# CHAPER IV

## Process Improvement in Engineering Department

This chapter is intended to point out the process improvement in Engineering Department to support company target. Base on analysis result from chapter three, *"Goal - Improve manufacturing base on production performance"* is under responsibility of Engineering Department. The department is required to provide the department strategic map that gets along with the master plan (company holistic plan) as describe in Chapter 3 - Figure 3.3.1. Then develop improvement plan to accomplish the goal including of select one project for implementation. This chapter will illustrate the project selection process, problem solving technique, action plan, project result, control plan and summary.

### 4.1 Create Department Strategic Map

Regarding to the Blueprint for Change approach in order to preparing the organization to be ready support the change and accomplish the *"Goal - Improve manufacturing base on production performance"*, then department setup team implementation which including of 8 team members. The team responsible for provides inputs score weighting, listing the process weak point, assessment current process issue and recommendations what, why, who and how they should be, analysis the root cause of problems and provide improvement plan. These are based on The Team's opinions and experiences which would more or less beneficial for all readers while they apply on their current organizations.

Implementation Team Member:

- Process engineer – Project Leader
- Tooling engineer
- Quality engineer
- Software engineer
- Training supervisor

- Production supervisor
- Technician
- Operators

*Strategic Selection*

Low Cost Manufacturing strategy was selected by department manager and team implementation to cope with the *"Improve manufacturing base on production performance"* goal. Because of the strategy emphasizes on the efficiency and productivity by producing high volumes of standardized products, the firm hopes to take advantage of economies of scale and experience curve effects. The product is often a basic no-frills product that is produced at a relatively low cost and made available to a very large customer base. Maintaining this strategy requires a continuous search for cost reductions in all aspects of the business. To be successful, this strategy usually requires a considerable market share advantage or preferential access to raw materials, components, labors, and effectiveness of internal process and capability of human.

To create the strategic map (development plan) for Low cost manufacturing strategy, the team required to setup the discussion and brainstorming meeting to derive the holistic plan in Chapter Three - Figure 3.3.1, filter only the items related to the Engineering Department and/or Low cost manufacturing strategy. The selected items are consolidating to Strategic Map for Low cost manufacturing strategy as illustrate in Figure 4.1.1.

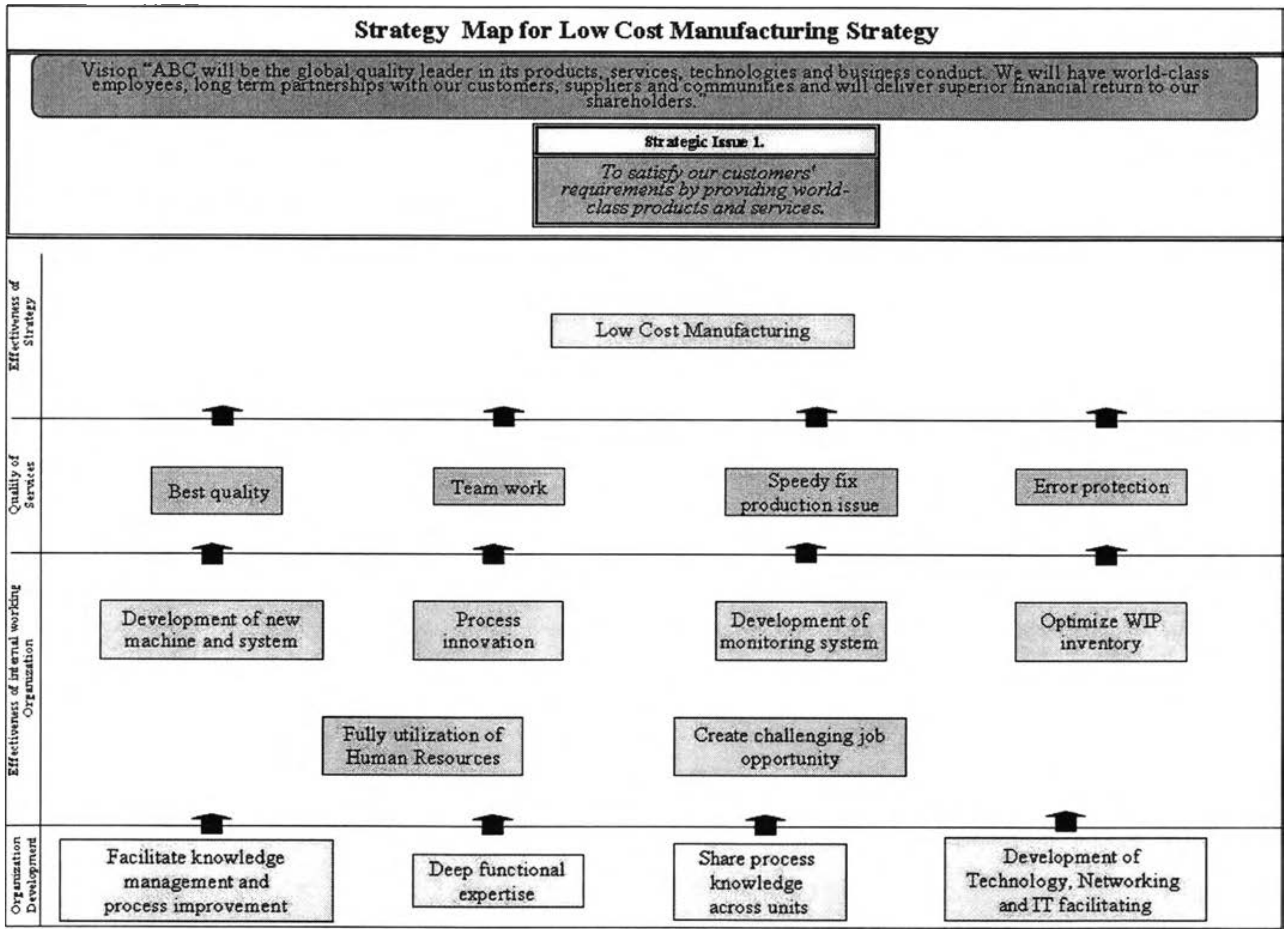

Figure 4.1.1: Strategic map for low cost manufacturing strategy

## 4.2 Create Department Development Plan

According to the Strategic Map for Low cost manufacturing strategy as above, there are 3 development areas need to concentrate with:

1. Quality of Services (propose: customer satisfaction)
2. Effectiveness of Internal process (propose: cost reduction and increase productivity)
3. Human Capital Development program (propose: build up specialist and professional human resource)

Team implementation creates the development plan by using **Strategic Map** as above integrated with **the interview and brainstorming research methodology**. Each of team member responsible for interview ten employees under the same department function to assess the working constrain, production issue, suggestion and etc. (the survey question are attached in Appendix 4.C), then all information was summarized and review with the team and department manager. The conclusions from interview and brainstorming meeting get along with the strategic map, so the development plan can illustrate as Table 4.2.1.

- Quality of Services – increase quality of service by develop the risk assessment in the process, develop contingency plan for any of critical issues, create and support recreation program and deployment of six sigma technique
- Effectiveness of Internal process – increase effectiveness of process toward automation system, design/redesign machine and tooling with flexible conversion, minimize setup time and standardize components, use continuous improvement concept create challenging job, minimize WIP with lean manufacturing technique, training people to perform multiple tasks and control and monitor performance with SPC
- Human Capital Development program – support organization and people toward organization of knowledge, knowledge sharing. Invest in IT and technology to get the useful and reliable information as fast as possible.

| Engineering Department Development Plan | |
|---|---|
| **Improvement Aspect** | **Improvement Plan** |
| 1. Quality of Services | 1. Error protection by Risk Assessment<br>2. Speedy fix production issue by Contingency plan and improve sense of urgency<br>3. Team work – recreation program<br>4. Best quality by Six sigma |
| 2. Effectiveness of Internal process | 1. Process innovation by Automation system<br>2. Development of new machine and system by Reduce set-ups time, standard components and support various product line<br>3. Create challenging job opportunity by clearly career path<br>4. Optimize WIP inventory by lean manufacturing<br>5. Development of monitoring system by SPC<br>6. Fully utilization of Human Resources by job reallocation and Train workers to perform multiple tasks |
| 3. Human Capital Development program | 1. Facilitate knowledge management and process improvement by KM<br>2. Deep functional expertise by specific training program<br>3. Share process knowledge across units by KM<br>4. Development of Technology, Networking and IT facilitating by Real-time data, online information, eliminate paper work with e-solution and database |

Table 4.2.1: Development program support strategic readiness

### 4.3 Process selection for improvement

The Blueprint for Change Approach start the process selection with select the strategic issue then assessing to the current process in dimension of internal process, technology, structure and human capital to see the weak point. Then select the most critical process that create strategic impact the most, provide improvement plan in details with control plan to sustaining the implementation result. Evaluate the implementation results demonstrate to the effectiveness of process selection phase and give an idea of implementations constrain for further improvement.

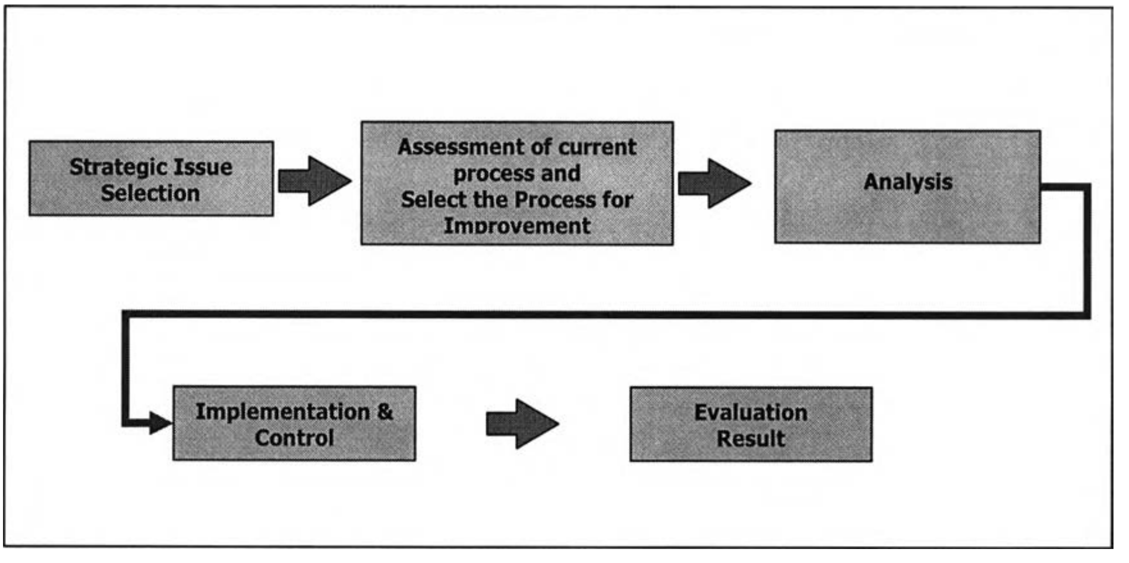


Figure 4.3.1: process selection by Blueprint for Change Approach

#### 4.3.1 Strategic Issue Selection

Base on the management team analysis in Chapter Three – Table 3.2.3 Goals analysis, Engineering Department responsible to support *"Goal - Improve manufacturing base on production performance"*, under the first strategic issue: **To satisfy our customers' requirements by providing world-class products and services**.

### 4.3.2 Assessment of Current Process and Process Selection

There are 7 major processes in ABC manufacturing plant, start with receiving raw material components from suppliers, the part will keep at store wait for production schedule loading then go to un-pack process and setup to be ready to feed to support assembly line in clean room. Backend process is under responsibility of Quality Department; all drive has to pass functional test and visual inspection 100% before move to pack and ship to the customer as depicts in Figure 4.3.2.1.

As ABC Company is the manufacturing plant, **Assembly Process** is the key process which needs the rest six processes to support. Thus Assembly Process contains 7 activities to complete hard disc drive (production line).

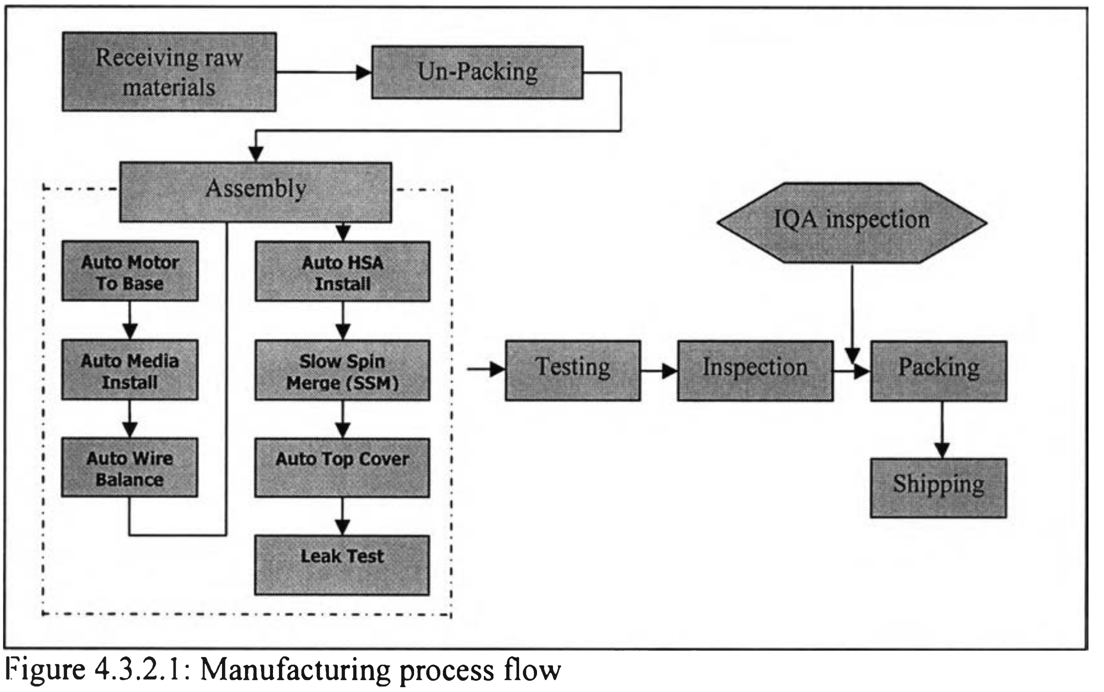


Figure 4.3.2.1: Manufacturing process flow

Assembly process's activity list:

Hard Disc Assembly (HDA) is the final process in the production procedure so as to get the complete hard disk. The production procedure of the HDA is to assemble the Spindle Motor, Media and Head Stack according to a series of particular courses with the auto and semi-auto operation throughout the process. There are seven activities list, each activity operate by one operator with one machine station, to complete a hard disk drive as in Figure 4.3.2.2. Appendix A will describe each activity in details.

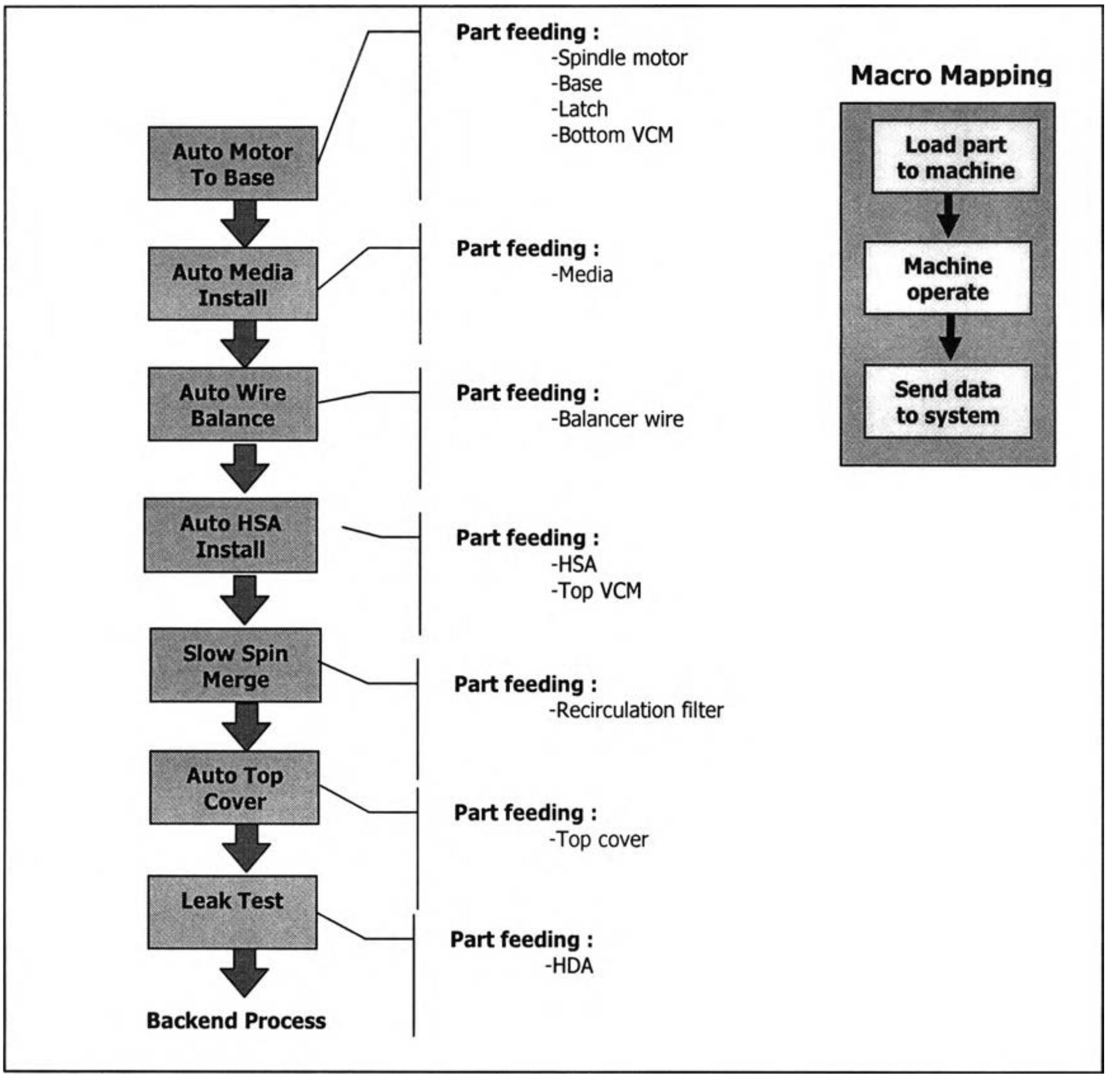


Figure 4.3.2.2: Hard drive process mapping

In order to improve the assembly process, the department segregates area of improvement to four perspectives – four projects (Scrap rate, Cycle time, Yield and Downtime) which it's key performance indicators of the department.

Project selection is a critical task in starting – and sustaining – an ongoing cycle of value-adding improvement. Organizations that can invest in the right opportunities will see the biggest payoff and the most effective adoption of Blueprint for Change practices.

In this action-focused working session, the essential steps to establish a solid set of improvement priorities, from developing ideas through scoping and strategy selection. The application of project selection criteria is balancing with projects that promise important returns in customer satisfaction, strategic impact, new revenue and/or cost reduction.

Team implementation provided process analysis and evaluation in-dept of the two criteria below, in order to prioritize the project implementation plan by using score weighting technique, to see the requirements and beneficially in terms of human resources, investment and expected benefit gain up.

- Projects that promise important returns in customer satisfaction, strategic impact, new revenue and/or cost reduction.
- Projects for which have the necessary resources, support and control to get it done.

Measurement criteria and Score preference was defined by company's document (document code: Prj-000-05001). The document provides a guideline of project registration and project requisition approval.

From table 4.3.2.3, the **scrap rate reduction** got the highest score, point up contribution and productivities enhancement up to 32%. As a result the department decision to put this project as the first priority to accomplish with.

| Key measurement Perspective | Investment (Time) | | | Investment (Cost) | | | Benefit (USD) | | | Summary (Score) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Days | preference (*3) | Score | USD (K) | preference (*3) | Score | USD (K) | preference (*4) | Score | |
| 1. Scrap | 15 | 4 | 12 | 0.8 | 4 | 12 | 180 | 2 | 8 | **32** |
| 2. Cycle Time | 40 | 2 | 6 | 6 | 3 | 9 | 960 | 4 | 16 | 31 |
| 3. Mechanical Yield | 30 | 3 | 9 | 26.2 | 1 | 3 | 280 | 3 | 12 | 24 |
| 4. Tooling Downtime | 45 | 1 | 3 | 7.5 | 2 | 6 | 86 | 1 | 4 | 13 |
| **Summary (Score)** | | | **30** | | | **30** | | | **40** | **100** |

Table 4.3.2.3: Assessment four key measurement of Low cost manufacturing in Assembly process

### 4.3.3 Project Analysis

This section provides assessment of the present failure modes of major severity avoidable accident/incident of the **Scrap Rate Reduction Project** and identifies the potential causes by using analysis tools such as Flowcharting, Cause & Effect Diagram, Brainstorming and FMEA.

#### I. Introduction

Media Visual Mechanical Inspection (VMI) founds many defective units which contribute significantly to the drive scrap cost. Project timeline was set limit to complete within 4 months, and target to reduce defective rate from 12% to 6%. Figure 4.3.3.1 illustrates the broad process map of media VMI process.

There are two sources of media to entering to Media VMI process. The first are from failed drives in prime component line and the second source are from failed drive in teardown process. There are three majors cases found from media failed from visual mechanical inspection, which are dent, glove mark and scratch.

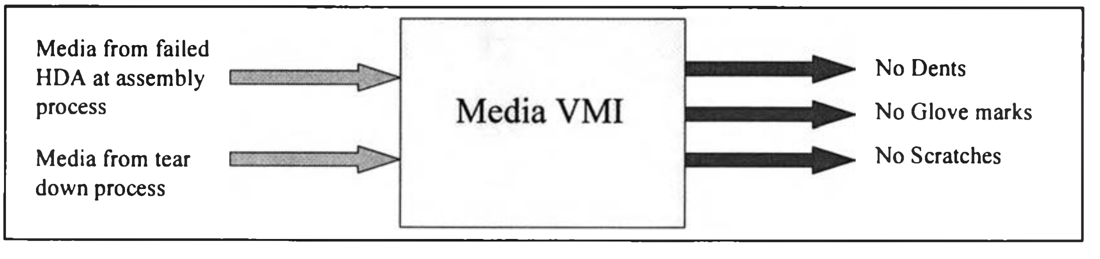


Figure 4.3.3.1: Broad process map of Media VMI

The implementation team responsible for brainstorm potential effects, causes and recommended actions in the problem analysis step, scoring the FMEA, the team would then create policy planning, quality procedure and work instruction development in the later stage. The team comprised people knowledgeable in all aspects of the operation of ABC Assembly.

## II. Brainstorm and Cause & Effect Diagram

The team conducted brainstorming meeting to gathering the possible root causes by using flowcharting tools. From the flowchart, illustrate in Figure 4.3.3.2, found that there are 4 major failure modes (Auto media install, Manual media install, Auto Gang Bias and Auto wire balance & Suppressor Comb) which are common or similar among the 3 cases of major severity avoidable accident/incident (dent, glove mark and scratch). This summation base on data during the period of June 2004 to December 2004, the potential causes are classified into categories on cause & effect diagrams which are as follows,

- Man
- Machine
- Method
- Material

**Flowcharting**

Flowcharts are maps of a process. Steps in a process are shown with symbolic shapes, and the flow of the process is indicated with arrows connecting the symbols. In improvement work, flowcharts are particularly useful for displaying how a process currently functions or could ideally function, the steps of a process are logical, uncover problems or miscommunications, define the boundaries of a process, and develop a common base of knowledge about a process.

Assembly Process Flowchart in Figure 4.3.3.2 illustrates a process currently function and decision in a process, information provided by Process Engineer. The cause & effect (fish bone) diagram of 4 major failures are shown in Figure 4.3.3.3 to Figure 4.3.3.6, provided by the team.

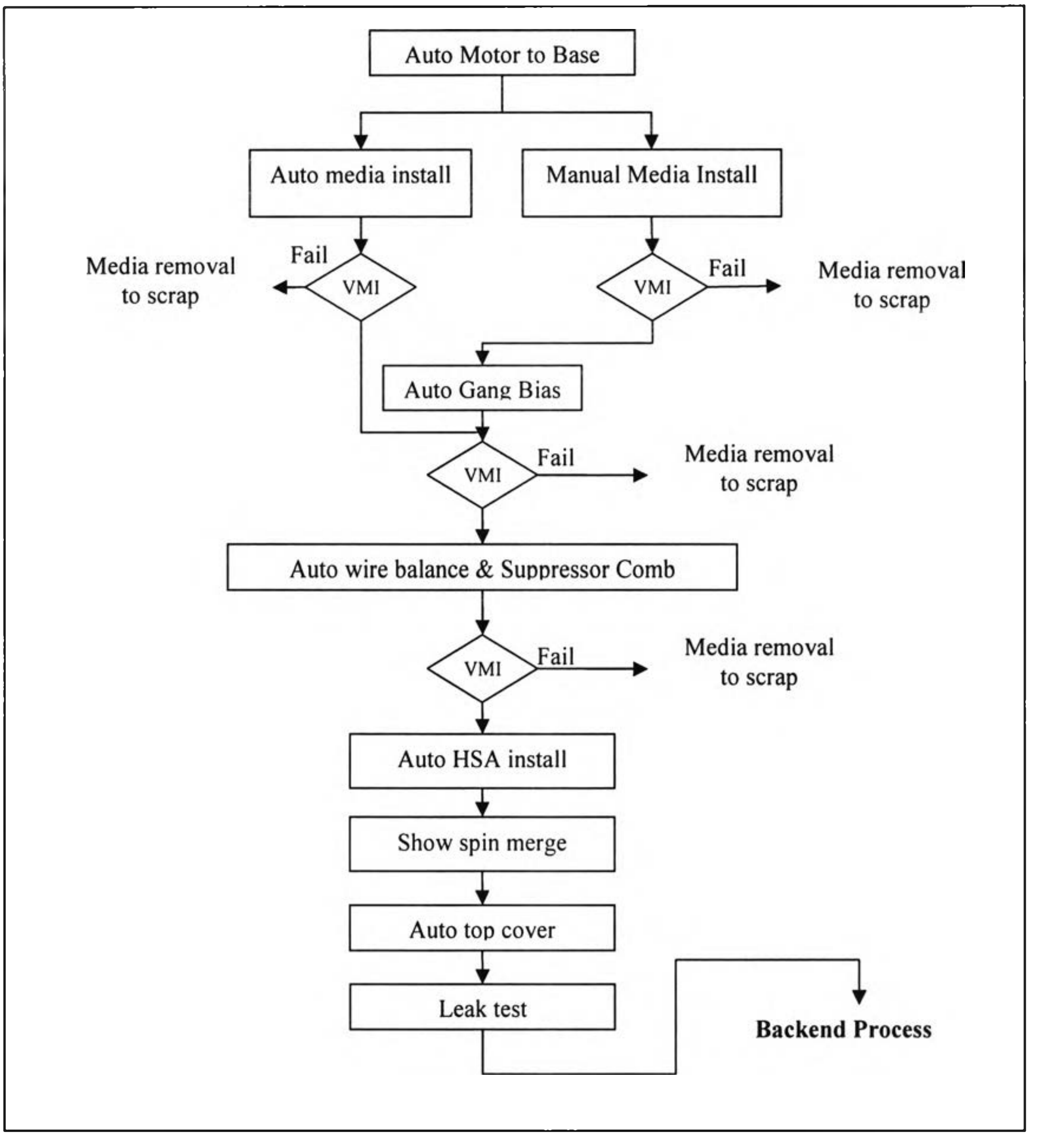


Figure 4.3.3.2: Assembly Process Flowchart

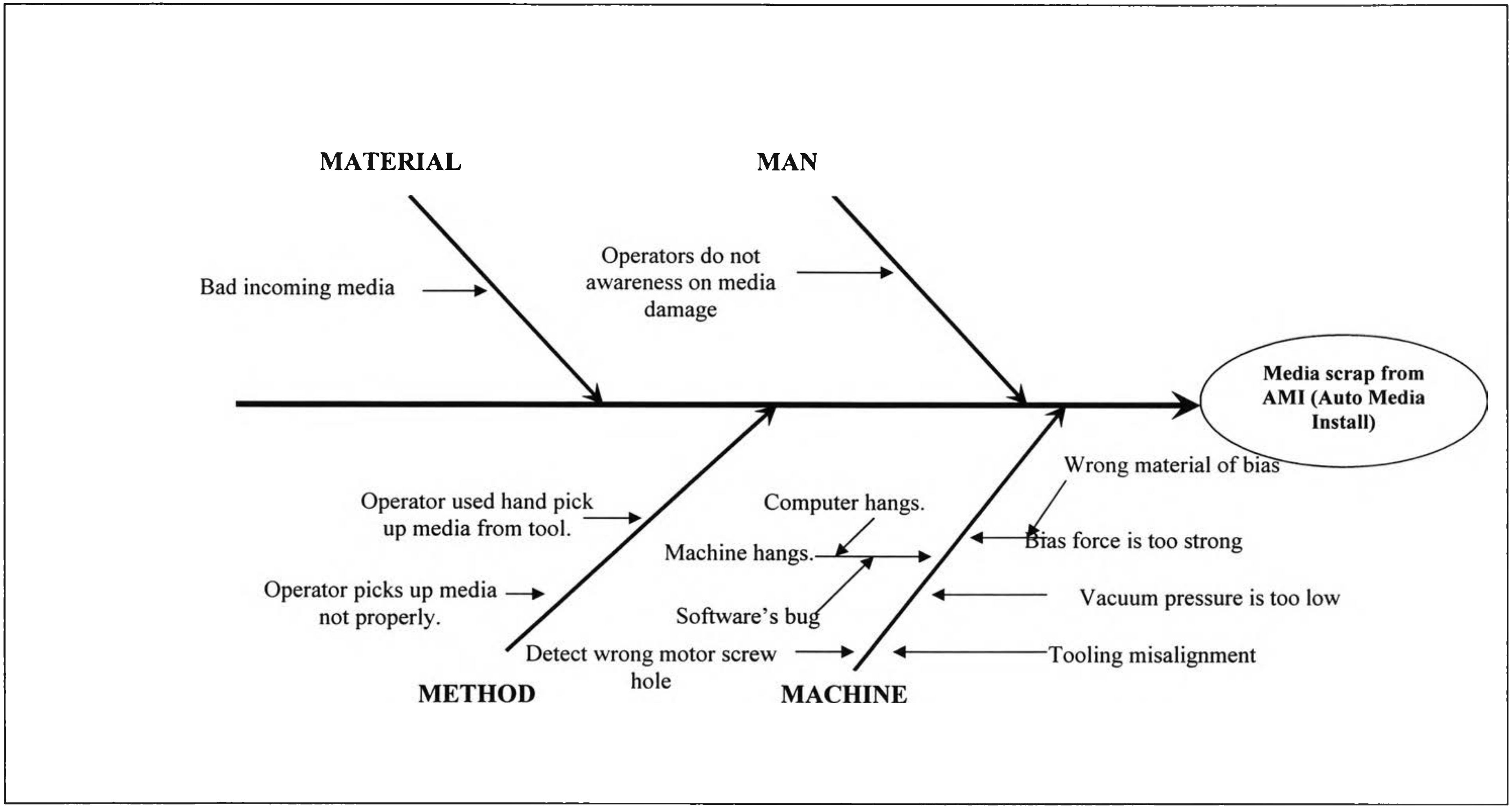


Figure 4.3.3.3: Fish bone diagram for media scrap from Auto Media Installation Activities

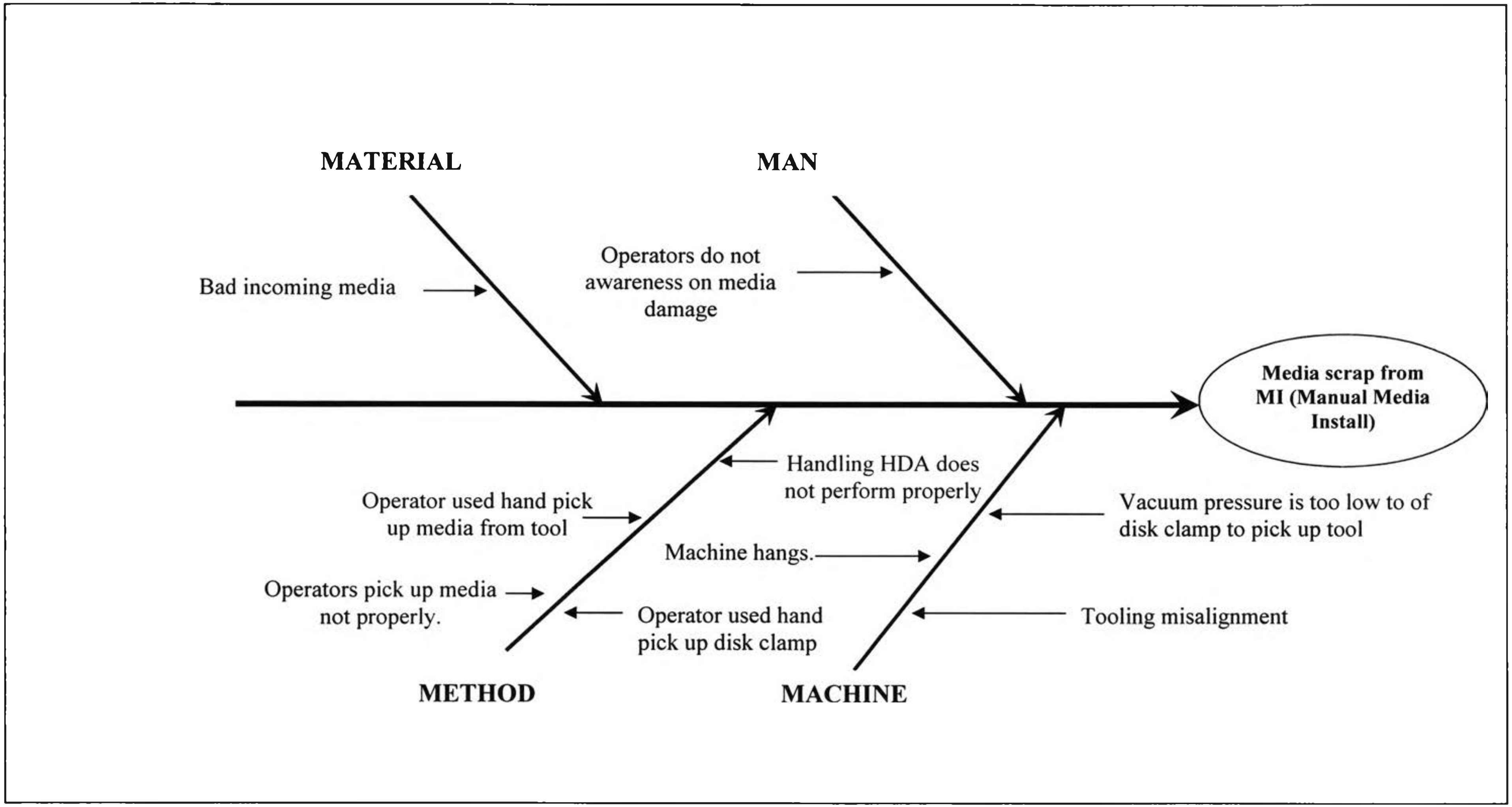


Figure 4.3.3.4: Fish bone diagram for media scrap from Manual Media Installation Activities

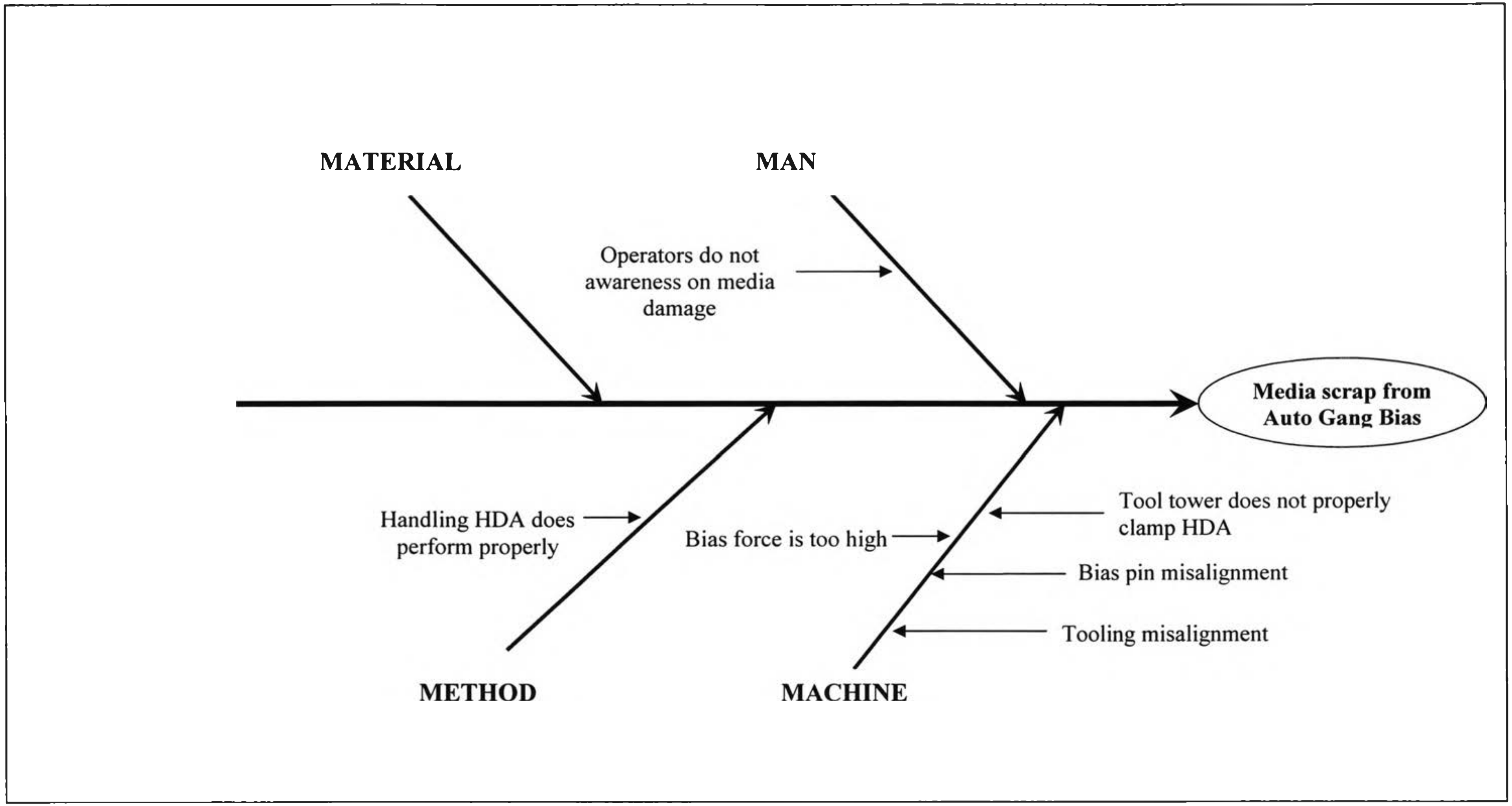


Figure 4.3.3.5: Fish bone diagram for media scrap from Auto Gang Bias Activities

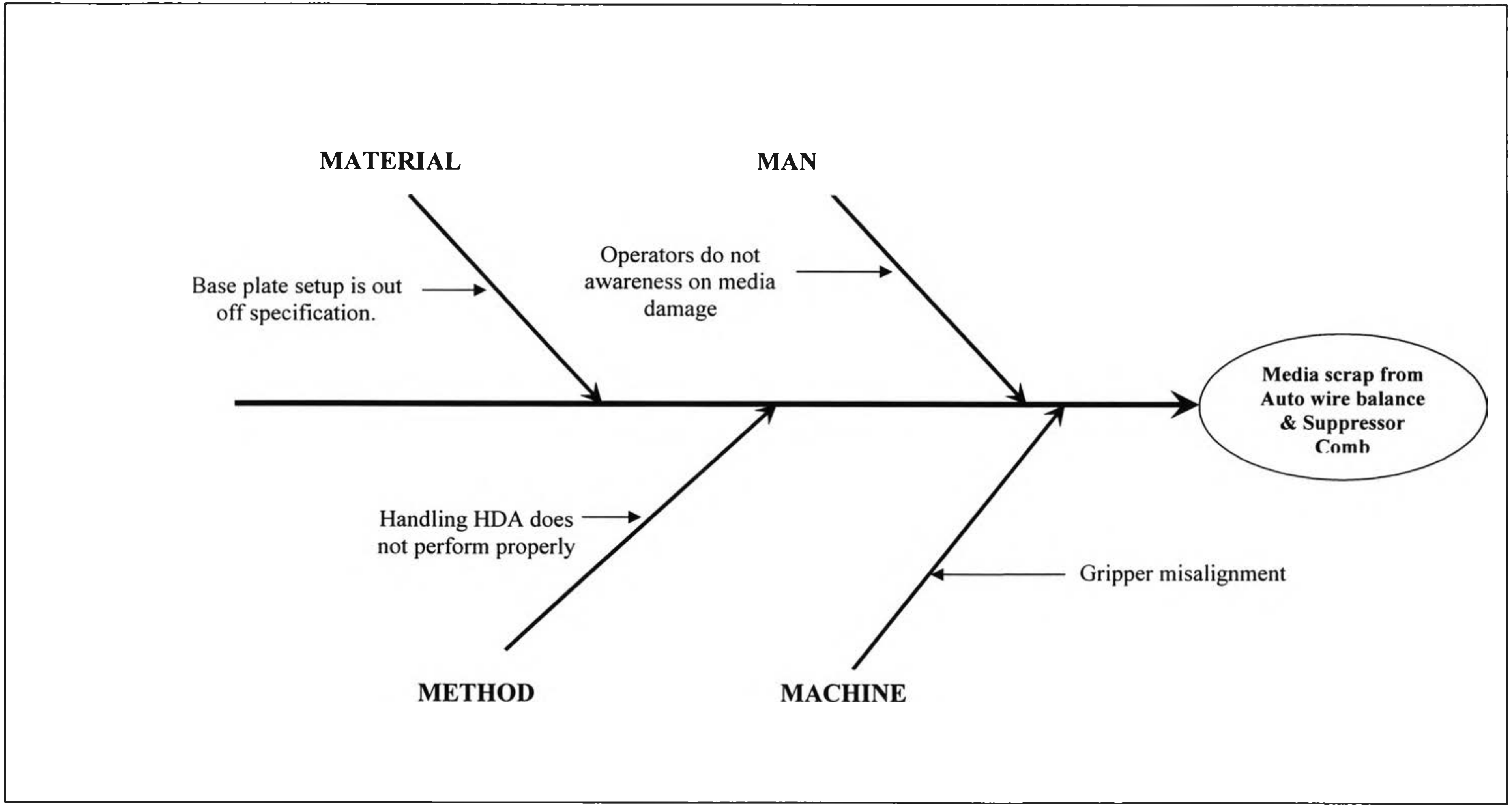


Figure 4.3.3.6: Fish bone diagram for media scrap from Auto wire balance and suppressor comb install activities.

## III. FMEA

### *FMEA in General*

The FMEA analysis procedure is a tool that has been adapted using in this project. It can contribute to improved designs for products and processes, resulting in higher reliability, better quality, increased safety, enhanced customer satisfaction and reduced costs. The tool can also be used to establish and optimize maintenance plans for repairable systems and/or contribute to control plans and other quality assurance procedures.

The implementation team applied FMEA in this project because of following reasons:

- Identify the relative risks designed into a product or process.
- Initiate action to reduce those risks with the highest potential impact.
- Track the results of the action plan in terms of risk reduction.
- Provides a knowledge base of failure mode and corrective action information that can be used as a resource in future troubleshooting efforts and as a training tool for new engineers

FMEA, a systematic methodology approach, is used to rate the risks relative to each other. An RPN or Risk Priority Number is calculated for each failure mode and its resulting effect(s). The RPN is a function of three factors: The Severity of the effect, the frequency of Occurrence of the cause of the failure, and the ability to detect the failure or effect. .

RPN = Severity rating X Occurrence rating X Detection rating

The RPN can range from a low of 1 to a high of 1,000

Once the RPNs are determined, development of an action plan is required to reduce the risks of failure modes of unacceptably high RPNs. Next, use the FMEA as the basis for developing a Control Plan (Control Plans are a summary of defect prevention and reactive detection techniques).

*FMEA in Practical*

The next step is to bring 4 major failure modes and the selected 16 major potential causes as identified in fish bone diagrams into FMEA worksheet. Some of the potential causes are filtered out because the team concluded that the severity or occurrence of the potential effects and causes are not significant.

From the fishbone diagram, the major failure modes are selected into FMEA worksheet and each of potential cause will be rated for level of severity, occurrence and detection, to assess the risk associated with those failure modes, to rank the issues in terms of importance and to identify and carry out corrective actions to address the most serious concerns. The rating criteria of the severity, occurrence and detection are according to detail described in Appendix F.

RPN = Severity(S) x Occurrence (O) x Detection (D)

Highest RPN = 10 x 10 x 10 = 1,000; High RPN is determined by any value that is higher than the acceptable RPN

Acceptable RPN: 6 (S) x 5 (O) x 6 (D) = 180

High RPN is RPN > 180, therefore the potential causes that have RPN above 180 will be taken into consideration for improvement.

Base on the same industry, acceptable RPN is around 100 while ABC accepts RPN at 180 due to limitation of machine both hardware and software are the old model which cause to many problems and issues such as tooling misalignment, software's bug, software do not support the new setting/adjustment and etc. In addition of some causes those are from bad material which ABC does not have incoming inspection material check up.

*FMEA Form Content*

- Column 1: the process components and the intended function
- Column 2: considerable of the potential failure modes for each component and its corresponding function
- Column 3: determine the effects associated with each failure mode
- Column 4: assign a severity ranking to each effect that has been identified
- Column 5: considerable of the potential cause
- Column 6: consider customized occurrence ranking scales based on time-based, event-based, or piece-based frequencies
- Column 7: current process controls that prevent the causes of each failure mode must be identified
- Column 8: assign detection rankings
- Column 9: the RPN is calculated by multiplying the three rankings together
- Column 10: RPN ranking
- Column 11: the recommended actions
- Column 12: assign owner and target completion date
- Column 13-15: recalculate the RPN, reassess the severity, occurrence, and detection rankings for the failure modes after the action plan has been completed
- Column 16: expected RPN

**Process** :FMEA (Failure Mode and Effect Analysis)

**Process Name**: Manual Media Installation | **Documented By**: Jintana Lersvisalsin | **FMEA No.**: 01

**Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor | **Responsibility**: Team. | **FMEA Date** (Org): Feb 27, 2005 (Rev): ________

**Page**: 1 of 6

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | S | O | D | RPN |
| Media Installation | Glove touches media | Glove mark media | 8 | Handling HDA do not perform properly | 3 | QC audit follow procedure | 6 | 144 | 9 | | | | | | |
| | | | | Operator use hand pick up disk clamp from HAD | 3 | QC audit follow procedure | 7 | 168 | 7 | | | | | | |
| | | | | Operator does not pick up media from tool properly when machine hang | 5 | No control | 8 | 320 | 2 | 1. Design proper tool for operator to remove media from machine | Tooling Design Engineer March 2005 | 8 | 2 | 4 | 64 |

Table 4.3.3.1: FMEA for Auto Media Installation Activities

**Process** :FMEA (Failure Mode and Effect Analysis)

**Process Name**: Manual Media Installation **Documented By**: Jintana Lersvisalsin **FMEA No.**: 01

**Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor **Responsibility**: Team. **FMEA Date** (Org): Feb 27, 2005 (Rev): ________

**Page**: 2 of 6

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | S | O | D | RPN |
| | Handle disk clamp then accidence drop and hit media. | Scratch on media | 8 | Operator does not handle the tool to pick up disk clamp properly | 4 | Operator performs follow work instruction. | 6 | 192 | 6 | Alert operator on scrap awareness and perform routine audit | QC Engineer and Production Supervisor. March 2005 | 8 | 2 | 3 | 54 |
| | | | 8 | Vacuum pressure of disk clamp is too low pick up the tool | 7 | Uncontrolled | 5 | 280 | 3 | 1. Routine check vacuum pressure of disk clamp pick up tool by using Go/No-Go gauge. 2. Routine check picks up tool condition. | Production, Tooling Engineer April 2005 | 8 | 7 | 3 | 168 |

Table 4.3.3.1: FMEA for Auto Media Installation Activities cont'

**Process** :FMEA (Failure Mode and Effect Analysis)

**Process Name**: Auto Media Installation. **Documented By**: Jintana Lersvisalsin **FMEA No.**: 01

**Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor **Responsibility**: Team. **FMEA Date** (Org): Feb 27, 2005 (Rev): ________

**Page**: 3 of 6

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | S | O | D | RPN |
| Media Installation | Disk clamp or screw drop on media. | Scratch on media | 8 | Vacuum pressure of disk clamp is too low pick up the tool | 4 | Daily checklist by tool. | 3 | 96 | 11 | | | | | | |
| | | | | Tooling misalignment | 5 | Daily checklist by tooling. | 4 | 160 | 8 | | | | | | |
| | | | | Detect wrong motor screw hole | 5 | Daily checklist by tooling. | 4 | 160 | 8 | | | | | | |
| | Bias too strong | Dent on media | 7 | Wrong material type was biased. | 3 | Daily checklist by tooling. | 3 | 63 | 11 | | | | | | |
| | | | | Bias force is too strong | 4 | Not available. | 8 | 224 | 5 | Find method to check bias force | Tooling Design Engineer. April 2005 | 8 | 7 | 3 | 168 |

Table 4.3.3.2: FMEA for Manual Media Installation Activities

**Process** :FMEA (Failure Mode and Effect Analysis)

**Process Name**: Auto Media Installation. **Documented By**: Jintana Lersvisalsin **FMEA No.**: 01

**Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor **Responsibility**: Team. **FMEA Date** (Org): Feb 27, 2005 (Rev): _________

**Page**: 4 of 6

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | S | O | D | RPN |
| | Machine hangs | Glove mark on media | 8 | Software's bug | 4 | Not available. | 6 | 192 | 6 | Design proper tool for operator to remove media from machine | Tooling Design, Process Engineer April 2005 | 8 | 2 | 2 | 32 |
| | | | | Computer hangs | 5 | Not available | 6 | 240 | 4 | Design proper tool for operator to remove media from machine | Tooling Design, Process Engineer April 2005 | 8 | 2 | 2 | 32 |

Table 4.3.3.2: FMEA for Manual Media Installation Activities cont'

**Process** :FMEA (Failure Mode and Effect Analysis)

**Process Name**: Auto Gang Bias | **Documented By**: Jintana Lersvisalsin | **FMEA No.**: 01

**Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor | **Responsibility**: Team. | **FMEA Date** (Org): Feb 27, 2005 (Rev): ________

**Page**: 5 of 6

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | S | O | D | RPN |
| Auto gang bias | Bias hit media surface | Scratch on media | 7 | Tool tower does not clamp HDA properly | 6 | Visual inspection | 4 | 168 | 7 | | | | | | |
| | | | | Bias pin misalignment | 6 | Visual inspection | 4 | 168 | 7 | | | | | | |
| | | | | Tooling misalignment | 5 | Visual inspection | 4 | 140 | 10 | | | | | | |
| | Bias too strong | Dent on media | 6 | Bias force is too high | 5 | Check incoming pressure | 8 | 240 | 4 | Find method to check bias force | Tooling. April 2005 | 6 | 5 | 4 | 120 |

Table 4.3.3.3: FMEA for Auto Gang Bias Activities

**Process** :FMEA (Failure Mode and Effect Analysis)

**Process Name**: Suppressor comb installation. **Documented By**: Jintana Lersvisalsin **FMEA No.**: 01

**Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor **Responsibility**: Team. **FMEA Date** (Org): Feb 27, 2005 (Rev): ________

**Page**: 6 of 6

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | S | O | D | RPN |
| Suppressor comb install. | Suppressor comb hit media | Scratch on media | 8 | Gripper misalignment | 8 | Visual inspection | 6 | 384 | 1 | Design gauge to check alignment | Tooling Design Engineer April 2005 | 8 | 5 | 3 | 120 |
| | | | | Base plate dimension was setup out of specification | 4 | Visual inspection | 7 | 224 | 5 | Check base plate cavity and feedback SQE to screen out if found dimension is out of specification | Process Engineer. March 2005 | 8 | 4 | 5 | 160 |

Table 4.3.3.4: FMEA for suppressor comb installation Activities

**IV. Develop Action Plan**

From the FMEA result, the RPNs are determined and development of an action plan is required to reduce the risks of failure modes of unacceptably higher than 180. There are 11 Potential Causes/Mechanisms of Failure have got RPN more than 180, ranking from 1 (RPN = 384) to 6 (RPN = 192) which ranking number 1 represent to the highest critical risk. From 11 Potential Causes can combine recommendation action to 7 activities.

Action Plan was conform from follow the Blueprint for Change Technique which required reprioritizing the activities list from ranking base on critical risk to consideration of others project implementation requirement factor.

The implementation team conducted the meeting to reprioritize activities base on implementation's requirement readiness rather than critical activities, responsibility owner and KPIs would provide in this section. This decision accepts in the meeting and along with management agreement (attached in Table 4.3.3.5: Revised Activities list and Table 4.3.3.6: Work load delegation and timeline).

| Priority Item | RPN | Ranking By RPN | Activity List | Owner |
|---|---|---|---|---|
| 1 | 192 | 6 | Inform the operator of this problem so that proper care can be taken | Production |
| 2 | 280 | 3 | Daily check of the vacuum pressure using the GO/NOGO gauge and daily inspection of the pick up tool. | Production |
| 3 | 192 | 6 | Daily check alignment of the bias pins by visual inspection and design precision gauge to align the bias pin. | Tooling |
| 4 | 224 | 5 | Look for base plate cavity and feedback SQE to screen out if found dimension is out of specification. | Process. |
| 5 | 384 | 1 | Design a precision gauge to align the gripper. | Process/ Tooling |
| 6 | 320 | 2 | Designed a tool to remove the media without causing damage. | Tooling |
| 7 | 240 | 4 | Determine a method to verify the bias force and adjust it. Have written procedure available for the technicians. | Process/ Tooling |

Table 4.3.3.5: Revised Activities list

| | | | Mar,05 | | | | Apr,05 | | | | May,05 | | | | June,05 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Week | Week | Week | Week | Week | Week | Week | Week | Week | Week | Week | Week | Week | Week | Week | Week |
| Item | Action List | Response | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 1 | Inform the operator of this problem so that proper care can be taken | Production | | | | | | | | | | | | | | | | |
| 2 | Daily check of the vacuum pressure using the GO/NOGO gauge and daily inspection of the pick up tool. | Production | | | | | | | | | | | | | | | | |
| 1 | Daily check alignment of the bias pins by visual inspection and design precision gauge to align the bias pin. | Tooling | | | | | | | | | | | | | | | | |
| 4 | Look for base plate cavity and feedback SQE to screen out if found dimension is out of specification. | Process/Production | | | | | | | | | | | | | | | | |
| 5 | Design a precision gauge to align the gripper. | Process/Tooling | | | | | | | | | | | | | | | | |
| 2 | Designed a tool to remove the media without causing damage. | Tooling | | | | | | | | | | | | | | | | |
| 7 | Determine a method to verify the bias force and adjust it. Have written procedure available for the technicians. | Process/Tooling | | | | | | | | | | | | | | | | |
| 3 | Small lot build (1K drives) | | | | | | | | | | | | | | | | | |
| 4 | DPPM build starts (6K drives) | | | | | | | | | | | | | | | | | |
| 5 | Production build starts | | | | | | | | | | | | | | | | | |

Table 4.3.3.6: Work load delegation and timeline

**V. Review Result**

There are many tools to aid the FMEA team in reducing the relative risk of failure modes requiring action. Among the most powerful tools, the team selects Statistical Process Control to define the output of a process to determine the capability of the process against the specification.

The result after implement action activities, the overall media scrap was declined to 10.33% from 14% as illustrate in Figure 4.3.3.7, the data of percentage media scrap have being collected for 20 weeks (from Dec 2004 to May 2005) for assess trend of scrap rate.

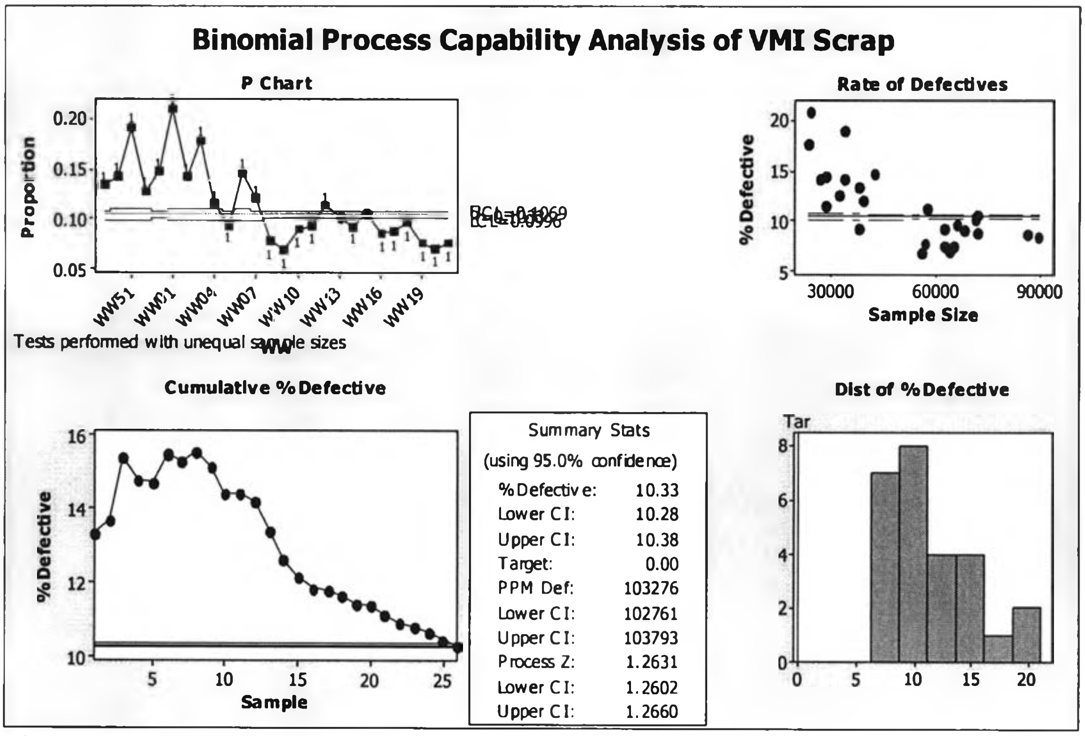


Figure 4.3.3.7: Overall media scrap

When consider on each defects of media scrap, Dent defect rate declined from 2% to 1.08% as illustrate in Figure 4.3.3.8, Scratch defect rate declined from 5% to 2.60% as illustrate in Figure 4.3.3.9 and Glove mark defect rate declined from 4% to 2.32% as illustrate in Figure 4.3.3.10.

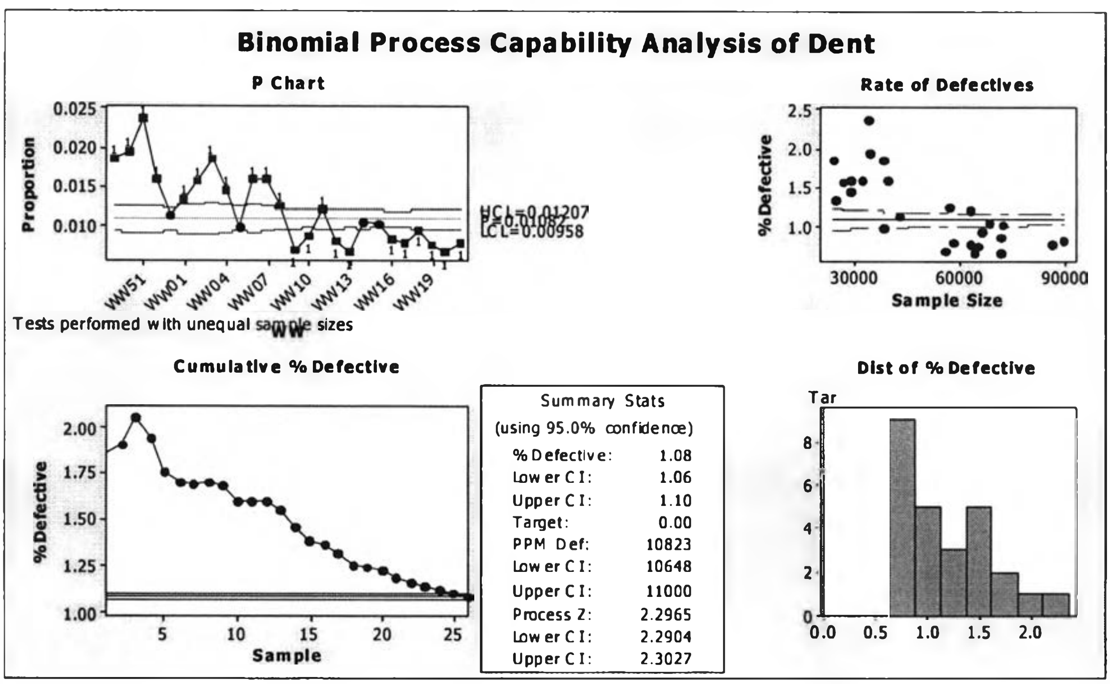


Figure 4.3.3.8: Result of Dent defect

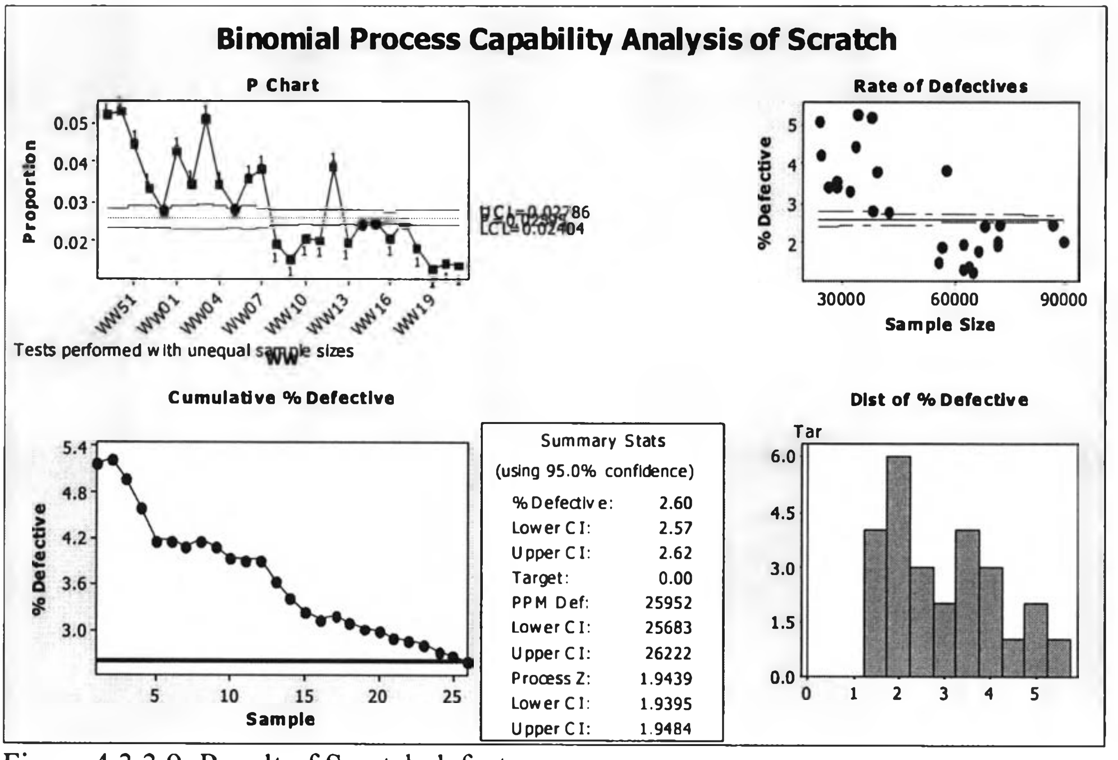


Figure 4.3.3.9: Result of Scratch defect

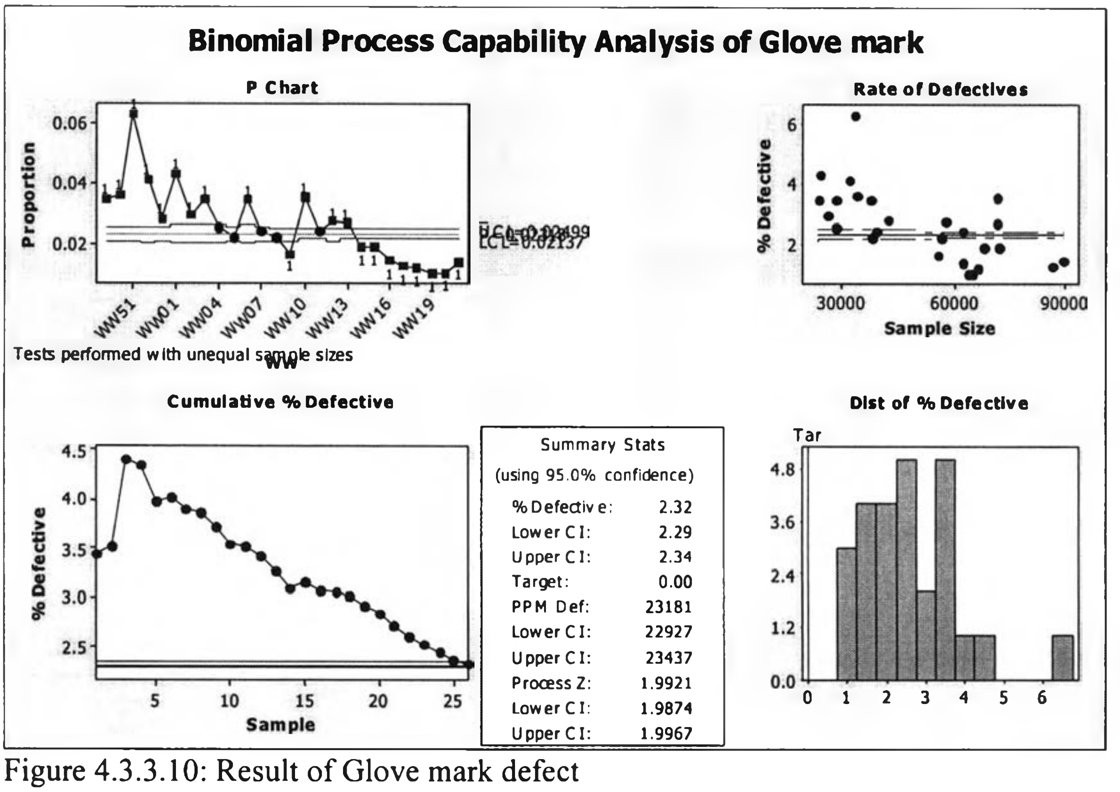


Figure 4.3.3.10: Result of Glove mark defect

**Recalculation RPN**

Recalculate the Resulting RPN; this step in a FMEA confirms the action plan had the desired results by calculating the resulting RPN. The implementation team set up meeting in order to recalculate the RPN reassesses the severity, occurrence, and detection rankings for the failure modes after the action plan has been completed base on one month data collection in June 2006 (ww19 to ww24).

The result of RPN recalculation are shown in Table 4.3.3.7 to 4.3.3.10, there are some meet the expected RPNs as mention in Table 4.3.3.3 to 4.3.3.6 and there are some items miss the target but they are all under accepted RPN (RPN less than 180).

**Process** :FMEA (Failure Mode and Effect Analysis)

**Process Name**: Manual Media Installation | **Documented By**: Jintana Lersvisalsin | **FMEA No**.: 02

**Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor | **Responsibility**: Team. | **FMEA Date** (Org): Jun 26, 2005 (Rev): ________

**Page**: 1 of 5

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | S | O | D | RPN |
| Media Installation | Glove touches media | Glove mark media | 8 | Handling HDA do not perform properly | 3 | QC audit follow procedure | 6 | 114 | 5 | | | | | | |
| | | | | Operator use hand pick up disk clamp from HAD | 3 | QC audit follow procedure | 7 | 168 | 1 | | | | | | |
| | | | | Operator does not pick up media from tool properly when machine hang | 2 | No control | 5 | 80 | 8 | | | | | | |

Table 4.3.3.7: FMEA for Auto Media Installation Activities

| **Process** :FMEA (Failure Mode and Effect Analysis) | | |
|---|---|---|
| **Process Name**: Manual Media Installation | **Documented By**: Jintana Lersvisalsin | **FMEA No.**: 02 |
| **Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor | **Responsibility**: Team. | **FMEA Date** (Org): Jun 26, 2005 (Rev): ________ |
| | | **Page**: 2 of 5 |

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected S | Expected O | Expected D | Expected RPN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Handle disk clamp then accidence drop and hit media. | Scratch on media | 8 | Operator does not handle the tool to pick up disk clamp properly | 2 | Operator performs follow work instruction. | 3 | 48 | 10 | | | | | | |
| | | | 8 | Vacuum pressure of disk clamp is too low pick up the tool | 5 | Uncontrolled | 3 | 120 | 4 | | | | | | |

Table 4.3.3.7: FMEA for Auto Media Installation Activities cont'

**Process** :FMEA (Failure Mode and Effect Analysis)

**Process Name**: Auto Media Installation. **Documented By**: Jintana Lersvisalsin **FMEA No.**: 02

**Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor **Responsibility**: Team. **FMEA Date** (Org): Jun 26, 2005 (Rev): ________

**Page**: 3 of 5

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected S | Expected O | Expected D | Expected RPN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Media Installation | Disk clamp or screw drop on media. | Scratch on media | 8 | Vacuum pressure of disk clamp is too low pick up the tool | 4 | Daily checklist by tool. | 3 | 96 | 6 | | | | | | |
| | | | | Tooling misalignment | 5 | Daily checklist by tooling. | 4 | 160 | 2 | | | | | | |
| | | | | Detect wrong motor screw hole | 5 | Daily checklist by tooling. | 4 | 160 | 2 | | | | | | |
| | Bias too strong | Dent on media | 7 | Wrong material type was biased. | 3 | Daily checklist by tooling. | 3 | 63 | 9 | | | | | | |
| | | | | Bias force is too strong | 3 | Not available. | 4 | 84 | 7 | | | | | | |
| | Machine hangs | Glove mark on media | 8 | Software's bug | 2 | Not available. | 6 | 96 | 6 | | | | | | |
| | | | | Computer hangs | 2 | Not available | 6 | 96 | 6 | | | | | | |

Table 4.3.3.8: FMEA for Manual Media Installation Activities

**Process** :FMEA (Failure Mode and Effect Analysis)

**Process Name**: Auto Gang Bias | **Documented By**: Jintana Lersvisalsin | **FMEA No.**: 02

**Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor | **Responsibility**: Team. | **FMEA Date** (Org): Jun 26, 2005 (Rev): _________

**Page**: 4 of 5

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | S | O | D | RPN |
| Auto gang bias | Bias hit media surface | Scratch on media | 7 | Tool tower does not clamp HDA properly | 6 | Visual inspection | 4 | 168 | 1 | | | | | | |
| | | | | Bias pin misalignment | 2 | Visual inspection | 3 | 42 | 11 | | | | | | |
| | | | | Tooling misalignment | 5 | Visual inspection | 4 | 140 | 3 | | | | | | |
| | Bias too strong | Dent on media | 6 | Bias force is too high | 5 | Check incoming pressure | 4 | 120 | 4 | | | | | | |

Table 4.3.3.9: FMEA for Auto Gang Bias Activities

**Process** :FMEA (Failure Mode and Effect Analysis)

**Process Name**: Suppressor comb installation. **Documented By**: Jintana Lersvisalsin **FMEA No.**: 02

**Core Team**: Process Engineer, Tooling Engineer, Quality Engineer, Production Supervisor **Responsibility**: Team. **FMEA Date** (Org): Jun 26, 2005 (Rev): ________

**Page**: 5 of 5

| Process Function and Requirement | Potential Failure Mode | Potential Effect (s) of Failure | Severity | Potential Cause (s) / Mechanism (s) of Failure | Occurrence | Current Process Controls | Detect ability | RPN | Ranking | Recommended Action (s) | Responsibility and Target Completion Date | Expected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | S | O | D | RPN |
| Suppressor comb install. | Suppressor comb hit media | Scratch on media | 8 | Gripper misalignment | 4 | Visual inspection | 5 | 160 | 2 | | | | | | |
| | | | | Base plate dimension was setup out of specification | 4 | Visual inspection | 5 | 160 | 2 | | | | | | |

Table 4.3.3.10: FMEA for suppressor comb installation Activities

### 4.3.4 Sustaining Process and Standardization

Assure a system is in place to control the risks of the same failure modes as identified in the FMEA, there are some new procedures created as following:

1. Create new tooling check sheet including on caused of media damaged (see the Tooling check sheet in Appendix E)
2. Retrain all technicians for new gauge setup by monthly
3. Setup weekly meeting for all supervisor and head of technician to get feed back production issues and review check sheet result
4. Perform daily QC audit and audit check list sheet to assess the operators and all concerns according to causing media damaged (QC Audit Check Sheet show in Table 4.3.4.1)

**QC Audit Check Sheet - Media Scrap Cost Reduction**

Tool ID : ________ Module : ________ Date Perform : ________
QC : ________ Product : ________

**CheckSheet For Media Scrap Cost Reduction**

| Station. | OK | NOT OK | Media Damage Cause |
|---|---|---|---|
| 1. AMI (Auto Media Install) | | | |
| 1.1 Tool operating order is correct as below step<br>- Turn drive in.<br>- Pick up media<br>- Pick up disk clamp and install screw.<br>- Install media to drive.<br>- Install disk clamp and drive screw.<br>- Turn drive out. | | | |
| 1.2 Handling follow procedure | | | |
| 1.3 Using the right tool for each activity and case | | | |
| 1.4 Repeat 3 drives operating without obstruction. | | | |
| 2. MI (Manual Media Install) | | | |
| 2.1 Tool operating order is correct as below step<br>- Turn drive in.<br>- Pick up media<br>- Pick up disk clamp and install screw.<br>- Install media to drive.<br>- Install disk clamp and drive screw.<br>- Turn drive out. | | | |
| 2.2 Handling follow procedure | | | |
| 2.3 Using the right tool for each activity and case | | | |

Table 4.3.4.1: QC Audit Check Sheet

## 4.4 Process Changed in Summary

From Chapter Three, company vision, strategic issues and goals was done analysis and conform to Holistic Plan, for every department at ABC Company using as a guideline for their department direction and prepare for handling the change with effectiveness. Each department has to derive the company holistic plan then consolidate with the company strategy to get the department roadmap targeting to achieve company goals. As same as in Engineering Department, the department responsible to support one company's goal with selected Low Cost Manufacturing Strategy to cope with its. Then the company derived the master plan (company holistic plan), filter the related and supported conform to the department strategic map as illustrate in Figure 4.1.1.

Once the department Strategic Map conformed, the development plan have to identified in details of what methodology using to get each items in the map. This process cannot complete by someone but its need the team from various job functions or across the organization if required. The team will responsible for provides inputs score weighting, listing the process weak point, assessment current process issue and recommendations what, why, who and how they should be, analysis the root cause of problems and provide improvement plan. The outcome from the team meeting are based on The Team's opinions and experiences which would more or less beneficial for all readers while they apply on their current organizations.

Engineering Department, improvement plan was segregated to four projects according to the department KPIs (scrap rate, cycle time, yield and downtime). To prioritize the four projects the team need to assess each project by company criteria to scoring its. The scoring result illustrates how much the project response to the strategic plan and then the department can arrange resources and prepare for project implementation effectively.

In the same way, other departments can applied this process in their department. The differences are the goals and strategy, by the way it's still common in the process of change management as above describe. Below are some project improvement for others department created.

## 4.5 Blueprint for Change in Summary

In summary of Blueprint for Change Approach, there are three perspectives need to evaluated and summarized up by project or yearly (support performance appraisal). One of these perspectives is the highlight of Blueprint for Change Technique that is each of the project improvement can evaluate to see the impact of project's result to strategic issue and vision respectively. The follow are the three evaluation perspectives.

1. Impact of the improvement result to Strategic issue and company vision
2. Summary of the process changed
3. Summary of the organization development

### 4.5.1 Impact of the improvement result to Strategic issue and company vision

As the way of strategic and KPIs deployment by Blueprint for Change Technique was done by systematically approach started with vision deploy to project action plan with clearly measurable the success. Therefore the feedback evaluation can do at any level of the deployment start from the bottom back to the top (project level to Vision). Figure 4.5.1.4 illustrates the strategic evaluation process, stating with the project, up to department goal and company goal. Once the Scrap Rate Reduction project was completed implementation and got 4% reduction rate improvement to see the impact of the project to department level, that will be prove by OEE (Overall Equipment Effectiveness) before project implement and OEE after project implemented.

Overall Equipment Effectiveness (OEE): calculation: its overall performance of a single piece of equipment or even an entire factory will always be governed by the cumulative impact of the three OEE factors: **Availability, Performance Rate and Quality Rate**. In term of calculation, OEE is represented for a percentage derived by multiplication of the three ratios for the factors mentioned above. The OEE percentage is used for analysis and benchmarking.

OEE = Availability X Performance Rate X Quality Rate

Availability - Percent of operating hour per calendar hours 24/7/365, to measure equipment utilization that a production line is available for production. This parameter related to **machine downtime** (one of the Engineering's KPIs) KPI.

Availability = 1(Full utilization) – Percentage of actual downtime

Performance Rate - Percent of parts produced per time frame (actual UPH – unit per hour), of maximum rate of production speed at. . This parameter related to **cycle time** (one of the Engineering's KPIs) KPI. UPH at maximum production rate calculate from the best cycle time at bottle neck machine station. Actual UPH calculate base on average cycle time (use the cycle time at bottle neck machine station) from historical data.

Performance Rate = Percentage of (Maximum UPH – Actual UPH)

Quality Rate - Percent of good sellable parts out of total parts produced per time frame. This parameter related to two KPIs, **Yield and Scrap rate** KPIs. Scrap rate is the failure rate under yield factor plus any drive failed from elsewhere in the plant or between shipments to the customer.

Quality Rate = 1(input = output, 100% yield) - Percentage of average yield

Thus, the result of Scrap Rate Reduction project will affect to only Quality Rate parameter, yield trend between implementation periods illustrate in Figure 4.5.1.3. Availability and Performance Rate will be the same for both before and after project implementation. Downtime and UPH parameter are from the historical data as illustrate in Figure 4.5.1.1 and 4.5.1.2.

*Overall Equipment Effectiveness (OEE) Calculation:*

OEE = Availability * Performance Rate * Quality Rate

| | |
|---|---|
| Availability Rate | = 1(Full utilization) – Percentage of actual downtime |
| | = 100% – 4.33% |
| | = 95.67% |
| Performance Rate | = Percentage of (Average UPH / Maximum UPH) |
| | = (4,420 / 6093) * 100 |
| | = 72.54% |

Quality Rate = Percentage of average yield; (before project implemented)

= 95.03%

Quality Rate = Percentage of average yield; (after project implemented)

= 98.64%

OEE = Availability * Performance Rate * Quality Rate

OEE (before) = 95.67% * 72.54% * 95.03%

= 65.95%

OEE (after) = 95.67% * 72.54% * 98.64%

= 68.46%

Year 2004, OEE average is 65.89%. Therefore 10% OEE improvement according to year 2005 target is 72.48%.

Department level, from above calculation scrap rate reduction project affected to the department goal by 2.51% (from 65.95% to 68.46%) OEE increased from total required 6.59%.

Company level, Improve manufacturing base on production performance goal accounted to 15% from the overall company target. After implement Scrap Rate Reduction project, OEE value increased up to 68.46%, affected to company level by 5.71% from total 15% or 38.06% affected to this goal.

*OEE Calculation Summary:*

- Scrap rate reduction project affected to department goal by increased OEE value from 65.95% to 68.46%, target at 72.48%
- Scrap rate reduction project affected to company target by 5.71% and affected 38.06% to the goal *"Improve manufacturing base on production performance"*
- The rest 3 department projects have to create the OEE affected not rather than 4.02% in order to accomplish the department and company goals.

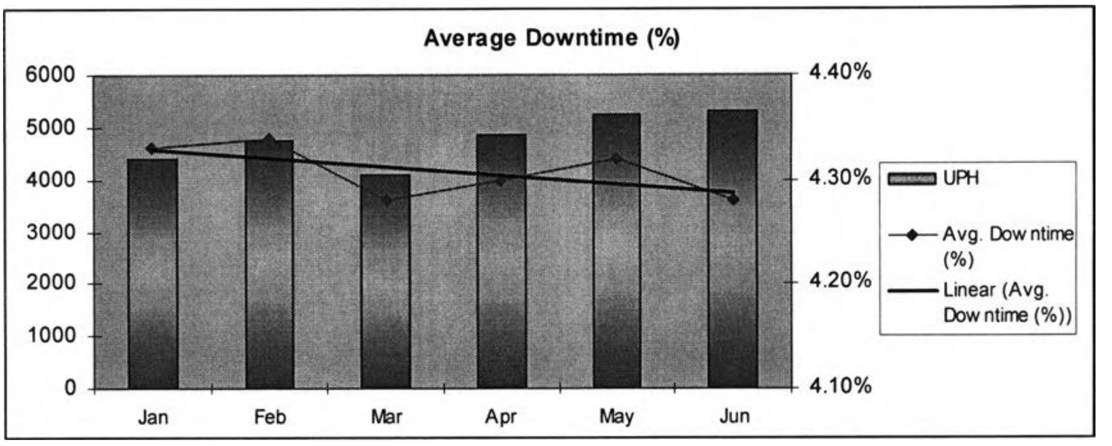


Figure 4.5.1.1: Downtime trend

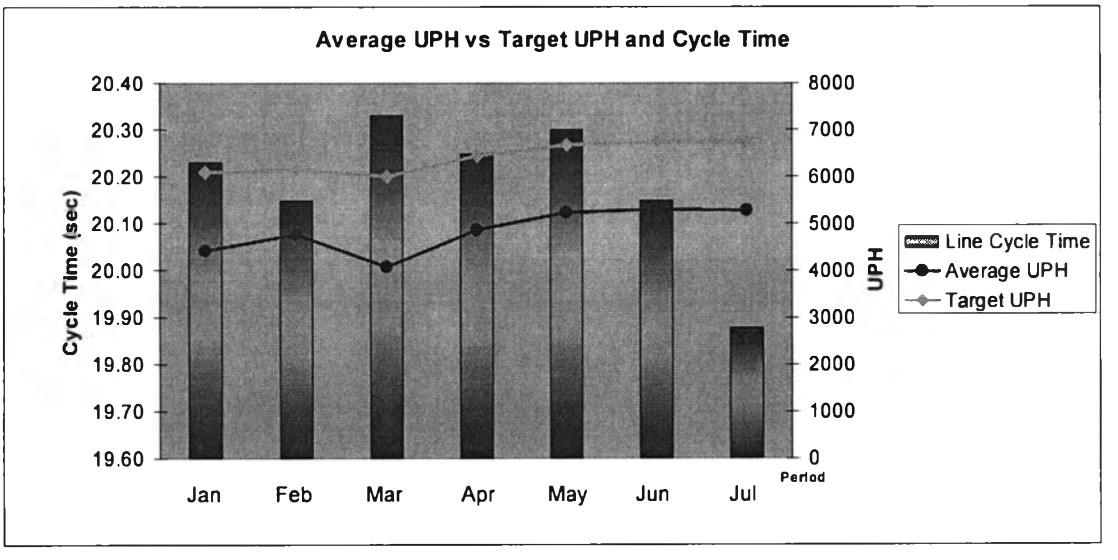


Figure 4.5.1.2: Cycle time against UPH trend

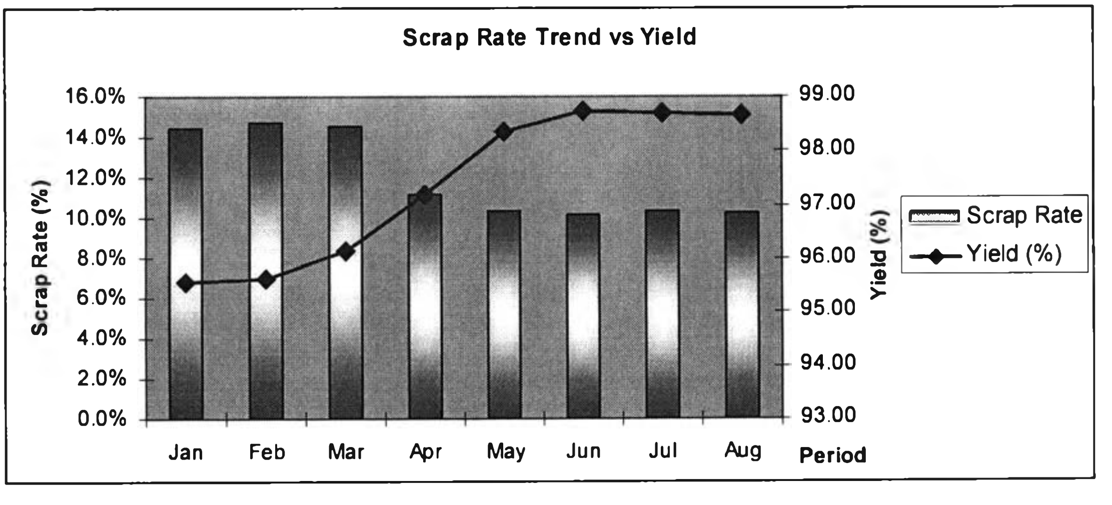


Figure 4.5.1.3: Scrap rate against Yield trend

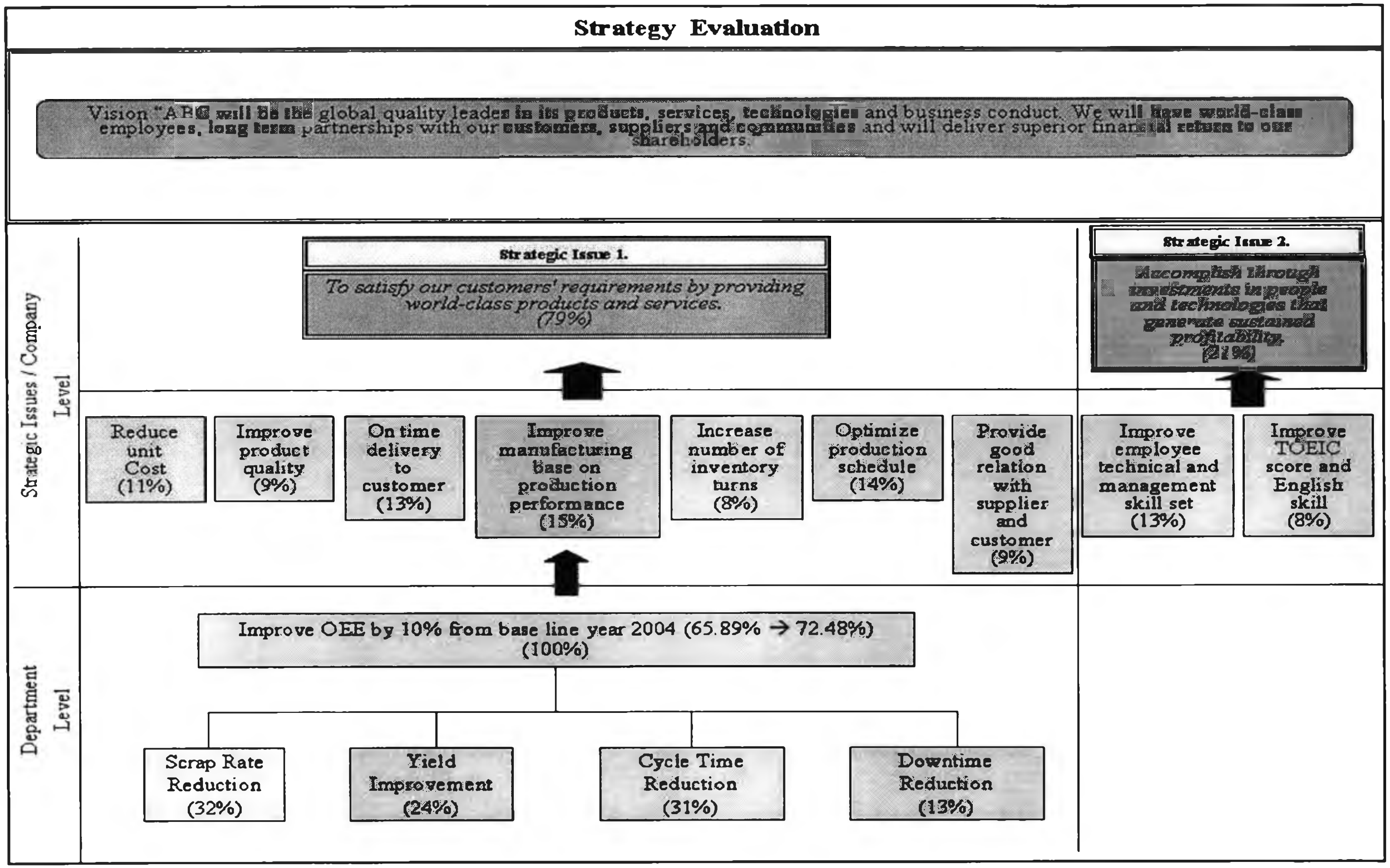


Figure 4.5.1.4: Strategic Evaluation Diagram

### 4.5.2 Summary of the process changed

In December 2005, each department required to submit the summary of department performance report. Engineering department achieved all four improvement projects (scrap rate reduction, cycle time reduction, yield improvement and downtime reduction projects) The following Table 4.5.2.1 is the summary of keys process changed in Engineering Department by Blueprint for Change Approach.

| Project | Issue | Action List | Owner |
|---|---|---|---|
| Scrap Rate Reduction | Process | Revised media handling procedure | Process Engineer |
| | Technology | Designed new proper tools | Tooling Engineer |
| | Structure | Daily machine calibration check | Tooling Engineer |
| | Human | Conducted training session and retrain scheduling | Production/ Process Eng |
| | Others | | |
| Cycle Time Reduction | Process | Revised media handling procedure<br>Revised materials feeding schedule | Process Engineer |
| | Technology | Re-adjustment machine setup variable<br>Upgraded new software and hardware | Tooling Engineer |
| | Structure | Changed 100% inspection to sampling | Process Engineer |
| | Human | Conducted training session and retrain scheduling | Production/ Process Eng |
| | Others | | |

Table 4.5.2.1: Engineering process changed summary

| Project | Issue | Action List | Owner |
|---|---|---|---|
| Yield Improvement | Process | Setup procedure for visual inspection before passing drive thru the next station<br>Revised drive movement procedure<br>Increased set point yield to increase system sensibility | Process Engineer |
| | Technology | Designed new for fix misalignment issues<br>Upgraded new software and hardware revision to get more feature and accuracy | Tooling Engineer |
| | Structure | Daily machine calibration check | Tooling/Process Engineer |
| | Human | Conducted training session for problem solving technique and create trouble shooting | Production/ Process Eng |
| | Others | | |
| Downtime Reduction | Process | Revised maintenance schedule for tools and machines both prime and spare part | Tooling Engineer |
| | Technology | Changed/Upgraded software and hardware to get more accuracy and features, reduced setup time<br>Setup machine auto calibration when alignment is out of specification | Tooling/ Process Engineer |
| | Structure | Setup the procedure in order to get availability of spare part | Tooling Engineer |
| | Human | Conducted training class for technician in dept technical | Production/ Process/ Tooling |
| | Others | | |

Table 4.5.2.1: Engineering process changed summary cont’

### 4.5.3 Summary of the organization development

Over the year 2005, there are many development programs were created and implemented to support organization to capable with the more challenging task. The development plan in Table 4.2.1: Development program support strategic readiness, most of them was implemented and there is some still pending in queue. Table 4.5.3.1 illustrates the summary of organization development over the year 2005 with timeline and owner.

| Engineering Department Development Plan | | | |
|---|---|---|---|
| **Improvement Aspect** | **Improvement Plan** | **Training Timeline** | **Owner** |
| 1. Quality of Services | 1. Error protection by Risk Assessment<br>2. Speedy fix production issue by Contingency plan and improve sense of urgency<br>3. Team work – recreation program<br>4. Best quality by Six sigma | 1. Mar 1-15, 05<br>2. May 25-30, 05<br>3. Apr, 20-30, 05<br>4. Apr – Jul, 05 | Training |

Table 4.5.3.1: Summary organization development

| Engineering Department Development Plan | | | |
|---|---|---|---|
| **Improvement Aspect** | **Improvement Plan** | **Training Timeline** | **Owner** |
| 2. Effectiveness of Internal process | 1. Process innovation by Automation system<br>2. Development of new machine and system by Reduce set-ups time, standard components and support various product line<br>3. Create challenging job opportunity by clearly career path<br>4. Optimize WIP inventory by lean manufacturing<br>5. Development of monitoring system by SPC<br>6. Fully utilization of Human Resources by job reallocation and Train workers to perform multiple tasks | 1. Pending<br>2. Mar 1-15, 05<br>3. Mar-Apr, 05<br>4. Jul 15-30, 05<br>5. Feb-Mar, 05<br>6. May 1-15, 05 | 1. Tooling Eng.<br>2. Process Eng.<br>3. HR<br>4. Training<br>5. Training<br>6.HR |
| 3. Human Capital Development program | 1. Facilitate knowledge management and process improvement by KM<br>2. Deep functional expertise by specific training program<br>3. Share process knowledge across units by KM<br>4. Development of Technology, Networking and IT facilitating by Real-time data, online information, eliminate paper work with e-solution and database | 1.Jul-Nov, 05<br>2. Pending<br>3. Oct-Nov, 05<br>4. Apr-Jun, 05 | 1. HR<br>2. Process, Tooling, Software Eng.<br>3. HR<br>4. IT |

Table 4.5.3.1: Summary organization development cont'