Chapter 2

Theoretical Study

2.1 IDEF0 Modeling and Technique

2.1.1 IDEF0 Modeling Overviews

IDEF is an acronym for Integrated DEFinition Language (or sometimes, ICAM Definition). It is a structured methodology for functional process analysis, which is based on the Structured Analysis and Design Technique (SADT), a graphical approach to system description, introduced by Douglas T. Ross in the early 1970s. In 1981, the U.S. Air Force Program for Integrated Computer-Aided Manufacturing (ICAM) standardized and made public a subset of SADT, called "**IDEF0.**" It was originally used to apply structured methods to better understand how to improve manufacturing productivity. An IDEF0 activity diagram contains one level of decomposition of a process. Boxes within a diagram show the sub processes of the parent process named by the diagram. Arrows between the boxes show the flow of products between processes.

IDEF0 modeling technique is easy to understand because it expresses a process in the same way the performer naturally think about the process. With this technique. A group of processes is broken down into sub processes and product flows, which operates in the same function. Basically, this technique consists of the following seven fundamentals as follows; [23]

The IDEF0 *modeling* technique consists of the following seven fundamentals: [23]

1. IDEF0 attacks a problem by building a model of the subject. The model answers questions about the subject.
2. Analysis of any problem is top-down, modular, hierarchical, and structured.
3. IDEF0 provides an activity model independent of both organization and time.
4. IDEF0 is a diagramming technique that shows component parts, ***inter-relationships between them***, and shows how they fit into a hierarchical structure.

5. IDEF0 methods support disciplined, coordinated teamwork.
6. IDEF0 methods follow rules and require all analysis and design decisions and comments to be in written form.
7. IDEF0 follows the principle of gradual exposition of detail.

2.1.2 IDEF0 Components

A model of an enterprise is developed through a top-down process of decomposition, through a series of boxes such as the one at the highest level of the enterprise. The fundamental mission of the enterprise is established as the first activity. This activity is decomposed into several subordinate activities, whose interfaces must be consistent with those in the parent process.

The first step in constructing an IDEF0 function model is to create the Context Diagram. The Context Diagram sets boundaries for the scope of the modeling effort. It is a model of the function at the highest level and the highest level of *inputs, controls, outputs, and mechanisms* are as follows;

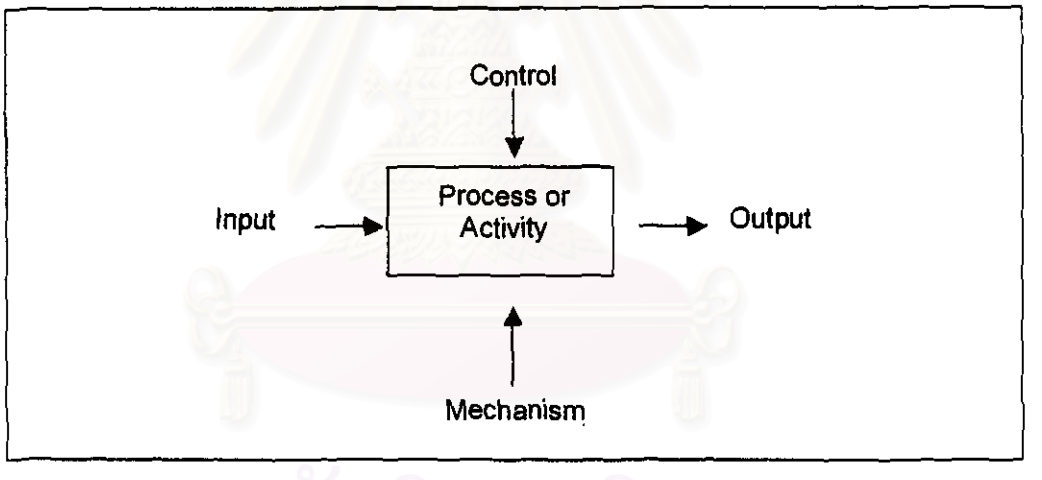

Figure 2-1: The ICOM of each process in IDEF0 model

- *Inputs:* These include material and information that will be transformed by the activity or process.
- *Controls*: the elements related to the activity that constrains or governs how the activity will be conducted.
- *Outputs*: The result of the activity. This is the input after it is transformed by the activity.

- *Mechanisms*: Those things that accomplish or support the activity (such as people, systems, or facilities).

The next step in IDEF0 modeling is to perform a functional decomposition of the context diagram. In IDEF0, the node tree *diagram* is used to show that decomposition. This step is just like a work breakdown structure. Each of these activities could be further decomposed as needed for analysis. When an activity is decomposed, it is broken down into three to six sub-activities. A number that indicates their level in the model and relationship to the parent activity identifies activities are as follows;

The Existing Production Activity Control Syste	Responsibility	Document No.
A1 Order Planning Activity		PD 02
A11 Collecting the Customer Order Plan	Production Control Section	
A12 Planning process	Production Control Section	
A13 Collecting the Component List	Production Control Section	
A14 Planning process for Components	Production Control Section	
A2 Operation Scheduling Activity		PD 03
A21 Operation Scheduling for Assembly		PD 03-1
A211 Matching the Component List	Production Department	
A212 Planning Process	Production Department	
A22 Operation Scheduling for Machining		PD 03-2
A221 Matching the Component List	Production Department	
A222 Planning Process	Production Department	
A23 Operation Scheduling for Die Casting		PD 03-3
A231 Matching the Component List	Production Department	
A232 Planning Process	Production Department	
A3 Production Recording Activity		PD 04
A31 Preparing the Production Resource	Assembly, Machining, Die Casting Sections	
A32 Production Process	Assembly, Machining, Die Casting Sections	
A33 Modifying the Work Order Schedule	Assembly, Machining, Die Casting Sections	
A34 Updating the Final Assembly Schedule	Production Control Section	

Figure 2-2: A sample of node tree diagram in the IDEF0 model.

The Decomposition Diagram as shown in the Figure 2-3, the next step of IDEF0 modeling can be built after the node tree is finished. First, a number of boxes are arranged in a descending, stair step fashion. This arrangement facilitates drawing lines on the diagram. The ICOMs from the context diagram are reflected on the decomposition diagram. The same process is used to build decomposition diagrams at each level as the models are further decomposed.

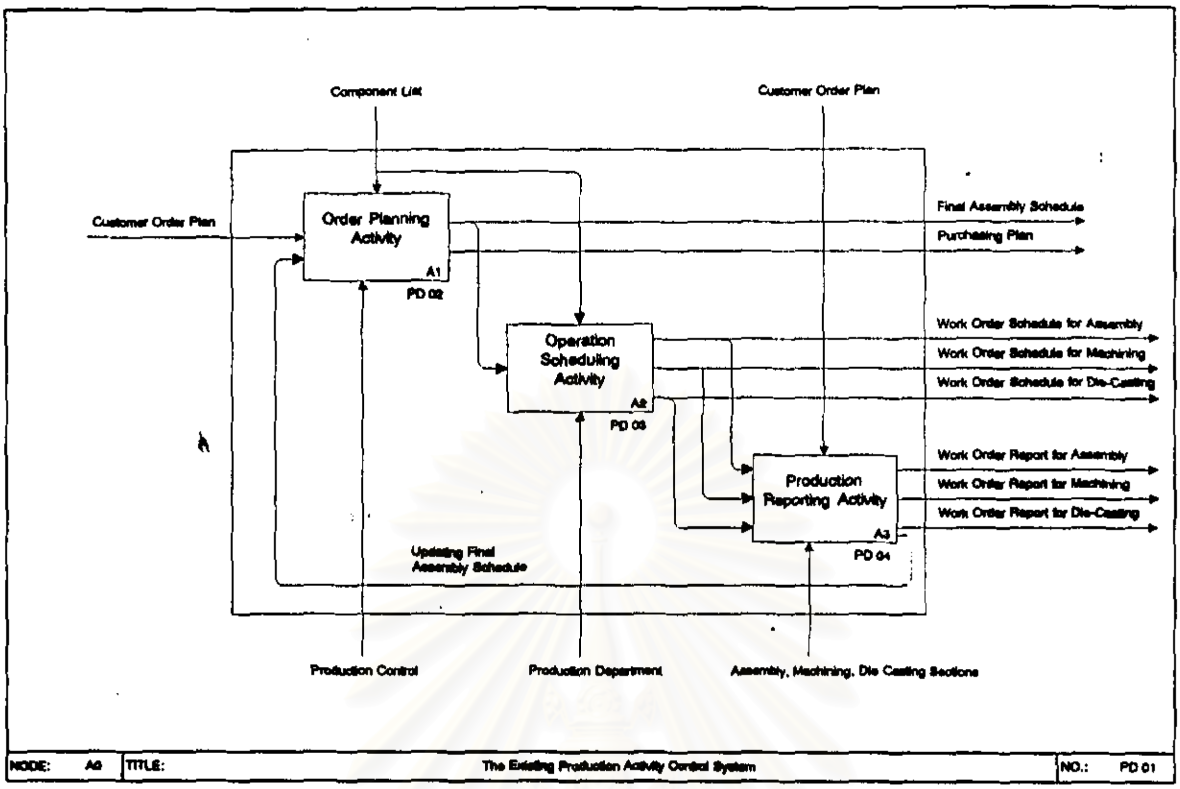

Figure 2-3: A sample of the decomposition diagram

IDEF0 modeling technique facilitates the development of a new perspective of an organization's activities. Thus, we can develop improved alternatives that will add value to the process. The projecting functional process improvement model is also constructed with valuable information, which illustrates the proposed changes and makes it possible to simulate the proposed system.

2.2 The Production Activity Control

When the planned orders are released to the sequential processes, the main objective is to deliver the product at the right time, in the right quantities, meeting quality specifications. But many random events, may affect schedule adherence and the eventual delivery of the product and force to change the schedule. To minimize the impact of these events, the Production Activity Control (PAC) is an efficient sequential processes data collection and information system that can be communicated with the high-level planning of order, order release, and operation scheduling.

The major functions of PAC system are to schedule and sequence job orders on the sequential processes and to provide complete and relevance order status information, which includes some information such as order batch sizes, job completions, and remain operations. The basic function of PAC system consists of six activities as follows; [20]

2.2.1 Order Release Activity

The first activity of PAC is order release, which is composed of order reviews and order documentation. Once an order comes in, the planner must check whether the necessary resources are available, or will be available, when they are needed. If not, it is better to withhold issuing the order to avoid any undesirable processes that may occur, such as the damage of exposed materials during the production process.

Order documentation will be prepared once it is determined that resources are available. Order documentation helps in tracking the order and in accumulating costs in accounting. It is also used as the authorized paper to prevent any conflicts may occur.

Production Order

Order No. 5862	Part No. 17654	Part description :			Support Bar			Date 10/22/xx
Routing No. 63	Quantity : 120	Drawing revision :			23			
							Standard Hours	
OPERATION NO.	*OPERATION DESCRIPTION*	*WORK CENTER*	*DEPT. NO.*	*TOOL NO.*	*LABOR GRADE*	*SET UP*	*RUN (LABOR)*	*RUN (MACHINE)*
		62# ?" Round SAE-1020 Cold Drawn Steel						
10	Clean	11	5		C	0.00	1.40	0.00
20	Cut off	15	20	6831	C	0.25	2.50	2.50
30	Mill flats	27	10	1725	B	0.50	3.20	6.40
40	Turn end	21	12	1683	A	0.25	4.50	4.50
50	Drill	16	17	2168	B	0.70	3.25	3.25
60	Inspect	8	19		B	0.00	2.00	0.00

Figure 2-4: A sample production order in the PAC system [22]

2.2.2 Operation Scheduling Activity

Operation scheduling, which is the next activity of PAC, is the assignment of start and completion times to manufacturing operations. This involves determining what set of orders will be ready for processing at a production process, deciding on the sequence, and calculating the resulting start and finish time for each operation.

In the past, schedulers within an organization are usually assigned the task of creating daily production schedules with the aid of spreadsheets and nothing else. This method works fine in an environment that has limited product variation and minimal resources to schedule. However, today's manufacturing process is more complex, so many schedule rules have been developed in an attempt to deal with the complexity of the scheduling problem. Thus, this activity simulates the progress of orders through the plant from the present to some time in the future in order to produce a daily or per shift dispatch list for each process. This simulation is based on the following three concepts:

- Forward scheduling:- Scheduling starts from the current date and order status, working forward and adding set-up, run, wait, and move times to determine start and completion times for operation.

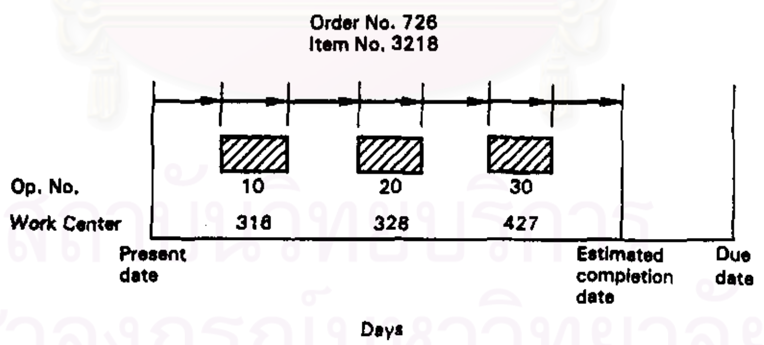

Figure 2-5: A sample of forward scheduling diagram [19]

- Finite capacity:- Work is loaded into a production process only up to the process capability as determined by the number of hours. The process is scheduled to work and the efficiency and utilization anticipated for the process.

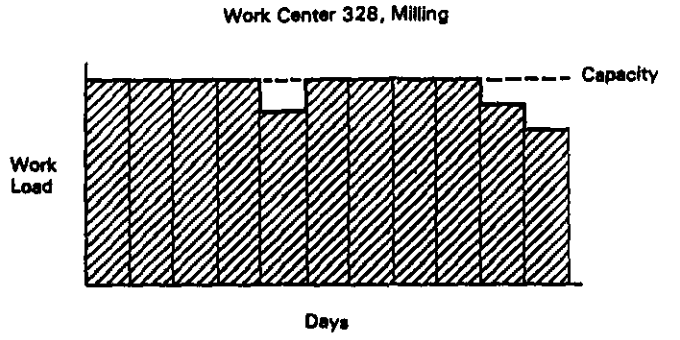

Figure 2-6: A sample of fine capacity diagram [20]

- Priorities:- There are technologies to assign the priority to each work/order as critical ratio. Nevertheless, it should be taken into consideration whether it is in regular or emergency basis. Rules may be included that route order to a pre-specified alternate production process where this would help alleviate a behind-schedule situation or when the alternate production process would otherwise be idle.

2.2.3 Dispatching Activity

Dispatching activity is the selection and sequencing of jobs to be processed at a production process and their assignment to workers and machines. The objective in making these assignments is to accomplish the operation schedule established in prior planning. Generally, the dispatching list is made up daily or by shift. Dispatching has been organized in several ways, depending on the characteristics or situation of each company.

Dispatch List

From Day 723 to 725 | Run day 722 | Page 52
Work Center No. 8623 Kearney & Trecker | Work day 723
Number of machines 4

ORDER NO.	PART NO.	OP. NO.	SETUP HOURS	RUN HOURS	LOT SIZE	LAST WC	NEXT WC	ARRIVAL	START TIME
2730	69312	10	1.0	3.0	50	4632	5871	Avail.	8.0
1695	71856	30	2.5	4.6	100	2430	6972	Avail.	8.0
3428	32640	25	0.8	1.2	80	4182	9331	Avail.	8.0
6910	54810	15	2,1	4.5	150	2648	5871	Avail.	8.0
8320	93201	45	1.0	5.9	40	6872	9114	9.0	10.0
7156	86785	50	1.2	3.0	100	3826	4116	10.5	12.0

Figure 2-7: A sample of dispatching list [20]

2.2.4 Data Collection Activity

Data collection is the next activity after the start at production process. Many data are needed to manage the whole system properly. The data must be complete, reliable, and up to date. Developments in data collection techniques are due to the change from manual systems to computerized systems. However, the proper data collection technique for each company may not be the same. Many constraints such as manpower, machine, and material must be brought into consideration.

This activity should concentrate primarily on measuring variables of output or results rather than intensity of activities. Focusing on the results instead of the activities offers more benefits, as well as a more stable plan, since the production process is carried out and new information is available. Information can be received in many ways – each of which is suitable for some types of measure.

It is important for any measurement or data capture to be at appropriate levels of accuracy. The level of accuracy and the acceptable tolerance level should be identified, because the precision of measurement generally can be increased by an increase in the cost of making. Typically, a higher level of accuracy is required on critical processes, as any problem on these processes will effect the production plan.

2.2.5 Production Reporting Activity

Production reporting activity processes the data from data collection activity. Periodical batch processing is more efficient in computation. However, with overnight processing the data are, on average, half a day behind actual events. Generally, the usage of this activity can be described as follows:

2.2.5.1 Corrective Action

Corrective action is used to ensure the achievement of production plans. Generally, the need for corrective action is brought to attention by the production reports. Some are brought by other sources, such as from the customer base. When problems occur, it is usually directed to the respective functional unit. It is applied in the following three major ways:

- Alarm:- to warn the foreman when an emergency case occurs, such as significant longer time consumed in the process or a machine breakdown.

- Response:- immediate response to any inquiries made by the foreman, production planner, or others who need the information to support their work such as the current status of a particular production order.

- Reports periodically on performance:- To show the performance such as efficiency, utilization, attendance which are needed for further action to optimise all the resources. The examples of the production reporting are below :

Order Status Report [20]

Date : 3/17/xx (150)

					Release Date		Completing Date	
ORDER NO.	ITEM NO.	ITEM DESCRIPTION	ORDER QUANTITY	QUANTITY COMPLETED	PLANNED	ACTUAL	PLANNED	ACTUAL
2681	1682	Flange	120	-	140	140	170	-
2683	2431	Bearing	40	-	142	145	185	-
2686	5914	Support rod	300	-	144	144	160	-
2688	6728	Hub	60	-	144	146	180	-

released Order Status Report [20]

Date : 3/17/xx (150)

ORDER NO.	ITEM NO.	ITEM DESCRIPTION	ORDER QUANTITY	PLANNED RELEASE DATE	DUE DATE	REASON
2682	3462	Gear	100	140	170	Machine down
2684	5715	Housing	120	142	185	WC overloaded
2685	6843	Sprocket	200	142	160	Material short
2687	2917	Valve assembly	40	145	175	Tooling being repaired

Weekly Machine Utilization Report Week 12/10 - 12/4 [20]

Date : 12/15/xx

WORK CENTER	DESCRIPTION	HOURS SCHEDULED	HOUR WORKS	UTILIZATION PERCENT
10	Drills	160.0	137.6	86
11	Turret lathes	360.0	346.2	96
12	Milling machines	300.0	248.0	83
13	Heat treat	250.0	230.0	92

Weekly labour Efficiency Report Week 12 /10 - 12 / 14 [20]

Date : 12/15/xx

WORK CENTER	DESCRIPTION	ACTUAL HOURS WORKED	STANDARD HOURS PRODUCED	EFFICIENCY PERCENT
10	Drills	137.6	156.5	114
11	Turret lathes	346.2	380.8	110
12	Milling machines	248.0	265.7	107
13	Heat treat	230.0	245.4	107

Figures 2-8: A sample of production reporting in the PAC system

2.2.5.2 Monitoring and Control

The monitoring system is a feedback process between planning and control. A poor correspondence between the planning and the control system is a critical problem. The control system can be missing if the monitoring system does not collect and report information on some significant variables of the plan. On the other hand, the monitoring system can provide better control of the work scope.

The objective of the monitoring system is to create an information system, which can provide required information to make timely decisions that will keep production performance as close to the project plan as possible. It includes collecting, recording, and reporting information regarding any or all aspects of production performance, which concerns both the management and operator levels in the organization. On the other hand, the objective of the control system is to act on data. It includes the processes of monitoring, evaluating, and comparing desired results with actual results, which are collected about production performances in order to determine the production status. The management staff may take necessary actions if the desired performances differ enough that he wishes to decrease the difference and to bring the actual performance into a reasonably close resemblance with the plan established for attaining the objectives.

The monitoring system should be capable of developing data streams, which indicate variances yet to come, because these variances obviously are apt to be statistical or trend-like in nature. This benefits in preventing problems rather than correcting them. It consists of data verification, measurement determination and report.

Reports should be designed in some kind of form and sent out regularly. It should be a single-paged document, which reports against the plan, against the defined criteria for control. Thereby, the reports should be designed in the way that allows worker to spend as little time as possible filling them.

2.2.6 Order Closeout Activity

The last activity of PAC is the order closeout. At this stage, the production will result in completed work and scrap. The completed work will be transferred to the inventory control department and the scrap will be sold or disposed. Before the order is closed, the following should be checked: [20]

- Do the receipts equal the original order quantity minus the number of units reported scrapped?
- Are the materials issued equal to those required on the requisition?
- Do the standard hours reported equal those required on the routing?

This question may lead to the disclosure of any errors hiding in both the data reporting and the data base and provide the opportunity to correct them.

2.3 The Database System

The database system is the main of information system for PAC. It should include extensive information on the products, assemblies, component parts, materials, and what resources are available for each production control and sequential processes. Information about products, materials, and processes is used in various section and files containing these data were maintained in many location. The useful information and techniques are describe as follows:

2.3.1 The Data Dictionary/Directory

Data Dictionary/Directory (DD/D) is the principal tool for database administration. It stores and manages all metadata (data about data) used by the organization. It is composed of two major items, as follows:

- *Data Dictionary*:- contains definition of record, data items, relations, and other data objects that are use to describe the property of data. An information of data dictionary is very useful to generate the conceptual model of database system.

- *Data Dictionary*:- contains information about what data are stored at each location in database system. This information is essential for the system administration to monitor and control a changing of data in the system.

Generally, DD/D tool can use with the database system in terms of the following:

1. *Documentation support*:- It can be applied for recording, classifying, and reporting metadata.
2. *Design toolkit*:- It is used for documenting the relationships of each data entity in database system.
3. *Performing metadata*:- It can be applied to generate metadata in formats that are required by the data management system (such as DBMS and application programs).
4. *Changing and monitoring control*:- It is used for enforcing standards and evaluating the impact of implementing change.

C:\My Documents\The Developed PAC system.mdb — Saturday, September 18, 1999
Table: Data Collection — Page: 10

Data CollectionOperation Scheduling

Data Collection		Operation Scheduling
Job_Number	—	Job_Number
Item_Number	—	Item_Number

Attributes: Unique, Not Enforced
RelationshipType: One-To-One

Problem StatusData Collection

Problem Status		Data Collection
Job_Number	—	Job_Number
Item_Number	—	Item_Number

Attributes: Not Enforced
RelationshipType: Indeterminate

Table Indexes

Name		Number of Fields
Item_number		1
	Clustered:	False
	DistinctCount:	0
	Foreign:	False
	Ignore Nulls:	False
	Name:	item_number
	Primary:	False
	Required:	False
	Unique:	False
	Fields:	Ascending
job_number		1
	Clustered:	False
	DistinctCount:	0
	Foreign:	False
	Ignore Nulls:	False
	Name:	job_number
	Primary:	False
	Required:	False
	Unique:	True
	Fields:	Ascending
PrimaryKey		2
	Clustered:	False
	DistinctCount:	0
	Foreign:	False
	Ignore Nulls:	False
	Name:	PrimaryKey
	Primary:	True
	Required:	True
	Unique:	True
	Fields:	Ascending
		Ascending

Figure 2-9: A sample of data dictionary/directory (DD/D)

2.3.2 The Normalization Technique

2.3.2.1 Overviews

Normalization technique was developed by E.F. Codd to group tabular data structures called relations into a relational, logical data model. It involves dividing a database into two or more table and defining relationships between the tables. It also refers to the process of creating an efficient, reliable, flexible, and appropriate "relational" structure for storing information.

Normalized data must be in a "relational" data structure, which is a defined set of information that can be manipulated by a single program and united as necessary. A relational database management system (RDBMS) is a program that allows the user to create relational structures for storing data. It comprises a program and sets of data (called tables) constructed with an RDBMS. The use of normalization techniques at the conceptual stage of database design has several advantages such as:

- The two-dimensional tabular format is easy to read and understand.
- The normalization technique used to create data grouping that eliminate possible data structures at an early stage in the design process.
- The normalized databases are stable and easy to perform the operation.

2.3.2.2 The Steps of Normalization

1. *Grouping data items*:- this step is grouping data items to generate a basic conceptual model in two dimension (column and row). Each column is an attribute of entity and each row is the set of data. The conceptual model has a primary key, which is one of the attributes to identify other attributes in each row. The primary key is a unique value.

2. *Removing the repeating group*:- this step is removing the repeating group from the conceptual model to make a normalized relation, which contains a single repeating group (primary key). The repeating group is combined with a primary key

to set the new relation, which uses a combination of other key and primary key to identify other attributes.

3. *Removing partial key dependencies*:- This step is removing partial key dependencies from the new relation of step 2 with two relations. First relation is fully dependent on the primary key and the other is on only part of that key.

4. *Removing transitive dependencies*:- This step is analyzing with two new relations from step 3. Other attributes are compared with the primary key to act as a new primary key of the relation. Then, the new relation are referred with a new primary key.

A normalized data structure takes advantage of the features of an RDBMS in efficient, powerful, and appropriate ways. There are certain characteristics that can be seen in most well-normalized data structures as follows: [20]

- It is common for one table to take on a role as the "**central**" table in a data structure. These tables have relationships to most of the tables in the database. Thus, the information in each table can be used and manipulated as a group of database.

- A well-normalized data structure typically has referential integrity enforced for most of its relationships. (Note that referential integrity cannot be enforced in one-to-many relationships where the many side can be left blank.)

- RSD has terms for two special types of tables: "Link" tables, and "Lookup" tables, which are used very widely in practically every data structure.

2.3.3 Bill of Materials (BOM)

A bill of materials is a completed list of all material showing the quantity of each component part. It is fundamental information. A listing of all the sub assemblies, work-in-process, component parts, and raw materials that go into a parent assembly showing the quantity of each required to make an assembly are shown on a BOM. It is used in conjunction with the master production schedule to determine the items for which purchase requisitions and production orders must be released. There is a variety of display formats for bills of materials.

No.	Level	Item number	Items name	Qty	Source of items
1	0	AB-10000	FRONT COVER	1	Assembly Section
2	1	AB-10100	MAIN BODY (FINISHING)	1	Machining Section
3	2	AB-10110	MAIN BODY (CASTING)	1	Die-Casting Section
4	1	AB-10210	COVER-FW	1	Purchased
6	1	FP001020	TIMING PIN	1	Purchased
7	1	FP001018	TIMING PIN	1	Purchased
8	1	CD-00121	OIL SEAL	1	Purchased
9	1	CD-00513	OIL SEAL	1	Purchased
10	1	PD010010	PLUNGER	1	Purchased
11	1	PD010018	PLUNGER	1	Purchased
12	1	AB-10410	ROTOR-INNER	1	Purchased
13	1	AB-10411	ROTOR-OUTER	1	Purchased
14	1	BL010612	BOLT-HEXAGON	5	Purchased
15	1	BL010808	BOLT-MACHINE	6	Purchased
16	1	BU001010	BUSH	1	Purchased

Level 0 = The finished product

Level 1 = The finished part (Main Body (Finishing) and Components)

Level 2 = The casting part (Main Body (Casting)

Figure 2-10: A sample of BOM information

2.4 Literature Survey

1. Akhaphan Mahaampornpreuk, 1997 [1]

This thesis is to reduce budget control problems through the development of a revised budget control system. This thesis includes the analysis and design utilized a relational model and the development of and electronic budget control system that employs streamlined data entry procedures, cut-off budget capabilities and revised report processing. System advantages include data independence and reduced data redundancy.

2. Apinan Klawwutinum, 1980 [2]

This thesis presents the result of applying Material Requirements Planning technique in steel furniture manufacturing by introducing computer program in recording information of vendor, inventory transaction order, purchasing order, and single level bill of materials. A result shows the quantity on hand more accurate, and calculate gross requirement, net requirement, and planned order release by studying information from bill of materials, stock status, purchasing lead time, ordering and holding cost. This thesis is applied with the technique of calculation lot size to purchase in order to calculate demand of various materials as well.

3. Chatchawan Chinvipai, 1997 [4]

This thesis explains about an improvement of production management and information system in the sleepware industry by improving a computer program in recording information of operation. The result of improvement shows a comparison between traditional and developed method in term of usage time to edit and prepare document.

4. Edwards, Eric Kenyatta, 1998 [6]

This research describes about the manufacturing information system (MIS), which have evolved into large scale software and database management systems and the need for these system to be open, flexible, and adaptable to a manufacturing organization's local culture and practices for the successful operation. This research presents the concept and the software framework, which can be adapted to a broad range of discrete products manufacturing such as job shop, batch, make to order, and make to stock philosophies. This information system has been designed to satisfy a new set of design and implementation issues as follows [6]; (1) open, (2) dynamic, (3) events adaptability, (4) integration adaptability, (5) procedural adaptability, (6) GUI adaptability, and (7) data definition adaptability.

5. Kunniga Getwite, 1997 [8]

This research presents the result of information system development for monitoring and evaluation of breast feeding in community hospital. This research consists of the analysis of the breast feeding operating system and develops the applied program on database for storing, evaluating and illustrating the evaluation of the breast feeding. This research also applies in appropriate section of health care units to show the status of breast feeding and to bring about solutions to the problems.

6. Piyarat Tangkasemchit, 1997 [12]

This research is concerned about the application for an executive information system by using a case study of Levi's products. The objective is designing a database system to compare and forecast sale information as well as review operational results based on daily transaction. This study show that the prototype system performed quite satisfactorily in term of accuracy, fast response, flexibility, and easy of use.

7. Rondeau, Patrick Joseph, 1997 [16]

This research consists of the evaluation of manufacturing from the industrial to post industrial model of competition, which has created an organizational environment. This research represents an initial cross-functional investigation between the manufacturing and information systems fields of study, which is executed with 37 respondents from a target group of senior manufacturing managers. The results confirm the existence of a strong positive relationship between time-based manufacturing practices and work system practices that firm will generally exhibit greater work system standardization, formalization, reutilization, and integration than those firms who do not adopt such practices. This research also confirms the existence of a strong positive relationship between work system practices of the firm and the effectiveness of its information system management practices, which turn contribute to the creation of greater competitive capability and firm performance.

8. Siradeat Chartniyom, 1996 [17]

This thesis shows a development of an information system for production control in the manufacturing of control switch board and cable tray by improving a document managing system. This thesis suggests a solution to design and apply an information system for controlling a production process. It shows the pattern of workflow and document managing system.

9. Sirichai Ngowkarnchananak, 1991 [18]

This thesis presents the management information system for controlling the production in toy industry by improving an organization structure, operating workflow, working procedure and frequency of delivering documents. These improvement is based on an information system to solve the communicating data, relationship, and decision making of management level.

10. Steele, G.D.; Matthews, I.A., 1990 [21]

This journal is a part of "Factory 2001 - Integrating Information and Material Flow, 1990, Second International Conference" to demonstrate the Rover Group factory information system (FIS), which meets users' need for access to data in many production system with standard. The resulting system is followed by project team organization, the software, hardware, and communication.