PRODUCTIVITY IMPROVEMENT IN INDUSTRY BY USING WITNESS SOFTWARE

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree Bachelor of Mechanical Engineering.

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STUDENT'S DECLARATION

I declared that this dissertation entitled "Productivity Improvement in Industry by Using Witness Software" is the result of my own research except as cited in the references. The dissertation has not been accepted for any degree and is not currently submitted in candidature of any other degree.

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To my beloved mother and father,

Mrs. Siti Rakiah Binti Mat Lazin
Mr. Wan Mustafa Bin Musa

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ABSTRACT

Productivity is a method to measure the performance or efficiency in the industry, organization or factory. The project is focused on trim line production of Mercedes Benz car. The study are about to improve production productivity, reduce waiting time in production line, increase the production in one day in order to achieve the target, used up all the space in the factory usefully and increase the busy at production line to the maximum by using Witness software. Person in charge and workers interview is done to collect some information about the assembly line in determining problems occur. Other than that, direct observation method, archival data and self collecting data are used. Live experiments are conducted on production lines. Four problems are identified such as reworked, not enough manpower, delayed process, high waiting time, and low production which are not in the target for one day production. Interventions are made to rectify the problems such as to reduce waiting time in problem's section by adding buffer which for temporarily storage for finished part in order to minimize waiting time for finished section sent the finish part without have to wait. As a result, the production productivity for the trim line production is increased.

ABSTRAK

Produktiviti adalah satu cara untuk mengukur prestasi atau kecekapan di sesebuah kilang, industri atau pun syarikat. Projek ini di fokuskan kepada jajaran pengeluaran kereta Mercedes Benz. Kajian ini fokus untuk meningkatkan produktiviti pengeluaran, mengurangkan masa menunggu di jajaran pengeluaran, meningkatkan pengeluaran, untuk satu hari untuk mencapai jumlah produk yang ditetapkan, menggunakan ruang yang ada sebaik-baiknya, dan menambah kesibukan di setiap stesen jajaran pengeluaran menggunakan perisian Witness. Dengan menggunakan kaedah ini akan mengurangkan bayaran kos untuk kerja lebih masa kepada pekerja untuk mencukupkan pengeluaran sasaran untuk hari tersebut. Ketua dan pekerja di temurah untuk mendapatkan maklumat yang diperlukan tentang jajaran pengumpulan bagi menentukan masalah yang berlaku. Selain itu, cara pemerhatian terus, data simpanan dan pengumpulan data sendiri digunakan. Eksperimen secara terus dijalankan di jajaran pengeluaran. Terdapat empat contoh masalah yang ditemui iaitu pembuatan semula, pekerja tidak mencukupi, proses terhenti, masa menunggu terlalu lama, dan pengeluaran rendah tidak mencapai tahap sasaran. Aktiviti telah di bentuk untuk mengatasi masalah tersebut, “buffer” iaitu tempat simpanan sementara di letakkan untuk penyimpanan sementara bagi bahagian yang telah siap dalam proses mengurangkan masa menunggu bagi stesen yang telah siap untuk terus menghantar bahagian itu tanpa perlu menunggu. Sebagai keputusannya, produktiviti untuk jajaran pengeluaran kereta tersebut telah meningkat.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter is discussed about the project overview, project background, and the problem of the project, the project objectives and project scopes.

1.2 Project Overview

In the world of manufacturing, the very important things to be considered are the finish product. Whether the finish product comes out with the criteria needed in the planning, more profitable, to strengthen business competitive edge to ensure company's consistent growth and can fulfill the customers supplies. So the product is the main priority to keep the customer and the owner itself to satisfied. In much management, sometimes there are lacks of due to delivery, due to movement, due to ineffective production process, due to waiting, due to defects and correction machine functional, outworkers, waste of space, cycle time and rework. All this problems could make the product not flow easily. But this problem can be solved or can be improved.

An ability to fix all this problems is necessary for the productivity and quality of the finish product. But to find the source of each of the problem may take time. The best way is to start with the good arrangement of the machines at the workplace, assembly place or the factory. The criteria that must be considered are machine, material, method, required production requirements, operates at competitive cost, complies with today's tough environmental regulations, and can be built at a reasonable price despite the rising costs of equipment, energy and construction labor.

Machines or equipments or the process component such as conveyor, forklift, work path, workers room, storeroom and others arrangement at a certain place is called plant layout. All these components may have the relationship with the outcome productivity. By using this way of plant layout, the old plant layout can be modified to improved productivity and to reduce the waiting time for each department. All these phenomenons are consequently affect the productivity and production. Hence, industries need the proper method that could help to improve productivity. This paper is more focused on to improve productivity by using plant layout. All criteria would be considered in this research.

1.3 Project Background.

Usually, in all manufacturing or process company there must be problems that emerge from small problem until the big problem. Even in a small shop there's still has its own problem. Usually, the problems face by the company such as low production, the quality is not satisfied, waste of time in each process and high cost production. In the shop itself also exist this problem, but it maybe because of the plant layout of the shop that is the base for the shop.

Besides that, these problems occur because of the machine used for the process. Hence, machine or tools used must have maintenance or updated within the period of time. This may cause the failure of the machine or tools. In other case, some company used completely man power without machine but tools are also used. But remind that, human also can be the source of the problem, usually in case of wasting time and quality. Hence to increase the productivity, all these problems must be reduced as lower as could. If it cannot be fix but at least to reduce or improve it.

The important thing is to keep the process or working flow on schedule without idle time and delay process. Some of the things to be measure in the plant layout are the arrangement of the machine used. The path use to travel by the workers or product is also need to be considered. With these two things are better will result in the time used to be lower. These entire criterions connected to each other but the basic or base must be strongly built with the right method. However, this criterion can be analyzed to get the best result in plant layout.

1.4 Project Problem Statement.

After the visiting and researching in a company, the major criterions seem to be found in this company are rework, not enough manpower, low production which is not on target and delayed process. But the main problem there is no exact cycle time for each section. In order to establish an adequate relationship between these criterions and plant layout, cycle time for each process, production target in line, workers involved, tools used, and number of cells used are required to be analyzed and develop. Each arrangement gives the different plant layout performance.

The bottleneck in process flow also occurs which can delay the process. So, the combination of the statement will be analyzed. The most of the cell arrangement could result in reducing the bottleneck. The different arrangement of cell will be analyzed to see the effective ones to be chosen as the new plant layout.

1.5 Project Objectives.

1) To analyze the plant layout by using witness software.
2) To design new layout of the selected process.
3) To improve the productivity in the industry.

1.6 Project Scopes.

The scope for this project covers the analysis of the plant layout design. This study is about to analyze this plant layout including all the criterions affected. In the visited company which is producing prosperous cars, there are three types of models they produce such as S-class, E-class and C-class. However, this research will be focus at the production line of S-class only. Under the same roof, these cars were produce divided in three lines for each class. Each line also divided by two which is trim line and mechanical line. In the trim line for S-class, there are five sections and for mechanical line are five sections also. Altogether are 10 sections to produce a complete car. However, it is still in the same straight line but the working instruction is different. This may take several analysis and arrangement to take out the best plant layout using the WITNESS software.

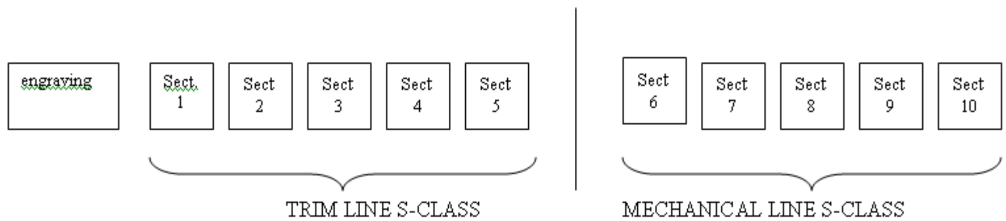


Figure 1.1: S-class Line.

Figure above show the assembly line for S-class car which is currently used in the factory.

CHAPTER 2

OVERVIEW OF PLANT LAYOUT

2.1 INTRODUCTION

This chapter will explain about improving the plant layout to improve productivity. All of it gives the information needed to complete this project. There are many things need to be consider in designing the new plant layout to get the most efficient, low cost, high production and the important thing is to improve the current productivity. The new design should have the characteristic needed and give the modification for the current design.

2.2 How to Improve Plant Layout.

How does one go about improving plant layout? If already done it before, know it is not an easy task! The way is take into account every phase of plant operations plus diverse considerations such as order taking, employee break room, utilities, special ventilation requirements as well as all processes and activities. In other words, many factors must be considered. Since it is difficult to take that many different factors into account in any one problem, a systematic approach is needed in order to arrive at the “best” layout for you. One approach is documented in Richard Muther’s Simplified Systematic Layout Planning (1994). This method is broken down into six basic steps. The steps and a brief description of each are shown below [1].

2.2.1 Step 1. Chart the relationships.

By identifying departments, activities, or work centers to be included in the project. It's best to keep the number in the range of 10-15 different work centers with a maximum of 20[1].

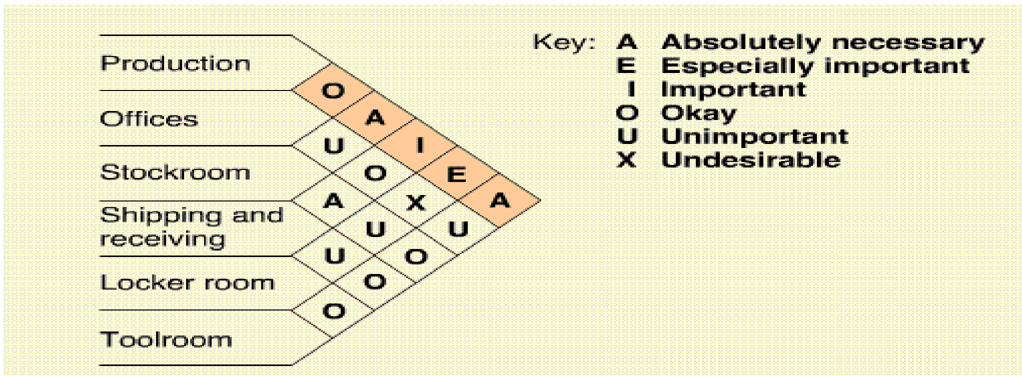


Figure 2.1: A sample of a mileage-type

Figure 2.1 shows the activities, department or work station in order of important and classification for the first step of this method.

Table 2.1: Relationship Chart.

VALUE	CLOSENESS
A	Absolutely Necessary
E	Especially Important
I	Important
O	Ordinary - Closeness OK
U	Unimportant
X	Not Desirable

Table 2.1 shows the Relationship Chart used to document the desired "closeness" between a work centers relative to all the other work centers. The desired closeness of each relationship value is defined in.

Some examples of reasons for a specific relationship value are:

- Shared equipment
- Shared personnel
- Movement of material
- Movement of personnel
- Shared utilities
- Noise
- Dirt
- Contamination
- Fumes
- Shared dock
- Supervision
- Cost of material handling

2.2.2 Step 2. Establish space requirements.

The next step in Muther's method is to prepare an "Activities Area & Feature Sheet." At this point the area required for each activity, work center, or department will need to determine. Other physical features that may be required, such as:

- Overhead clearance
- Maximum overhead
- supported load
- Maximum floor loading
- Minimum column spacing
- Compressed air
- Foundations or pits
- Fire or explosion hazard
- Ventilation
- Electrical

The above features are included on the form but should not be considered all-inclusive. Each manufacturing facility will have its own unique considerations and the form should be amended to include any necessary features [1].

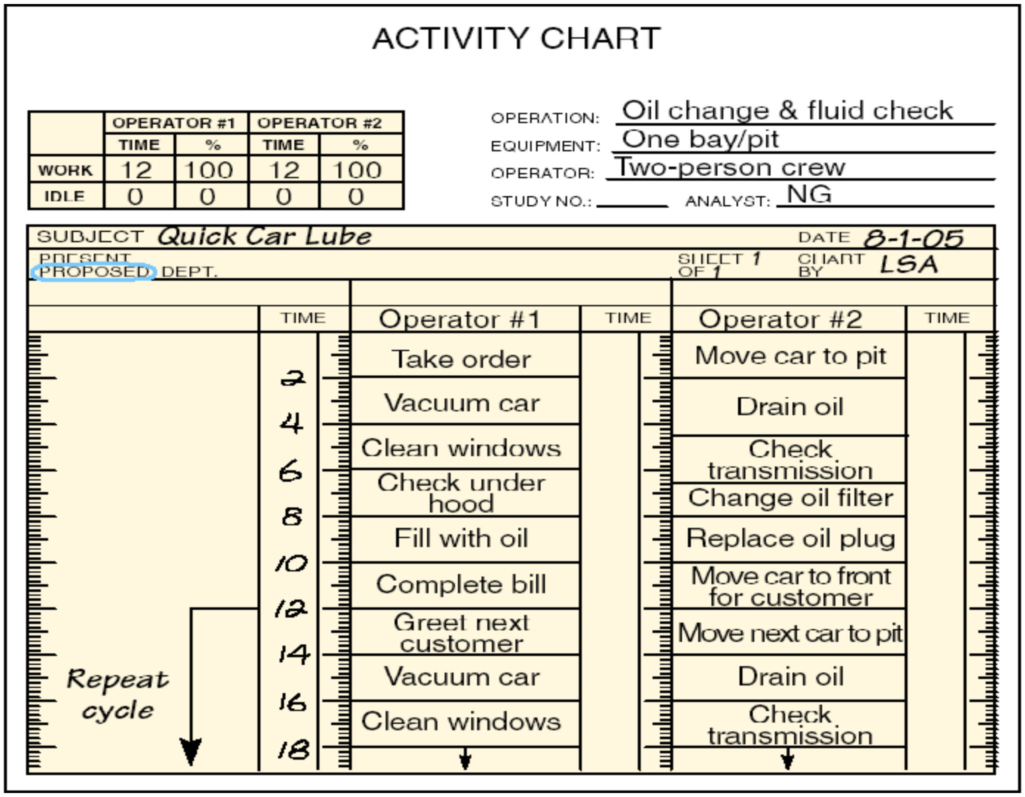


Figure 2.2: A sample of a completed Activities Area & Features Sheet.

This figure is a completed filling form of activities running at workstation. Time for each work finish is taken and type of work is listed.

2.2.3 Step 3: **Diagram activity relationships**.

First, a node diagram is constructed, showing a graphical representation of the activities and their closeness relationships. Each node represents an activity.. Then, connect the nodes with four parallel lines. These four lines represent an "A" relationship. Then rearrange and redraw as necessary to achieve the best arrangement. Repeat through the rest of the relationships and activities using different lines for each relationship. After that rearrange or redraw as necessary to achieve the best arrangement [1].

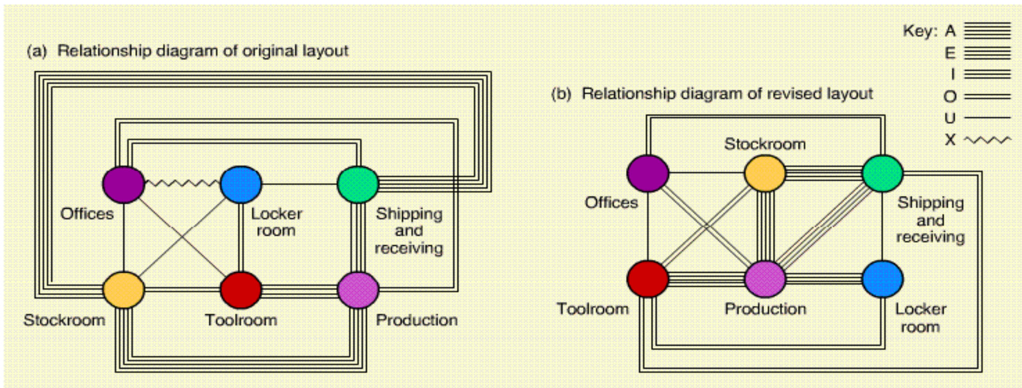


Figure 2.3: A sample of a completed diagram.

Figure 2.3 shows the process of before the rearrangement and after the process of rearrange using closeness of relationship.

2.2.4 Step 4: Draw space relationship layouts.

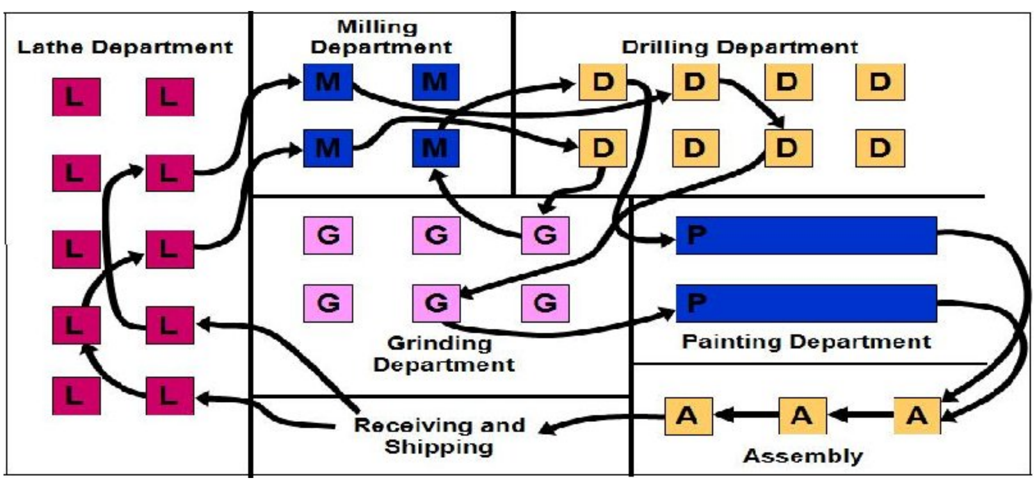
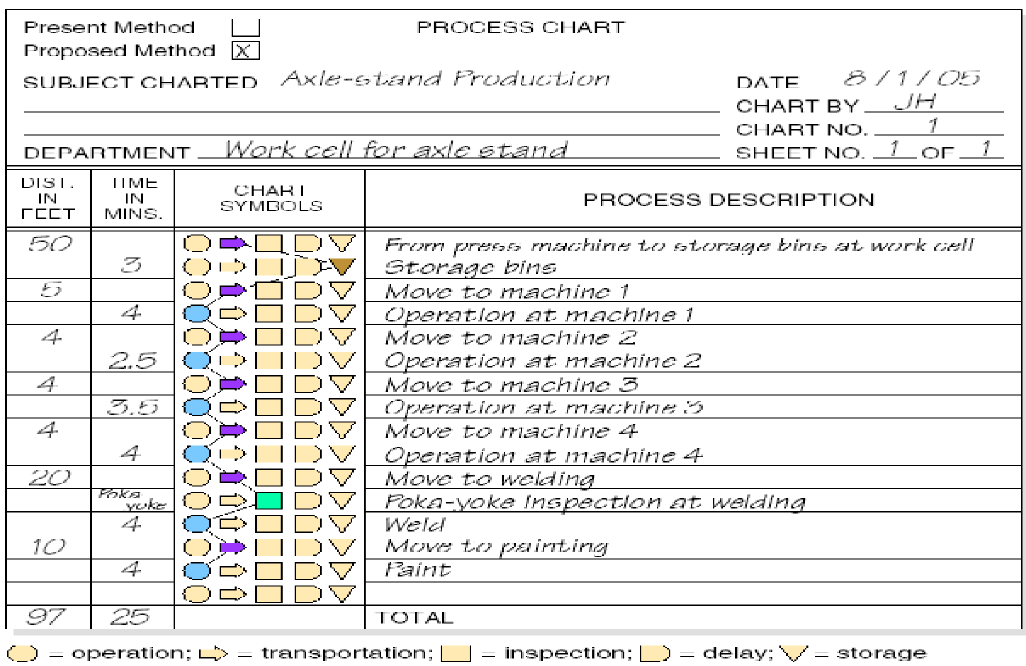


Figure 2.4: A sample space relationship layout

Figure 2.4 is the finish next step after combine the relationships diagram with the space requirements for each activity.

2.2.5 Step 5: Evaluate alternative arrangements.

The first step in evaluating different arrangements is to decide on the criteria by which each layout will be evaluated. These criteria may include such things as ease of supervision, flexibility in expansion, cost, material flow, etc. These criteria or factors must then be prioritized and assigned a weight value with the highest priority factor being a 10, the second a lower weight, the third lower, etc. Then, evaluate and rate each alternative layout by these factors using the same A,E,I,O,U ratings as used previously. After rating each alternative, convert the letters to numbers (A=4, E=3, I=2, O=1, U=0) and multiply by the respective weight values. Total the weighted rate values for each layout. The layout with the highest total score should be the best alternative [1] & [10].


Present Method ☐ PROCESS CHART
Proposed Method ☒
SUBJECT CHARTED Axle-stand Production DATE 8 / 1 / 05
CHART BY JH
CHART NO. 1
DEPARTMENT Work cell for axle stand SHEET NO. 1 OF 1

DIST. IN FEET	TIME IN MINS.	CHART SYMBOLS	PROCESS DESCRIPTION
50			From press machine to storage bins at work cell
	3		Storage bins
5			Move to machine 1
	4		Operation at machine 1
4			Move to machine 2
	2.5		Operation at machine 2
4			Move to machine 3
	3.5		Operation at machine 3
4			Move to machine 4
	4		Operation at machine 4
20			Move to welding
	Poka yoke		Poka-yoke Inspection at welding
	4		Weld
10			Move to painting
	4		Paint
97	25		TOTAL

Figure 2.5: A sample of a completed evaluation.

2.2.6 Step 6. Detail the selected layout plan.

Up to this point, the layout consists of blocks or various shapes for departments and areas. This step will be developing the final plan that will be used as a guide to show precisely where everything goes installing the plan. Reproduce the selected layout plan, preferably to a scale of 1/8- or 1/4-inch equals a foot. Identify and draw in the activities and major features, major equipment, and primary services not already included. Then begin to draw in the details of individual equipment, machinery, utilities, or auxiliary services, and label them. This is to re-evaluating the fit of these details and making minor adjustments for such things as free door swings, adequate aisle space, space for maintenance or service, etc. Make sure that the arrangement is functionally sound. One of the best ways of accomplishing this is to involve employees from the individual areas in this step. Finally, indicate the type of scale used. Add the compass points (or at least "north" to orient users), mark any key dimensions, and add the title block. Then the plan prepared to install [1].

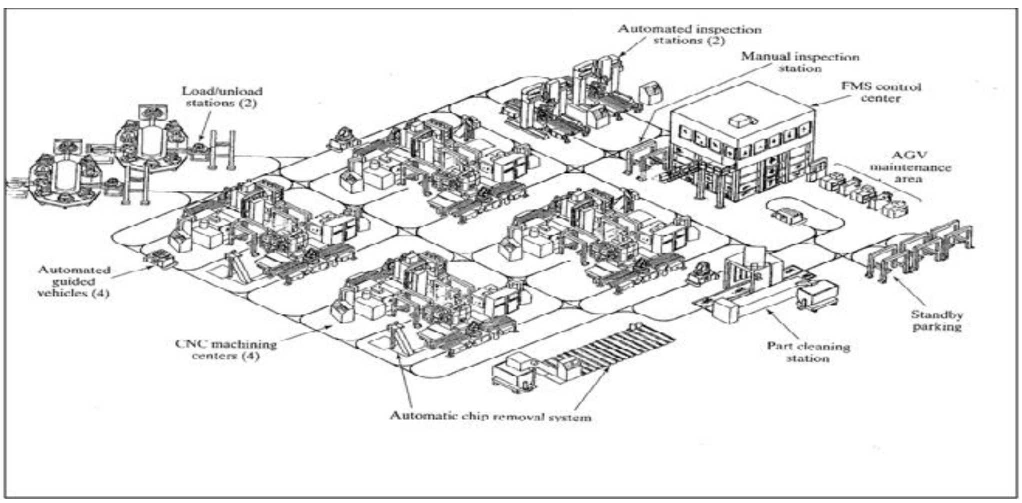


Figure 2.6: Sample of a detailed area.

To achieve the objectives of the study, the requirements of the following five steps were sequentially satisfied:

- Current manufacturing system was modeled and analyzed to determine the performance of the system.

- Manufacturing cells was constructed.

- Physical layout of machines (intra-cell) and cells (inter-cell) were developed by means of powerful and well known *CRAFT* algorithm, which is the basis for many computer-aided layout programs.

- New manufacturing system was modeled and analyzed to determine the system performance according to predetermined performance measures.

- Current and new improved layouts were compared [13].

2.3 Assembly lines.

An assembly line is a flow-oriented production system where the productive units performing the operations, referred to as stations, are aligned in a serial manner. The work pieces visit stations successively as they are moved along the line usually by some kind of transportation system, e.g. a conveyor belt.

Originally, assembly lines were developed for a cost efficient mass-production of standardized products, designed to exploit a high specialization of labor and the associated learning effects. Multi purpose machines with automated tool swaps al-low for facultative production sequences of varying models at negligible setup costs. This makes efficient flow-line systems available for low volume assembly-to-order production and enables modern production strategies like mass-customization, which in turn ensures that the thorough planning and implementation of assembly systems will remain of high practical relevance in the foreseeable future [6] & [4].

2.3.1 Terms of assembly lines

In light of the high practical relevance, it is not astounding that a massive body of academic literature covers configuration planning of assembly systems. In the scientific discussion, the term assembly line balancing (ALB) is used to subsume optimization models which seek to support this decision process.

Since the first mathematical formalization of ALB, academic work mainly focused on the core problem of the configuration, which is the assignment of tasks to stations. Because of the numerous simplifying assumptions underlying this basic problem, this field of research was labeled simple assembly line balancing (SALB).

Subsequent works however, more and more attempted to extend the problem by integrating practice relevant aspects, like u-shaped lines, parallel stations or processing alternatives (Becker and Scholl 2006). In spite of these efforts, which are referred to as general assembly line balancing (GALB), there seems to be a wide gap between the academic discussion and practical applications [6].

2.4 A Definition of Assembly Line Balancing (ALB).

According to the underlying concept of any SALB formulation, an assembly line consists of $k = 1,...,m$ *(work) stations* arranged along a conveyor belt or a similar mechanical material handling device. The work pieces (jobs) are consecutively launched down the line and are hence moved on from station to station until they reach the end of the line. A certain set of operations is performed repeatedly on any work piece which enters a station, whereby the time span between two entries is referred to as cycle time. In general, the line balancing problem consists of optimally partitioning (balancing) the assembly work among all stations with respect to some objective. For this purpose, the total amount of work necessary to assemble a work-piece is split up into a set $V = \{1,...,n\}$ of elementary operations named *tasks*. Tasks are indivisible units of work and thus each task j is associated with a processing time t_j also referred to as task time. Due to technological and/or organizational requirements, tasks cannot be carried out in an arbitrary sequence, but are subject to precedence constraint [4].

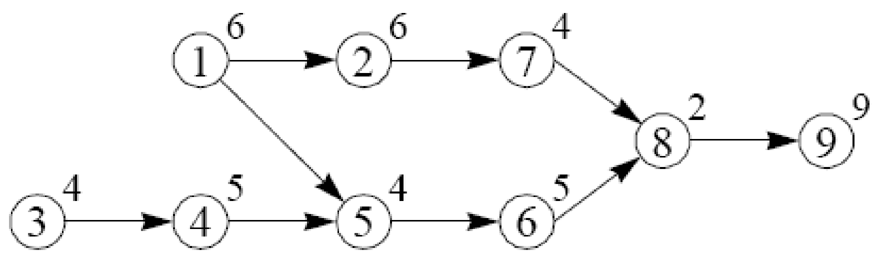


Figure 2.7: Precedence graph.

Figure 2.7 above is a diagram that shows the sequence of tasks to be performed on a unit of product in an assembly line.

The general input parameters of any SALB instance can be conveniently summarized and visualized by a precedence graph. This graph contains a node for each task, node weights which equal the task times and arcs reflecting direct as well as paths reflecting indirect precedence constraints.

SALB further assumes that the cycle time of all stations is equal to the same value c. Assembly lines with this attribute are called paced, as all stations can begin with their operations at the same point in time and also pass on work pieces at the same rate. As a consequence, all station times of a feasible balance may never exceed c, as otherwise the required operations could not be completed before the work piece leaves the station. Station times can however be smaller than the cycle time, in which case a station k has an unproductive idle time of $c - t\,(S_K)$ time units in each cycle.

In order to ensure high productivity, any good balance should cause as few idle times as possible. With regard to the objective function considered, SALB problems can further be distinguished into four types: For a given cycle time c,