PROVIDING A MATHEMATICAL METHOD OF ZERO &ONE TO SELECT THESEQUENCE OF MODELS INMULTI- MODEL PRODUCTION LINE BALANCING PROBLEM.

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Abstract:

The problem of Production line balance is one of the issues that there have been extensive studies about it in the last decades. Most of these studies are on SALBP model.

Another form of these kinds of issues is line balance for multi- model mode.

Multi- model production line investigates different numbers and size of a product for assembling different models of it. These models follow each other to enter the production line.

Because the time cycle of each model may be different from others and also their function will assign separately, so their sending order is important on the production line.

In these kinds of subjects, the modelsarrangement on the production line is significant.

For producing subjects with different types in a short time cycle, is necessary to make an efficient decision in assigning the models function, their arrangement on the production line can also affect the whole system time cycle. Therefore we can achieve to the optimum sequence with calculation of time cycle for each sequence of the models.

This article will determine the best arrangement of different models of a product with the same output, by providing a mathematical method of zero & one and considering the minimum time cycle.

Keywords: line balance, multi-model assembling line, zero & one method

Introduction:

The problem of Production line balance is one of the issues that there have been extensive studies about it in the last decades. Most of these studies are on SALBP (Simple assembly line Balancing problem) model.

Line balancing problem, consists of assigning particular duties to the workstations in a specific time, So that thevaluesassigned, improvetheperformance ofproductionlines, such as time cycle orthe number ofmachines and...

The problem of Production line balance was considered from the time that massive production line was used as a new method of production.

In this context, the required activities for each process should be allocated to the workers and machines in the way that the number of workers and workstations reach to the minimum level by keeping the specific production rate.

Line balancing models are mainly included the following two types:

1: in the first issue, time cycle, the required activities of each process and the priority of duties have been assigned to minimize the number of workstations.

2: in the second type, the number of work stations or the production volume is fixed and the main goal is to minimize the time cycle or maximize the efficiency of production line.

The second type occurs when a production unit wants to optimizeits productswith afixed numberofworkstations.
Moststudies onthe productionline balancingproblemswere on planning and allocation the required processes to the stationon a model. In the case that just one model of product is on the production line, it is called SALBP. Another issue is ALDP (Assembly line design problem). ALDP is selecting a group of machines and distributing the activities among them. The main assumption in this issue is to have M same machines of the type Mi. It is clear that if m=1, this problem will change to SALBP.
ALDP is created to solve the problem of SALBP. The main goal of SALBP is to minimize the number of machines in the production line. Clearly, the objective function may not be appropriate when there will be same machines with different types and costs.
This subject will be explained better with an example below.
Ifasingleproduct line, which includes threeprocessesand Operations1 and 2mustbecompletedbefore thethirdoperation, the purpose of this question is to minimize the number of machines and also the total cost.
Assuming thatthetime cycleisequal to 10and operations1 and 2shalltakeplaceprior tooperation3.

Pij	Machine 1	Machine 2	Machine 3
Function 1	5	5	3
Function 2	4	11	3
Function 3	11	8	4
Cost machine	40	30	90

If the problem will be solved with SALBP, this is the answer: All operations should be assigned to machine 3. But operation 1 and 2 should be assigned to machine 1 and operation 3 will be assigned to machine 3 for minimizing the cost.
Another type of production line balancing problem is multi- model line balancing. This issue is mainly about production line designing and balancing for more than one model for simultaneously production.
In thistype ofproblem, thereistheassumptionthatmost ofthe processes that are performedonthis line are commonfor theproduction of manyproducts and various models enter the production line respectively with different time cycle. In this case, the performance of the station varies depending on the process that is used for producing the product.
There are not enough studies around this subject in compare with similar problems. Complex nature of these models causes them to be very difficult to solve.
In multi- model line balancing, due to the number of models, costs and various time cycle of each model, and also the priority of the models, assigned values of work stations will change by changing the models order and priority.
So in addition to minimizing the time cycle of each model, the sequences of each model entrance to production line is important. This is the main subject of this article.
A review on the history of line balancing problem:
There have been extensive studies about line balancing problem in the last decades and some algorithm have been suggested or used in these studies.Hioristikimethods, network methods, the use of queuing network, the boundarybranches, Dynamic programmingand... are the main methods which have been used. Some studies with the used method are mentioned in the following.

There are several studies about SALBP which SALOME OPTPACH , FABLE are the most popular ones.
The main method in SALBP problem is network model. The problems which have different types of machines with the same quality are mainly solved with the queuing network method.
Redfeld and Graves studied an optimal method for assigning the activities to the stations and selecting the required equipment for each station. The main goal is to minimize the fixed andvariableoperating costs and the problem has been solved by the shortest way algorithm. LeeandJohnson have designed a system with parallel machines that can be solved by Integerprogrammingandqueuingnetwork models.

Nicosia studies production line balancing with different stations, the used methods in this article are the boundarybranches and Dynamic programming. Gokcen and Erel have studied a multi-model production line balancing problem by network model and Integerprogramming. The main goal is to minimize the time cycle. This problem can be solved by the shortest way algorithm. The most popular algorithm in directional networks area was introduced by Nemhauser&Gutjahr.Roberts & Villa expanded this algorithm for multi- model situation.
Tolani and Ding have studied another type of problem, It isassumedthat the demand fordifferent modelsintheproduct lineisrecognized and eachapplicationmustbe completedwithinthe specific time period. Differentweightsforeach modelare specified too.
Issue planning:
Here, production line balancing in multi- model method will be examined.
Multi- model line is used for producing different models of a product in various number and size. These models will enter the line respectively. The main goal of this article is to assign the best models arrangement with minimizing the products time cycle.
The Assumption:
In this issue, It is assumed that the number of models and also stations in the line are fixed, and the amount of time cyclefor each model operationon the machineand the whole time cycle of models is certain. Each activity of the models can just be done in one station in order to do it in a shorter time than the specific time cycle.
The notation in this article is as below:
The period that each work station is available (j=1,,,,,J),
The time cycle of the function (k) in workstation (j) is changeable form 0 to 1.
It will be zero if the function (k) of model (i) is assigned to workstation (j) from the S models (*p*□€ *S)*.
The" P" collection from "S" collection whichconsists of various orders of different models.
The activities which have priority to "k" function. (K= 1,,,,,k)
The models which have priority to "I" model in "p" collection.
"Y" is variable from 0 to 1, it equals one if the "p" is selected for production from "s" group. Otherwise is zero.
So theproblemisformulatedas below:
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The objective function in addition to determination of time cycle for each model, will answer the question by "Y" 0-1.
Second limitation shows that only one order of the models will be selected. The third limitation is the time limitation of each workstation, the forth limitation shows that each function is only

allocated to one workstation. The fifth limitation assuresthat the priorityforactionislimited. The sixth limitation is the limitation of priority in the models, and assures that the function of the models which are in priority to "I" model. The seventh limitation is "Y" 0-1.
There are some simple examples below:
1: we assume that A and B models are available for the process. The information about the time of each activity in each station is mentioned in table 2, 3, 4.
Completion times any activity as for station kind in model 1.
Table2:

Model 1	station 1	station 2	station 3
Function 1	2	1	4
Function 2	4	2	4
Function 3	5	5	5
Function 4	6	4	2

Table3:
Completion times any activity as for station kind in model 2.

Model 1	station 1	station 2	station 3
Function 1	5	4	3
Function 2	4	3	4
Function 3	6	3	5
Function 4	7	5	2

Table4:
Available time any station.

	station 1	station 2	station 3
available time	9	10	11

The priority of each model function is:
Mode 2 model 4

1 —— 2 —— 4 1 3 4

The main goal to solve the above question is to select ______________ the model order, (1 and 2) or (2 and 1). The second one is selected. In the first model, the operation 1 and 2, 3 and 4 will be assigned to station 2, 1 and 3 respectively. In the second model the operation 1 and 4 will be done in station 3 and the operation 2 and 3 will be allocated to station 2.
2: we assume that A, B and C models are available for the process. The information about the time of each activity in each station is mentioned in table 5, 6, 7 and 8.

Table5:
Completion times any activity as for station kind in model 1.

Model 1	station 1	station 2	station 3
Function 1	4	4	6
Function 2	3	5	4
Function 3	3	8	5

Table6:
Completion times any activity as for station kind in model 2.

Model 1	station 1	station 2	station 3
Function 1	8	6	5
Function 2	6	4	6
Function 3	7	6	5

Table7:
Completion times any activity as for station kind in model 3.

Model 1	station 1	station 2	station 3
Function 1	5	6	6
Function 2	5	4	4
Function 3	5	5	6

Table8:
Available time any station.

	station 1	station 2	station 3
available time	20	18	19

Also, itis assumedthatnooperationshavepriority over each other.
The main goal to solve the above question is to select the model order, (3, 1, 2) or (3, 2, 1) or (1, 2, 3).
The first one is selected. In the first model, the operation 1, 2 and 3 will be assigned to station 2, 1 and 3 respectively. In the second model the operation 1, 2 and 3 will be allocated to station 1, 2 and 3 respectively and in the third model the operation 2 and 1 will be done in station 2 and the operation 3 will be assigned to station 1.

Conclusions:

For producing different types of products in a shorter time cycle, it is necessary to pay attention to assigning the functions. The models order in production line is important in line balancing problem,

Therefore we can achieve to the optimum sequence with calculation of time cycle for each sequence of the models. In this article the parallel stationor a semi manufactured thing was not considered.

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