CHAPTER 2

LITERATURE REVIEW

Basic Theory survey

2.1 Efficiency and lost time.

Lost time in this case concerned stoppage losses, which occurred in loading time. The methods for increasing productivity in automated production line can be summarized as improvement in the rate of equipment effectiveness.

On the other hand, manual production lines consist of the combined manufacturing activities of labor and machine or tools. In this kind of operation time, layout and production flow lines are designed to keep people occupied by working at 100% of the time.

Equipment effectiveness rate indicates that the equipment is being operated efficiently and effectively or not. According to figure 2.1, there are 4 specific losses, which affect the equipment efficiency

1. Planned down time
2. Down time losses
3. Speed losses.
4. Defect losses.

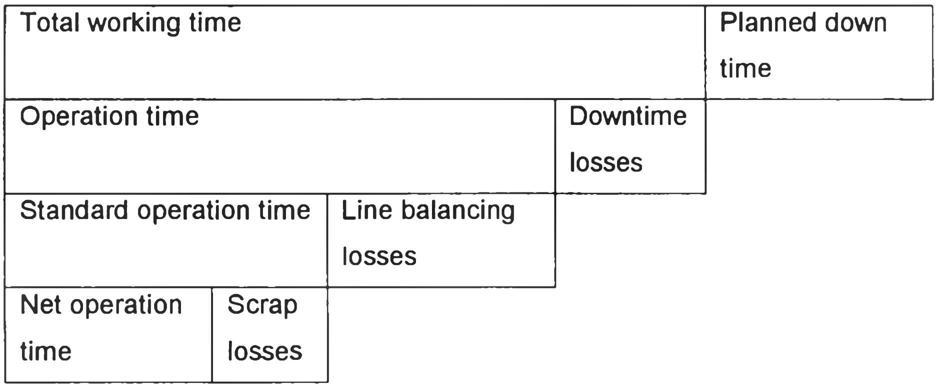

Figure 2.1 shows a time structure chart of an equipment.
(Source:Seiichi Nakajima, Introduction to TPM, Productivity press,1988)

1. Planned down time

Planned down time refers to the amount of down time officially scheduled in the production plan. Planned down time of pilot company includes downtime for management activities (such as meeting before working, cleaning production line and other non-operating time because of labor cause). Subtracting planned downtime from operating time resulted in the loading time.

$$\boxed{\text{Loading time} = \text{operating time} - \text{planned downtime}} \quad \text{---------------------------(2.1)}$$

In case of pilot company, operating time per shift is 470 minutes in first shift and 440 minutes in second shift. Planned down time is 30 minute per shift. Table 3.2 (chapter3) is a working schedule of pilot company.

2. Down time losses.

   Down time losses are any causes which interrupt equipment operating. Equipment loss time involve equipment stoppage loss resulting from equipment failure (breakdown losses) or set-up and adjustment. Change in operating conditions, such as change jigs and tool to start-up cause set up and adjustment losses other product, adjustment when controlled dimensions is error,and start-up at each shift.

3. Line balancing loss or speed losses

   Speed losses are caused by reduced operating speed. Equipment can not be operated at original or theoretical speed. At higher operating speed, quality defect and minor stoppages frequently occur because machine will be easy to failure.

4. Scrap losses

Scrap losses compose of

1 Quality-defect and rework losses which caused by off-specification or defective product manufactured during normal operation.

2. Yield losses, which caused by unused or wasted raw materials and are exemplified by the quantity of rejects, scraps, chips, etc.

2.2 Content of an operation.

Shigeo Shingo(1985) classified the structure of operation as in figure 2.2.It can be described as followed

1. Preparation, after-adjustment: refers to preparing for a task and cleaning up after task this is called set-up.
2. Principal operations: Task that are repeated everytime.
   1. Main operations: Refers to actual work such as cutting (processing), measuring using a gauge (inspection), transporting, or shortage (delay).
   2. Incidental operations: Refers to such actions as load/unload work into machine, applying a gauge inspection, loading goods onto a vehicle (transport) or loading goods on racks(delay).

3. Fatique allowances: Refers to taking periodic breaks during a shift because of fatique.
4. Personal hygiene allowances: Refers to going to the lavatory, drinking water, wiping away perspiration , etc.
5. Operation allowances: Refers to such actions as applying oil to a machine, sweeping away cutting scrap, etc.
6. Workplace allowances : Refers to actions such as waiting for material to arrive or taking a break because of an equipment failure.

The main approach for improvement are

1 Eliminate all operation other than principal operation which are incidental, preparation, after adjustment

2. Look for better ways of performing and allocating main operations, incidental operations, preparation and after adjustment, operations allowances, and workplace allowances.

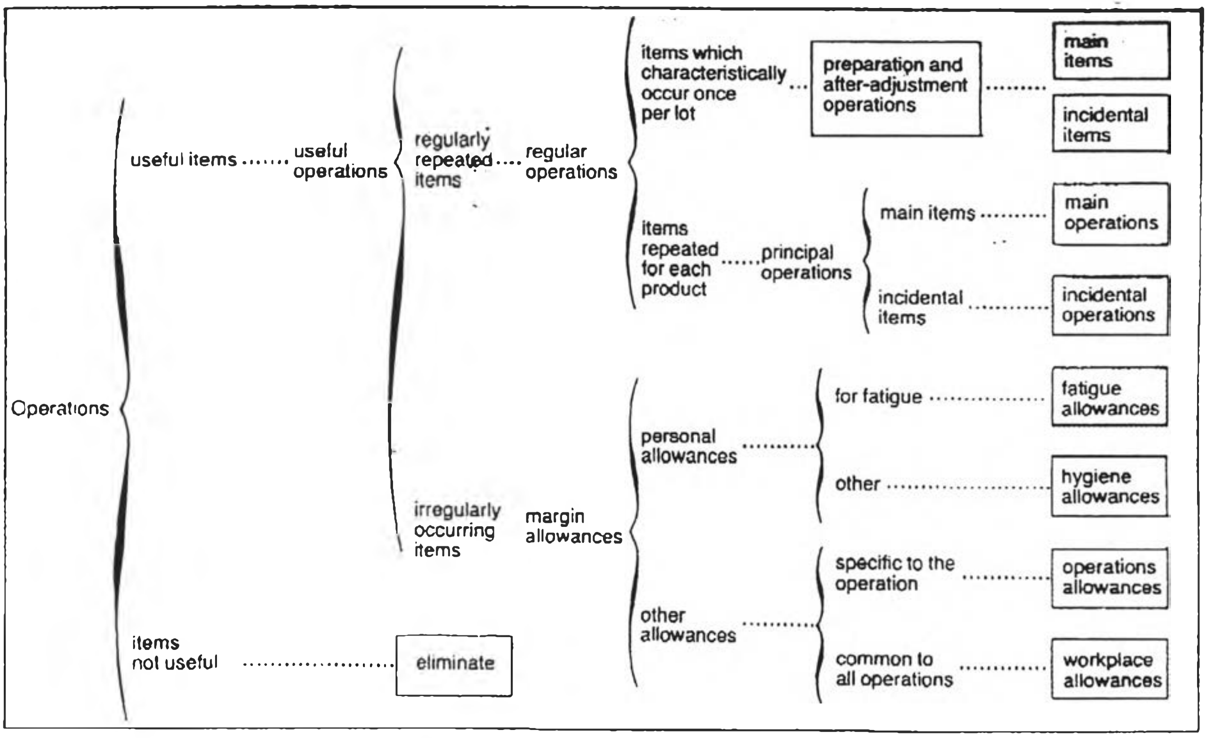

Figure 2.2 Structure of operation (Source: SHIGEO SHINGO, Zero Quality control,1985)

2.3 Productivity definition.

Productivity is a measure of the output resulting from a given input. Productivity is a measure of how well the productive forces are combined to produce desirable results. David A. Garvin (1992) describe productivity measurement into 3 catagories, moving from simple to more complex are composed of

1. Utilization and efficiency measures

   They reflect the intensity with which machinery and equipment are used and typically appear as percentage. This method suitable for capital-intensive industries where efficient equipment usage is a key to success.

2. Partial factor productivity measures.

   This measures go a step further by formally comparing inputs and outputs. But they are limited, because they track only a single input at a time. Substitution effects, with one input traded off against another, are not captured. The most popular partial measures involve labour, because it has traditionally been such as output per labour hour.

3. Total factor productivities measures

   It is the ratio of output to all inputs consumed. Such indexes combine labor, materials, capital and energy into a single aggregate input, which is then matched against output. Measurement problems are formidable, and the recommended procedures are often complex and difficult. But total factor productivity has and important advantage over partial measures. It accounts simultaneously for all inputs and this captures trade offs, such as reductions in direct labor that are due solely to new capital investment.

From the engineer's standpoint, productivity and efficiency are synonymous and efficiency is the measure of the amount of energy supplies converted

2.4 Q.C. tools for problem solving.

Dr. Ishikawa (1990) explained about Q.C. tool which mostly use for problem solving as follows

1. Cause and effect diagram

   Cause and effect diagrams, illustrate the relationship between characteristics(the results of a process), and those causes considered for technical reasons to exert an effect on the process. Diagram is used to show a primary and secondary causes of a problem. This diagram has been used to identify and solve a specific problem. Suspect causes and sub causes are generally presented under 5 major catagories: machine, method, material, man, environment.

2. Pareto diagram.

   Pareto diagram used to identify and analyze failure cause. To determine the causes of failure and what corrective actions are needed to reduce future failure cause. Dr

Ishikawa(1990) explained about pareto diagram that the pareto diagram is a type of frequency

distribution. It is prepared by collecting data and percentage losses together with their various causes and plotting them is descending order of frequency. When data were arrange in this way and plot the cumulative totals as shown by the solid line, it is generally found that the first two or three types of defect, for example, account for at least 70 to 80% of the total. It is clear that if these particular defects are eliminated, the majority of the defects will be eliminated, and the fraction defective will drop dramatically.

2.5 Metal cutting theory

KALPAKJIAN (1995) explained the main theory for cutting theoty as follows

1. This theory used for solve problem of cutting condition in machining line. Cutting processes remove material from the surface of a workpiece by producing chips. The major independent variables(Those that can be changed directly) in the cutting process are:
    - Tool material, coatings and condition.
    - Tool shape, surface finish and sharpness
    - Workpiece material, condition and temperature
    - Cutting parameters, such as speed, feed , and depth of cut.
    - Use of cutting fluid.
    - The characteristics of the machine tool, such as its stiffness and damping
    - Workholding, fixturing,etc.

    Dependent variables are those that are influenced by changes in the independent variables and are

    - Type of chip produced.
    - Force and energy dissipated in the cutting process.
    - Temperature rise in the workpiece, the chip, and the tool.
    - Wear and failure of the tool.
    - The surface finish produced on the workpiece after machining.

1. Cutting speed and feed

Cutting speed means surface speed or rate at which the work passes the cutter .
Cutting velocity is expressed by the formula (2.2)

$$\boxed{V = \frac{\pi DN}{1000}} \text{ -------------------------------(2.2)}$$

Where D: Diameter of tool (mm)

N : Rotary speed of work piece. (rpm)

Feed speed refers to the distance the tool travels per unit revolution of the work piece for stationary work and rotary tools. It is expressed in mm per revolution of the tool. The most important factor which must be considered when selecting the proper feed and speed are

1) the type and hardness of the material
2) the diameter and material of cutting tool
3) the depth of hole
4) the type and condition of the drill press
5) the efficiency of the cutting fluid employed
6) the accuracy and quality of the hole required
7) the rigidity of the work set up.

2. Machinability of metal

Machinability is the ease or difficulty which metal can be cut. Two factors that affect the machinability of a metal are ductility and hardness. Machinability is defined in terms of 3 factors

1) surface finish and integrity
2) Tool life obtained
3) Force and power requirement

3. Suface finish.

Factor which affect the surface finish are composed of

1) feed rate
2) nose radius of the tool
3) cutting speed
4) rigidity of machining operation
5) temperature generated during the machining process. High temperature, metal particles tend to adhere to the cutting tool and form a built-up edge.

The factors for improving surface finish are light cuts, small feed, high cutting speeds, cutting fluid, round nose tool(for turning)

Theoretical surface roughness.

The maximum surface roughness is given by

$$\boxed{Hmax = \frac{f^2}{8r}} \qquad \text{--(2.3)}$$

Where r is the radius of the tool. (nose radius) (mm.)

Hmax is the distance which measured by a midline-roughness datum.

F is cutting feed. Figure 2.3 shows the relationship between tool radius and surface roughness.

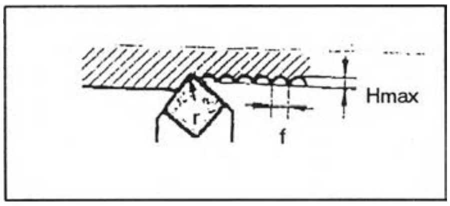

Figure 2.3 Tool radius and surface roughness.

In this case, chatter or BUE effects or effects of tool wear are ignored. This model is used for the single point effect on a rotating.

4. Cutting fluids.

Cutting fluid action

During a machining process, heat and friction cause metal to adhere to the tool's cutting edge, causing the tool to breakdown.

The fluid is drawn into the tool-chip interface by the capillary action of the interlocking network of surface asperities.The cutting fluid gains access to the interface by seeping from the sides of the chip. Because of the small size of this capiliary network, the cutting fluid should have small molecular size and proper wetting (surface tension) characteristics.

Types of cutting fluids

There are 4 main types of cutting fluids

1. Neat oil
2. Emulsion or soluble oil. This is mineral oils containing a soaplike material which make them soluble in water and cause them to adhere to the workplace during machining.
3. Chemical cutting fluid(synthetic fluids). Chemical cutting fluids depend on chemical agents for lubrication and friction reduction.

The advantage of cutting fluid.

1) Reduce friction between chip, tool and workpiece.
2) Reduce the temperature of the tool and work
3) Wash away chips
4) Improve surface finish
5) Reduce the power required
6) Increase tool life
7) Reduce possible corrosion on both the work and machine.
8) Help to prevent welding the chip to the tool.

Position of cutting fluid supply.

Sufficient cutting fluid should be supply directly to hole position as shown in figure 2.4

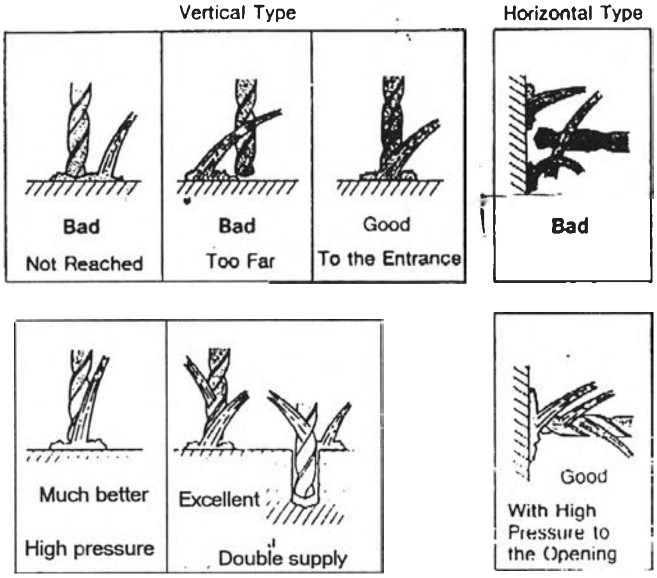

Figure 2.4 Position of coolant supply(Source: TOSHIBA TUNGALOY catalogue,1995)

high pressure or double coolant supply is better than single line.

2.6 Line balancing

The explanation of line balancing was given by james B. dilworht(1992) that each operation in a continuous line must require approximately the same length of time. The design of a continuous process line to equalize the time required at each workstation is called balancing the line.

If there are no buffers in a line, and the operation times of all the machines are different, then there is inefficiency even while no machine is down. This is because all machines that are faster than the slowest must wait for the slowest to complete its operations. This is undesirable, and lines without buffers should be designed so that all machines work at the same speed. The line balancing design problem is to assign operations to stations in a way that satisfies all the constraints and maximizes the wpeed of the slowest machine.

- **Conclusion**

All of these theory will be apply with sample line. The next chapter will show the background of line M05 concerning

- Product
- Process
- Present efficiency of line M05
- Selection of lost time for improvement