Chapter IV

System Formulation

4.1 Formulation of Material Management System

The material management system for a hard disk drive manufacturer that will be developed focus on material planning and inventory control. The study is also limited to a single HSA product in HSA laptop process.

4.2 Demand Policy Development for Establishing MPS

The demand that shown in Master Production Schedule (MPS) is the independent demand which already consider the availability of capacity, manufacturing constraints, company policies, and objectives. There are several ways to represent the MPS, however, independent demand planning horizon is one of the content. From the study, planning horizon should be at least as long as the longest cumulative lead time for the item to be scheduled in MPS. Planning horizon is the amount of time the master schedule extends into the future. The demand in MPS shows a rolling schedule. For example if the current period is period one then after period one expired, period two becomes period one.

4.2.1 Current Demand Situation of Case Study

The planning horizon of case studied company is for twelve months (one year).

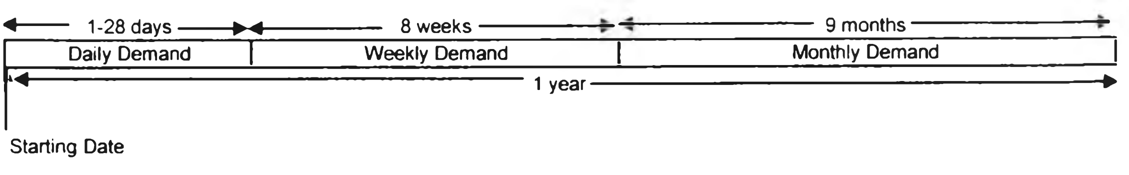

Figure 4.2.1 Planning Horizon of Case Studied Company

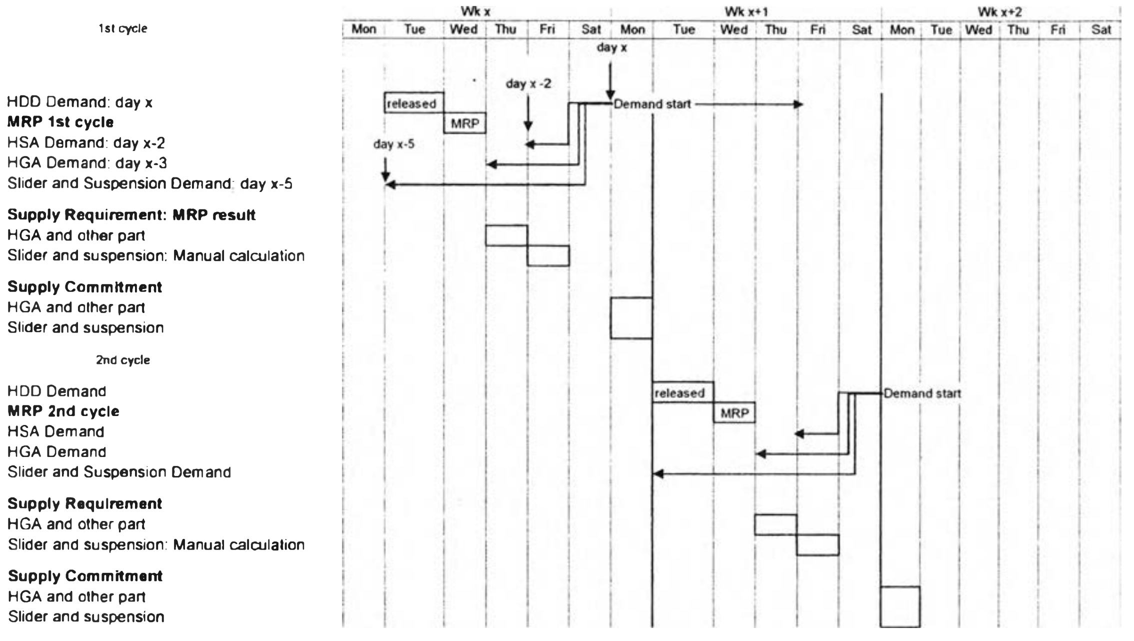

Figure 4.2.1.1 MRP Schedule of Case Studied Company

The rolling MPS is normally released every Tuesday late afternoon and MRP process will be start on the following day, Wednesday. After the MRP Process, there will be a manual adjustment and analysis process in order to get the manager approval. MRP result after manager approval will be available on Thursday. As a consequent, purchasing orders will be release to each supplier on Thursday and Friday. After the supply request, purchase order, has been send to suppliers, supplier will reply back their supply commitment notification to company within Monday of next week. From figure 4.2.1.2, it shown that MPS, which is HDD demand, releases on Tuesday of week x and its demand starting from Monday of week x+1, day x. From the company process lead time information, it takes two days to produce HDD. Therefore, HSA finished good inventory is required on the day HDD start to produce, day x-2. Since HSA production takes one day to complete, HGA finished good inventory has to be available for HSA production. So HGA demand is on day x-3. In addition, it takes two more days to produce HGA from slider and suspension. The available date for slider and suspension, slider and suspension demand date, is day x-5. For case studied company, there are six working days for each week from Monday to Saturday. The key date of MRP period can be summarized as follow:

MPS released date: day x- 5

HDD Demand started date: day x

HSA Demand started date: day x-2

HGA Demand started date: day x-3

Slider and suspension Demand started date: day x-5

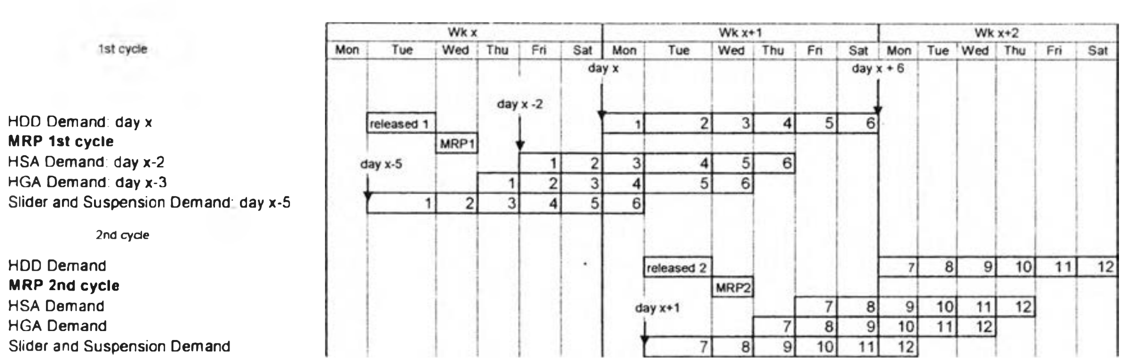

Figure 4.2.1.2 MRP Schedule of case studied company: detail by process

From the study the demand history of case studied company; it can be found that the demand for each week MRP are so fluctuated and lumpy through out the planning horizon. By comparing MPS of each week, it can also be found that even the demand of week x+1 also deviated week by week. The change of demand came from manufacturing yield and transformation of customer requirement. From Figure 4.2.1.2, it shown that the demand in week x +1 of first cycle MRP relates to the production in wk x means that the in order to get output according to the demand requirement in week x+1 from MPS, the production has to be start since Tuesday of week x. However, the historical data of case studied company shows that in first cycle of MRP, even the demand of week x+1 has been changed comparing to previous MRP. From second cycle of MRP, demand of week x+2 has been changed comparing to first cycle of MRP. Not only the demand change effects on production lead time, it also effects on the supply commitment from supplier. From Figure 4.2.1.2, supply commitment of MRP first cycle will be on Monday of week x+1. According to this supply commitment process, case studied company has no visibility of supply availability in week x+1 until Monday of wk x+1. Once the demand of week x+1 had been changed, supply commitment from supplier may not be sufficient to support the change. Eventually, case studied company cannot meet the demand x+1 due to insufficient supply availability. From the changed that happen in MPS, most of time case studied company cannot react according to the change since there is a constraint on production lead time and part supply.

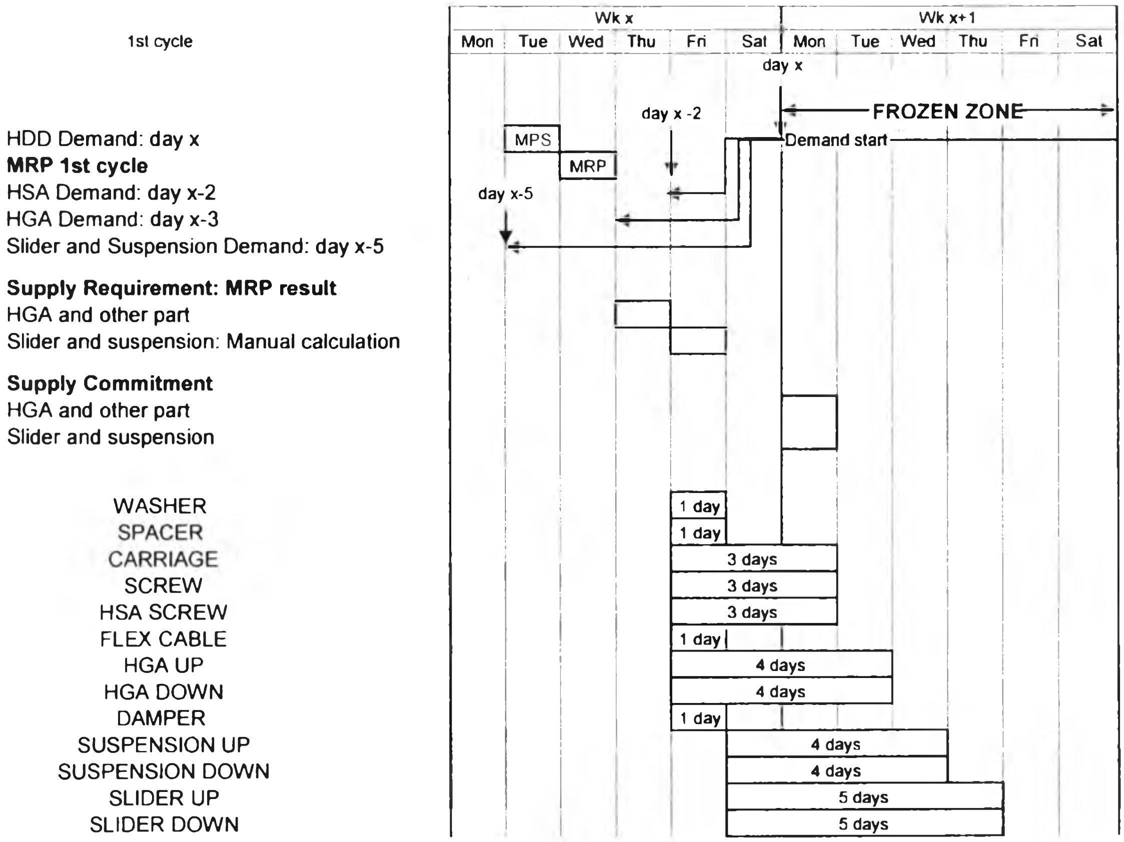

Figure 4.2.1.3 MRP Schedule of Case Studied Company: Detail by Part

Above figure, it elaborately shown the supplier lead time comparing to demand time line. It shown the reason why the demand x+1 is required to be freeze. The longest supplier lead time is five days and if there is any change especially additional requirement happens in week x+1, there is almost impossible for supplier to react for any change.

4.2.2 Proposed Demand Policy for Establishing MPS

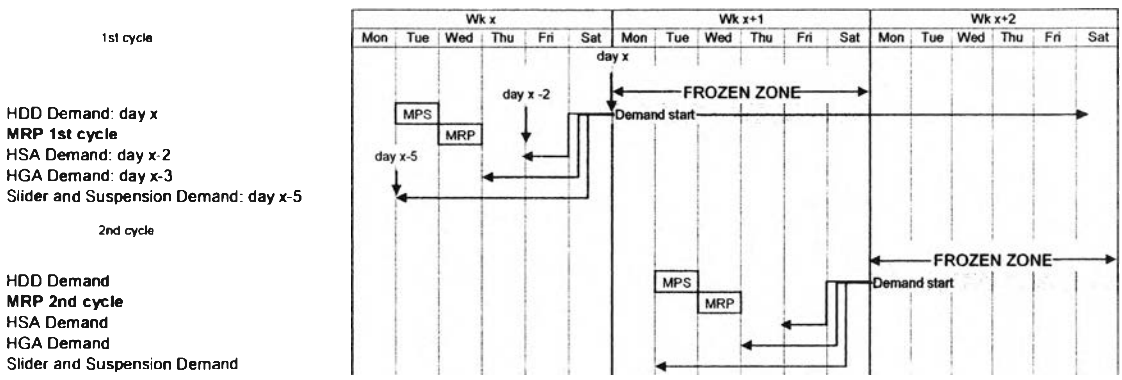

Figure 4.2.2 MRP Schedule of Case Studied Company: Proposed Frozen Zone

From the current situation and problem of demand management of case studied company, demand frozen zone is a proposed solution for effective demand management system. The frozen zone will cover the first week of demand in each cycle for instance the frozen zone of MPS that is released on Tuesday of week x is week x+1 and frozen zone of MPS that release on Tuesday of week x +1 is week x+2. The benefits of the demand frozen zone will be directly on demand management of case studied company. Frozen zone means any kind of changes are not allow in the frozen period. The reason that first week of the demand was selected to be a frozen zone because of the demand in first week (week x+1) of MPS produces one week advance which is the week that MPS was released (week x). If there are some changes in week x+1, it is almost impossible to react according to production lead time. Also for the supply commitment point of view, suppliers are not able to respond to the demand change in such a short period of time. As a consequent, having the frozen zone will not benefit only to customers but will also benefit on suppliers.

4.3 Procedure for Developing Material Requirement Planning (MRP)

4.3.1 Parameters Identification

Before getting start with system formulation and development, all parameters are required to be identified. The source of data and data specification are as follow:

1. Part Number: A Part number is a number or a reference used by a manufacturer to uniquely identify a product. A Part number is often different from the commercial name of the product. The general part number of case studied consists of seven digits, alphabet and number for example 0A25020, 13G1616, etc. Information of part number can be downloaded from SAP under the BOM document.

2. Description: Description is a statement that represents something in words. Description will be explained the detail of each part number for example the description of 08K1897 is HSA screw and the description of 13G1619 is HSA long beam. Information of description can be downloaded from SAP under the BOM document.

3. Annual Demand: Annual demand is the yearly usage of each item. The annual demand information can be downloaded from SAP under the inventory usage document.

4. Bill Of Material (BOM): The American Production and Inventory Control Society (APICS) defines a bill of material as “a listing of all subassemblies, intermediates, part, and raw materials that go into making the parent assembly showing the quantities of each required to make an assembly”. BOM is a complete list of the components which make up the finished goods. The BOM include part number, quantity, and description. An indented Bill of Materials includes descriptions of sub assemblies and how they relate to the finished good. Information of Bill Of Material can be downloaded from SAP under the BOM document.

5. Inventory Records: Inventory Records are the major inputs for MRP system. To complete the material calculation, the available on hand inventory need to be considered. Information of inventory records can be downloaded from SAP under the inventory document. The information of inventory records is categorized by location and part number.

6. Price: The unit price of each item will be identified in SAP under the BOM document.

7. Master Production Schedule: Master Production Schedule, HSA Demand is acting as a master production schedule for this study. HSA Demand is a statement of which end items are to be produced, the quantity of each and the dates they are to be completed. The information of HSA demand can be downloaded from SAP under the demand document.

8. Supplier information: Supplier information is mostly general information about customer such supplier name, supplier location, sourcing ratio, etc. The supplier information can be downloaded from E2OPEN under the supplier information document.

9. Supplier Lead time: Supplier lead time is the time duration from purchased order released to material receiving at the plant. The supplier lead time can download from E2OPEN under the part information.

10. Production Lead time: Production lead time is the time duration from start to build to finish the last process and become finished good. The production lead time information from Engineering department.

11. Scrap: Scrap is the unexpected loss of a completed part for any reason. The Projected Gross Requirements should be inflated by the Scrap allowance. If there are Yield losses or Shrinkage due to the nature of the manufacturing process, these losses should be allowed for in the Explosion.

The scrap information can be downloaded from SAP under the MRP parameter information.

12. On order Purchase Order: On order purchase order is the released order which have not closed by supplier. On order quantity is very important for MRP in order to calculate net requirement. On order purchase order information can be downloaded from either SAP or E2OPEN.

Part Name	Level	Lot Sizing Technique
HGA Up	1	Lot for Lot
HGA Down	1	Lot for Lot
Suspension Up	2	Lot for Lot
Suspension Down	2	Lot for Lot
Slider Up	2	Lot for Lot
Slider Down	2	Lot for Lot
Damper	2	Lot for Lot
Washer	1	Period Order Quantity
Spacer	1	Period Order Quantity
HSA Screw	1	Period Order Quantity
Cable	1	Lot for Lot
Carriage	1	Lot for Lot
Screw M1	1	Period Order Quantity

Table 4.3.1 Parameter Identification

4.3.2 MRP Input

4.3.2.1 Product Structure Hierarchy

To develop MRP, product structure hierarchy is a crucial element. The product structure hierarchy is typically referred to as a parent-child relationship. Each element in the product structure has a parent and a child. An end item has only children and raw material and purchased part items have only parents. The major outputs of MRP system are planned order released. There are two major types, purchase order and work orders. Purchase orders are quantities of raw material and purchased part items that required to purchase and the timing of their availability. Purchase order will be issued on its due date minus supply lead times while work orders are the quantities of manufactured part and subassembly items that required to manufacture and the timing of their delivery. Consequently, the work order will be issued on its due date minus manufacturing lead time. Purchase orders constitute the purchasing plan, as work orders generate the production plan for shop floor.

0A25020 ACTUATOR A MPC HSA 4HD 100G

Mat Level	Part Number	Description	Qty
1	0A25078	HEAD ASM D MPC HGA DN 100GB	2
2	13G1610	SUSPENSION MPC SUSPENSION D	2
3	13G1619	BEAM LOAD BEAM	2
3	13G1618	BEAM HINGE DN	2
3	13G1616	FLEXURE FLEXURE DN	2
3	13G1412	MOUNTPLATE MPA MOUNT PLAT	2
2	0A25010	SLIDER FGI MORAGA PLUS C TOP	2
1	0A25077	HEAD ASM U MPC HGA UP 100GB	2
2	13G1609	SUSPENSION MPC SUSPENSION U	2
3	13G1619	BEAM LOAD BEAM	2
3	13G1617	BEAM HINGE UP	2
3	13G1615	FLEXURE FLEXURE UP	2
3	13G1412	MOUNTPLATE MPA MOUNT PLAT	2
2	0A25009	SLIDER FGI MORAGA PLUS C BOT	2
1	0A25071	CABLE MPC FLEX ASM 2 D	1
1	0A25053	CARRIAGE A MPC CARRIAGE ASM	1
2	0A25055	COIL MPC COIL 2D	1
2	0A25054	COMB ASM MPC COMB 2D	1
1	08K1897	SCREW SCREW COMB FLE	1

Table 4.3.2.1 Example of HSA BOM

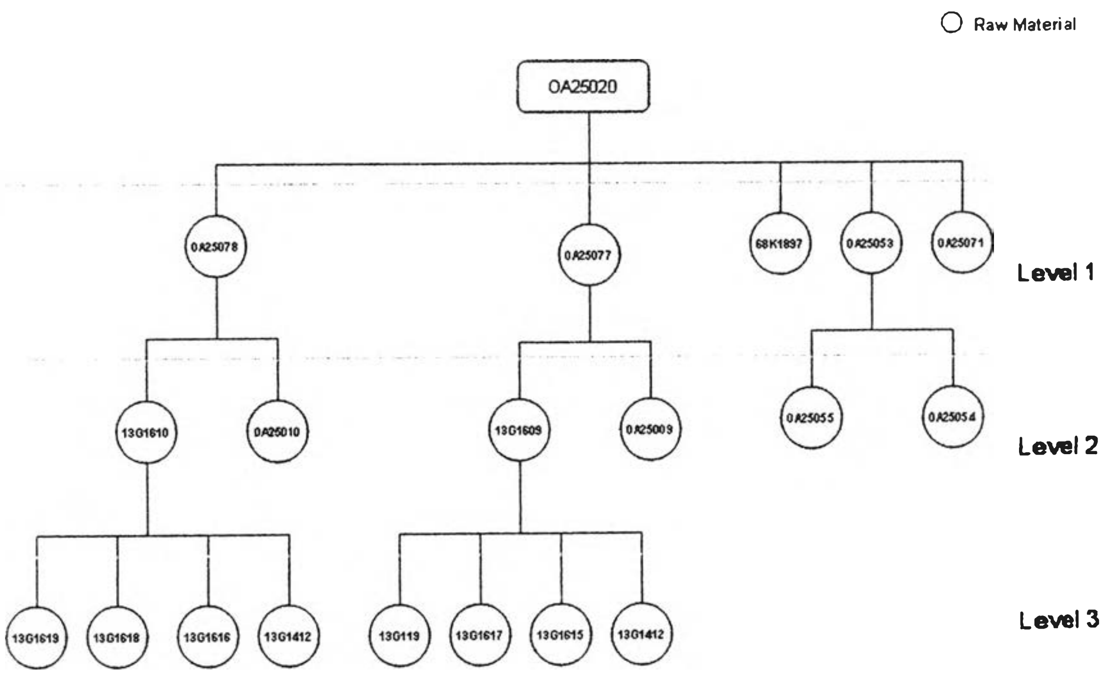

Figure 4.3.2.1 Example of HSA Product Structure

4.3.2.2 Master Production Schedule (MPS)

Master Production Schedule is generated either from aggregate plan or explicitly from demand. If the MPS is generated from aggregate plan, it must be disaggregated into individual products.

Master Production Schedule – States the requirements for individual end items by date and quantity. (APICS Dictionary, 10^{th} ed., 2002)

MPS consists of the following details

a. Which end items are needed and when to produce
b. Time period: it can be days, weeks or months
c. Total time to produce is the cumulative lead time
d. In the MPS
    1. Quantities represent production not demand
    2. Quantities may be a combination of customer orders and demand forecast
    3. Quantities represent what needs to be produced, not necessarily what can be produced.
e. For many companies there is a time called the time periods when no changes to the schedule are allowed form several combinations of subassemblies.

			Prod Year	2005	2005	2005	2005	2005	2005	2005
			Prod Month	12	12	12	12	12	12	Total
Genus	Family	Pn	Prod Week	48	49	50	51	52	53	Total
CPMOR	HSA	0A25020	Max base	5109	4260	4259	5965	3664	2218	159255
CPMOR	HSA	0A25020	Min base	5109	4260	4259	5965	3664	2218	159255
CPMOR	HSA	0A25020	Delta	0	0	0	0	0	0	0

Figure 4.3.2.2 Example of MPS

4.3.2.3 Inventory Master File

Inventory Master File is substantial information for MRP process. Inventory Master File contains extensive inventory and inventory related information which include:

1. on hand quantity
2. on order quantity
3. Work In Process quantity

The inventory records enable the checking of all levels of assemblies for the available quantities and comparing to actual requirements: There are three types of file on inventory records:

- Item master file: part number for clear identification
- Transaction file: receipts into stock, issues and balance
- Location file: point where inventory is kept mistakes can occur in inventory recording, so frequent checking is performed

Report ID: YCPPPI34
Page: 77

YPK1: Unassigned Inventory for Profit

Date: 04/06/2005

Transaction: YPK1 Time: 16:57:36

Plant TH01

Material	InvTyp	Unit	Quantity	St. Loc	Document #	Vendor	TTR Vendor	Avail Dt	Delivery Dt	Quality Ind	Del.No.
0A26790	PO/TO	ST	600	MDC1	0000422029 00010	0000073610	0310	20050430	20050429	0001	
0A26790	PO/TO	ST	13,180	MDC1	0000422030 00010	0000073610	0310	20050530	20050529	0001	
0A26790	PO/TO	ST	11,680	MDC1	0000422031 00010	0000073610	0310	20050627	20050626	0001	

Total inventory for 0A26790 : 30,395

Figure 4.3.2.3 Example of YPK1 (Inventory data)

The YPK1 report is the overall inventory report included oh hand inventory, on order quantity, and work in process quantity separated by storage location. The details of YPK1 are as follow:

1. Material: Part number
2. Inv Type: Inventory type
3. Quantity: Quantity of inventory categorized by part number and storage location.
4. St Loc: Storage location is where the inventory actually located at the time before MRP process start.
5. Document #: Document Number is the number which SAP was assigned as a reference.

6. Vendor: Vendor is the vendor name who actually supplies the specific material.
7. TTR Vendor: TTR Vendor is the vendor code which was assigned by SAP as a reference.
8. Avail Dt: Available date means the expected date when inventory will be available to be used.
9. Delivery Dt: Delivery date means the expected date when inventory will be deliver to the company.
10. Quality Ind: Quality of the specific material
11. Del No. : Delivery Number is the number of delivery which was assigned by SAP as a reference.

4.3.2.4 Planning Factor

1. Lot size
2. Scrap Ratio

=COMMODITY CODE	20050226	20050402	20050430	20050528	20050702	20050730	20050827	20051001
	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
HEAD UP	0	0.62	0.6	0.23	0.22	0.21	0.21	0.21
HEAD DOWN	0	0.62	0.6	0.23	0.21	0.21	0.21	0.21

Figure 4.3.2.4 Example of Scrap Ratio

3. Lead time: (Ptak, 2000) defines that lead time as associated with the item number is the expected time between the recognition of need and receipt of supply. For the case studied company, lead time depends on service levels of transportation. However, the default of transportation service levels of case studied company is SL2. There are four types of service levels which are NFO, SLE, SL1 and SL2. NFO is the most expensive transportation due to it takes the shortest lead time for deliver. In the proposed MRP, SL2 will be used as a default delivery lead time for every supplier. The rationale of assigning SL2 as a default service is because the lowest cost of transportation even though it gives the longest lead time of transportation. Since the material is not perishable, transportation lead time is acceptable.

Origin Country	Destination Country	SVC	Door to Port (hrs)
Japan	Thailand	NFO	30
Singapore	Thailand	NFO	30
Malaysia	Thailand	NFO	30
China (Shenzhen)	Thailand	NFO	44

Table 4.3.2.4 Details of NFO service

Origin Country	Destination Country	SVC	Door to Port (hrs)
Japan	Thailand	SLE	32
Japan	Thailand	SL1	60
Japan	Thailand	SL2	96
Singapore	Thailand	SLE	32
Singapore	Thailand	SL1	48
Singapore	Thailand	SL2	76
Malaysia	Thailand	SLE	32
Malaysia	Thailand	SL1	60
Malaysia	Thailand	SL2	96
China (shenzhen)	Thailand	SLE	48
China (shenzhen)	Thailand	SL1	60
China (shenzhen)	Thailand	SL2	72
US MW	Thailand	SLE	56
US MW	Thailand	SL1	80
US MW	Thailand	SL2	116
Mexico	Thailand	SLE	64
Mexico	Thailand	SL1	88
Mexico	Thailand	SL2	124

Table 4.3.2.5 Details of SLE, SL1, and SL2 Service

4.3.3 MRP Output

Normally, the major outputs of MRP are Planned Order Schedule and Work Order Schedule. Planned Order Schedule is the report that represents the quantity of material that are expected to be ordered from specific supplier according to required date offset by supplier lead time.

Order date = Required date offsetting by Supplier lead time

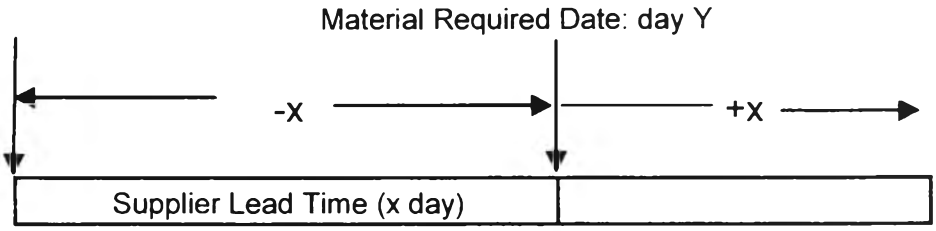

Figure 4.3.3 Planned Order Date Identification

Work Order Schedule is the report that represents the quantity of product or semi product to be produced instead of buying according to required date offset by production lead time.

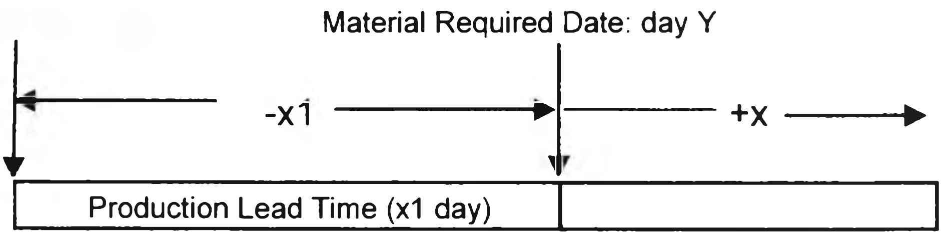

Figure 4.3.3.1 Work Order Date Identification

4.3.4 Material Requirement Planning Process Flow

In order for a MRP system to be effectively operated, the accuracy of inventory record must be minimum 95%. The major functions of MRP Process are

1. Responsible for scheduling all items (child parts) below the finished product
2. Recommends the release of work orders, purchase orders and issue rescheduling notices as required.

Two key considerations in setting up the MRP are the size of time buckets and the planning horizons. A time bucket is the unit of time on which the schedule is constructed and is typically daily or weekly. The planning horizon is how far to plan forward, and is determined by how far ahead demand is known and by the lead times through the operation. Before constructing MRP process, there are three major assumptions that need to be considered. The first, and perhaps the most considerable, is that there is adequate capacity available, infinite capacity scheduling. The second is that the lead times are predictable, or can be estimated. The third is that the date the order is required can be used as the starting date from which to develop the schedule.

4.3.5 Bill of Capacity

Bill of Capacity: A listing of required capacity and key resources needed to manufacture one unit of the selected items of family. Rough cut capacity planning uses these bills to calculate the approximate capacity requirements of the master production schedule. Resource planning may used a form of this bill. (APICS Dictionary, 10th ed., 2002)

Capacity: The capability of a worker, machine, work center, plant, or organization to produce output per period. Capacity required represents the system capability needed to make a given product mix. As a planning function, both capacity available and capacity required can be measured in the short term (capacity requirement plan), intermediate term (rough-cut capacity plan), and long term (resource requirement plan). (APICS Dictionary, 9th ed., 1998)

Load: The amount of planned work scheduled for and actual work released to a facility, work center, or operation for a specific span of time. Usually expressed in terms of standard hours of work or, when items consume similar resources at the same rate, units of production. (APICS Dictionary, 9th ed., 1998)

From the element checklist and cause and effect diagram, case studied company does not have the system to build and buy decision. To initiate the system for building and buying, it requires capacity information of particular process. For case studied company, only the HGA process requires the capacity in order to create build and buy system. In order to create Bill of capacity for HGA process, the information of work center, standard time of each work center and finally mapping out with BOM.

After complete construct Bill of Capacity, we can now calculate Day Going Rate (DGR) for each workstation. Finally, select the gating capacity, the work center that have the lowest capacity, in order to create the constraint capacity through out the planning horizon of MPS.

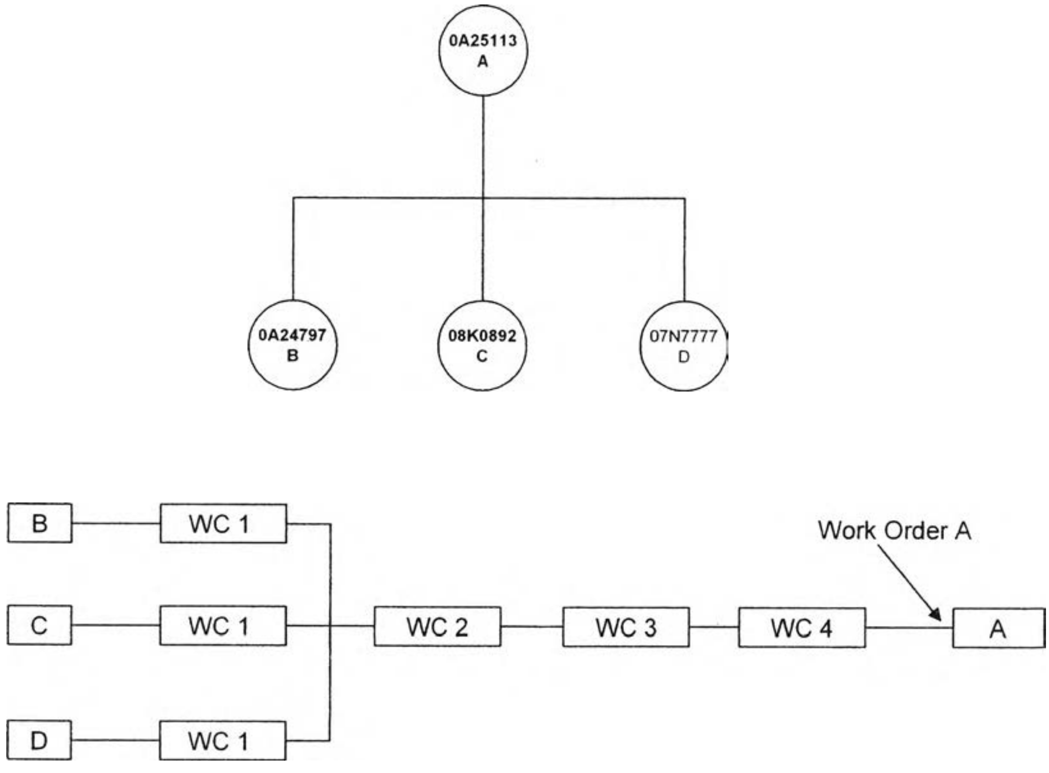

Figure 4.3.5 HSA Bill of Capacity

Work Center 1: WC1: HGA Assembly Line

Work Center 2: WC2: ABS

Work Center 3: WC3: Final Inspection

Work Center 4: WC4: Quasi Test

4.3.6 Material Management Process Flow

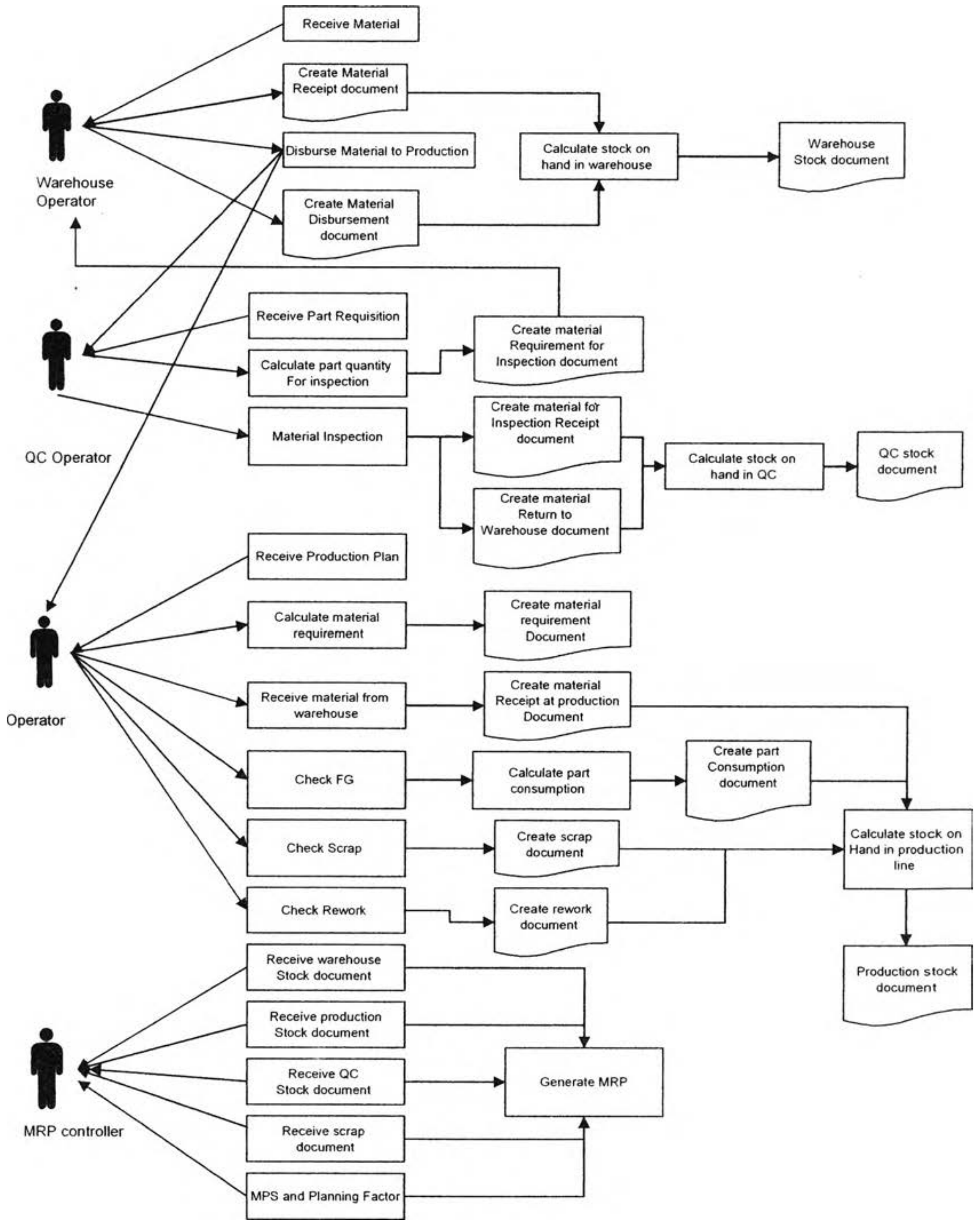

Figure 4.3.6 Material Management Process Flow

From figure 4.3.6, it shown material management process flow, they are four departments in the chain which are Warehouse, QC, Production, and Part Planning. The rough steps are as follow:

1. Starting from Warehouse operator receive a material and stock it in warehouse. After that once the material is required by QC or Production, warehouse reimburse the material to required department.
2. Once the material is required by production, sampling test is required for quality control process. Therefore, before Warehouse reimburses the material to production QC department, Warehouse is required to reimburse some part to QC department for quality checking prior to Production department. After the sampling of material pass the criteria of quality control, then Warehouse can be transferred the material to Production.
3. After Production receives required material from Warehouse, Production starts the production process according to production plan that they have received from Production Planner. Along the production process, there are many data that need to be collected for instance part consumption, scrap quantity, rework quantity, etc.
4. Finally, MRP controller utilizes the data from all departments to generate MRP.

4.4 Development of Lot Sizing Policy and Scrap Allowances

4.4.1 Lot Sizing Technique

Quantity decisions--summary

Method	Demand	Solution	Objective	Quantity	Application	Remarks
Economic Order Quantity	Uniform	Optimal	Min total cost	$\sqrt{\frac{2AD}{h}}$	Raw material, Finished goods, retail	First inventory model
Economic Production Quantity	Uniform	Optimal	Min total cost	$\sqrt{\frac{2AD}{h(1-\frac{D}{\psi})}}$	Production	Finite production rate
Quantity Discounts	Uniform	Optimal	Min total cost	$\sqrt{\frac{2AD}{h}}$	Raw material, Finished goods, retail	Price discounts
Resource Constrained	Uniform	Optimal	Min total cost	$\sqrt{\frac{2AD}{h+2c\lambda}}$	Raw material, Finished goods, retail	Multiple items
Fixed Period Demand	Lumpy	Arbitrary	Convenience ordering	Arbitrary period demand	Raw material, in process, Finished goods, retail	
Period Order Quantity	Lumpy	Arbitrary	Convenience ordering	Calculated period demand	Raw material, in process, Finished goods, retail	
Lot for Lot	Lumpy	Arbitrary	Holding cost	D1	Raw material, in process, Finished goods, retail	Wide application
Silver-Meal	Lumpy	Heuristic	Cost/period	ΣD_t	Raw material, in process, Finished goods, retail	
Least Unit Cost	Lumpy	Heuristic	Cost/unit	ΣD_t	Raw material, in process, Finished goods, retail	
Part Period Balancing	Lumpy	Heuristic	Balance cost	ΣD_t	Raw material, in process, Finished goods, retail	Wide application
Wagner-Whitin	Lumpy	Optimal	Min total cost	ΣD_t	Raw material, in process, Finished goods, retail	Comparison

Source: Sipper and Bulfin. PRODUCTION: Planning, Control, and Integration. 1998, p.260

Figure 4.4.1 Quantity Decisions Summary for Lot Sizing

4.4.2 Formulation of Lot Sizing Technique for HSA product

From table 4.4.2, there are four parts which have significantly high unit cost. For HGA up and down, there are suspension and slider which are the child part. Since these parts are consider as a high value part, Lot for Lot techniques is the most suitable technique for planning and managing the part planning and controlling process. For other parts, they positively required the most appropriate lot sizing techniques for part planning and controlling process.

Part No.	Description	Unit Cst
0A25078	HEAD ASM D MPC HGA DN 100GB	11.59
0A25077	HEAD ASM U MPC HGA UP 100GB	11.59
0A25071	CABLE MPC FLEX ASM 2 D	5.98
0A25053	CARRIAGE A MPC CARRIAGE ASM	4.72
13G1619	BEAM LOAD BEAM	0.01
13G1412	MOUNTPLATE MPA MOUNT PLAT	0.01
13G1618	BEAM HINGE DN	0.01
13G1616	FLEXURE FLEXURE DN	0.01
13G1617	BEAM HINGE UP	0.01
13G1615	FLEXURE FLEXURE UP	0.01
08K1897	SCREW SCREW COMB FLE	0.02
0A25055	COIL MPC COIL 2D	0.01
0A25054	COMB ASM MPC COMB 2D	0.01

Table 4.4.2 Unit cost for HSA Part

From the table 4.4.2, the selection process can be initiated.

1. According to the study and historical data, demand of case studied company is considerably Lumpy, therefore the method that are using with the uniform demand will be definitely not applicable. Economic order quantity, Economic production quantity, Quantity discounts, and Resource Constrained are the method for uniform demand.
2. Since the unit cost of the remaining part supply is significantly low, the objective of the solution doesn't have to be lowest holding cost or lowest unit cost. The objective of the lot sizing technique for the remaining part supply should be convenience ordering.
3. After sourcing out some of the methods, there are two types of lot sizing technique available which are Fixed period demand and Period order quantity. The different between these two techniques is the calculation method. Fixed period demand is using arbitrary period demand while Period order quantity is

using calculated period demand. The decision for the case studied company is to select Period order quantity since it used the period demand to calculate the lot sizing. The period demand is

$$POQ = \frac{P}{A/EOQ} = \frac{P \times EOQ}{A}$$

$$POQ = \frac{P \times \sqrt{2AS/Ci}}{A}$$

P = Planning Period

A = Annual Usage; generally determined as twelve times monthly usage

S = Cost per Order; consists of ordering cost and setup cost

C = Cost of Item; typically the standard cost

I = Annual Cost to Carry

Part Name	Level	Lot Sizing Technique
HGA Up	1	Lot for Lot
HGA Down	1	Lot for Lot
Suspension Up	2	Lot for Lot
Suspension Down	2	Lot for Lot
Slider Up	2	Lot for Lot
Slider Down	2	Lot for Lot
Damper	2	Lot for Lot
Washer	1	Period Order Quantity
Spacer	1	Period Order Quantity
HSA Screw	1	Period Order Quantity
Cable	1	Lot for Lot
Carriage	1	Lot for Lot
Screw M1	1	Period Order Quantity

Table 4.4.2.1 Lot sizing Technique for HSA Part

4.4.3 Formulation of Scrap Allowances

There are several parameters that effect on the result of material requirement planning. Once any parameter is deviated from plan, the result of MRP is definitely deviated from original plan and conclusively it creates part supply availability problem. One of the parameter that frequently deviates from forecast is scrap ratio. To formulate scrap allowance, scrap ratio will be used for standard deviation creation. The data of actual scrap ratio was collected for twelve month from June 2004 until May 2005. Since part supply shortage is an unacceptable situation, then service levels will be set as 99%.

	Actual	Forecast	Deviation	Deviation Square
June	A	B	(A-B)= C	C^2
July				
August				
September				
October				
November	⇨ Total 12 months			
December				
January				
February				
March				
April				
May				
Total				

Standard Deviation	σd	v(sum of C^2)/ (total month -1)
Z for 99 % service levels	Z	2.33
Safety stock	SS	= Z x σd
Scrap ratio + Safety Factor		= Forecast Scrap ratio + SS
Scrap Allowance		= B + SS

Figure 4.4.3 Scrap Allowance Formulation