CHAPTER 6

ANALYSIS OF PROBLEM

In this chapter, selected problems will be analyzed by using cause-effect diagram and brainstorming between different section. The major problems, which will be analyzed, are

- Inspection time
- Adjustment time
- Tool change time

6.1 Inspection time analysis

6.1.1 Cause-effect diagram

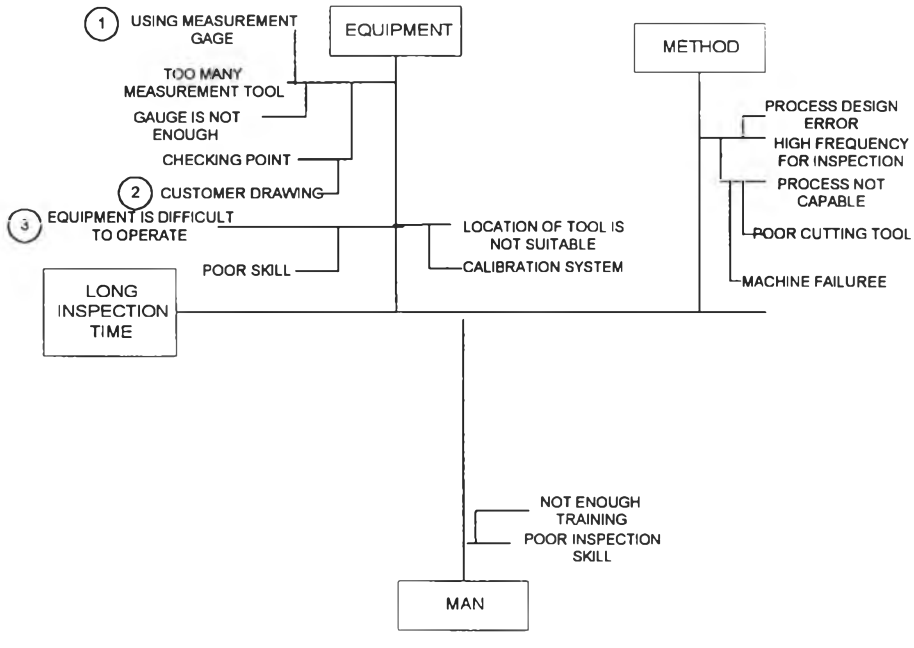


Figure 6.1 cause-effect diagram of inspection time

In case of inspection losses will be analyzed into 3 main causes (as shown in figure 6.1) there are man, method and equipment, 3 possible cause of equipment was extracted to solve.

6.1.2 Selected possible causes.

1. Using measurement gauge.

There are two types of gauge i.e., measurement gage and attribute gage: Measurement gauges, provides a specific, reading or value for any measurable characteristic of the work piece. Attribute gage, only indicates whether a measurable characteristic is within, or beyond set limits. The advantage of measurement gage is it can show the trend of dimension but take long time to use.

2. High frequency for inspection.

Frequency for inspection is decided by tolerance, importance of dimension, process capability, etc. If process capability is enough, the frequency for inspection can be decreased.

3. Equipment is difficult to operate.

   According data in table 5.3, the measurement gauge which take longest time is the cylinder gauge. This gauge is used to check the inside diameter. Compare between using cylinder gage and plug gage as in table 6.1, it can be seen that step of using cylinder gage is more complex than plug gage and take longer time.

   Before working in machining line, operator will be trained to use all measuring gage, and train on the job for 3 months.

Table 6.1 method of using cylinder gage and plug gage

Cylinder gage	Time (minutes)	Plug gage	Time (minutes)
1. Calibrate cylinder gage with ring gage	0.15	1. Insert go side into checking hole	0.1
2. Adjust dial gage by rotate zero point at dial to the indicator.	0.05	2. Insert no-go side into checking hole. This side must not go into the hole	0.1
3. Insert measuring head into hole	0.1		
4. Adjust cylinder gage at the shortest length in the hole	0.15		
5. Read data on dial gage	0.05		
Total time	0.5		0.2

6.2 Adjustment time analysis

6.2.1 Cause-effect diagram

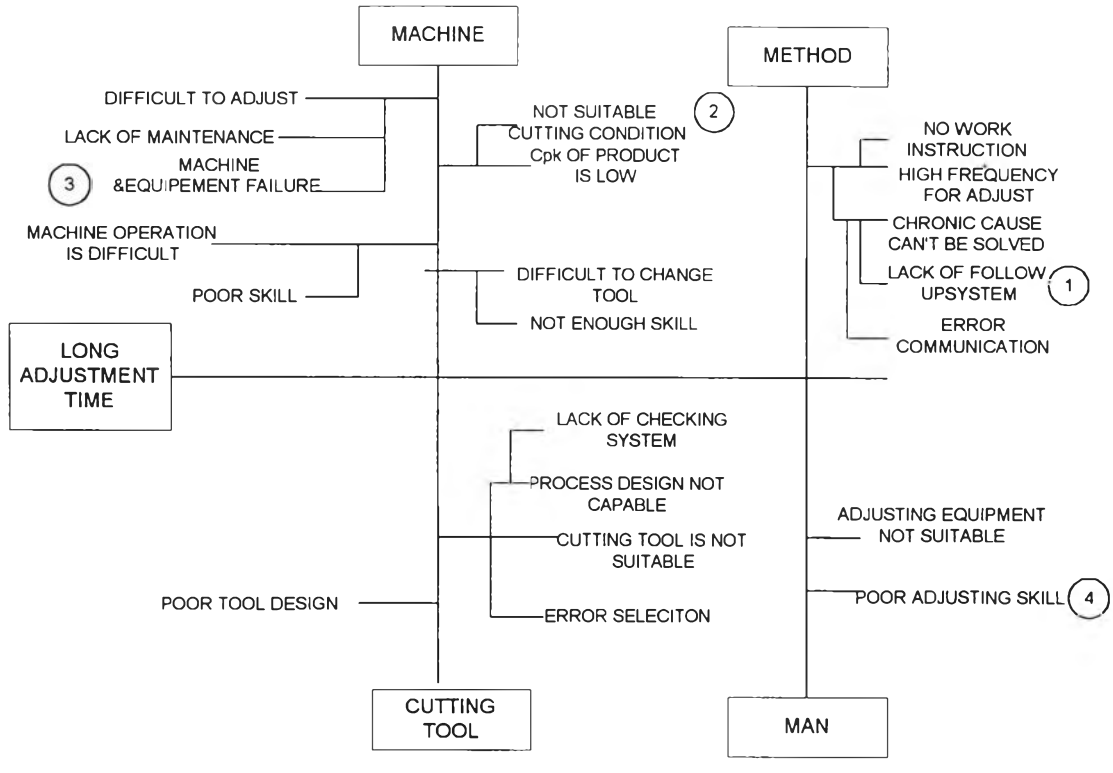


Figure 6.2 cause-effect diagram of adjustment time

Adjustment time can be divided into 4 main causes (as shown in figure 6.2), there are cause of machine, method, cutting tool and man.

6.2.2 Selected possible cause.

Cause of problem solving system was extracted from the various cause of adjustment because this cause is a root cause of all problems in current line.

1. Lack of follow up system.
2. Not suitable cutting condition.
3. Machine & equipment failure.
4. Poor adjusting skill.

Some kinds of tool, such as, reamer and boring bar require skill for adjustment because using measurement machines and other special equipment.

To solve the problem of adjustment in M0508 can be show as table 6.2 and table 6.3

Table 6.2 Lost time assessment

Assessment criteria

Item	Score	Assessment criteria
1. Frequency of occurrence	4	> 5 times/month
	2	4-2 times / month
	1	< 1 times / month
2. Mean time to adjust	4	> 25 min/ time
	2	25-5 min / time
	1	< 5 min / time

(Source TPM total productive maintenance by Yoshikazu Takahashi Osada, Asian productivity Organization, 1990)

Table 6.3 Adjustment time assessment.

Machine No.	*Tool name*	*Frequency of occurrence*	*Mean time for adjust*	*Assessment*		
				Frequency of occurrence	*Mean time for adjust*	*Do or not*
M0502,03	*ENDMILL DIA 50*	*2*	*27.5*	*1*	*4*	*0*
	BORING DIA 90	*3*	*54*	*2*	*4*	✓
	CUTTER DIA 53	*3*	*54*	*2*	*4*	*0*
	REAMER DIA 6,11,16.5	*0.3*	*55*	*1*	*2*	*0*
M0507	*COVER CUTTER DIA 18.5*	*2.3*	*18*	*2*	*2*	✓
	BURNISHING REAMER DIA 17	*2.7*	*14*	*2*	*2*	*0*
M0508	*REAMER DIA 15*	*11*	*30*	*4*	*4*	✓
	FACE MILL	*0.3*	*40*	*1*	*4*	*0*
	TAP M6	*1*	*30*	*1*	*4*	*0*

Specific tool which has serious problem in line M05 are reamer diameter 15 , boring cutter diameter 90 and boring cutter diameter 53.

6.2.3 Weighting cause of problem

table 6.4 weight cause of adjustment

Tool name	Problem			Selected cause
	Follow up system	Not suitable cutting condition	Machine equipment failure	
Reamer diameter 15 • Roughness • Diameter small.	5	5	1	Follow up system Not suitable cutting condition
Boring cutter diameter 90 • Roughness • Diameter small	5	1	5	Follow up system Machine equipment failure
Boring cutter diameter 53 • Roughness • Diameter small	5	1	5	Follow up system Machine equipment failure

Table 6.4 shows cause of each tool which take longest adjustment time. The major cause of all tools is lack of follow up system. The other cause is depend on each type of problem.

6.3 Tool change time analysis

6.3.1 Cause-effect diagram

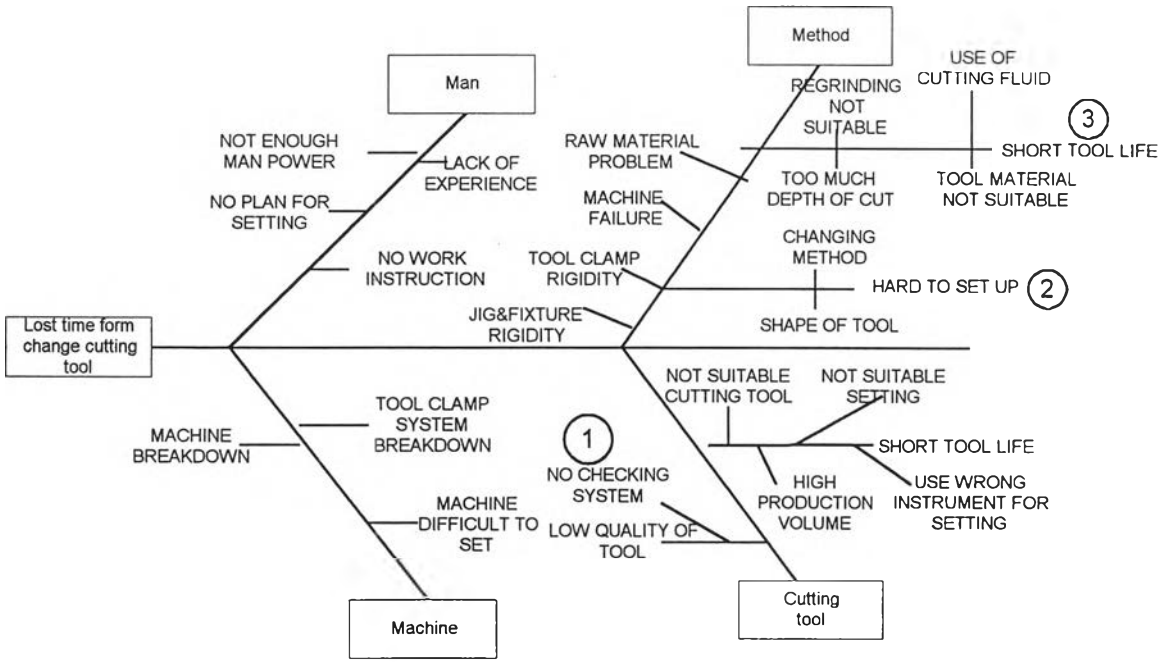


Figure 6.3 cause-effect diagram of tool change

Figure 6.3 shows cause of tool change by using cause-effect diagram. Cause of change cutting tool can be divided into 4 major cause. There are causes of man, machine, method and cutting tool.

6.2.2 Selected possible cause.

From cause- effect diagram 3 possible causes were selected. There are

1) No tooling inspection system

In process which seriously control dimension such as roughness, position and diameter, tooling precision should be accurate. Run out of tooling must be less than 0.01 mm. Normally, run out before assemble with tool holder is less than 0.005mm. Low tooling quality causes the longer set-up time and high defect rate (because of wrong setting)

Tooling are classified into 2 types

1. Standard tool: tools, which use for general work, such as drill, tap and insert.
2. Special tool: tool, which design for specific work. For example burnishing reamer, boring cutter.

Tooling problem always occur with special tool. At present, tooling section does not set system for tool incoming inspection.

2) Hard to set up

Method for change tool of machining center has 9 step which take 425 seconds for changing, The changing method was separated into internal and external operation. Internal operations can be down when machine stop. External set up will be done outside machine.

Table 6.5 analyzes tool change operation

No.	Changeover step	Time(sec)		Changeover	
		Total	Step	Internal	External
1.	Extract tool form machine	30	30	✓	
2.	Take tool to tooling room	54	24		✓
3.	Set tool at jig, unclamp tool, clean and change new tool.	71	17		✓
4.	Prepare jig for set run-out	250	179		✓
5.	Set run-out and lock tool.	340	90		✓
6.	Set height of tool and write tool length at tool holder.	358	18		✓
7.	Take tool to machine.	382	24		✓
8.	Input data of new tool offset.	412	30	✓	
9.	Set new tool to spindle.	425	13	✓	

From the analyzing tool change operation (Table 6.5) , it can be seen that from 425 minutes of tool change operation there are 73 minutes of internal work or only 17% of total work. Internal work compose of extract tool from machine spindle, set data of tool length to machine and set new tool to machine spindle.

Table 6.6 shows the description of tool change for precision tool. The difference between precision and non precision tool is in step 3. The precision tool need to set tooling run-out but non-precision tool will be set only tool length.

Table 6.6 The Procedure for changing of precision tool.

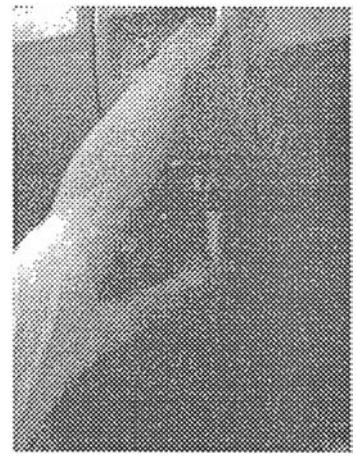
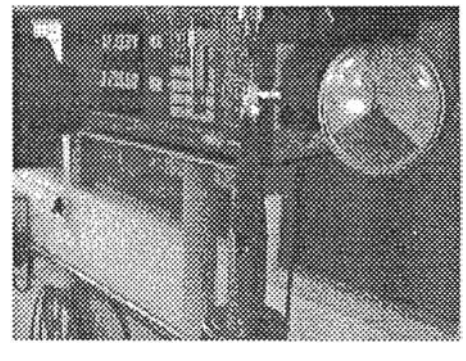
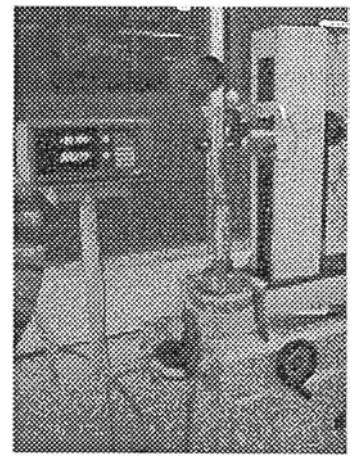
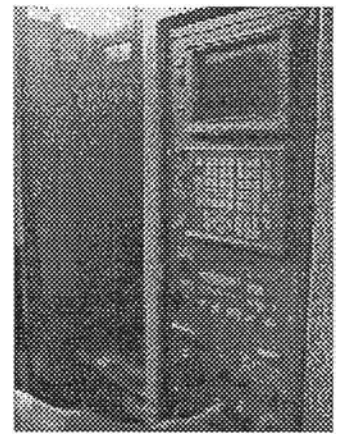
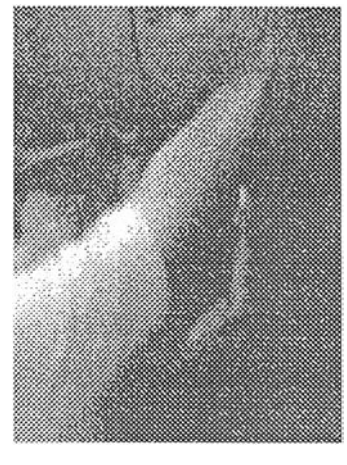
Tool change process for precision tool	
1. Extract tool from tool spindle.	
2. unclamp tool holder and change new tool into tool holder Instrument • Hook spanner • Jig for locate tool	
3. Set run-out of tool. In case of reamer tool run-out must be less than 0.005 mm. Instrument • Hook spanner • Tool presetter machine	

Table 6.6 (Continue) 4. set tool length and write tooling length at tool holder. <u>Instrument</u> • Tool presetter machine	
5. Input tool offset at machine monitor. After tooling section set the new tool length,	
6. insert tool to machine spindle	

3) Short tool life

There are many problems, which cause of tool breakdown as follow

- Improper tool selection.
- Inappropriate cutting condition such as, excessive cutting speed, inadequate feed, too much depth of cut. Nevertheless, the minimum production time per workpiece is more important than long tool life.
- Cutting hard material and unfavorable surface condition
- Cutting fluid (proper selection of cutting fluid (Additive), Carry out through filtration of cutting fluid).
- Machine is the cause such as spindle run-out too large, concentricity of spindle and guide bushing.

6.3.3 Weighting cause of problem

Table 6.7 weighting cause of tool change.

Tool name	Problem			Selected cause
	No tool inspection	Hard to set up	Short tool life	
Reamer diameter 15	5	5	1	Lack of inspection Hard to set up
Boring cutter diameter 90	1	1	5	Short tool life
Boring cutter diameter 53	1	1	5	Short tool life

Table 6.7 used for select the possible cause for each tool. Causes of tool change for reamer diameter 15 are about quality of tool and method for set up. Moreover, cause of boring cutter is short tool life.

- Conclusion

Table 6.8 problems and causes of lost time

Problem	Tool name	cause
Long inspection time		Using measuring gage
		High checking point
		Equipment is difficult to use
Long adjustment time	Reamer diameter 15	Follow up system Not suitable cutting condition
	Boring cutter diameter 90	Follow up system Machine equipment failure
	Boring cutter diameter 53	Follow up system Machine equipment failure
Long tool change time	Reamer diameter 15	Lack of inspection Hard to set up
	Boring cutter diameter 90	Short tool life
	Boring cutter diameter 53	Short tool life

All problem of lost time was analyzed and concluded cause as table 6.8. Causes of adjustment time and tool change were selected from cutting tool which take the highest lost time.