

# ASSEMBLY LINE BALANCING AND LAYOUT DESIGN OF A BICYCLE

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## ABSTRACT

In the light of the high practical significance of assembly line balance(ALB),it is not surprising that a substantial body of academic literature covers configuration planning of assembly system. This paper focus is on practical use of the theorem of ALB.A consideration of this methodology as it pertains to bicycle assembly by identifying the parts and procedure; the precedence diagram of part constructed and workstation defined with cycle time of 18seconds implemented.The idle time is eliminated and workstation constraint optimized.

**KEYWORDS:** (workstation,task,cycle time precedence diagram)

## INTRODUCTION

In assembly line balancing we attempt to arrange (layout) individual work elements (tasks) into groups (workstations) so that ideally, each workstation is never idle. The layout of line processes differs greatly from the layout of intermittent processes. This difference arises because the sequence of processing activities in the line process is fixed by the product design. The product is made sequentially from one step to the next along the line flow. While the line flows layout does not affect the direction of flow of the product, it does affect the efficiency of the line and the jobs assigned to individual worker. The classic case of line flow operations is the moving assembly line. This form of production, result in great efficiency. At the same time, the assembly line seems to have serious side effects in terms of job boredom, absenteeism and turnover.

Therefore, the design of assembly lines and alternatives to the traditional assembly line should be carefully considered.

## OBJECTIVE OF THIS PAPER

The focus of this study is to design a layout (assembly lines) for the assembling of a bicycle.

### 1.2 AIM OF THE PAPER

The aims of this study includes

- i). To determine the least amount workstations minimum number of workstations or workers required
- ii). To assigned task to each station so that a desired level of output is achieved.
- iii). To establish the sequence of task to be assigned

### 1.3 SIGNIFICANCE OF THE RESEARCH

If a good design that meet with the criteria of desired output capacity, feasibility and efficiency is achieved, unnecessary input resources will not be wasted.

The significance of this project therefore, is to attain a design that will ensure capacity utilization, sequencing and efficiency.

## LITERATURE

Originally, assembly lines were developed for a cost efficient mass production of labour and the associated learning effects (Shtub and Dar-EI, 1989; Scholl, 1999, P.2). since the times of Henry ford and the famous model –T, however, production requirements of production systems has changed dramatically. In order to respond to diversified customer needs, companies have to allow for an individualization of their productions. For example German car manufactures BMW offers a catalogues of optional features which theoretically, result in different models (Meyr, 2004). Multipurpose machines with automated tool swaps allows for facultative production sequences of varying models at negligible set up costs. This make efficient flow line systems available for low volume assembly-to-order production (Mather, 1989) and enables modern production strategies like mass customization (Pine, 1993), which in turn ensures that the thorough planning and implementation of assembly systems will remain of high practical relevance in the foreseeable future.

Since the first mathematical formalization of ALB by Salveson (1955), academic work mainly focused on the core problem of the configuration, which is the assignments, of tasks to stations. Because of the numerous simplifying assumptions underlying these basic problems, this field at research was labeled simple assembly line balancing (SALB) in the widely accepted review of Baybars (1976), subsequent works however, more and more attempted to extend the problem by integrating practice relevant aspects, like u-Shaped lines, parallel station processing alternatives (Backer and Scholl 2006). Example, the assembling of the seat and front fork can be intermixed, but according to the diagram, not with assembly of the rear wheel. Within the 20 seconds cycle times, the operation time and the precedence diagram operation can be assigned to workstations to minimize the number f workstation required. There are a great number of possible assignments to consider.

If the procedure constraints are ignored, there are 18 operations ways to workstation. Since we cannot enumerate all possibilities in real world cases, assembly line balancing methods have been devised to solve this problem the best methods currently available are heuristics methods, which do not necessarily find the minimum number of workstation but do usually find solutions, which are close to optimum.

One of the methods to solve the problem at hand is to begin the assignment with the one that has the least number of predecessors and then move on to those with more predecessors as first suggested by Kenbridge and Wester (1961).

In table 4.2, the operations are ranked-ordered in terms of their number of predecessors. The operations are then assigned to workstations moving down the list, until a maximum of 20 seconds is reached.

## HOFFMAN'S APPROACH

Hoffman's method (1963); for example, required three types of inputs common to all assembly line balancing problems; precedence relationships, operations to workstations, the theoretical minimum numbers of stations and the efficiency of the balance as shown in figures.

Hoffman's method attempts to assign to the first station those operations, which would result in the least idle time at that station. Enumerating feasible solutions from the precedence graph. If a solution with no idle time is found, the enumeration is stopped. A similar procedure is followed for the second station; the third station and so on, until all operation has been assigned.

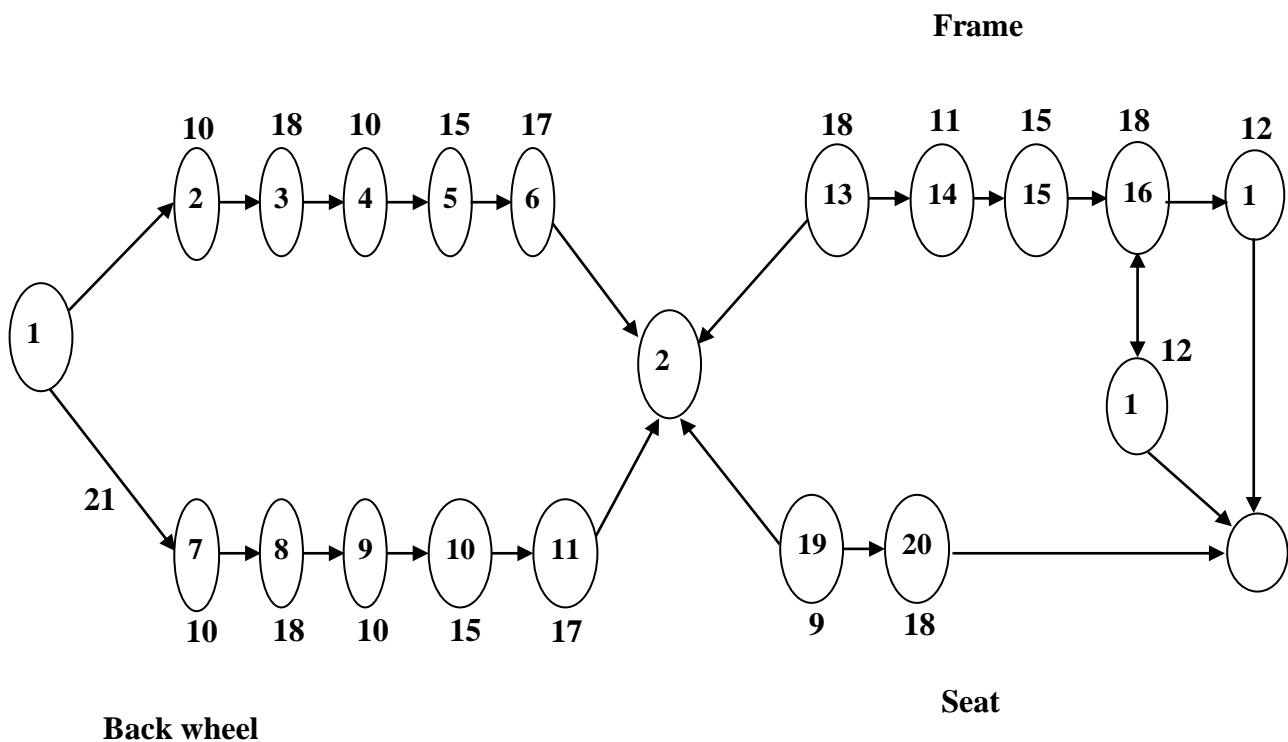
The assembly line is then also balanced backwards on the precedence graph, and the best forward and backward solution is taken as the final balance.

One of the implications of assembly line balancing is that efficiency varies greatly with cycle line as shown in this study. Tabulation of Result/Diagrams

**Table 1: Assembly operation (Bicycle)**

Operation Number	Description Of Work	Tasks Time (Seconds)
1	Starting Pointfront Wheel Assembly	0
2	Insert Front Wheel In	10
3	Fit Collar On Front Wheel Fork	18
4	Insert Handle Bars And Grips In Fork	10
5	Fix Wheel On Axle	15
6	Fit Type And Tube Back Wheel Assembly	17
7	Insert Back Wheel Fork In	10
8	Insert And Fasten Cotter Key	18
9	Fit Washer On Back Axle	10
10	Fix Wheel In Axle	15
11	Fit Tyre And Tube	17
12	Dummy Operationframe Assembly	0
13	FIX PEDAL	18
14	Fix Sprocket	11
15	Attach Frame To Front Wheel	15
16	Attach Frame To Real Wheel	18
17	Fix Chain To Pedal	12
18	Fit Chain Into The Rear Wheelseat Assembly	12
19	Insert Seat Into Frame	9
20	Tighten Sit Set Screw	15
21	End Point	0
	TOTAL	253

Operation 1, 12 and 21 are added for purpose of computer convenience. The computer requires a single beginning and ending point in the diagram.



**Fig 11: Precedence diagram: for bicycle front wheel**

**TABLE 2: BICYCLE OPERATION RANKED BY NUMBER OF PREDECESSORS**

Operation	Numbers of predecessors	T <sub>1</sub>
1	0	0
2	1	10
7	1	10
3	2	18
8	2	18
4	3	10
9	3	10
5	4	15
10	4	15
6	5	17
11	5	17
12	11	0
13	12	18
19	12	9
14	13	11
20	13	18
15	14	15
16	15	18
17	16	12
18	16	12
21	20	0

**TABLE 3: Least predecessor rule line balance 20-second cycle time**

Station	Operation	Idle
1	1, 2, 7	0
2	3	2
3	8	2
4	4, 9	0
5	5	5
6	10	5
7	6	3
8	11	3
9	12, 13	2
10	19, 14	0
11	20	2
12	15	5
13	16	2
14	17	8
15	18, 21	8

**TABLE 3: SAMPLE ASSEMBLY LINE BALANCING**

Total element time = 2530000 Number of element is 21 Number of precedence restriction is 23  
Cycle time is 20 Assembly line balance cycle time = 20,0000

Station number	Slack time	Element numbers
1	0	1 2 7
2	2,0000	3
3	2,0000	8
4	0	49
5	5,0000	5
6	3,0000	6
7	5,0000	10
8	3,0000	11, 12
9	2,0000	13, 12
10	0	14, 19
11	2,0000	20
12	5,0000	15
13	2,0000	16
14	8,0000	17
15	8,0000	18, 21

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