UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PRODUCTIVITY IMPROVEMENT THROUGH LINE BALANCING IN AEROSPACE INDUSTRY

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By

KHAIRUL AZAM BIN BUHARI

Faculty of Manufacturing Engineering
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KHAIRUL AZAM BIN BUHARI

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process). The members of the supervisory committee are as follow:

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Main Supervisor

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DECLARATION

I hereby, declare this thesis entitled "Productivity Improvement Through Line Balancing In Aerospace Industry" is the result of my own research except as cited in the references.

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ABSTRACT

This study focusing on enhancing the productivity through line balancing method in painting department in CTRM AC (M). There are many ways to improve process line in production department. Line balancing is one of the approach to rebalance the process line to enhance the productivity in each work cells. This study will be focused on improving the assembly line in painting process department. The activities such as identifying the problems/wastes, problems classification; man, method, material, management and machine, process improvement and time study will be employed during this study. Then, the new concept of production process will be proposed and discussed for the implementation of the idea

ABSTRAK

Projek yang dijalankan akan memfokus kepada mempertingkatkan produktiviti melalui kaedah aliran sekata di jabatan cat di CTRM AC. Terdapat pelbagai kaedah di dalam mempertingkatkan aliran proses di bahagian pengeluaran. Aliran sekata adalah salah satu pendekatan yang digunalan didalam menstabilkan aliran proses dan ini secara langsung mempertingkatkan produktiviti di dalam kluster kerja. Antara aktiviti yang akan dijalankan termasuk masalah pembaziran, menklasifikasikan masalah kepada; manusia, kaedah, duit, pengurusan dan mesin, mempertingkatkan proses dan juga kaji masa akan digunapakai semasa menjalankan projek ini. Setelah itu, kaedah baru akan diusul dan dibincang untuk diaplikasikan

DEDICATION

For my beloved family:

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KHAIRUL AZMI BIN BUHARI

FARAH WAHIDA BTE BUHARI

KHAIRUL ANWAR BIN BUHARI

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

CTRM AC	-	Composite Technology Research Malaysia Aero Composite
LE	-	Leading Edge
TE	-	Trailing Edge
AIL	-	Aileron
U/WING	-	Under Wing
F/WING	-	Falsework Wing
O/WING	-	Over Wing
M/F	-	Movable Fairing
A/F	-	Affix Fairing
F/ FAIRING	-	Fix Fairing
MINS	-	Minute

CHAPTER 1

INTRODUCTION

1.0 Project Background

There are many ways to enhance the productivity, quality and cost (PQC) of a factory. This is true because a technology rapidly change due to improving each product to meets markets demand and customer satisfaction. In other words, improvement is limitless. For PSM's project, the project will be perform with the cooperation of industrial company which is the CTRM Aero Composite Sdn. Bhd. Malacca (CTRM AC). This study will be held in painting department whereas the scope study is to improving process line in painting department and to enhance the productivity of panit shop.The study will focusing using line balancing approach which one of the common method when improving process line. Line balancing be use because it will resulted with an optimum asembly line by equalize the workload among people, cells and deparment and all of this can significantly will lead on improving the productivity of painting department. There will be a several visit to CTRM AC for collecting data and discussion with CTRM side.

1.1 Problem Statements

Every workplace has its own mix of problems; often many of the problems are related with each other. For example improving the quality of just one product can make all the differences between timely and late delivery, and sometimes correcting on problem results in the correction of others in such cases, the key to find out what the most basic problem is. When there are several basic problems, we need to establish a priority list and solve them one at a time beginning with the most serious problem. This project is intended about the implementation and practices of lean manufacturing in painting department. There are several problems that arise in painting department that have to be tackled and solve:-

- Imbalance workload between each operator.
- Man, Method, Machine, Money, Management

1.2 Aims and Objective

The purpose of this project is to study the implementation and practices of line balancing in CTRM AC. The objective of this project is:-

- To re-balance the workload of operators in painting department.
- To have a healthy and better working environment in painting department.
- To enhance the productivity

1.3 Expected Result

At the end of project, the expected result is:-

- Higher and better productivity.
- Make workstation more comfortable to operator.

1.4 Scope of Project

The project will focus on:-

- Improving painting department in CTRM Aero Composite (M) Malacca.

In order to achieve the above aims and objectives, the following tasks are required to be performed:-

1. Literature review
    - Understanding to concept of Lean Manufacturing
    - Identify factors that influence the performance of production process.
    - Know various type of waste
    - Layout of painting department of CTRM.
    - Check current productivity

2. Process study
    - Familiarization process
    - Time study – do comparison current and previous
    - Observation

3. Analyze data
    - Analyze time study (cycle time, waste, productivity rate)

4. Proposed new process
    - Proposing new process with balance work distribution.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction of Line Balancing

Assembly Line Balancing, or simply Line Balancing (LB), (Falkenauer. E, 1992) is the problem of assigning operations to workstations along an assembly line, in such a way that the assignment be optimal in some sense. Ever since Henry Ford's introduction of assembly lines, (Boysen. N, 2006) line balancing has been an optimization problem of significant industrial importance: the efficiency difference between an optimal and a sub-optimal assignment can yield economies (or waste) reaching millions of dollars per year.

Purpose of the assembly line balancing technique is to:

- Equalize workload among the assemblers
- Identify the bottleneck operation
- Establish the speed of the assembly line
- Determine the number of workstations
- Determine the labor cost of assembly and pack out
- Establish the percentage workload of each operator
- Assist in plant layout
- Reduce production cost

The balancing technique is a use of elemental time standards for the purpose of (Falkenauer. E, 1992):

- Equalizing the workload among the people, cells, and departments.
  It doesn't help if one person, cell, or department can do one more unit of work if those departments feeding them with work or departments they are sending work to cannot keep up. All people, calls and departments need to be balanced with each other. To make it fairer for all, we can take work away from a busy station and give it to someone who doesn't have enough work.

- Identifying the bottle neck operation.
  The person, cell, or department with the most work is the bottleneck station, and we need to work on bringing this station into balance with the rest of the plant. This station needs more industrial engineering and supervisory help on an assembly line; we can save the equivalent of one-fifth of a person with every 1% reduction in the bottleneck station time until we reduce the bottleneck station 10%. We can justify 20 times the normal tooling cost because of this multiplier. The balancing technique is also a good cost reduction tool.

- Establishing the speed of the assembly line.
  Conveyor speeds need to be adjusted to the rate of the plant. Even if we don't have conveyors, move schedules are needed

- Determining the number of work stations.
  When one job has more work than one person can handle to achieve the quantity goals set by the customers, additional work stations must be added. The question is, how many? The time standard divided by the plant rate gives us the number of stations

- Helping determine the labor cost.
  Adding all operations hour per piece time standards will give us total hours. Total hours multiplied by the average hourly wage rate gives us labor cost.

- Establishing the per percentage work load of each operator.
  This determines how busy each person is compared to the bottleneck station, Takt time, or plant rate.

The steps for balancing an entire factory are:

- Balancing the rate of parts production to match the final assembly line rate (overall cycle times are the inverse of production rates).
- Adjusting work content and cycle times at each cell or station until times match system cycle times are nearly as possible.
- Trying to off-load work content of selected are no longer needed.

2.0.1 Definitions of Line Balancing

The classic definition of the line balancing problem, dubbed SALBP (Simple Assembly Line Balancing Problem) (Becker and Scholl, 2004), goes as follows. Given a set of tasks of various durations, a set of precedence constraints among the tasks, and a set of workstations, assign each task to exactly one workstation in such a way that no precedence constraint is violated and the assignment is optimal. The optimality criterion gives rise to two variants of the problem: either a cycle time is given that cannot be exceeded by the sum of durations of all tasks assigned to any workstation and the number of workstations is to be minimized, or the number of workstations is fixed and the line cycle time, equal to the largest sum of durations of task assigned to a workstation, is to be minimized.

The major problem with most of the approaches (Becker and Scholl, 2004) is that they generalize the simple SALBP in just one or two directions. The real-world line balancing, as faced in particular by the automotive industry, requires tackling many of those generalizations simultaneously.

2.0.2 Do Not Balance but Re-balance

Many of the operation research (Becker and Scholl, 2004), approaches implicitly assume that the problem to be solved involves a new, yet-to-be-built assembly line, possibly housed in a new, yet-to-be-built factory. This is the gravest over simplification of the classic research approach, for in practice, this is hardly ever the case. The vast majority of real-world line balancing tasks involve existing lines, housed in existing factories, in fact, the target line typically needs to be rebalanced rather than balanced, the need arising from changes in the product or the mix of models being assembled in the line, the assembly technology, the available workforce, or the production targets. This has some far-reaching implications, outlined below.

2.0.3 Workstations Have Identities

As pointed out above, the vast majority of real-world line balancing tasks involves existing lines housed in existing factories (Becker and Scholl, 2004). In practice, this seemingly "uninteresting" observation has one far-reaching consequence, namely that each workstation in the line does have its own identity. This identity is not due to any "incapacity of abstraction" on part of the process engineers, but rather to the fact that the workstations are indeed not identical: each has its own space constraints (e.g. a workstation below a low ceiling cannot elevate the car above the operators' heads), its own heavy equipment that cannot be moved spare huge costs, its own capacity of certain supplies (e.g. compressed air), its own restrictions on the operations that can be carried out there (e.g. do not place welding operations just beside the painting shop), etc.

2.0.4 Unmovable Operations and Zoning Constraints

The need to identify workstations by their position (Falkenauer and Delchambre, 1992), along the line (rather than solely by the set of operations that would be carried out there) is illustrated by the typical need of line managers to define unmovable operations and zoning constraints. An operation is marked as unmovable if it must be assigned to a given workstation.

This is usually due to some kind of heavy equipment that would be too expensive to move elsewhere in the shop. Zoning constraints are a generalization of unmovable operations: they express the fact that an operation can only be assigned to a given (not necessarily contiguous) subset of the workstations in the line. A typical example is operations that require the vehicle to be elevated above the operators: such operations can only be assigned to workstations with enough space to contain the elevated vehicle. Zoning constraints are typical in the automotive industry – any algorithm to be applied there must support them.

2.0.5 Cannot Eliminate Workstations

Since workstations do have their identity, it becomes obvious that a real-world Line Balancing tool cannot aim at eliminating workstations. Indeed, unless the eliminated workstations were all in the front of the line or its tail, their elimination would create gaping holes in the line, by virtue of the other workstations' retaining of their identities, including their geographical positions in the workshop. Also, it is often the case that many workstations that could possibly be eliminated by the algorithm are in fact necessary because of zoning constraints.