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THE EFFECT OF IMBALANCE ON THE PERFORMANCE OF UN-PACED PRODUCTION LINE WHEN THE OPTIMAL BOWL UNKNOWN

Mohammad Tarique Jamali [1],
Lecturer, Department of Industrial Engineering
King Khalid university, Abha , Kingdom of Saudi arbia
mtjamali@gmail.com

Prof. Arif Shail [2](Rtd) Professor,
Mechanical Engineering Deptt. ,ZHCET
Aligarh Muslim University
Aligarh (India)

Abstract

A study of the effect of imbalance on the performance of un-paced production line is carried out in this research work. An Un-paced production line is defined as a series or workstations where work is carried out to complete a process and working time is not constant in work stations. There is no outside pacing agency forcing the stations to complete their respective operation in a fixed time(variation of time for every worker because the assembling or making any product the time is not constant for each work). Instead the stations are free to carry out their work at their own pace and transfer the job to the next station only after the completing the operation.
Previous research has largely been done to either determine the production rate of balanced lines (fix the time for each work is same) or to find the unbalancing strategy to maximize the production rate. Real-world production lines however are seldom balanced and it is hardly ever possible to unbalanced them in a particular way. Generally the designers have to allocate workload on stations within the given constraints of unbalancing.
In this study a 5-station line with exponentially distributed operation times with no buffer capacities is considered. A practical situation where 5 means operation times are to be assigned on 5 stations is considered. Assuming that precedence restrictions are minimal the operation can be permuted on stations. A number of data sets with different kinds of imbalances and with different degrees of imbalance have been used for arriving at important conclusions.
In this research we assume optimal strategy[1] is not known. The complete set of 60 ordering was examined closely. We obtain guidelines for designers in arriving to a relatively better ordering.
The result shows that we utilize this ordering according their work timing on the station and maximize the production rate of the un-balanced line.
Key Words- production line, un-paced production line, optimal strategy, imbalance, workload, Paced ,un-paced, workstation.

I. INTRODUCTION

Production line is sequence of workstation where the processing of job is occurs. For production line require standard products, stable demands, part interchangeability, adequate volume, continuous supply of material, mean arrival time.

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In paced line the completion of work forced to same for every worker.

In un-paced line the distribution of work depends on work. it is standardized by the industrial designer for different works occurs in a production line for maximum production rate in assembly / production line. e.g. Assembly of Automobile vehicle (chassis assembly time is different as compare to assembly of steering device).Therefore we not give the same time for each line workstation assembling automobile vehicle.

Due to random variability of work there are three states (working/ processing, starved/Idle ,blocked/unfinished task).Due to blocking and idle state the performance of line is not 100% . we provide buffer for every station to continuity of production line.

In past Designer are trying to maximize the production rate by using bowl phenomenon in 1966(Hillier and Boling). El Rayah (1979) proved it is true.

Many researchers (e.g. yamashina and okamura (1983), Hillier and So1993) specific values for every station for maximum production rate.

[1]M .T Jamali, Dr. Arif suhail(oct. 2016)" The Effect Of Imbalance On the Performance Of Un-paced Production line when the optimal bowel known".www.academia.edu

Beg, HA(1996) showed that apart from an optimal bowl which gives highest production rate, they give more un-balancing in line to give production rate equal to balanced line called critical bowl.

In this study on a 5 – station un-paced line[2] find the way to determine maximum production rate when the workloads are fixed and unbalanced and which ordering is best when the station time are exponential distribution with no buffer capacity and processing time are independent across the work station. Developed a mathematical model for it.

We study the behavior of un-balanced line to judge the suitability of our arrangement of stations over another when optimal bowel is not known. The study is done for 6 different cases of imbalance. When mean operation time are linear function arranged in ascending order.

[2]M.T. Jamali, Mohd Ziaulhaq,Dr. A.Suhail, Mohammad Khalid (Jan- Feb. 2015), The Effect of Imbalance on the Performance of Un-paced Production Line – A Mathematical Modeling Approach" , IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), PP 14-19, Volume 12, Issue 1 Ver. I, www.iosrjournals.org

II. PROBLEM FORMULATION AND METHODOLOGY

for Problem formulation we discuss some notation
D = degree of imbalance (highest – lowest) mean operation Time
R= Production Rate
C =Degree of closeness with optimal bowl configuration.

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X= (x_1, x_2, x_3,x_4,x_5) data set of 5 mean operation time.Where
x1= mean operation time of station 1
x2= mean operation time of station 2
x3= mean operation time of station 3
x4= mean operation time of station 4
x5= mean operation time of station 5

In this we know the optimal bowl is not known in 5- station line. from computer C program developed and find out 120 sequence of ordering .Each one have mirror image of it. Therefore we set 60 ordering (sequences) of operation[3].The ordering are then sorted in descending order of production rate. The ordering are than studied. It seem obvious to believe that a sequence is closer to the optimal bowl configuration should give higher production rate compare to the one that is farther from optimal bowl.

If for 5 –station line the such assignment are given as

x_1= 1.6(sec ,min, hrs. according to work) x_2= 0.4 x_3= 1 x_4=0.7 x_5= 1.3

The total Time is constant(= 5 Sec, min, hrs. according to work)
The data set is then permuted to give 120 permutation. we select 60 ordering.
We investigate these ordering and production rate of each ordering. And find out the behavior of unbalanced production line.

[3] MT Jamali , M. Tech Dissertation AMU (2002)

Result – For linear distribution of workload the strategy are
$x_2 = x_1+d$ $x_3 = x_2+d$ $x_4 = x_3+d$ $x_5 = x_4+d$,
where d = constant difference between two successive values
Data set of investigation are(Here total time is 5 sec, min, hrs. according to work)

Table 1
Data set of investigation

Data set of Work load	Degree of imbalance D
Linear Distribution {0.4, 0.7, 1.0, 1.3, 1.6} d=0.3	1.2
{0.8, 0.9, 1, 1.1, 1.2 } d= 0.1	0.4

Table 2
The behavior of sorting ordering of workload assignments for linear values are given below D=1.2

S. No.	X1	X2	X3	X4	X5	R
1	1.6	0.4	1	0.7	1.3	0.469
10	0.7	1.3	1	0.4	1.6	0.4544
20	0.7	1.6	1	0.4	1.3	0.4451

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40	0.7	1.6	1.3	0.4	1	0.4287
60	0.7	1.3	1.6	1	0.4	0.4131

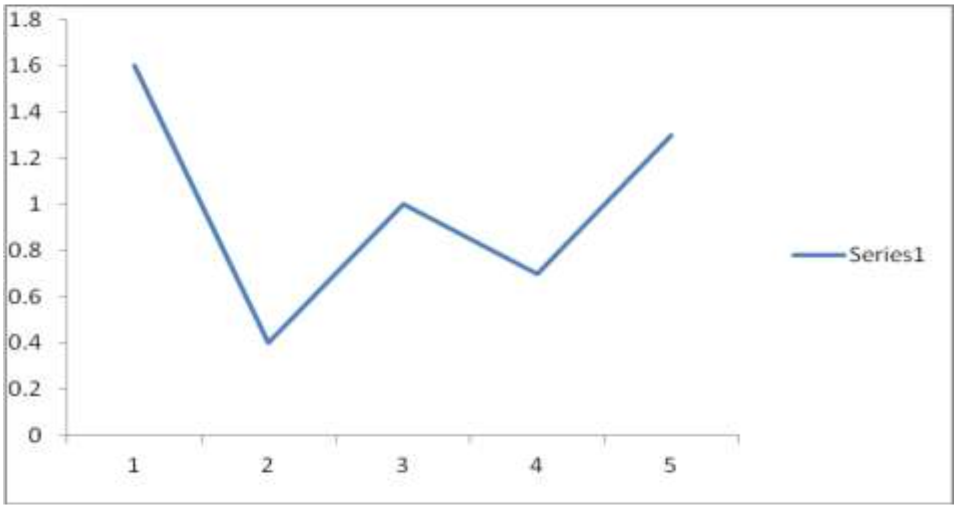

Fig-1 for S. No 1 workload ordering table-2

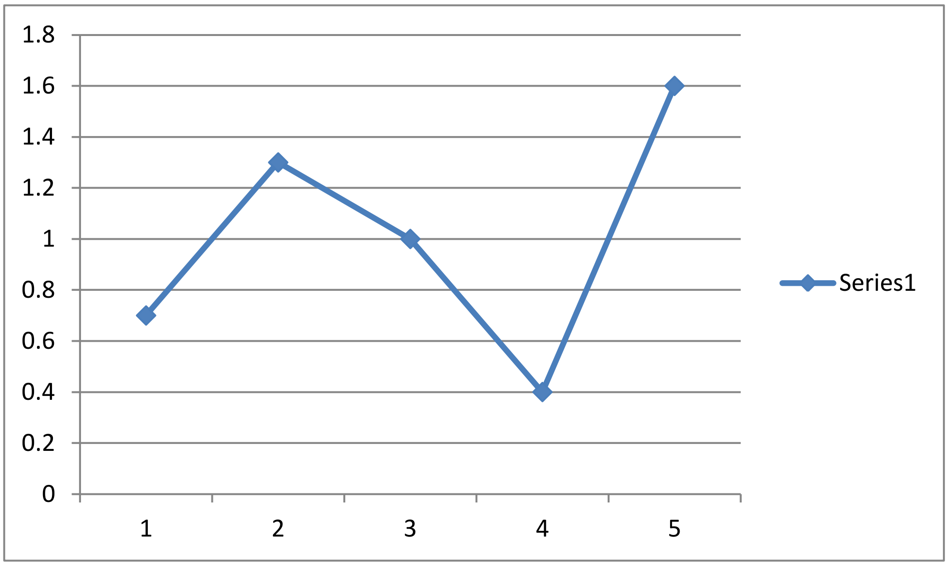

Fig-2 for S. No 10 workload ordering in table-2

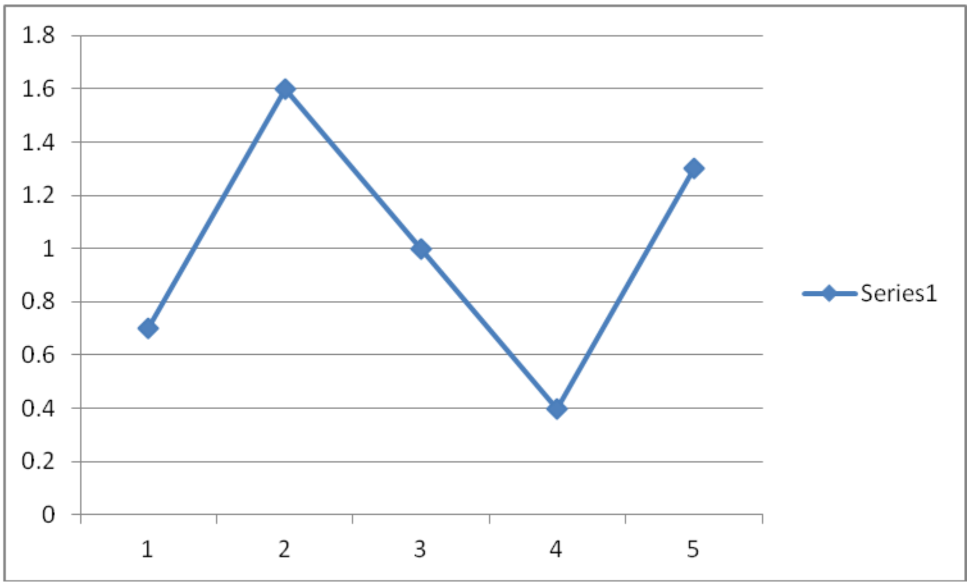

Fig-3 for S. No 20 workload ordering in table-2

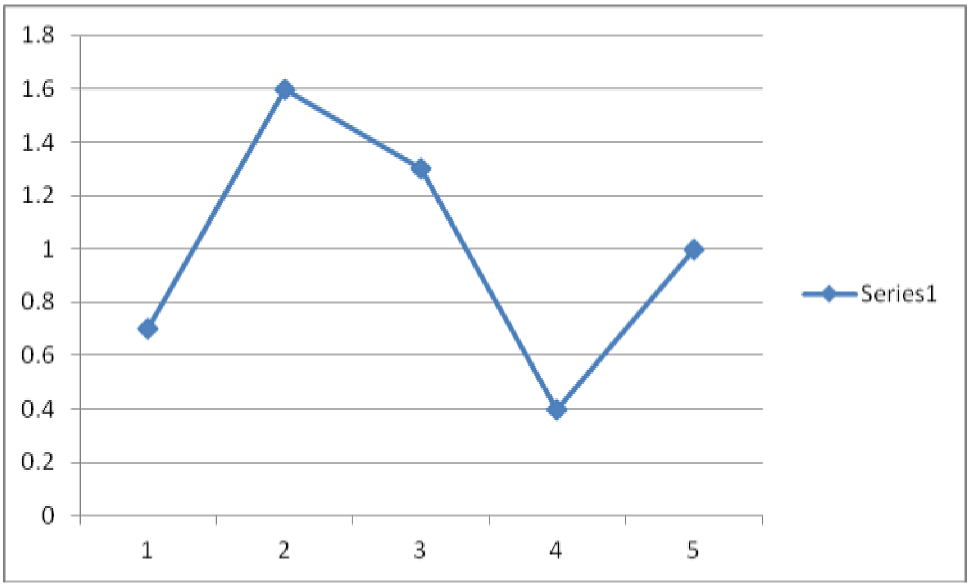

Fig-4 for S. No 40 workload ordering in table-2

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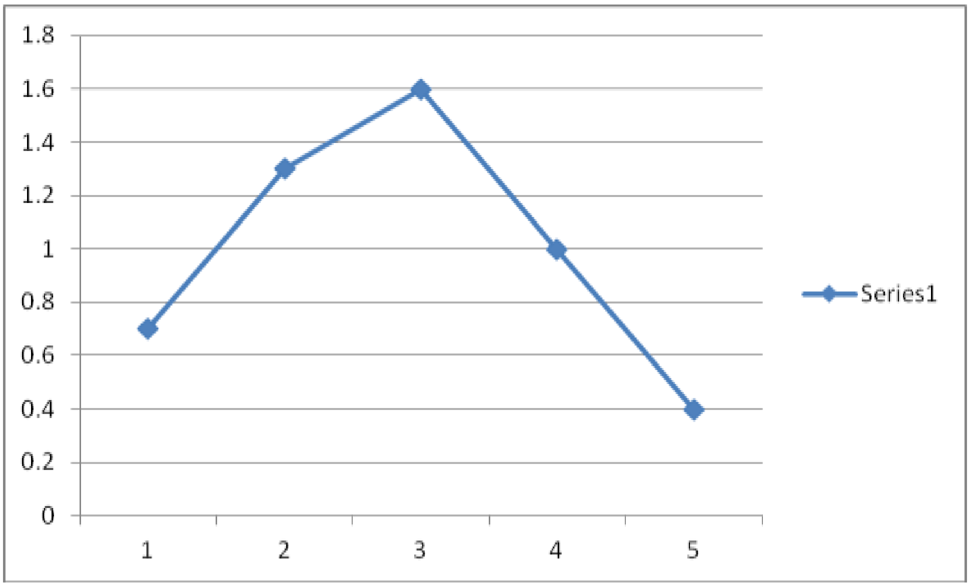

Fig-5 for S. No 60 workload ordering in table-2

For all fig-
Horizontal- number of station, vertical- allotted time for workstation

Table3
The behavior of sorting ordering of workload assignments for linear values are given below D=0.4

S.No.	X1	X2	X3	X4	X5	R
1	1.2	0.9	0.8	1	1.1	0.4907
10	1.2	1.1	0.8	0.9	1	0.4854
20	0.9	1.0	0.8	1.1	1.2	0.4827
40	1.1	1.2	1.0	0.8	0.9	0.476
60	0.8	1.0	1.2	1.1	0.9	0.4687

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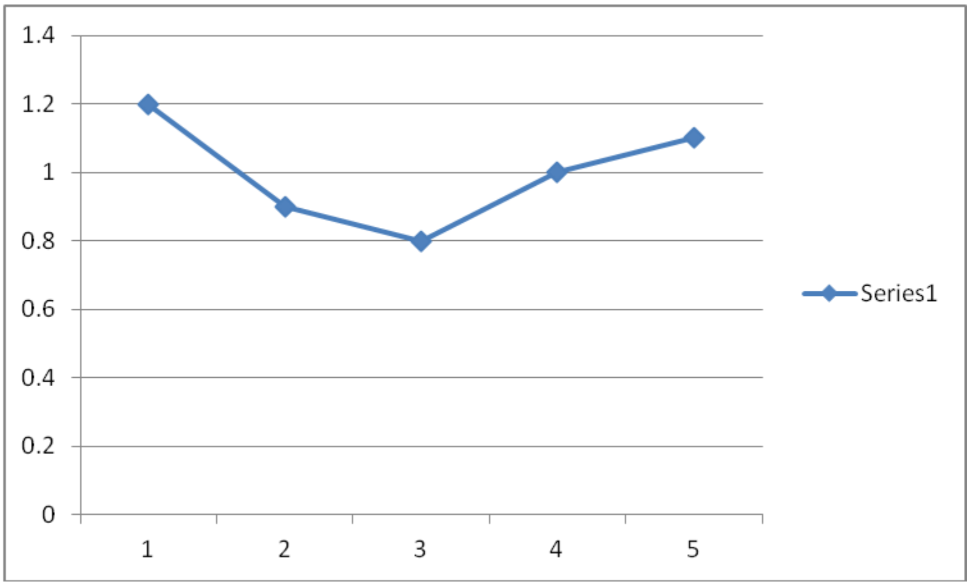

Fig-6 for S.No.1work load ordering in Table-3

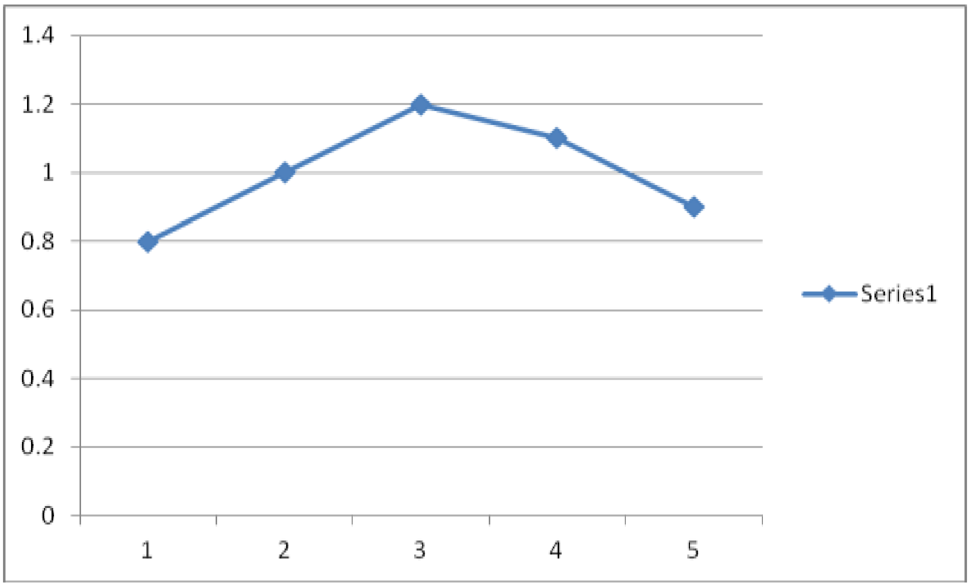

Fig-7 for S.No.1work load ordering in Table-3

III. CONCLUSION

In this case, we study all cases and find out

1- A bowl or a double bowl is always better than an inverted bowl
2- Degree of imbalance is high than a double bowl is better than a bowl while at a low degree of imbalance a bowel is better than a double bowl.

3- A double bowl with x3 less than the minimum of x1 and x5 is better than a double bowl with x3greater than minimum of x1 and x5. In this we conclude that preference given to bowl type of ordering to another ordering.
We also use this Philosophy where the time variations in workloads are high.
If we not see the maximum production rate in line than we use any type of curve(ordering) in the line because the Inverted bowl and bowl type ordering have very lass difference in production rate. Therefore we see here for task Completion as well as production rate.

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