REDUCING SHIFTING COST OF MACHINE BY APPLICATION OF REPLACEMENT ANALYSIS IN FACILITY PLANNING

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ABSTRACT

This paper is a review and consolidation of the emerging literature on the_Facilities planning and Plant Layout_A framework of analysis for developing the Plant layout is also suggested.

A facilities layout, also called plant layout, consists of the production areas, production related or support areas and personnel areas within the building. Plant layout design is one of the strategic fields that determine the long run efficiency of operation. Layout determines the way in which materials and other inputs (like people and information) flow through the operation. Relatively small changes in the position of a machine in a factory can affect the flow of materials considerably. This in turn can affect the costs and effectiveness of the overall manufacturing operation. Getting it wrong can lead to inefficiency, inflexibility, large volumes of inventory and work in progress, high costs and unhappy customers. Changing a layout can be expensive and difficult, so it is best to get it right first time.

Replacement problem fall into two categories depending upon the life pattern of the equipment involved that is whether the equipment wear out or become obsolete with time (because of constant use or new technological developments) or suddenly fails.

This dissertation proposes an efficient and flexible plant layout algorithm to minimize the transporting cost and deal with change in future. Replacement (replacement of machine) evaluation methods of layouts are also proposed by this dissertation. A computer-based system will be developed to integrate all of the functions.

1.Introduction

Concept of Facilities Planning and Plant Layout

A facility planning is a complex and broad subject that covers several disciplines. It involves civil, electrical, industrial and mechanical engineers, as well as architects, consultants, managers and urban planners.

According to Tompkins and White [Tompkins, 1996], facilities planning determines how an activity's tangible fixed assets best support achieving the activity's objective. Facilities planning can be divided into two components: facilities location and facilities design.

Facilities location is about placement of the facility on a specific plot of land with respect to customers, suppliers and other facilities. Facilities design consists of the facility systems design, the layout design and the handling systems design. The facility systems consist of the structural systems, the environmental systems, the lighting/electrical systems and safety systems. The layout consists of all equipment, machinery and furnishings within the building structure. The handling system consists of the mechanisms needed to satisfy the required facility interactions.

Concept of Replacement Analysis

Replacement problem fall into two categories depending upon the life pattern of the equipment involved that is whether the equipment **wear out or become obsolete with time** (because of constant use or new technological developments) or **suddenly fails.**

For items that wear out, the problem is to balance the cost of new equipment against the cost of maintaining efficiency on the old and /or cost due to the loss of efficiency. Though no general solution is possible, models have been constructed and solutions have been derived using simplified assumption about the condition of the problem.

A separate but similar, problem involves the replacement of items such as electric bulb, radio tubes etc. of equipment which does not deteriorate with time but suddenly fails. The problem in this case, is of finding which items to replace and whether or not to repave them in a group and, if so, when. The objective is to minimize the sum of the cost of the item, cost of replacing the item and cost associated with failure of item.

The most common question asked in industry is when should the existing be replaced?

- When should a new machine replace the existing machine?
- When should a process be redesigned?
- When should a product be redesigned?

2.Replacement Model

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There is still another situation in which replacement become necessary. This is obsolescence due to new discoveries and better design of equipment. The equipment needs replacement not because it no longer performs to the design standard, but because more modern equipment perform higher standard.

Quite often that repair and maintenance cost of items increase with time and a stage may come when these costs become so high that it is more economical to replace the item by a new one. Since both of these costs tend to increase with time, they are grouped while analyzing a problem.

Replacement of Item that Deteriorate i.e., Whose Maintenance Cost Increase with Time

Case 1: When time't' is a continuous variable

Let C = Capital cost of item,

S = Scrap value of the item,

T_{avg} = Average annual cost of the item,

n = Number of year the item is to be in use,

f(t) = Operating and maintenance cost of the item at time t.

It is desired to find the value of n that minimizes T(n), the total cost incurred during n year.

Annual cost of the item at any time t = capita cost – scrap value + maintenance cost at time t = C – S + f(t).

Now total maintenance cost incurred during n year = $\int_0^n f(t).dt$.

Total cost incurred during n year $T(n) = C - S + \int_0^n f(t).dt$.

Average annual cost incurred on the item $T_{avg} = 1/n \left[C - S + \int_0^n f(t).dt.\right]$

Now we shall find that value of n for which T_{avg} is minimum.Diffrentiating previous equation w.r.t. n, we get

$$d/dn(T_{avg}) = -1/n^2.(C-S) - 1/n^2 \int_0^n f(t).dt + 1/n.f(n).$$

$d/dn(T_{avg}) = 0$, we have

$$f(n) = T_{avg} = 1/n \left[C - S + \int_0^n f(t).dt.\right]$$

Thus the item should be replaced when the average annual cost to date becomes equal to the current maintenance cost. Using this result we can decide when to replace an item provided an explicit expression is given for the maintenance and repair costs.

Case 2: when time't' is a discrete variable

In this case, the total cost incurred during n year,

$$T(n) = C - S + \sum_{t=0}^{n} f(t).dt.$$

Average annual cost incurred on the item,

$$f(n) = 1/n\left[C - S + \sum_{t=0}^{n} f(t).dt.\right]$$

'n' is optimal at the east average annual cost.

Facility Problem Statement And Modeling

Here the problem is to arrange "n" machine with different areas into a process plant to minimize the total expected transporting cost given several possible future material flows. The material flows can have the different cost per unit distance. The model is presented below:

$$\text{Minimum } T = \sum_{i=1}^{n}\sum_{j=1}^{n} f_{ij}d_{ij}c_{ij}$$

Where:

f_{ij}=frequency/volume of movement

c_{ij}=cost to move one unit load per one distance unit between two machines

d_{ij}=distance between machine *i* and *j*

Assuming the cost c_{ij} remain constant, the objective would be reduced to minimizing the total distance traveled for the parts.

Example of three machine layout:

There are six possibilities for three machine layout that is given below:

1	**2**	**3**	***f12*d12+f13*d13+f21*d12+f23*d23+f31*d13+f32*d23***
1	**3**	**2**	***f13*d12+f12*d13+f31*d12+f32*d23+f21*d13+f23*d23***
2	**1**	**3**	***f21*d12+f23*d13+f12*d12+f13*d23+f32*d13+f31*d23***
2	**3**	**1**	***f23*d12+f21*d13+f32*d12+f31*d23+f12*d13+f13*d23***
3	**1**	**2**	***f31*d12+f32*d13+f13*d12+f12*d23+f23*d13+f21*d23***
3	**2**	**1**	***f32*d12+f31*d13+f23*d12+f21*d23+f13*d13+f12*d23***

Table 1

fij	***1***	***2***	***3***	***dij***	***1***	***2***	***3***
1	-	2	4	***1***	-	1	3
2	6	-	3	***2***	1	-	2
3	5	1	-	***3***	3	2	-

Table 2

$$Minimum\ T = \sum_{i=1}^{n}\sum_{j=1}^{n} f_{ij}d_{ij}c_{ij}$$

			T
1	2	3	***38***
1	***3***	***2***	***37***
2	1	3	***43***
2	3	1	***43***
3	1	2	***47***

3	2	1	***46***

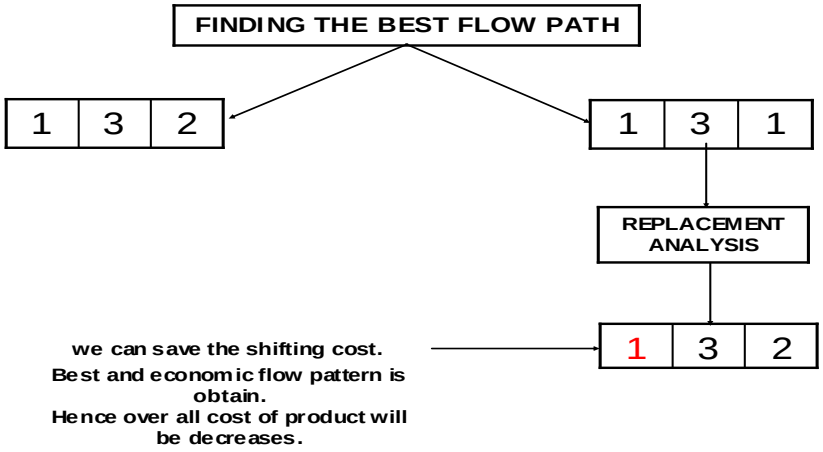
Table 3

Here we can see that the layout 1-3-2 is most optimum layout.

Here we can see that the layout 1-3-2 is most optimum layout. Now we can also calculate the overall shifting cost by using similar concept: First part is total transportation cost second part is total installation cost.

2.Summary And Conclusion

By the above analysis we can determine the optimum replacement time and hence we save the shifting cost



This paper has deal with some of the aspects of Facilities location and design procedures and has shown the reader that the flow of elements is greatly influenced by the layout of the plant.

The **combination of facility location decision and replacement analysis** will give the most optimum layout and hence production will be increase without failure of machine.

By applying replacement model we can easily calculate the replacement time of existing machine and can be make a new highly efficient layout these also **reduce the shifting cost** which further decreases the overall cost of product.

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