CHAPTER 2

Theoretical Consideration

2.1 Project Management

Traditionally, the project management involves three fundamental stages that include project planning, project scheduling, and project controlling. Project planning is to explain what have to be done in the project and what resources are needed to accomplish the project. Project scheduling is to convert the project plan into the operating timetable used as a mean for monitoring and controlling project activities. Finally, the project controlling is to see the project tasks are carried out according to the plan. In controlling, it includes monitoring the project performance, assessing the result by the changes detected from monitoring, resolving the problem incurred in the project, and communicating.

2.1.1 Project Planning

The purpose of the project planing is determining what has to be done and what resources are needed. Since the nature of every project is different, the answer of such questions could not be carried out as a standard. Therefore, the project management is certainly started by the planning process. However, the project planing is able to rely on past project experience or historical records whenever the project characteristic is quite similar. [John M. Nicholas, 1990]

2.1.1.1 Work Breakdown Structure

In clarification of what has to be done question, Work Breakdown Structure (WBS) is one of the project management tool applied to divide the total project into small elements, since it possible to prepare project schedules and cost estimation and to assign management and task responsibility. To reduce the total project into work elements is the objective of WBS analysis. The work elements are so clearly defined that they can be thoroughly and accurately defined, budgeted; scheduled, and controlled.

In creating WBS, typically, the total project is divided into five levels that consist of the total project, category, task, sub task, and work package. Work package represents the work performed by outsider, subcontractor, or the work performed by inside functional unit, internal contractor.

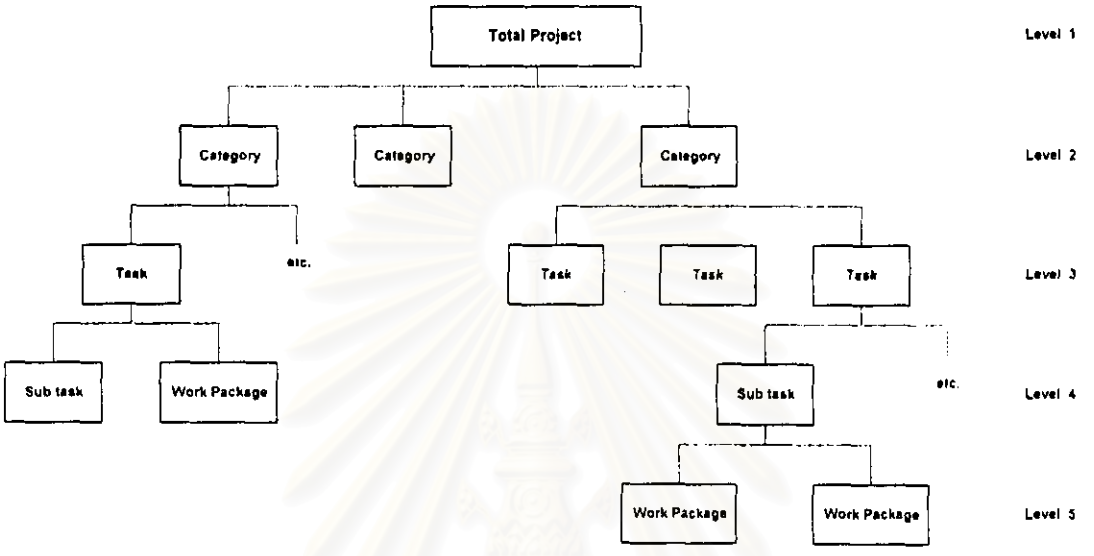

Figure 2.1 Elements of a work breakdown structure

2.1.1.2 Responsibility Matrix

In addition to the answer of what activities have to be done, the answer of what resources are needed is also required from the project planning. There are four categories of resources needed in the project that usually include time, money, people, and material.

For the need of people, Responsibility matrix is a chart that represents the intersection between WBS and the organizational structure. It is easily for project personnel to see what is their responsibility in the project through the work package and other individual. However, the work listed and their managers and other affect parties must have mutual agreement in determining the kind of responsibility defined for each organizational position and work package intersection. This chart is useful for monitoring and assessing how well responsibilities are being carried out because how units in organization should perform is prescribed by this responsibility matrix.

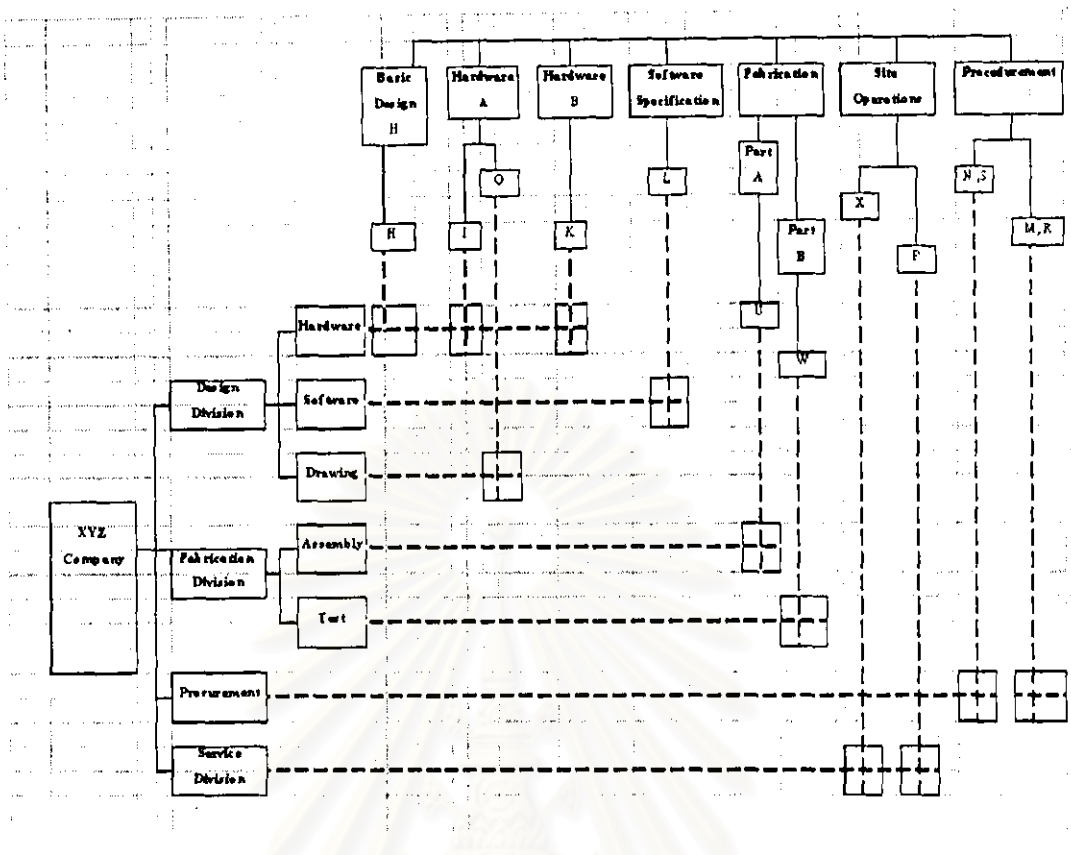

Figure 2.2 : Integration of WBS and Project Organization

	Activity	Project Manager	Project co-ordinator	Project Engineer	Design	Software	Site Operations	Drawing	Assembly A	Assembly B	Industrial	Purchaser
	Project coordination	A	P									
	Project development	A	P		S							
H	Basic design				A	N	N	N				
I	Hardware design A				A							
J	Hardware design B				A							
K	Drawing B							A				
L	Software specification				A	A						
M	Parts purchase B		N								P	A
N	Parts purchase A								A			
O	Drawing A							A			A	
P	Installation Drawings										A	
Q	Software purchase		N							A		
U	Assembly A								N			P
V	Assembly B											
W	Test A											
X	Test B											
Y	Finall Installation	N							N			P
Z	Final test	N							N			P

Figure 2.3 Responsibility matrix

2.1.2 Project Scheduling

The scheduling of work elements is the next step in project planning after the WBS analysis. This operation is important because it is the bases for resources assignment, cost estimation, and project performance tracking. In scheduling project tasks, drawing the network of work activities is necessary done first because it shows the precedence relationship of different activities. Thus, duration of each activity is applied to signify deadline and milestones. In addition, network analysis can connote the critical path, by CPM. Every activity in that path is controlled to avoid delay schedule. *When* and in *what* order are the purposes of this step. Schedule techniques applied are Network diagram, Gantt chart, and Events and Milestones.

2.1.2.1 Network diagram

The network diagram is basically use to show the precedent of different work package in the project. The diagram is provided by draw the lines to connect tasks with each other due to the dependency relationship of the tasks. In planning and control the project by using network diagram, it is important to know that which path makes the longest time to complete. This path is called critical path and is developed by PERT/CPM network diagram. The importance reason for seeking the critical path is to control the duration time of the tasks laid on the critical path. To finish this entire task on time mean that the project completion finish on time accordingly.

2.1.2.2 Gantt Charts

Gantt chart or bar chart is the simplest and commonly chart used for showing the work package starting and finishing time. This chart is also indicating the relationship between the work packages by precedence of work package; others work can not be started if this one work is not finish completely. Certainly, WBS analysis is prepared before Gannt chart because during WBS is prepared the duration in working of each work package are estimated. On Gnat chart all listed work packages are indicated on the left-hand side, or vertical axis, and work time on the bottom, horizontal axis. In

addition, the beginning and ending of each bar are indicated time of work start and finish.

The advantage of Gantt chart is simple to construct and easy to understand because it gives a clear pictorial model of the project. Moreover, it can be used in evaluating each work progress. It is important that the update information such as diary or weekly must be recorded when we use it as a monitoring work progress.

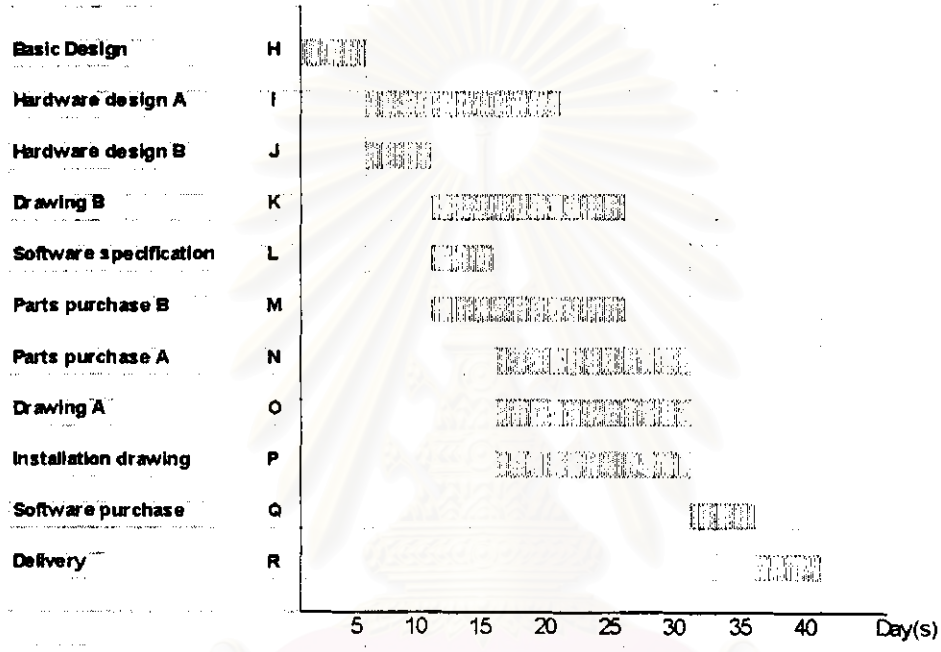

Figure 2.4 Gantt chart

2.1.2.3 Events and Milestones

The actual time planed of all work packages and the point that work package start or stop can be showed. Those points or a moment in time we called *events.* There are two events present in the planning: interface events and milestones events. The interface events signify changes in the completion of one work package and simultaneous start of one subsequent task. The milestone events signify the completion of several critical or difficult tasks or the availability of crucial resources. In addition, it also signifies the project progression and used as measures of project performance.

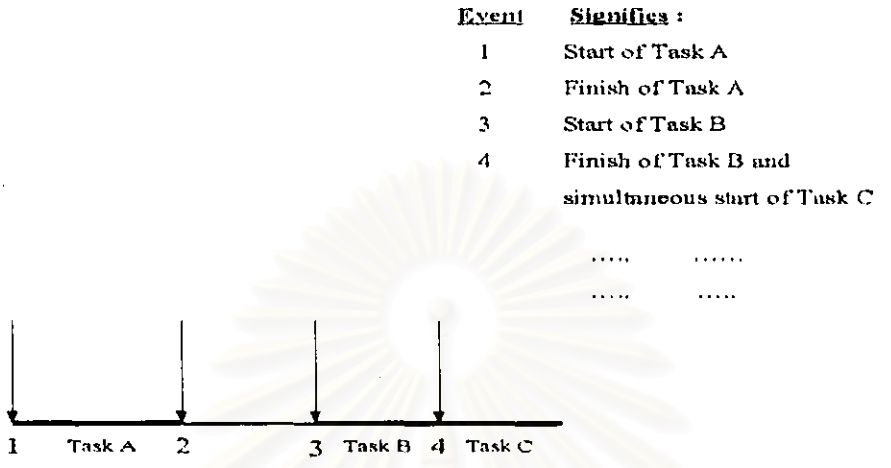

Figure 2.5 Relationship between tasks and events

2.1.2.4 Expense charts

This chart is a periodically cumulative figure of expenditures, resources requirement and manpower constructed by information from Gantt chart .The advantage of this chart is clearly reveal capital funds, labor and other requirements. In addition it is useful chart for resource allocation and work progress monitoring.

2.1.3 Project Controlling

In general, John M. Nicholas (1990) states that "there are three phases in achievement of the project control process: setting performance standards, comparing set standards with the actual performance, and then taking necessary corrective action." On the other word, above three phases can be defined into *measuring*, *evaluating*, and *correcting*. The Project Manager is responsible for controlling the project to achieve the organization goal and objective, therefore he/she has to understand the policy of standards and cost control.

2.2 Quality Meaning

Quality of products and services become to be the measures in how to survive in business environment for several organizes. The people in any organization are under increasing pressure to complete each project faster, to high standard, at lower cost, and using increasingly scarce professional and skill resources. To achieve the customer satisfaction, the quality of products and services must be the number one priority

2.2.1 Definition of Quality

The quality meaning is defined by individual specialist that:

- is "a predicable uniformity and dependability at low cost, and is suited to needs of the market" (Gitlow and Oppenheim, 1995)
- is " the totality of attribution and characteristics of a product or service that bear on its ability to satisfy implied or stated needs." (Dale H., 1994)
- is "the totality of proper characteristics or performance which are the objectives of estimation to determine whether a product or service satisfies the purpose of use or not" (Komatsu, 1993)

With the definition above, it is actually that the quality is the responsibility of every functional area and everyone the business; Marketing, Design Engineering, Procurement, Process Design, Production, Inspection and Test, Packing and Storage, and Product Service. (Dale H. and Besterfield, 1994) For Example, Marketing is responsible for evaluating the level of product quality that customer needs and requires whereas Design Engineering has responsibility to translate that requirement into the specifications, tolerances, and the attributes of the new products.

2.2.2 Type of Quality

There are three types of quality that are critical to the production and services. They include the Quality of Design, the Quality of Conformance, and the Quality of Performance. Quality of Design is the determination of the product's attributes that are fit to the market requirements, at a given cost (Gitlow,Oppenheim, 1995). Thus, the

customer orientations assist the development of the quality of design. The procedure of design quality has started from the consumer research, sale call analysis, service call analysis, and then up to the determination of a product concept that meet the customer requirements.

2.2.3 Quality Assurance

The quality assurance definition of The Japanese Industrial standard (JIS) is "The systematic activities carried out manufacturer to guarantee that the quality by the customer is fully satisfied" (Komatsu, 1993)

2.2.4 Cost of quality

According to Lesley and Malcolm [1], the quality costs are all the costs that company incurs to ensure the products or service provided conforms to the customers' requirements. These costs comprise costs associated with support activities and cost of company lost opportunities sometime called hidden cost. Quality costs can be classified into prevention costs, appraisal costs, and failure costs.

1. Prevention costs

These costs are incurred performing designed activity to prevent poor quality in product or service. They usually are incurred before actual operation. These costs include design reviews, supplier selection and capability reviews, quality planning, quality assurance, training and education.

2. Appraisal costs

These costs are associated with the customers and supplier's evaluation, measurement, or examination the products or services to assure that they conform to specified requirement. These costs can be found anywhere the raw materials or activities-in-process. They include incoming material inspection, work-in-process inspection, final inspection or testing, and calibration of measuring or testing equipment.

3. Failure costs

These costs occur when the finished product or service fails to reach the customer requirements. They consist of internal and external failure costs. *Internal failure costs* occur when the product or service does not conform to requirements and is found before product is transferred or service is provided to the customer. Internal failure includes waste, scrap, rework or rectification, and re-inspection. *External failure costs* occur when a nonconforming product or service is not detected until it reaches to the customer. External failure includes customer returns and complaints, warranty claims, repair and servicing, and liability.

In classification the quality-related costs, sometimes quality costs are grouped into costs of conformance and costs of nonconformance. Prevention and appraisal costs are costs of conformance. Failure costs are costs of nonconformance. It is importance that company can reduce only costs of nonconformance so prevention activities are performed. After company can reduce failure costs, appraisal costs are reduced accordingly.

Below are the advantages of the quality cost usage.

- To promoting the quality as business parameter.
- To giving rise to performance measures.
  - Trend analyses is used to show alteration in cost or cost ratios with time
  - Pareto analyses is used to identify quality improvement projects.
- To motivating all levels in organization such as senior manger is motivated to take part in the promotion of quality.
- To use as a tool of planning and controlling

2.3 International Organization Standard (ISO 9000)

This ISO 9000 is a series of International Standard for Quality Systems. It currently consists of published and planned documents ISO 9001, ISO 9002, ISO 9003, and ISO 9004. (David, 1994). There are twenty key elements in ISO 9001 standards as following:

1. Management responsibility

The first and major element that participant for ISO 9000 standard is a general requirement for management in creating, monitoring, and improving quality assurance system within an organization. The management responsibility is the key requirement for all ISO 9000 standards, therefore top management has to strong and demonstrated commitment in order to pass this element of the standard. It is necessary and important for organization to assure that top management is informed and understood on the requirements of ISO 9000 standards. In addition, they are required to play an active role before attempting to implement the requirement of this element. Management responsibility of any company requires policy, objective, organization, and review by top management. In performing of organization, the firm shall define the responsibility and authority for people who have to work with quality affecting. Furthermore, verification resources and personnel and management representative are also required.

2. Quality System

The documented quality system is established and maintained as a tool to enable the conformance of product to specified requirement. This requirement is an extension of management responsibility element. It will be unique if the organization have planned, implemented, and maintained all of 19 elements of ISO standard. Therefore, if an element is in non-conformance, company is in non-conformance of quality system accordingly.

The quality system under ISO 9004 applies to all activities relates to the quality of a product or service. It involves quality loop, which include marketing, design,

procurement, process planning and development, production, inspection, packaging, sales and distribution, Install and operation, technical assistance and maintenance, and disposal after use.

3. Contract review

This contract verification element is to assure that company can meet the customer needs and expectation. The company supplies the customer the products by two means. The first is producing product for keeping in stock. This means can make relationship with customer by favor in timing, delivery, and quality. The second means is producing product for sale to a mass-market. This means can make relationship with customer by product satisfaction and competitive position. The company whether produce in stock or produce in mass-market, the translation contractual stated into engineering and production is needed a formal and well-documented procedure.

4. Design Control

The organization has been required to assure a product or service that can meet the needs of a customer, therefore, company will be required to develop the procedures of the design activities control. Design review is a competitive weapon involved and it requires a considerable amount of discipline. Design control consists of design procedures, design input, design output, design verification, design validation, and design and modifications.

5. Document Control

Since the data and document control are important aspect of the quality system, company has been required to control a number of documents that relate to ISO 9000 standards. Company categorized the responsibility among the departments and management assigns a specific person within each department to responsible for the procedure. In addition, audits are separated by both the department involved and by management for double-checking the effectiveness of document control within each department. The result of this is a series on document control. To control the document is one of the weak areas for the company especially the original specification and

blueprints. This is because any person can make a copy of these documents, i.e. circulation document. Fortunately, the technology can help in prevention. Company use computer networks to keep all document and available only at workstation screen. As a result, company can prevent the document are copied or modified.

6. Purchasing

In order to ensure that the purchased product has conformed to specified requirement, company need all purchases are made by using formal contracts, explicit purchase orders, and certificates vendors. By the requirement, purchasing department is needed to both keep phone logs and supplier communication records. In addition, the quality problem reaction should be documented as well. In case of subcontracted services, they are required to provide a description of how they will meet the requirements stated by organization in a bid document submitted. In addition, they are evaluated by using ISO 9002 standard checklist through an on-site quality system audit.

7. Purchaser Supplied Product

In case of customer supply product used in manufacturing process, company is required verification, shipment, storage, maintenance, and incorporation on those supplied products in order to preventing the damage.

8. Product Identification and Traceability

The critical to assuring that company uses the correct materials for optimal quality is identification and traceability all materials used in the process. In the process, it is critical to assure that the rights product is being use to the correct units for assembly line. The company is needed to use a method of identification consistent on the products or raw materials. For example, the simple code is used for few products and barcode is used for complex mix of product. Traceability requires company to set the unique code based on the day and shift of

production, the same as any change in material used.

9. Process Control

The requirement for process control is assuring new staff can read the procedure and thereafter understand his job responsibilities. Process consists of paperwork, manufacturing, training service, installation and design. The company has to identify and plan the process of production that is under controlled condition.

10. Inspection and Testing

This element requires inspection and testing for receiving goods, in-process goods, and a final inspection of products. In addition, it requires following a plan, using controls, and keeping records. As in manufacturing, every people in the plant is someone's customer so inspection and testing are based on the idea of assuring that only high quality parts are acceptable. The difficult part of this requirement is controlling of holding materials and parts until the reveal of inspection and recording of the results.

11. Inspection, Measuring, and Test equipment

The organization is required to list, track, and calibrate all parts of equipment used for measuring, inspecting, or testing. The role of these procedures is for verifying engineering specification, monitoring the process, and inspecting the final product. Therefore, the design and document a system for testing, measuring, and inspecting control is large in scope and complete in practice.

12. Inspection and Test Status

This element is requires organization to track the current quality status of production materials. This is because the purpose is assuring that the acceptable material can be identified to unacceptable by the nest person who use the material after. There are two basic systems of inspection and test status tracking. The former is the tag and shop floor travelers is used for the assembly line. The latter is used in the work cell areas.

13. Control of Nonconforming Product

The purpose of this element is assuring that non-conforming product do not allow to pass to the production line. In manufacturing, for example, a Defective Material Report can be used to identify with labels on the nonconforming products.

14. Corrective Action

The corrective action is a modern model that makes all employees responsible for quality assurance. They are taken to reduce and to prevent costly mistakes so company can reduce source of waste. In addition, empowered work team and statistical process control are the example of new management techniques used for corrective action.

15. Handling storage, Packaging, and Delivery

These activities are basically responsible for each department rather than quality assurance. Therefore, company needs only reference them in quality assurance manual while shipping and production department already have provided these procedures. The reason for company to provide quality assurance activities is to preventing the quality problems. However, this requirement can take place in multi location within a plant

16. Quality Records

Since the data collection is an importance, this element requires an organization to record quality data such as cost of quality, SPC, defect counts, and loss-functions. Thus, company should select the appropriate types of data collection that can make the best benefit for organization. The importance of quality record is the ability to identify, monitor, and adjust quality situation.

17. Internal Quality Audit

The requirement's purpose is to ensure that company's management is checking the effectiveness of its management quality system.

18. Training

The training element is a requirement needed for expansion in the standard. Training models for an organization affect the training requirement. In addition, training is a path to greater competitiveness in an organization when planing and executing to meet specific, identified needs. It approaches to employ to promote continuous improvement of men, means, and products.

19. Servicing

The service function procedure is primarily needed and applied to manufactured products including within related procedure in order to find the most efficient for organization. This service activity can be contracted for post delivery activity and also is after-sale service, product support, and customer service.

20. Statistical Technique

This element can be used for company making strategic, tactical, and operational decision. This is because statistical techniques are used as an economical method of estimating the quality of product and the capability of process. Therefore, statistical techniques are called out wherever needed to assure quality and confirm conformance to customer specifications. However, this requirement may not apply to all product acceptance decisions (David, 1995) because if the product acceptance does not depend on the acceptance decision being made on its component parts, there is not important to the product acceptance decision in carrying out any sampling on receipt inspection or in-process. Then, it can be ignored in the documented quality system.

2.4 Quality tools

2.4.1 Brainstorming

Brainstorming is a mean to elicit a large number of ideas from a team in a short period of time (Gitlow and oppenheim, 1995). There are several purposes for brainstorming: to find possible cause f a problem; to find the solutions to a problem; to determine problems to work on; or to find the way to implement the solutions. The number of Brainstorming team should be between 3 to 12 person and has a variety of people. The issued of being examined is a criteria in composition of a team. However, a team leader should be experienced person in brainstorming technique. This is because the leader is responsible for keeping the group focused, preventing distractions, keeping ideas flowing, and recording the outputs. Brainstorming should take place in closet meeting in order to preventing the interruptions that might interfere with the team's creative process.

Brainstorming procedure is recommended to initiate from selecting the topic or problem to be discussed firstly. Then, each member makes a list of his ideas on a price of paper. The period for this process should no longer than 10 minutes. The third step is reading the idea of each person from the top of his list until the last idea. During each person reading, team leader is recording and displaying those ideas. However, if any idea is duplication with someone, it can be skip to the next idea of the list. The members are free to pass on each go-round but should be encouraged to add something. The leader then asking for the new ideas, which had not thought before, from the members in team. Until the leader makes sure that team can not think of any more ideas, leader stop to ask.

Anyway, in order to ensure the successful of brainstorming session, the certain rule should be observed by the participants. Those rule include as following:

- Participant do not criticize anyone' s idea by either word of gesture
- If any ideas do not need the clarification, participants do not discuss that ideas during the session
- Each member should suggest only one idea at a time
- Team does not allow one or two people to dominate.

2.4.2 Cause and Effect Diagram (Fish Bone Diagrams)

The cause-and-effect diagram, also known as Ishikawa diagrams or fishbone diagram, is a structured problem-solving technique developed by Professor Kaoru Ishikawa in 1943 (Gitlow and Oppenheim, 1995). This diagram is usually used to identify and structure the possible reasons or causes of an occurrence or problem (given effect). Noted that it is normally a result of brainstorming session in which the most probable cause are selected and then verifying possible causes until a valid cause-and-effect relationship is established. The causes are displayed the hierarchy, as in figure 2.6. From the figure, a key effect is defined and the factors that contribute to that effect, indicating either a name of *cause* or a *cause area*, are delineated. Since there are probably many potential causes that could appear, the angled lines are added to indicate more detail for the horizontal lines or the lines at right angles to one another. Noted that cause area is not a cause but it may contain causes, and cause areas are mostly addressed in nouns form whereas causes are addressed in form of verbs. However, for a problem, there may be only one or two actual causes.

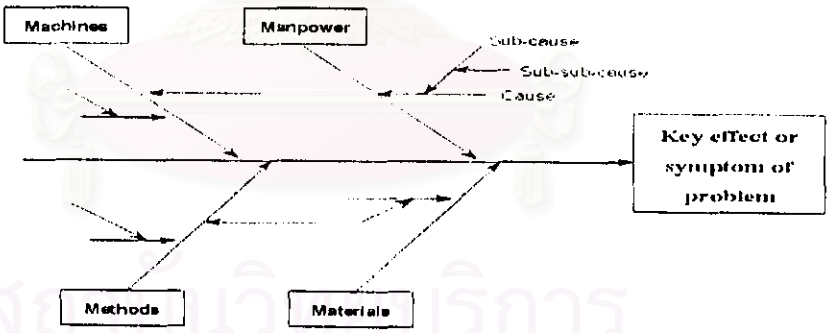

Figure 2.6 Elements of Cause-Effect Diagram

Source : David Straker: London, 1995

In the figure, the primary cause areas are concerned in term of "Four Ms" that mean Manpower, Methods, Materials, and Machines. The step in constructing the Cause-and-Effect Diagram is firstly initiated by stating the problem, write it on the right side of the flip chart, and drawing the core line that has arrow or pointer to the problem. Secondly, address Four Ms as the primary or major causes. Thirdly, the team brainstorms to uncover all possible subcauses that create the problem. Those subcauses are recorded on the diagram by drawing the straight line and writing down subcauses. Fourthly, the causes are considered before evaluating them. However, in consideration, there are aided questions as following: (Gitlow and Oppenheim, 1995)

- Is this cause a variable or an attribute?
- Has the cause been operationally defined?
- Is there a control chart or running record of data for this cause?
- Does this cause interact with other causes?

Fifthly, the causes of the problem are evaluated and circled on the diagram. Finally, the cause of the problem is verified by analyzing the cause that significant impact on the problem.

2.4.3 Check sheets

Check sheets are logical format used to ensure that the data are collected or gathered carefully and accurately by operating personnel (Dale H., 1994). This is because the result presented in the sheet can be easily and quickly used and analyzed. The form of sheets is usually designed depending on the situation and the purpose. They can be diary basis, weekly basis, and some checks are measured. In addition, the type check sheet can be developed to insure that a check or test is made.

Checklist or *check-up Confirmation Check Sheet* is one of the practical variations of check sheet. It contains a list of actions or results of actions, which are ticked as they are done.

2.5 Failure Mode and Effect Analysis (FMEA)

The FMEA technique is important because it indicates the potential of process or design that affects the failure of the final products, and also evaluates the potential effects of failure affecting to the customer. In addition, it implies the possible problem of process and the parameter of process that must be controlled in order to reduce the rate of failure occurrence.

There are twenty-two elements in the development of FMEA

2.5.1 FMEA Number

This FMEA document number is entered for tracking.

2.5.2 Item or system or Component name and number

The name and number of system, component is entered for which the process is being analyzed.

2.5.3 Design/ Process Responsibility

This can be the OEM, department and group, or person is entered. This also includes the supplier name if known.

2.5.4 Prepared By

The name, telephone number and company of engineer who is responsible for preparing the FMEA are entered.

2.5.5 Model of product

The product model and significant information of product that will utilize and/or be affected by the design/process being analyzed (if known) are entered.

2.5.6 Key Date

The initial FMEA due date is entered. This date should not exceed the scheduled start of production.

2.5.7 FMEA Date

The date the original FMEA and the latest revision is entered.

2.5.8 Core Team

This includes the listed name, telephone number, and address of the responsible individuals and departments, which have the authority to identify and/or perform tasks.

2.5.9 Process Function or Requirements

The simple description of the process or operation being analyzed is entered.

2.5.10 Potential Failure Mode

The definition of Potential Failure Mode is the manner that the process or design could potentially fail to meet the requirements or intent. This could mean the description of the nonconformance at the typical operation. In preparation of the FMEA, the assumption should be made that the incoming parts are correct.

Each potential failure mode for the typical operation is listed in term of a system or process, component characteristic. However, these listed failures could occur, but may not necessary occur. In consideration, such guided question could assist the process engineer to pose and answer. They include "How can the process fail to meet specifications? and Regardless of specification, what would a customer consider objectionable?"

2.5.11 Potential Effect(s) of Failure

The effect of the failure mode on the customer, which could be both internal as next operation and external as the owner, is a definition of the Potential Effect of Failure. In description the effect of failure, it should be stated in term of what the customer might notice or experience. For the end customer, the effect should be stated in term of product or system performance. However, if the effect is on the internal, the next operation, and the effect should be stated in term of process performance.

2.5.12 Severity(S)

The seriousness of the potential effect of failure can be assessed in term of Severity that should be estimated on a "1" to "10" scale. Noted that brainstorming technique is implemented on the FMEA team and then come out with consensus.

2.5.13 Classification

This column is used to classify the special process characteristics for system or component that may require additional process control.

2.5.14 Potential Cause(s) of Mechanism of Failure

The definition of Potential Cause of Failure mean how the failure could occur and be described in terms of something that can be corrected or can be controlled. Many causes of each effect are listed as much as the FMEA team can. In case of many causes are not mutually exclusive, design of experiments might be applied to identify the major cause that is the most contribute to the effect and might be applied to identify the cause that can be the most easily controlled.

Only specific malfunction should be list (e.g. operator failure to install seal); ambiguous phrase such as operator error machine malfunction should not be used.

2.5.15 Occurrence (O)

The definition of Occurrence is how frequently the specific failure cause or mechanism is projected to occur. This occurrence can be quantified by ranking number that has a meaning rather than a value. The estimation value of occurrence is likelihood on a "1" to "10" scale.

2.5.16 Current Design/Process control

The current process controls are descriptions of the controls that either prevent to the extent possible the failure mode or detect the existing failure mode. These controls can be process controls such as Statistic Process Control (SPC). However, there are three types of Process control or features, which to be considered.

(1) Prevent the cause or failure mode or reduce their rate of occurrence.

(2) Detect the cause and lead to corrective actions, and

(3) Detect the failure mode.

2.5.17 Detection (D)

Detection is an assessment of the probability that the proposed current process controls will detect a potential cause, or the probability that the proposed process controls will detect the subsequent failure mode. The detection value will quantify in terms of scale "1" to "10". Do not automatically presume that the detection ranking is low because the occurrence is low, but do assess the ability of the process controls to detect low frequency failure modes or prevent them from going further in the process. Random quality checks are unlikely to detect the existence of an isolated defect and should not influence the detection ranking.

2.5.18 Risk Priority Number (RPN)

The description of RPN means the product of Severity (S), Occurrence (O), and Detection (D) ranking. It is calculated by multiply the Severity value by Occurrence value and Detection value, or

$$RPN = (S) \times (O) \times (D)$$

Noted that the RPN will be between "1" to "1,000". Certainly, since all quality issue could not be solved, these RPN values will be applied in order to prioritize the importance of quality issue. The high RPN(s) will be reduced through corrective action (s) by FMEA team first.

2.5.19 Recommended Action (s)

The recommended action or corrective action should be first directed at the high ranked concerns and critical items, when the failure modes have been rank ordered by RPN. Noted that the objective of any recommended action is to reduce the severity, occurrence, and detection ranking. In case, there is no any action for specific cause to be recommended, then enter a "NONE" in this column.

To have the positive effective corrective action and the effective follow-up all recommended actions are the most important for the effective FMEA program. The following actions should be considered:

(1) To reduce the probability of occurrence, process and/or design revisions are required. An action-oriented of the process using statistic methods could be implemented with on-going feedback for continuous improvement and defect prevention.

(2) Design or process revision can bring about a reduction in the severity ranking only.

(3) To increase the probability of detection, design and/or process revisions are required. Increasing frequency inspection of quality control is not positive action because it is costly and ineffective for quality improvement. It should be utilized as a temporary measures because permanent corrective is required. Even though the change of current control system is implemented to increase thus probability, the prevention of defect should be focused rather than prevention of detection.

2.5.20 Responsibility (For the recommended action)

The person in organization who has responsible for the recommend action is entered together with the target completion date.

2.5.21 Action Taken

Enter the brief description of the action and target completion date after an action has been implemented.

2.5.22 Resulting RPN

The resulting RPN value is calculated and recorded from the estimated resulting occurrence, severity, and detection after corrective action have been identified. However, all result RPN(s) should be reviewed and if further action is considered necessary, repeat steps 19 to 22.

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)

Item ____________ Process responsibility ____________ FMEA Doc Number ____________

Project Managem ____________ Key Date ____________ Page ____ of ____

Core Team ____________ Prepared By ____________

FMEA Date (Orig.) ____________

FMEA Date (Rev.) ____________

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Potential cause(s) / Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	Sev	Occ	Det	R.P.N.

Figure 2.7 FMEA sheet

Sources : Chrysler Corporation, Ford Motor company, General Motor Corporation, 1995