Technical Guide On

“Line Balancing and Cycle Time”

Small and Medium Enterprises Development Authority
Ministry of Industries & Production
Government of Pakistan
www.smeda.org.pk

HEAD OFFICE
4th Floor, Building No. 3, Aiwan-e-Iqbal Complex, Egerton Road,Lahore
Tel:(92 42)111 111 456, Fax:(92 42) 36304926-7
helpdesk@smeda.org.pk

REGIONAL OFFICE PUNJAB	REGIONAL OFFICE SINDH	REGIONAL OFFICE KPK	REGIONAL OFFICE BALOCHISTAN
3rdFloor, Building No. 3, Aiwan-e-Iqbal Complex, Egerton Road Lahore, Tel: (042) 111-111-456 Fax: (042) 36304926-7 helpdesk.punjab@smeda.org.pk	5TH Floor, Bahria Complex II, M.T. Khan Road, Karachi. Tel: (021) 111-111-456 Fax: (021) 5610572 helpdesk-khi@smeda.org.pk	Ground Floor State Life Building The Mall, Peshawar. Tel: (091) 9213046-47 Fax: (091) 286908 helpdesk-pew@smeda.org.pk	Bungalow No. 15-A Chaman Housing Scheme Airport Road, Quetta. Tel: (081) 831623, 831702 Fax: (081) 831922 helpdesk-qta@smeda.org.pk

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1. Disclaimer

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2. Introduction to SMEDA

The Small and Medium Enterprises Development Authority (SMEDA) was established in October 1998 with an objective to provide fresh impetus to the economy through development of Small and Medium Enterprises (SMEs).

With a mission "to assist in Employment Generation and Value Addition to the national income, through development of SME sectors, by helping increase the number, scale and competitiveness of SMEs", SMEDA has carried out 'sectoral research' to identify Policy, Access to Finance, Business Development Services, strategic initiatives and institutional collaboration & networking initiatives.

Preparation and dissemination of prefeasibility studies in key areas of investment has been a successful hallmark of SME facilitation by SMEDA.

Concurrent to the prefeasibility studies, a broad spectrum of Business Development Services is also offered to the SMEs by SMEDA. These services include identification of experts and consultants and delivery of need-based capacity building programs of different types in addition to business guidance through help desk services.

For more information on services offered by SMEDA, please contact our website: www.smeda.org

2.1 Industry Support Program

In order to enhance competitiveness of SMEs and achieve operational excellence, SMEDA established an Industry Support Cell (ISC) for provision of foreign technical support and knowledge transfer in collaboration with International Development Organizations. SMEDA's Industry Support Program (ISP) initially launched with Japan International Cooperation Agency (JICA) and actively engaged in reducing energy inefficiencies and improving production and quality of products with the support of Japanese Experts. Later on, similar activities with other international partner organizations like German Corporation for International Cooperation (GIZ), Training and Development Centers of the Bavarian Employers' Association (bfz), Germany, and United Nations Industrial Development Organization (UNIDO) were also successfully implemented

3. Background

Lean manufacturing is a production process based on a philosophy of maximizing productivity while minimizing waste within a manufacturing process.

The main idea in implementing lean manufacturing is to eliminate waste for continuous improvement in the process. Process waste include those processes, activities, products or services that require time, money or skills but do not create value for the customer. These may include underused talent, excessive motion or inventories or ineffective or wasteful processes and procedures. Removing these inefficiencies should streamline services, reduce costs and ultimately provide savings for a specific product or service through the supply chain to the customer.

Lean manufacturing benefits the industry in major four ways:

a- Eliminate Waste: Waste is a negative factor for cost, deadlines and resources. It provides no value to products or services.

b- Improve Quality: Better quality allows companies to remain competitive and meet the changing needs and requirements of customers.

c- Reducing Costs: Overproduction or having more materials than is required creates storage costs, which can be reduced through better processes and materials management

d- Reducing Time: Wasting time with inefficient working practices is a waste of money too, while more efficient practices create shorter lead times and allow for goods and services to be delivered faster

The idea behind lean manufacturing is “continuous improvement” and to achieve the same various techniques are adopted. Line Balancing is one of the common technique used in manufacturing where process is aligned with customer’s demand by utilizing the resources effectively and removing the waste.

4. What is Line Balancing?

Line balancing is the flow oriented production strategy adopted to meet the customer’s demand within the specified time. In this strategy right number of workers and machines are deputed on the assembly line to produce the products in stipulated time by reducing the waste (muda) that includes waiting, un-necessary movement and idle resources.

In lean manufacturing, line balancing is done to match the **takt time**.

Takt Time is the rate at which you need to complete a product to meet customer demand.

$$Takt\ Time = \frac{Total\ Available\ Production\ Time}{Customer\ Demand}$$

4.1 Benefits of Line Balancing

- Reduce Waiting Waste – *line balancing ensures the machines and workers should be worked in balance way, no one over burden or idle.*
- Minimize Inventory Waste – *it ensures that there is minimum work in progress*
- Absorb Changes – *a balanced production line is stable and flexible enough to adapt the changes*
- Reduce Production Cost and Maximize Profits
- Customer Satisfaction

4.2 How to Balance the Assembly Line?

Step 1 – Calculate the Takt Time

Main objective of the line balancing is to match the production rate to takt time , therefore first calculate the takt time using the aforesaid formula.

Step 2 – Perform Time Studies

The purpose of time studies is to find the time required to complete each task in the production line. In other words, how much time worker and machine spend on each process in the production line.

Time studies can be performed using the stopwatch.

Term "***Cycle Time***" is used in the manufacturing referring to the total time required to produce a product.

Time studies will help to identify the cycle time of assembly / production line.

Step 3 – Identify Bottlenecks and Excess Capacities

Using the data from the time studies, identify which process in production are taking longer time which results cycle time become greater than takt time. Exceeding takt time means late delivery to the customers.

And in case cycle time is less than takt time then find that process which causes the same. In this scenario, more resources are deputed than required and possibility of over-production.

Step 4 – Relocate Resources

Considering the situation your company is facing, rearrange the resources in the light time studies. Try to remove the bottlenecks or excessiveness and distribute the workload accordingly.

In simple words, organize the production line and minimize the idle time, movement and work in process (WIP).

5. How to improve the Cycle Time?

As mentioned earlier that that cycle time is the time required to complete the process and ideally it must in line with the takt time in order to meet the customer's demand. Therefore, in line balancing cycle time is very critical. There are many methods, ways and techniques to improve the cycle time.

The most common is to minimize the un-necessary worker movement, provide training , develop Standard Operating Procedures (SOPs) , implement Single Minute Exchange of Dies (SMED) and Factory Layout Improvement.

Few of them are briefed as follows:

5.1 Modular Arrangement of Predetermined Time Standards (MODAPTS)

This technique is adopted to analyze human work to determine reasonable expectations for the time to complete a defined task by a normal operator.

The accuracy of the system has been found comparable to most other such systems. It differs from most other systems in that it is based on human physiology.

Using MODAPTS, all body limb motion, eye and mental activity required of a person to complete a task are recorded. These motions may be analyzed for Value Added Analysis and Ergonomic review.

The unit time is **0.129 sec per MOD**. Like many such systems, they are coded with Letter & number combinations of MOD codes. Letter represents a type of activity such as R for read , W for walk ,P for put , F for foot action, G for Get and many others. The number represents the time it takes to complete the activity.

For instance,

M1 = 1 MOD of time for: Finger movement
M2 = 2 MODs of time for: Hand movement
M3 = 3 MODs of time for: Arm movement

M4 = 4 MODs of time for: Whole arm movement
M5 = 5 MODs of time for: Extended arm movement
M7 = 7 MODs of time for: Trunk movement

Some more examples:

Load (L): applies when an article is heavy. The factor starts above 4.4 pounds and is labeled L1

Extra Force (X): used where pressure is applied to overcome resistance , to restrain , or to achieve control and coded as X4. An example is the final tightening of a screw with the screwdriver.

Decision (D): apples when there is a delay in motion caused by the need to make a binary decision. The element is coded as D3

Read (R): refers to the eye use dealing with words, symbols and numbers. When the overall meaning is being looked for, the element is coded R2 and when the information is being read with more care, the element is coded as R3.

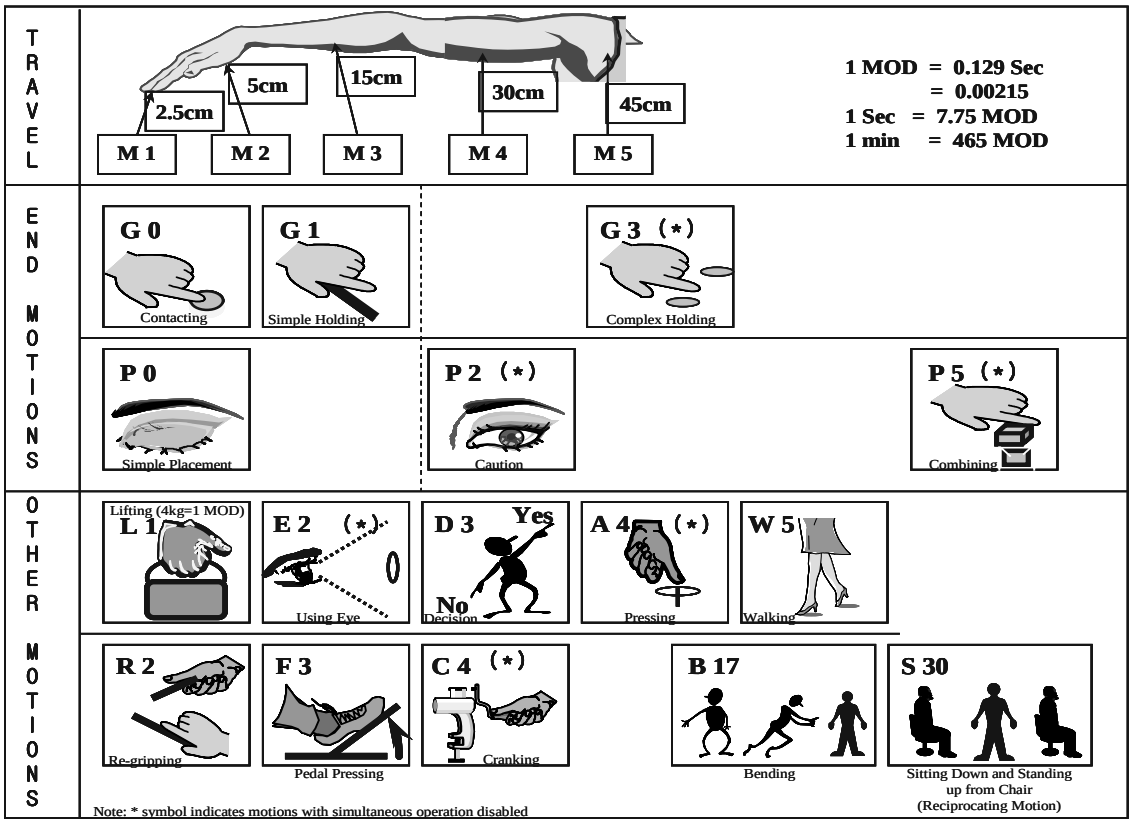

Fig 1: Example of MODAPTS

To understand further, take a case from production floor. To grab one ply of fabric from a stack on the sewing table and position to the sewing machine foot, this activity would be coded in MODAPTS as M3G3, M3P2 (3+3+3+2 = 11 MODs x .00215 = .02365 minutes).

The complete manual of MODAPTS is available from International MODAPTS Association, USA (website: https://modapts.org/)

5.2 Single Minute Die Exchange (SMED)

It is a system for intensely decreasing the time it takes to complete equipment changeovers. The essence of the SMED scheme is to convert as many changeover steps as possible to "external" (performed while the equipment is running), and to shorten and streamline the remaining steps.

Detailed document on "SMED" is available on SMEDA's Website which can be accessed by: https://smeda.org/index.php?option=com_phocadownload&view=category&download=1652:technical-guide-on-single-minute-exchange-of-dies&id=198:productivity-improvement&Itemid=977

5.3 Factory Layout

It is the arrangement of machines and equipment. Manufacturing concerns do focus on the layout of the production to maximize the capacity utilization.

There are number of ways that to plan the layout that includes: Process Layout, Product Layout, Fixed-Position Layout, Combination Layout and Cellular Manufacturing Layout.

Amendments in existing layout is quite difficult and SMEs usually face the same as they are usually out of space. In this scenario, it is best that bring the necessary tools and fixture close to the machines so that waste of time is minimized.

Detailed document on "Factory Layout" is available on SMEDA's Website which can be accessed by: https://smeda.org/index.php?option=com_phocadownload&view=category&download=1675:technical-guide-on-factory-layout-planning-october-2020&id=198:productivity-improvement&Itemid=977