2. LITERATURE REVIEW

2.1. Limit Switch

Osiswitch Limit Switches is the latest concept in modular design, offering machine designers and end users complete flexibility with a wide range of actuators and bodies to choose. Installation time can be reduced by as much as 40% compared to conventional limit switch design. Osiswitch modular construction allows the user to choose from five different bodies styles available in both plastic and metal housings. An extensive range of actuators is also available being interchangeable between different bodies. In addition, both contact blocks and conduit entries are removable to facilitate fast replacement and installation.

Figure 2.1. Four Sections in Orchid Products

Figure 2.1. Four Sections in Orchid Products (continue)

Source: Schneider Electric Manufacturing Batam

Applications:

- Lifts or elevators car positioning and safety XCR latched operation
- Machining position control
- Dumper trucks bucket detection
- Scissor lifts or cherry pickers

2.2. Four Types of Making Components

There are so many types of components in Schneider such as in the Table 2.1. as follows in which EE refers to Electronic & Electrical, FC refers to Fabrication Component, RM refers to Raw Material:

Table 2.1. Types of Schneider Components

Mkt	Comm	Description
EE	G1	CUSTOM ELECTRONIC DEVICES
	G2	STANDARD ELECTRONICS & ELECTRICAL DEVICES
	G3	CONNECTORS, CORDS AND CABLES ASSEMBLY
	G4	BOARDS,DESIGN,SOFTWARE SUBCONTRACTING & DISTRIBUTION
	G5	MEASUREMENT, SENSORS, POWER SUPPLIES & WINDINGS
		EE Market Total
FC	D1	CERAMIC AND GLASS
	K1	MECHANICAL PARTS
	K2	PROGRESSIVE STAMPINGS
	K3	SHEET METAL,ROLL-FORMING,COATING
	K4	SPRINGS
	M1	LAMINATED INSULATING - MISC. PLASTICS
	M2	INDUSTRIAL MARKING
	P1	THERMOPLASTIC AND THERMOSET (injection and compression)
	P2	ELASTOMER PARTS, SEALS
		FC Market Total
RM	B1	NON FERROUS MATERIALS & ENAMELLED WIRE
	B3	SILVER AND CONTACTS
	D2	PACKING PRODUCTS
	E1	CHEMICALS
		RM Market Total

Source: Schneider Electric Manufacturing Batam

Components that will be analyzed in this case are only components that have tooling and SEMB take care of these tools such as K1 (Casting), K2 (Stamping),

P1 (Plastic), and P2 (Rubber). Process of making components will be explained as follows.

2.2.1. Injection Molding

In 2000, Rosato defined injection molding as manufacturing technique for making parts from both thermoplastic and thermosetting plastic materials in production. Molten plastic is injected at high pressure into a mold, which is the inverse of the product's shape. After a product is designed by an Industrial Designer or an Engineer, molds are made by a mold maker (or toolmaker) from metal, usually either steel or aluminum, and precision-machined to form the features of the desired part. Injection molding is widely used for manufacturing a variety of parts, from the smallest component to entire body panels of cars. Injection molding is the most common method of production, with some commonly made items including bottle caps and outdoor furniture (*Wikipedia*. Injection Molding, 2008).

Figure 2.2. Standard Two Plates Tooling

Source: http://en.wikipedia.org/wiki/Injection_mold

Injection molding machine is a machine for making plastic parts. Manufacturing products are made by injection molding process. Injection

molding machines can fasten the molds in either a horizontal or a vertical position. The majority is horizontally oriented but vertical machines are used in some niche applications such as insert molding, allowing the machine to take advantage of gravity. A robotic arm is often used to remove the molded components; either by side or top entry, but by it is more common for parts to drop out of the mold, through a chute and into a container (*Wikipedia*. Injection Molding Machine, 2008).

Figure 2.3. Injection Molding Machine

Source: http://www.china-hautek.com/information/4/big/injection%20molding%20machine.jpg

2.2.2. Die Casting

Die-casting is the process of forcing molten metal under high pressure into mold cavities. Most die castings are made from nonferrous metals, specifically zinc, copper, aluminum, magnesium, lead, and tin based alloys, but ferrous metal die castings are possible. The die casting method is especially suited for applications where large quantity of small to medium sized parts are needed with good detail, a fine surface quality and dimensional consistency (*Wikipedia*. Die Casting, 2008).

There are four major steps in the die casting process. First, the mold is sprayed with lubricant and closed. The lubricant both helps control the temperature of the die and it also assists in the removal of the casting. Molten metal is then shot into the die under high pressure. Once the die is filled, the pressure is maintained until the casting has solidified. Finally, the die is opened

and the shot is ejected by the ejector pins. Finally, the scrap that includes the gate, runners, sprues and flash, must be separated from the casting. This is often done using a special trim die in a power press or hydraulic press. An older method is separating by hand or by sawing, which case grinding may be necessary to smooth the scrap marks. A less labor-intensive method is to tumble shots if gates are thin and easily broken; separation of gates from finished parts must follow. This scrap is recycled by remelting it (*Wikipedia*. Die Casting, 2008).

From Wikipedia, the main die casting alloys are zinc, aluminum, magnesium, copper, lead, and tin. Specific dies casting alloys include ZAMAK, zinc aluminum, AA 380, AA 384, AA 386, AA 390, and AZ91D magnesium. The following is a summary of the advantages of each alloy:

- Zinc: the easiest alloy to cast, high ductility, high impact strength, easily plated, economical for small parts, promotes long die life.
- Aluminum: lightweight, high dimensional stability for complex shapes and thin walls, good corrosion resistance, good mechanical properties, high thermal and electrical conductivity, retains strength at high temperatures.
- Magnesium: the easiest alloy to machine, excellent strength-to-weight ratio, lightest alloy commonly die cast.
- Copper: high hardness, high corrosion resistance, highest mechanical properties of alloys die cast, excellent wear resistance, excellent dimensional stability, strength approaching that of steel parts.
- Lead and Tin: high density, extremely close dimensional accuracy, used for special forms of corrosion resistance.

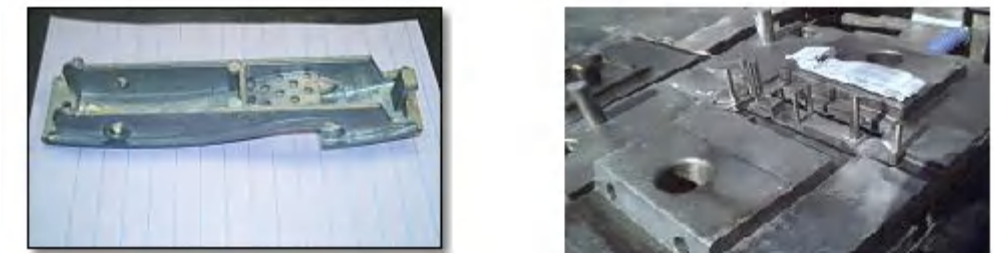

Figure 2.4. Die Casting Parts and Die Casting Tool

Source: http://www.kineticdiecasting.com/tooling_die_casting.html

2.2.3. Stamping

Stamping is a metalworking process by which sheet metal strips are punched using a press tool, which is loaded on a machine press or stamping press to form the sheet into a desired shape. This could be a single stage operation which every stroke of the press produce the desired form on the sheet metal part, or could occur through a series of stages (*Wikipedia*. Stamping, 2008).

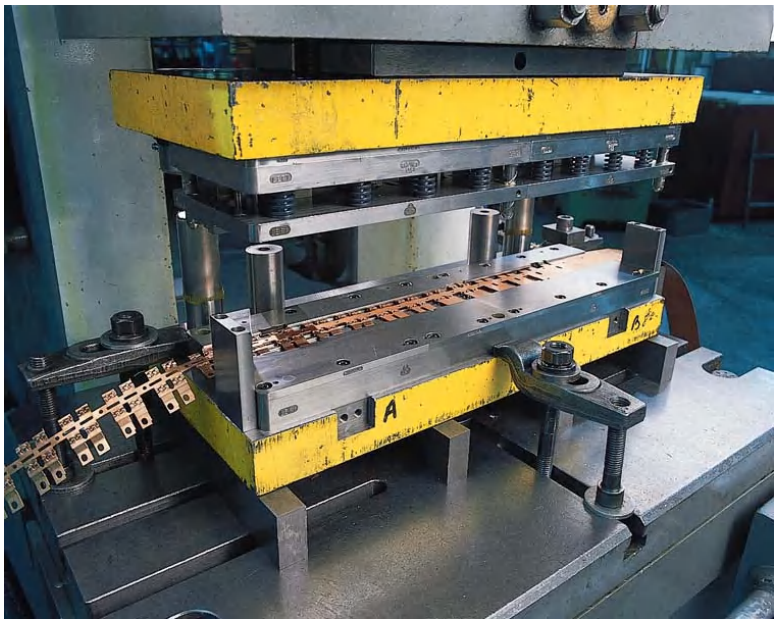

Figure 2.5. Stamping Machine

Source: http://www.alliedtool.com/tour/images_tour/metal_stamping_machine.jpg

2.2.4. Rubber

To make rubber, the process is the same when making plastic in injection molding. The difference is just the raw material. If plastic, the raw material is molten plastic but for rubber, the raw material is silicon rubber.

From Wikipedia, Injection molding for silicon rubber, chemically, silicone rubber is a family of thermoset elastomers that have a backbone of alternating silicone and oxygen atoms and methyl or vinyl side groups. Silicone rubbers constitute about 30% of the silicone family, making them the largest group of that family. Silicone rubbers maintain their mechanical properties over a wide range of

temperatures and the presence of methyl-groups in silicone rubbers makes these materials extremely hydrophobic.

Typical applications for liquid silicone rubber are products that require high precision such as seals, sealing membranes, electric connectors, multi-pin connectors, infant products where smooth surfaces are desired, such as bottle nipples, medical applications as well kitchen goods such as baking pans, spatulas, etc. Often, silicone rubber is over molded onto other parts made of different plastics.

From the metering section of the injection molding machine, the compound is pushed through cooled sprue and runner systems into a heated cavity where the vulcanization takes place. The cooling allows production of silicon rubber parts with nearly zero material waste, eliminating trimming operations and yielding significant savings in material cost.

Figure 2.6. Rubber Injection Mold and Rubber Part

Source: Schneider Electric Manufacturing Batam

2.3. Preventive Maintenance

The simple meanings of preventive maintenance are:

- Preventive maintenance is conducted to keep equipment working and/or extend the life of the equipment.
- Corrective maintenance, sometimes called "repair", is conducted to get equipment working again.

From Wikipedia, Preventive maintenance, the primary goal of preventive maintenance is to prevent the failure of equipment before it actually occurs. It is designed to preserve and enhance equipment reliability by replacing worn components before they actually fail. Preventive maintenance activities include equipment checks, partial or complete overhauls at specified periods, oil changes, lubrication and so on. In addition, workers can record equipment deterioration so they know to replace or repair worn parts before they cause system failure. The ideal preventive maintenance program would prevent all equipment failure before it occurs.

In Industrialization Parts Department there are four preventive maintenance for their tools; renewal, refurbish, repair, and modification. Every tool of Schneider component has two parts that is mold base and insert. If renewal, Engineer must changes both of mold base and insert. If refurbish, Engineer must changes mold base or insert. If repair, Engineer just change little part of insert. Modification only happens if Technical Antenna or Quality Department develops the component.

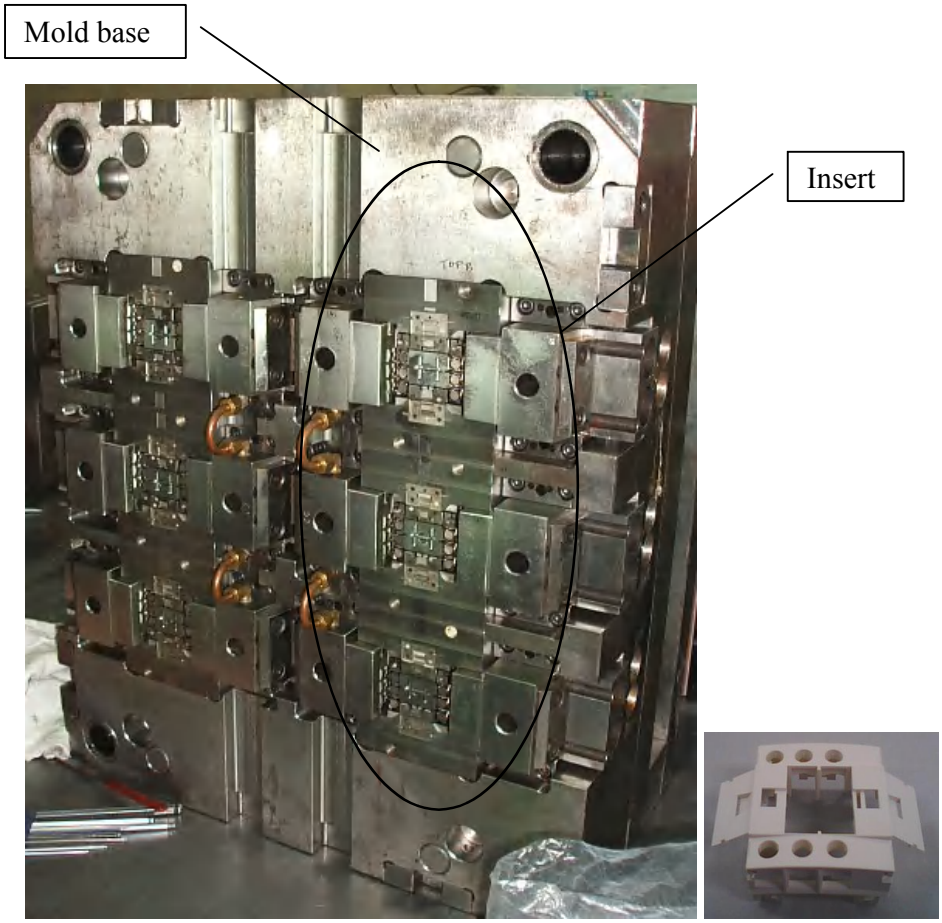

Figure 2.7. Mold Base, Insert, and Example of Component

Source: Schneider Electric Manufacturing Batam

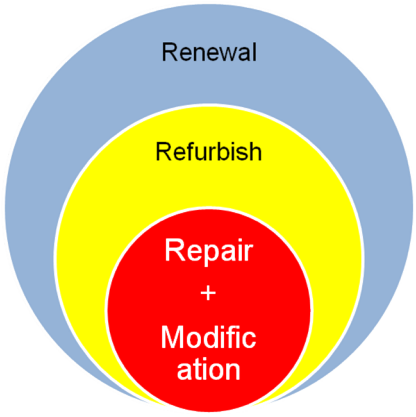

Figure 2.8. Relationship of Renewal, Refurbish, Repair and Modification

2.4. Scheduling

Scheduling is an important tool for manufacturing and engineering, where it can have a major impact on the productivity of a process. In manufacturing, the purpose of scheduling is to minimize the production time and costs, by telling a production facility what to make, when, with which staff, and on which equipment. Production scheduling aims to maximize the efficiency of the operation and reduce costs (*Wikipedia*. Scheduling Production Process, 2008).

Production scheduling tools greatly outperform older manual scheduling methods. This provides the production scheduler with powerful graphical interfaces which can be used to visually optimize real-time work loads in various stages of the production, and pattern recognition allows the software to automatically create scheduling opportunities which might not be apparent without this view into the data (*Wikipedia*. Scheduling Production Process, 2008).

Companies use backward and forward scheduling to allocate plant and machinery resources, plan human resources, plan production processes and purchase materials. Forward scheduling is planning the tasks from the date resources become available to determine the shipping date or the due date. Backward scheduling is planning the tasks from the due date or required-by date to determine the start date and/or any changes in capacity required (*Wikipedia*. Scheduling Production Process, 2008).

The benefits of production scheduling include:

- Process change-over reduction
- Inventory reduction, leveling
- Reduced scheduling effort
- Increased production efficiency
- Labor load leveling
- Accurate delivery date quotes
- Real time information

2.5. Microsoft Project

Microsoft Project is a project management software program developed and sold by Microsoft which is designed to assist project managers in developing

plans, assigning resources to tasks, tracking progress, managing budgets and analyzing workloads. Schedules can be resource leveled, and chains are visualized in a Gantt chart. Additionally, Project can recognize different classes of users. These different classes of users can have differing access levels to projects, views, and other data. Custom objects such as calendars, views, tables, filters and fields are stored in an enterprise global, which is shared by all users (*Wikipedia*. Microsoft Excel, 2008).

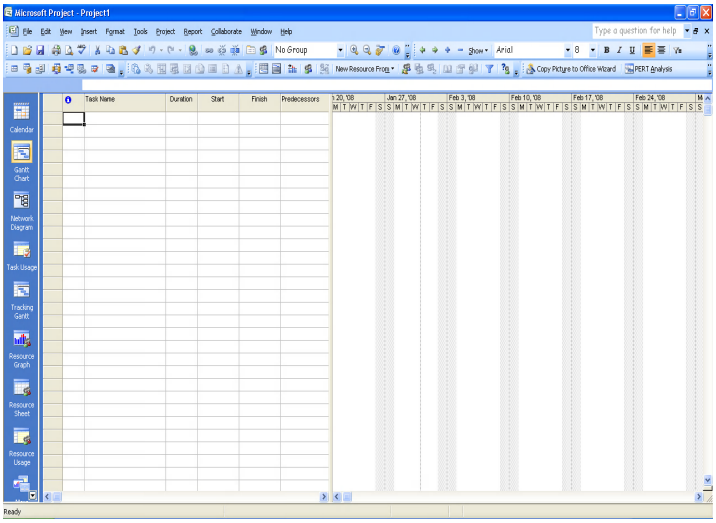

Figure 2.9. Microsoft Project

2.6. Gantt Chart

Gantt chart is a popular type of bar chart that illustrates a project schedule. Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project. Terminal elements and summary elements comprise the work breakdown structure of the project. Some Gantt charts also show the dependency (i.e., precedence network) relationships between activities. Gantt charts can be used to show current schedule status using percent-complete shadings and a vertical "TODAY" line (also called "TIME NOW" or "DATA DATE"), as shown here.

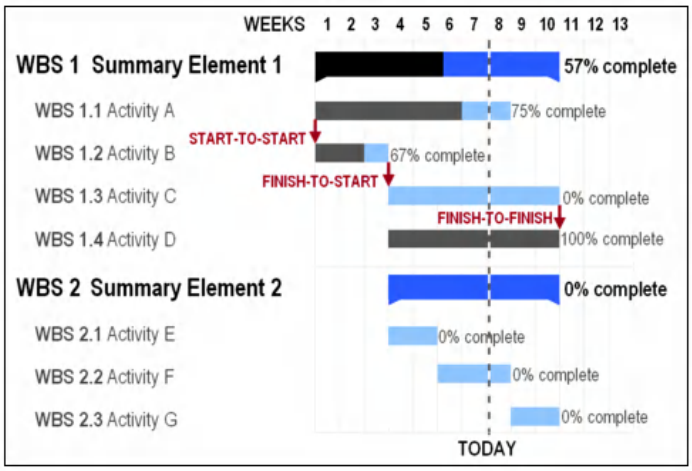

Figure 2.10. Gantt Chart

Source: http://en.wikipedia.org/wiki/Gantt_chart

Gantt charts have become a common technique for representing the phases and activities of a project work breakdown structure (WBS), so a wide audience can understand them. A common error made by those who equate Gantt chart design with project design is that they attempt to define the project work breakdown structure at the same time that they define schedule activities. Although a Gantt chart is easily comprehended for small projects that fit on a single sheet or screen, they can become quite unwieldy for projects with more than about 30 activities. Larger Gantt charts may not be suitable for most computer displays. A related criticism is that Gantt charts communicate relatively little information per unit area of display. That is, projects are often considerably more complex than can be communicated effectively with a Gantt chart (*Wikipedia*. Gantt Chart, 2008).

Gantt charts only represent part of the triple constraints of projects, because they focus primarily on schedule management. Moreover, Gantt charts do not represent the size of a project or the relative size of work elements, therefore the magnitude of a behind-schedule condition is easily miscommunicated. If two projects are the same number of days behind schedule, the larger project has a larger impact on resource utilization, yet the Gantt does not represent this difference.

Although project management software can show schedule dependencies as lines between activities, displaying a large number of dependencies may result in a cluttered or unreadable chart. Because the horizontal bars of a Gantt chart have a fixed height, they can misrepresent the time-phased workload (resource requirements) of a project. In the example shown in this article, Activities E and G appear to be the same size, but in reality, they may be orders of magnitude different. A related criticism is that all activities of a Gantt chart show planned workload as constant. In practice, many activities (especially summary elements) have front-loaded or back-loaded work plans, so a Gantt chart with percent-complete shading may actually miscommunication the true schedule performance status.

2.7. Microsoft Excel

Microsoft Excel 2003 is a software application that can be used as a spreadsheet, database, or graphing program. The electronic spreadsheet portion of Excel allows performing sophisticated calculations and creating formulas that automatically calculate answers. It features calculation, graphing tools, pivot tables and a macro programming language called VBA (Visual Basic for Applications).

Since 1993, Excel has included Visual Basic for Applications (VBA), a programming language based on Visual Basic which adds the ability to automate tasks in Excel for use in worksheets. Macro recording can produce VBA code replicating user actions, thus allowing simple automation of regular tasks. VBA allows the creation of forms and in-worksheet controls to communicate with the user (*Wikipedia*. Microsoft Excel, 2008).

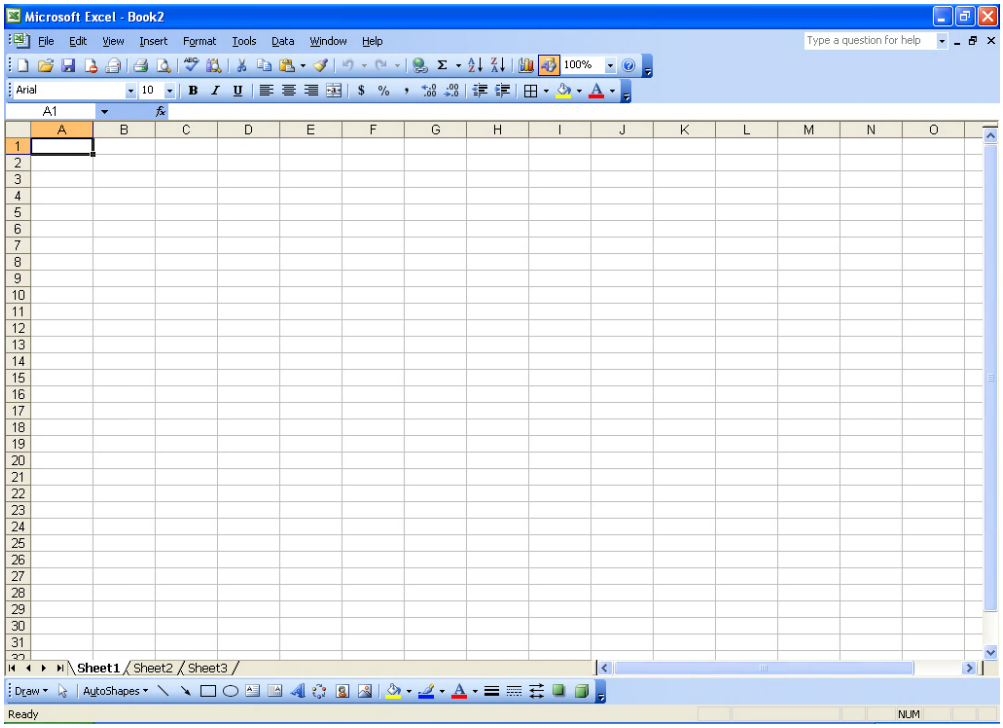

Figure 2.11. Microsoft Excel

2.8. Flowchart

A flowchart is a schematic representation of an algorithm or a process. A flowchart is one of the seven basic tools of quality control, which also includes the histogram, pareto chart, check sheet, control chart, cause-and-effect diagram, and scatter diagram. They are commonly used in business or economic presentations to help the audience visualize the content better, or to find flaws in the process (*Wikipedia*. Flowchart, 2008).

A typical flowchart from older Computer Science textbooks may have the following kinds of symbols:

- Start and end symbols, represented as lozenges, ovals or rounded rectangles, usually containing the word "Start" or "End", or another phrase signaling the start or end of a process.
- Arrows, showing what is called "flow of control" in computer science. An arrow coming from one symbol and ending at another symbol represents that control passes to the symbol of arrow point.
- Processing steps, represented as rectangles.

- Input or Output, represented as a parallelogram.
- Conditional (or decision), represented as a diamond. These typically contain a Yes/No question or True/False test. This symbol is unique in that it has two arrows coming out of it, usually from the bottom point and right point, one corresponding to Yes or True, and one corresponding to No or False. The arrows should always be labeled. More than two arrows can be used, but this is normally a clear indicator that a complex decision is being taken, in which case it may need to be broken-down further, or replaced with the "pre-defined process" symbol.
- A number of other symbols that have less universal currency.
- A Document represented as a rectangle with a wavy base.
- A Manual input represented by rectangle, with the top irregularly sloping up from left to right. An example would be to signify data-entry from a form.
- A Manual operation represented by a trapezoid with the longest parallel side at the top, to represent an operation or adjustment to process that can only be made manually.
- A Data File represented by a cylinder

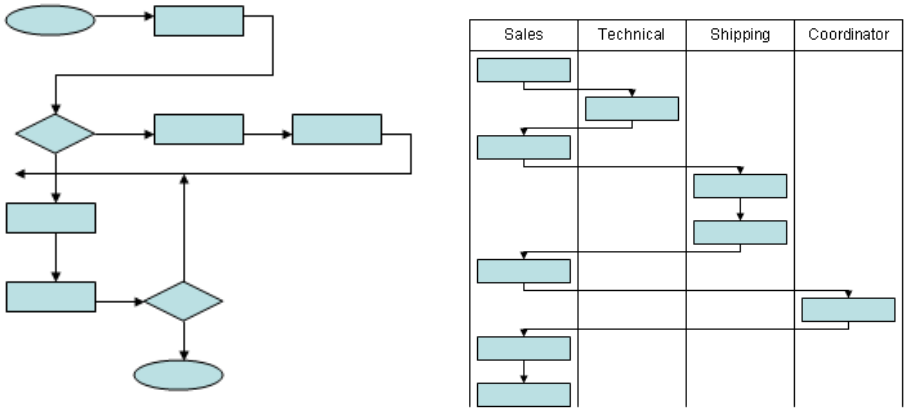

Figure 2.12. Activity and Deployment Flowchart