CHAPTER II

LITERATURE REVIEW

In this chapter aim to review the current academic printed and previous research works that were involved with the improvement of production planning system in order to be used as further guideline of the thesis.

The tools to be discussed including

- Group Technology Coding
- Master Scheduling
- Material Resource Planning
- Production Plan
- Forecast Models
- Database Development

2.1. Group Technology (GT)

Group Technology (GT) helps structural grouping of product or components using code and symbols based on identified category which are similar product feature, product function, and production characteristic. Benefits of GT are [1];

- Easy to retrieve and modify product design and production process based on same group of part
- Reduce number of parts
- Reduce effort to create similar design or process to same group of parts
- Reduce inventory and work in process
- Improve quality control and standardize
- From all above, reduce cost and total lead times

Most product models use an exact definition of geometry, or other details. It can be useful to have a more abstract representation of a part for some tasks,

- Storage and recall of designs
- Recall of process plans for similar parts
- Classification of designs for analysis of production

GT is used to families of similar parts for the purpose of realizing common features in order to improved design and process efficiency through standardization. GT codes can be used to represent products using any combination of product feature, geometry, manufacturing processes, or function.

The advantages of such a system can be found in,

- Product design - Group technology allows similar designs to be retrieved from the computer rather than restarting the design.
- Tooling and setups - standard tooling can be developed for certain part family, also standard setup procedures and times can be used commonly
- Materials Handling - Factory floor layout can be updated to reflect part families, and reduce part handling time, for example to introduce cell manufacturing production rather than long continuous line production.
- Production and Inventory Control - The use of GT to set up standard production techniques, these allow faster production, and provide less inventory, and Work in Process (WIP).
- Employee Satisfaction - Grouping of machines allows easier product recognition, tracking of quality, and individual achievement.

- Process Planning – Same as product design, Standard plans can be developed for GT part families. The plans can then be altered to fit, instead of producing a new process plan.

However, the Problems with GT systems are,

- It is difficult to a factory with widely varying products
- GT may lead to a long setup time, and debugging in the implementation
- There are no standard GT codes developed - each GT code application will probably be unique from industry to other depend on the essential identification need
- A GT code may be hard for inexperienced users to read

Parts can be encoded using process flow, tool axis, tolerance, function, material, shape, etc. When selecting what the GT digits represent, the guidelines, based on J.Rehg are,

- They must differentiate products
- Must represent non-trivial features
- Only critical features should be encoded
- Function should be encoded
- Every digit should be significant

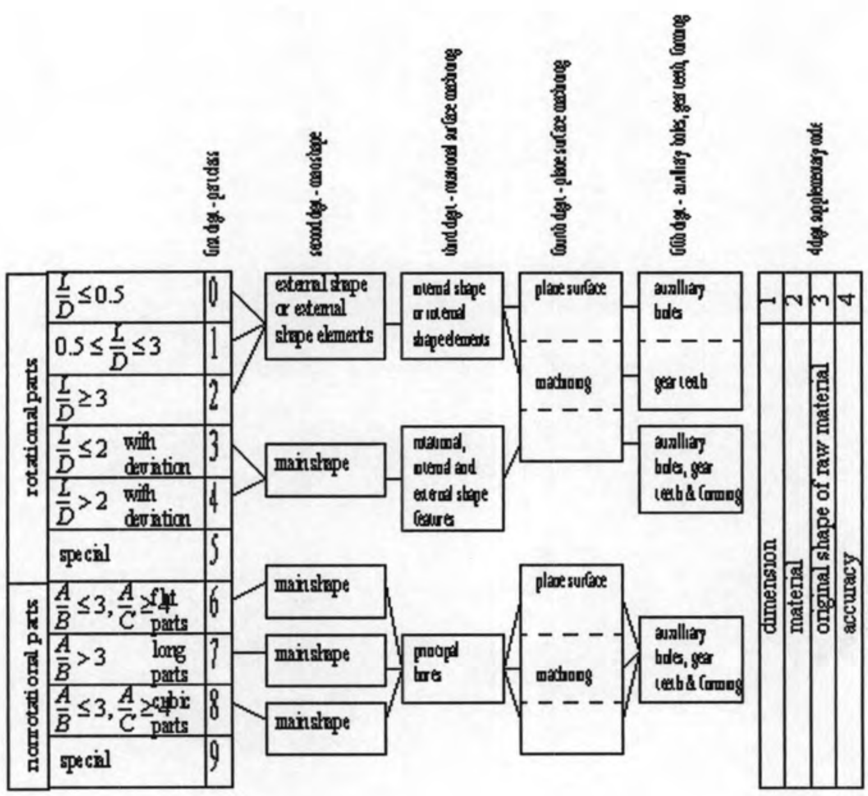
2.1.1. Poly Code

Poly code is the coding method that each digit will not relate to the other; an example of poly code is Opitz code [2], developed by H.Opitz. This code uses a sequence of 5 digits, 4 digits, and 4 letters, such as '11223 4455 ADEA'

- The first five digits are the form code (identify shape). See the table for form codes.
- The next four digits are the supplementary code - used to represent non-form details such as tolerances, materials, etc.
- The last four letters are the secondary code, used to represent production operation types, sequences, or other functions chosen by the manufacturer.

The Opitz code for a part is constructed from the first digit on, as shown in figure 2.1.

Figure 2.1: Opitz code structure



2.1.2. Decision Tree Mono Code

Decision trees are developed to be specific to typical product line, or manufacturing facility. To develop one of these trees we draw a tree that shows alternate possibilities for a part, and then number the options. The decision tree can be design to suit a particular manufacturer or industry.

2.1.3. Implementation of GT

GT should be used when there are a large number of parts that can be divided into groups based on feature, geometry, function, or production. The implementation of GT is[2];

a) Develop a GT code

b) verify the GT code by coding about 10-20% of the parts in the factory.

c) The results of the coding should be reviewed. Each part should have a unique GT code.

d) An examination of all the parts for the factory that will allow the identification of patterns in production, or design. According to this, the standard production, or standard product designs may be selected.

2.2. Master Scheduling (MS)

The master schedule (MS) is a presentation of the demand, including the forecast and the backlog which are customer orders received, the master production schedule (MPS), on hand inventory, and the available-to-promise quantity. The MPS is the primary output of the master scheduling process. The MPS specifies the end items the organization anticipates manufacturing each period. End items are either final products or the items from which final assemblies are made. Thus, the MPS is the plan for providing the supply to meet the demand.

2.2.1. Difference competitive strategy

The competitive strategy of an organization may be any of the following:

- Make to stock and sale inventory
- Assemble final products from the stock raw material
- Custom design and make-to-order

The competitive nature of the market and the strategy of the organization determine which of the MS alternates it should use. It is not unusual for an organization to have different strategies for different product lines and, thus, use different MS approaches.

2.2.1.1. Make-to-Stock

Make-to-stock focus on an immediate delivery of reasonably priced off-the-shelf standard items. In this environment the MPS is the schedule of the items required in order to maintain the finished goods at the desired level. Quantities on the schedule are based on manufacturing capacity and the forecast demand and safety stock levels. Product may be produced either on a mass production (continuous or repetitive) line or in batch production.

2.2.1.2. Package-to-Order

In this environment, options, subassemblies and components are either produced or purchased to stock. The competitive strategy is to be able to supply a large variety of final product configurations from standard components and subassemblies within a relatively short lead time

2.2.1.3. Custom Design & Make-to-Order

The final product is usually a combination of standard items and items custom designed to meet the needs of the customer, combined material handling and manufacturing processing systems are an example, special trucks for off-the-road work on utility lines and facilities are another.

2.2.2. Implementation of MS

Master scheduling activities implementation follow 3 stages:

- Designing the MS,
- Creating the MS, and
- Controlling the MS.

2.2.2.1. Designing the MS includes the following steps:

1. Select the items; which is to select the levels in the bill of material structure to be represented in scheduling (can be both components and final assemblies may be included).
2. Organize the MS by product groups; which is to group the selected product into the same families
3. Determine the planning factor, the time barriers, and the related operational guides.
4. Select the method for calculating and presenting the available-to-promise information.

2.2.2.2. Creating the MS includes the following steps:

1. Obtain the necessary informational inputs, including the forecast, the customer commitments, and finish goods inventory.
2. Prepare the initial draft of the master production schedule (MPS).

3. Develop the capacity requirement plan

4. Increase capacity or revise the initial draft of the MPS to obtain a feasible schedule, if required

2.2.2.3. Controlling the MS includes the following activities:

1. Track actual production and compare it to planned production to determine if the planned MPS quantities and delivery promises are being met.

2. Calculate the available-to-promise to determine if an incoming order can be promised in a specific period.

3. Calculate the projected on hand to determine if planned production is sufficient to fill expected future orders.

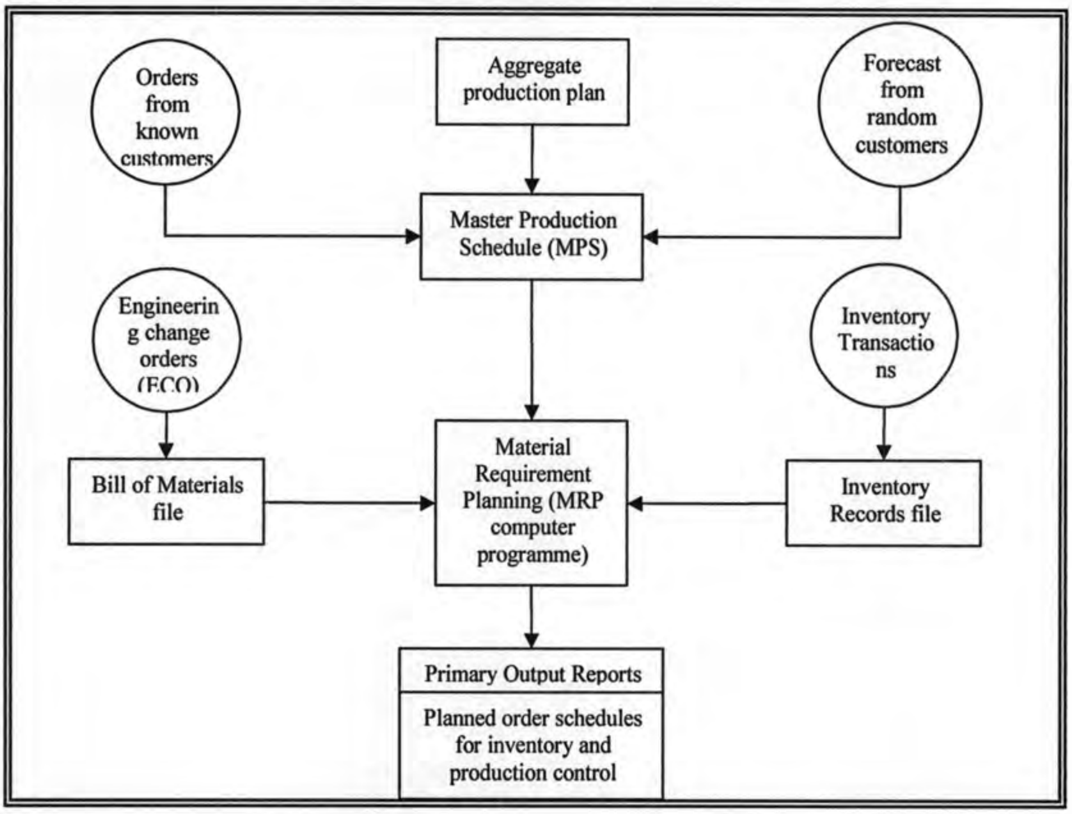
4. Use the results of the preceding activities to determine if the MPS or capacity should be revised.

The MS will then include the demand, the available-to-promise, and the projected on hand and the MPS quantity by period.

2.3. Material Resource Planning (MRP)

S. Crosby [3] developed low cost MRP system SME Electronics Company in Thailand follow the structure in figure 2.2. Since the existing MRP software cost too much to the company budget and too many function, Crosby proposed to use customized MRP for low cost and suit the requirement.

Figure 2.2: MRP System Structure



2.3.1. Master Production Schedule (MPS)

MPS is a plan used to specify how many products will be produce during certain period of time. Crosby identified the general and economic level of MPS is on weekly basis. However, in this study we will need to develop the MPS that can flexible to daily change.

R.Venkataraman and J.Nathan [4] used the weighted integer goal programming to solve the multiple production lines and minimum batch-size production restrictions.

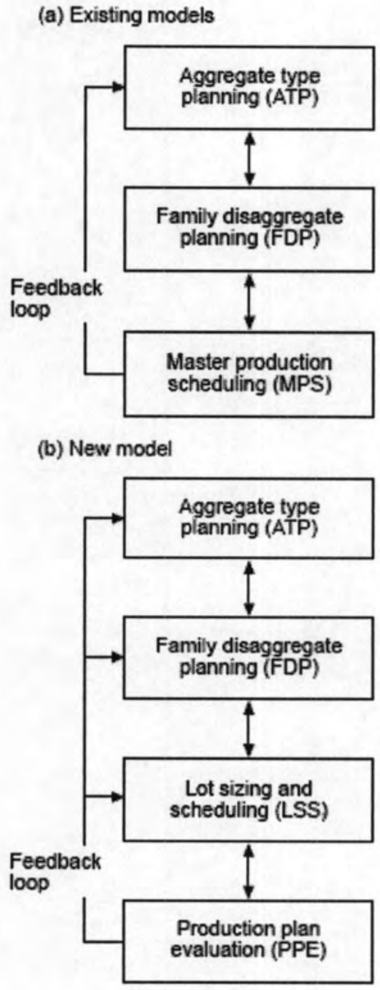
2.3.2. Bill of Material (BoM)

Product BoM can be simple or complex based on product level that we need to explore. Considering the Japanese snack study, the BoM level will only breakdown to 3 levels: dough, seasoning, and seaweed.

2.4. Production Plan

H.Jodlbauer [5] introduced the new model of optimum schedule using lot-sizes and sequences for a multi-item capacitated production system. He also calculated the effect of holding up and set up time cost for the schedule. The model using non linear solver which summarize that the standard linear solver can also give the good solution for cost calculation.

Figure 2.3: Hierarchical Production Planning



Source: Mohammad Z. Meybodi, *Integrating production activity control into a Hierarchical production-planning model*, Indiana University Kokomo, Kokomo, Indiana, USA, 1994

M.Z.Meybodi [6] use the Hierarchical Production Planning (HPP) model to identified the suitable production method for manufacturing. HPP consists of the following three levels:

- *Items*: specific final products to be shipped to the customers. A given product may generate a large number of items differing in characteristics such as colour, package, size, etc.
- *Families*: groups of items with common manufacturing set-up costs. Economically it is desirable to manufacture jointly items belonging to the same family.
- *Types*: groups of families with similar costs per unit of production and similar seasonal demand pattern.

2.5. Forecast Models

In order to do the effective planning, the ability to do the accurate forecast demand is important for resource planning. In associate with the rapidly change of market demand and the market trend, the forecast, however, still need to use historical data for prediction. N.R. Sanders and L.P. Ritzman pointed that the major area that use the forecasts are marketing function and production function, where the marketing function typically generates sales forecasts based on judgmental methods that rely heavily on subjective assessments and "soft" information, while operations rely more on quantitative data.

Forecast model was discussed by R.L.Luft [10] about 3 quantitative forecasting methods including Time Series Methods, The Indicator Approach, and Regression Models.

2.5.1. The Time Series method is the forecasting model that use historical data to predict the future value against time. The time series forecast can be sorted to 3 types which are seasonal, trend, and unsystematic.

2.5.2. The Indicator Approach uses the composite index or essential indicators of the forecast object and use the trend and relationship between indicators to forecast the business cycle.

2.5.3. The regression models are simply the use of historical set of data and result to form up the calculation equation, an example of equation model is linear regression $f(x) = ax+b$.

M.A.Razi and J.M.Tarn [7] talked about using ERP to help calculate safety stock and demand forecast in order to determine the reorder point, especially to use with the slow moving items in the industry such as spare parts. The observation was done under assumptions: no seasonal consumption pattern, presence of trend in consumption no identified, and based on irregular consumption patterns.

Though ERP is out of scope for this study the assumption of forecast formula is relate to the character of discrete order which could be of reference in making forecast for the system.

K.A.H.Kobbacy and Y.Liang [8] made a research on practical model to forecast demand and actually gave decision for inventory management. They also categorised types of demand to 3 types (Statistically unpredictable, Low demand, and Statistically predictable) and analyse the statistical models to be used for each type.

Y.Xie, D.Petrovic, and K.Burnham [9] presented hierarchical, two-level approach to inventory management and control in supply chains. The concept was to identify the production hierarchy activities and take pair of activity with problem and follower activity to determine the imprecise constraints. Then use fuzzy environment to introduce the demand forecast model.

2.6. Database Development

T.Jungthirapanich [11] studied on production and inventory control database for plastic injection manufacturing using Data Flow Diagram (DFD) technique to create model. He identified major resource concerned for database development including

- Software: Which needed to be evaluated based on change of production development time and manpower utilization
- Hardware: Need to suit with the usage and have enough capacity to support system
- People: Set up responsible person who need to maintain database. Proper training for database user is also required.
- Procedure: Need to set up the system development and maintaining procedure
- Files: The method of data storage and security need to be cleared.

2.7. Summary

In summary, all above discussed production planning support tools can be categorized in to 4 major tools as below:

2.7.1. Product Coding and Bill of Material Generating

The product coding and BoM generating is a very first step to make the effective planning. A good product coding and BoM grouping will result to:

- To reduce confusion on product variety in case product have wide array of features

- To group the product into same classified family in order to improve productivity or manufacturing lay out in the way that can make the best from the same family; e.g. reduce raw material or work in process, reduce production cell for the common process, reduce set up time, etc.

- To reduce possible error on production or material handling by showing the important feature of product on the code

- To help reduce time and cost on the design and development in case the new product might have similar feature as the existing product by provide the important relate information to be guideline prior to the design

2.7.2. Forecast Model

An predict of the future demand for the use in Master Scheduling for the timely plan of the product requirement.

2.7.3. Master Scheduling

Master scheduling will integrate the use of effective part coding, forecast model, product capacity planning, and available to commitment in order to result in the effective manufacturing to order with in the provided lead time.

2.7.4. Computer Integrated Planning Model

After all tools and standard are study and set up, the computer integrated planning model will help planner in the way of

- History information tracking that can easily to retrieve and use for further analysis
- Automate or Semi-automate calculation and planning that can help reduce time and increase planning accuracy