

CHAPTER 8

RESULTS

Result after reduction of lost time from April until September 1998, the increasing of line productivity was shown in figure 8.1. Trend of labor productivity of line M05 was increased.

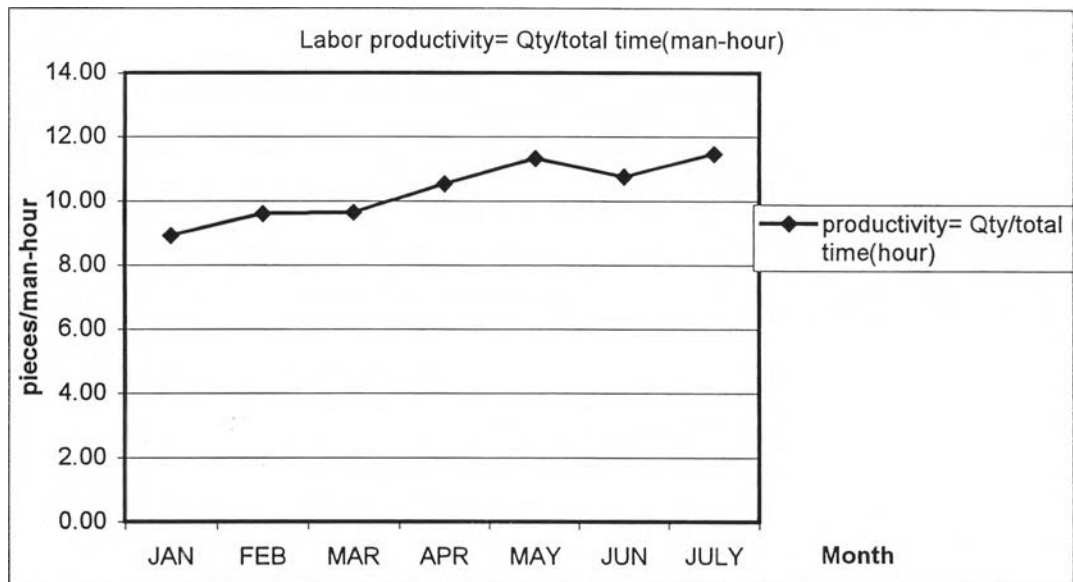


Figure8.1 graph of labor productivity from January-July98.

Productivity improvement can be defined as

$$\text{Productivity improvement} = \frac{\text{Productivity}_{\text{after}} - \text{Productivity}_{\text{before}}}{\text{Productivity}_{\text{before}}} \times 100\%$$

From data in table 8.5 ,

average productivity before improvement (January – March) = 9.4 pieces/ man-hour

average productivity after improvement (April – September) = 10.7 pieces/ man-hour

$$\text{Productivity improvement} = \frac{(10.7 - 9.4)}{9.4} \times 100\% = 14\%$$

Productivity can be increased by 2 approaches.

- shorter cycle time per piece
- lower down time which cause longer operation time

The improvement was separated into 2 approaches.

1. Reduce line balancing losses by improve cutting process which is non added value to product.
2. Reduce down time losses for this case 3 specific losses were selected.

- Inspection losses
- Adjustment losses
- Tool change losses

8.1 Reduction of line balancing loss

1st improvement

The bottleneck machine of this process was studied. The longest operating time of process is machine No.M0508. Reduction was done by

1. reduce air cut time
2. Increase feed speed of tool, which not affect to quality of product. In this operation, we select to improve rough reamer diameter 14.5. Former process, the old reamer, which is slightly undersize as a rough reamer, was used. However, it takes a long time for cutting. We improve by change cutting to carbide drill, which can cut with a higher feed speed.

2nd improvement

Reduction of process No.2&3 was done by

1. Reduce air cut time of reamer diameter 6,11,16.5 time was reduced 8.4 seconds.
2. Change efficient tool of boring cutter time was reduced by 6.4 seconds.

Result after improvement.

First of improvement in process No. M0508 cycle time was decreased from 4.55 to 4.25 minutes. The second improvement in process No. M0502, 03 cycle time was decrease to 3.83 minutes. The operation time decreased from 4.55 min/Pieces to 3.83 min/Pieces.

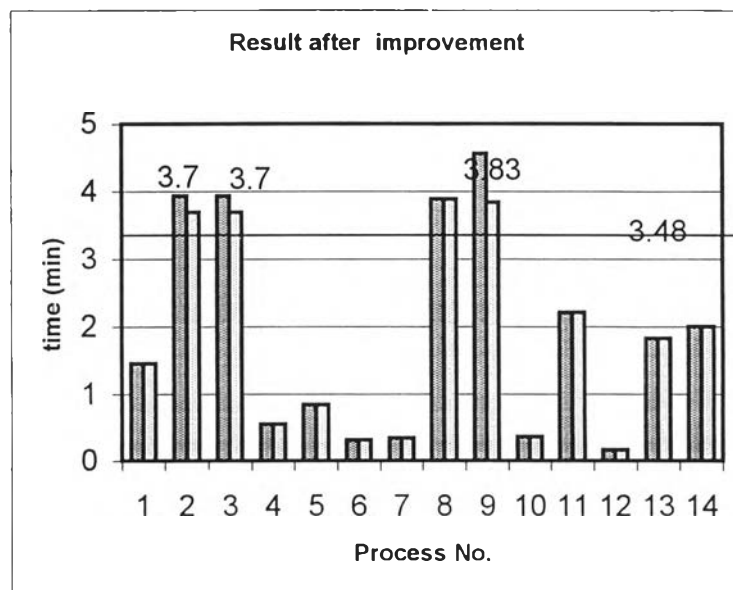


Figure 8.2 Result of improve line balancing losses.

Figure 8.2 shows time chart after improve cutting time and non-cutting time in machine M0502,03, M0509.

8.2 Reduction of down time losses.

8.2.1 Inspection time

Table8.1 Result of inspection time reduction

| | JAN | FEB | MAR | APR | MAY | JUNE | JULY |
|-------------------------------|-------|-------|-------|-------|-------|-------|-------|
| Inspection time | 1446 | 713 | 1301 | 749 | 1150 | 1178 | 287 |
| Operation time | 15959 | 15745 | 18550 | 21138 | 21116 | 31205 | 20091 |
| Q'ty | 2369 | 2516 | 2980 | 3714 | 3982 | 5594 | 3839 |
| Working day | 19 | 19 | 22 | 23 | 23 | 29 | 23 |
| % of lost time/operation time | 9.06 | 4.53 | 7.01 | 3.54 | 5.45 | 3.78 | 1.43 |
| min/100 pieces | 61.04 | 28.34 | 43.66 | 20.17 | 28.88 | 21.06 | 7.48 |

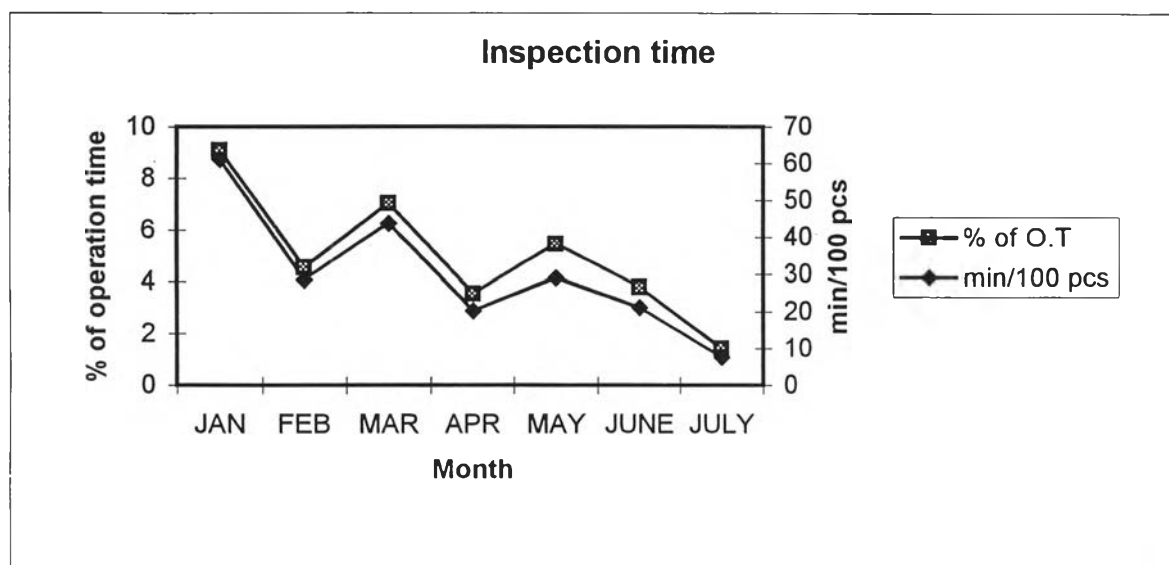


Figure8.3 graph of inspection time from Jan-July98.

Inspection can not be reduced because it important to ensure the quality of product. The best way for reduce inspection time is to make a good product quality. From this graph (figure 8.3), inspection time reduce because inspection was not done by operator. Leader of line checked it in April. After that the measurement gage was changed to attribute gage for easier to operate. From data in table 8.1 lost time from inspection was reduced from 44.35 minutes /100 pieces to 19.39 minutes/100 pieces (table 8.1).

8.2.2 Adjust time

Table 8.2 Result of adjust time reduction

| | JAN | FEB | MAR | APR | MAY | JUNE | JULY |
|---------------------|-------|-------|-------|-------|-------|-------|-------|
| Adjust time | 492 | 1035 | 870 | 733 | 856 | 1127 | 650 |
| Operation time | 15959 | 15745 | 18550 | 21138 | 21116 | 31205 | 20091 |
| Q'ty | 2369 | 2516 | 2980 | 3714 | 3982 | 5594 | 3839 |
| Working day | 19 | 19 | 22 | 23 | 23 | 29 | 23 |
| % of operation time | 3.08 | 6.57 | 4.69 | 3.47 | 4.05 | 3.61 | 3.24 |
| min/100 pieces | 20.77 | 41.14 | 29.19 | 19.74 | 21.50 | 20.15 | 16.93 |

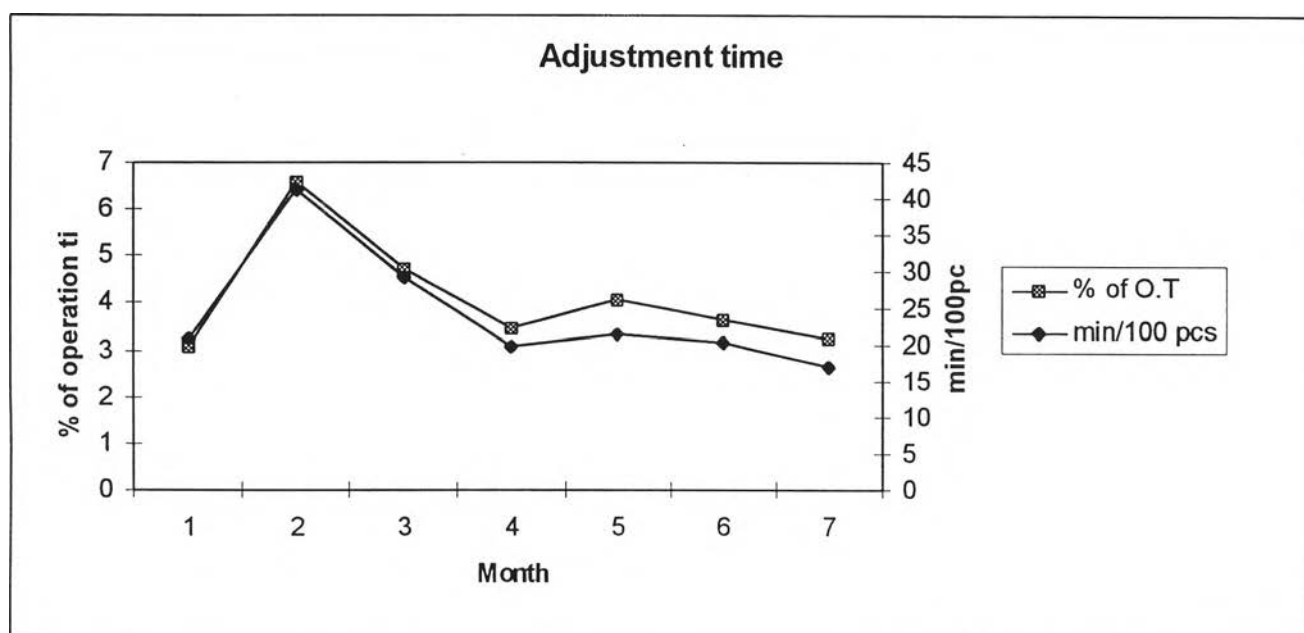


Figure 8.4 graphs of adjust time from January-July 98.

Reduce adjustment time by reduce the problem of quality in line. Quality improvement system was set to improve quality of product and eliminate chronic cause of problem. Three problem of adjustment was improved. In this line, the problem of faulty surface roughness in burnishing reamer and boring cutter were studied. Cause of poor surface finish is insufficient coolant supply. Tool of this process was changed to fluted reamer, which has oil hole at center of tool. Figure 8.4 shows trend of reduction after implemented in April. After improved, adjustment time was reduced from 30.37 minutes/100 pieces to 19.58 minutes/100 pieces.(table 8.2)

8.2.3. Tool change time Reduction

Table8.3 Result of tool change time reduction

| | JAN | FEB | MAR | APR | MAY | JUNE | JULY |
|-------------------------------|-------|-------|-------|-------|-------|-------|-------|
| Tool change time | 522 | 685 | 476 | 252 | 415 | 416 | 258 |
| Operation time | 15959 | 15745 | 18550 | 21138 | 21116 | 31205 | 20091 |
| Q'ty | 2369 | 2516 | 2980 | 3714 | 3982 | 5594 | 3839 |
| Working day | 19 | 19 | 22 | 23 | 23 | 29 | 23 |
| % of lost time/operation time | 3.27 | 4.35 | 2.57 | 1.19 | 1.97 | 1.33 | 1.28 |
| min/100 pieces | 22.03 | 27.23 | 15.97 | 6.79 | 10.42 | 7.44 | 6.72 |

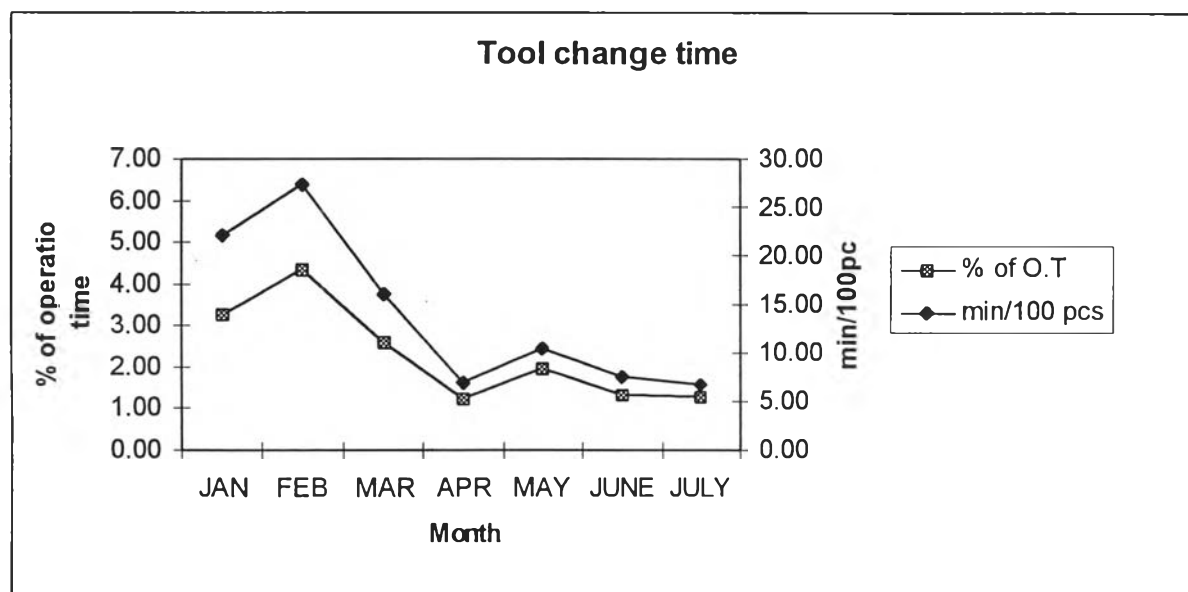


Figure8.5 Graph of tool change time from January-July,98

Tool change improvement. Was done by

1. Select appropriate cutting tool.

By improve cutting tool which easy to wear. In this research, tool which take a long time for setting and high occurrence of change was selected. Improvement point is

- Change insert material of boring cutter diameter 53 and 90 was changed from carbide insert to diamond insert. After improvement, both of tools has longer time than before. Frequency of tooling change could be reduced.

2. Set spare tool.

To reduce tool change time operation of tool change was separated into internal and external. External operation was done outside line, without line stopped.

3. Control quality of special tool.

By tool supplier inspection and delivery inspection result with tool. This system will ensure that special tool meet the quality quality.

After improved, tool change time was reduced from 21.07 minutes/100 pieces to 7.84 minutes/100 pieces.(table 8.3) Trend of lost time reduction was shown in figure 8.5.

- Conclusion

Table 8.4, the conclusions of improvement

| Lost time | Before improvement (Jan-Mar) | After improvement (Apr-Jul) | Difference | % improve |
|--------------------------------|------------------------------|-----------------------------|------------|-----------|
| B: Tool change | 3.4% | 2.08% | -1.32 | 38.8 |
| FI : inspection | 6.87% | 3.55% | -3.32 | 48.3 |
| Fa : Adjustment | 4.76% | 4.27% | -0.49 | 10.3 |
| % of lost time /operation time | 17.41% | 10.69% | 6.72 | 38.6 |
| Labor Productivity | 9.4 pieces/hour | 10.7pieces/hour | 1 | 14 |

Table 8.4 shows the result after improvement. Lost time from tool changed was reduced 38.3%, inspection 48.3%, adjustment 10.3%. It will cause of increasing labor productivity 14%. The calculation of labor productivity and lost time was shown in table 8.5. Figure 8.6 shows the relationship between productivity improvement and lost time reduction.

Table8.5 Data of time from January to July

| | JAN | FEB | MAR | APR | MAY | JUN | JULY |
|------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| Total operation time | 15959 | 15745 | 18550 | 21138 | 21116 | 31205 | 20091 |
| Total qty | 2369 | 2516 | 2980 | 3714 | 3982 | 5594 | 3839 |
| Total lost time | 2692 | 3088 | 2923 | 2307 | 2981 | 3261 | 1463 |
| working day | 19 | 19 | 22 | 23 | 23 | 29 | 23 |
| productivity= Qty/total time(hour) | 8.91 | 9.59 | 9.64 | 10.54 | 11.31 | 10.76 | 11.46 |
| Actual time= total time/Qty | 6.74 | 6.26 | 6.22 | 5.69 | 5.30 | 5.58 | 5.23 |
| Cyt. | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| %eff= cyc time/actual time | 66.8 | 71.91 | 72.29 | 79.07 | 84.86 | 80.67 | 85.99 |
| % of lost time=lost time/ OT | 16.87 | 19.61 | 15.76 | 10.91 | 14.12 | 10.45 | 7.28 |

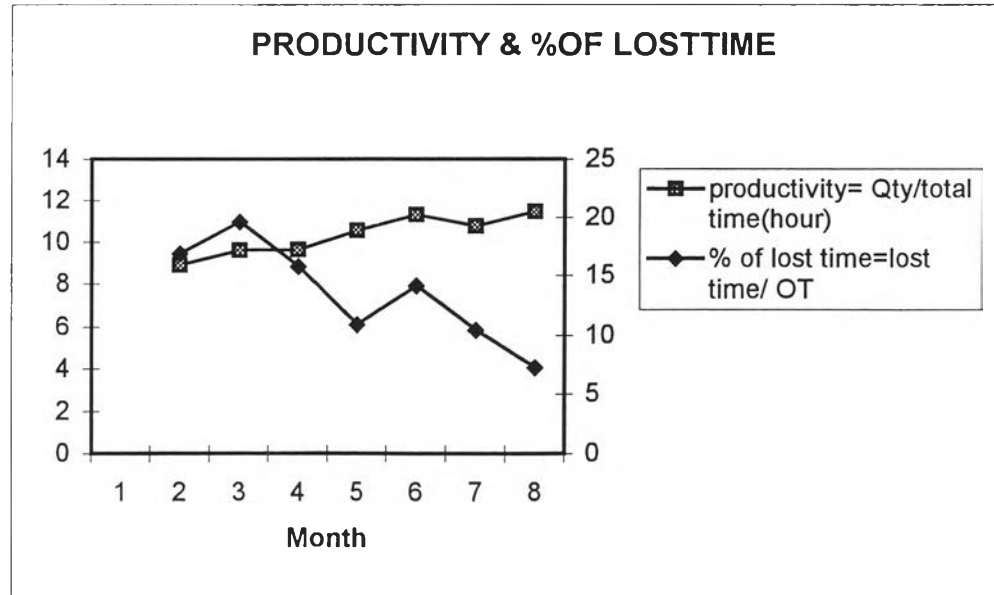


Figure8.6 Graph shows relationship between productivity and lost time.