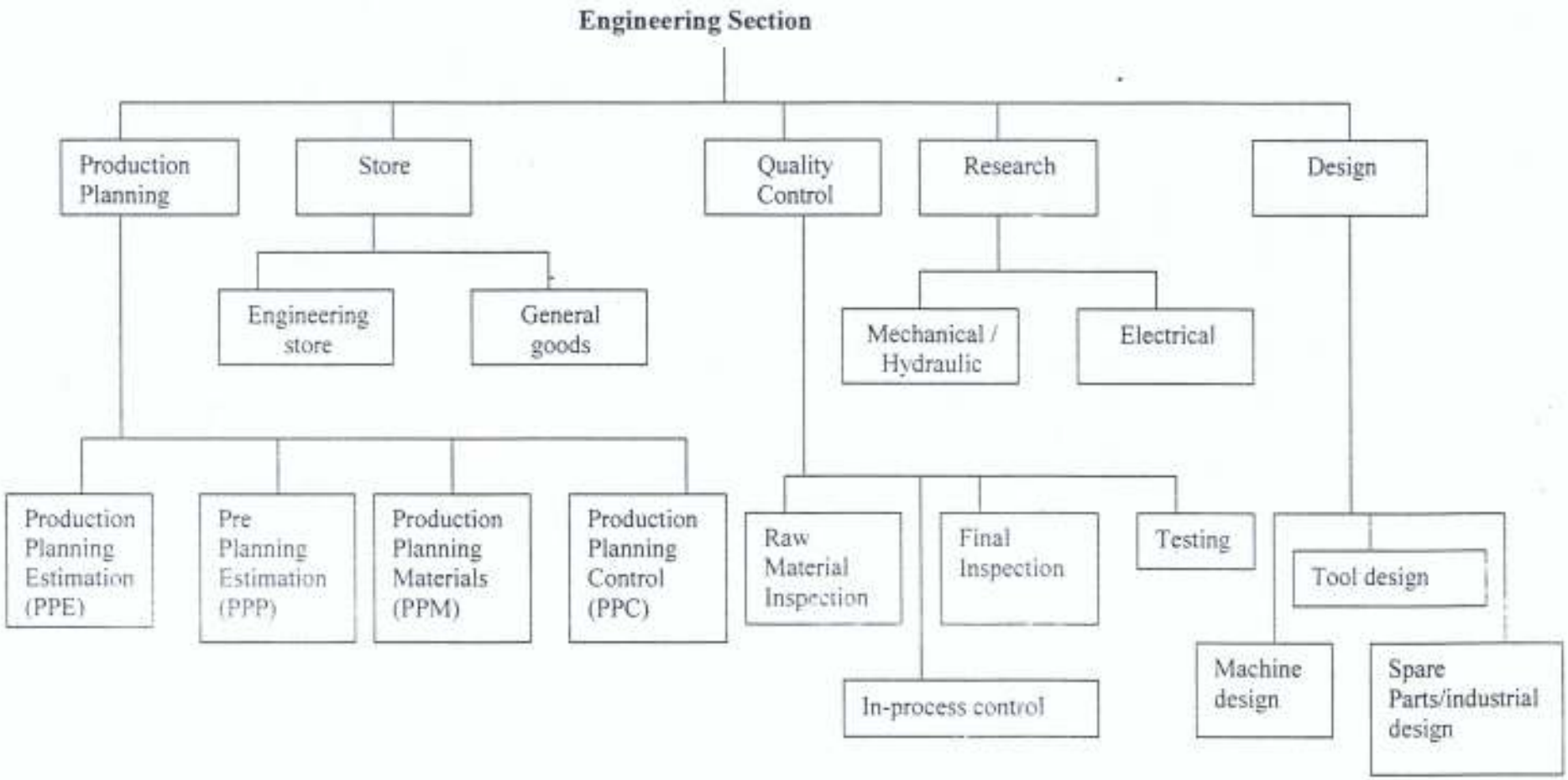

Fig.2.5 Engineering department of NMT Ltd. Osogbo

Source: NMT(1992)

CHAPTER THREE

3.0 MATERIALS AND METHODS

The materials and methods used in this project allow easy modification of the design to be carried out. This is achieved by formulating the database handling system for production and engineering department in order to know the operation carried out in each unit of the department and developing the work flow chart of NMT Ltd in order to know the work process and movement of the job in various unit of the industry. These provide information for the development of the software called CADDNMT software. The software developed shows the database of the standard facilities that suppose to be in existence in a standard machine tool industry and existing facilities available in the case study Nigeria Machine Tool Limited in Osogbo.

The software developed shows the database of the difference in the standard and existing facilities. The database of the operation of each section in production and manufacturing department of the industry was also developed using the software

3.1 DATABASE HANDLING SYSTEM

The database handling system of Production and Engineering department shows various section, unit, result and functions of each unit. These provide the data for the Computer – Aided Design used in software development. The database handling system for the production and Engineering department are shown in the tables below.

MODULE	UNIT	FUNCTION
anufacturing op	Small Parts	Small round parts, flats, gears, sprocket, hub, bushes and other related small part are machined.
	Heavy Parts	Machining of rounds, flat above 7kg (single part)
	Heat Treatment	Annealing, carburizing, hardening, electroplating, nickel plating and

		blackening are done on the machined product.
	Assembly	Sub-assembly and final assembly and final assembly are done in conformity with designed drawing. Testing is carried out in assembly line.
	Fabrication	All sheet metal work requiring folding, rolling, cutting & welding are done here, forming, and blanking punching is also done. Trace cutting is done for precious work.
Foundry Shop	Moulding	Moulding of pattern with sand to produce moulds for pouring molten metal in order to generate casting.
	Pattern Shop	Patterns are produced with wood, resins or metal according to customer's specification
	Fettling	Castings are cleaned, the gating system are cut-off with cutting disc or oxy-flame and grid to size. Casting geometry is checked.
	Melting	Molten metal of controlled composition are produced and verified before pouring.

	Laboratory	Sand testing, which includes sand properties like permeability, strength, and moisture content of molding sand are checked for conformity. Metallography and measurement are also checked for consistency in quality requirement.

Table3.1 Database Handling System of Production Department

Source: Author's Compilation

MODULE	UNIT	FUNCTION
Research	Mechanical/ Hydraulic	To design mechanical and hydraulic system. To simulate system designed. Modelings are done in conformity with designed. Modelings are done in conformity with design system. Analysis of part and final design are done.
	Electrical	To design electrical system. Analysis of part and final design are done. To stimulate electrical system designed. To model electrical circuit.
Design	Machine	Design machine and machine parts.

	Design	Providing part drawings, sub-assembly and assembly drawings Liaise with manufacturing and assembly section on machine/tool design. Alteration and modification or already designed machine
	Tool Design	Design of cutting tools, special tools, jigs and fixtures. Selections of tools. Advice production planning unit on special type of job.
	Spare Part and Industrial Design	Design spare part and industrial machine part. Provide part drawing, sub-assembly and assembly drawing of the spare parts. Modification on spare part designed.
Production Planning	Production Planning Estimation (PPE)	Estimation of time and cost of production. Establish performance standard. Establish the economic production volume.
	Pre-Production Planning (PPP)	Link design dept and manufacturing sector. Determine practical and economic way of doing a job. Initiative design & use of tools keep manufacturing records.
	Production Planning Materials	Minimize total cost of material input into the production of company products.

	(PPM)	Preparation of bill of material. Establishing min & max ordering levels.
	Production Planning Tools (PPT)	Resharpening, reconditioning and maintenance of tools. Arrange for procurement of standard tools. Determine total tool requirements
	Production Planning Control (PPC)	Release production papers and raw materials to prod. Dept. Liaising with inspection dept for periodic and routine check control of all requisition of mat.
Quality Control	Raw Material Inspection	Raw materials are inspected on supplied to test whether it conform with specification given to supplier.
	In-Process Control	At every stage of machine production or machine part process, checking are done for conformity with dimensions.
	Final Inspection	Checking of machines part for conformity with dimension and drawing. Checking of sub-assembled and assembled machine for conformity with design.
	Testing	Testing of assembled machines usually under no load and under load and under load for 8hrs everyday for 3days temperature level, vibration levels are checked in conformity to

		tolerance given.
	Engineering Store	Engineering goods & parts, spare parts, parts completed but yet to be assembled, standard parts, assembled machine are stored in engineering store.
	General Goods	Every item supplied to the company is stored as general goods. Send material delivery in ward slip (MDIS) to the quality control.

Table3.2 Database Handling System Engineering Department

Source: Author's Compilation

3.2 WORK FLOW CHART OF NMT LTD. OSOGBO

The work flow chat shows the channel through which all the jobs taking into the company are distributed to different sections/unit of the company for proper communication and manufacturing processes. It also shows that the production planning section serves as a nucleus of the company from where all the necessary information concerning manufacturing and production processes are given.

All the jobs coming into the company are taking in through the marketing department, from where it is then transferred to production planning section that link all other departments. When the job is ready for collection the customer has to liaise with the production planning section for proper information.

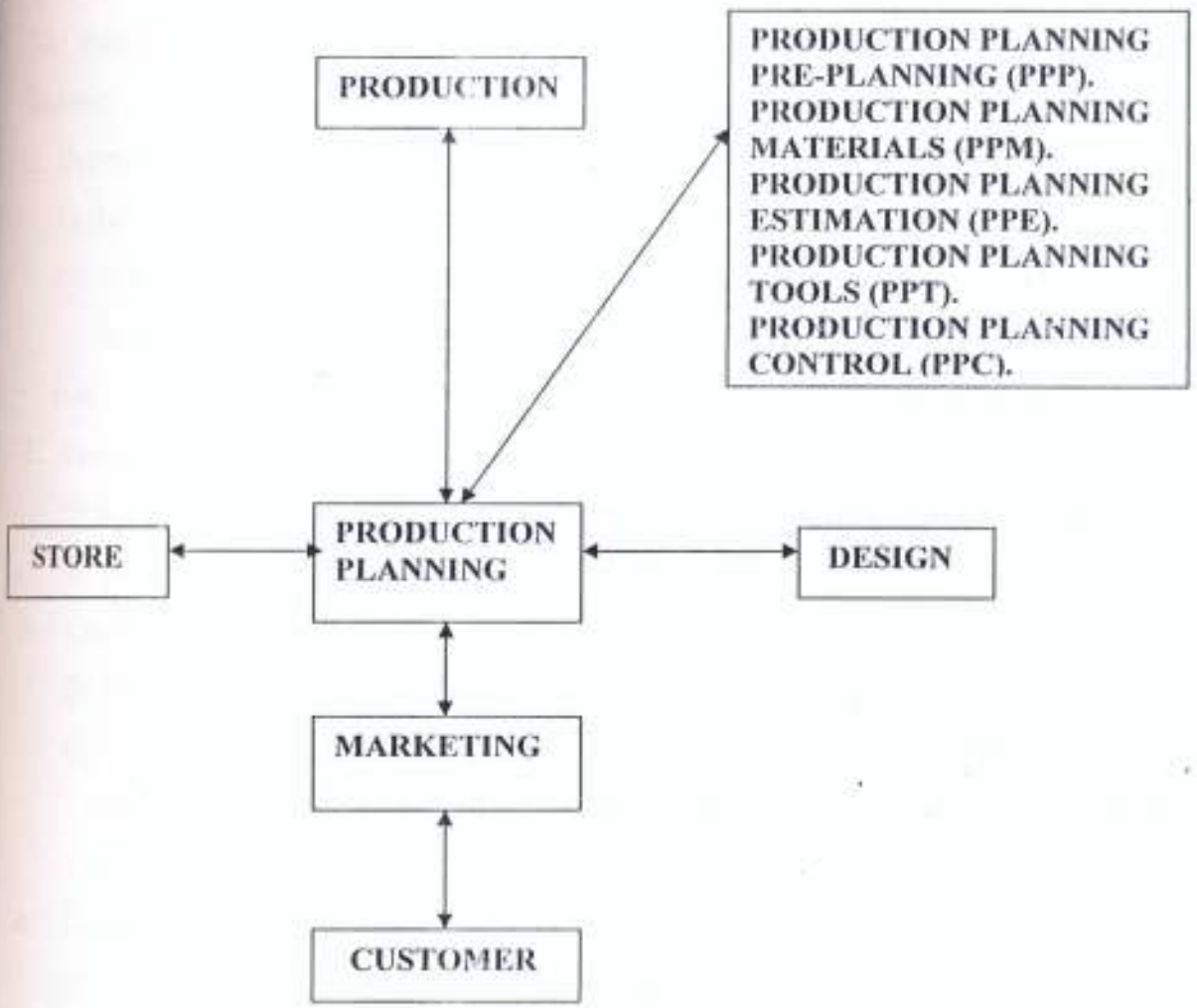

Fig. 3.1 Work flow chart of Nigeria Machine tools Ltd. Osogbo

Source: Author's Compilation

3.2.1 PRODUCTION PLANNING AND CONTROL

Production Planning seeks to deploy the manufacturing facilities of a company in such a manner that the required quantity of the product is manufactured to the right quality at the required time by the best and cheapest method. Production control is the mechanism for supervising the plan when it is effected to attain the defined goal.

Manufacturing consists of a sequence of operation which transforms materials from a given form to a desired form (Jay,1988).

3.2.2 Function of Production Planning and Control

The functions of production planning and control according to Adejuyigbe(2002) are as follows;

1. Control activities within the industry
   (i) Releasing of orders
   (ii) Setting the plans in motion at time and seeing to the completion of the jobs at a targeted time.
   (iii) Proper identification of material before being used at the shop floor.
2. Control of material movement
   (i) Supply of right materials in right quality at the right time and to the right place.
   (ii) Ensures the flow of materials through the various stage of manufacture.
3. Control of services
   (i) Ensure smooth and coordinated flow of work within the industry
   (ii) Foresees the likely difficulties or snags in carrying out the jobs in advance and takes remedies or measures instead of facing the difficulties during and after they have already occurred.
4. Control of due dates
   (i) Monitors every job and check against delay.
   (ii) Works towards a fixed target and customer's satisfaction.
5. Control of replacement
   (i) It sees that no chance is allowed for replacement.
   (ii) It issues order for replacement in respect of defective job.
6. Control of quality and quantity
   (i) It ensures that quality job is done at all time and in the required quantity.
   (ii) It takes precaution to see that the materials are not scrapped during various management processes.
   (iii) It compensate for the scrap if the material is scrapped.
7. Control of labour efficiency
   (i) It improves the productivity and efficiency of the industry

(ii) It relates with various department like design, marketing, quality control, maintenance, production and stores.

8. Process monitoring

(i) It gives the progress report on any particular job and ascertain whether everything is moving as schedule.

In order to carry out these functions, it is necessary to identify all the branches of production planning and control which will carry out these manufacturing analyses(NMT,1992).

These branches of production planning and control are:

(i) Production planning pre-planning (PPP)

(ii) Production planning Materials (PPM)

(iii) Production planning Estimation (PPE)

(iv) Production planning Tools (PPT)

(v) Production planning Control (PPC)

3.3 PRODUCTION PLANNING PRE-PLANNING (METHODS)

The production planning pre-planning (Methods) performs the following functions such as;

It serves as link between the design department and manufacturing sector.

It serves as a source of information for both the material planning and estimation section.

It keeps the manufacturing records.

It writes and releases manufacturing papers through the production planning and control section to the production floor.

It initiates design, manufacture and use of special tools and equipment where and when necessary.

It concerns with the determination and most practical and economical way of doing a job.

Production Planning Pre-Planning (PPP) methods is divided into four groups

The figure below shows the production planning pre-planning method used in the

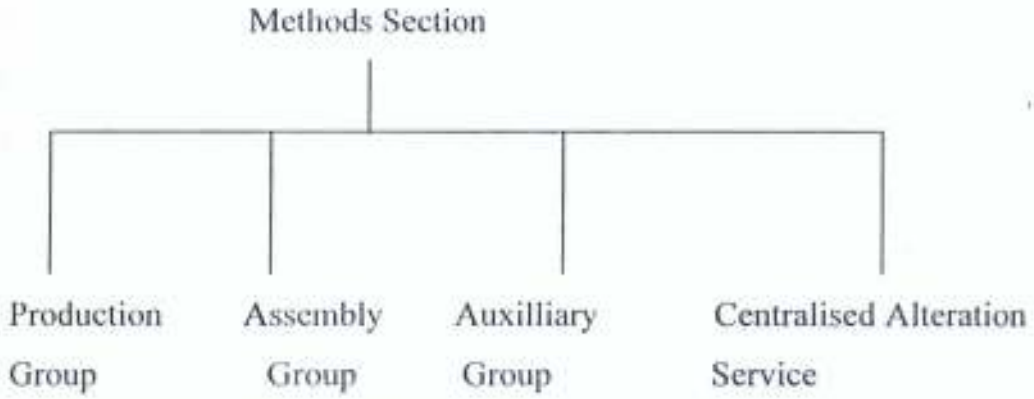

Fig. 3.2 Production Planning Pre planning Method

Source: NMT(1992)

According to the manual for production planning department NMT Ltd Osogbo, the discussion on each of the group can be summarized thus;

3.3.1 Production group.

- Liase with design department, manufacturing department and other relevant department to implement alteration in drawings and document when necessary.
- It divides the component part into three

(i) Manufacturing component

(ii) Order finished component to be procured from outside

(iii) Standard component to be procured and stocked for general use.

- Prepare an operation layout giving the sequence of various operation, their details, machines where these are to be performed, size of raw materials to be used and the planned quantity.

3.3.2 Assembly Group.

- It studies the assembly drawings and list of parts accompanying the component drawing sent by the design department
- It divides the assemblies into sub- assemblies for convenience of manufacture and a set of sub-assembly drawing to show the various over all dimensions.
- It prepare assembly instruction and the assembly route charts
- It determines the parts and the secuence in which they are to be assembled.
- It prepares assembly instruction format and assembly designation of parts.

3.3.3 Auxiliary Group

It pre- plans the manufacture of special tools and other equipment which are required in small numbers. For example- manufacture and use of (i) form tools, (ii) Production aids e.g. jigs and fixtures, marking templates, mandrel etc.

- Form tools are essential when the shape of a component to be machined is awkward.
- Production aids are those items (component) designed, manufactured and used for a specific operation to facilitate production and to achieve more and better accuracy.
- Mandrel are used for turning and grinding of component, while the jigs are for drilling and fixtures for milling, turning, grinding, etc.

3.3.4 Alteration Services.

It effects an alteration during the batch production of component.

It effects alteration in design in future date when it is convenient to change to the new design.

It prepares the design alteration request format and sends it to the design department where change in design will be effected.

3.4 PRODUCTION PLANNING MATERIAL (PPM)

Production Planning Material (PPM) is responsible for materials planning and inventory control. Material planning and inventory control's main objective is to minimize total cost of materials input into the production of company products. The various cost elements includes purchase cost of items, ordering cost, carrying cost plus stock out costs (Aderoba, 1994).

PPM focuses on what to buy, store and how to buy in order to save cost. A systematic analysis of material requirement, good planning and inventory help in carrying out the objectives.

3.4.1 Machine Tool Materials

Machine tools materials being planned and controlled can be categorized into two.

(i) Direct materials

(ii) Indirect materials

The production planning material (PPM) section is handling only the direct materials. The various materials in these categories are given in the figure below

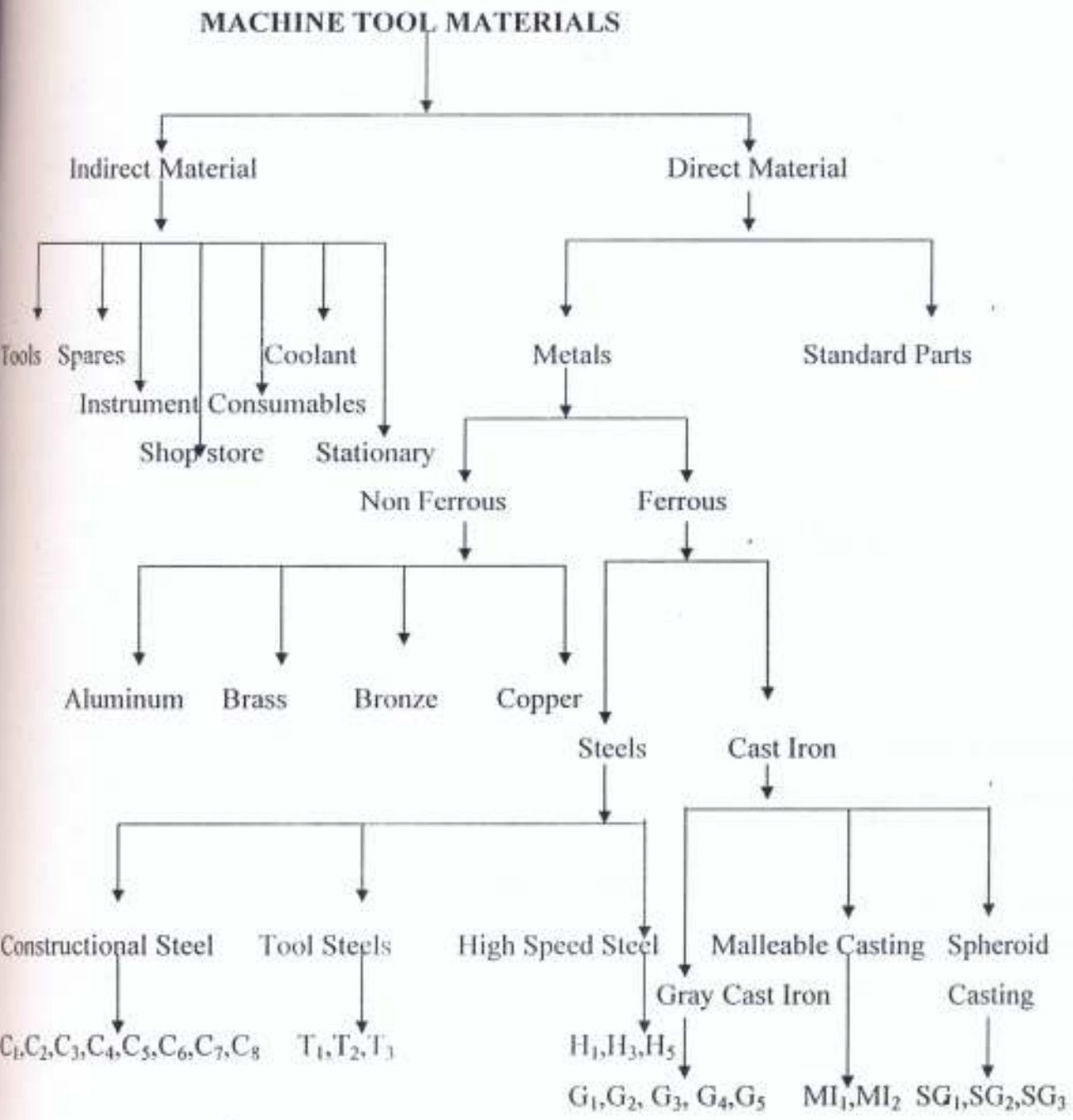

Fig 3.3 Machine Tool Materials

Source: NMT(1992)

3.4.2 Function of Production Planning Materials (PPM)

The Production Planning Materials (PPM) section is responsible for the following activities:

(a) Checking and authorizing material warrants and demand note.

(b) Maintaining and up-dating of planning card and material registers.

(c) Control inventories of all materials.

(d) Assist in the making or buy decision

(e) Repair of materials budget

(f) Identifying the fast, slow and non moving item

(g) Classifying materials into A, B and C group

(h) Preparation of bill of material

(i) Preparation of material master

(j) Establishment of minimum and maximum ordering levels

(k) Liaises with procurement department for prompt procurement of delivery of materials.

3.4.3 Preparation of Bill of Material

The Bill of material is a document which contains raw material and standard parts and is prepared for each product. It has the material specification of all the components making up a specific product.

Each machine has its own bill of material. This bill is prepared from operation layout where the raw material size of each component has been specified. It gives the raw dimension for each component. The bill of material is shown in Table 3.3 below.

NMT	PART LIST	PRODUCT FAMILY	ASSEMBLY NO		
ASSEMBLY DESIGNATION					
S/NO	COMPONENT DESCRIPTION	COMPONENT NO	QTY	MATERIALS	RAW DIMENSION

Table3.3: The Bill of Material

Source: Manual for Production Planning Department NMT Ltd, Osogbo

3.4.4 Preparation of Material Master

The material master gives a comprehensive detail of material for each component making up a specific product. It gives the total length of material for each component where the components are to be made in batches; the batches quantity is taken into consideration here i.e. the total length of material for a certain batch quantity.

The difference between the bill of material and material master is in the dimension, while the bill gives the raw material dimension; the material master gives the raw material dimension plus machining allowance and other allowances. The material master is shown in Table 3.4 below

S/NO	MATERIALS MASTER						OBJECT	W.O.N. O TYPE		AUTHORITY DATE			SHEET
	Compt.	No Off	Drg. No	Mtl	Size	Stock No	Qty Reg	Qty issued	Unit	Rat	Val	Bin Bal	Rec.

Table3.4: The material master

Source: Manual for Production Planning Department NMT Ltd. Osogbo

3.4.5 Preparation of Bill of standard parts and fastener

Standard parts are parts, which cannot easily be made in-house due to lack of facilities of high cost of production. These parts are purchase on request.

As a product has its bill of material, so also do standard parts, once these parts are identified a bill of these item are prepared and sent to store for processing, this bill of standard part and fastener is same as the bill of component part.

3.4.6 Issuing of material purchase request (MPR)

Material purchase request is when necessary, this normally happen when the material or standard parts required are not in stock. The department requesting for this material or parts send their list to material planning section , the MPR will then be issued, copies of this MPR will forwarded to procurement department, store, account, and inspection department for processing.

3.4.7 Compilation of material requirement

In compiling material request the following point are taken into consideration.

(i) The lead time: This is the time between ordering and arrival of material

(ii) Cutting or blade allowance

(iii) Overall allowance: This take into consideration scrap wastrage and unforeseen circumstance.

(iv) Facing and pasting off allowance

(v) Production programme for the period in question.

With all these points considered the overall length is computed (i.e raw length plus allowances) for each component. The total requirements for all machines are then complied and send to store for processing.

This is the comprehensive bill of material as it gives the final raw material requirement send to store for processing (i.e. material master).

Below is the analysis of calculating the overall length of round Bars and flat (Bars sheets):

(a) ROUND BARS

(i) Use drawing in conjunction into operation layout from method planning section to obtain raw dimension.

(ii) Add machining allowance to the raw dimension using machining allowance chart.

(iii) Add facing allowance on the size of material between 2-5mm and parting allowance between 5-10mm

(iv) Check from the operation layout the mode of machining whether batch or piece/ piece to decide overall allowance for the bar.

(v) If a batch quantity, and 20-100mm holding allowance depending of size of material.

(vi) Add 6-10mm cutting allowance as blade thickness, this depends on the machine, which the cutting will be done.

(vii) Sum up to give overall length per piece.

(viii) For batch quantities, add up and divide by the quantity to give length per piece.

(b) FLATS (BARS AND SHEETS)

(i) Use drawing in conjunction with the operation layout

(ii) Add machining allowance using the machine chart.

(iii) An allowance of 5-10mm added to the length and breadth of the plate or sheet depending on the machine to do the cutting of the plates or sheets.

(iv) The overall length is then computed after the allowance has been added.

3.4.8 Material Control Records.

In order to monitor the in and out of materials, standard parts, machine component and machine, a record has to be kept all the time the data for this record comes in from the stores, production planning and control section.

(i) The material inward slips (MIS)

(ii) Demand note and material warrant.

(iii) Return note

(iv) Final inspection report

(v) Stock taking sheets

(i) Material Inward slip (MIS): This is prepared by the store after inspection must have been carried out on the items coming into the stock and sent to material planning and other relevant section for record purposes. This gives the items purchased coming into stock.

(ii) Demand note and material warrant: This is prepared by production planning and control, authorized by planning and form the basis of issuance of items in the store. These items could be raw material, standard part and component part for assembly purposes. After the items has issued, a copy of this demand note is sent to material planning for record purpose. For material warrant, they are used when there are many items grouped together. Demand note will not be in use here because it does not give information regarding the use, charging / cost centre and purpose of the item.

(iii) Return note: These are note, which are sent to material planning from store. It gives information on items, which were earlier issued, and being returned to stock.

(iv) Final inspection report: This is sent to material planning from stores, but prepared by inspection department. This gives information on completed manufactured components, which has being inspection and accepted into stock.

(v) **Stock taking sheets:** These are sheet prepared during the stock taking of items in store. The stock taking is done by material planning in conjunction with the store. This gives information of items in stock and those that need in replenishment.

3.4.9 Raw Material Planning Record

For a well organized material planning to institute proper inventory and control over raw materials, record of issuance and withdrawal should be kept. This gives rise to the planning record card. Each direct material has its own planning card; information from record purposes comes in from MIS, DN & Stock taking sheet.

3.4.10 The standard parts and fastener record:

As we have record for raw material so also do will have for standard parts and fasteners. Like the raw materials, each item of the standard part is entered in a material planning card, if record of issuance is taking time, there is a release from stores users department.

3.4.11 Finished parts and control record

Documentation of any compelled component is made for proper accountability and judicious use of any raw material issued out. These records are made in a finished part and control card. This card is for each component part of a machine.

Information about these finished parts get to material planning through the final inspection report issued by inspection while the component are moved to store.

3.5 PRODUCTION PLANNING TOOL (PPT)

Tool is a devices used, in addition to machine tool. The tools used in machine tool industry can be summarized below thus (Adejuyigbe, 2000);

(i) Cutting Tool : Any small appliance used in doing work on material e.g. Milling cutters drills, grinding wheels, reamers, taps, and dies pliers, chisels etc.

(ii) Jig: A tool that clamps the work and guides other tools in performing cutting operation i.e. drill jig.

(iii) Fixtures: Special tool used in a press for forming, shearing or cutting of materials.

(iv)Measuring Tools: A tool used for measuring actual dimensions e.g. Calipers, Micrometer, and depth gauge etc.

(v) Gauges: Tool of standard measure used in measuring e.g Thread gauge.

3.5.1 FUNCTION OF PRODUCTION PLANNING TOOL

Production Planning Tool is concern with the following activities.

(1) Resharpening, reconditioning and maintenance of tools.

(2) Storing and issuing of tools, measuring instruments gauges.

(3) Manufacture, Storing and control of all forms tools e.g. Radiusing, undercutting tools.

(4) Arrange for procurement of standard tools

(5) Arrange for the manufacture of special tools from tool room

(6) Maintain inventory record of all machines accessories and equipment

(7) Determination of total tool requirements.

(1). Resharpening, reconditioning and maintenance of tools:

To ensure the quality of the end product, it is essential to maintain all tools, gauges, measuring instruments. Jig and fixtures etc. in good working condition so that they serve to achieve and intended purpose when used. Tools need to be maintained to prolong life span and thereby reduce the cost involved on procurement of tools. Due to wear, tear or damage to the cutting edges, tools are resharpening and reconditioned. Presently, the following machines are available in the NMT light machine shop tool crib for the purpose of resharpening and reconditioning.

(i) Universal Tool and Cutter Grinding Machine (GTC 28T)

Used for resharpening and reconditioning of milling cutter (end mills, plain milling cuter , shell end mills) , reamers, involutes gear drilling cutter and form cutter.

For manufacture of a special shapes and forms. E.g. Undercutting, grooving, radiusing, and slotting tools.

To resharpen or regrind the cutters, you grind the following on the cutters:

(a) End mill primary clearance (first angle) grinding.

(b) End secondary clearance (second angle) grinding.

© Peripheral secondary clearance grinding.

(d) Peripheral primary clearance grinding

(e) End chamfering

For reamers, you grind the following

(a) Cylindrical grinding

(b) End chamfering

(ii) Drill sharpening machines:

- For resharpening and regrinding of drills

- You grind the following on the drills

(a) Point relief grinding

The drill-sharpening Gauge is used to check the drill for accuracy after regrinding

(iii) Cold circular saw grinding machine

- For reconditioning and resharpening of saw blades.

For grinding the following on blades.

(a) Rake and relief angles

(b) Teeth chamfering

(iv) Gear Hob Sharpener

- For resharpening of gear hobs

(v) Tap and dies grinding machine

- For resharpening and reconditioning of hand and machine taps die.

(2) Storing and issuing of tools, Measuring Instruments and gauges:

Tool cribs are point-of-use tool stores that are located at user section, nearest to the majority of users in the shop floor (manufacturing floor).

The main objective of locating tool cribs nearest to the manufacturing floor is to reduce the idle time or the unproductive time of the operators, while accomplishing the production tasks, by providing necessary tooling, gauges, measuring instruments, jigs and fixture etc. at the points of use with a minimum distance.

Tools are stored in the cribs according to the following groupings. The reason for this is not to overload a section while others may be free as some tools are frequently demanded for than others.

Group 1: Cutting tools for milling machines i.e. End mills, slab cutters, slitting saws, convex and concave cutters, shell end mills etc.

Group 2: Cutting tools for turning and slotting machine i.e 590^0, 90, 60, & 45, Turning Tools Grooving, Radiusing, Boring and under-cutting tools

Group 3: Cutting tools for drilling machine i.e. Drills, Reamers, Counter bores, Taps, Dies Hole mills etc.

Group 4: Hand and measuring Tools i.e. Pliers, screwdriver, hammer, steel rule chisels, vernier calipers, micrometer and vernier depth gauge etc.

Issuing of tool measuring instrument and gauges:

Tools are issued to operators, section or department as personal, sectional or departmental inventory based on the nature and frequent usage of the tools and gauges.

(i). Issuing of tools and personal inventory: Tools are issued to operators as personal inventory and is by two methods.

- By tools token: Tools are issued to concerned operators by presenting one tool token for one item. The tool token carries the ticket number of the operator and is deposited where the tool or gauge had been stored. After the use of the tool, the operator will return it and is then given his token back.

- By material loan slip (MSL): Material loan slip is used for the drawer of tool by staff not entitled to tool tokens. The slip is normally completed in duplicate with necessary detail i.e. name, ticket No and department etc. before a tool will be issued against it. A copy of the slip is given to the concerned staff after returning the tool.

(ii). Issue of tool as sectional / department inventory:

- In the case of Assembly, maintenance and servicing department, tools and gauges are normally issued to them as sectional departmental inventory. These tools issued on sectional basis are to be recorded, in two copies of sectional inventory record, with one copy retained in the tool crib and the second copy to the section or department involved.

(3). Manufacture, Storage and Control of Special Tools

- Special tools are used where standard tools are not available for particular operation i.e. cutting and measuring operation
- May be produced from standard tools i.e manufacturing a special counter bore from a standard drill. Radiusing the end mill for use as convex milling cutters.
- Are sometimes produced on request from blank H.S.S (High Speed Steel) e.g. under-cutting, radiusing, grooving and slotting etc.
- Mandrels, Jigs and Fixtures are also produced on request and are stored and controlled by Tool Planning Section.

(4) Arrange for procurement of standard Tools

Procurement of tools, as all other items, is the sole responsibility of the procurement division, but must be initiated by tool planning section. This is by originating a document called Material Purchase Request (MPR) and this document, having been checked and authorized by the departmental head, is then routed to procurement department for necessary action. When the tools are eventually delivery and inspected, a copy of the MI Slip (Material inward Slip) is forwarded to Tool Planning Section.

Tool Planning Cards which carry the name of the tool and size, stock No. in-out-balance columns, MI Slip and demand note No etc., are then open for the tools.

(5). Maintain Inventory record of all Machine, accessories and Equipment

Inventory record is prepared for all machines, accessories and equipment in triplicates and contains the name of all machines and its location i.e. Rounds, Non-rounds, Heavy parts Sheet

Metal, etc and the standard and special accessories supplied with the machine to the user section.

The 3 copies of the inventory Record are distributed as follow:

(i) One copy to user section

(ii) One copy to Account Department

(iii) One copy is retained by the planning tool section.

(6) Determination of total tool Requirements

At the beginning of each production year, the Tool Planning Section will prepare the total tool requirements for the production year. The total requirement for a particular tool is estimated with the help of the following factors.

(i) The stock balance of the tool at the beginning of the production year in question.

(ii) The total number of machines that required such tool.

(iii) Demand for the tool under consideration

(iv) The breakage frequency of the tool, based on the total breakage history.

(v) Add extra 10% of the total requirement for each tool.

3.6 PRODUCTION PLANNING CONTROL (PPC)

Production planning control (PPC) is the intermediary between planning department, Manufacturing (i.e.) and allied departments.

It controls and keeps custody of all inventories of material /product components and dispatches regarding sales, assembly and storage of all finished component products. It is also the responsibility of production planning control (PPC) to release production papers for various machine products to production department for the purpose of manufacturing. It releases assembly instructions and other related materials/ paper to assembly.

Procedure

Production Planning Control (PPC) systematically performs its function if planned and monitored well. Its responsibilities start as soon as the production programme for current year comes out.

This programme highlights the quality of orders received together with sale forecasts and come out with a concrete verdict on how many are the machines to be produced of various orders and schedule of batch requirements.

Immediately this document is got, it is the duty of PPC to arrange for the manufacturing papers and materials.

These manufacturing papers include;

1 – Operation layout

– Sub, group and final assembly instructions

2 – Component parts list

- Standard parts/ bought out items list
- Components drawings and
- Assembly drawing (i) Sub assembly (ii) group assembly (iii) Final assembly

Raw material requests are made to the stores for release of materials after these papers have got to PPC in order to carry out its duties undisturbed. When raw material has been issued, manufacture warrant (production papers) from planning and control will be attached to other papers like (i) Component drawing (ii) Operation Layout and release to production floor to commence manufacturing.

The job must be closely monitored and the daily progress on each component be recorded from start to completion of the processes involved in making the components. After completion, and final inspection, component is stored and released to assembly together with assembly papers according to schedule for assembly. The completed machine products are either stored or dispatched as case may be at completion time.

Components inspection

Components are inspected process per process along the line until it reaches the final stage of production. This occurs in order to minimize and control material wastages, production of scraps and storage of non-conformity components.

Inspection and tests are also carried out on the sub-assembly parts, group assembled parts and at the final stage of assembly. The complete assembled products are test run to see that they are

perfectly okay before they handed over to production planning and control PPC for storage or dispatch as the case may be.

3.6.1 Function of Production Planning Control (PPC)

In Nigeria Machine Tools NMT, the Management function of PPC are concerned with the planning, direction and control of material and processing activities of manufacturing. In other words, production planning and control works according to schedule in other to execute and deliver promptly customers orders. For the realization of these objectives, production planning and control perform the following accomplished functions.

1. Releasing of production papers and raw materials to production department for manufacturing purposes.
2. Monitoring and updating daily progress report on every component in progress
3. Liaising with inspection department for periodic and routine check on every component at each state of process and at final stage to minimize material wastage and production of scraps.
4. Preparation of necessary papers for storage of finished components, sub-assembly parts, group assembly parts and complete assembly products into stores for safety record purposes.
5. Control of all requisitions (demand note, material warrant etc) for raw materials, standard parts, and other bought-out items as per production programme.

- Release of standard parts, finished component and assembly papers as the schedule to assembly department.
- Assist in preparation production programme and budgeting.
- Updating production planning and control records (i.e. progress report, material movement register etc.
- Liaising with design and production department in solving problem arising is a result of incomplete information and Design error.

3.6.2 Production Planning Control Records

Apart from the afore-mentioned duties, it is pertinent to mention some of the records maintained by the production planning and control for accomplishment of its objectives.

1. Daily Progress Report

This is the report that shows the progress of work on each component released to the production floor. The description of job, drawing number, issued quantity, date issued, number of operations, operation in progress, time duration, machine on which component is loaded, inspection verdict and constraint are given in the report. This enable sequential follow-up of every component to be carried out easily and adequately.

2. Monthly Production Report

It is a record that gives detail progress, production report of job completed, in-progress and out standings in a particular month. For example, if a batch of 10 machines is to be released to production department; the total components for that batch would be calculated and recorded.

At the end of the month, total No of completed components are calculated from daily progress and recorded in the monthly production report.

Those in progress and the outstanding balance due to any constraints i.e. no material, no tools etc. are also recorded in order to know the action to be taken.

3. Manufacture Warrant:

Manufacture warrant as the name depicts is a document that empowers production department to commence on a particular jobs. The No of processes to be performed on the jobs are itemized, section to which jobs belongs, setting up time and operation time are also specified. There is column for inspection verdict on the completed process.

4. Components register

There is always component register opened for each product in order to know the quantity of material released, date issued, date of completion and inspection verdict on quantity accepted or rejected. This is for proper recording and documentation.

5. Non-conformity Register

A non-conformity register is maintained for proper accountability of material issuance. This is a result of scrapped job, works that are undersized but are still useful, and request for replacement. Reason for rejection of any particular job wil be stated in the register and the jobs kept for future use.

Return Note:

There is return note form, which is used to return

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Return Note:

There is return note form, which is used to return:

- To find out whether parts or assemblies can be much cheaply fabricated or purchase.
- To determine plant and labour requirements.
- To determine economics of making revision of production facilities and practices and to intimate means of cost reduction.
- To determine the most economical method, process or material or combination thereof for manufacturing a product.
- To provide a base for award of incentive to outstanding workers.

3.7.1 THE QUALITIES OF AN ESTIMATOR

The basic requirements of an estimator is that he should have a good knowledge of the processes involved e.g. Production processes, tool room and tool design practices, materials metallurgy , some general accounting knowledge, a good degree of mathematical accuracy and some experience. These requirements indicate someone with formal engineering training; nevertheless others with different backgrounds may be trained for the job if such people have the interest. Even the engineer has to be trained before performing effectively production planning estimation functions. However, this section must be headed by an experienced process or production Engineer.

3.7.2 Function of production planning estimation:

The function of production planning estimation can be divided into two sub headings:

The functional (functions that are being performed)

The unexploited (functions yet to be performed)

The functional: These functions are the day- to-day activities of PPE

(i). **Standard Time**: This is calculating and establishing set up and operation times for manufacturing assembly of parts. By performing this, a standard time will be established for each component.

Standard time is the time a trained and experience operator will carry out a job with full incentive effort and skill at standard performance.

Standard time is divided into two.

- Setup time (TS)
- Operation time (TO)

Setup time, TS is the time it take an operator to collect, fix, removed and returned to, prepare and adjust machine, study drawing, taking instruction from supervisor, punch in and punch out on job card, prepare job on machine, clear working place and take job to inspection.

TS = Basic set up + Tool set up + Job set up + Idle allowance.

Operation time, TO, is the time it takes an operator to perform an operation from the time he picks up the job up to the time he places the job back.

TO= tm+ th +Ti

tm = machining time – the period of contact between work piece and tool.

th = handling time – the time for loading and unloading of jobs, tool change and manipulation of jobs.

ti = Idle allowance – time for personal needs e.g. drinking, toilet, washing of hands, time for workshop needs e.g. oiling of machines, waiting for crane, cleaning work place ; time for fatigue e.g. complexity of job.

Calculation cards are used in calculating set up and operation time for our main products.

N.B. Set up time varies according to types of machine and sizes of job. Machining Time is calculated using formulae while a factor of 15% of the sum of machining and handling time is added as idle allowance. See a list of formulae for calculating machining time of different operations on **appendix 1.**Other parameters are obtained from standards or from work measurement.

(ii). Work measurement: Time and motion studies are carried out to establish set up time and operation time when necessary.

There are many work measurement techniques; these are some of the techniques.

Work Spelling: This is a method of calculating the percentage of occurrence or the frequency of a particular activity using statistical sampling and random observation. It is used in measuring work content in process industries e.g. Steel Rolling Mills.

Stop-watch time study: It is a technique used in recording the time and the rate of working for the elements of a specified job in order to obtain a standard time necessary to carry out this job at a define level of performance. It is mainly used in manufacturing industries e.g. NMT

Predetermined Time Standard (PTS): It is the technique which establishes time for basic human motions to build up the time for a job at a define level of performance. It is used in the measurement of manual work where time studies is not convenient e.g. watch assembly, electronic component assembly.

Standard Data: Where many elements are common and occur repeatedly at the work place, a standard data is established in order to make time estimation easier. To be more reliable, it is necessary to analyze these data. This can be used in any industry.

(iii). Activi'y statement: PPE has a performance-monitoring wing, which monitors the performance of operators on the production floors. This is to obtain information, which is to be transmitted to the appropriate authority. This information's are complied to give progress, report of the activities in production. Some of these reports are:

1. Capacity utilization (Daily/Monthly machine idle report)
2. Man power utilization (Monthly efficiency report)
3. Production aims manufacturing report.
4. Contribution to industrial spares.
5. Manufacturing reports (for outside and NMT product)
6. Job register.
7. Job cards.

These reports and documents enable the authority to identify where there are failures and find solutions and also to appraise where there are successes

(iv). Incentive schemes: Initiative and recommendation for incentive originates from PPE as a result of report prepare by this section. Calculating the efficiency for each operator does this. Operators with high degree of efficiency are recommended for incentive. These encourage operators and boost their ego and consequently increase productivities.

Note-Efficiency = $\frac{\text{output}}{\text{Input}} \times 100$

(v). **Selling price / Manufacturing cost of production:** In achieving this there are many factors to be considered.

Machine Hour Rate: This is the cost of running a machine or facility for one hour. To calculate this, the cost of machine or facility and the period of machine will function, depreciation (Fixed expenses) must play a prominent role. The existing machine hour rate for all machine were calculated by PPE.

(vi). **Cost estimation**: This is to determine the machining cost, manufacturing cost and eventually the selling price of products. It is also used to establish the economic production volume. In cost estimation the elements to be considered are:

1. **Work shop expenses (labour):** This is the cost of performing each operation.
   Labour cost = standard time (in Hrs) x machine hour rate.
2. **Material expense:** This is the cost of raw materials, standard parts and castings.
   $$\text{Material cost} = \frac{\text{(Material length x weight (kg/m)}}{1000} \times \frac{\text{(Machine Rate M/T)}}{1000}$$
3. **Material handling expenses:** A percentages of material cost is calculated to obtain material handling charges. This is to cater for rust, storage etc.
4. **Administrative charges**: A percentage of production cost is calculated to obtain administrative charges.

Production cost = Material cost + handling charges + labour cost.

Administrative charges + production cost = **Factory cost.**

5. **Venture/ Risk allowance**: This is to cater for any increase in material cost, error in estimation, increase in work content, and deviation from planned method.
6. **Special cost**: This includes parking and freight cost, Design and planning (for special job).
7. **Profit:** This is a percentage of manufacturing cost.

Manufacture and assembly masters for each product manufacture in-house, it also scrutinizes and approves cost estimate sheets for outside jobs prepared by industrial spare Department.

The unexploited: These are functions yet to be fully exercise by PPE.

1. Ascertain whether parts or assemblies can be more cheaply fabricated or purchased.
2. Make a revision study of existing production facilities with the bid to reduce cost.
3. Scrutinized methods, process or material or combination thereof for manufacturing a product.
4. Estimate operating cost at the start of a project by providing a standard of production performance and control.

3.8 ENGINEERING FACILITIES IN NMT

The engineering facilities refer to in this project are the equipment available in the production and manufacturing department of the industry. The name, quantity and the capacity of all the equipment under each section were stated and tabulated.

3.8.1 FOUNDRY

The foundry is an integrated plant designed to meet the casting requirement for NMT products range as well as to satisfy orders and requests from customers. There are different segments of the foundry plant such as; Melting section, Non-ferrous, Moulding section, Die-casting, Fettling shop, Laboratories and Pattern shop. The table below shows the name, quantity and capacity of all the facilities in each of the segments in the foundry section.

No	Name	Qty	Capacity
	Melting Section		Power: 1000Kw
1.	Coreless Induction Melting Furnace	2	2,000Kg/hr melting rate 50HZ – Frequency
2.	Coreless Induction Melting Furnace	1	Power: 250 Kw 250 Kg/hr, Frequency:- 10000 Hz
	Non-Ferrous		
3.	Crucible Furnace	2	Capacity Crucible:- 200kg Fuel tank - (600 Ltrs)
4.	Immersion Thermometer	2	Temp. 1800 ^{0}C Max.

	Moulding Section		
5.	Furan Sand Mixer (Articulated sand Mixer)	1	Nominal Capacity:- 12 Tons/hr Primary arm length:- 2,800mm Mixing arm length:- 100mm Total Max Reach: 4,200mm
6.	Furan Sand Mixer (Floor Moulding) (No bake system)	1	Nominal capacity – 12 Tons/hr Mixing arm length:- 1,800mm Outlet height:- 1,700mm
7.	Green Sand Moulding System Small moulding machine	2	Table size 750 x 500mm Suitable for flasks 650x460x130mm Pattern draw 80mm Jolt capacity 4,500N Dynamic squeeze pressure 110,000 N
8.	Medium size moulding machine	1	Table size 920 x 580mm Suitable for flask 1000 x 700mm Pattern draw 350mm Squeeze stroke 230mm Jolt capacity 11,000 N
	Die Casting		
9.	Die Casting Machine	2	Casting weight: 0.3 to 1kg (zinc) Metal Pot Capacity: 68kg (zinc) Die size: 150 x 150 100mm Air requirement 0.5m/mm
	Fettling Shop		
10.	Forklift Trunk	2	Lifting Capacity: 2,500kg Load arm: 1,220mm Max. Lifting Height 3,300mm
11.	Pail Loader	3	Capacity 1,200g 300 llrs

12.	Shot Blasting Machine (monorail)	1	Capacity: 2 Ton s/P Chamber size 1.6 x 2.0 x 2.3m
13.	Shot Blasting Machine	1	Table Dia: 1,000mm Capacity: 2 Ton s/hr
14.	Pedestal Grinder	1	Peripheral Velocity 60m/s Wheel diameter 600mm Wheel width: 60mm Power: 11Kw Spindle speeds: 1,900 r.p.m. -2,300 " -2,850 "
15.	Pendulum Cut-Off Machine	1	Wheel diam: 40mm Power: 8.5 Kw Spindle Speed: 3,810 r.p.m Cutting Speed: 80m / sec
16.	Electric Welding Equipment	1	Secondary Capacity: 45 – 300 A Zero Load Tension: 80 r
17.	Gas welding set	1	For welding up to 10mm thick M.S. plate
18.	Heat Treatment Furnace	1	Length: 3,500 mm Width: 1,000 mm Height: 1000mm Max Temp: 1,100 ^{0}C Power: 150 Kw Max Load: 200 kg
19.	Spraying Booth		Height: 3,500 mm Depth: 2,000 mm Length: 4,000 mm

	Laboratories		
20.	Electronic	1	Reading accuracy: 0.00 1 kg Capacity: 1,200 (1.2kg)
21.	Rammer Device	1	
22.	Strength Tester	1	
23.	Permeability Tester	1	
24.	Moisture Tester	1	
25.	Compactibility Tester	1	
26.	Laboratory Sifter	1	
27.	Rapid Sand Washer	1	
28.	Drying Cabinet	1	Inside dimension: 300 x 300 x 300 mm Temp. Control Range: 40 – 240 ^{0}C
29.	Annealing Furnace	1	Inside dimension: 150 x 150 x 300 mm Temp. Control Range: up to 1,110 ^{0}C
30.	Moulding Strength Tester		
31.	Methylene Blue Clay Tester		
32.	Sand Mixer	1	Bath Capacity: 1 – 2.5 Kg Power: 600 w
33.	Speedy Moisture Tester	1	
34.	Core Hardness Tester	1	
35.	Shatter Index Tester	1	
36.	$C0_2$ Gassing Accessories	1	
37.	Impact Penetration Tester	1	
38.	Abrasive Cut – off machine	1	Max Capacity: 130 x 70 or 95 x 95 mm
39.	Grinding and Polishing Machine	1	Diameter: 250mm
40.	Bedding in Press	1	Mount dia: 30mm Power: 1,600 Kw

41.	Metallurgical Microscope	1	Eye piece & Mc Planachromats to achieve enlargement (50 x to 1,000)
42.	Etching Facility	1	
43.	Dessicator	1	Dia: 300mm
44.	Quick Laboratory (Molten Metal)	1	
45.	Tensile Test Bench	1	Capacity: 50 Tons Pressure fore: 500 KN Height x width x depth: 1250 x 600 x 440mm Compression Plate: 340mm Width btw column: 230mm
46.	Hardness Testing Machine	1	Pre-Load: 100N Rockwell: 600 – 1,000 – 1,500 N Brinell: 625 – 1,250 – 1,875 N
47.	Spectrometer	1	Analyses 26 elements at a time
48.	Fume Stand Hood	1	
49.	Weighing scale	1	Max. Weight capacity: 10kg Graduation: 0.02kg
50.	Hot Plate	1	2 Kw
	Pattern Shop		
51.	Parallel Pendulum Saw	1	Saw Blade, Adjustable: Loaded at 90^0 Saw Blade diameter: 500mm Cutting Capacities: 170 x 450mm Power: 7.5Kw
52.	Thickness Planning Machine	1	Planning width: 520mm Planning height: 2 – 240mm Table size: 520 x 850mm Power: 5.5 Kw

53.	Surface Planning Machine	1	Planning Width: 400 mm Total table Length: 2,600mm Power: 4 Kw
54.	Universal Pattern Milling Machine	1	Column: 400mm Milling height: 2,600mm Work Table: 490 x 630mm Compound Table: 400 x 490mm
55.	Pattern Makers' Lathe	1	Centers : 1000mm Centre height above bed: 500mm " " " slide rest: 225mm
56.	Disc Sander	1	Sanding disc (dia) : 600mm Table length : 800mm Table width : 280mm Table tilting : 30/45 degrees
57.	Profile Band Grinding Machine	1	Sanding table : 400 x 400mm Swivel inward/outward: 45/20 dgr Sanding height : 240mm Rasping " : 130mm Sawing " " 40mm
58.	Bobbing Sander	1	Table size 500 x 500mm Bobbin g 20 – 120mm Sanding Height: 180mm Table inclination: 30/20 degree
59.	Pattern Maker Band Saw	1	Pulley dia : 400mm Free dist. : 380mm Cutting height : 350mm Table size : 500 x 500mm
60.	Drill Press Boring	1	Overhand column spindle centre: 500mm

			Max working height on swivel Table : 715mm Table size : 490 x 400mm
61.	Tool Grinding Machine	1	
62.	Band & Circular Saw and Plane Cutters grinding Machine	2	Circular saw dia: 120 – 600mm Band saw dia: 5 – 60mm Plane cutters: Length Max: 650mm
63.	Circular saw	1	Dia: 500mm

Table 3.5 Foundry Facilities

Source: Author's compilation

3.8.2 TRAINING CENTRE

The training centre has capability to train the managers, engineers, technician and the craftsmen. The facilities of the centre are also open to non-NMT personnel. The table below shows the facilities in the training centre.

S/No	Description	Qty	Technical Specification
1.	Centre Lathe	1	Centre Height – 260 x 1000 mm Between Centre
2	Centre Lathe	7	Centre Height – 220 mm x 1000 mm Between centre
3	Centre Lethe – Vikram – 750	10	Centre Height – 190 mm x 1250 mm Between Centres
4	Pedestal Grinder GG -300	2	Wheel dia. 300 mm
5	Tool and Cutter GTC 28T	1.	Swing Diameter – 280 mm
6	Power Hacksaw HS – 20	1	Max diameter – 200 mm of materials
7	Pillar Drill	1	Max. Drill diameter – 25 mm MT 3 Taper, Spindle; Power 1.5 kw
8	Bench Drill	2	Max. drill diameter – 13 mm

9	Radial Drill RM 63	1	Max Diameter of hole – 50 mm in steel
10	Universal Cylindrical Grinding Machine K 13 – 300 U	2	Max. diameter - 125 mm Max Length - 550 mm Height - 130 mm
11	Internal Grinding Machine G 9	1	Max bore dia – 30 mm Grinding spindle 45 x 160 mm long Spindle speed 4,000 rpm Work head 250 rpm Table 1070 x 230 mm vertical – 400 mm
12	Ram Type Milling Machine (MITR)	1	Traverse Longitudinal 760 mm Cross – 305 mm ram – 305 mm
13	Shaping Machine CSM -63 -45	2	Max stroke 630 mm & 500 mm respectively
14	Vertical Milling FN 2V	3	Taper ISO40, 1,350 x 310 mm Table size
15	Horizontal Milling Machine FN2 H	2	----------DO----------
16	Universal Milling Machine FN 2U	3	Taper ISO40, 1350, x 310 mm Table size Swivel table --- V 45^0
17	Cylindrical Grinding G 9 U	1	Max Grinding dia – 30 mm Centre height - 90 mm Between Centres – 200 mm
18	Surface Grinding Machine SEWI	1	Working surface – 100 x250 mm Max. traverse of Grinding Wheel -320 mm Max longitudinal trav. Of table – 115 mm Max. Grinding length " " -1100 mm Max. Grinding Height - 400 mm

Table 3.6: Training Centre

Source: Author's compilation

3.8.3 HEAT TREATMENT SHOP/CHEMICAL LABORATORY

The heat treatment shop/ chemical laboratory consists of a standard and well equipped heat treatment plant for machine components, complete with carburizing/hardening line, annealing/normalizing line and galvanizing line. The facilities for carrying out these operations are listed in the table below.

S/No	Specification	Qty
1	STC I Bath (Salt bath)	-1N0.
2	STC II Bath (Salt bath)	-1N0.
3	STC III Bath (Salt bath)	-1N0.
4	Annealing furnace	-1N0.
5	Shot blasting machine	-1N0.
6	Nickel plating equipment	-1 set
7	Blackening equipment	-1 set
8	Hardness Testing Machine	-1N0.
9	Carbon – Sulphur analyzer	-1N0.
10	Desiccators	-1N0.
11	Metter balance	-1N0.
12	H2O Sterilizer	-1N0.
13	Single arm analytical balance	-1N0.

Table 3.7 Heat treatment shop/chemical laboratory facilities

Source: Author's compilation

3.8.4 TOOL RECONDITIONING AND RESHARENING

The tools are generally maintained in order to ensure the quality of the end product and to prolong the life span of the tools, thereby reducing the cost of procurement of tools. The table below shows the facilities in the tool reconditioning and resharpening section.

S/No	Description	Qty	Technical Specifications
1	Tool & Cutter -GTC 28 T	3	Swing dia: -- 280 mm Dist btw Tail stock Centre – 760 mm

			Dist btw Tail stock and W/head – 615 mm
2	Tool & Cutter Grinder	1	Dist. Btw T.S. centre – 600 mm
	(UW II)		Dist. Btw wheel centre and table – 310 mm Max
3	Automatic Sharpener	1	Min / Max Twist drill dia – 200 mm
	for Circular Saw		
4	Twist Drill Grinder	1	Min./Max twist drill dia – 3/40 mm
	(BSA 40)		Max. grinding dia – 200 mm
5	Twist Drill Grinder	1	Min/Max Twist drill dia 8/40 mm
	-BSA 80		Max. grinding wheel dia 300 mm
6	Gear Hob Sharpener	1	Module of Hob - 1 to 20 mm
	SWFW 250		Work dia min/max – 50/260 mm
			Work length –400 mm (max)
7	Tap & Die Grinder –	1	Centre Height above table – 170 mm
	RS 300		Centre dist. Above table – 180 mm
			Max grinding dia - 120 mm
			Max. wheel dia – 125 x 25 x 32 mm
8	Engraving Miller Gm	1	Work table -500 x 300 mm
	1-2		Pantograph ratios -1: 1 to 1: 100
			Travel X,Y,Z - 300 x 180 x 250 MM

Table 3.8 Tool reconditioning and resharpening facilities

Source: Author's compilation

3.8.5 TOOL AND MEASURING ROOM

This room is located nearest to the manufacturing floor so as to reduce the idle time or the unproductive time of the operators, while accomplishing the production tasks, by providing necessary tooling, gauges, measuring instruments, jigs and fixture etc. at the point of use with a minimum distance. The table below shows the technical specification and quantity of the facilities in the tool and measuring room.

S/No	Description	Qty	Technical Specifications
1.	Jib Boring machine Micromat 9B	1	Table traverse X axis – 1120 Cross travel Y axis - 710 Table size 1400 x 1900
2.	Universal Tool & Cutter Milling Machine FNGJ 32	1	Mounting Table - 800 x 400 mm Working dist. X,Y,Z axes -800 x 400 x 400 mm Taper in spindle – SK 40
3	Universal Tool Room Milling and Boring Machine	1	Mounting table – 112 x 630 mm Travels X,Y,Z – 800 x 400 x 400 mm Taper in spindle - SK 40
4	Linear & Circular Dividing Machine – FNK 25 A + PA + DU 250A	1	Mounting Table 1- 1250x 290mm Table travels XYZ – 800 x 360 x 460mm Spindle head swivel (to each side) – 90^0 Spindle head rotation (to each side)- 180^0
5.	Mechanical Platform Scale 5110.5 x 3	1	Capacity – 500 Resolution – 500g Pan size – 690 x 690mm
6	Electronic Counting scale – FC 5000	1	Capacity – 500 gm Resolution – 0.5 gm Pan size –315 x 270mm Min. Unit Weight – 0.01gm
7.	Linear Height measuring instrument – 518 – 905	1	Measuring range 0 – 600mm Least count – 0.005mm
8. M	Ultrasonic Flaw detector - USK 75	1	Test ranges - Min / Max 0-10mm / 0-1[illegible] Pulse shift 0-25mm steel Frequency Range 0.5 – 10mHz Gain 010.5dB control range, 0/20/40 60dB
9.	Talyrond 3 Mit PC	1	External & Internal dia. –355mm (max) Height above table Surface – 686 (H) Throat Depth – 305mm

			W/P Lg. Using table aperture – 1270mm (max) W/P Lg. Using table aperture – 215mm (min)
10	Taper Checking Machine – 818K	1	Max. taper angle - 45^0 Travel of carriage – 160mm Centre dist. of sine roller – 300mm Mounting bore of indicator-8mm Weight – 14Kg
11.	Portable surface Roughness measuring	1	As: 0.05 – 40Um Rz: Rimax: 0.3 – 160Um Cut-off :0.25,0.080,0.50

Table 3.9 Tool and Measuring room facilities

Source: Author's compilation

3.8.6 METAL FABRICATION SHOP

This section caters for metal fabrication needs of the industry. Processes like cutting, folding, welding etc. are done in this section. The table below shows the facilities in the metal fabrication shop.

S/no	Description	Qty	Specifications
1.	ASE Guillotine Shear – TS 8022194		
2.	Morgan Press Brake –8610-003	1	Max thickness of late –6mm
3.	Morgan Asis 50 Threaded Manual Guillotine Shear	1	Max thickness of late –1.5mm
4.	BSRN/800/50- Manual Rolling Machine	1	Max. thickness of plate – 2mm
5	Hand operated Guillotine- NPT 1000 2	1	Max. thickness of plate – 1.5mm
6	Mechanical Eccentric Press – LEN 63C	1	Tonnage – 63 Tons
7	Morgan Press Brake	1	Max. thickness – 6mm of plate
8	Power Rolling Machine	1	
9	Spot Welding Machine	1	Max. thickness of plate – 2mm

10	Gross Carriage Profile Flame cutting Machine Corta – N1500 x 1500	1	Working width 1 x 1500mm Carriage length: 800 mm - Tracing width: 1500mm - Cutting Thickness width 2 torches Max. 200 mm - Width 4 torches max. 100mm
11	Welding Bending Machine	1	Max. thickness of plate – 1.5mm
13	Hydraulic pipe blender	1	
14	Hydraulic Guillotine shear	1	Max. thickness of plate – 6mm

Table 3.10 Metal fabrication shop facilities

Source: Author's compilation

3.8.7 HEAVY PARTS WORKSHOP

This workshop consists of the facilities that are mostly modern computer numerical control (CNC) machine tools available in the market as well as conventional machines that can handle heavy casting and related jobs. The table below shows the facilities in the heavy parts workshop.

S/no	Description	Qty	Specifications
1	Heavy duty centre lather L-45	1	Swing – 900mm Length of work between centre-3m Max. turning diameter – 850mm Max swing with side head lowered below the table – 1000mm Max weight of work – 5 tons
2	Vertical Turret Lathe CVT-85	2	Max. hole diameter – 60mm in steel Spindle Taper MT 5
3	Radial Drilling Machine RD-65 RD- 65	1	Mounting table 800 x 4000mm Travel in XYZ axes 400 x 800 x 1000mm Max Table Load – 3500 Kg. Taper in Spindle – ISO50
4	Single Column Bed Milling Machine FSS 80 CNC	1	Working surface of Table 630 x 220mm
5	Vertical Machining Centre		

	FCQV 63 CNC		Travel in XYZ axes 1500 x 630 x 630 Spindle speed range 20-3500rpm Taper in spindle – ISO50 No of Tools on Tool Magazine –40
6	Universal Column and knee Type Milling machine FGS 83 CNC	1	Mounting table – 630 x 1400mm travel in XYZ axes – 1120 x 630 x 500mm taper in spindle –ISO50
7	Turret Lathe NC Control SU1 63 CNC	1	Centre height – 220mm Swing – 530mm Max. length turned with box tool – 360mm Max. diameter of holding – 55mm No of Tools on turret head – 8 Nos
8	Heavy Duty vertical surface Grinder BPV 80A – 3000	1	Working surface of table –800 xx 3000mm Max height of grinding – 800mm Micro feed of wheel spindle grit –8mm/min
9	Vertical Hydraulic Honing machine VZH 160/800F	1	Table size – 700x 500 mm Stroke length –800mm Honing & Stroke length – 700mm Honing diameter – 15 to 250mm
10.	Vertical Milling M/CEM 4V	1	Longitudinal traverse – 1400mm Cross traverse – 360mm Vertical traverse – 475mm Max. safe weight on the table –1000g
11	Horizontal Boring/Milling machine AZ 9	2	Max. Permissible Weight – 4 tons Traverse of the tables (XYZ)-900mm Vertical traverse of the head stock – 900mm Axial traverse of Boring Spindle –630mm Table working Area- 900 x 1200mm
12	Horizontal Boring and Milling machine WHN 13.8CNC	1	Mounting table – 1800 x 1600mm Max capacity – 12 tons Travels in XYZ axes 3500 x 2000 x 1250mm

			taper in spindle – ISO50
13	Horizontal Boring and Milling machine W 100 A	1	Largest drill depth – 900mm Distance between spindle and mounting table – 0/1120 mm (min/max)- Y axis table min/max. (Y) Mounting table – 1250 x 1250mm Travels X & Y axis- 1600 x 1250mm
14	Horizontal Milling EM 4H	1	Longitudinal travers – 1400mm Cross traverse – 360mm Vertical traverse – 475mm Maximum safe weight on the table – 1000 Kg

Table 3.11 Heavy parts workshop

Source: Author's compilation

3.8.8 SMALL PARTS SHOP

The shop is equipped with machines for the production of small and medium components. Units within this shop include the round section, gear section, non-round section; central tools crib section and assembly section. The table below shows the facilities in the small parts shop.

S/no	Description	Qty	Specifications
1.	Capstan lathe	3	Swing Over Carriage –260mm Centre height – 125mm
2.	Centre Lathe NH22/100	8	Centre height – 220mm Swing Over bed – 500mm Dist. Btw Centre- 1000m
3.	Centre lathe NH26/1500	5	Centre height – 220mm Swing Over bed – 500mm Dist. Btw Centre- 1500m
4	Centre lathe NH26/1000	1	Centre height – 260mm Swing Over bed – 550mm

			Dist. Btw Centre- 1,000m
5	Centre lathe NH26/1500	2	Centre height – 260mm Swing Over bed – 550mm Dist. Btw Centre- 1,500m
6	Centre lathe NH26/2,000	5	Centre height – 260mm Swing Over bed – 550mm Dist. Btw Centre- 2,000m
7.	Copying lathe SU140	2	Swing Over bed – 550mm Swing Over Relieved Section of the bed – 460mm Max swing Over- 220m Cross slide Dist. Btw Centre- 1000m
8	Drum Turret Lathe	1	Max. swing dia with – 410mm chasing attachment Max swing dia. Without chasing attachment – 460mm Normal Chuk dia – 2600mm No. of tools on turret – 16
9	Facing & Centering Machine	1	Max. facing dia. 150mm Dia. Of work hel in vices –20 to 200m Max length of work – 1200mm
10.	Oil Groove cutting	1	
11.	Universal Numerically Controlled lathe SPT32 CNC	1	Max. Turning dia – 320 Max. Swing above bed – 490mm Max. Turning length – 1,500mm
12	Automatic Cold Circular Metal Sawing Machine – PKA 13		Dia. of saw blade – 400/360/315mm Max length of Cutting by single feeding- 400mm Min. Length of cutting – 6mm Max. dia of cut – 130mm
13	-do- PKA –25	1	Max. dia. of material -250mm
14.	Power Hacksaw – CH20	1	/Max. dia. of material cut – Rd/Sq- 200/180mm Strokes/ Minute- 80/100/125

			Length of Blade – 400mm
15	-do-CH30	1	Max. dia. of material cut – Rd/Sq-300/250mm Strokes/ Minute- 80/100/125 Length of Blade – 525mm
16.	Horizontal Milling Machine FN2H	3	Table size – 1350 x 310mm Travels in XYZ – 800x 265x400mm Spindle Nose Tapes – ISO 40 Max. safe wt. on table – 350kg
17	Horizontal Milling Machine FN3H	2	Spindle Nose Taper – ISO 50 Table size – 1600 x 355mm Max. Safe wt. on table – 600kg
18	Vertical milling machine – FN2V	5	Table Size- 1350 x 310mm Spindle Nose taper – 110 40mm Travels in XYZ axes – 800 x 265x400mm
19	Vertical milling machine – FN3V	1	Spindle Nose Taper – ISO 50 Table size – 1600 x 355mm Max. Safe wt. on table – 600kg
20.	Ram-Type Milling machine – MITR	1	Table –1070 x 230mm Longitudinal traverse- 760mm Cross – 305mm, Ram – 305 Vertical – 400mm
21.	Universal Milling Machine – FN	4	Able Swivel (to each side) 45^0 Table size – T1350 x 310mm Spindle Nose – ISO 40 Travels in XYZ – 800 x 265 x 400mm
22.	Keyway Milling Machine	1	Max length of key-way – 400mm
23.	Slotting machine – CH25	1	Max stroke – 250mm
24	Horizontal Broaching machine RW 5	1	Max. tractive Force – 50.000N Max Stroke – 1320 mm Max. w/p.dia with sted coolant guard – 340mm Max. broach dia. – 60 mm

			Max \. Shank Piece dia. – 36mm Max End Piece dia- 36mm Clearance btw. Guide Plates – 160mm
25	Bench Drilling Machine DB13	2	Drilling Capacity – 13mm
26	Pillar Drilling Machine DP 25	1	Drilling Capacity – 25mm Spindle Nose taper – MT 3
27	Radial Drilling Machine – RD61	3	Drilling Radius Max/Min –1190/530mm Drilling Capacity – 50mm in steel Spindle Nose taper – MT 5
28	Radial Drilling Machine mm – RD 63	5	Drilling radius. Max/Min – 1790/530
29	Pedestal grinder GP-25	1	Grinding Wheel – 250 x 50th Spindle Speed – 1440rpm
30	Pedestal grinder GP-30	2	Grinding Wheel Dia – 300mm Spindle Speed – 1440rpm
31	Surface grinding machine – SFW1	3	Working Surface – 250 x 1000mm Max transverse of Grinding Wheel – 320mm Max. Transverse of table – 1150mm Max. Grinding length – 1000mm
32	Surface Grinding machine – SFWII	1	Working Surface – 250 x 1500 Max traverse – 320 of wheel Max traverse Longitudinal – 1650mm
33.	Cyl. Grinding Machine – G130/800 P	2	Grinding Wheel dia.-300mm Max. Grinding length – 800mm
34	Cyl. Grinding Machine – G17/800 P	1	Grinding Wheel dia.-500mm Max. Grinding length – 800mm
35	Cyl. Grinding Machine – G17/12,00 P	1	Grinding Wheel dia.-500mm Max. Grinding length – 12,00mm
36.	Tool & Cutter Grinder – GTC 28	2	Swing Dia.- 280mm Dist. btw T-S Centres – 760mm

			Dist. Btw T-S centers and W/ head – 615mm
37	Drilling Machine for Polyangular holes- FNK 25A + 31005	1	Mounting Table – 1250 x 290mm Table Travels XYZ – 800 x 360 x 460mm Spindle head swivel (to each side)-90o Spindle head Rotation (to each side)- 180o
38	Universal Internal grinder – BDU 250A	1	Bore dia., Min/Max – 1025mm Max grinding length – 250mm Max. swing – 400mm Max. swing without protection –470mm
39	Multi – spline Hobbing and Thread Milling Machine ZFWVG 250 x 3150/4F	1	Centre height above bed slide ring –260mm Max. W/P dia. above bed carriage –250mm Max. W/P dia. above slideway – 500mm Bore of collect – 100mm (max.) max. working length – 3, 000mm
40	Gear Shaping machine – OHA 50A	1	Max dia. swing – 250mm Max helix angle – 45 degrees Dia of Cutter Spindle – 85mm Max. dia f. cutter – 150mm Dist. btwn W/P Spindle and cutter spindle faces; Max./Min – 10/45mm
41	Gear Shaping Machine -OHA 50A	1	Biggest real module – 8mm Smallest real module – 1.5mm Max./Min Wheel dia with external toothing- 500mm Largest Helix angle- 41^0

42.	Gear Hobbing Machine -H-400	2	Diameter of Work table – 400mm Dist. btwn Hob and Work axes – 30 to 300mm Max. Dia of Hob- 186mm Max. length of Hob – 180mm Max. travel of Hob slide – 300mm
43.	Gear Tooth Rounding & Chamfering Machine	1	Min./Max. pitch to be milled – 1/10mm Max. permissible W/P dia for external toothing – 800mm Min./Max. W/P dia. for internal toothing – 45/300mm
44.	Hydraulic Straightening Press	1	Pressing Power – 400N Stroke Length – 200mm Peration speed – 50mm/s

Table 3.12 Small parts workshop facilities
Source: Author's compilation

3.9 HARDWARE REQUIREMENTCAD hardware must comply with a number of requirements in order to achieve the following: on-line man-machine interaction; sufficient computing performance and requisite size of main memory to solve design problems in acceptable time; application of hardware resources on a time-sharing basis; high reliability; and reasonable cost(O'Leary,1998).

These requirements can only be met by organizing hardware support in the in the form of a special-purpose hierarchical computing system or a computer network complete with sophisticated peripheral devices designed to process, store, and provide alphanumeric and graphical information.

The problem of hardware development is to select, evaluate, and validate the structure

of a multilevel hardware system intended to solve the problems of computer –aided design of specific objects. A hardware system can be made up of standard equipment such as computers, data channels, displays, external memory devices, and other facilities, or it can be built of custom-designed equipment including, for example, workstations, plotters, and encoders.

A multilevel hardware system must be complete with one or a few high-performance computers at the highest level. This type of computer solves complex design problems which require a large amount of computer time and considerable memory space. At the lower levels in the hierarchy, the system can include medium-scale computers and also minicomputers and microcomputers (terminal computer) which are integral parts of workstations. These computers solve relatively simple design problems, control integrated peripheral equipment, and coordinate information exchange between various levels of the hardware system.

3.10 SOFTWARE REQUIREMENTS.

The development of CAD software is one of the stages in implementing the CAD system. With a gradual expansion of software support, the software expenses continuously grow and as a rule, considerably exceed hardware expenses. Software tools are now evolved on an industrial basis. The final product of software development is a programme product which consists of a set of programmes properly tried out and recorded on data media and a set of guidance documents(world wide web).

The efficiency of a computer-aided system is greatly dependent on the quality of programme products. A poor quality of programme products entails large losses of time and money, cause distrust in the products, and distracts the user's attention from his job.

The cost of detecting and removing errors in the programme product in service is tens of times the cost of debugging at the development stage.

The estimation of programme product quality is a complex (multiple-factor) problem which is difficult to formalize. Since the interests of users are diverse, it is impossible to suggest the only universal criterion of software quality.

Many quality factors are needed to cover the entire range of the desired properties. According to Koryachko(1990) these are:

1. The degree of documenting. This characteristic of software combines the properties of understandability, conciseness, and completeness. Software is understandable if the user understands the purpose of software tools. A programme product is concise if its documentation does not contain extraneous information and excludes an ambiguous interpretation of the terms and symbols. A programme product is complete if it contains all requisite components, each being thoroughly developed.

2. Efficiency. The ability of a programme product to accomplish the required function without excessive amounts of resources. The estimate of efficiency can be the programme characteristic whose value is directly proportional to the speed and inversely proportional to the volume of the resources used. We take the term resource in its broadest sense, which can identify an internal or an external memory devices, graphics inputs device, plotter, channel throughput, etc.

3. Reliability. The ability of a programme product to steadily handle the assigned functions. Reliability primarily implies that the programme does not contain errors. But since errors inevitably occur, the programme should be written so that all errors can be cleared easily; this is possible to do if the programme documentation has sufficient quality.

4. Simplicity of operation: The property which enables a programme product to function normally in a clear-cut area of its application.

5. Ease of operation: The property which enables a programme product to adapt to changes in the requirement.

6. Portability: The degree of adaptation of a programme product to computers of various operating systems.

7. Compatibility: The ability of a programme product or its programmes to be written onto various types and to various operating system.

8. Testability: The property of a programme product that affords ease of checking the programmes for serviceability in definite condition.

Cost: The cost of a programme is a function of all its characteristics. Improving any of its characteristics increases the cost, and so a reasonable compromise has always to be sought in trading the desired degree of improvement against a higher cost

3.11 DATA TOOLS

According to Jeffrey et al (2000) the following are the data tools used in database design.

- Data administrators (DBAS) are responsible for the data based technology, database design and construction, security, backup and recovery and performance turning.
- Database Architecture refers to the database technology including the database engine, database utilities, database CASE tools for analysis and design and database application development tools.
- Database management system (DBMS) is specialized computer software available from computer vendors that is used to create, access, control, and manage the database. The core of the DBMS is often called its database engine. The engine responds to specific commands to create database structures and then to create, read, update and delete records in the database.
- Data definition language (DDL) is used by the DBMS to physically establish those record types, fields, structural relationships. Additionally, the DDL defines views of the database. Views restrict the portion of a database that may be used or accessed by different users and programs.
- Data manipulation language (DML) is used to create, read, update and delete records in the database and to navigate between different records and types of records for example, from a customer record to the to the order records for that customer. The DBMS and DML hide the details concerning how records are organized and allocated to the disk.

3.12 NETWORKING

Networking is the connection of two or more computers linked together in order to access each other. This is done so that these computers can share resources (Renaud, 1996).

Type of Network

Computer network can be classified by their scope, topology and model (Cisco, 2004).

Network scope

The scope of a network refers to the geographical area the network spans. A network could be laid within an office building, or extends from one continent to the other. The following are the scopes available in today's network according to Cisco(2004).

1. Local Area Network (LAN)

A Local Area Network (LAN) is the networking of several computers housed in a clearly defined geographical area, such as in a single building. A LAN can only be as large as the physical limitations of the cabling you use, which varies depending upon the cabling type.

2. Wide Area Network (WAN)

A Wide Area Network (WAN) is the networking of devices that can span large geographical areas like countries and continents. In a WAN, at least some of the connections rely on long- distance fibre-optic cable, or specialized high-speed telephone lines.

3. Metropolitan Area Network (MAN)

A Metropolitan Area Network (MAN) is a sort of mini-WAN that is typically confined to a single municipality. A company might use a private MAN to link several different office buildings together within the same city. For instance networking between Ikoyi and Victoria Island.

Network topology

This is the physical layout of a network. It is the manner in which computers are arranged in a network.

Network Model

This includes peer-to-peer network and the client-server network.

In this project, all the departments are networked together using a Local Area Network (LAN) connection, so as to have access to different information available in each of the department. The results of the networking is shown in the result of the software developed.

3.13 THE INVESTMENT STRATEGY FOR MAKING THE INDUSTRY FULLY OPERATIONAL.

Growth in the size of an organization can be measured in many ways; profit, turnover, earnings per share, manpower etc, but the real aim of a growth strategy is growth in profits. The pursuit of size of increased turnover is not an end in itself but is only worthwhile if it leads to higher profits.

During the initial stage of business review and assessment, management are likely to encounter a profit or growth gap between estimated future performance and the firm's desired position. Identification of the causes of the gap, and thus areas for strategic consideration is known as gap analysis.

Different strategies for closing the gap may be summarized by the following grid.

	Existing products	**New products**
Existing Markets	Internal Efficiency Market Penetration	Product Development
New Markets	Market development	Diversification

Improvements in internal efficiency are not something about which strategic decisions are taken. They should be constantly sought as part of the day- to -day running of the firm and so are covered in the operations plan (which is one of the sub-plans which elaborate the strategy).

Market penetration, product development and market development cover the expansion of a firm within its own industry. Diversification is concerned with moves into new product-market areas.

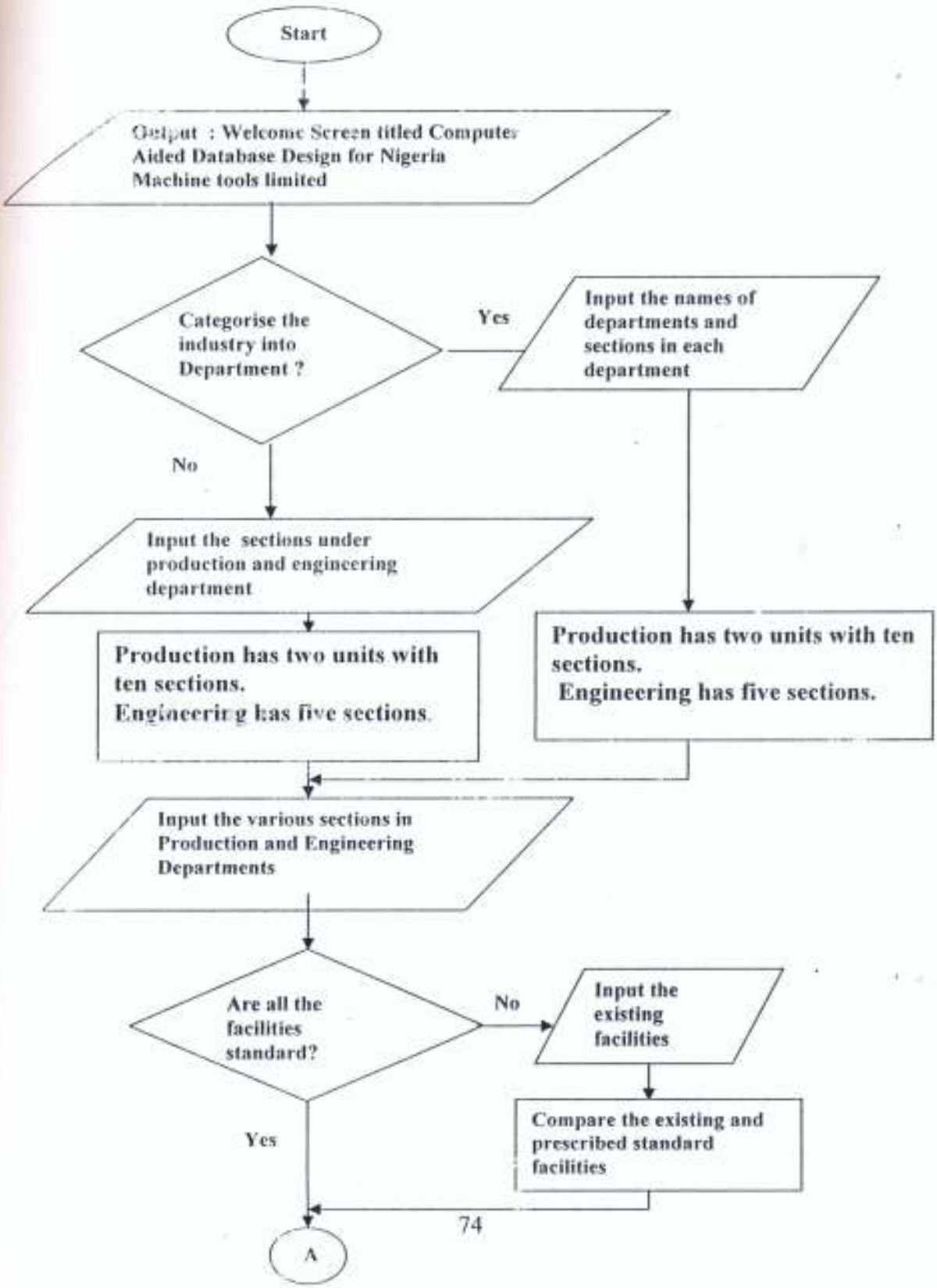
The main strategic decisions to be taken are:

1. Shall we attempt increased market penetration?
2. Can our objectives be achieved solely by increased market penetration or shall we need to expand the product range or market base or diversify as well .
3. Shall we expand and if so in what general direction?
4. What resources are available or can be made available for expansion?
5. Shall we diversify, and if so into what general area(s)?
6. What resources are available or can be made available for diversification?

CHAPTER FOUR

4.0 RESULT AND DISCUSSION OF SOFTWARE DEVELOPMENT

The flowchart developed in preparation for the development of the software for evaluating capacity build-up of a machine tool industry.



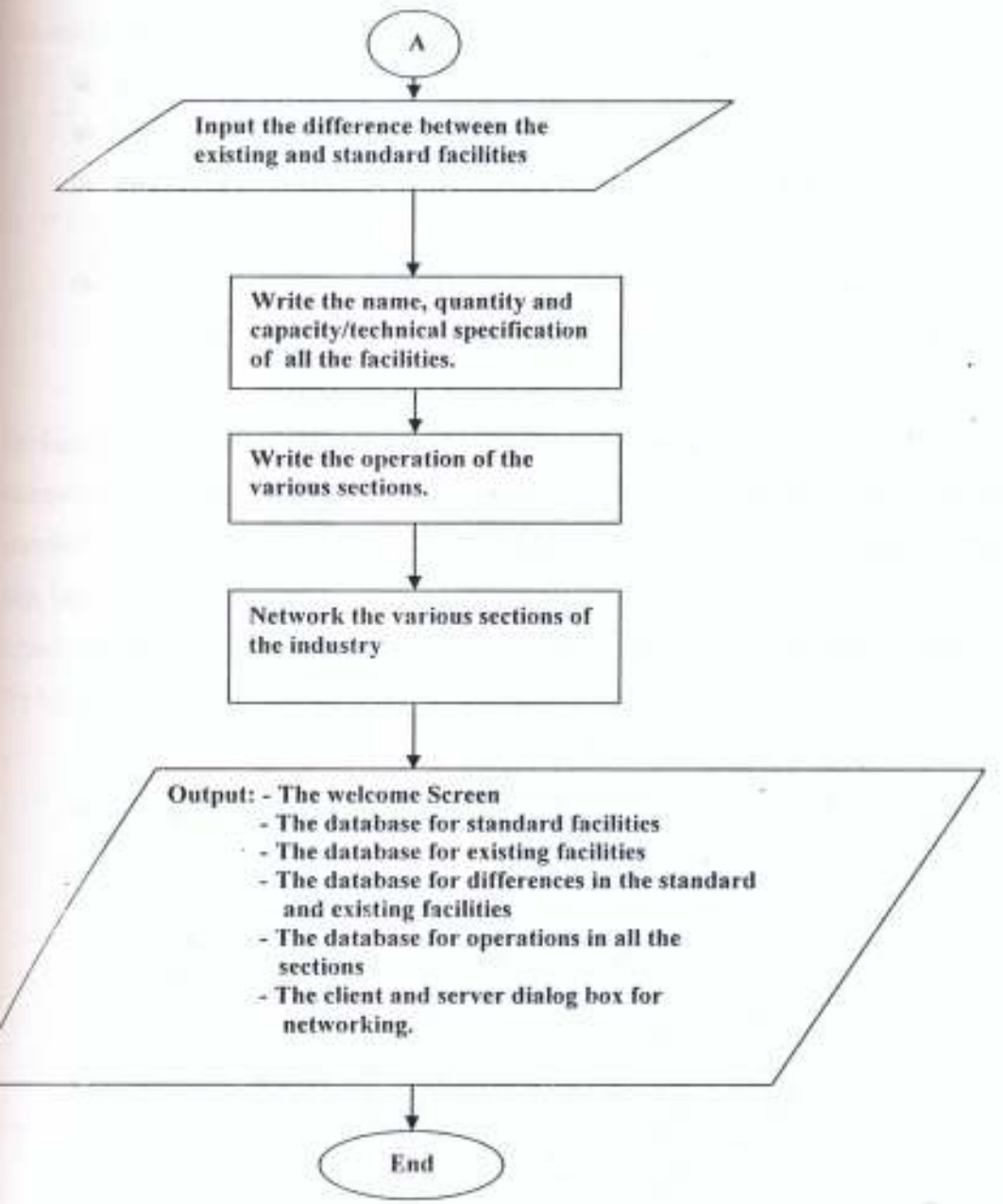


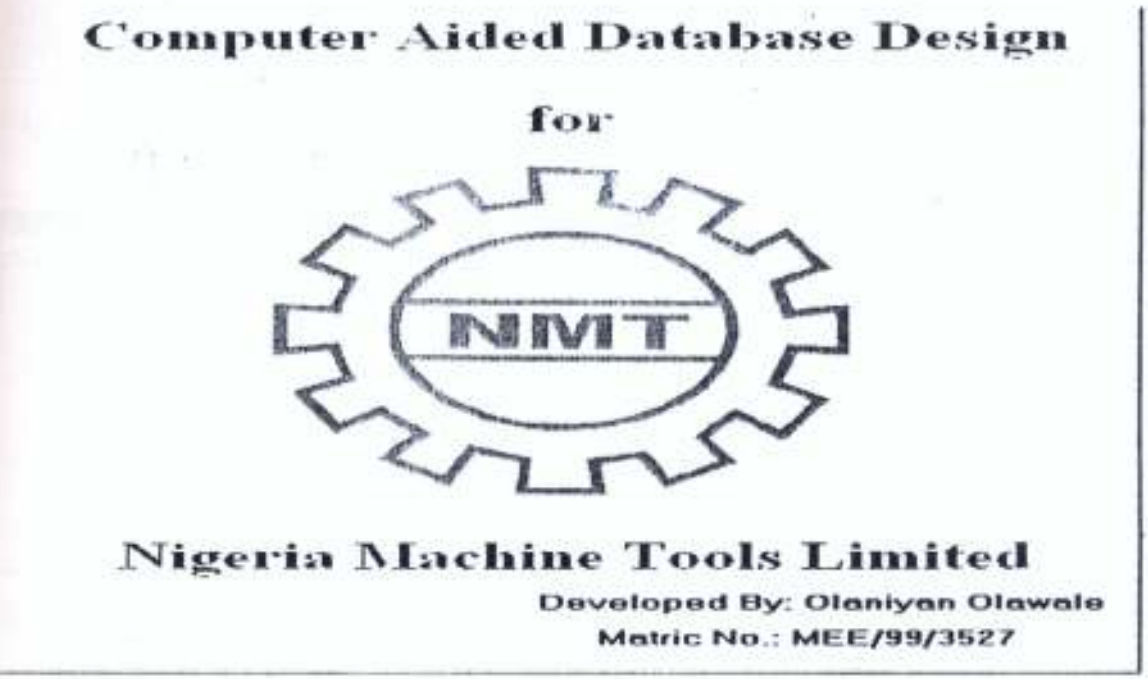
Figure4.1: Flowchart Diagram of the Developed Software

The results of the software developed shows:

- The database of the standard facilities in Machine Tools Industries.
- The database of the existing facilities in Nigeria Machine Tools Industry.
- The database of the differences in the standard and existing facilities in Nigeria Machine Tools Industry.
- The database of the operation carried out in each section of the production and engineering department of the industry.

The figures shows below are the database of the standard facilities that are obtainable in a well equipped machine tools industry. The database cut across the foundry, metal fabrication shop, heat treatment shop, laboratory, tool reconditioning& resharpening shop, training centre, tool measuring shop, heavy parts and small parts. The database in the foundry unit includes; melting section, non-ferrous, moulding section, die casting, fettling shop, laboratories and pattern shop.

The figure below show the welcome screen of the software.



ig. 4.2 Welcome Screen of the software.

The figure below shows the dialog box displaying the buttons of the database for standard, existing, differences in the standard and existing and the operation carried out in the production and manufacturing department of the industry. By pressing any of the buttons it will take you to another dialog box that displays the different section of the machine tool industry. By further pressing of the buttons of each section, it will display the database of the facilities of the section that shows the facility, the quantity of it and their capacity.

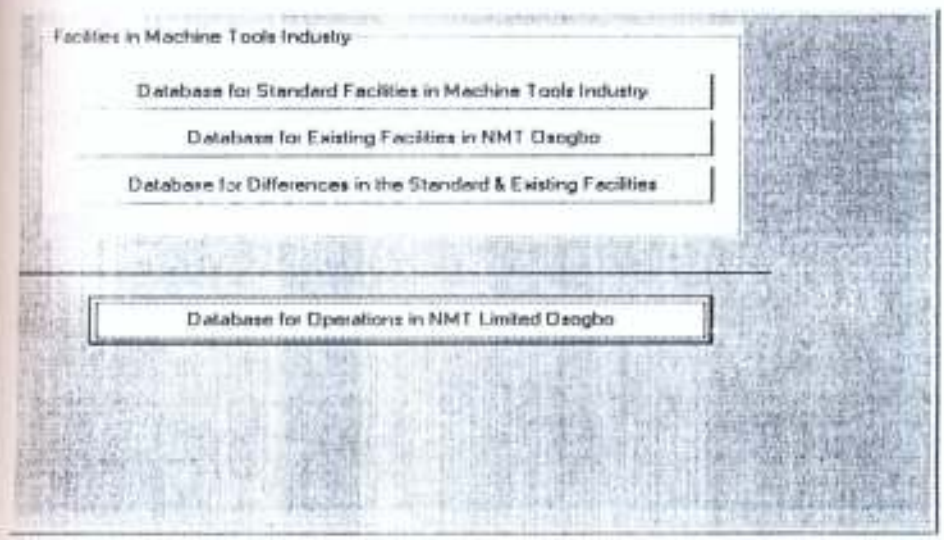


Fig.4.3. The dialog box showing the buttons for the database access.

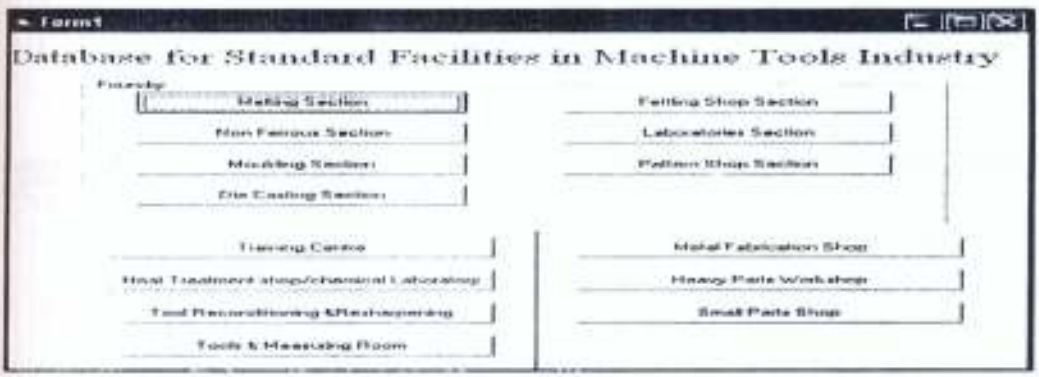
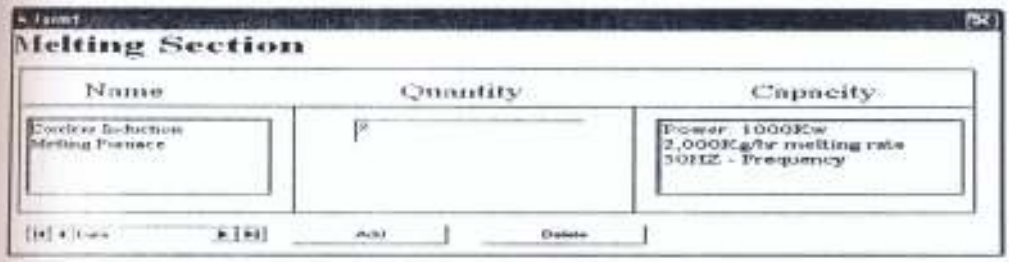
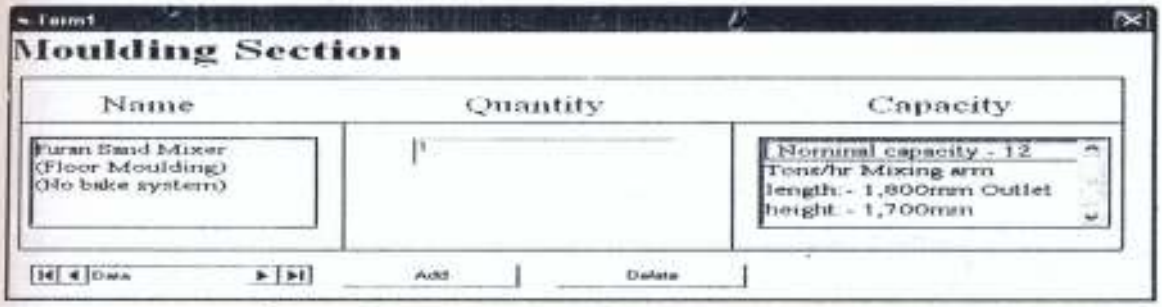


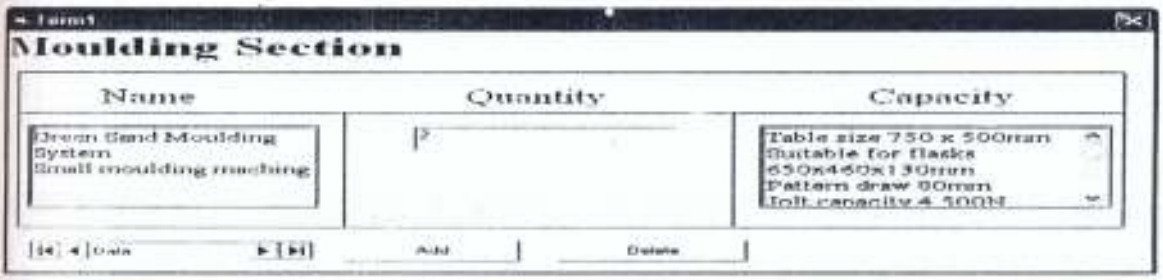
Fig 4.4 The dialog box showing the buttons of different section of the machine tool industry.

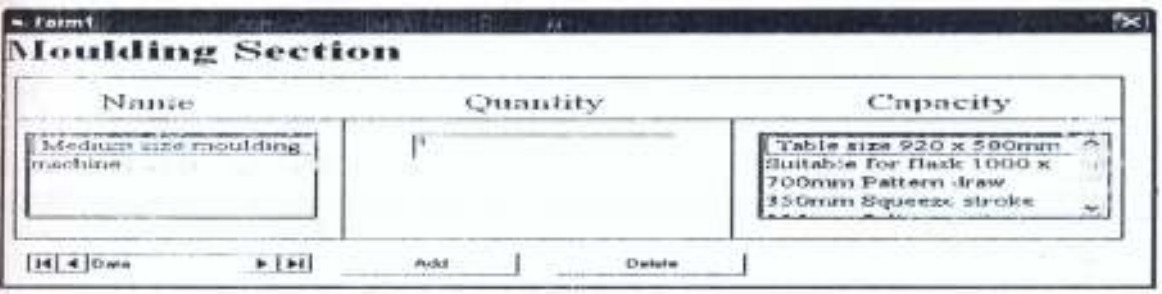
By pressing any of these buttons it will display the database of the facility of each section. The databases are as shown below:

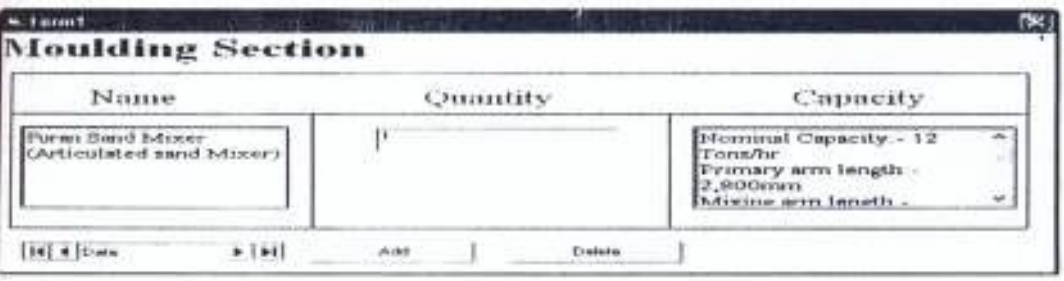

Form1
Melting Section
Name
Quantity
Capacity
Coreless Induction Melting Furnace
Power: 1000Kw
2,000Kg/hr melting rate
50HZ - Frequency
Add
Delete

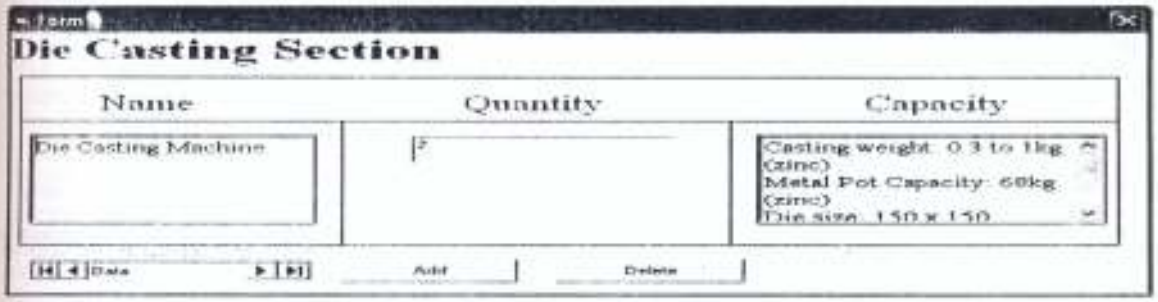

Form1
Non Ferrous Section
Name
Quantity
Capacity
Crucible Furnace
Capacity Crucible - 200kg
Fuel tank
- (600 Litre)
Add
Delete


Form1
Moulding Section
Name
Quantity
Capacity
Furan Sand Mixer
(Floor Moulding)
(No bake system)
Nominal capacity - 12
Tons/hr Mixing arm
length - 1,800mm Outlet
height - 1,700mm
Add
Delete

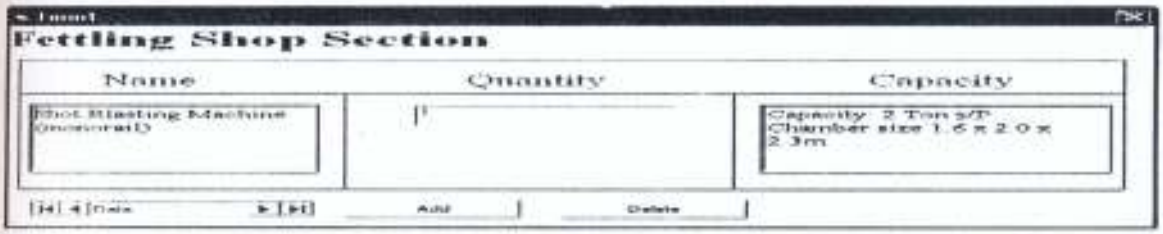

Form1
Moulding Section
Name
Quantity
Capacity
Green Sand Moulding System
Small moulding machine
Table size 750 x 500mm
Suitable for flasks
650x460x130mm
Pattern draw 80mm
Add
Delete

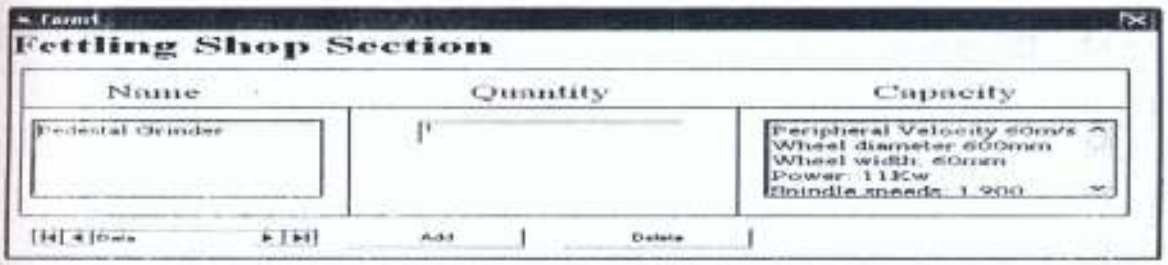

Form1
Moulding Section
Name
Quantity
Capacity
Medium size moulding machine
Table size 920 x 500mm
Suitable for flask 1000 x
700mm Pattern draw
350mm Squeeze stroke
Add
Delete

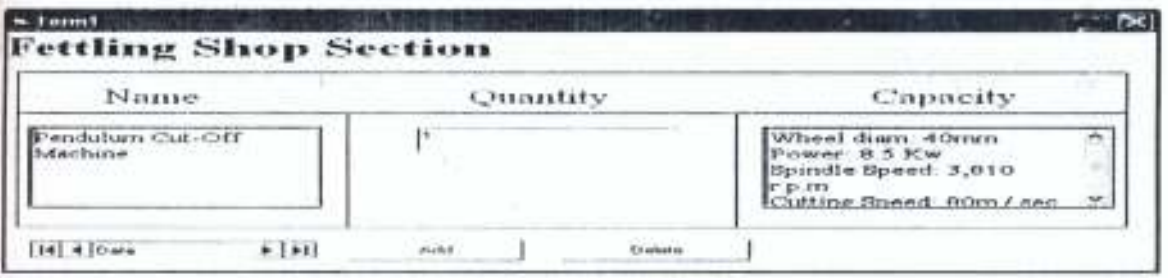

Form1
Moulding Section
Name
Quantity
Capacity
Furan Sand Mixer
(Articulated sand Mixer)
Nominal Capacity - 12
Tons/hr
Primary arm length -
2,900mm
Add
Delete

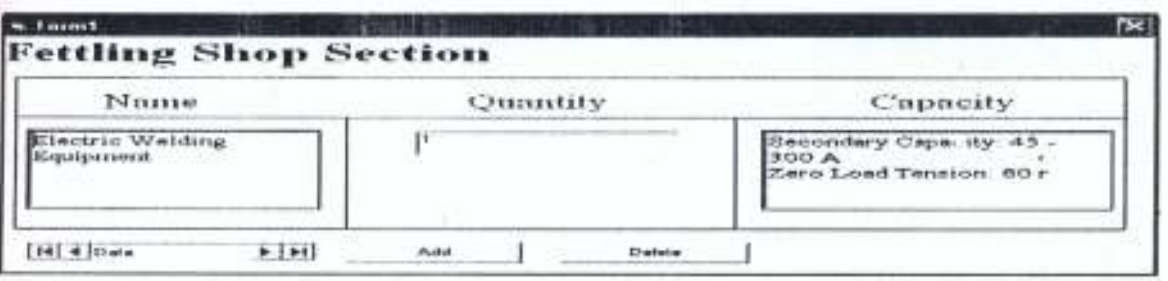

Die Casting Section
Name
Quantity
Capacity
Die Casting Machine
2
Casting weight: 0.3 to 1kg (zinc)
Metal Pot Capacity: 60kg (zinc)
Die size: 150 x 150
Add
Delete


Fettling Shop Section
Name
Quantity
Capacity
Forklift Trunk
2
Lifting Capacity: 2,500kg
Load arm: 1,220mm
Add
Delete

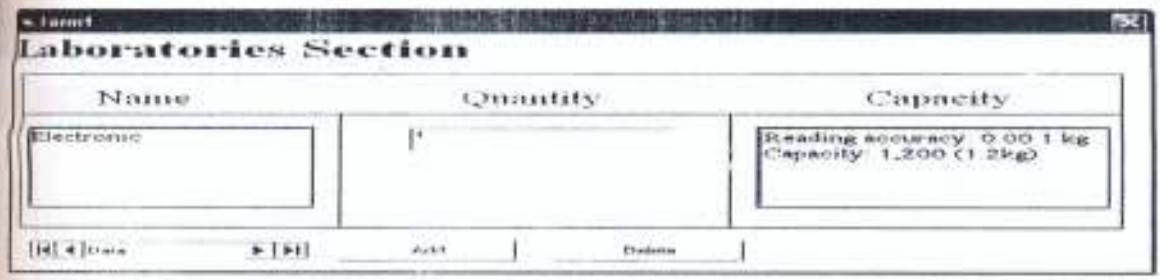

Fettling Shop Section
Name
Quantity
Capacity
Shot Blasting Machine (Monorail)
1
Capacity: 2 Ton s/T
Chamber size 1.6 x 2.0 x 2.3m
Add
Delete

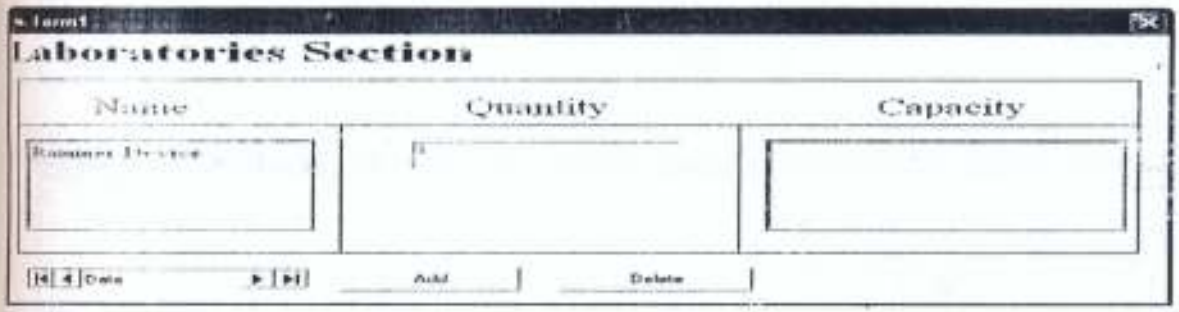

Fettling Shop Section
Name
Quantity
Capacity
Pedestal Grinder
1
Peripheral Velocity 60m/s
Wheel diameter 600mm
Wheel width: 60mm
Power: 11Kw
Spindle speeds: 1,900
Add
Delete

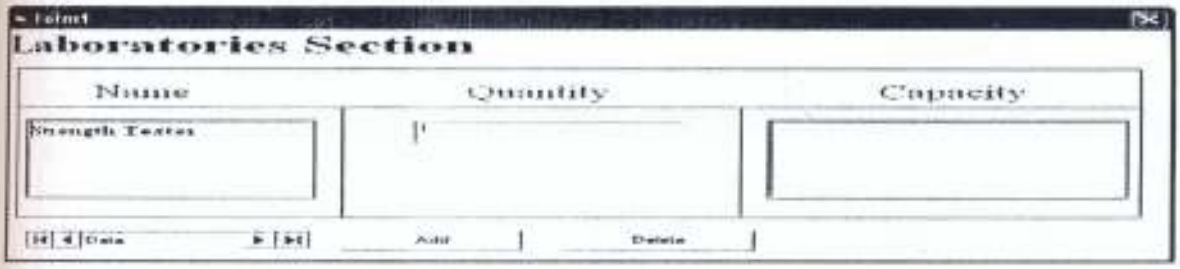

Fettling Shop Section
Name
Quantity
Capacity
Pendulum Cut-Off Machine
1
Wheel diam: 40mm
Power: 8.5 Kw
Spindle Speed: 3,010 r.p.m
Cutting Speed: 80m / sec
Add
Delete


Fettling Shop Section
Name
Quantity
Capacity
Electric Welding Equipment
1
Secondary Capacity: 45 - 300 A
Zero Load Tension: 60 r
Add
Delete

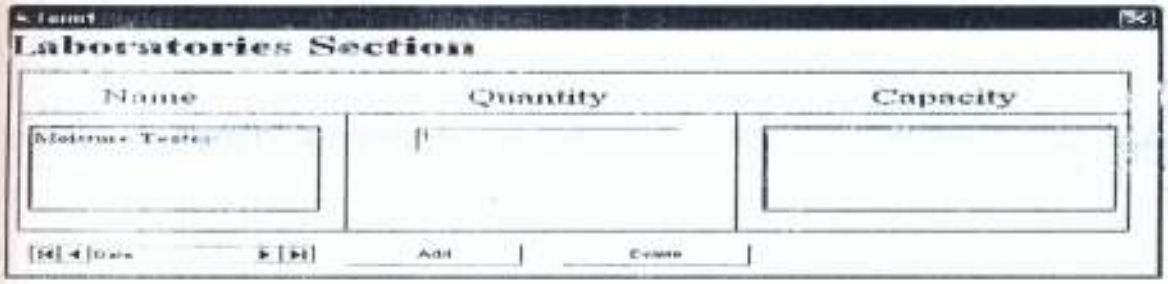

Fettling Shop Section
Name
Quantity
Capacity
Heat Treatment Furnace
Length 3,500 mm
Width 1,000 mm
Height 1000mm
Max Temp 1,100 °C
Power 150 Kw
Add
Delete

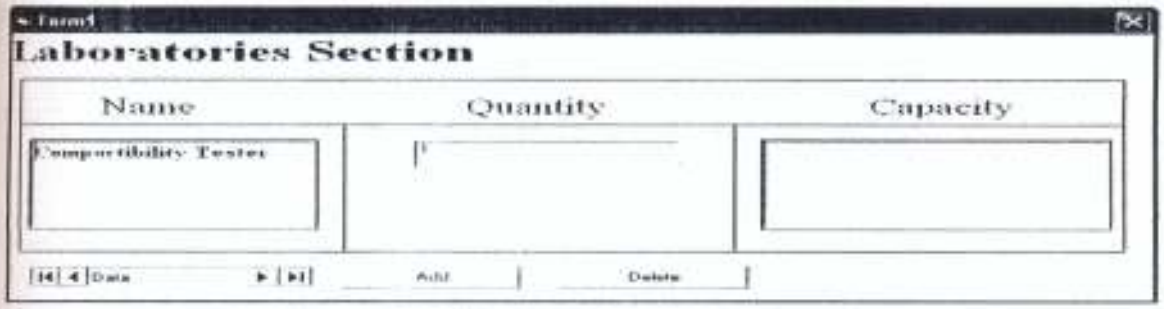

Laboratories Section
Name
Quantity
Capacity
Electronic
Reading accuracy 0.00 1 kg
Capacity 1,200 (1.2kg)
Add
Delete

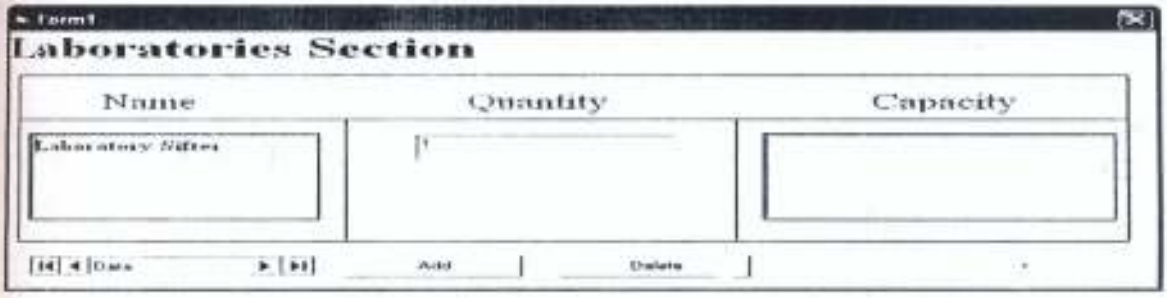

Laboratories Section
Name
Quantity
Capacity
Add
Delete

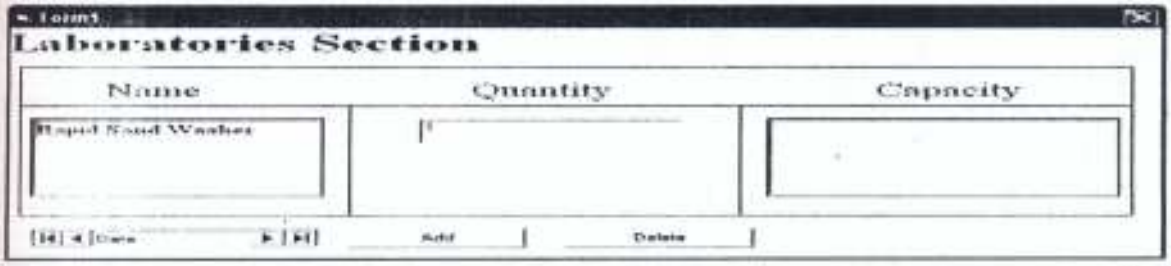

Laboratories Section
Name
Quantity
Capacity
Strength Tester
Add
Delete

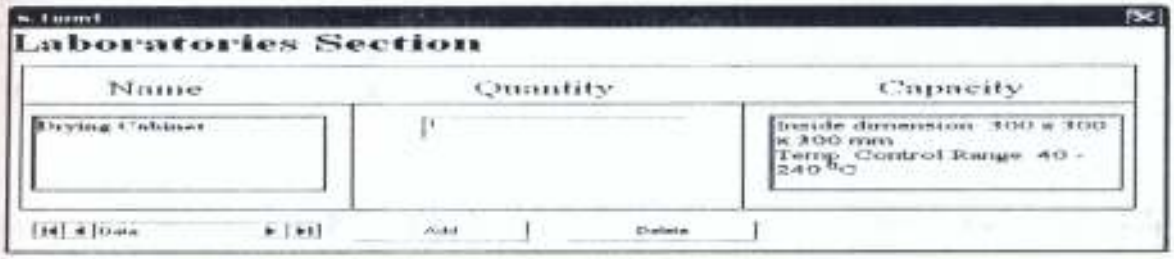

Laboratories Section
Name
Quantity
Capacity
Permeability Tester
Add
Delete

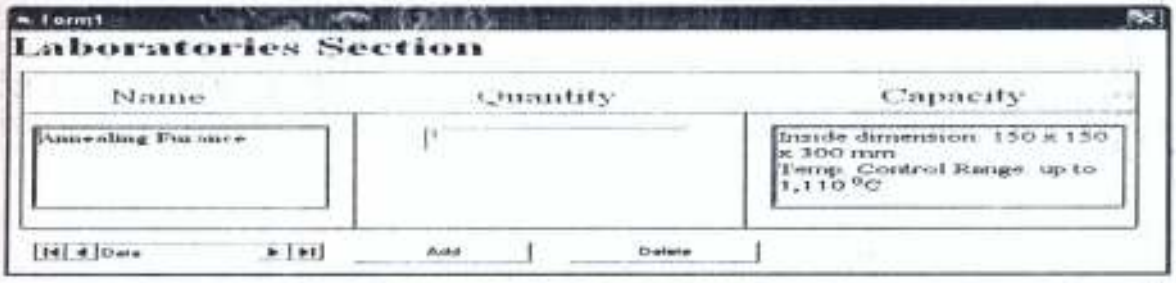

Laboratories Section
Name
Quantity
Capacity
Add
Delete


Form1
Laboratories Section
Name
Quantity
Capacity
Compactibility Tester
Add
Delete

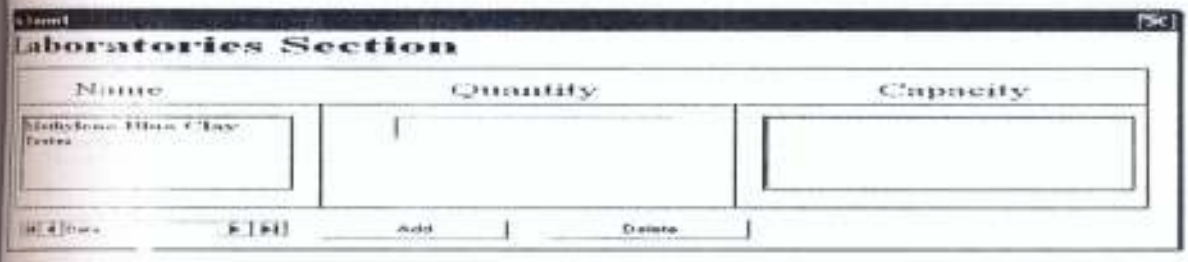

Form1
Laboratories Section
Name
Quantity
Capacity
Laboratory Sifter
Add
Delete

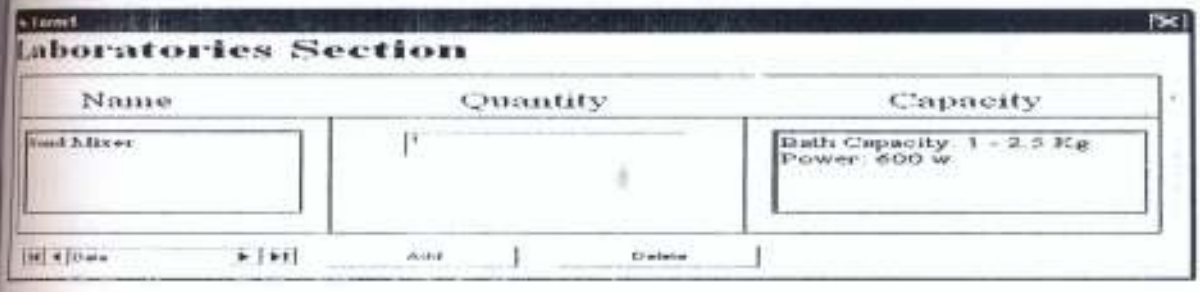

Form1
Laboratories Section
Name
Quantity
Capacity
Rapid Sand Washer
Add
Delete

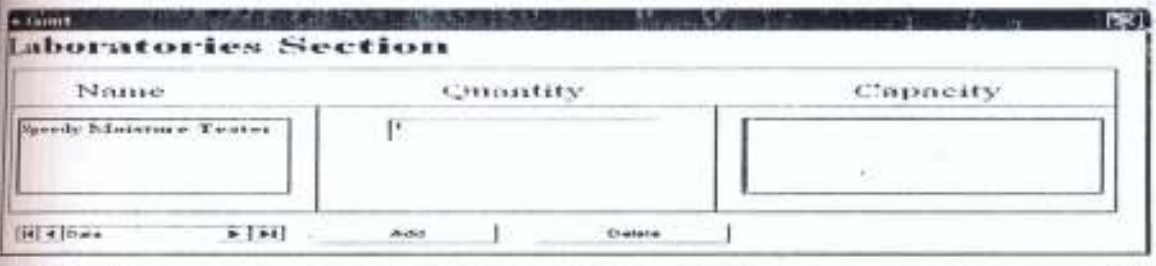

Form1
Laboratories Section
Name
Quantity
Capacity
Drying Cabinet
Inside dimension 300 x 300 x 300 mm
Temp. Control Range 40 - 240 °C
Add
Delete

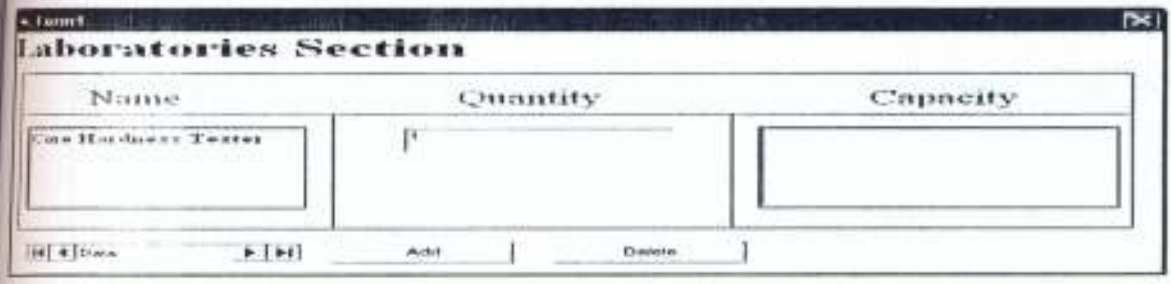

Form1
Laboratories Section
Name
Quantity
Capacity
Annealing Furnace
Inside dimension 150 x 150 x 300 mm
Temp. Control Range up to 1,110 °C
Add
Delete

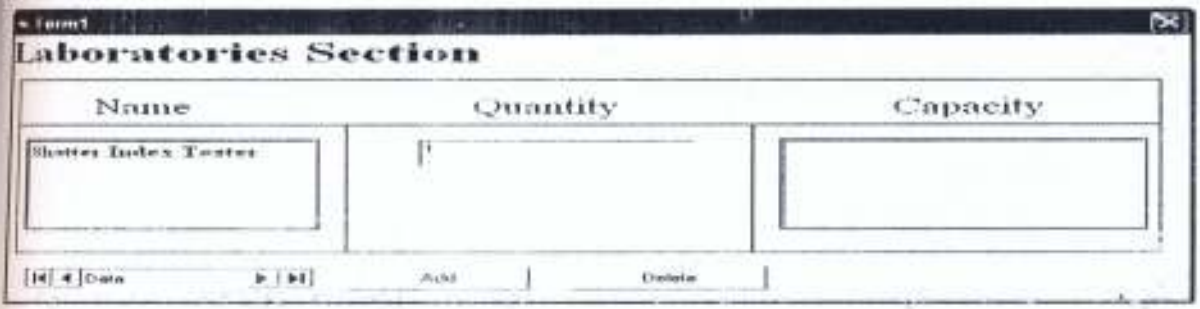

Form1
Laboratories Section
Name
Quantity
Capacity
Add
Delete


Laboratories Section
Name
Quantity
Capacity
Add
Delete

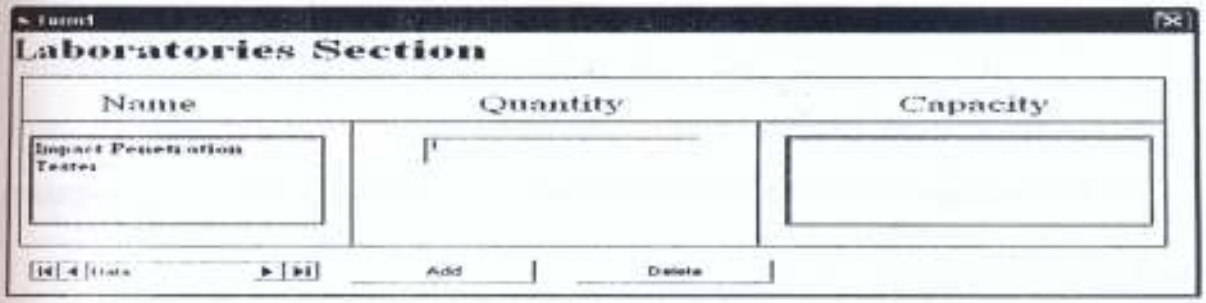

Laboratories Section
Name
Quantity
Capacity
Bath Capacity: 1 - 2.5 Kg
Power: 600 w
Add
Delete

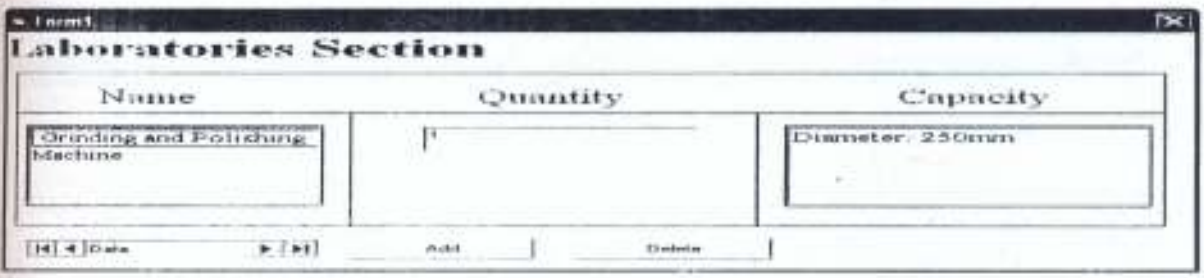

Laboratories Section
Name
Quantity
Capacity
Add
Delete

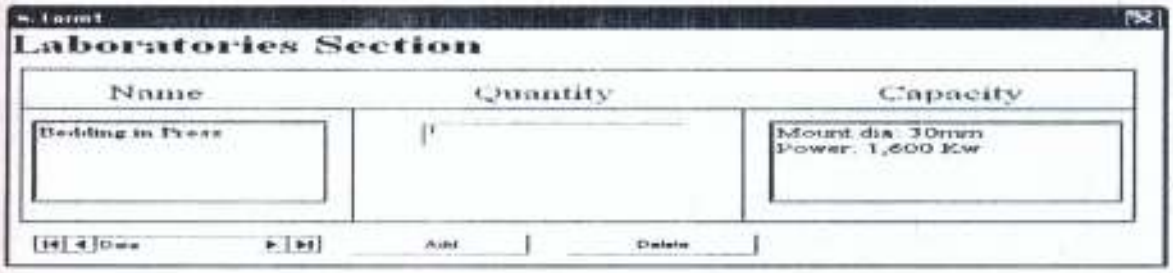

Laboratories Section
Name
Quantity
Capacity
Add
Delete

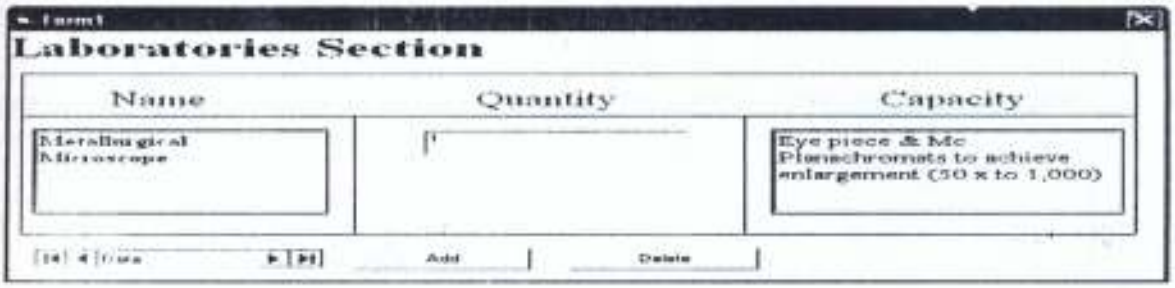

Laboratories Section
Name
Quantity
Capacity
Shutter Index Tester
Add
Delete

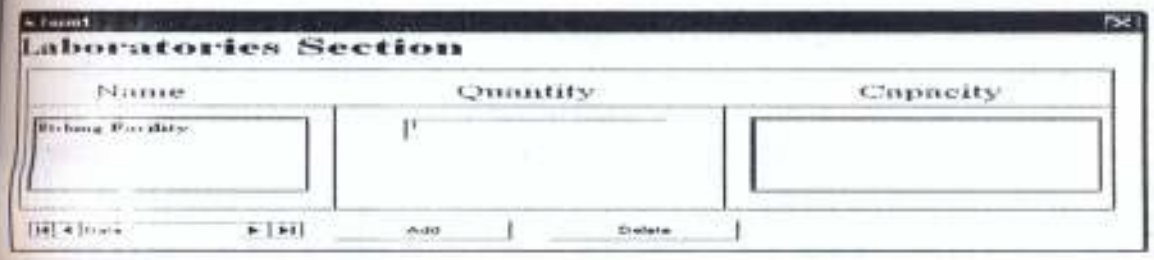

Laboratories Section
Name
Quantity
Capacity
Add
Delete


Laboratories Section
Name
Quantity
Capacity
Add
Delete


Laboratories Section
Name
Quantity
Capacity
Grinding and Polishing Machine
Diameter: 250mm
Add
Delete

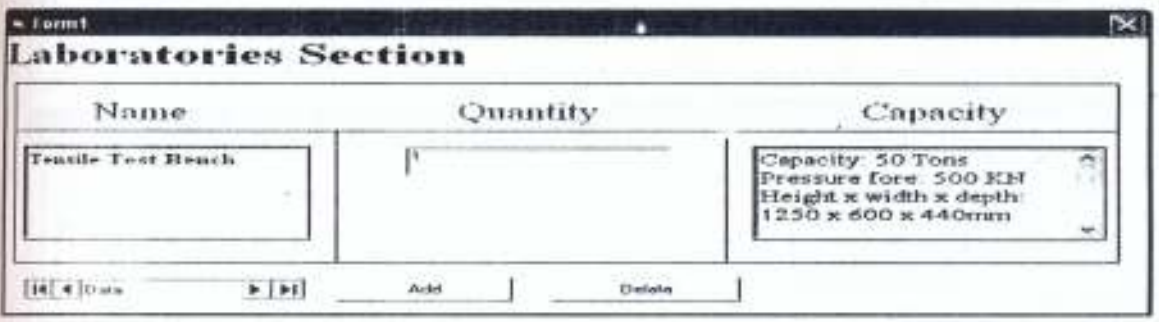

Laboratories Section
Name
Quantity
Capacity
Mount dia: 30mm
Power: 1,600 Kw
Add
Delete

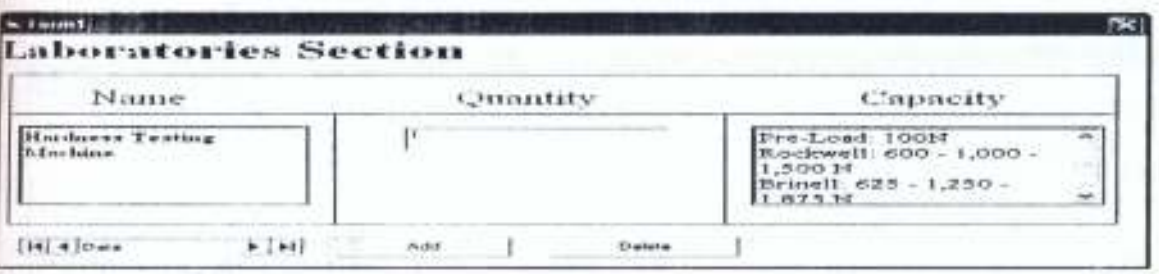

Laboratories Section
Name
Quantity
Capacity
Metallurgical Microscope
Eye piece & Mc
Planechromats to achieve
enlargement (50 x to 1,000)
Add
Delete


Laboratories Section
Name
Quantity
Capacity
Add
Delete


Laboratories Section
Name
Quantity
Capacity
Add
Delete

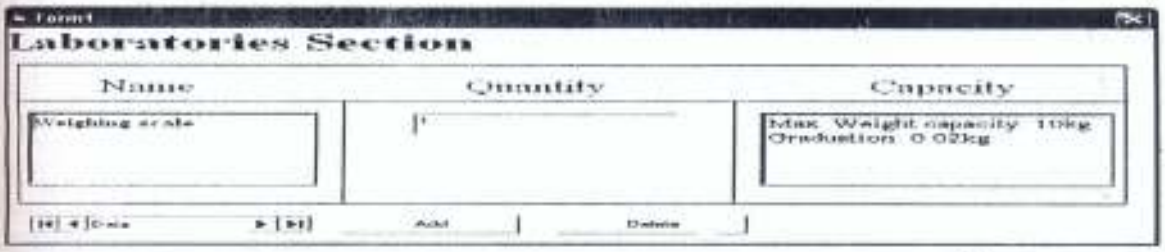

Laboratories Section
Name
Quantity
Capacity
Quick Laboratory (Molten Metal)
Add
Delete


Laboratories Section
Name
Quantity
Capacity
Tensile Test Bench
Capacity: 50 Tons
Pressure fore: 500 KN
Height x width x depth:
1250 x 600 x 440mm
Add
Delete

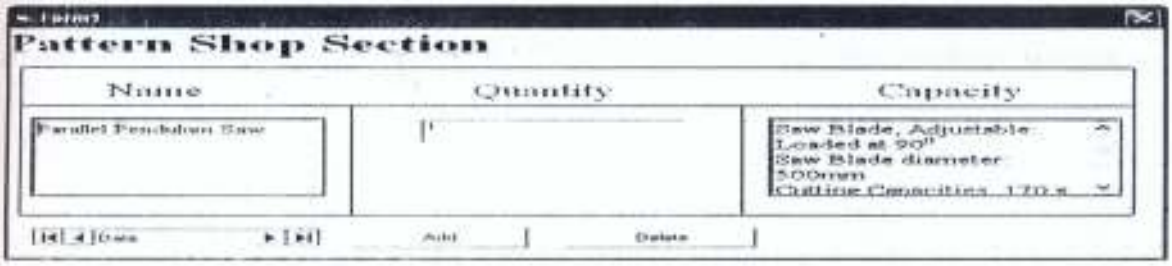

Laboratories Section
Name
Quantity
Capacity
Hardness Testing Machine
Pre-Load: 100N
Rockwell: 600 - 1,000 - 1,500 N
Brinell: 625 - 1,250 - 1,875 N
Add
Delete


Laboratories Section
Name
Quantity
Capacity
Spectrometer
Analyzes 26 elements at a time

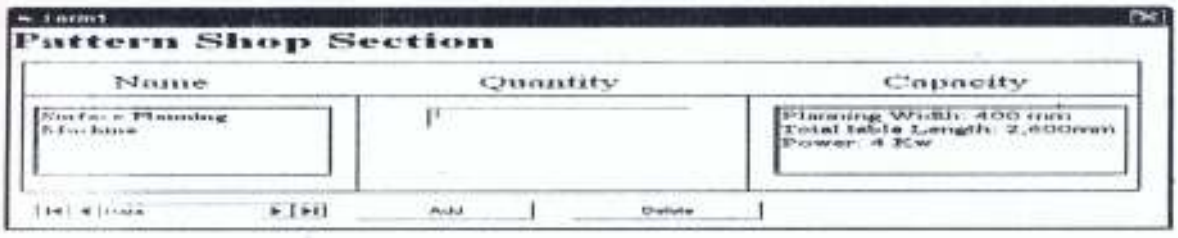

Laboratories Section
Name
Quantity
Capacity
Pillar Drill Head
Add
Delete

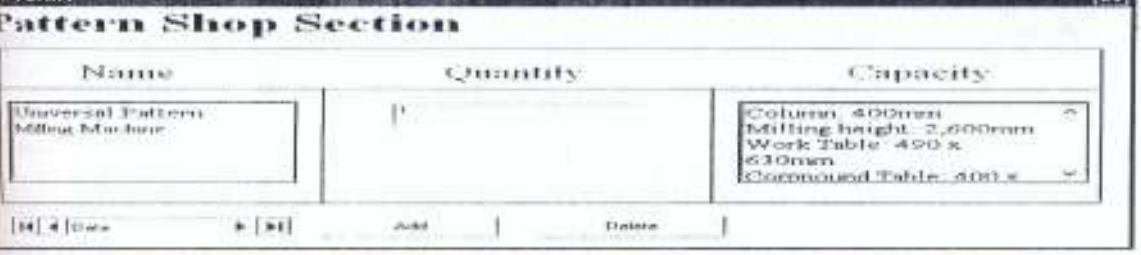

Laboratories Section
Name
Quantity
Capacity
Weighing scale
Max. Weight capacity 10kg
Graduation 0.02kg
Add
Delete


Laboratories Section
Name
Quantity
Capacity
Hot Plate
2 Kw
Add
Delete


Pattern Shop Section
Name
Quantity
Capacity
Parallel Pendulum Saw
Saw Blade, Adjustable
Leaded at 90°
Saw Blade diameter
500mm
Cutting Capacities 120 x
Add
Delete


Pattern Shop Section
Name
Quantity
Capacity
Thicknesss Planning
Machine
Planning width: 520mm
Planning height: 2 -
240mm
Table size: 520 x 850mm
Power: 5.5 Kw
Add
Delete


Pattern Shop Section
Name
Quantity
Capacity
Surface Planing
Machine
Planning Width: 400 mm
Total table Length: 2,600mm
Power: 4 Kw
Add
Delete


Pattern Shop Section

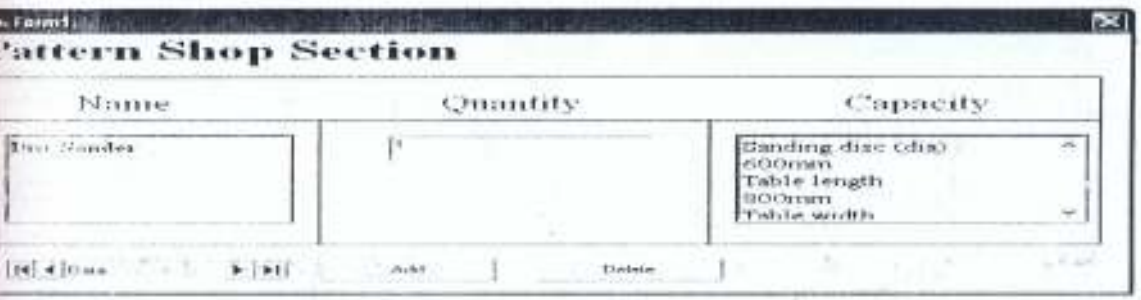
Name	Quantity	Capacity
Universal Pattern Milling Machine		Column 400mm Milling height 2,600mm Work Table 490 x 630mm Cornmoued Table 400 x

Add Delete


Pattern Shop Section

Name	Quantity	Capacity
Pattern Makers' Lathe		Centers 1000mm Centre height above bed 500mm * * * slide rest 225mm

Add Delete


Pattern Shop Section

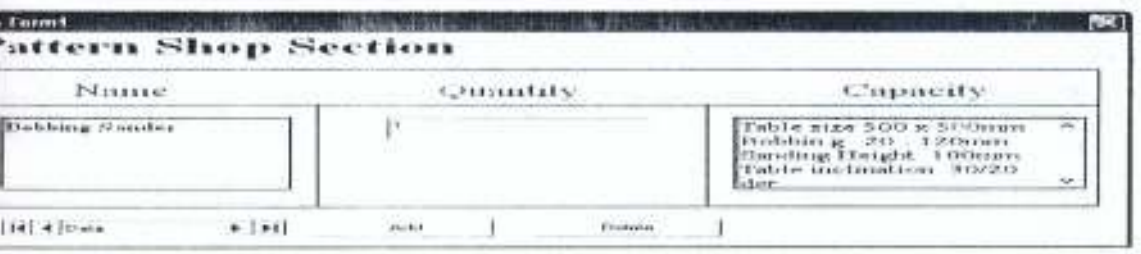
Name	Quantity	Capacity
Disc Sander		Sanding disc (dia) 600mm Table length 800mm Table width

Add Delete


Pattern Shop Section

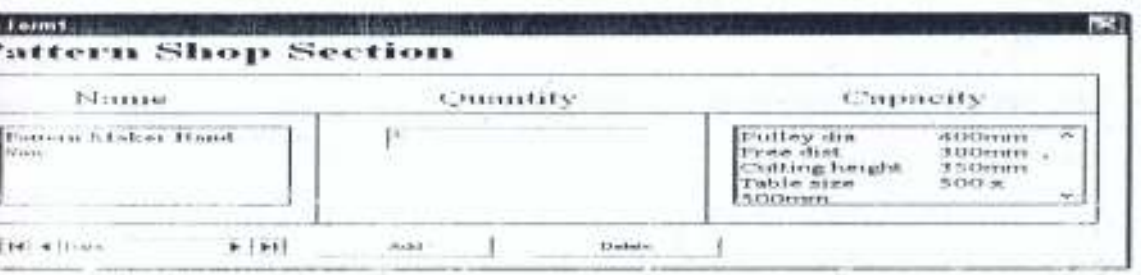
Name	Quantity	Capacity
Profile Hand Grinding Machine		Sanding table 400 x 400mm Swivel inward/outward 45/20 dgr Sanding height 240mm

Add Delete


Pattern Shop Section

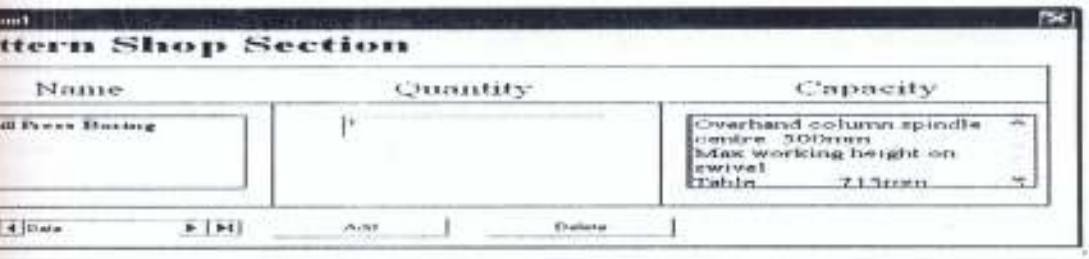
Name	Quantity	Capacity
Dobbing Sander		Table size 500 x 510mm Dobbing g 20 120mm Sanding Height 100mm Table inclination 30/20 der

Add Delete

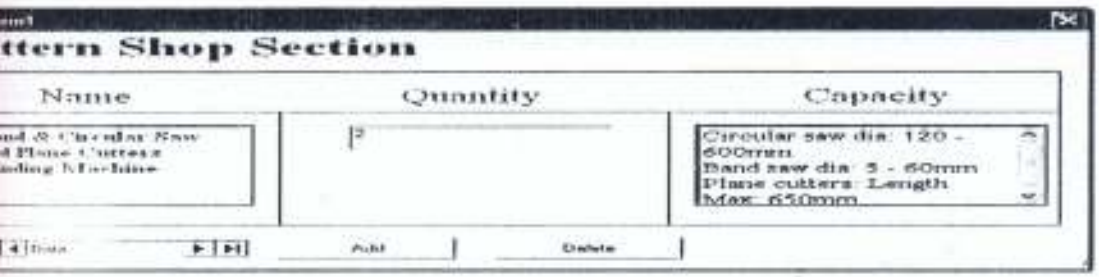

Pattern Shop Section

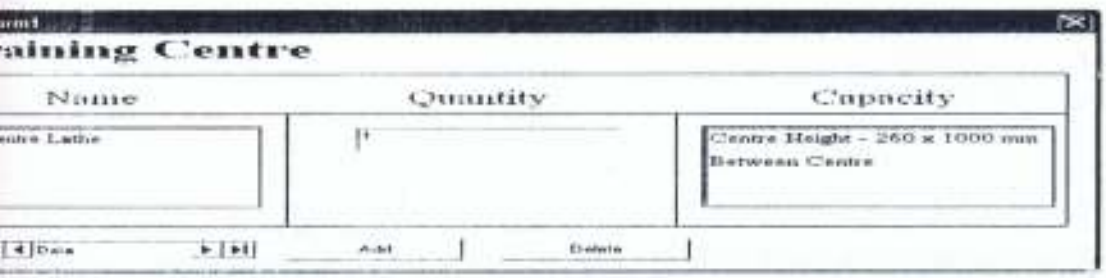
Name	Quantity	Capacity
Pattern Maker Hand Saw		Pulley dia 400mm Free dist 300mm Cutting height 350mm Table size 500 x 500mm

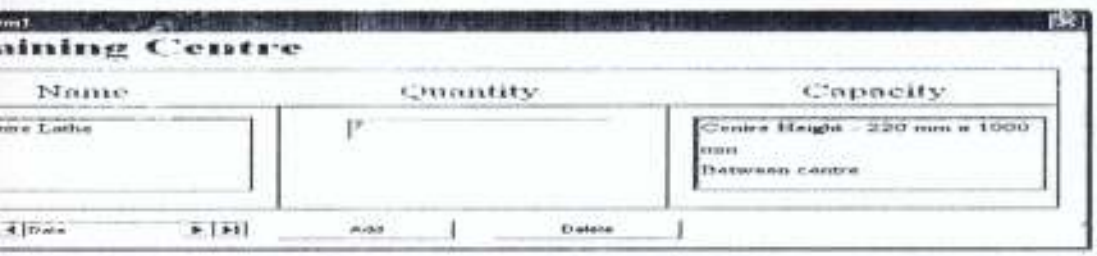
Add Delete

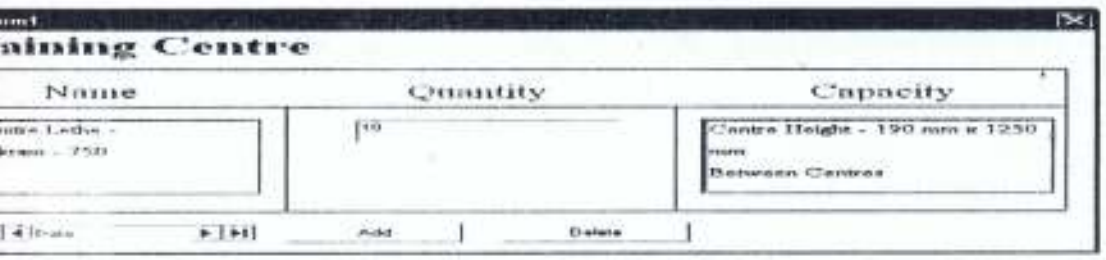

ttern Shop Section
Name
Quantity
Capacity
Overhand column spindle centre 300mm
Max working height on swivel
Table 715mm
Add
Delete


ttern Shop Section
Name
Quantity
Capacity
Add
Delete


ttern Shop Section
Name
Quantity
Capacity
Circular saw dia: 120 - 600mm
Band saw dia: 5 - 60mm
Plane cutters: Length Max: 650mm
Add
Delete


aining Centre
Name
Quantity
Capacity
Centre Height - 260 x 1000 mm Between Centre
Add
Delete


aining Centre
Name
Quantity
Capacity
Centre Height - 220 mm x 1000 mm
Between centre


aining Centre
Name
Quantity
Capacity
Centre Height - 190 mm x 1250 mm
Between Centres
Add
Delete

Training Centre

Name	Quantity	Capacity
Pedestal Grinder	2	Wheel dia. 300 mm

Record: 1 | Add | Delete

Training Centre

Name	Quantity	Capacity
Tool and Cutter	1	Swing Diameter - 280 mm

Record: 1 | Add | Delete

Training Centre

Name	Quantity	Capacity
Power Hacksaw HS - 30	1	Max diameter - 200 mm of materials

Record: 1 | Add | Delete

Training Centre

Name	Quantity	Capacity
Pillar Drill	1	Max. Drill diameter - 25 mm MT 3 Taper, Spindle, Power 1.5 kw

Record: 1 | Add | Delete

Training Centre

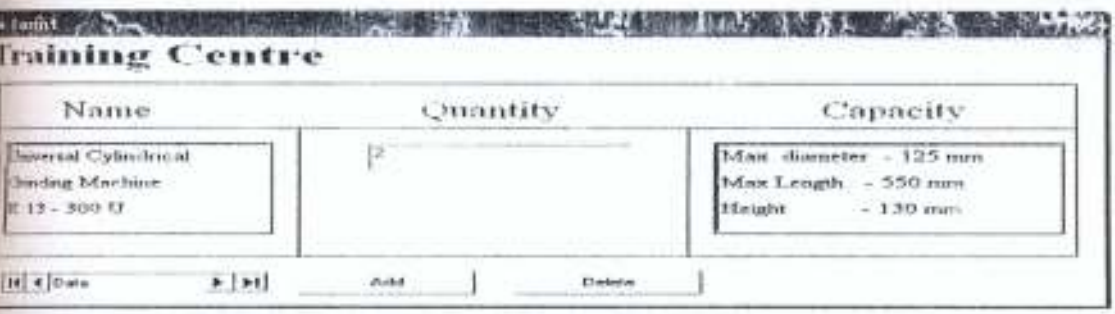
Name	Quantity	Capacity
Bench Drill	2	Max. drill diameter - 13 mm

Record: 1 | Add | Delete

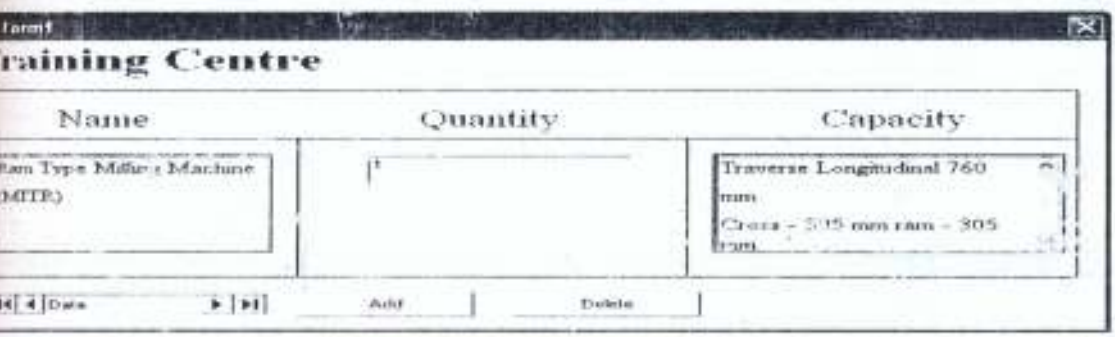
Training Centre

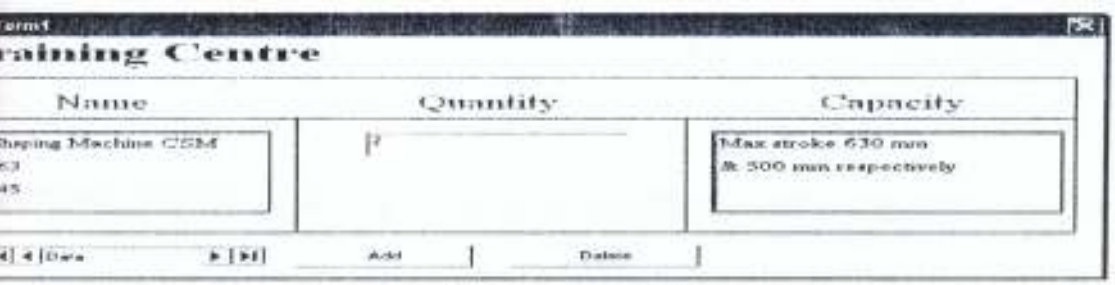
Name	Quantity	Capacity
Radial Drill RM 4.5	1	Max Diameter of hole - 50 mm in steel

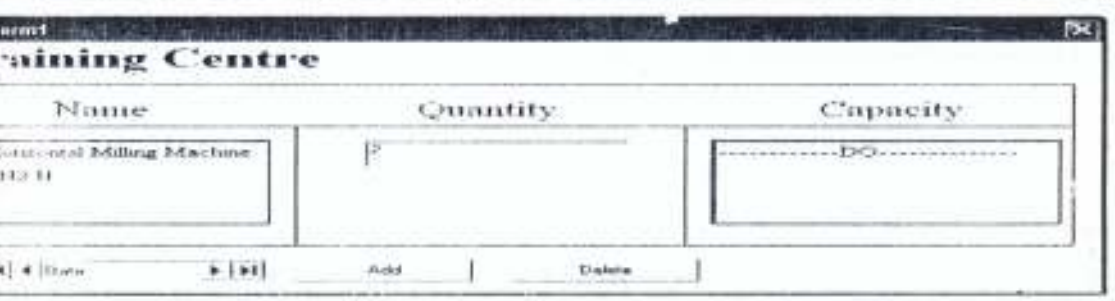
Record: 1 | Add | Delete

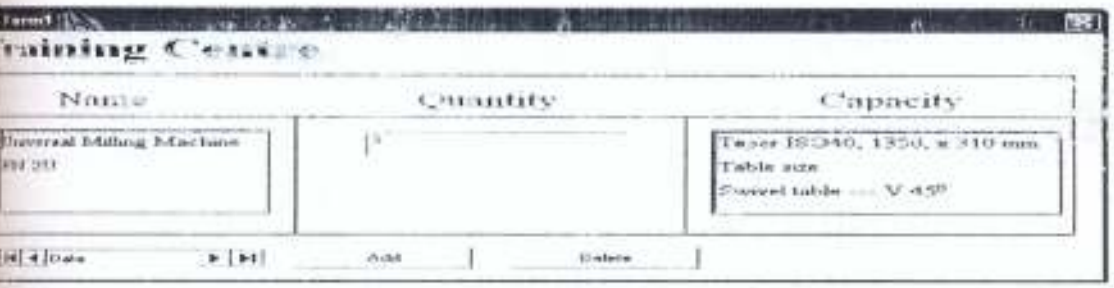

Training Centre
Name
Quantity
Capacity
Universal Cylindrical
Grinding Machine
Max diameter - 125 mm
Max Length - 550 mm
Height - 130 mm
Add
Delete

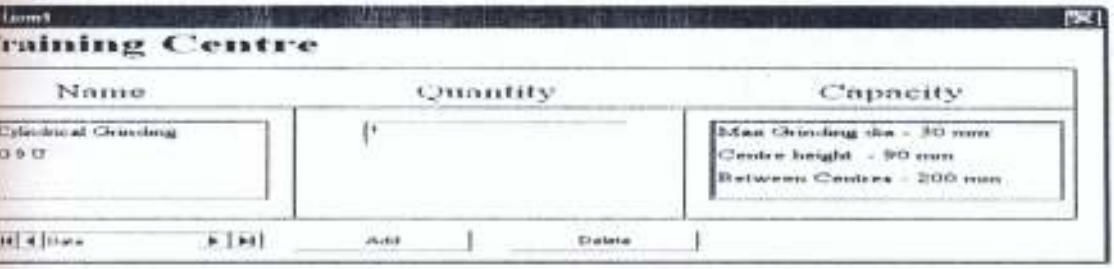

Training Centre
Name
Quantity
Capacity
Max bore dia - 30 mm
Grinding spindle 45 x 160 mm
long
Add
Delete

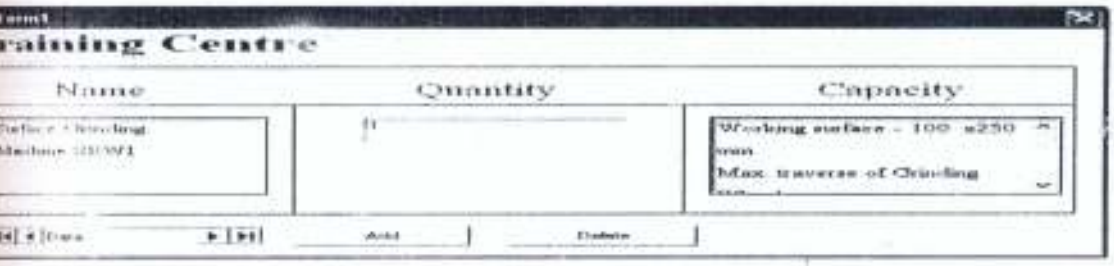

Training Centre
Name
Quantity
Capacity
Traverse Longitudinal 760
mm
Add
Delete

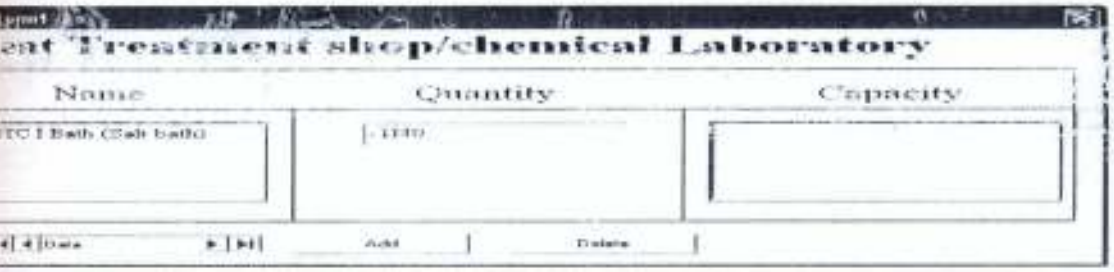

Training Centre
Name
Quantity
Capacity
Max stroke 630 mm
& 500 mm respectively

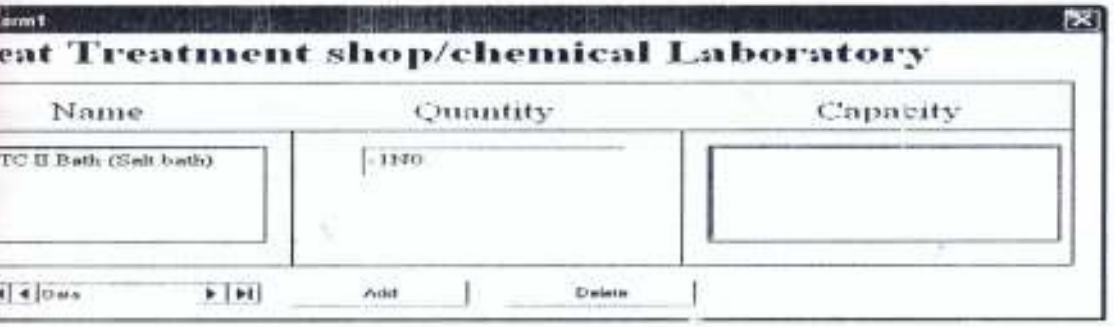

Training Centre
Name
Quantity
Capacity
----------DO----------
Add
Delete

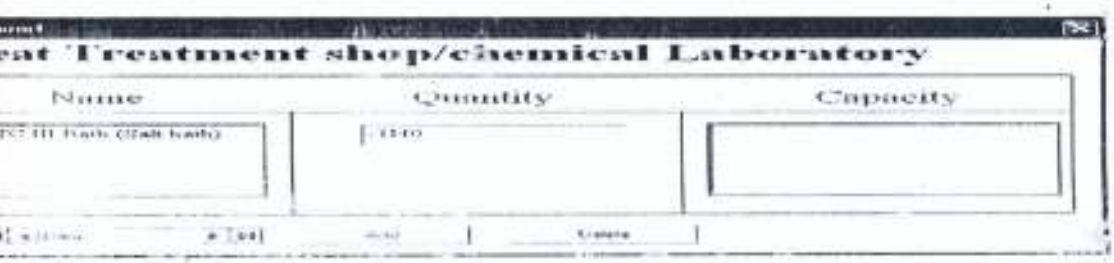

Name
Quantity
Capacity
Universal Milling Machine
Taper IS:340, 1350, x 310 mm
Table size
Swivel table ... V 45°
Add
Delete

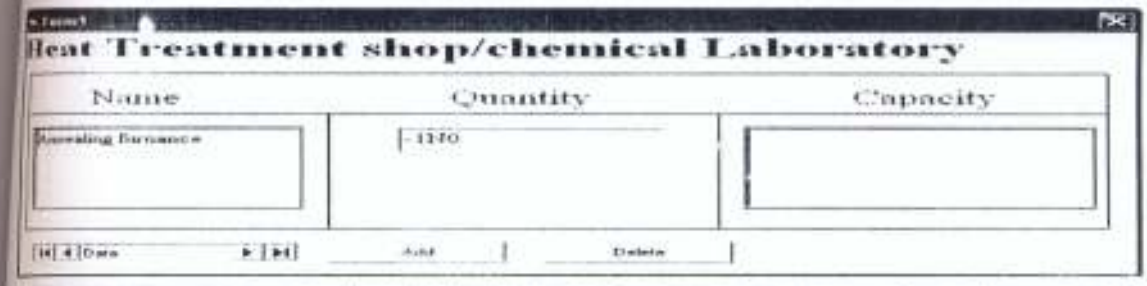

Name
Quantity
Capacity
Cylindrical Grinding
Max Grinding dia - 30 mm
Centre height - 90 mm
Between Centres - 200 mm
Add
Delete

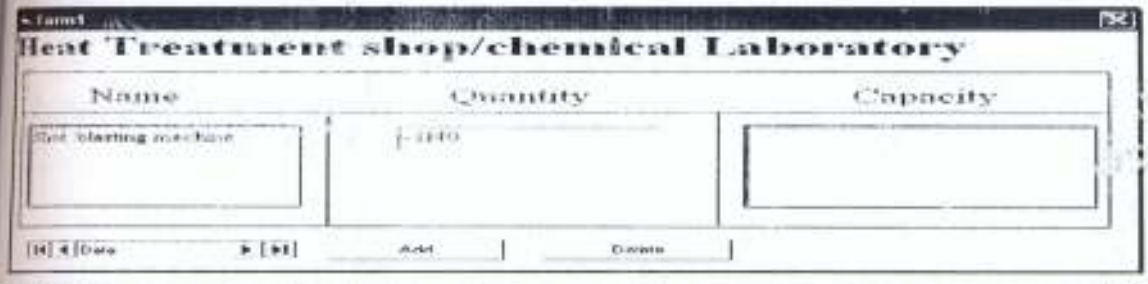

Name
Quantity
Capacity
Working surface - 100 x250 mm
Max. traverse of Grinding
Add
Delete

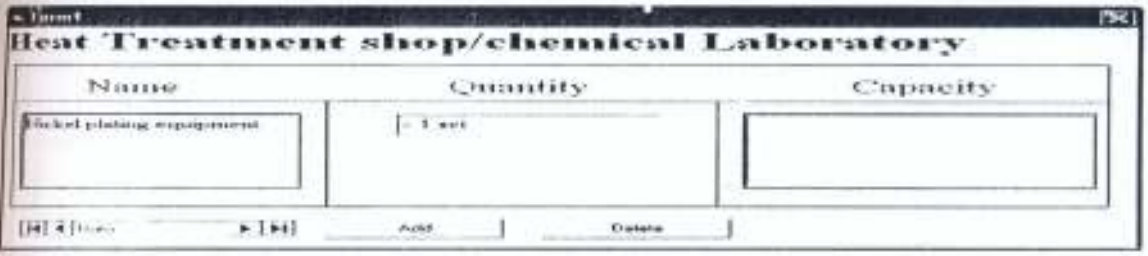

Name
Quantity
Capacity
Add
Delete

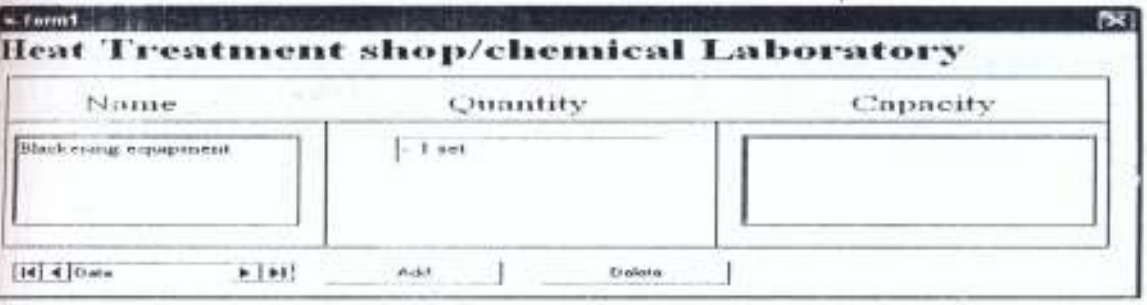

Name
Quantity
Capacity
TC II Bath (Salt bath)
Add
Delete

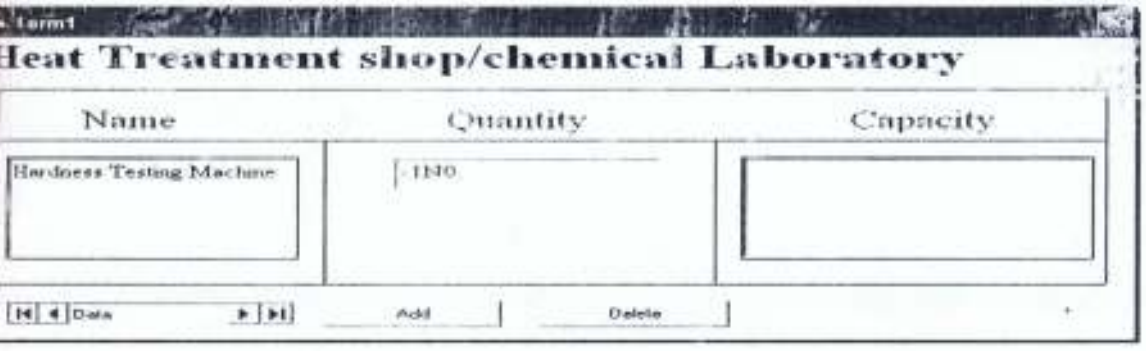

Name
Quantity
Capacity
Add
Delete


Form1
Heat Treatment shop/chemical Laboratory
Name
Quantity
Capacity
Annealing furnance
- 1No
Add
Delete


Form1
Heat Treatment shop/chemical Laboratory
Name
Quantity
Capacity
Add
Delete


Form1
Heat Treatment shop/chemical Laboratory
Name
Quantity
Capacity
Nickel plating equipment
- 1 set
Add
Delete


Form1
Heat Treatment shop/chemical Laboratory
Name
Quantity
Capacity
Blackening equipment
- 1 set
Add
Delete


Form1
Heat Treatment shop/chemical Laboratory
Name
Quantity
Capacity
Hardness Testing Machine
- 1No
Add
Delete

form1

Heat Treatment shop/chemical Laboratory

Name	Quantity	Capacity
Carbon - Sulphur analyzer	1NO	

Data | Add | Delete

form1

Heat Treatment shop/chemical Laboratory

Name	Quantity	Capacity
Desiccators	1NO	

Data | Add | Delete

form1

Heat Treatment shop/chemical Laboratory

Name	Quantity	Capacity
Metler balance	1NO	

Data | Add | Delete

form1

Heat Treatment shop/chemical Laboratory

Name	Quantity	Capacity
H2O Oxidiser	1NO	

Data | Add | Delete

form1

Heat Treatment shop/chemical Laboratory

Name	Quantity	Capacity
Single arm analytical balance	1NO	

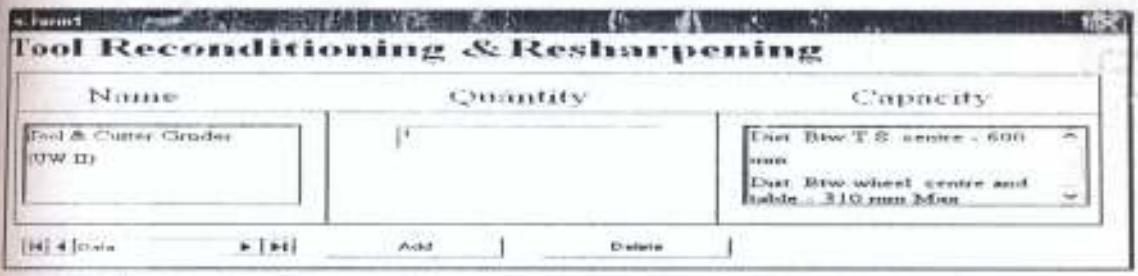
Data | Add | Delete

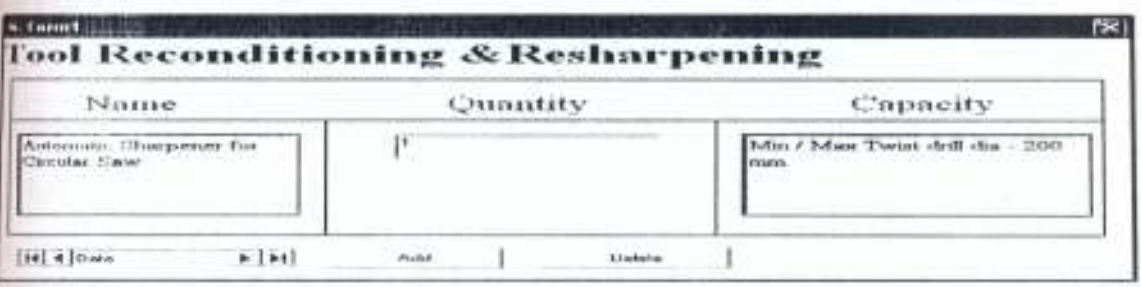
form1

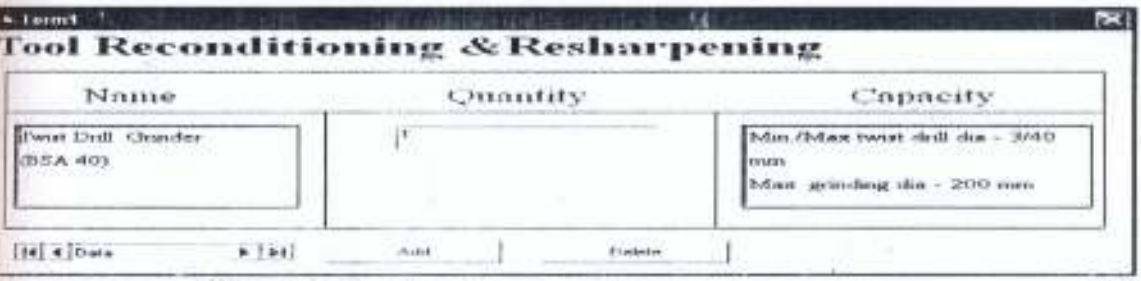
Tool Reconditioning & Resharpening

Name	Quantity	Capacity
Tool & Cutter -CTC 28 T	3	Swing dia -- 280 mm Dist btw Tail stock Centres - 760 mm

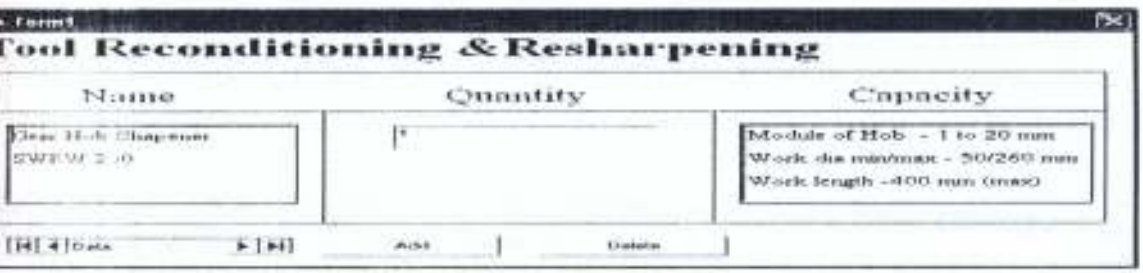
Data | Add | Delete

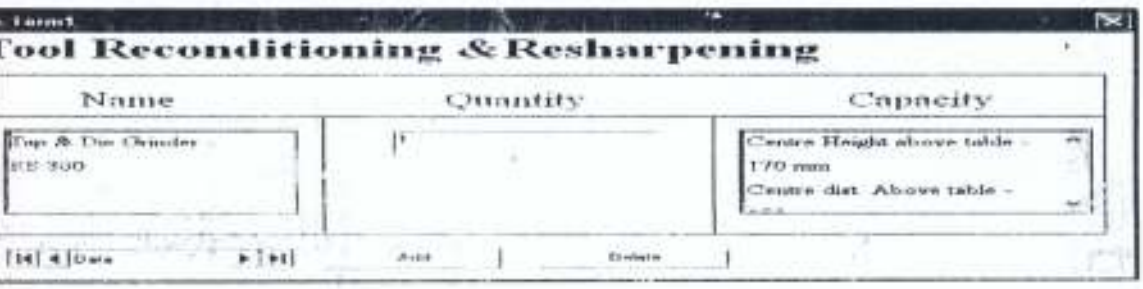

Tool Reconditioning & Reshrpening
Name
Quantity
Capacity
Tool & Cutter Grinder (UW II)
Dist. Btw T.S. centre - 600 mm
Dist. Btw wheel centre and table - 310 mm Max
Add
Delete


Tool Reconditioning & Reshrpening
Name
Quantity
Capacity
Min / Max Twist drill dia - 200 mm
Add
Delete


Tool Reconditioning & Reshrpening
Name
Quantity
Capacity
Twist Drill Grinder (BSA 40)
Min./Max twist drill dia - 3/40 mm
Max. grinding dia - 200 mm
Add
Delete


Tool Reconditioning & Reshrpening
Name
Quantity
Capacity
Twist Drill Grinder -BSA 80
Min/Max Twist drill dia 3/40 mm
Max. grinding wheel dia 300 mm
Add
Delete


Tool Reconditioning & Reshrpening
Name
Quantity
Capacity
Module of Hob - 1 to 20 mm
Work dia min/max - 50/260 mm
Work length -400 mm (max)
Add
Delete


Tool Reconditioning & Reshrpening
Name
Quantity
Capacity
Centre Height above table - 170 mm
Centre dist. Above table -
Add
Delete

Form1

Tool Reconditioning & Resharpening

Name	Quantity	Capacity
Engraving Miller Gm 1-2	1	Work table -500 x 300 mm Pantograph ratios -1: 1 to 1:

Form1

Tool Reconditioning & Resharpening

Name	Quantity	Capacity
Engraving Cutter Sharpener - 8102	1	Cutter size -1 to 3 mm Taper Angle -0° to 180°

Form1

Tools & Measuring Room

Name	Quantity	Capacity
Jib Boring machine Micromat 9B	1	Table traverse X axis - 1120 Cross travel Y axis - 710 Table size 1400 x 1900

Form1

Tools & Measuring Room

Name	Quantity	Capacity
Universal Tool & Cutter Milling Machine FHCU 32	1	Mounting Table - 800 x 500 mm Working dist X,Y,Z axes

Form1

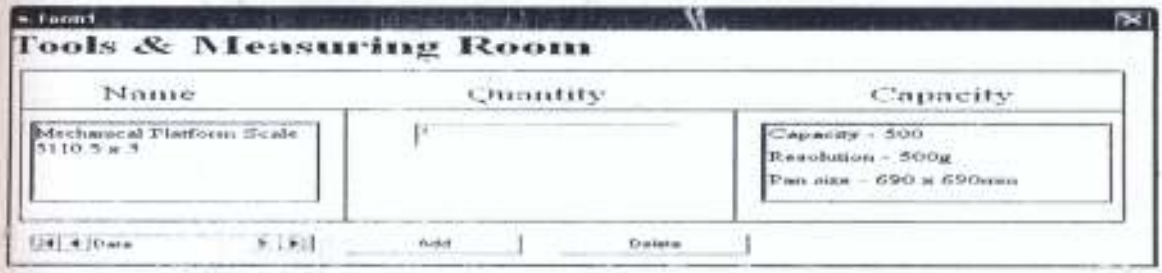
Tools & Measuring Room

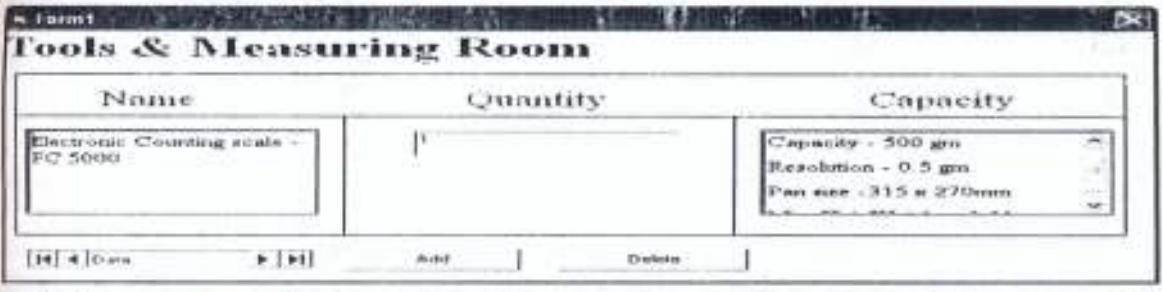
Name	Quantity	Capacity
Universal Tool Room Milling and Boring Machine	1	Mounting table - 112 x 630 mm Travels X,Y,Z - 800 x 400 x

Form1

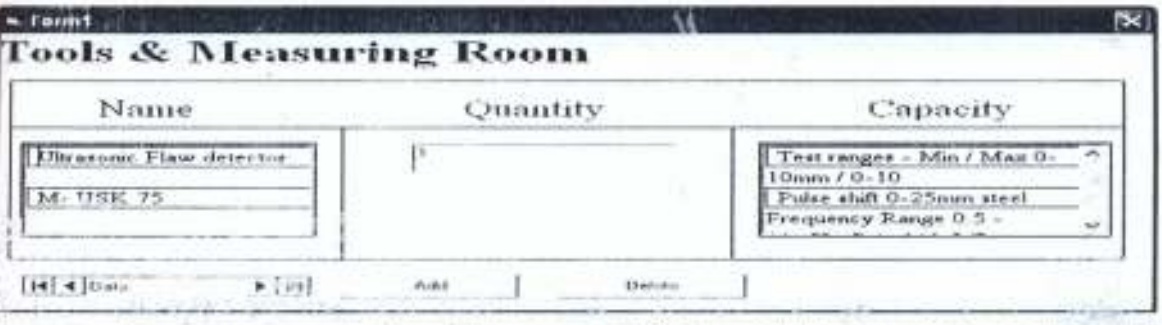
Tools & Measuring Room

Name	Quantity	Capacity
Linear & Circular Dividing Machine - FNK 25 A + PA + DH 250A	1	Mounting Table 1- 1250x 290mm Table travels XYZ - 800 x 360 x 460mm Spindle head swivel (to each side) - 90° Spindle head rotation (to

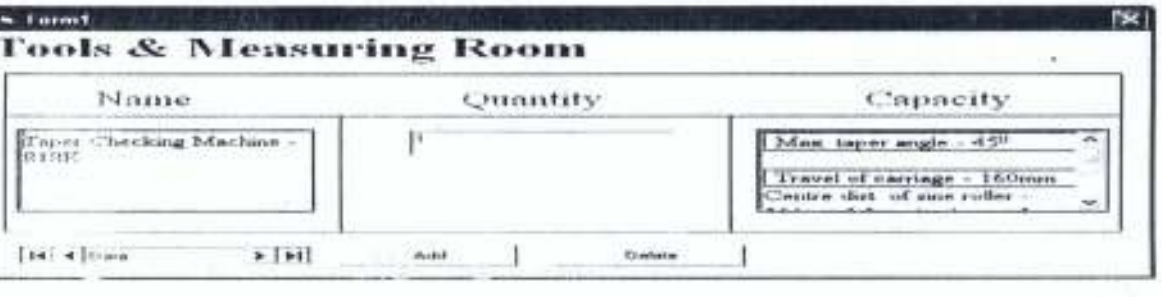

Form1
Tools & Measuring Room
Name
Quantity
Capacity
Mechanical Platform Scale 5110.5 x 5
Capacity - 500
Resolution - 500g
Pan size - 690 x 690mm
Add
Delete

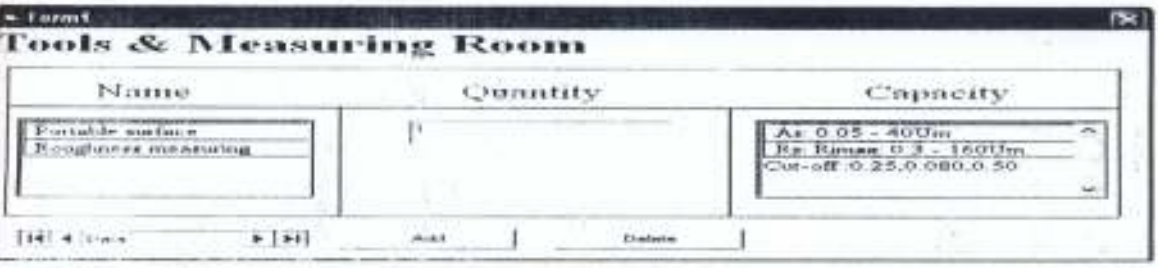

Form1
Tools & Measuring Room
Name
Quantity
Capacity
Electronic Counting scale - FC 5000
Capacity - 500 gm
Resolution - 0.5 gm
Pan size - 315 x 270mm
Add
Delete

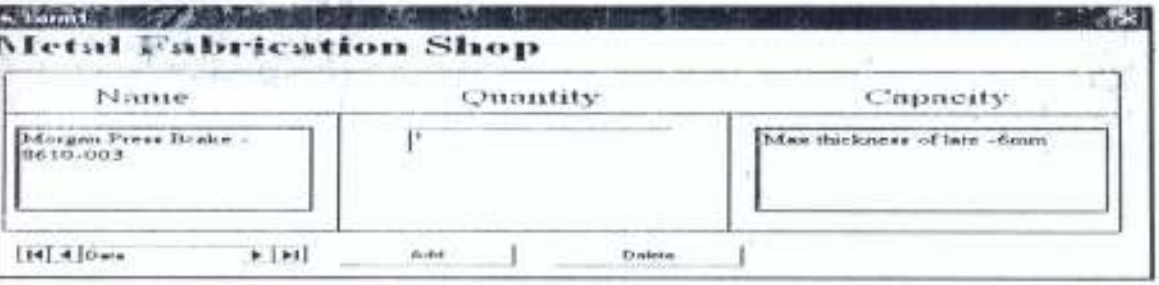

Form1
Tools & Measuring Room
Name
Quantity
Capacity
Linear Height measuring instrument - 518 - 905
Measuring range 0 - 600mm
Least count - 0.005mm
Add
Delete

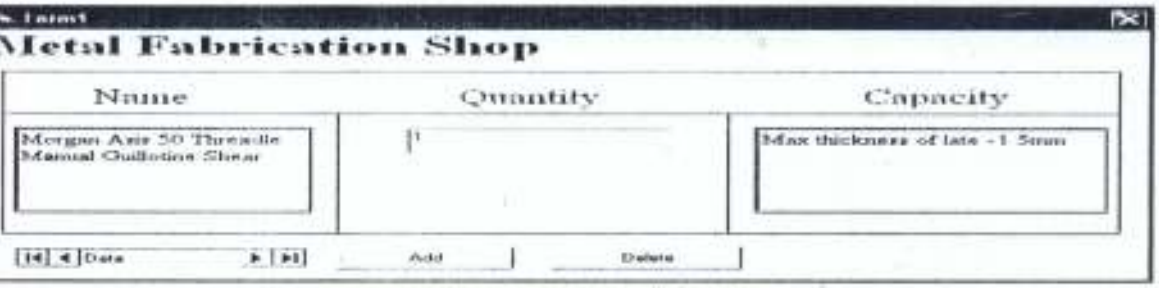

Form1
Tools & Measuring Room
Name
Quantity
Capacity
Ultrasonic Flaw detector
M- USK 75
Test ranges - Min / Max 0-10mm / 0-10
Pulse shift 0-25mm steel
Frequency Range 0.5 -
Add
Delete


Form1
Tools & Measuring Room
Name
Quantity
Capacity
Tabyrond 3 Mit PC
External & Internal dia - 355mm (max)
Height above table Surface -
Add
Delete

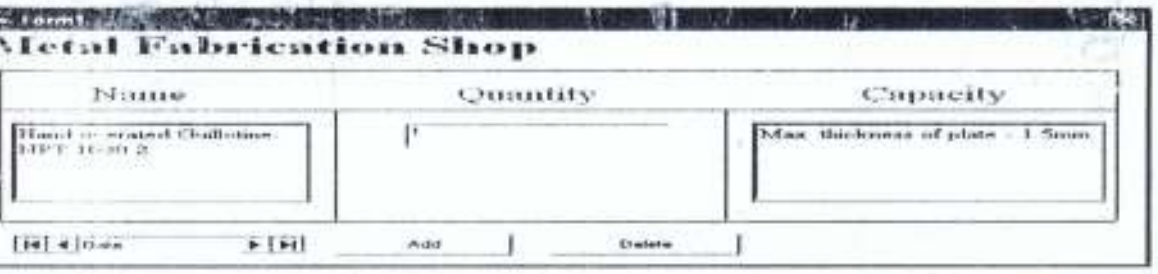

Form1
Tools & Measuring Room
Name
Quantity
Capacity
Taper Checking Machine - 8130C
Max taper angle - 45°
Travel of carriage - 160mm
Add
Delete

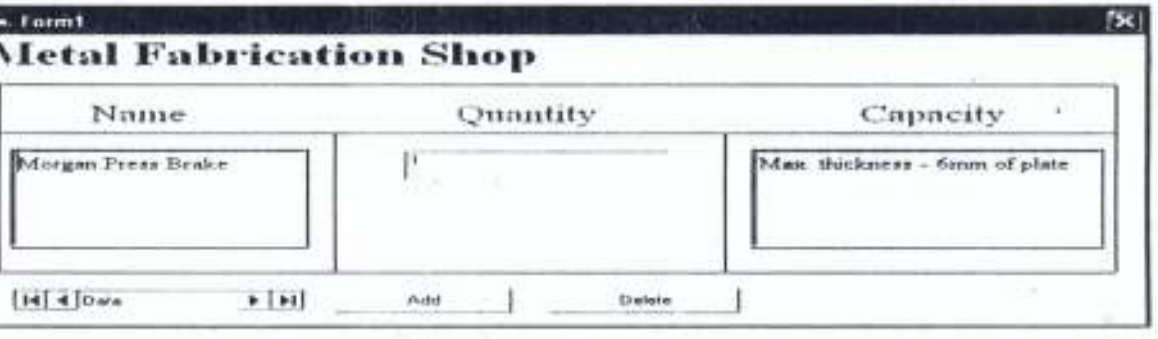

Form1
Tools & Measuring Room
Name
Qunntity
Capacity
Portable surface Roughness measuring
Ar: 0.05 - 400m
Rz: Rmax: 0.3 - 1600m
Cut-off :0.25,0.080,0.50
Add
Delete


Form1
Metal Fabrication Shop
Name
Quantity
Capacity
Morgan Press Brake - 8610-003
Max thickness of late -6mm
Add
Delete


Form1
Metal Fabrication Shop
Name
Qunntity
Capacity
Morgan Axis 50 Threaxile Manual Guillotine Shear
Max thickness of late -1.5mm
Add
Delete

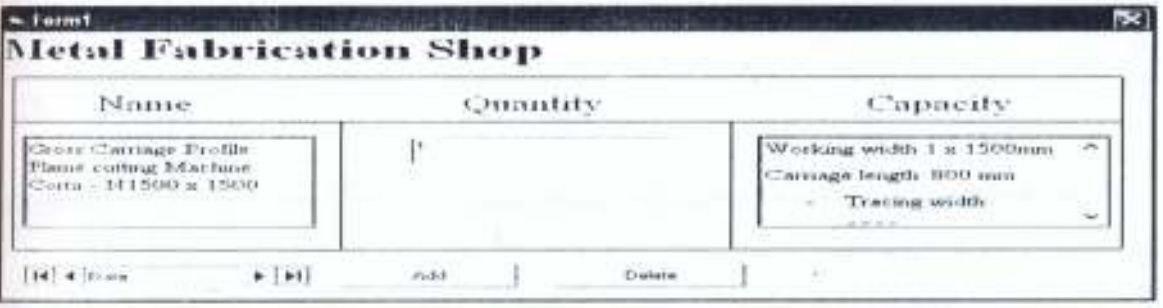

Form1
Metal Fabrication Shop
Name
Qunntity
Capacity
BSBM/800/50 - Manual Rolling Machine
Max thickness of plate - 2mm
Add
Delete


Form1
Metal Fabrication Shop
Name
Qunntity
Capacity
Max thickness of plate - 1.5mm
Add
Delete


Form1
Metal Fabrication Shop
Name
Qunntity
Capacity
Morgan Press Brake
Max thickness - 6mm of plate
Add
Delete

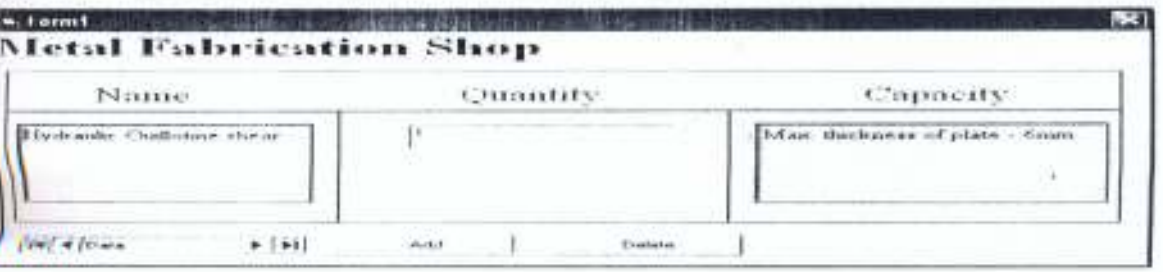

Form1
Metal Fabrication Shop
Name
Quantity
Capacity
Add
Delete


Form1
Metal Fabrication Shop
Name
Quantity
Capacity
Spot Welding Machine
Max. thickness of plate - 2mm
Add
Delete


Form1
Metal Fabrication Shop
Name
Quantity
Capacity
Gross Carriage Profile
Plane cutting Machine
Corta - 141500 x 1500
Working width 1 x 1500mm
Carriage length 800 mm
Tracing width
Add
Delete

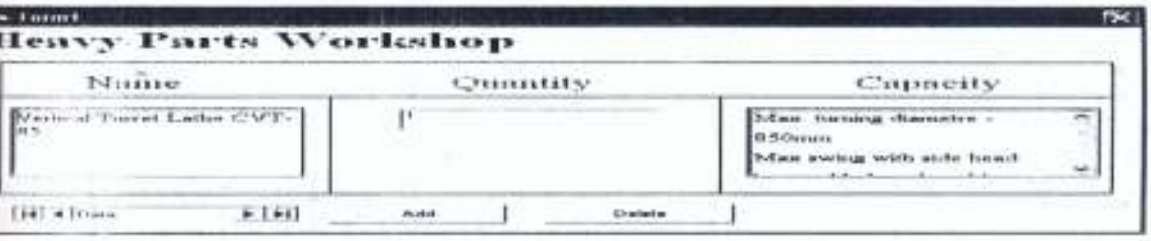

Metal Fabrication Shop
Name
Quantity
Capacity


Metal Fabrication Shop
Name
Quantity
Capacity

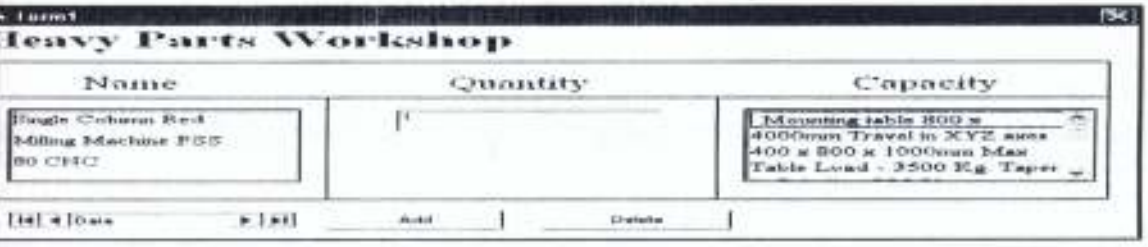

Form1
Metal Fabrication Shop
Name
Quantity
Capacity
Hydraulic Guillotine shear
Max. thickness of plate - 6mm
Add
Delete

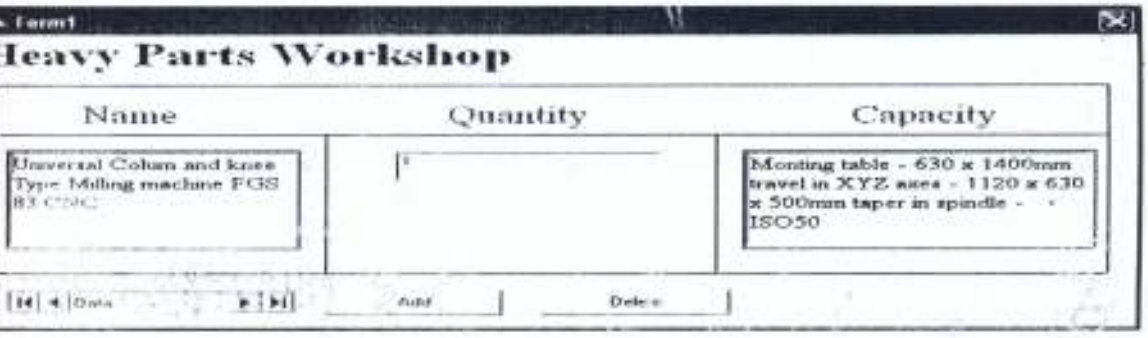

Metal Fabrication Shop
Name
Quantity
Capacity
Add
Delete

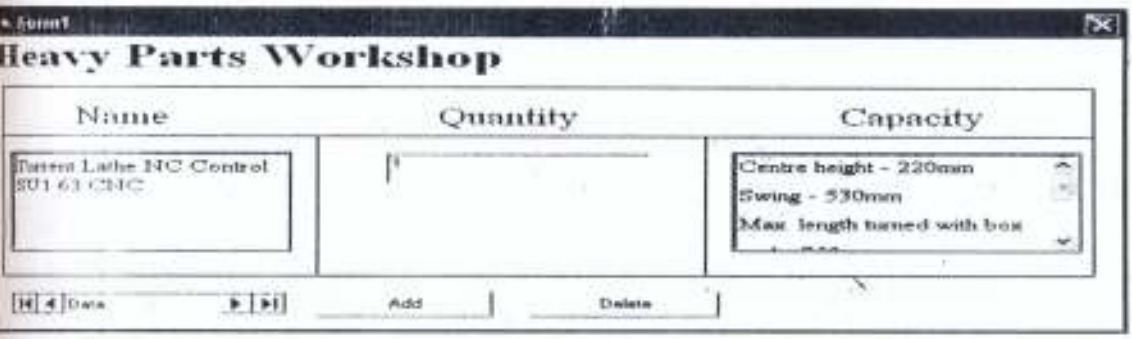

Heavy Parts Workshop
Name
Quantity
Capacity
Add
Delete

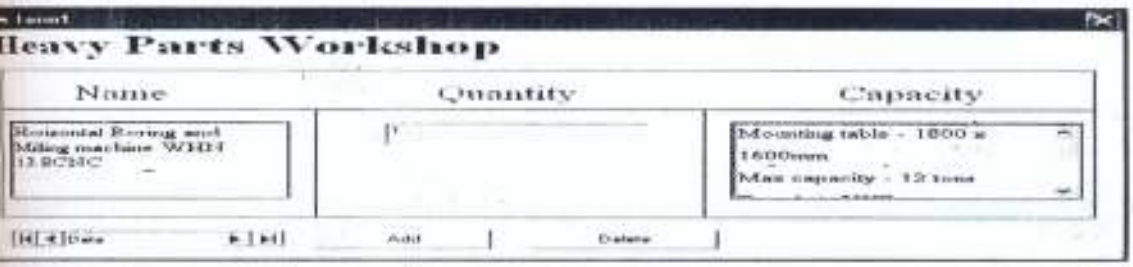

Heavy Parts Workshop
Name
Quantity
Capacity
Add
Delete

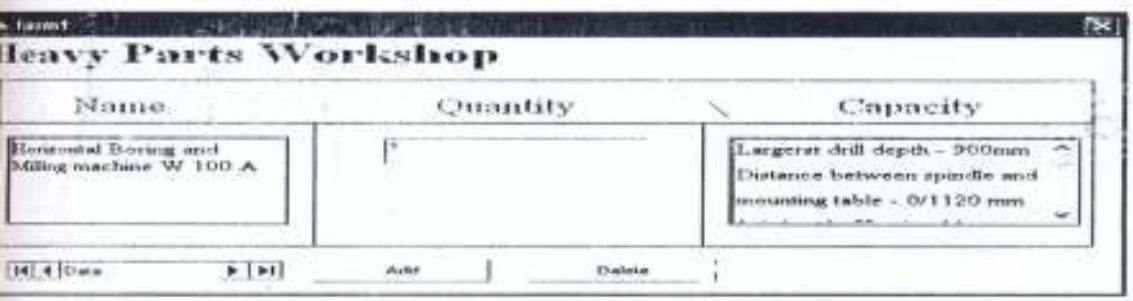

Heavy Parts Workshop
Name
Quantity
Capacity
Radial Drilling Machine
RD-65
RD- 65
Add
Delete

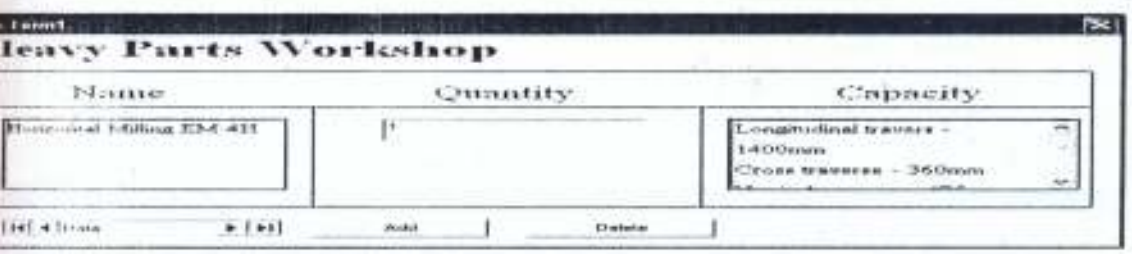

Heavy Parts Workshop
Name
Quantity
Capacity
Add
Delete


Heavy Parts Workshop
Name
Quantity
Capacity
Universal Colum and knee
Type Milling machine FGS
Add
Delete

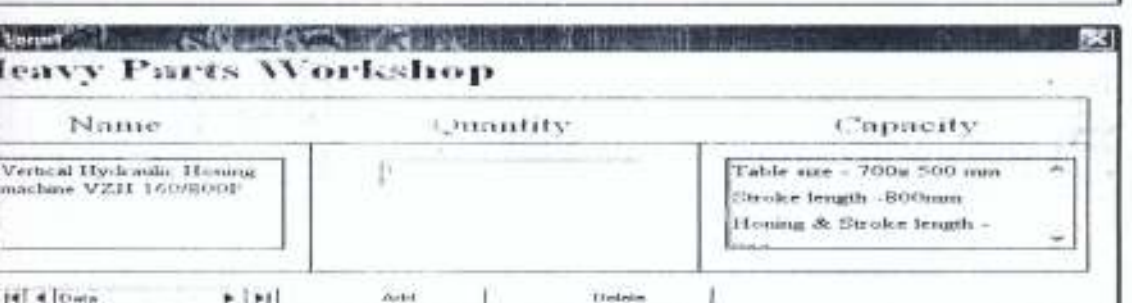

Heavy Parts Workshop
Name
Quantity
Capacity
Centre height - 220mm
Swing - 530mm
Add
Delete

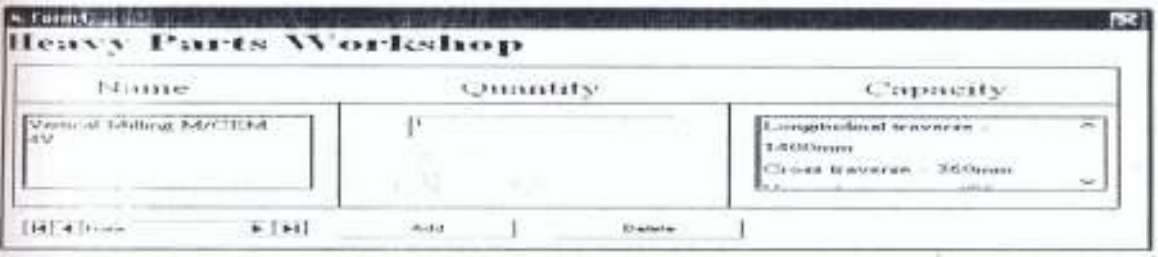

Heavy Parts Workshop
Name
Quantity
Capacity
Mounting table - 1800 x 1600mm
Add
Delete

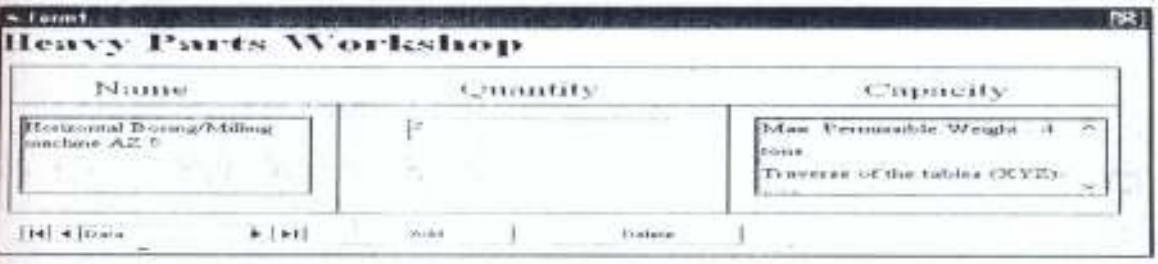

Heavy Parts Workshop
Name
Quantity
Capacity
Horizontal Boring and Milling machine W 100 A
Largest drill depth - 900mm
Distance between spindle and mounting table - 0/1120 mm
Add
Delete

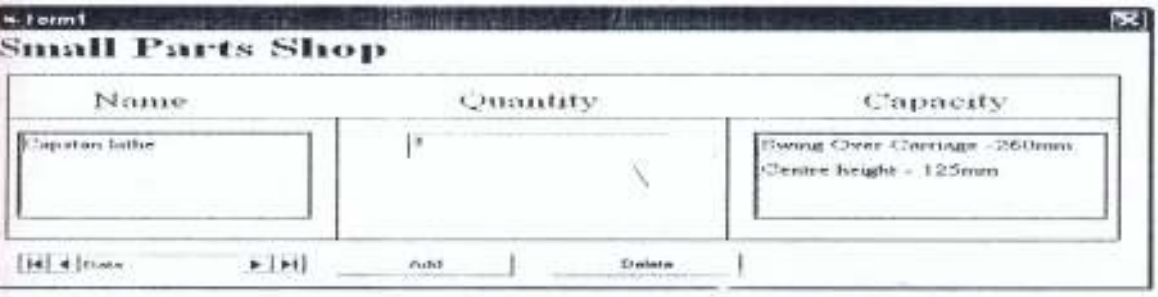

Heavy Parts Workshop
Name
Quantity
Capacity
Longitudinal travers - 1400mm
Cross travesse - 360mm
Add
Delete


Heavy Parts Workshop
Name
Quantity
Capacity
Working surface of table -800 x 3000mm Max height of grinding - 800mm Micro feed of wheel spindle grant -


Heavy Parts Workshop
Name
Quantity
Capacity
Table size - 700x 500 mm
Stroke length -800mm
Honing & Stroke length -
Add
Delete


Heavy Parts Workshop
Name
Quantity
Capacity
Vertical Milling M/C10M 4V
Longitudinal traverse - 1400mm
Cross traverse - 360mm
Add
Delete


Heavy Parts Workshop
Name
Quantity
Capacity
Horizontal Boring/Milling machine AZ 6
Max Permissible Weight - 4 tons
Traverse of the tables (X,Y,Z)
Add
Delete


Small Parts Shop
Name
Quantity
Capacity
Capston lathe
Swing Over Carriage - 260mm
Centre height - 125mm
Add
Delete

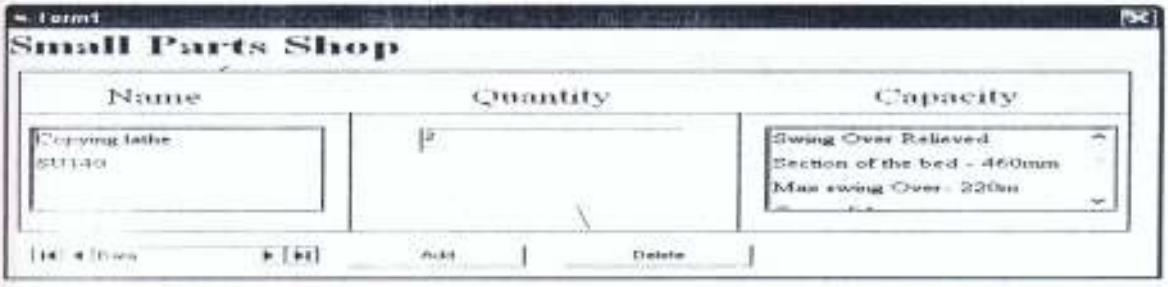

Small Parts Shop
Name
Quantity
Capacity
Centre height - 220mm
Swing Over bed - 500mm
Dist. Btw Centre - 1000m
Add
Delete

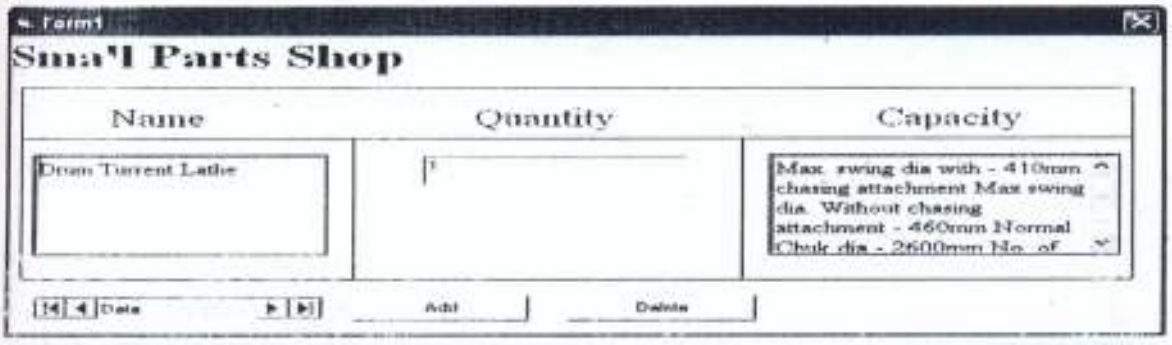

Small Parts Shop
Name
Quantity
Capacity
Centre lathe HH26/1500
Centre height - 220mm
Swing Over bed - 500mm
Dist. Btw Centre - 1500m
Add
Delete

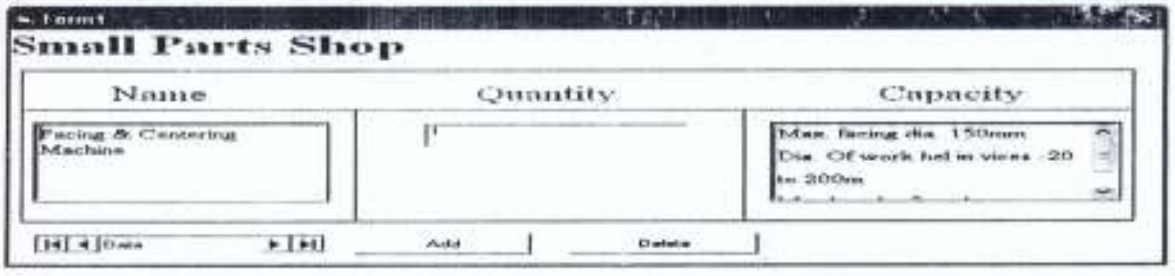

Small Parts Shop
Name
Quantity
Capacity
Centre lathe HH26/1000
Centre height - 260mm
Swing Over bed - 550mm
Dist. Btw Centre - 1,000m
Add
Delete

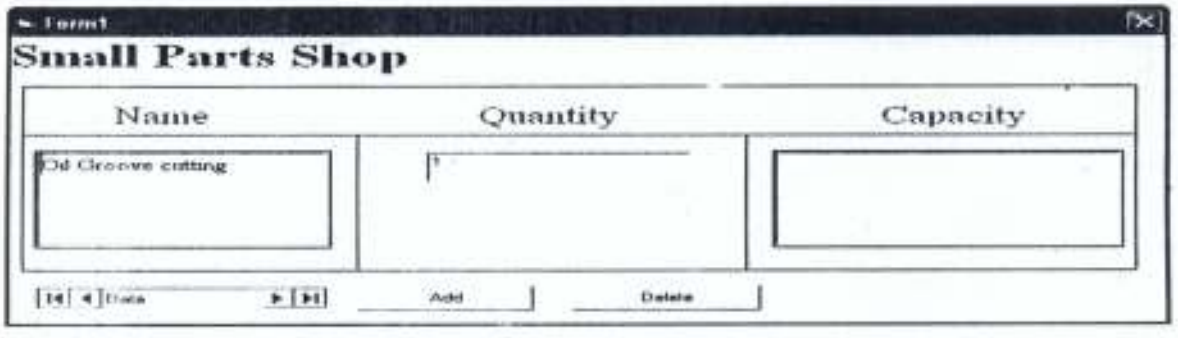

Form1
Small Parts Shop
Name
Quantity
Capacity
Centre lathe
HB26/1500
Centre height - 260mm
Swing Over bed - 550mm
Dist. Btw Centre - 1,500m
Add
Delete


Form1
Small Parts Shop
Name
Quantity
Capacity
Centre lathe
HB26/2,000
Centre height - 260mm
Swing Over bed - 550mm
Dist. Btw Centre - 2,000m
Add
Delete

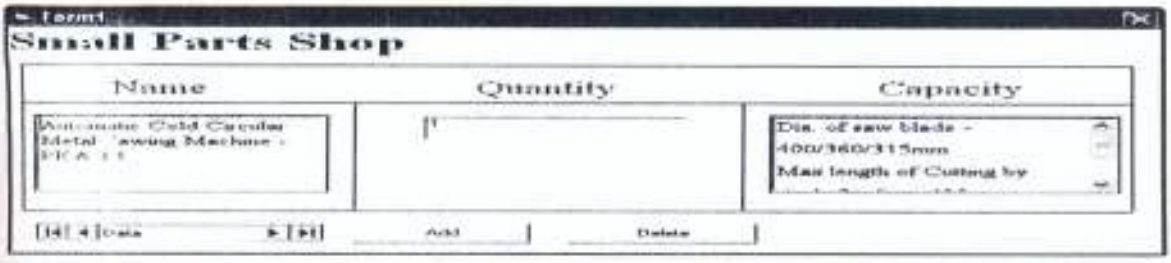

Form1
Small Parts Shop
Name
Quantity
Capacity
Copying lathe
SU140
Swing Over Relieved
Section of the bed - 460mm
Max swing Over - 220m
Add
Delete

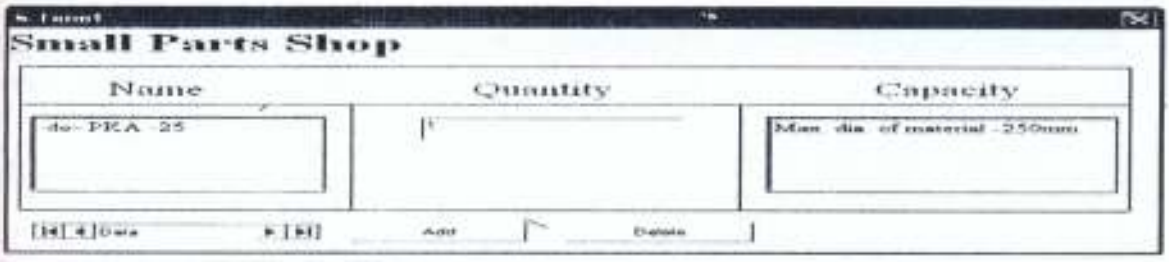

Form1
Sma'l Parts Shop
Name
Quantity
Capacity
Drum Turrent Lathe
Max swing dia with - 410mm
chasing attachment Max swing
dia. Without chasing
attachment - 460mm Normal
Chuk dia - 2600mm No. of
Add
Delete

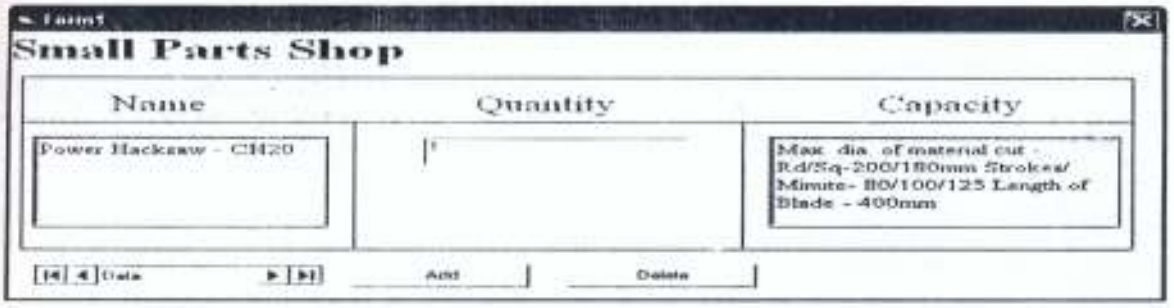

Form1
Small Parts Shop
Name
Quantity
Capacity
Facing & Centering
Machine
Max. facing dia. 150mm
Dia. Of work hel in vices - 20
to 300m
Add
Delete

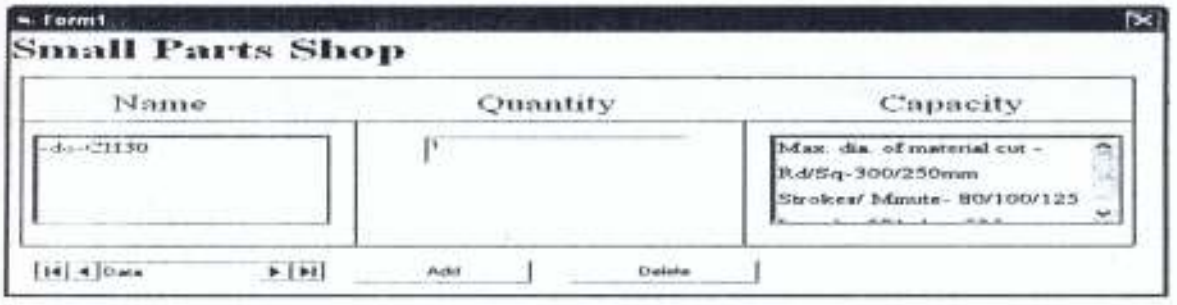

Form1
Small Parts Shop
Name
Quantity
Capacity
Od Groove cutting
Add
Delete

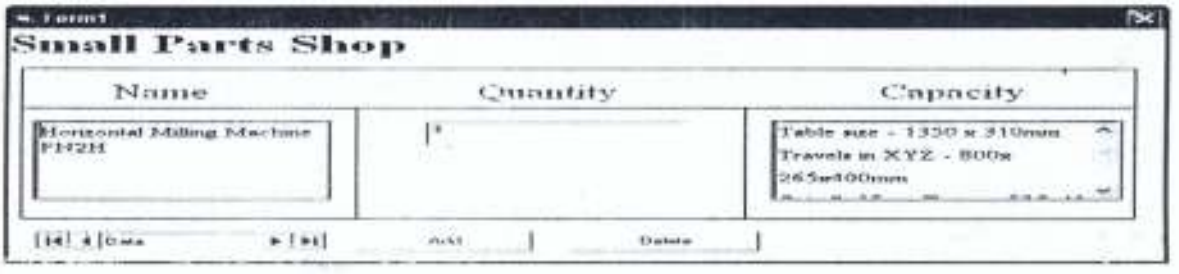

Small Parts Shop
Name
Qunatity
Capacity
Universal Nomerically Controlled lathe SPT32 CNC
Max. Turning dia - 320
Max. Swing above bed - 490mm
Add
Delete

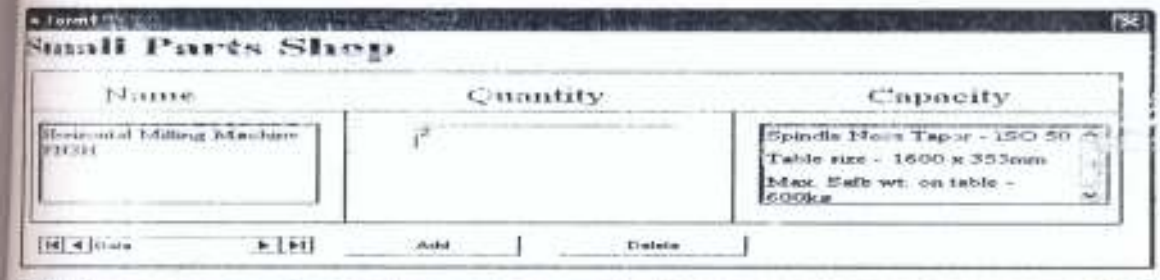

Small Parts Shop
Name
Qunatity
Capacity
Dia. of saw blade - 400/360/315mm
Max length of Cutting by
Add
Delete

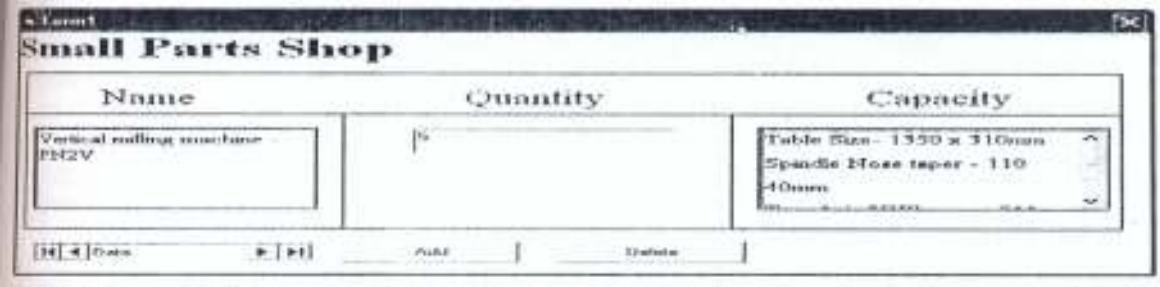

Small Parts Shop
Name
Qunatity
Capacity
Max. dia. of material - 250mm
Add
Delete

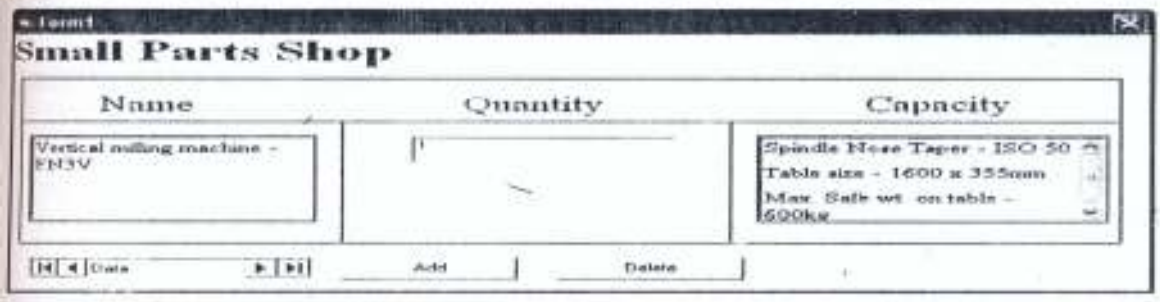

Small Parts Shop
Name
Qunatity
Capacity
Power Hacksaw - CH20
Max. dia. of material cut - Rd/Sq-200/180mm Strokes/ Minute- 80/100/125 Length of Blade - 400mm
Add
Delete

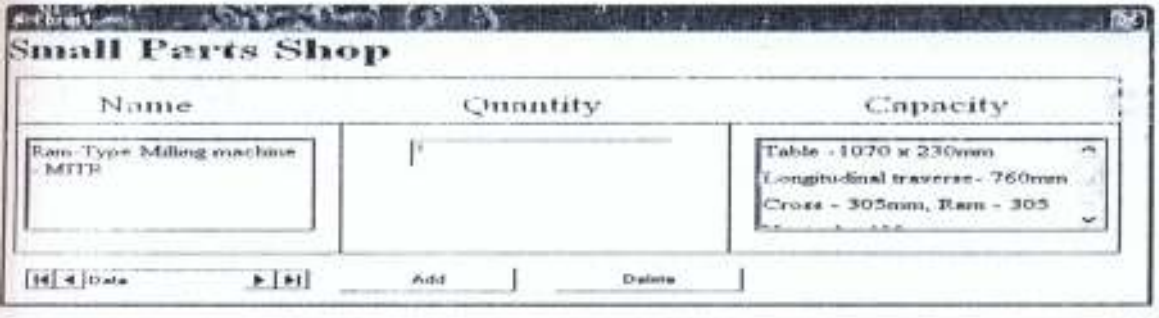

Small Parts Shop
Name
Qunatity
Capacity
Max. dia. of material cut - Rd/Sq-300/250mm
Strokes/ Minute- 80/100/125
Add
Delete

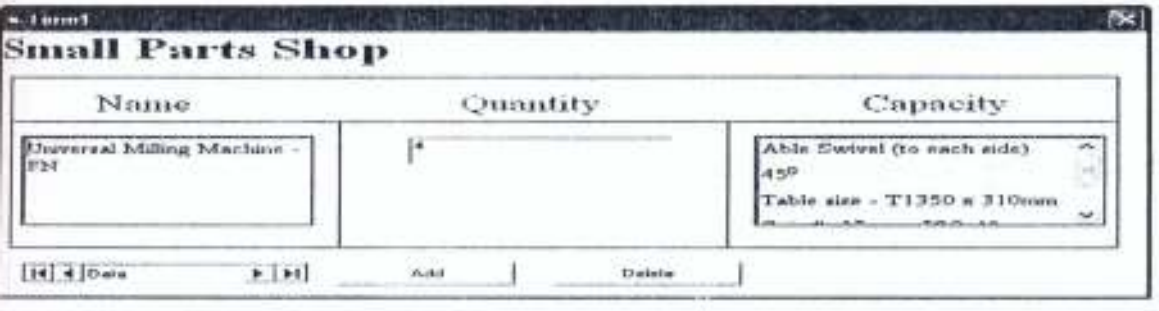

Small Parts Shop
Name
Qunatity
Capacity
Horizontal Milling Machine FH2H
Table size - 1350 x 310mm
Travels in XYZ - 800x 265x400mm
Add
Delete


Small Parts Shop
Name
Quantity
Capacity
Horizontal Milling Machine - FH3H
Spindle Nose Taper - ISO 50
Table size - 1600 x 355mm
Max. Safe wt. on table - 600kg
Add
Delete


Small Parts Shop
Name
Quantity
Capacity
Vertical milling machine - FN2V
Table Size - 1350 x 310mm
Spindle Nose taper - 110
40mm
Add
Delete

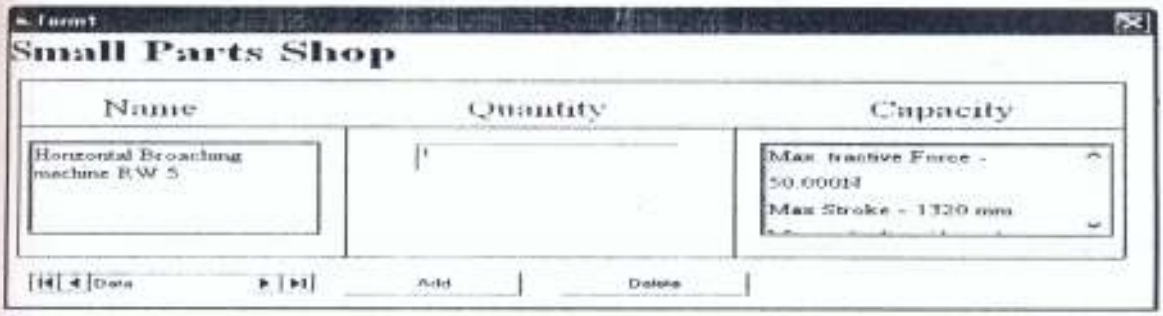

Small Parts Shop
Name
Quantity
Capacity
Vertical milling machine - FN3V
Spindle Nose Taper - ISO 50
Table size - 1600 x 355mm
Max. Safe wt. on table - 600kg
Add
Delete


Small Parts Shop
Name
Quantity
Capacity
Ram-Type Milling machine - MTTP
Table - 1070 x 230mm
Longitudinal traverse - 760mm
Cross - 305mm, Ram - 305
Add
Delete

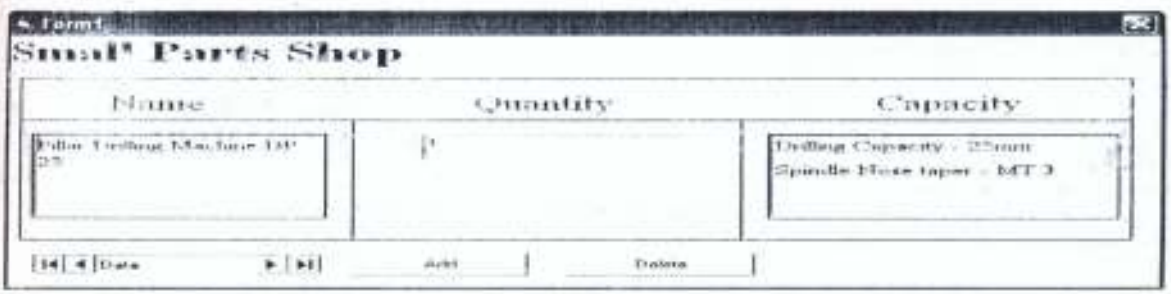

Small Parts Shop
Name
Quantity
Capacity
Universal Milling Machine - FN
Able Swivel (to each side)
45°
Table size - T1350 x 310mm
Add
Delete

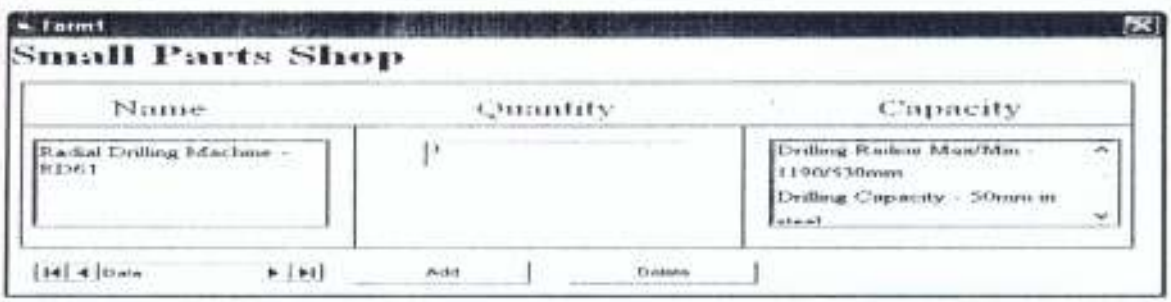

Small Parts Shop
Name
Quantity
Capacity
Keyway Milling Machine
Max length of key-way - 400mm
Add
Delete


Form1
Small Parts Shop
Name
Quantity
Capacity
Max stroke - 250mm
Add
Delete

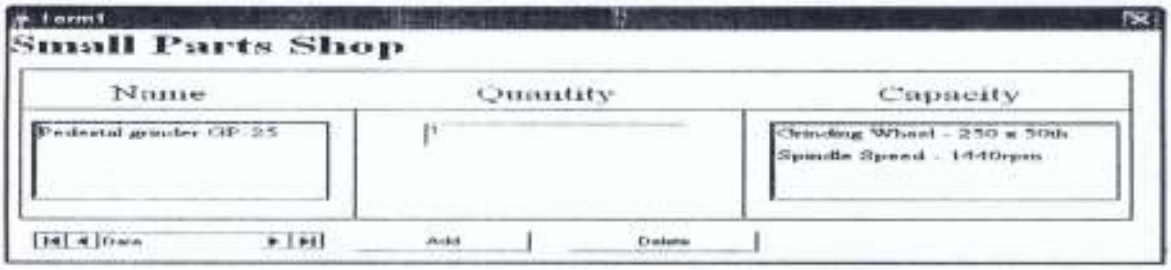

Form1
Small Parts Shop
Name
Quantity
Capacity
Horizontal Broaching machine BW 5
Max Inactive Force - 50.000N
Max Stroke - 1320 mm
Add
Delete


Form1
Small Parts Shop
Name
Quantity
Capacity
Drilling Capacity - 13mm
Add
Delete

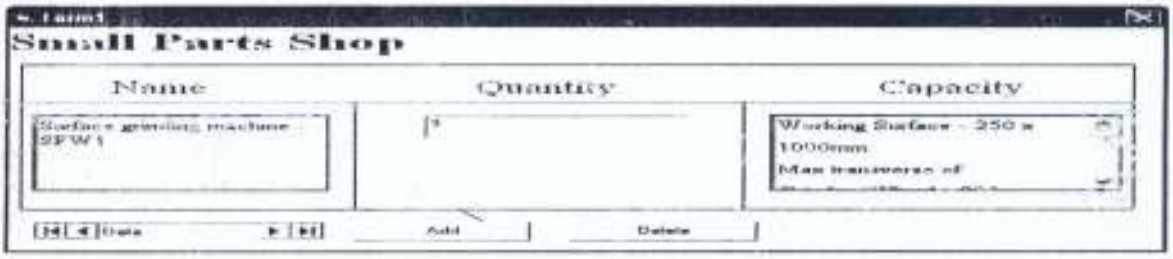

Form1
Small Parts Shop
Name
Quantity
Capacity
Drilling Capacity - 25mm
Spindle Nose taper - MT 3
Add
Delete

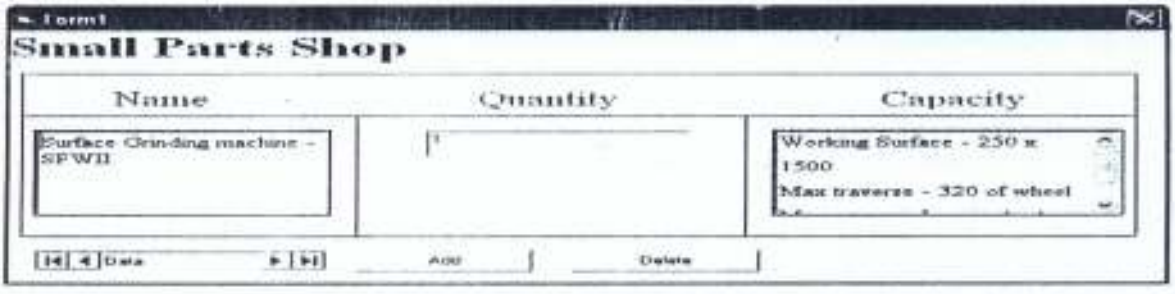

Form1
Small Parts Shop
Name
Quantity
Capacity
Radial Drilling Machine - RD61
Drilling Radius Max/Min - 1190/530mm
Drilling Capacity - 50mm in
Add
Delete

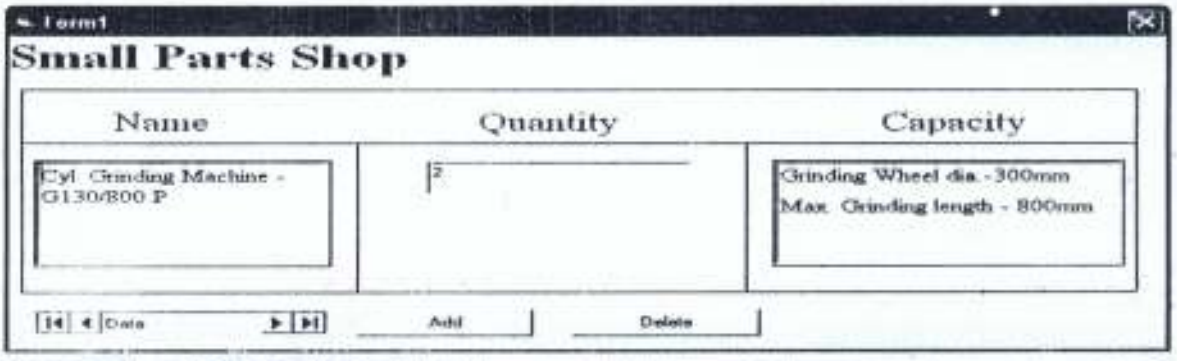

Form1
Small Parts Shop
Name
Quantity
Capacity
Drilling radius Max/Min - 1790/530
Add
Delete


Form1
Small Parts Shop
Name
Quantity
Capacity
Pedestal grinder GP-25
1
Grinding Wheel - 250 x 50th
Spindle Speed - 1440rpm
Data
Add
Delete


Form1
Small Parts Shop
Name
Quantity
Capacity
Pedestal grinder GP-30
2
Grinding Wheel Dia - 300mm
Spindle Speed - 1440rpm
Data
Add
Delete


Form1
Small Parts Shop
Name
Quantity
Capacity
Surface grinding machine - SPWI
1
Working Surface - 250 x 1000mm
Max traverse of
Data
Add
Delete

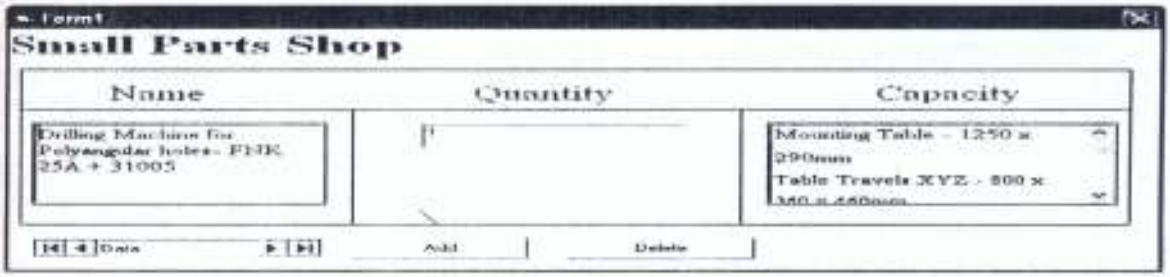

Form1
Small Parts Shop
Name
Quantity
Capacity
Surface Grinding machine - SPWII
1
Working Surface - 250 x 1500
Max traverse - 320 of wheel
Data
Add
Delete


Form1
Small Parts Shop
Name
Quantity
Capacity
Cyl. Grinding Machine - G130/800 P
2
Grinding Wheel dia. - 300mm
Max. Grinding length - 800mm
Data
Add
Delete

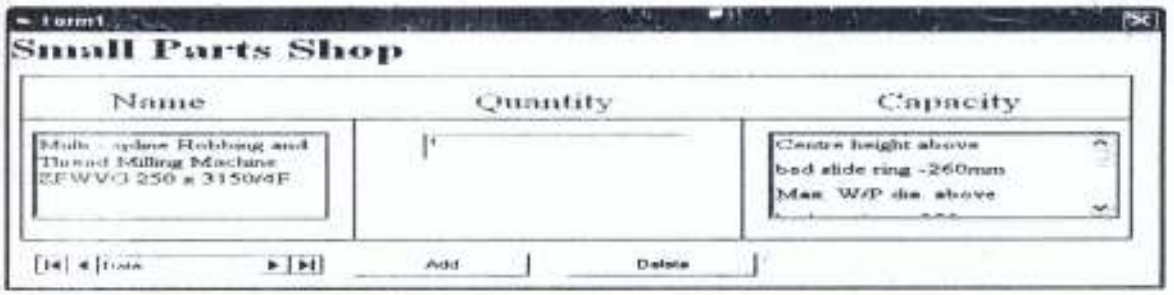

Small Parts Shop
Name
Quantity
Capacity
Cyl. Grinding Machine - G17/800 P
1
Grinding Wheel dia - 500mm
Max. Grinding length - 800mm
Data
Add
Delete

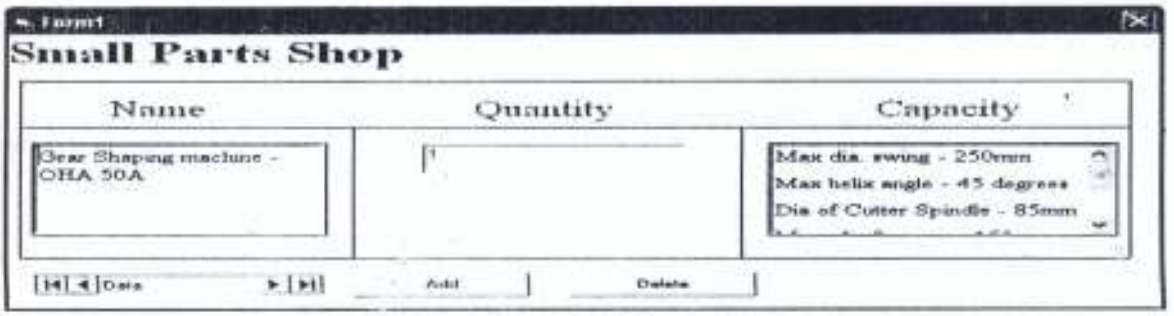

Form1
Small Parts Shop
Name
Quantity
Capacity
Cyl. Grinding Machine - 917/12,00 P
Grinding Wheel dia - 500mm
Max. Grinding length - 12,00mm
Add
Delete

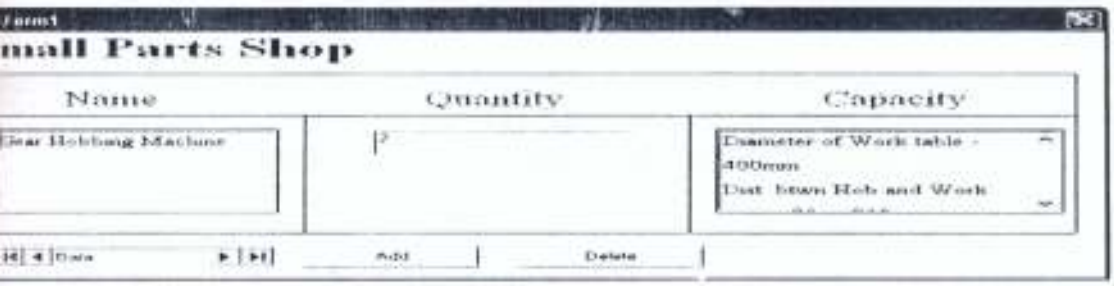

Form1
Small Parts Shop
Name
Quantity
Capacity
Tool & Cutter Grinder - CTC 2R
Swing Dia - 280mm
Dist. btw T-S Centres - 760mm
Add
Delete


Form1
Small Parts Shop
Name
Quantity
Capacity
Drilling Machine for Polyangular holes- PHK 25A + 31005
Mounting Table - 1250 x 290mm
Add
Delete


Form1
Small Parts Shop
Name
Quantity
Capacity
Universal Internal grinder - RDU 250A
Bore dia., Min/Max - 1025mm
Max grinding length - 250mm
Add
Delete

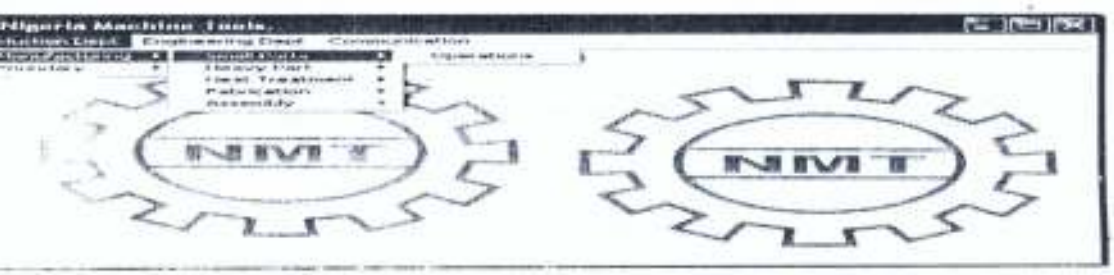

Form1
Small Parts Shop
Name
Quantity
Capacity
Centre height above bed slide ring -260mm
Add
Delete


Form1
Small Parts Shop
Name
Quantity
Capacity
Gear Shaping machine - OHA 50A
Max dia. swing - 250mm
Max helix angle - 45 degrees
Dia of Cutter Spindle - 85mm
Add
Delete



m the database of the difference between the existing and the standard facilities ,it was shown Nigeria Machine Tools only need to upgrade their industry with a few facilities in order to et up with the standard.

database of the operation carried out in different sections of the Manufacturing and production artment of Nigeria Machine Tool are shown below



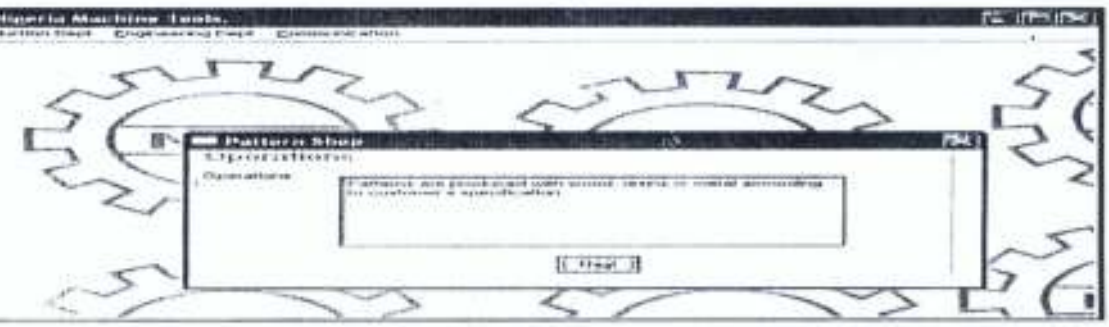

Nigeria Machine Tools
Heavy Parts
Operations
Next


Nigeria Machine Tools
Heat Treatment
Operations
Next


Nigeria Machine Tools
Lubrication
Operations
Next

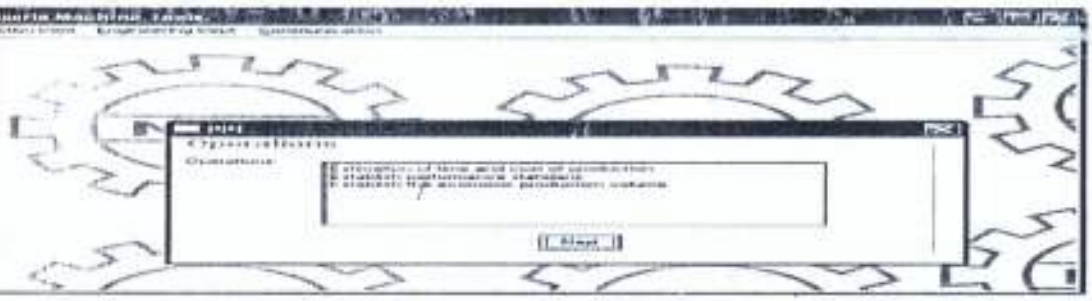

Nigeria Machine Tools
Assembly
Operations
Next


Nigeria Machine Tools
ENGINEERING STORE
Operations
Next


Nigeria Machine Tools
Pattern Shop
Operations
Next


Nigeria Machine Tools.
Engineering Dept
Communication
Next

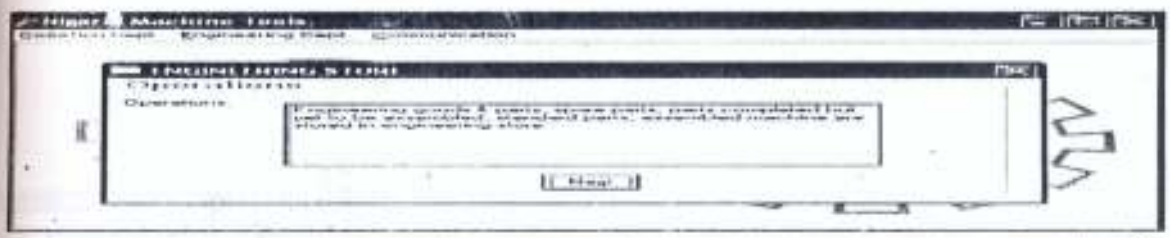

Engineering Dept
Communication
Next


Next


Nigeria Machine Tools.
Engineering Dept
Communication
ppp
Operations
Operations
Next


Next


Nigeria Machine Tools.
Engineering Dept
Communication
Operations
Next


Nigeria Machine Tools.
Production Dept Engineering Dept Communication
Operations
Next


Nigeria Machine Tools.
Production Dept Engineering Dept Communication
GENERAL GOODS
Operations
Next


Nigeria Machine Tools.
Production Dept Engineering Dept Communication
Operations
Next


Nigeria Machine Tools.
Production Dept Engineering Dept Communication
Operations
To design mechanical and hydraulic system
To simulate system designed
Modelings are done in conformity with designed
Modelings are done in conformity with design system
Analysis of part and final design are done
Next


Nigeria Machine Tools.
Production Dept Engineering Dept Communication
Operations
Next


Nigeria Machine Tools.
Production Dept Engineering Dept Communication
MACHINE DESIGN
Operations
Next

- The networking of different sections of the production and manufacturing department can be done using server/client connection system and this is shown in the figures below.

If all these facilities are put in place and the networking system is properly utilized the efficiency of the manufacturing processes of the machine tool industry will be highly enhanced.

4.1 THE CORRELATION BETWEEN THE EXISTING AND STANDARD FACILITIES

Section	Code
Foundry	10
Training Centre	20
Heat Treatment	30
Tool Reconditioning & Resharpening	40
Tool & Measuring Room	50
Metal Fabrication Shop	60
Heavy Part Shop	70
Small Part Shop	80

Table 4.1: Different sections and their code

Source: NMT Manual

Code	10	20	30	40	50	60	70	80
Standard Facilities (x_1)	63	18	13	8	11	14	14	44
Existing Facilities (x_2)	59	18	11	7	8	10	14	40

Table 4.2 : The quantity of standard and existing facilities with their code

Source: Author's compilation

Assuming $\sigma_1 = \sigma_2$; $n_1 = n_2 = 8$

$\overline{x_1} = 23.13$ $\overline{x_2} = 20.88$

The test statistics is $t = \dfrac{\overline{x_1} - \overline{x_2}}{S\sqrt{\dfrac{1}{n_1} + \dfrac{1}{n_2}}}$

X_1	$x_1 - \overline{x_1}$	$(x_1 - \overline{x_1})^2$	x_2	$x_2 - \overline{x_2}$	$(x_2 - \overline{x_2})^2$
	39.87	1589.62	59	38.12	1453.13
	-5.13	26.32	18	-2.88	8.29
	-10.13	102.62	11	-9.88	97.61
	-15.13	228.92	7	-13.88	192.65
	-12.13	147.14	8	-12.88	165.89
	-9.13	83.36	10	-10.88	118.37
	-9.13	83.36	14	-6.88	47.33
	20.87	435.56	40	19.12	365.57
		2696.90			2448.84

Table 4.3: Testing the variance and the level of significance of the facilities

Source: Author's compilation

$$S_1 = \sqrt{\frac{\sum(x_1 - \overline{x_1})}{n}} \qquad S_2 = \sqrt{\frac{\sum(x_2 - \overline{x_2})}{n}}$$

$$S_1 = \sqrt{\frac{2696.9}{8}} \qquad S_1 = \sqrt{337.11} \qquad S_1 = 18.36$$

$$S_2 = \sqrt{\frac{2448.84}{8}} \qquad S_2 = \sqrt{306.11} \qquad S_2 = 17.50$$

$$S = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}$$

$$S = \sqrt{\frac{(8-1)336.95 + (8-1)306.11}{8+8-2}}$$

$$S = \sqrt{\frac{4501.42}{14}}$$

$$S = \sqrt{321.53} = 17.93$$

$$= \frac{\bar{x}_1 - \bar{x}_2}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

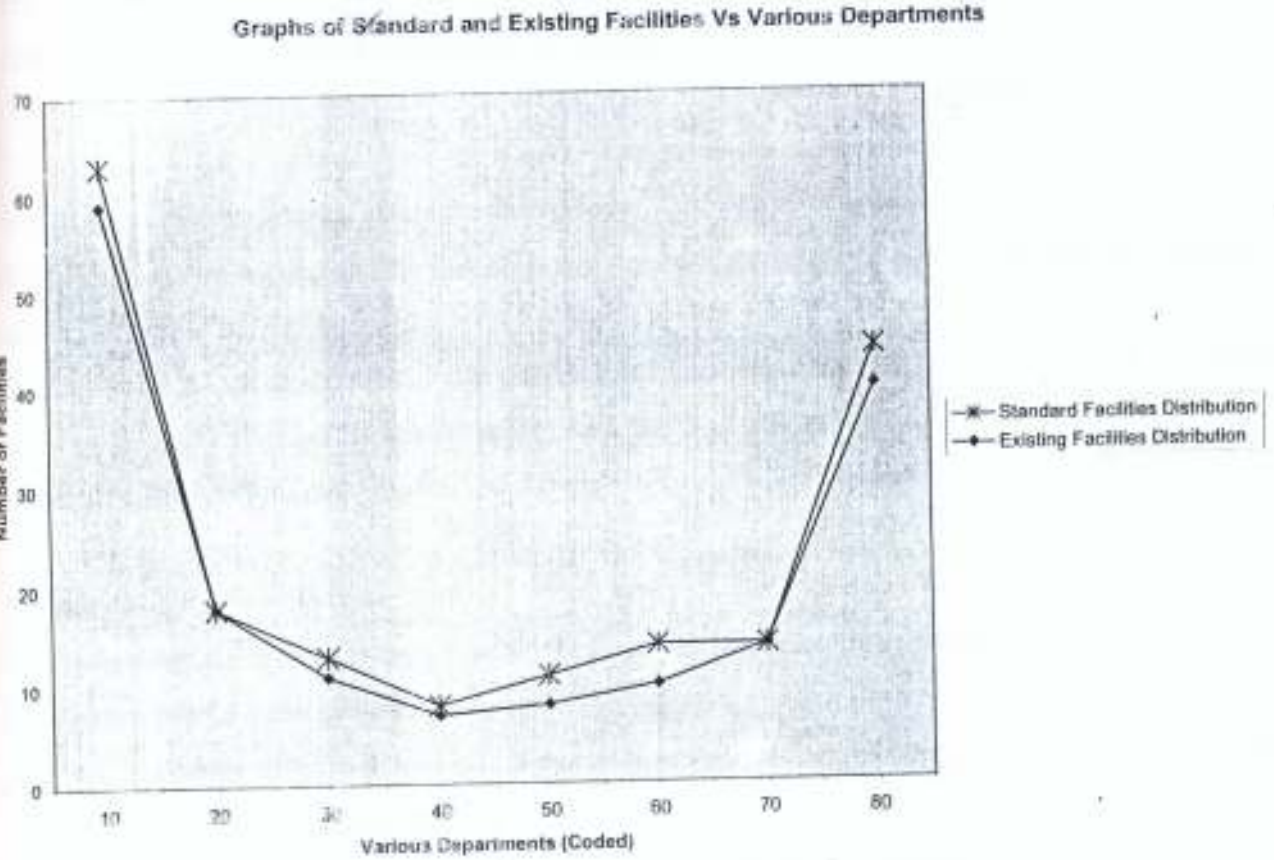
$$\frac{23.13 - 20.88}{17.93\sqrt{\frac{1}{8} + \frac{1}{8}}} = \frac{2.25}{17.93 * \sqrt{0.25}} = \frac{2.25}{8.965}$$

0.251

ng a 5% level of significance and a degree of freedom of 8+8-2 = 14

$_{0}(14) = 2.145$

ce $t_c < t_T$ There is no significant difference between the standard and existing facilities



g. 4.5 The correlation between the standard and existing facilities distribution

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The computer-Aided Design system in database design permits automation in some certain phases of design and manufacturing. The introduction of CAD system in database design is to give fast and easy modification of design.

In the cause of this project, an interactive software known as **CADDMT 2006** was developed. This software permits proper communication with the user (user-friendliness) having a common input/output language familiar to them. The software generates accurate engineering facilities data in Nigeria Machine Tools Limited Osogbo and gives the name quantity and technical specification of each facility. The visual basic program developed shows the database of the standard facilities that suppose to be in existence in a standard machine tool industry and existing facilities available in the case study Nigeria Machine Tool Limited in Osogbo.

The software developed shows the database of the difference in the standard and existing facilities The database of the operation of each section in production and manufacturing department of the industry was also developed using the software..

It also links all the sections in the company and network all the department in the company thereby making it interactive.

Conclusively, it was observed that the software developed will successfully enhanced the efficiency of any design and manufacturing processes. And the cost of the software will be determined by the quantity of the equipment available and the complexity of the program.

5.2 RECOMMENDATION

The following recommendations are made from the successful realization of the stated goals and objectives of this research work.

(i) The software developed should be commercialized so that improvement can be done on it as a result of the responsiveness from the end-users.

(ii) The software developed should also be adopted in other manufacturing industries.

(iii) Further development could be achieved by developing a more detailed database design with the software developed covering all other sections and departments of the machine tools company.

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APPENDIX 1

Formulae for machining time on different operations

Abbreviation

L cut, Lg = Length (mm)

L1 + L2 = Approach + overrun (mm)

N = Revs per min (rpm)

f = feed (mm/min)

D = Diameter (mm)

v = Speed (mm/min)

tm = Machining time (min)

B = Width (mm)

M = Ratio of return to cutting time

Rv = Return speed (mm/min)

Sz = Feed/Tooth on cutter

Z = No of tooth on cutter

G = No of hub thread

fr = Radial feed (mm/min)

d = tooth depth

b = tooth length (mm)

1. Turning and allied operations

Hole mill/turning, counter bore, Drilling, Reaming, Turning, Facing, Parting off

$$tm = \frac{lg + l_1 + l_2}{N \times f}$$

$$N = \frac{1000V}{D}$$

N.B. V-speed varies according to operation, depending on material of tool

(20-60) mm/min for carbide and H.S.S tools.

2. Threading:

$$Tm = \frac{L.cut}{N \times Pitch}$$

3. Tapping:

$$tm = \frac{L + D/2}{\text{Pitch x N4}} + \frac{1/2L + D/2}{\text{Pitch x N}}$$

4.Grinding

i. Surface grinding:

$$t_m = \frac{strokel_g + l_i + l}{tablespeed} x \frac{EffectiveWidthOfJob + l}{CrossFeed / Stroke} x \frac{GrindingAllowance}{EffectiveDepthOfFeed / Stroke}$$

ii. Cylindrical Grinding:

$$t_m = \frac{GrindingAllowance}{EffectiveFeed} x \frac{L + C_1 + C_2}{NxF}$$

5. planning and shaping:

$$t_m = \frac{StrokeLg}{V} + \frac{Stroke \quad \lg}{Rv} + time \quad \log \frac{WidthOfJob}{Feed}$$

Stroke l_g = cutting $l_g + l_1 + l$

6. Milling:

$$t_m = \frac{L + l_1 + L_2}{S_c xZxN} = \frac{L + l_1 + L_2}{Feed / Min}$$

7. Cutting:

$$t_m = \frac{CrossSecti \quad onalAreaOf \quad Material \quad + l_1 + l_2}{RateOfCutx \quad 100} = \frac{A + l_1 + l_2}{RateOfCutx \quad 100}$$

$$A = \frac{\Pi D^2}{4}$$

For square or rectangle bars

A = L x B

8. Slotting:

$$t_m = \frac{DepthOfKeyway + SegmentalHeight}{FeedxNoOfStroke / Min}$$

9. Gear Milling

$$t_m \frac{L + l_1 + l_2}{Feed / Min} xFactor$$

10. Gear Hobbing:

$$t_m = z \left(\frac{d + b}{fr + f} \right)$$

```
frmWelcome
Private Sub mnuFacilities_Click()
Unload frmFacilities
frmFacilities.Caption = "Small Parts"
frmFacilities.dbFacilities.RecordSource = "SmallParts Facilities"
frmFacilities.dbFacilities.Refresh
frmFacilities.txtDescription.DataField = "Description"
frmFacilities.txtQty.DataField = "Quantity"
frmFacilities.txtSpecification = "Technical Specification"

frmFacilities.Show


End Sub

Private Sub mnuOperations_Click()

Unload frmOperations
frmOperations.Caption = "Small Parts"
frmOperations.txtOperation.FileName = App.Path + "\operations\smallpart.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations10_Click()
Unload frmOperations
frmOperations.Caption = "Laboratory"
frmOperations.txtOperation.FileName = App.Path + "\operations\laboratory.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations2_Click()
Unload frmOperations
frmOperations.Caption = "Heavy Parts"
frmOperations.txtOperation.FileName = App.Path + "\operations\heavypart.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations3_Click()
Unload frmOperations
frmOperations.Caption = "Heat Treatment"
frmOperations.txtOperation.FileName = App.Path + "\operations\heatTreatment.txt"
frmOperations.Show

End Sub
```

```
Private Sub mnuOperations4_Click()
Unload frmOperations
frmOperations.Caption = "Fabrication"
frmOperations.txtOperation.FileName = App.Path + "\operations\fabrication.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations5_Click()
Unload frmOperations
frmOperations.Caption = "Assembly"
frmOperations.txtOperation.FileName = App.Path + "\operations\assembly.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations6_Click()
Unload frmOperations
frmOperations.Caption = "Pattern Shop"
frmOperations.txtOperation.FileName = App.Path + "\operations\patternshop.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations7_Click()
Unload frmOperations
frmOperations.Caption = "Fettling"
frmOperations.txtOperation.FileName = App.Path + "\operations\moulding.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations8_Click()
Unload frmOperations
frmOperations.Caption = "Heavy Parts"
frmOperations.txtOperation.FileName = App.Path + "\operations\fetting.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations9_Click()
Unload frmOperations
frmOperations.Caption = "Melting"
frmOperations.txtOperation.FileName = App.Path + "\operations\Melting.txt"
frmOperations.Show

End Sub
```

```
rivate Sub Operations11_Click()
nload frmOperations
mOperations.Caption = "PPE"
mOperations.txtOperation.FileName = App.Path + "\operations\PPE.txt"
mOperations.Show

nd Sub

rivate Sub Operations12_Click()
nload frmOperations
mOperations.Caption = "PPP"
mOperations.txtOperation.FileName = App.Path + "\operations\PPP.txt"
mOperations.Show

nd Sub

rivate Sub Operations13_Click()
nload frmOperations
mOperations.Caption = "PPM"
mOperations.txtOperation.FileName = App.Path + "\operations\PPM.txt"
mOperations.Show

nd Sub

rivate Sub Operations14_Click()
nload frmOperations
mOperations.Caption = "PPC"
mOperations.txtOperation.FileName = App.Path + "\operations\PPC.txt"
mOperations.Show

nd Sub

rivate Sub Operations15_Click()
nload frmOperations
mOperations.Caption = "ENGINEERING STORE"
mOperations.txtOperation.FileName = App.Path + "\operations\ENGINEERINGSTORE.txt"
mOperations.Show

nd Sub

rivate Sub Operations16_Click()
nload frmOperations
mOperations.Caption = "GENERAL GOODS"
mOperations.txtOperation.FileName = App.Path + "\operations\GENERALGOODS.txt"
mOperations.Show

nd Sub

rivate Sub Operations17_Click()
```

```
Unload frmOperations
frmOperations.Caption = "RAW MATERIAL INSPECTION"
frmOperations.txtOperation.FileName = App.Path + "\operations\RAWMATERIAL.txt"
frmOperations.Show

End Sub

Private Sub Operations18_Click()
Unload frmOperations
frmOperations.Caption = "IN-PROCESS CONTROL"
frmOperations.txtOperation.FileName = App.Path + "\operations\INPROCESS.txt"
frmOperations.Show

End Sub

Private Sub Operations19_Click()
Unload frmOperations
frmOperations.Caption = "FINAL INSPECTION"
frmOperations.txtOperation.FileName = App.Path + "\operations\FINALINSPECTION.txt"
frmOperations.Show

End Sub

Private Sub Operations20_Click()
Unload frmOperations
frmOperations.Caption = "TESTING"
frmOperations.txtOperation.FileName = App.Path + "\operations\TESTING.txt"
frmOperations.Show
End Sub

Private Sub Operations21_Click()
Unload frmOperations
frmOperations.Caption = "MECHANICAL / HYDRA LINE"
frmOperations.txtOperation.FileName = App.Path + "\operations\mechanicalhydra.txt"
frmOperations.Show

End Sub

Private Sub Operations22_Click()
Unload frmOperations
frmOperations.Caption = "ELECTRICAL"
frmOperations.txtOperation.FileName = App.Path + "\operations\electrical.txt"
frmOperations.Show

End Sub

Private Sub Operations23_Click()
Unload frmOperations
frmOperations.Caption = "TOOL DESIGN"
```

```
frmOperations.txtOperation.FileName = App.Path + "\operations\toooldesign.txt"
frmOperations.Show
```



```
End Sub

Private Sub Operations24_Click()
Unload frmOperations
frmOperations.Caption = "MACHINE DESIGN"
frmOperations.txtOperation.FileName = App.Path + "\operations\machinedesign.txt"
frmOperations.Show

End Sub

Private Sub Operations25_Click()
Unload frmOperations
frmOperations.Caption = "SPARE PARTS / INDUSTRIAL DESIGN"
frmOperations.txtOperation.FileName = App.Path + "\operations\sparepart.txt"
frmOperations.Show

End Sub
```

```
Private Sub mnuFacilities_Click()
Unload frmFacilities
frmFacilities.Caption = "Small Parts"
frmFacilities.dbFacilities.RecordSource = "SmallParts Facilities"
frmFacilities.dbFacilities.Refresh
frmFacilities.txtDescription.DataField = "Description"
frmFacilities.txtQty.DataField = "Quantity"
frmFacilities.txtSpecification = "Technical Specification"

frmFacilities.Show


End Sub

Private Sub mnuOperations_Click()

Unload frmOperations
frmOperations.Caption = "Small Parts"
frmOperations.txtOperation.FileName = App.Path + "\operations\smallpart.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations10_Click()
Unload frmOperations
frmOperations.Caption = "Laboratory"
frmOperations.txtOperation.FileName = App.Path + "\operations\laboratory.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations2_Click()
Unload frmOperations
frmOperations.Caption = "Heavy Parts"
frmOperations.txtOperation.FileName = App.Path + "\operations\heavypart.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations3_Click()
Unload frmOperations
frmOperations.Caption = "Heat Treatment"
frmOperations.txtOperation.FileName = App.Path + "\operations\heatTreatment.txt"
frmOperations.Show

End Sub
```

```
Private Sub mnuOperations4_Click()
Unload frmOperations
frmOperations.Caption = "Fabrication"
frmOperations.txtOperation.FileName = App.Path + "\operations\fabrication.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations5_Click()
Unload frmOperations
frmOperations.Caption = "Assembly"
frmOperations.txtOperation.FileName = App.Path + "\operations\assembly.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations6_Click()
Unload frmOperations
frmOperations.Caption = "Pattern Shop"
frmOperations.txtOperation.FileName = App.Path + "\operations\pattenshop.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations7_Click()
Unload frmOperations
frmOperations.Caption = "Tetlling"
frmOperations.txtOperation.FileName = App.Path + "\operations\moulding.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations8_Click()
Unload frmOperations
frmOperations.Caption = "Heavy Parts"
frmOperations.txtOperation.FileName = App.Path + "\operations\fetting.txt"
frmOperations.Show

End Sub

Private Sub mnuOperations9_Click()
Unload frmOperations
frmOperations.Caption = "Melting"
frmOperations.txtOperation.FileName = App.Path + "\operations\Melting.txt"
frmOperations.Show

End Sub

Private Sub Operations11_Click()
```

```
frmOperations.Show

End Sub

Private Sub Operations12_Click()
Unload frmOperations
frmOperations.Caption = "PPP"
frmOperations.txtOperation.FileName = App.Path + "\operations\PPP.txt"
frmOperations.Show

End Sub

Private Sub Operations13_Click()
Unload frmOperations
frmOperations.Caption = "PPM"
frmOperations.txtOperation.FileName = App.Path + "\operations\PPM.txt"
frmOperations.Show

End Sub

Private Sub Operations14_Click()
Unload frmOperations
frmOperations.Caption = "PPC"
frmOperations.txtOperation.FileName = App.Path + "\operations\PPC.txt"
frmOperations.Show

End Sub

Private Sub Operations15_Click()
Unload frmOperations
frmOperations.Caption = "ENGINEERING STORE"
frmOperations.txtOperation.FileName = App.Path + "\operations\ENGINEERINGSTORE.txt"
frmOperations.Show

End Sub

Private Sub Operations16_Click()
Unload frmOperations
frmOperations.Caption = "GENERAL GOODS"
frmOperations.txtOperation.FileName = App.Path + "\operations\GENERALGOODS.txt"
frmOperations.Show

End Sub

Private Sub Operations17_Click()
Unload frmOperations
```

```
Operations.Show

Sub

vate Sub Operations24_Click()
ad frmOperations
Operations.Caption = "MACHINE DESIGN"
Operations.txtOperation.FileName = App.Path + "\operations\machinedesign.txt"
Operations.Show

Sub

vate Sub Operations25_Click()
ad frmOperations
Operations.Caption = "SPARE PARTS / INDUSTRIAL DESIGN"
Operations.txtOperation.FileName = App.Path + "\operations\sparepart.txt"
Operations.Show

Sub
```

```
frmOperations
Private Sub cmdNext_Click()
Dim strOperations As String
Static oVar As Integer

oVar = oVar + 1

If oVar = 1 Then
  strOperations = "Machining of Small round parts"
ElseIf oVar = 2 Then
  strOperations = "Machining of flats components"
ElseIf oVar = 3 Then
  strOperations = "Cutting and Machining of gears"
ElseIf oVar = 4 Then
  strOperations = "Machining of sprocket, hub, bushes"
ElseIf oVar = 5 Then
  oVar = 0
End If

txtOperations = strOperations
End Sub

Private Sub cmdNext2_Click()

Dim str1 As String
Dim str2 As String
Dim str3 As String

Static oVar2 As Integer

oVar2 = oVar2 + 1

If oVar2 = 1 Then
  str1 = "Capstan lathe"
  str2 = "Swing Over Carriage -260mm Centre height - 125mm"
  str3 = "3"
ElseIf oVar2 = 2 Then
  str1 = "Centre Lathe NH22/100 "
  str2 = "Centre height - 220mm Swing Over bed - 500mm Dist. Btw Centre- 1000m"
  str3 = "8"
ElseIf oVar2 = 3 Then
  str1 = "Centre lathe NH26/1500"
  str2 = "Centre height - 220mm Swing Over bed - 500mm Dist. Btw Centre- 1500m"
  str3 = "5"
ElseIf oVar2 = 4 Then
  str1 = "Centre lathe NH26/1000"
  str2 = "Centre height - 260mm Swing Over bed - 550mm Dist. Btw Centre- 1,000m"
  str3 = "1"
ElseIf oVar2 = 5 Then
```

```
  str1 = "Centre lathe NH26/1500"
  str2 = "Centre height - 260mm Swing Over bed - 550mm Dist. Btw Centre- 1,500m"
  str3 = "2"
 Elself oVar2 = 6 Then
  str1 = "Centre lathe NH26/2,000"
  str2 = "Centre height - 260mm Swing Over bed - 550mm Dist. Btw Centre- 2,000m"
  str3 = "2"
 Elself oVar2 = 7 Then
  str1 = ""
  str2 = ""
  str3 = ""
 Elself oVar2 = 8 Then
  str1 = ""
  str2 = ""
  str3 = ""
 Elself oVar2 = 9 Then
  str1 = ""
  str2 = ""
  str3 = ""
 Elself oVar2 = 10 Then
  str1 = ""
  str2 = ""
  str3 = ""

 Elself oVar2 = 11 Then
  oVar2 = 0
 End If

 txtDescription = str1
 txtSpecification = str2
 txtQty = str3

 End Sub
```

```
Communication Server

Private Sub Form_Load()
  If InIDE Then
    MsgBox "This application uses subclassing!" + vbCrLf + "Never press the Stop button from the VB toolbar or use the 'End' keyword to exit the
application. Your IDE will crash if you do this!" + vbCrLf + "Always click the x button on the top-right of the form, or use 'Unload frmMain' to exit the
application from VB code.", vbExclamation + vbOKOnly
  End If
  'Start WinSock... This must be called before any other WinSock function call
  StartWinsock vbNullString
  txtIP.Text = GetIPAddress
  txtPort.Text = Str(SERVER_PORT)
  'Start subclassing
  StartSubclass Me
  'Create server socket
  listenSocket = ListenForConnect(SERVER_PORT, Me.hwnd)
  If listenSocket = INVALID_SOCKET Then
    AddText "Error while creating server socket..."
  Else
    AddText "Successfully created server socket.."
  End If
End Sub
Private Sub Form_Unload(Cancel As Integer)
  Dim Cnt As Long
  'Close all the client connections
  For Cnt = 1 To Sockets.Count
    closesocket Sockets.Item(Cnt)
  Next Cnt
  'Close the server socket
  closesocket listenSocket
  'Stop subclassing
  StopSubclass Me
  'Uninitialize WinSock
  EndWinsock
  Set Sockets = Nothing
  Set IPAddresses = Nothing
End Sub
```

```
mServer

blic Const SERVER_PORT As Long = 12345
blic Const GWL_WNDPROC = (-4)
blic Type HostEnt
  hName As Long
  hAliases As Long
  hAddrType As Integer
  hLen As Integer
  hAddrList As Long
nd Type
blic Declare Sub CopyMemoryIP Lib "kernel32" Alias "RtlMoveMemory" (hpvDest As Any, ByVal hpvSource As Long, ByVal cbCopy As Long)
Declare Function SetWindowLong Lib "user32" Alias "SetWindowLongA" (ByVal hwnd As Long, ByVal nIndex As Long, ByVal dwNewLong As
Long) As Long
Declare Function CallWindowProc Lib "user32" Alias "CallWindowProcA" (ByVal lpPrevWndFunc As Long, ByVal hwnd As Long, ByVal Msg As
Long, ByVal wParam As Long, ByVal lParam As Long) As Long
Public listenSocket As Long
Public Sockets As New Collection
Public IPAddresses As New Collection
Private PrevProc As Long
Function to retrieve the IP address
Public Function GetIPAddress() As String
  Dim sHostName As String * 256
  Dim lpHost As Long
  Dim Host As HostEnt
  Dim dwIPAddr As Long
  Dim tmpIPAddr() As Byte
  Dim I As Integer
  Dim sIPAddr As String
  If gethostname(sHostName, 256) = SOCKET_ERROR Then
    GetIPAddress = ""
    MsgBox "Windows Sockets error " & Str$(WSAGetLastError()) & " has occurred. Unable to successfully get Host Name."
    Exit Function
  End If
  sHostName = Trim$(sHostName)
  lpHost = gethostbyname(sHostName)
  If lpHost = 0 Then
    GetIPAddress = ""
    MsgBox "Windows Sockets are not responding. " & "Unable to successfully get Host Name."
    Exit Function
  End If
  CopyMemoryIP Host, lpHost, Len(Host)
  CopyMemoryIP dwIPAddr, Host.hAddrList, 4
  ReDim tmpIPAddr(1 To Host.hLen)
  CopyMemoryIP tmpIPAddr(1), dwIPAddr, Host.hLen
  For I = 1 To Host.hLen
    sIPAddr = sIPAddr & tmpIPAddr(I) & "."
  Next
  GetIPAddress = Mid$(sIPAddr, 1, Len(sIPAddr) - 1)
```

```
End Function
'For more information about subclassing,
'visit our subclassing tutorial on http://www.allapi.net/
Public Sub StartSubclass(F As Form)
  PrevProc = SetWindowLong(F.hwnd, GWL_WNDPROC, AddressOf WindowProc)
End Sub
Public Sub StopSubclass(F As Form)
  If PrevProc <> 0 Then SetWindowLong F.hwnd, GWL_WNDPROC, PrevProc
End Sub
Public Function WindowProc(ByVal hwnd As Long, ByVal uMsg As Long, ByVal wParam As Long, ByVal lParam As Long) As Long
  If uMsg = WINSOCK_MESSAGE Then
    ProcessMessage wParam, lParam
  Else
    WindowProc = CallWindowProc(PrevProc, hwnd, uMsg, wParam, lParam)
  End If
End Function
'Process socket messages
Public Function ProcessMessage(ByVal wParam As Long, ByVal lParam As Long) 'wParam = Socket Handle, lParam = connection message
  Select Case lParam
    Case FD_ACCEPT
      Dim tempSocket As Long, tempAddr As sockaddr
      tempSocket = accept(wParam, tempAddr, Len(tempAddr))
      AddSocket tempSocket, getascip(tempAddr.sin_addr)
      AddText "*** " + GetIPFromSocket(tempSocket) + " connected..."
    Case FD_WRITE
    Case FD_READ
      Dim sTemp As String, lRet As Long, szBuf As String
      Do
        szBuf = String(256, 0)
        lRet = recv(wParam, ByVal szBuf, Len(szBuf), 0)
        If lRet > 0 Then sTemp = sTemp + Left$(szBuf, lRet)
      Loop Until lRet <= 0
      If LenB(sTemp) > 0 Then
        AddText "From " + GetIPFromSocket(wParam) + ": " + sTemp
      End If
      SendData wParam, "From Server: Thank you for sending me a message!"
    Case Else 'FD_CLOSE
      AddText "*** " + GetIPFromSocket(wParam) + " disconnected..."
      RemoveSocket wParam
  End Select
End Function
Public Sub AddText(sInput As String)
  frmMain.txtReceived.Text = frmMain.txtReceived.Text + sInput + IIf(Right$(sInput, 2) = vbCrLf, "", vbCrLf)
  frmMain.txtReceived.SelStart = Len(frmMain.txtReceived.Text)
End Sub
Public Function IsInIDE() As Boolean
On Local Error GoTo ErrHandler
  Debug.Print 1 / 0
Exit Function
```

```
ErrHandler:
  bInIDE = True
End Function
'Here are some functions to keep a list of all the connections to the server
Public Sub AddSocket(ByVal s As Long, ByVal FromIP As String)
On Local Error Resume Next
  IPAddresses.Add FromIP, CStr(s)
  Sockets.Add s, CStr(s)
End Sub
Public Sub RemoveSocket(ByVal s As Long)
On Local Error Resume Next
  IPAddresses.Remove CStr(s)
  Sockets.Remove CStr(s)
End Sub
Public Function GetIPFromSocket(lSocket As Long) As String
On Local Error GoTo ErrHandler
  GetIPFromSocket = IPAddresses.Item(CStr(lSocket))
Exit Function

ErrHandler:
  GetIPFromSocket = "Unknown IP address"
End Function
```

```
mWinsock
Option Explicit

Public Const WINSOCK_MESSAGE As Long = 1025

Public Const FD_SETSIZE = 64
Type IN_ADDR
  S_un_b(1 To 4) As Byte
  S_un_w(1 To 2) As Integer
  S_addr As Long
End Type

Type fd_set
  fd_count As Integer
  fd_array(FD_SETSIZE) As Integer
End Type

Type timeval
  tv_sec As Long
  tv_usec As Long
End Type

Type HostEnt
  h_name As Long
  h_aliases As Long
  h_addrtype As Integer
  h_length As Integer
  h_addr_list As Long
End Type
Public Const hostent_size = 16

Type servent
  s_name As Long
  s_aliases As Long
  s_port As Integer
  s_proto As Long
End Type
Public Const servent_size = 14

Type protoent
  p_name As Long
  p_aliases As Long
  p_proto As Integer
End Type
Public Const protoent_size = 10

Public Const IPPROTO_TCP = 6
Public Const IPPROTO_UDP = 17
```

```
Public Const INADDR_NONE = &HFFFF
Public Const INADDR_ANY = &H0

Type sockaddr
  sin_family As Integer
  sin_port As Integer
  sin_addr As Long
  sin_zero As String * 8
End Type
Public Const sockaddr_size = 16
Public saZero As sockaddr


Public Const WSA_DESCRIPTIONLEN = 256
Public Const WSA_DescriptionSize = WSA_DESCRIPTIONLEN + 1

Public Const WSA_SYS_STATUS_LEN = 128
Public Const WSA_SysStatusSize = WSA_SYS_STATUS_LEN + 1

Type WSADataType
  wVersion As Integer
  wHighVersion As Integer
  szDescription As String * WSA_DescriptionSize
  szSystemStatus As String * WSA_SysStatusSize
  iMaxSockets As Integer
  iMaxUdpDg As Integer
  lpVendorInfo As Long
End Type

Public Const INVALID_SOCKET = -1
Public Const SOCKET_ERROR = -1

Public Const SOCK_STREAM = 1
Public Const SOCK_DGRAM = 2

Public Const MAXGETHOSTSTRUCT = 1024

Public Const AF_INET = 2
Public Const PF_INET = 2

Type LingerType
  l_onoff As Integer
  l_linger As Integer
End Type


#If Win16 Then
'--Windows System functions
```

```
Public Declare Function PostMessage Lib "User" (ByVal hwnd As Integer, ByVal wMsg As Integer, ByVal wParam As Integer, lParam As Any) As
nteger
Public Declare Sub MemCopy Lib "Kernel" Alias "hmemcpy" (Dest As Any, Src As Any, ByVal cb&)
Public Declare Function lstrlen Lib "Kernel" (ByVal lpString As Any) As Integer
'--async notification constants
Public Const SOL_SOCKET = &HFFFF
Public Const SO_LINGER = &H80
Public Const FD_READ = &H1
Public Const FD_WRITE = &H2
Public Const FD_OOB = &H4
Public Const FD_ACCEPT = &H8
Public Const FD_CONNECT = &H10
Public Const FD_CLOSE = &H20
'--SOCKET FUNCTIONS
Public Declare Function accept Lib "Winsock.dll" (ByVal s As Integer, addr As sockaddr, addrlen As Integer) As Integer
Public Declare Function bind Lib "Winsock.dll" (ByVal s As Integer, addr As sockaddr, ByVal namelen As Integer) As Integer
Public Declare Function closesocket Lib "Winsock.dll" (ByVal s As Integer) As Integer
Public Declare Function Connect Lib "Winsock.dll" Alias "connect" (ByVal s As Integer, addr As sockaddr, ByVal namelen As Integer) As Integer
Public Declare Function ioctlsocket Lib "Winsock.dll" (ByVal s As Integer, ByVal CMD As Long, argp As Long) As Integer
Public Declare Function getpeername Lib "Winsock.dll" (ByVal s As Integer, sName As sockaddr, namelen As Integer) As Integer
Public Declare Function getsockname Lib "Winsock.dll" (ByVal s As Integer, sName As sockaddr, namelen As Integer) As Integer
Public Declare Function getsockopt Lib "Winsock.dll" (ByVal s As Integer, ByVal Level As Integer, ByVal optname As Integer, optval As Any, optlen
s Integer) As Integer
Public Declare Function htonl Lib "Winsock.dll" (ByVal hostlong As Long) As Long
Public Declare Function htons Lib "Winsock.dll" (ByVal hostshort As Integer) As Integer
Public Declare Function inet_addr Lib "Winsock.dll" (ByVal cp As String) As Long
Public Declare Function inet_ntoa Lib "Winsock.dll" (ByVal inn As Long) As Long
Public Declare Function listen Lib "Winsock.dll" (ByVal s As Integer, ByVal backlog As Integer) As Integer
Public Declare Function ntohl Lib "Winsock.dll" (ByVal netlong As Long) As Long
Public Declare Function ntohs Lib "Winsock.dll" (ByVal netshort As Integer) As Integer
Public Declare Function recv Lib "Winsock.dll" (ByVal s As Integer, buf As Any, ByVal buflen As Integer, ByVal flags As Integer) As Integer
Public Declare Function recvfrom Lib "Winsock.dll" (ByVal s As Integer, buf As Any, ByVal buflen As Integer, ByVal flags As Integer, from As
ckaddr, fromlen As Integer) As Integer
Public Declare Function ws_select Lib "Winsock.dll" Alias "select" (ByVal nfds As Integer, readfds As fd_set, writefds As fd_set, exceptfds As fd_set,
neout As timeval) As Integer
Public Declare Function Send Lib "Winsock.dll" Alias "send" (ByVal s As Integer, buf As Any, ByVal buflen As Integer, ByVal flags As Integer) As
teger
Public Declare Function sendto Lib "Winsock.dll" (ByVal s As Integer, buf As Any, ByVal buflen As Integer, ByVal flags As Integer, to_addr As
ckaddr, ByVal tolen As Integer) As Integer
Public Declare Function setsockopt Lib "Winsock.dll" (ByVal s As Integer, ByVal Level As Integer, ByVal optname As Integer, optval As Any, ByVal
tlen As Integer) As Integer
Public Declare Function ShutDown Lib "Winsock.dll" Alias "shutdown" (ByVal s As Integer, ByVal how As Integer) As Integer
Public Declare Function socket Lib "Winsock.dll" (ByVal af As Integer, ByVal s_type As Integer, ByVal protocol As Integer) As Integer
'--DATABASE FUNCTIONS
Public Declare Function gethostbyaddr Lib "Winsock.dll" (addr As Long, ByVal addr_len As Integer, ByVal addr_type As Integer) As Long
Public Declare Function gethostbyname Lib "Winsock.dll" (ByVal host_name As String) As Long
Public Declare Function gethostname Lib "Winsock.dll" (ByVal host_name As String, ByVal namelen As Integer) As Integer
Public Declare Function getservbyport Lib "Winsock.dll" (ByVal Port As Integer, ByVal proto As String) As Long
Public Declare Function getservbyname Lib "Winsock.dll" (ByVal serv_name As String, ByVal proto As String) As Long
```

```
Public Declare Function getprotobynumber Lib "Winsock.dll" (ByVal proto As Integer) As Long
Public Declare Function getprotobyname Lib "Winsock.dll" (ByVal proto_name As String) As Long
'--WINDOWS EXTENSIONS
Public Declare Function WSAStartup Lib "Winsock.dll" (ByVal wVR As Integer, lpWSAD As WSADataType) As Integer
Public Declare Function WSACleanup Lib "Winsock.dll" () As Integer
Public Declare Sub WSASetLastError Lib "Winsock.dll" (ByVal iError As Integer)
Public Declare Function WSAGetLastError Lib "Winsock.dll" () As Integer
Public Declare Function WSAIsBlocking Lib "Winsock.dll" () As Integer
Public Declare Function WSAUnhookBlockingHook Lib "Winsock.dll" () As Integer
Public Declare Function WSASetBlockingHook Lib "Winsock.dll" (ByVal lpBlockFunc As Long) As Long
Public Declare Function WSACancelBlockingCall Lib "Winsock.dll" () As Integer
Public Declare Function WSAAsyncGetServByName Lib "Winsock.dll" (ByVal hwnd As Integer, ByVal wMsg As Integer, ByVal serv_name As
String, ByVal proto As String, buf As Any, ByVal buflen As Integer) As Integer
Public Declare Function WSAAsyncGetServByPort Lib "Winsock.dll" (ByVal hwnd As Integer, ByVal wMsg As Integer, ByVal Port As Integer,
ByVal proto As String, buf As Any, ByVal buflen As Integer) As Integer
Public Declare Function WSAAsyncGetProtoByName Lib "Winsock.dll" (ByVal hwnd As Integer, ByVal wMsg As Integer, ByVal proto_name As
String, buf As Any, ByVal buflen As Integer) As Integer
Public Declare Function WSAAsyncGetProtoByNumber Lib "Winsock.dll" (ByVal hwnd As Integer, ByVal wMsg As Integer, ByVal number As
Integer, buf As Any, ByVal buflen As Integer) As Integer
Public Declare Function WSAAsyncGetHostByName Lib "Winsock.dll" (ByVal hwnd As Integer, ByVal wMsg As Integer, ByVal host_name As
String, buf As Any, ByVal buflen As Integer) As Integer
Public Declare Function WSAAsyncGetHostByAddr Lib "Winsock.dll" (ByVal hwnd As Integer, ByVal wMsg As Integer, addr As Long, ByVal
addr_len As Integer, ByVal addr_type As Integer, buf As Any, ByVal buflen As Integer) As Integer
Public Declare Function WSACancelAsyncRequest Lib "Winsock.dll" (ByVal hAsyncTaskHandle As Integer) As Integer
Public Declare Function WSAAsyncSelect Lib "Winsock.dll" (ByVal s As Integer, ByVal hwnd As Integer, ByVal wMsg As Integer, ByVal lEvent As
Long) As Integer
Public Declare Function WSARecvEx Lib "Winsock.dll" (ByVal s As Integer, buf As Any, ByVal buflen As Integer, ByVal flags As Integer) As
Integer
'Elself Win32 Then
'--Windows System Functions
Public Declare Function PostMessage Lib "user32" Alias "PostMessageA" (ByVal hwnd As Long, ByVal wMsg As Long, ByVal wParam As Long,
ByVal lParam As Long) As Long
Public Declare Sub MemCopy Lib "kernel32" Alias "RtlMoveMemory" (Dest As Any, Src As Any, ByVal cb&)
Public Declare Function lstrlen Lib "kernel32" Alias "lstrlenA" (ByVal lpString As Any) As Long
'--async notification constants
Public Const SOL_SOCKET = &HFFFF&
Public Const SO_LINGER = &H80&
Public Const FD_READ = &H1&
Public Const FD_WRITE = &H2&
Public Const FD_OOB = &H4&
Public Const FD_ACCEPT = &H8&
Public Const FD_CONNECT = &H10&
Public Const FD_CLOSE = &H20&
'--SOCKET FUNCTIONS
Public Declare Function accept Lib "wsock32.dll" (ByVal s As Long, addr As sockaddr, addrlen As Long) As Long
Public Declare Function bind Lib "wsock32.dll" (ByVal s As Long, addr As sockaddr, ByVal namelen As Long) As Long
Public Declare Function closesocket Lib "wsock32.dll" (ByVal s As Long) As Long
Public Declare Function Connect Lib "wsock32.dll" Alias "connect" (ByVal s As Long, addr As sockaddr, ByVal namelen As Long) As Long
Public Declare Function ioctlsocket Lib "wsock32.dll" (ByVal s As Long, ByVal CMD As Long, argp As Long) As Long
```

Public Declare Function getpeername Lib "wsock32.dll" (ByVal s As Long, sName As sockaddr, namelen As Long) As Long
Public Declare Function getsockname Lib "wsock32.dll" (ByVal s As Long, sName As sockaddr, namelen As Long) As Long
Public Declare Function getsockopt Lib "wsock32.dll" (ByVal s As Long, ByVal Level As Long, ByVal optname As Long, optval As Any, optlen As
ng) As Long
Public Declare Function htonl Lib "wsock32.dll" (ByVal hostlong As Long) As Long
Public Declare Function htons Lib "wsock32.dll" (ByVal hostshort As Long) As Integer
Public Declare Function inet_addr Lib "wsock32.dll" (ByVal cp As String) As Long
Public Declare Function inet_ntoa Lib "wsock32.dll" (ByVal inn As Long) As Long
Public Declare Function listen Lib "wsock32.dll" (ByVal s As Long, ByVal backlog As Long) As Long
Public Declare Function ntohl Lib "wsock32.dll" (ByVal netlong As Long) As Long
ublic Declare Function ntohs Lib "wsock32.dll" (ByVal netshort As Long) As Integer
ublic Declare Function recv Lib "wsock32.dll" (ByVal s As Long, buf As Any, ByVal buflen As Long, ByVal flags As Long) As Long
Public Declare Function recvfrom Lib "wsock32.dll" (ByVal s As Long, buf As Any, ByVal buflen As Long, ByVal flags As Long, from As sockaddr,
nlen As Long) As Long
ublic Declare Function ws_select Lib "wsock32.dll" Alias "select" (ByVal nfds As Long, readfds As fd_set, writefds As fd_set, exceptfds As fd_set,
eout As timeval) As Long
ublic Declare Function Send Lib "wsock32.dll" Alias "send" (ByVal s As Long, buf As Any, ByVal buflen As Long, ByVal flags As Long) As Long
ublic Declare Function sendto Lib "wsock32.dll" (ByVal s As Long, buf As Any, ByVal buflen As Long, ByVal flags As Long, to_addr As sockaddr,
Val tolen As Long) As Long
ublic Declare Function setsockopt Lib "wsock32.dll" (ByVal s As Long, ByVal Level As Long, ByVal optname As Long, optval As Any, ByVal
en As Long) As Long
ublic Declare Function ShutDown Lib "wsock32.dll" Alias "shutdown" (ByVal s As Long, ByVal how As Long) As Long
ublic Declare Function socket Lib "wsock32.dll" (ByVal af As Long, ByVal s_type As Long, ByVal protocol As Long) As Long
DATABASE FUNCTIONS
ublic Declare Function gethostbyaddr Lib "wsock32.dll" (addr As Long, ByVal addr_len As Long, ByVal addr_type As Long) As Long
ublic Declare Function gethostbyname Lib "wsock32.dll" (ByVal host_name As String) As Long
ublic Declare Function gethostname Lib "wsock32.dll" (ByVal host_name As String, ByVal namelen As Long) As Long
ublic Declare Function getservbyport Lib "wsock32.dll" (ByVal Port As Long, ByVal proto As String) As Long
ublic Declare Function getservbyname Lib "wsock32.dll" (ByVal serv_name As String, ByVal proto As String) As Long
ublic Declare Function getprotobynumber Lib "wsock32.dll" (ByVal proto As Long) As Long
ublic Declare Function getprotobyname Lib "wsock32.dll" (ByVal proto_name As String) As Long
VINDOWS EXTENSIONS
ublic Declare Function WSAStartup Lib "wsock32.dll" (ByVal wVR As Long, lpWSAD As WSADataType) As Long
ublic Declare Function WSACleanup Lib "wsock32.dll" () As Long
ublic Declare Sub WSASetLastError Lib "wsock32.dll" (ByVal iError As Long)
ublic Declare Function WSAGetLastError Lib "wsock32.dll" () As Long
ublic Declare Function WSAIsBlocking Lib "wsock32.dll" () As Long
ublic Declare Function WSAUnhookBlockingHook Lib "wsock32.dll" () As Long
ublic Declare Function WSASetBlockingHook Lib "wsock32.dll" (ByVal lpBlockFunc As Long) As Long
ublic Declare Function WSACancelBlockingCall Lib "wsock32.dll" () As Long
ublic Declare Function WSAAsyncGetServByName Lib "wsock32.dll" (ByVal hwnd As Long, ByVal wMsg As Long, ByVal serv_name As String,
al proto As String, buf As Any, ByVal buflen As Long) As Long
ublic Declare Function WSAAsyncGetServByPort Lib "wsock32.dll" (ByVal hwnd As Long, ByVal wMsg As Long, ByVal Port As Long, ByVal
o As String, buf As Any, ByVal buflen As Long) As Long
ublic Declare Function WSAAsyncGetProtoByName Lib "wsock32.dll" (ByVal hwnd As Long, ByVal wMsg As Long, ByVal proto_name As String,
As Any, ByVal buflen As Long) As Long
ublic Declare Function WSAAsyncGetProtoByNumber Lib "wsock32.dll" (ByVal hwnd As Long, ByVal wMsg As Long, ByVal number As Long,
As Any, ByVal buflen As Long) As Long

```
  Public Declare Function WSAAsyncGetHostByName Lib "wsock32.dll" (ByVal hwnd As Long, ByVal wMsg As Long, ByVal host_name As String,
buf As Any, ByVal buflen As Long) As Long
  Public Declare Function WSAAsyncGetHostByAddr Lib "wsock32.dll" (ByVal hwnd As Long, ByVal wMsg As Long, addr As Long, ByVal addr_len
As Long, ByVal addr_type As Long, buf As Any, ByVal buflen As Long) As Long
  Public Declare Function WSACancelAsyncRequest Lib "wsock32.dll" (ByVal hAsyncTaskHandle As Long) As Long
  Public Declare Function WSAAsyncSelect Lib "wsock32.dll" (ByVal s As Long, ByVal hwnd As Long, ByVal wMsg As Long, ByVal lEvent As
Long) As Long
  Public Declare Function WSARecvEx Lib "wsock32.dll" (ByVal s As Long, buf As Any, ByVal buflen As Long, ByVal flags As Long) As Long
#End If


'SOME STUFF I ADDED
Public MySocket%
Public SockReadBuffer$
Public Const WSA_NoName = "Unknown"
Public WSAStartedUp As Boolean    'Flag to keep track of whether winsock WSAStartup wascalled


'these are old functions, or examples of various things
'
'
Private Sub oldfuncs()
'use this function for the read function in line mode apps
'   Dim s$, buf$, a%, i%, ii%
'   buf$ = String$(1024, " ")
'   a% = recv%(MySocket%, ByVal buf$, 1024, 0)
'   If a% > 0 Then
'      'SockReadBuffer$ = SockReadBuffer$ + RTrim$(buf$)
'      SockReadBuffer$ = SockReadBuffer$ + Left$(buf$, a%)
'      While InStr(SockReadBuffer$, EndLine$)
'         i = InStr(SockReadBuffer$, EndLine$)
'         If i Then
'            If i < Len(SockReadBuffer$) Then
'               s$ = Left$(SockReadBuffer$, i - 1)
'               SockReadBuffer$ = Mid$(SockReadBuffer$, i + 1)
'               If InStr(s$, Chr$(13)) Then
'                  s$ = Left$(s$, InStr(s$, Chr$(13)) - 1)
'               ElseIf InStr(s$, Chr$(10)) Then
'                  s$ = Left$(s$, InStr(s$, Chr$(10)) - 1)
'               End If
'               ServerHandler s$ & CrLf$
'               'Debug.Print "["; s$; "]"
'            Else
'               s$ = SockReadBuffer$
'               SockReadBuffer$ = ""
'               If InStr(s$, Chr$(13)) Then
'                  s$ = Left$(s$, InStr(s$, Chr$(13)) - 1)
'               ElseIf InStr(s$, Chr$(10)) Then
'                  s$ = Left$(s$, InStr(s$, Chr$(10)) - 1)
'               End If
```

```
'            ServerHandler s$ & CrLf$
'            'Debug.Print "["; s$; "]"
'          End If
'        End If
'      Wend
'    End If

End Sub


Public Function WSAGetAsyncBufLen(ByVal lParam As Long) As Long
  If (lParam And &HFFFF&) > &H7FFF Then
    WSAGetAsyncBufLen = (lParam And &HFFFF&) - &H10000
  Else
    WSAGetAsyncBufLen = lParam And &HFFFF&
  End If
End Function

Public Function WSAGetSelectEvent(ByVal lParam As Long) As Integer
  If (lParam And &HFFFF&) > &H7FFF Then
    WSAGetSelectEvent = (lParam And &HFFFF&) - &H10000
  Else
    WSAGetSelectEvent = lParam And &HFFFF&
  End If
End Function



Public Function WSAGetAsyncError(ByVal lParam As Long) As Integer
  WSAGetAsyncError = (lParam And &HFFFF0000) \ &H10000
End Function



'this function DOES work on 16 and 32 bit systems
Function AddrToIP(ByVal AddrOrIP$) As String
  On Error Resume Next
  AddrToIP$ = getascip(GetHostByNameAlias(AddrOrIP$))
  If Err Then AddrToIP$ = "255.255.255.255"
End Function

'this function should work on 16 and 32 bit systems
#If Win16 Then
  Function ConnectSock(ByVal Host$, ByVal Port%, retIpPort$, ByVal HWndToMsg%, ByVal Async%) As Integer
  Dim s%, SelectOps%, Dummy%
#ElseIf Win32 Then
  Function ConnectSock(ByVal Host$, ByVal Port&, retIpPort$, ByVal HWndToMsg&, ByVal Async%) As Long
  Dim s&, SelectOps&, Dummy&
#End If
```

```
Dim sockin As sockaddr
SockReadBuffer$ = ""
sockin = saZero
sockin.sin_family = AF_INET
sockin.sin_port = htons(Port)
If sockin.sin_port = INVALID_SOCKET Then
   ConnectSock = INVALID_SOCKET
   Exit Function
End If

sockin.sin_addr = GetHostByNameAlias(Host$)

If sockin.sin_addr = INADDR_NONE Then
   ConnectSock = INVALID_SOCKET
   Exit Function
End If
retIpPort$ = getascip$(sockin.sin_addr) & ":" & ntohs(sockin.sin_port)

s = socket(PF_INET, SOCK_STREAM, IPPROTO_TCP)
If s < 0 Then
   ConnectSock = INVALID_SOCKET
   Exit Function
End If
If SetSockLinger(s, 1, 0) = SOCKET_ERROR Then
   If s > 0 Then
      Dummy = closesocket(s)
   End If
   ConnectSock = INVALID_SOCKET
   Exit Function
End If
If Not Async Then
   If Connect(s, sockin, sockaddr_size) <> 0 Then
      If s > 0 Then
         Dummy = closesocket(s)
      End If
      ConnectSock = INVALID_SOCKET
      Exit Function
   End If
   SelectOps = FD_READ Or FD_WRITE Or FD_CONNECT Or FD_CLOSE
   If WSAAsyncSelect(s, HWndToMsg, ByVal WINSOCK_MESSAGE, ByVal SelectOps) Then
      If s > 0 Then
         Dummy = closesocket(s)
      End If
      ConnectSock = INVALID_SOCKET
      Exit Function
   End If
Else
   SelectOps = FD_READ Or FD_WRITE Or FD_CONNECT Or FD_CLOSE
   If WSAAsyncSelect(s, HWndToMsg, ByVal WINSOCK_MESSAGE, ByVal SelectOps) Then
```

```
    If s > 0 Then
      Dummy = closesocket(s)
    End If
    ConnectSock = INVALID_SOCKET
    Exit Function
  End If
  If Connect(s, sockin, sockaddr_size) <> -1 Then
    If s > 0 Then
      Dummy = closesocket(s)
    End If
    ConnectSock = INVALID_SOCKET
    Exit Function
  End If
 End If
 ConnectSock = s

End Function

#If Win32 Then
 Public Function SetSockLinger(ByVal SockNum&, ByVal OnOff%, ByVal LingerTime%) As Long
#Else
 Public Function SetSockLinger(ByVal SockNum%, ByVal OnOff%, ByVal LingerTime%) As Integer
#End If
 Dim Linger As LingerType
 Linger.l_onoff = OnOff
 Linger.l_linger = LingerTime
 If setsockopt(SockNum, SOL_SOCKET, SO_LINGER, Linger, 4) Then
   Debug.Print "Error setting linger info: " & WSAGetLastError()
   SetSockLinger = SOCKET_ERROR
 Else
   If getsockopt(SockNum, SOL_SOCKET, SO_LINGER, Linger, 4) Then
     Debug.Print "Error getting linger info: " & WSAGetLastError()
     SetSockLinger = SOCKET_ERROR
   Else
     'Debug.Print "Linger is on if nonzero: "; Linger.l_onoff
     'Debug.Print "Linger time if linger is on: "; Linger.l_linger
   End If
 End If
End Function

'this function DOES work on 16 and 32 bit systems
Sub EndWinsock()
 Dim Ret&
 If WSAIsBlocking() Then
   Ret = WSACancelBlockingCall()
 End If
 Ret = WSACleanup()
 WSAStartedUp = False
End Sub
```

```
'this function DOES work on 16 and 32 bit systems
Function getascip(ByVal inn As Long) As String
  On Error Resume Next
  Dim lpStr&
#If Win16 Then
  Dim nStr%
#ElseIf Win32 Then
  Dim nStr&
#End If
  Dim retString$
  retString = String(32, 0)
  lpStr = inet_ntoa(inn)
  If lpStr = 0 Then
    getascip = "255.255.255.255"
    Exit Function
  End If
  nStr = lstrlen(lpStr)
  If nStr > 32 Then nStr = 32
  MemCopy ByVal retString, ByVal lpStr, nStr
  retString = Left(retString, nStr)
  getascip = retString
  If Err Then getascip = "255.255.255.255"
End Function

'this function DOES work on 32bit and 16 bit systems
Function GetHostByAddress(ByVal addr As Long) As String
  On Error Resume Next
  Dim phe&, Ret&
  Dim heDestHost As HostEnt
  Dim hostname$
  phe = gethostbyaddr(addr, 4, PF_INET)

  Debug.Print phe
  If phe <> 0 Then
    MemCopy heDestHost, ByVal phe, hostent_size
    Debug.Print heDestHost.h_name
    Debug.Print heDestHost.h_aliases
    Debug.Print heDestHost.h_addrtype
    Debug.Print heDestHost.h_length
    Debug.Print heDestHost.h_addr_list

    hostname = String(256, 0)
    MemCopy ByVal hostname, ByVal heDestHost.h_name, 256
    GetHostByAddress = Left(hostname, InStr(hostname, Chr(0)) - 1)
  Else
    GetHostByAddress = WSA_NoName
  End If
  If Err Then GetHostByAddress = WSA_NoName
```

```
    If Err Then GetLocalHostName = WSA_NoName
End Function

'this function DOES work on 16 and 32 bit systems
#If Win16 Then
    Function GetPeerAddress(ByVal s%) As String
    Dim addrlen%
    Dim Ret%
#ElseIf Win32 Then
    Function GetPeerAddress(ByVal s&) As String
    Dim addrlen&
    Dim Ret&
#End If
    On Error Resume Next
    Dim sa As sockaddr
    addrlen = sockaddr_size
    Ret = getpeername(s, sa, addrlen)
    If Ret = 0 Then
        GetPeerAddress = SockAddressToString(sa)
    Else
        GetPeerAddress = ""
    End If
    If Err Then GetPeerAddress = ""
End Function

'this function should work on 16 and 32 bit systems
#If Win16 Then
    Function GetPortFromString(ByVal PortStr$) As Integer
#ElseIf Win32 Then
    Function GetPortFromString(ByVal PortStr$) As Long
#End If
    'sometimes users provide ports outside the range of a VB
    'integer, so this function returns an integer for a string
    'just to keep an error from happening, it converts the
    'number to a negative if needed
    On Error Resume Next
    If Val(PortStr$) > 32767 Then
        GetPortFromString = CInt(Val(PortStr$) - &H10000)
    Else
        GetPortFromString = Val(PortStr$)
    End If
    If Err Then GetPortFromString = 0
End Function

'this function should work on 16 and 32 bit systems
#If Win16 Then
    Function GetProtocolByName(ByVal protocol$) As Integer
    Dim tmpShort%
#ElseIf Win32 Then
```

```
Function GetProtocolByName(ByVal protocol$) As Long
Dim tmpShort&
nd If
On Error Resume Next
Dim ppe&
Dim peDestProt As protoent
ppe = getprotobyname(protocol)
f ppe = 0 Then
  tmpShort = Val(protocol)
  If tmpShort <> 0 Or protocol = "0" Or protocol = "" Then
    GetProtocolByName = htons(tmpShort)
  Else
    GetProtocolByName = SOCKET_ERROR
  End If
lse
  MemCopy peDestProt, ByVal ppe, protoent_size
  GetProtocolByName = peDestProt.p_proto
nd If
f Err Then GetProtocolByName = SOCKET_ERROR
d Function

s function should work on 16 and 32 bit systems
 Win16 Then
Function GetServiceByName(ByVal service$, ByVal protocol$) As Integer
Dim serv%
lseIf Win32 Then
Function GetServiceByName(ByVal service$, ByVal protocol$) As Long
Dim serv&
nd If
On Error Resume Next
Dim pse&
Dim seDestServ As servent
pse = getservbyname(service, protocol)
If pse <> 0 Then
  MemCopy seDestServ, ByVal pse, servent_size
  GetServiceByName = seDestServ.s_port
Else
  serv = Val(service)
  If serv <> 0 Then
    GetServiceByName = htons(serv)
  Else
    GetServiceByName = INVALID_SOCKET
  End If
nd If
f Err Then GetServiceByName = INVALID_SOCKET
d Function

s function DOES work on 16 and 32 bit systems
 Win16 Then
```

```
  Function GetSockAddress(ByVal s%) As String
  Dim addrlen%
  Dim Ret%
#ElseIf Win32 Then
  Function GetSockAddress(ByVal s&) As String
  Dim addrlen&
  Dim Ret&
#End If
  On Error Resume Next
  Dim sa As sockaddr
  Dim szRet$
  szRet = String(32, 0)
  addrlen = sockaddr_size
  Ret = getsockname(s, sa, addrlen)
  If Ret = 0 Then
    GetSockAddress = SockAddressToString(sa)
  Else
    GetSockAddress = ""
  End If
  If Err Then GetSockAddress = ""
End Function

'this function should work on 16 and 32 bit systems
Function GetWSAErrorString(ByVal errnum&) As String
  On Error Resume Next
  Select Case errnum
    Case 10004: GetWSAErrorString = "Interrupted system call."
    Case 10009: GetWSAErrorString = "Bad file number."
    Case 10013: GetWSAErrorString = "Permission Denied."
    Case 10014: GetWSAErrorString = "Bad Address."
    Case 10022: GetWSAErrorString = "Invalid Argument."
    Case 10024: GetWSAErrorString = "Too many open files."
    Case 10035: GetWSAErrorString = "Operation would block."
    Case 10036: GetWSAErrorString = "Operation now in progress."
    Case 10037: GetWSAErrorString = "Operation already in progress."
    Case 10038: GetWSAErrorString = "Socket operation on nonsocket."
    Case 10039: GetWSAErrorString = "Destination address required."
    Case 10040: GetWSAErrorString = "Message too long."
    Case 10041: GetWSAErrorString = "Protocol wrong type for socket."
    Case 10042: GetWSAErrorString = "Protocol not available."
    Case 10043: GetWSAErrorString = "Protocol not supported."
    Case 10044: GetWSAErrorString = "Socket type not supported."
    Case 10045: GetWSAErrorString = "Operation not supported on socket."
    Case 10046: GetWSAErrorString = "Protocol family not supported."
    Case 10047: GetWSAErrorString = "Address family not supported by protocol family."
    Case 10048: GetWSAErrorString = "Address already in use."
    Case 10049: GetWSAErrorString = "Can't assign requested address."
    Case 10050: GetWSAErrorString = "Network is down."
    Case 10051: GetWSAErrorString = "Network is unreachable."
```

```
    Case 10052: GetWSAErrorString = "Network dropped connection."
    Case 10053: GetWSAErrorString = "Software caused connection abort."
    Case 10054: GetWSAErrorString = "Connection reset by peer."
    Case 10055: GetWSAErrorString = "No buffer space available."
    Case 10056: GetWSAErrorString = "Socket is already connected."
    Case 10057: GetWSAErrorString = "Socket is not connected."
    Case 10058: GetWSAErrorString = "Can't send after socket shutdown."
    Case 10059: GetWSAErrorString = "Too many references: can't splice."
    Case 10060: GetWSAErrorString = "Connection timed out."
    Case 10061: GetWSAErrorString = "Connection refused."
    Case 10062: GetWSAErrorString = "Too many levels of symbolic links."
    Case 10063: GetWSAErrorString = "File name too long."
    Case 10064: GetWSAErrorString = "Host is down."
    Case 10065: GetWSAErrorString = "No route to host."
    Case 10066: GetWSAErrorString = "Directory not empty."
    Case 10067: GetWSAErrorString = "Too many processes."
    Case 10068: GetWSAErrorString = "Too many users."
    Case 10069: GetWSAErrorString = "Disk quota exceeded."
    Case 10070: GetWSAErrorString = "Stale NFS file handle."
    Case 10071: GetWSAErrorString = "Too many levels of remote in path."
    Case 10091: GetWSAErrorString = "Network subsystem is unusable."
    Case 10092: GetWSAErrorString = "Winsock DLL cannot support this application."
    Case 10093: GetWSAErrorString = "Winsock not initialized."
    Case 10101: GetWSAErrorString = "Disconnect."
    Case 11001: GetWSAErrorString = "Host not found."
    Case 11002: GetWSAErrorString = "Nonauthoritative host not found."
    Case 11003: GetWSAErrorString = "Nonrecoverable error."
    Case 11004: GetWSAErrorString = "Valid name, no data record of requested type."
    Case Else:
  End Select
End Function

'this function DOES work on 16 and 32 bit systems
Function IpToAddr(ByVal AddrOrIP$) As String
  On Error Resume Next
  IpToAddr = GetHostByAddress(GetHostByNameAlias(AddrOrIP$))
  If Err Then IpToAddr = WSA_NoName
End Function

'this function DOES work on 16 and 32 bit systems
Function IpGetAddr(ByVal IP1$) As String
  'this function is DCC specific. It expects a long ip stored in network byte order, in a string
  'like that would be parsed out of a DCC command string
  On Error GoTo IpGetAddrError
  Dim lpStr&
#If Win16 Then
  Dim nStr%
#Else 'If Win32 Then
  Dim nStr&
```

```
End If
Dim retString$
Dim inn&
If Val(IPL) > 2147483647 Then
   inn = Val(IPL) - 4294967296#
Else
   inn = Val(IPL)
End If
inn = ntohl(inn)
retString = String(32, 0)
lpStr = inet_ntoa(inn)
If lpStr = 0 Then
   IrcGetAscIp = "0.0.0.0"
   Exit Function
End If
nStr = lstrlen(lpStr)
If nStr > 32 Then nStr = 32
MemCopy ByVal retString, ByVal lpStr, nStr
retString = Left(retString, nStr)
IrcGetAscIp = retString
Exit Function
rcGetAscIPError:
IrcGetAscIp = "0.0.0.0"
Exit Function
Resume
nd Function

his function DOES work on 16 and 32 bit systems
unction IrcGetLongIp(ByVal AscIp$) As String
'this function converts an ascii ip string into a long ip in network byte order
'and stick it in a string suitable for use in a DCC command.
On Error GoTo IrcGetLongIpError:
Dim inn&
inn = inet_addr(AscIp)
inn = htonl(inn)
If inn < 0 Then
   IrcGetLongIp = CVar(inn + 4294967296#)
   Exit Function
Else
   IrcGetLongIp = CVar(inn)
   Exit Function
End If
Exit Function
rcGetLongIpError:
IrcGetLongIp = "0"
Exit Function
Resume
End Function
```

```
'this function should work on 16 and 32 bit systems
#If Win16 Then
Public Function ListenForConnect(ByVal Port%, ByVal HWndToMsg%) As Integer
  Dim s%, Dummy%
  Dim SelectOps%
#ElseIf Win32 Then
Public Function ListenForConnect(ByVal Port&, ByVal HWndToMsg&) As Long
  Dim s&, Dummy&
  Dim SelectOps&
#End If
  Dim sockin As sockaddr
  sockin = saZero    'zero out the structure
  sockin.sin_family = AF_INET
  sockin.sin_port = htons(Port)
  If sockin.sin_port = INVALID_SOCKET Then
    ListenForConnect = INVALID_SOCKET
    Exit Function
  End If
  sockin.sin_addr = htonl(INADDR_ANY)
  If sockin.sin_addr = INADDR_NONE Then
    ListenForConnect = INVALID_SOCKET
    Exit Function
  End If
  s = socket(PF_INET, SOCK_STREAM, 0)
  If s < 0 Then
    ListenForConnect = INVALID_SOCKET
    Exit Function
  End If
  If bind(s, sockin, sockaddr_size) Then
    If s > 0 Then
      Dummy = closesocket(s)
    End If
    ListenForConnect = INVALID_SOCKET
    Exit Function
  End If
  SelectOps = FD_READ Or FD_WRITE Or FD_CLOSE Or FD_ACCEPT
  If WSAAsyncSelect(s, HWndToMsg, ByVal WINSOCK_MESSAGE, ByVal SelectOps) Then
    If s > 0 Then
      Dummy = closesocket(s)
    End If
    ListenForConnect = SOCKET_ERROR
    Exit Function
  End If

  If listen(s, 1) Then
    If s > 0 Then
      Dummy = closesocket(s)
    End If
    ListenForConnect = INVALID_SOCKET
```

```
  End If
  ListenForConnect = s
End Function

'this function should work on 16 and 32 bit systems
#If Win16 Then
Public Function SendData(ByVal s%, vMessage As Variant) As Integer
#ElseIf Win32 Then
Public Function SendData(ByVal s&, vMessage As Variant) As Long
#End If
  Dim TheMsg() As Byte, sTemp$
  TheMsg = ""
  Select Case VarType(vMessage)
    Case 8209   'byte array
      sTemp = vMessage
      TheMsg = sTemp
    Case 8      'string, if we recieve a string, its assumed we are linemode
#If Win32 Then
      sTemp = StrConv(vMessage, vbFromUnicode)
#Else
      sTemp = vMessage
#End If
    Case Else
      sTemp = CStr(vMessage)
#If Win32 Then
      sTemp = StrConv(vMessage, vbFromUnicode)
#Else
      sTemp = vMessage
#End If
  End Select
  TheMsg = sTemp
  If UBound(TheMsg) > -1 Then
    SendData = Send(s, TheMsg(0), (UBound(TheMsg) - LBound(TheMsg) + 1), 0)
  End If
End Function

Public Function SockAddressToString(sa As sockaddr) As String
  SockAddressToString = getascip(sa.sin_addr) & ":" & ntohs(sa.sin_port)
End Function

Public Function StartWinsock(sDescription As String) As Boolean
  Dim StartupData As WSADataType
  If Not WSAStartedUp Then
    If Not WSAStartup(&H101, StartupData) Then
      WSAStartedUp = True
      Debug.Print "wVersion="; StartupData.wVersion, "wHighVersion="; StartupData.wHighVersion
      Debug.Print "If wVersion == 257 then everything is kewl"
      Debug.Print "szDescription="; StartupData.szDescription
```

```
    Debug.Print "szSystemStatus="; StartupData.szSystemStatus
    Debug.Print "iMaxSockets="; StartupData.iMaxSockets, "iMaxUdpDg="; StartupData.iMaxUdpDg
    sDescription = StartupData.szDescription
  Else
    WSAStartedUp = False
  End If
End If
StartWinsock = WSAStartedUp
End Function
Public Function WSAMakeSelectReply(TheEvent%, TheError%) As Long
  WSAMakeSelectReply = (TheError * &H10000) + (TheEvent And &HFFFF&)
End Function
```