## CHAPTER 7

## COUNTERMEASURE

After cause of each problem was analyzed, action plan and implementation will be done. This chapter will describe the countermeasure, action plan and result for each problem.

### 7.1 Inspection

Causes of inspection are from measuring instrument, frequency of inspection, and equipment, which are difficult to operate. All of countermeasure will be evaluated by concerning of beneficial and feasibility (table 7.1). Countermeasure, which high beneficial and feasibility, will be selected to apply.

#### 7.1.1 Improvement plan

Table 7.1 improvement plan for inspection ——Implementation, —check result

| Cause | Countermeasure | Evaluation | | | Action plan | | | |
|---|---|---|---|---|---|---|---|---|
| | | Benefit | Feasibility | Score | Apr | May | Jun | July |
| Using measuring gage | Change to attribute gage | 0 | 0 | 1 | ◄——— | ►◄ | | ——► |
| Equipment difficult to use. | Change to attribute gage | 0 | 0 | 1 | ◄——— | ►◄ | ——— | ——► |
| High checking frequency | Check out side line by line leader | 0 | 0 | 1 | ►◄ | ——— | ——— | ——► |
| | Improve process capability | 0 | X | 5 | | | | |

Note : 0:Good, A : Fair, X: Poor

Score code: 0*0=1, 0*A=2, A*0=3,A*A=4,0*X=5,A*X=6.

(Apply from: Katsuya Hosotani, the QC problem solving approach, 1992)

To reduce inspection loss, measurement gage will be changed to attribute gage and inspected out side line by line leader. Time period for implementation is shown in table 7.1.

#### 7.1.2 Countermeasure

To solve these 3 causes, improvement plan can be separated into 3 stages

1. Emergency measures

Frequency for inspection can not be reduced because it is a tool for control quality of product.2 methods for solving high frequency of inspection are improve capability of process and inspect

by line leader. The first method is efficiently but it is difficult to implement because of highly investment.

1. The other method for reduce lost time from inspection is check outside line by line leader. In case of, production quantity is lower than plan leader who control line will do inspection.(Figure 7.1)

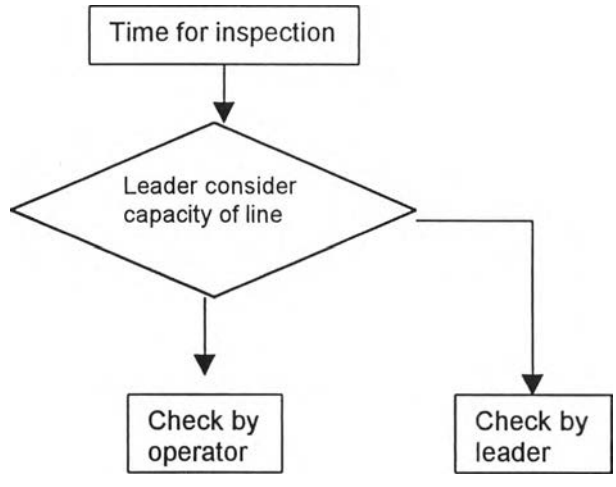



Figure 7.1inspection flow chart

2. Medium term plan,

- Using attribute gage.

Attribute gage takes shorter time than variable measuring gage. The examples of attribute gage are plug gage, snap gage, ring gage. At the first stage, the problem of cylinder gage will be improved.

Cylinder gage is equipment for measuring inside diameter of a hole. Plug gage is commonly used for holes too. Plug gages have 2-sides, go side and no go side. The Go side is smaller than the not go gage and slides into any hole whose smallest dimension is less than the diameter of the gage. The not- go gage must not go into the hole.

Improvement plan for change cylinder gage will be focused on the inspection point which check 5 times / shift. There are five positions, as shown in table 7.2. The frequency of using cylinder gage was reduced from five times/ shift to 2 times / shift. Estimation time after using plug gage (Table 7.3) time will reduce from 20 minutes to 10.4 minutes per shift. Dimension point, which checked by cylinder gages are diameter 90,53,11,60,28,18.5,17 and 15. The small size of diameter (11,18.5,17,15) will be changed to plug gage.

Although plug gages are easy to use and inexpensive, they only indicate whether a part is too small or too large, compare to an established standard. They do not measure actual dimension. From these reasons, cylinder gage still use 2 times/ shift to control trend of diameter.

Table7.2 Estimate plan for change instrument.

| Assumption | Frequency (checking point) | Total frequency (times/shift) | Cycle time (min) | Total time Before improve | Total time after improve |
|---|---|---|---|---|---|
| Cylinder gage | 8 points | 5 times/ shift =8x5= 40 times | 0.5 | 40x0.5 = 20 | 2 times/shift =16x0.5=8 |
| If change Plug gage 70% | 4 points | 3 times/shift =4x3= 12 times | 0.2 | 0 | 3 times/shift = 0.2x12=2.4 |
| | | | Total | 20 | 10.4 |

Table 7.3-inspection instrument improvement.

| PROCESS | CURRENT METHOD | IMPROVEMENT PLAN |
|---|---|---|
| Boring diameter 90 | Cylinder gage, 5 times/shift | - |
| Boring diameter 53 | Cylinder gage, 5 times/shift | - |
| Reamer diameter 11 | Cylinder gage, 5 times/shift | Cylinder gage, 2 times/shift<br>Go-no go gage,3 times/shift |
| Boring diameter 60 | Cylinder gage, 5 times/shift | - |
| Boring diameter 28 | Cylinder gage, 5 times/shift | - |
| Reamer diameter 18.5 | Cylinder gage, 5 times/shift | Cylinder gage, 2 times/shift<br>Go-no go gage,3 times/shift |
| Reamer diameter 17 | Cylinder gage, 5 times/shift | Cylinder gage, 2 times/shift<br>Go-no go gage,3 times/shift |
| Reamer diameter 15 | Cylinder gage, 5 times/shift | Cylinder gage, 2 times/shift<br>Go-no go gage,3 times/shift |

3. Long term plan

- Up date the related document in quality system such as control plan, operation standard, and check sheet.
- For further plan, in case of high production rate, the inspection can be eliminate by make auto check machine.

**7.2 Adjustment time.**

Tool which take long adjustment time are reamer diameter 15 in process M0508 and boring cutter diameter 90 and 53 in process M0502, M0503. Major causes of these tools are

Root cause can not be solved

Lack of cross-functional approach for solving problem

Lack of follow up system and the continuous problem solving system.

7.2.1 Countermeasure

Countermeasure for reduce adjustment time can be separate into three stage.

1. Emergency measure.

   At this stage, time for solving problem will be reduced by

   1. Make work instruction or manual for solving problem. ( in case of root cause can't be solved)
   2. Make jig & fixture for easier adjustment.

2. Medium term plan.

   To reduce quality problem in production line we should use a cross-functional team approach for improving and solving problem.

Improvement system flow chart (Figure 7.3).

1. Improvement system will be requested when
   1.1 Quality control section found non-conforming product in manufacturing line
   1.2 Manufacturing section can not solve the chronic cause
   1.3 Production engineer section needs to increase productivity in manufacturing line.
2. Data collection by production engineer section
3. Cause and countermeasure will be analyzed by production engineer and manufacturing
4. Planning for countermeasure
5. Implementing and checking result
6. Established working standard

The example of improvement report was shown in figure 7.4. Main information of improvement report compose of

- Cause – effect analyzing
- Immediate countermeasure
- Planning and cost evaluation for further improvement.

For example, in the case of burnishing reamer diameter 15, the immediate countermeasure is to control tool life and the permanent countermeasure is the use of tooling which supplied coolant from inside.

7.2.2 Improvement plan

Table 7.4 Improvement plan for adjustment

| Tool name | Cause | countermeasure | plan |
|---|---|---|---|
| Reamer diameter 15<br>• Surface roughness<br>• Diameter too small | Not suitable cutting condition | Increase coolant concentrate<br>Set tool life<br>Use reamer with inside coolant hole. | Mid of April 98 |
| Boring cutter diameter 90<br>• Surface roughness | Machine equipment failure | Change cutting tool | April 98 |
| Boring cutter diameter 53<br>• Surface roughness | Machine equipment failure | Change cutting tool | April 98 |

Critical problem will be considered for analyze cause of adjust tool. Three problems of cutting tool will be solved as shown in table 7.4 . The highest frequency and time for adjust is burnishing reamer diameter 15 of machine No. M0508. Analyzing cause and countermeasure is in Appendix c. after improvement, adjust time of this tool was reduced 60%. As shown in figure 7.2, table 7.5. Tool adjustment time of these tools was reduced from 597-minutes/ month to 290 minutes/month.

7.2.3 Result after improvement

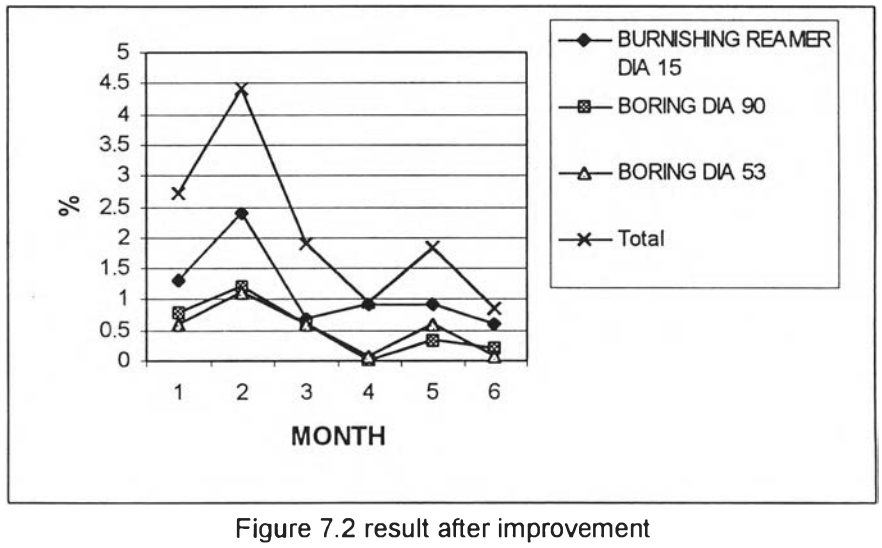



Figure 7.2 result after improvement

Table 7.5 data of time and percent of working time after improvement

| TOOL NAME | JAN | | FEB | | MAR | | APR | | MAY | | JUNE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time (min) | % | Time (min) | % | Time (min) | % | Time (min) | % | Time( min) | % | Time( min) | % |
| BURNISHING REAMER DIA 15 | 216 | 1.3 | 385 | 2.4 | 230 | 0.7 | 190 | 0.9 | 190 | 0.9 | 185 | 0.6 |
| BORING CUTTER DIA 90 | 143 | 0.8 | 200 | 1.2 | 200 | 0.6 | 0 | 0 | 70 | 0.33 | 75 | 0.2 |
| BORING CUTTER DIA 53 | 103 | 0.6 | 180 | 1.1 | 210 | 0.6 | 10 | 0.05 | 135 | 0.6 | 15 | 0.05 |
| Total | 462 | 2.7 | 690 | 4.4 | 640 | 1.9 | 200 | 0.95 | 395 | 1.83 | 275 | 0.85 |

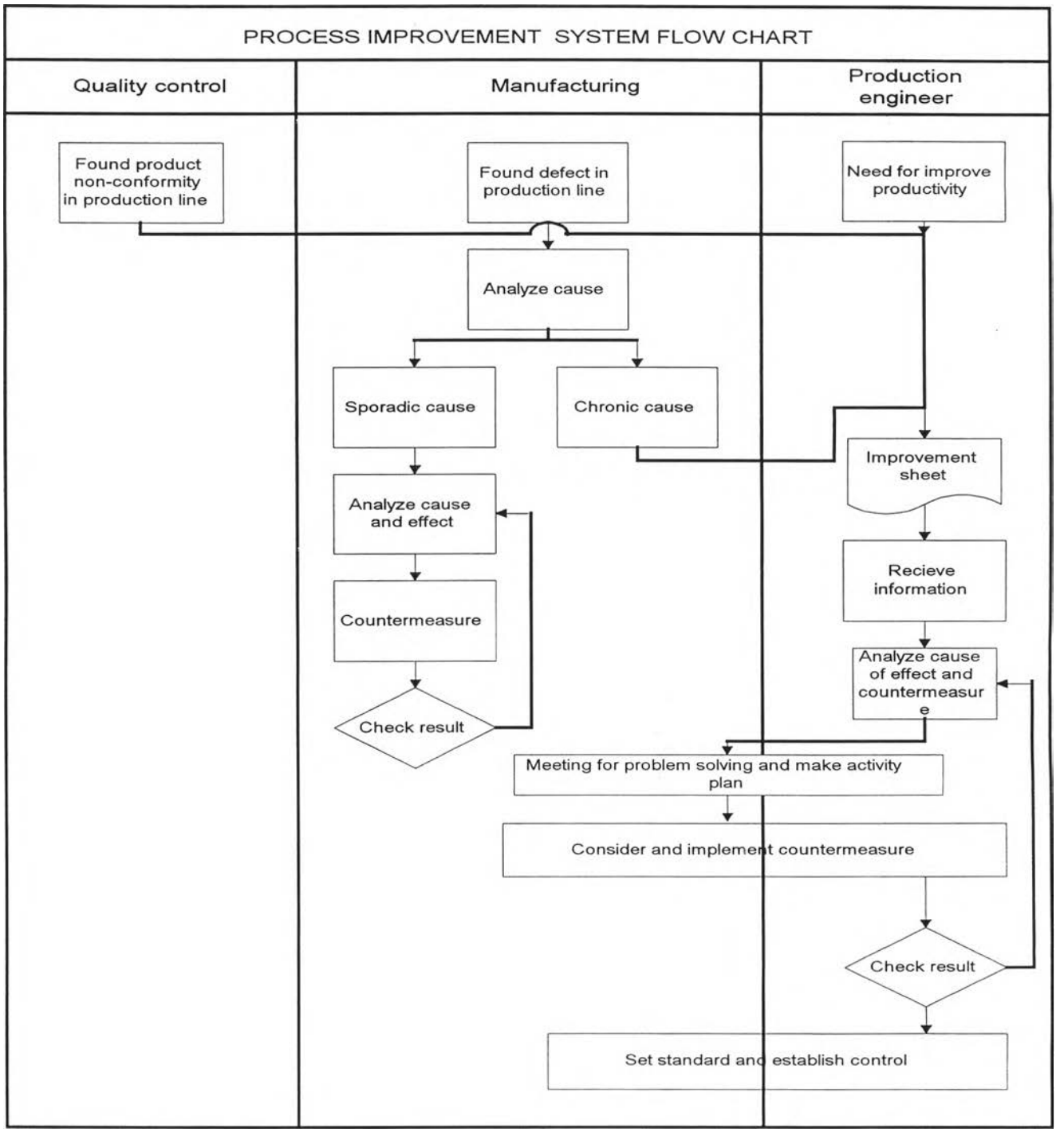



Figure 7.3Improvement-system flow chart.

# IMPROVEMENT REPORT

| FROM: PRODUCTION ENGINEER DEPT. | DATE 1/3/98 |
|---|---|
| | M.C. No. |

1. ข้อมูลจากแผนกผลิต/MANUFACTURING INFORMATION

| LINE M05 | PART NAM oil pump case | PROBLEM Roughness of valve hole |
|---|---|---|
| MACHINE M0508 | PROCESS burnishing valve hole | |

2. การตรวจสอบและสาเหตุ / DISCOVERY AND CAUSE OF DEFECT

Roughness failure from steel which melt at tool tip. Cause of melt come from

1. Tool wear . If tool not sharp the resistance between material and tool is high, it will cause of melt at tool tip

2. Coolant not enough. Because valve hole is a long hole ,length 35.7 , coolant was apply from external.The cutting fluid may not directly through hole.

3. การแก้ไขเบื้องต้น / IMMEDIATE COUNTERMEASURE ACTION/TAKEN:

1. Control tool life by make tool counter box and setting at machine

Tooling section responsible for collect tool life data of burnishing reamer diameter 15

4. การแก้ไขระยะยาว / PERMANENT COUNTERMEASURE

ACTIVITY PLAN

| Action Item | by | Date |
|---|---|---|
| Design tool and order(1.5 month) | surasa | 15may |
| Modify machine (contact OKK m | Tsuchiya | 20 may |
| Test machine | Tsuchiya | 22 May |

| Action Item | by | Date |
|---|---|---|
| | | |
| | | |
| | | |

ประมาณราคา/COST EVALUATION

| Variable cost | | Initial cost | |
|---|---|---|---|
| Tool 1 Pcs | 10,000 | Modify machine | 48,000 |
| | | Tool holder | 42,000 |

| Approved | Checked by | Report by |
|---|---|---|
| Tsuchiya | Surasa | |

Figure 7.4 example of improvement report for burnishing tool diameter 15

**7.3 Tool change time**

Causes of longer tool change time are composed of short tool life, quality of tool and tool hard to set up. Tools that take longest time for set up is burnishing reamer diameter 15, boring cutter diameter 90,53.

7.3.1 Improvement plan

Table 7.6 Improvement plan for tool change losses. ——— Implementation, ------ check result

| Tool name | Cause | Countermeasure | Evaluation | | | Action plan | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Benefit | Feasibility | Score | Apr | May | Jun | July |
| Reamer diameter 15 | Tool hard to set up | Set spare tool | 0 | 0 | 1 | | | | |
| | Tool quality | Inspection by tool maker | A | 0 | 3 | | | | |
| Boring cutter diameter 90 | Short tool life | Change tool material | 0 | 0 | 1 | | | | |
| Boring cutter diameter 53 | Short tool life | Change tool material | 0 | 0 | 1 | | | | |

Note : 0:Good, A : Fair, X: Poor

Score code: 0*0=1, 0*A=2, A*0=3,A* A=4,0*X=5,A*X=6.

(Apply from: Katsuya Hosotani, the QC problem solving approach, 1992)

Plan for reduce lost time from tool change, was shown in table 7.6. Implementation period started from April for preparing a spare tool, inspection by toolmaker and changing material of cutting tool.

7.3.2 Countermeasure

1. Set spare tool for burnishing reamer diameter 15.

Table 6.5 - 6.6 shows the method for change tool, it can be found that the method of setting precision tool for CNC machine, the external work take time more than internal work.( External work = 328 sec, Internal work = 73 sec)

The other alternative to reduce waiting time for setup tool is to prepare a spare tool for change. Tool, which takes a long time for setting, will be set before changing time. To reduce lost time in setting tool, spare for tool which high frequency to use will be prepared (As time chart in figure 7.5). Working step was reduced from 9 step to 5 step. It will cause of fewer machines set up time.

Figure 7.5 Tool change procedure

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Before | Extract tool form machine | Take tool to tooling room | Set tool at jig, unclamp tool, clean and change new tool. | Prepare jig for set run-out | Set run-out and lock tool. | Set height of tool and write tool length at tool holder. | Take tool to machine. | Input data of new tool offset. | Set new tool to spindle. |
| After | Extract tool form machine | Take tool to tooling room | Take tool to machine. | Input data of new tool offset. | Set new tool to spindle. | | | | |

2 lost time because of tooling quality

- Improve quality of tooling by introduce tooling supplier to inspect before delivery.
  Tooling problem always occur with special tool. At present, tooling section does not set system for tool incoming inspection. Supplier shall take full responsibility for the quality of their products and improve product quality. Requested tooling supplier delivery tool with inspection sheet. The special characteristics for each tool will be identify by tooling section. Figure 7.6 shows inspection report of reamer diameter 15.

3 Short tool life

Tool life was defined as the period of time that the cutting tool performs efficiently. Short tool life resulted in a high frequency of tool change.

- Establish tooling evaluation system.
  Study new tool type, which is longer tool life. The objective is to reduce frequency for change tool. For Boring cutter diameter 90 and diameter 53, diamond insert will be used instead of carbide insert because tool life of diamond insert is longer than carbide insert about 10 times. Tool evaluation sheet in figure 7.7 used for compare other tool type when tooling section need to change new tool.

## INSPECTION REPORT

| | | | |
|---|---|---|---|
| CUSTOMER | TOOLNET | MFG. NO. | 806177 |
| TOOL NO. | BD-0055 | DWG. NO. | SP-1149 |
| TOOL NAME | BURNISHING REAMER | P.O. NO. | TNT033-06/98 |
| QUANTITY | 1 | INSPECTOR | KOM / DATE 8/13/98 |

(BRIGHT ZrN COATING)

| DISCRIPTION | O.D. | O.D. | O.D. | O.D. | O.D. | STEP LENGTH | STEP LENGTH | STEP LENGTH |
|---|---|---|---|---|---|---|---|---|
| DIMENSION | 19.995 | 20.0 | 16.5 | 15.012 | 10.0 | 10.0 | 26.0 | 31.75 |
| TOLERANCE | +0 −0.005 | ±0.02 | +0 −0.02 | +0 −0.004 | +0 −0.02 | ±0.12 | ±0.10 | ±0.10 |
| 1 | 19.994 | 19.996 | 16.488 | 15.006 | 9.990 | 9.990 | 26.012 | 31.768 |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |

| DESCRIPTION | | RUNOUT | | WITHIN | | | |
|---|---|---|---|---|---|---|---|
| DIMENSION | A | B | C | D | E | F | G |
| TOLERANCE | .020 | .010 | .020 | .010 | .020 | .010 | .020 |
| 1 | .005 | .007 | .002 | .004 | .003 | .004 | .005 |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

NOTE

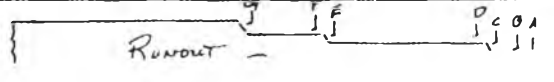



Figure 7.6 Tool inspection report

## Cutting Tool Evaluation Report

Company:

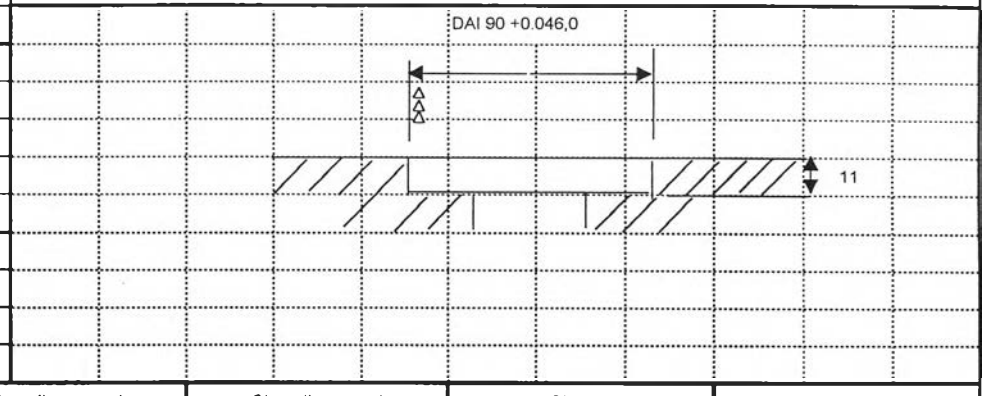
☐ Turnin ☐ Milling ☐ Endmilling ☐ Drilling
☒ Boring

Name:

Date

| | |
|---|---|
| Customer | |
| Product item | |
| Part name | *oil pump case* |
| Work material | *ADC12* |
| Hardness | ☐ HRC ☐ HB ☐ HS |
| Maching type | ☐ NC lathe ☒ Machining center ☐ Special purpose machine |
| | Horsepower HP ( Kw) |

Diagram/ Work Piece size, dimensions/Tooling/Number of Passes/etc.




| | | 1( sumitomo ) | 2( sumitomo ) | 3( ) | 4( ) |
|---|---|---|---|---|---|
| Tool | Manufacturer | | | | |
| | Insert Cat. No. | TPGA110304 | TPGA221 | | |
| | Grade | DIAMOND | CARBIDE | | |
| | Holder (Cutter Body) | | | | |
| Cutting Conditions | Revolution (R.P.M.) | *1500* | *1500* | | |
| | Speed:V (m/min or SFM) | *424* | *424* | | |
| | Feed:f (mm/rev or IPA) | *0.05* | *0.05* | | |
| | Feed:F (mm/min or IPM) | *80* | *80* | | |
| | Depth of cut (mm or inch) | | | | |
| | Cutting time (min/pe) | | | | |
| | Coolant (dry or wet) | *WET* | *WET* | | |

| | | No. of pcs | Reason for indexing* | No. of pcs | Reason for indexing* | No. of pcs | Reason for indexing* | No. of pcs | Reason for indexing* |
|---|---|---|---|---|---|---|---|---|---|
| Test data | 1st Edge | 2666 | (3) | *310* | (1) | | | | |
| | 2nd Edge | | | *350* | (1) | | | | |
| | 3rd Edge | | | *330* | (1) | | | | |
| | 4th Edge | | | | | | | | |
| | Average per Edge | | | *330* | | | | | |
| | Results | ● Excellent | | Excellent | | Excellent | | Excellent | |
| | | Good | | ● Good | | Good | | Good | |
| | | Satisfactory | | Satisfactory | | Satisfactory | | Satisfactory | |
| | | Poor | | Poor | | Poor | | Poor | |

Tested Inserts
(Please attach on the right)

| | | |
|---|---|---|
| *Please select the number corresponding to the reason for indexing | (1) When surface finish deteriorates unacceptably | (4) When power consumption reaches limit |
| | (2) When a fixed amount of tool wear is reached | (5) Sparking or Chip Discoloration and Disfigurement |
| | (3) When work piece dimension is out of tolerance | (6) Cutting Time or Component Quantity |

Figure 7.7 Tool evaluation report

- Conclusion

The countermeasure of lost time from inspection, adjustment and tool change can be concluded as table 7.7.

Table 7.7 Countermeasure report

| Problem | Tool | Cause | Countermeasure |
|---|---|---|---|
| Inspection time | | Using measuring gage | Change to attribute gage |
| | | Equipment difficult to use. | Change to attribute gage |
| | | High checking frequency | Check out side line by line leader |
| Adjustment time | Reamer diameter 15 | Not suitable cutting condition | Increase coolant concentrate<br>Set tool life |
| | Boring cutter diameter 90 | Machine equipment failure | Change cutting tool |
| | Boring cutter diameter 53 | Machine equipment failure | Change cutting tool |
| Tool change time | Reamer diameter 15 | Tool hard to set up | Set spare tool |
| | | Tool quality | Inspection by tool maker |
| | Boring cutter diameter 90 | Short tool life | Establish tool evaluation system. |
| | Boring cutter diameter 53 | Short tool life | Establish tool evaluation system. |