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Application of operation research techniques for solving assembly line balancing problem

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Abstract: In type's production management techniques, operation research is one of the most powerful techniques for purpose of shopfloor management decision making. The application of the techniques are helped to solve many complex problem regarding with assembly controlling, scheduling which otherwise are more difficult to solve. To the survival and growth of an industry product mix decision is an important planning activity. Single-product assembly line used for making mass production and mix-product lines used to assemble different shape and size product. There are many constraints under which the product mix decision is to be made.

Keywords: Operation research, Production scheduling, Product mix decision.

I. INTRODUCTION

Balancing work load is a first goal for assembly operations for various types of production system without the flexibility to respond effectively to changing production requirements by the customer or as well as the demand of market. It is need ability to maintain optimal line balance may be seriously compromised. However, the line routing flexibility of modular systems allows parallel system to be added for balancing of cycle rates between slow and fast workstation tasks or the routing of reject parts off-line and reworked parts back on-line. Integration of test functions. As assembly operations become both more complex and efficient; test or inspection functions are being incorporated as an integral part of the process. Retrofitting these functions into an existing system may pose insurmountable obstacles unless the system is modular and affords the flexibility of reconfiguration.

II. TYPES OF ASSEMBLY LINE BALANCING PROBLEM

In this type of the problems, models for the assembly line design and the development problem are developed. Finally start with a basic model that minimizes the number of stations, while allowing stations in U shape Parallel line. Further, this model is reformulated to incorporate cost effective factor for different paralleling situations as shown in fig.1. The basic assembly line balancing problem is techniques to allotment a set of tasks to an ordered set of workstations such that the precedence relations are balance, some measure of performance is optimised.

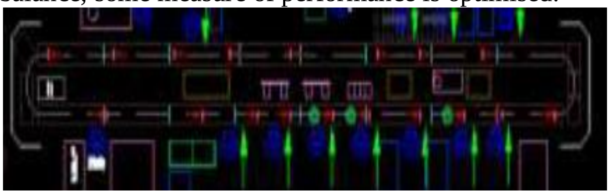

Fig.1. Parallel Assembly line layout

Assembly line balancing problems are classified into two types, type 1 and type 2. In type 1 problems, the required number of production rate, cycle time, assembly tasks, tasks times, and precedence requirements will be given. Our aim is to minimise the number of workstations. A line with also give results in lower labour number and reduced size requirements for the material handling so effort are to be less [4].

Type 1 [4] problems, generally occur when designing new assembly lines. For this purpose, to achieve the future demand the number of workstations should be reduced. For demand is very high from the market firm can also use this type 1 problem, to minimise the number of extra stations to be installed.

Type 2 [4] problems, when the number of station on assembly line or operators is fixed, the aim is to minimize the cycle time or through put time. This will maximise the production rate. Type 2 balancing problems generally find, when the organisation wants to produce the optimum number of production by using a fixed number of assembly stations without purchasing capital investments or without developed space. Here, we can identify precedence, while balancing the main line; we have also to consider subassembly lines. Type 1 problems are more common than type 2. One of the main problems to design and development of assembly line is how to arrange the workstations and various tasks which is to be performed.

III. VARIOUS O.R. TOOLS AND TECHNIQUES

1. Linear Programming: This is a constrained optimization technique, which optimize some criterion within some constraints. In Linear programming the objective function (profit, loss or return on investment) and constraints are linear. There are different methods available to solve linear programming.

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2. Game Theory: This is used for making decisions under conflicting situations where there are one or more players/opponents. In this the motive of the players are dichotomized. The success of one player tends to be at the cost of other players and hence they are in conflict.

3. Decision Theory: Decision theory is concerned with making decisions under conditions of complete certainty about the future outcomes and under conditions such that we can make some probability about what will happen in future.

4. Simulation: Simulation is a procedure that studies a problem by creating a model of the process involved in the problem and then through a series of organized trials and error solutions attempt to determine the best solution. Sometimes this is a difficult/time consuming procedure. Simulation is used when actual experimentation is not feasible or solution of model is not possible.

4. Non-linear Programming: This is used when the objective function and the constraints are not linear in nature. Linear relationships may be applied to approximate non-linear constraints but limited to some range, because approximation becomes poorer as the range is extended. Thus, the non-linear programming is used to determine the approximation in which a solution lies and then the solution is obtained using linear methods.

5. Dynamic Programming: Dynamic programming is a method of analysing multistage decision processes. In this each elementary decision depends on those preceding decisions and as well as external factors.

6. Integer Programming: If one or more variables of the problem take integral values only then dynamic programming method is used. For example number or motor in an organization, number of passenger in an aircraft, number of generators in a power generating plant, etc.

7. Markov Process: Markov process permits to predict changes over time information about the behaviour of a system is known. This is used in decision making in situations where the various states are defined. The probability from one state to another state is known and depends on the current state and is independent of how we have arrived at that particular state. [9]

IV. LINE BALANCING METHOD

1. Largest-Candidate Rule (LCR)

Procedure:

Step 1. List all elements are in descending order of Te value, largest value Te at the top of the list.

Step 2. To assign elements are to the first workstation, start from the top of the list work done, selecting the first right element for placement at the station. A feasible element is one that satisfies the precedence requirements and does not cause the sum of the T_{ej} value at station to exceed the cycle time Tc.

Step 3. Repeat the step 2.

2. Kilbridge and Wester's Method (KWM)

It is a heuristic procedure which works elements for ordering to stations according to their position values in the precedence diagram.

This is best one of the difficulties with the largest candidate rule (LCR), with which elements at the last of the precedence diagram might be the first candidates to be considered, because their values are large.

Procedure:

Step 1. Construct the precedence diagram so those nodes representing work elements of identical precedence are arranged vertically in columns.

Step 2. List the elements in order of their columns, column I at the top of the list. If an element can be located in more than one column, list all columns by the element to show the transferability of the element.

Step 3. To assign elements to workstations, start with the column I elements. Continue the assignment procedure in order of column number until the cycle time is reached (TC).

3. Ranked Positional Weights Method (RPW)

Introduced by Helgeson and Birnie in 1961 combined the LCR and K-W methods.

The RPW takes account of both the Te value of the element and its position in the precedence diagram. Then, the elements are assigned to workstations in the general order of their RPW values.

Procedure:

Step 1. Calculate the RPW for each element by summing the elements Te together with the Te values for all the elements that follow it in the arrow chain of the precedence diagram.

Step 2 List the elements in the order of their RPW, largest RPW at the top of the list. For convenience, include the Te value and immediate predecessors for each element.

Step 3. Assign elements to stations according to RPW, avoiding precedence constraint and time cycle violations.

Comparison & Selection of Method

Compare LCR, K-W, and RPW

The RPW solution represents a more efficient assignment of work elements to station than either of the two preceding solutions.

However, this result is accordingly by the acceptance of cycle time Tc = 1 and make those methods different.

If the problem were reworked with Tc = 0.92 minute, it might be possible to duplicate the efficiency. [7]

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V. PROBLEM FORMULATION

The formulation is made considering which assembly line station should choose to minimize time.

Optimal Substructure:

Fastest way to station S1j

If j = 1 there is one way

If j > 1 fastest is the min of
Fastest way to S1,j−1 then to S1j , and

Fastest way to S2,j−1 then to S1j

Fastest path thru S1,j includes fastest path through previous station

Recursive Formulation

Fi [j] is fastest time from start through Sij

f is the fastest time thru the factory

i[j] is the line used for station j−1 on fastest way through Sij; is the line whose n-th station gives fastest way through factory

$f1[j] = e1 + a11$ if = 1

$f1[j] = \min \{f1[j-1] + a1j,$

$f2[j-1] + a1j + t2,j-1\}$ if > 1

$f2[j] = e2 + a21$ if = 1

$f2[j] = \min \{f2[j-1] + a2j,$

$f1[j-1] + a2j + t1,j-1\}$ if > 1

$f = \min \{f1[n] + x1, f2[n] + x2\}$

VI. FUTURE SCOPE AND CONCLUSION

The paper shows that assembly line balancing research which traditionally was focused upon simple problems (SALBP) has recently evolved towards formulating and solving generalized problems with different characteristics such as cost optimization, machines selection, paralleling, U-shaped line layout and mixed-product production. While a lot of relevant problems have been identified and modelled, however, the new assembly design and solutions with procedures has just start. Thus, additional research is necessary to adopt for solution concepts like genetic algorithms and highly developed enumeration and bounding schemes to generalized problem. Furthermore, standardized and realistic test beds are required for testing and comparing different methods enhancements. Because research has produced a variety of problem statement definitions without a clear ways it seems to be necessary to produce a type which gives difference and help to those problem types. [8]

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