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Research Article

Balancing the Mixed Model Assembly Line for Minimizing Number of Stations, Cycle Time and Idle Time by Work Load Adjustment

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Abstract

The specified objective is to minimize system and balancing losses, subject to precedence constraints. The work carried is a multi-objective which will minimize cycle time, work stations, balancing losses, idle time, and smoothing the workload. The losses arises out of variable operation time will influence the system losses. If any of the work station has high idle time and another work station has no idle time than this may result in high disruption within the system. Therefore it is identified that the idle time is a prime factor for all the losses within the system that results in system imbalance and instability. When the idle time is minimized and workload distribution is optimized then the stability of the system will be high. For minimizing the idle time and losses the method is divided into two stages. 1) Optimize the number of work stations with predetermined cycle time. 2) Optimizing the assembly line (AL) for minimum losses.

Keywords: *Assembly line, line optimization, minimization, models load, number of stations, idle time of each station, iterations, balancing load*

Introduction

Assembly line balancing (ALB) and sequencing is an active area of optimization research in operations management. The concept of an assembly line (AL) comes into picture when the finished product is inclined to the perception of product modularity. The initial stage of configuring and designing an AL was focused on only cost efficient mass production of standardized products. However, the recent trend gained the insight of the manufacturers of shifting the AL configuration to low volume assembly of customized products and mass customization. The configuration planning of such AL's has acquired an important concern as high initial investment is allied with designing, balancing and installing an AL. The strategic shift took effect due to the diversified customer needs along with the individualization of products. This eventually triggered the research in the area of AL balancing and sequencing for an AL in a mixed scenario, which is characterized as mixed model assembly line balancing (MMALB) and sequencing.

Balancing refers to objective oriented workload balance of the assembly jobs to different workstations. Sequencing refers to finding an optimal routing/job dispatching, queues considering the supply and demand scenario, available time slots and resources. Systematic design and balancing of AL's is fairly complicated, especially for the large scale product customization due to uneven nature of tasks times of different models.

Keeping in view the above facts there is a need to carry the research work in the field of ALB which will identify the critical design parameters associated with ALB for optimization.

ALB is a technique to group tasks among workstations so that each workstation has in the ideal case the same amount of work. To work effectively, with no work pile ups between stations, the line must be balanced, e.g. work must get through each workstation in roughly the same amount of time. ALB deals with the distribution of activities among the workstations so that there will be maximum utilization of facilities and human resources without disturbing the work sequence. During the assembly process the product traverses the (AL), station by station, while at each work station (WS) a predetermined set of tasks are performed. Each task is considered as an atomic working unit, where certain operations are performed to convert raw material into finished product which usually requires specific skills and machineries.

Classification and description of assembly line balancing problem

(1) Single Model Deterministic (SMD)
(2) Single Model stochastic (SMS)

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(3) Multi/Mixed Model Deterministic (MMD)
(4) Multi/Mixed Model stochastic (MMS)

The SMD version of the ALB problem assumes single model assembly lines where the task times are known deterministically and an efficiency criterion is to be optimized. This is the original and simplest form of the assembly line balancing problem (SALB).

The SMS problem category introduces the concept of task-time variability. This is more realistic for manual assembly lines, where workers' operation times are seldom constant. With the introduction of stochastic task times many other issues become relevant, such as station times exceeding the cycle time, pacing effects on workers' operation times, station lengths, the size and location of inventory buffers, launch rates and allocation of line imbalances.

The MMD problem formulation assumes deterministic task times, but introduces the concept of an assembly line producing multiple products. In mixed-model lines single units of different models can be introduced in any order or mix to the line. Multi-mixed model lines introduce various issues that are not present in the single-model case. Model selection, model sequencing and launching rate(s) and model lot sizes become more critical issues here than in the single model case.

The MMS problem perspective differs from its MMD counterpart in that stochastic times are allowed. However, these issues become more complex for the MMS problem because factors such as learning effects, worker skill level, job design and worker task time variability become more difficult to analyze because the line is frequently rebalanced for each model assembled.

A) Single - model lines

In single model assembly line the same products are continuously manufactured in large quantities. According to Merengo Nava & Pozzetti (1999), single model lines are "suitable for large-scale production. In this line no operation changes are carried out at any station and all the stations repeat the same work. Thus, does not change in workloads of stations.

B) Mixed - model lines

In this line system can produce the production sequentially by mixing more than one product on the same line. Product ranges produces on the same line are quiet similar to the main product. According to Merengo, Nava & Pozzetti (1999), "it is possible to produce very small batches (even one – unit batches.)." (s. 2836). Also whenever required to change the model on the line, set-up is carried out quite fast and cheap. For example, if option differences of main product are produced sequentially mixed on the same line according to customer demand, this belongs to mixed-model assembly lines class

C) Multi-Model lines

In this line the similar products with differences in production processes are produced on these lines. Due to differences in production processes, because of situations like operation processing times, ergonomic need of work space and so on, products are produced in batches. Even a lengthy set-up study is needed during product change.

Objective

a) To develop the algorithm for optimizing the MMALBP parameters.
b) To minimize the number of stations and the cycle time
c) To derive the idle time for work load adjustment.

Literature Survey

- Erel and Gökcen (1999) are studied the balancing problem with the shortest-route formulation by turning mixed-model assembly lines into single model assembly lines.

In order to meet the customer satisfaction, and also to get high volume and variety of products, mixed-model assembly lines are examined within the scope of even this study. Creation of task sets of each model, performance time measurement of tasks, considering precedence relations are quite difficult. It is assumed that each model has common tasks to avoid this situation in this study.

- Matanachai and Yano (2001) have balanced mixed-model assembly lines, in order to reduce workload of work stations. Therefore a heuristic solution procedure based on filtered beam search is developed. Their focus is an assigning task to stations so that workloads are reasonably well balanced and it is relatively easy to construct daily sequences of jobs that provide stable workloads (in a minute to minute sense) on the assembly line. Stability provides to contribute to the quality of the product by the fact that employees working without having to rush. For it, they focused on closed-station, paced lines with Fixed-Rate Launching (FRL) on structure of the line.
- Jin and Wu (2002) tried to balance mixed-model assembly lines by taking advantage of goal chasing method and using good parts in early sequence. A heuristic method called „variance algorithm" is used for this. In just in time systems, a simple heuristic method called goal chasing method can be used in problem solving. Since the objective function is different within the scope of this problem, the algorithm has been revised without changing the impact of basic point. The goal chasing method is very simple and large scale problems can be solved with a small amount of time, regardless of the number of parts, models or demand.
- Esmaeilian, Ismail, Sulaiman, Ahmad and Hamedi (2009) focus on assigning and balancing of tasks to

workstations as long as target purposes are provided. Mixed model production balancing problem usually is transformed into a single model line-balancing problem to solve. But in this study, mixed-model problem has not been turned into single-model problem, and the settlement has been done by arranging it as mixed products on the parallel assembly lines.

- Yağmahan (2011) focused on balancing mixed-model assembly lines by using multi-objective ant colony optimization approach.

This study considers the aim to minimize smoothness index and the balance delay for the cycle time given in mixed-model assembly lines. The multi-objective ant colony optimization algorithm is used in the solution of this problem algorithm is given in the final balancing. After that, model sequencing is used to reduce the impact of rest unbalanced models. Model imbalance is measured by comparing targeted times and required times for stations

Problem Definition

The main objective of our problem is minimizing the number of workstations, cycle time and idle time associated with ALBP. The problem is chosen based on the presence of complexity and the number of models that are assembled on the line. This is a seat fabrication and assembly and has 31 tasks for four different models. The precedence relationship table is presented in table-1. The value one in the row represents the precedence relation with respect to the respective activity. It gives four different times as given in table-1.The algorithms and the computer codes developed are applied to an assembly line which is presently used in an automobile industry. The main purpose of our work is to optimize and assign different tasks of mixed models to different stations for minimizing number of stations, cycle time and idle time.

Algorithm developed for solving assembly line balancing problem

Algorithm is developed for Optimizing the Number of work stations and cycle time for the ALBP problem. The Objectives which were discussed were effectively achieved during the simulation. By running the algorithm the feasible solution was obtained by varying number of stations. For equivalent single models, the algorithm is defined below. The algorithm delivers the number of feasible solutions.

1. Predict the average number of stations required using NOOFSTATIONS=NOOFTASKS/3

a) Round off the NOOFSTATIONS to the lower integer.
b) Assign a new station STATION[1] with a cycle time T = MINCYCLETIME
c) Determine all the tasks that do not have the predecessor TASKSWOPRED = { i, j,…., n}
d) Assign one task in TASKSWOPRED to STATION[1]
e) Remove the tasks that is assigned to STATION [1] from the graph and update it as TASKSWOPRED = {j, k,…., n }.
f) Update the station cycle time as T = MINCYCLETIME - t_i
g) Repeat steps e to g, until T is positive and update the T and TASKSWOPRED each time.
h) When T turns negative, look for any other tasks in TASKSWOPRED to fit in STATION [1], but the T should remain positive.
i) When T turns zero or negative for all the tasks in TASKSWOPRED, create a new station as STATION [2].
j) Repeat steps e to j.
k) Repeat step e to k for all feasible solutions.
l) Try the solutions for a pre-decided number of stations. If the solutions derived are not feasible, repeat e to k after update the T as MINCYCLETIME+1.
m) When all the feasible solutions are obtained, store the updated T.
n) Decrease the number of stations to 1 less than the NOOFSTATIONS and run the above procedure again.
o) Increase the number of stations to 1 more than the NOOFSTATIONS and run the above procedure again.
p) Freeze the number of stations with best performance as NOOFSTATIONS
q) Define the number of models as NUMMOD
r) Define the quantity of each model to be produced as MOD_i , i=1,2,3..M
s) Calculate the entitled load bearing capacity of all stations for each model for the required quality as ENT_CAP, i=1,2,3..M
t) Calculate the time required for completion of all the tasks by each station for each model for the required quality as ACT_LOAD, i=1,2,3..M
u) Calculate the Smoothed load assignment SMT_LOAD_ASSGN = ENT_CAP- ACT_LOAD, i=1,2,3..M
v) Determine the maximum of the SMT_LOAD_ASSGN, i=1,2,3..M
w) Increment the MOD _i for which the SMT_LOAD_ASSGN is maximum
x) Repeat the steps t to w.
y) Run the step y for predetermined number of times and choose the quantity of each model based on the criteria of total of SMT_LOAD_ASSGN, for i=1, 2 ... M, is minimum.

Methodology

The current work is a multi objective sequential approach for balancing an AL. This approach is capable of solving different ALBP by MATLAB simulation which generates the set of solutions for optimizing the parameters. For achieving the above set objectives the following procedure is followed:

It is a multistage simulation approach where the procedure is generic in nature and can be used for different models, so that the size of the balancing problem or the complexity of the balancing problem cannot act as hindrance for optimizing the parameters.

1) Development of algorithms for a single model assembly line which is a base line model.
2) Develop an algorithm to minimize system loss and improve stability of the system for a real mixed model assembly line.

Precedance Diagram

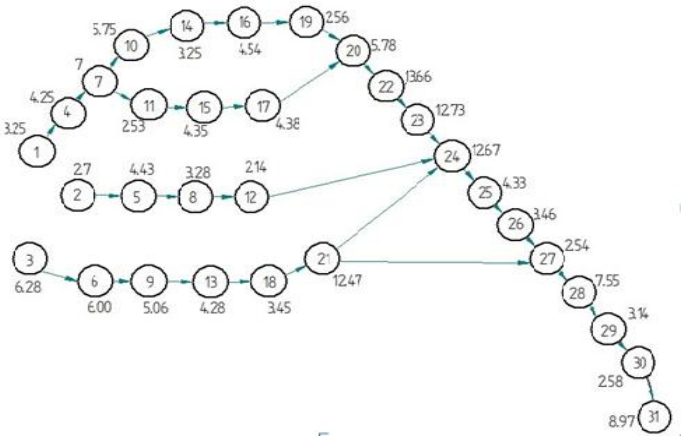

Fig.1

Tasks Time ▼	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Tasks times for different models in minutes

Tasks	Model1	Model2	Model3	Model4	Avg. Time
1	3.5	4	2.65	3.15	3.25
2	2.15	2.22	2.49	3.94	2.7
3	5.99	6.2	5.43	7.5	6.28
4	4.15	4.22	3.82	4.81	4.25
5	4.25	4.66	4.02	4.79	4.43
6	5.23	5.66	5.07	8.04	6
7	6.45	5.88	7.87	7.8	7
8	2.51	2.98	3.11	4.53	3.28
9	4.56	4.34	4.77	6.57	5.06
10	4.68	4.97	5.24	8.11	5.75
11	1.86	2.68	2.33	3.25	2.53
12	2.1	2.41	1.88	2.17	2.14
13	3.74	3.42	3.97	5.99	4.28
14	2.44	2.96	3.14	4.66	3.25
15	4.12	3.47	4.41	5.4	4.35
16	3.68	3.29	4.88	6.31	4.54
17	3.22	3.87	4.52	5.91	4.38
18	2.76	3.18	3.62	4.24	3.45
19	1.87	2.31	3.47	2.59	2.56
20	4.48	5.26	6.14	7.28	5.78
21	11.55	12.42	12.13	13.78	12.47
22	12.45	12.84	14.37	14.98	13.66
23	11.42	12.11	13.47	13.92	12.73
24	12.35	13.41	11.62	13.3	12.67
25	3.74	3.28	4.83	5.47	4.33
26	3.29	3.22	3.01	4.32	3.46
27	2.07	2.16	2.43	3.5	2.54
28	6.84	7.25	7.48	8.63	7.55
29	3.2	2.64	3.49	3.23	3.14
30	2.11	2.42	2.74	3.05	2.58
31	7.68	8.16	9.87	10.17	8.97

Table 6.1(b) shows the precedence matrix for the 31 tasks for seat assembly

1) Simulation results for 12 stations

	Smoothing Model 1	Smoothing Model 2	Smoothing Model 3	Smoothing Model 4	Total Smoothing	Model 1 Qty	Model 2 Qty	Model 3 Qty	Model 4 Qty	Incrementing model
Iteration1	68.6333	60.025	67.375	39.275	**235.3083**	10	10	10	10	0
Iteration2	56.0967	60.025	67.375	39.275	222.772	11	10	10	10	1
Iteration3	56.0967	60.025	53.3525	39.275	208.749	11	10	11	10	3
Iteration4	43.56	46.8675	53.3525	39.275	195.592	11	11	11	10	2
Iteration5	43.56	46.868	39.33	39.275	183.06	12	11	11	10	1
Iteration6	43.56	46.8675	39.33	39.275	169.033	12	11	12	10	3
Iteration7	43.56	33.71	39.33	39.275	155.88	12	12	12	10	2
Iteration8	31.0233	33.71	39.33	39.275	143.338	13	12	12	10	1
Iteration9	**31.0233**	**33.71**	**25.3075**	**39.275**	**129.316**	**13**	**12**	**13**	**10**	**3**
Iteration10	50.4233	52.87	46.0675	43.2025	192.563	13	12	13	11	4
Iteration11	50.4233	39.7125	46.0675	43.2025	179.406	13	13	13	11	2
Iteration12	37.8867	39.7125	46.0675	43.2025	166.869	14	13	13	11	1

Iteration13	37.8867	39.7125	32.045	43.2025	152.847	14	13	14	11	3
Iteration14	57.2867	58.8725	52.805	47.13	216.094	14	13	14	12	4
Iteration15	57.2867	45.715	52.805	47.13	202.937	14	14	14	12	2
Iteration16	44.75	45.72	52.81	47.13	190.4	15	14	14	12	1
Iteration17	44.75	45.715	38.7825	47.13	176.378	15	14	15	12	3
Iteration18	64.15	64.875	59.543	51.058	239.63	15	14	15	13	4
Iteration19	64.15	51.7175	59.5425	51.0575	226.468	15	15	15	13	2
Iteration20	51.6133	51.7175	59.5425	51.0575	213.931	16	15	15	13	1

Results

1) Maximum number of stations =12
2) Updated final cycle time =16 Min
3) Number of stations =12
4) Number of solutions =2
5) Idle time = (235.30-129.31) = 105.99 min.
6) Optimum Quantities of M1,M2.M3 and M4 =13,12,13 and 10

2) Simulation results for 13 stations

	Smoothing Model 1	Smoothing Model 2	Smoothing Model 3	Smoothing Model 4	Total smooting	Model 1 Qty	Model 2 Qty	Model 3 Qty	Model 4 Qty	Incrementing model
Iteration1	79.0769	52.0462	28.1615	15.1846	**174.469**	10	10	10	10	0
Iteration2	67.5046	52.0462	28.1615	15.1846	162.897	11	10	10	10	1
Iteration3	55.9323	52.0462	28.1615	15.1846	151.325	12	10	10	10	1
Iteration4	44.36	52.0462	28.1615	15.1846	139.752	13	10	10	10	1
Iteration5	44.36	39.9008	28.1615	15.1846	127.607	13	11	10	10	2
Iteration6	32.7877	39.9008	28.1615	15.1846	116.035	14	11	10	10	1
Iteration7	32.7877	27.7554	28.1615	15.1846	103.889	14	12	10	10	2
Iteration8	21.215	27.755	28.162	15.185	92.317	15	12	10	10	1
Iteration9	21.215	27.755	15.218	15.185	79.373	15	12	11	10	3

Iteration10	21.215	15.61	15.218	15.185	67.228	15	13	11	10	2
Iteration11	9.6431	15.61	15.218	15.185	55.655	16	13	11	10	1
Iteration12	9.6431	3.4646	15.218	15.185	43.51	16	14	11	10	2
Iteration13	**9.6431**	**3.4646**	**2.2738**	**15.1846**	**30.5662**	**16**	**14**	**12**	**10**	**3**
Iteration14	29.123	20.815	18.034	16.703	84.675	16	14	12	11	4
Iteration15	17.551	20.815	18.034	16.703	73.102	17	14	12	11	1
Iteration16	17.551	8.6692	18.034	16.703	60.957	17	15	12	11	2
Iteration17	17.551	8.6692	5.09	16.703	48.013	17	15	13	11	3
Iteration18	5.9785	8.6692	5.09	16.703	36.441	18	15	13	11	1
Iteration19	25.459	26.019	20.85	18.222	90.549	18	15	13	12	4
Iteration20	25.459	13.874	20.85	18.222	78.404	18	16	13	12	2

Results

1) Maximum number of stations =13
2) Updated final cycle time =15 Min
3) Number of stations =13
4) Number of solutions =115
5) Idle time = (174.46-30.5662) = 143.89 min
6) Optimum Quantities of M1, M2.M3 and M4 =16, 14, 12 and 10.

3) Simulation results for 14 stations

	Smoothing Model 1	Smoothing Model 2	Smoothing Model 3	Smoothing Model 4	Total smoothing	Model 1 Qty	Model 2 Qty	Model 3 Qty	Model 4 Qty	Incrementing model
Iteration1	47.9429	23.8214	35.7071	21.85	**129.321**	10	10	10	10	0
Iteration2	37.1971	23.8214	35.7071	21.85	118.576	11	10	10	10	1
Iteration3	26.451	23.821	35.707	21.85	107.83	12	10	10	10	1
Iteration4	26.451	23.821	23.688	21.85	95.811	12	10	11	10	3
Iteration5	15.706	23.821	23.688	21.85	85.065	13	10	11	10	1
Iteration6	15.706	12.544	23.688	21.85	73.787	13	11	11	10	2
Iteration7	**15.706**	**12.544**	**11.669**	**21.85**	**61.768**	**13**	**11**	**12**	**10**	**3**

Iteration8	31.2457	26.2036	27.2586	24.035	108.743	13	11	12	11	4
Iteration9	20.5	26.204	27.259	24.035	97.997	14	11	12	11	1
Iteration10	20.5	26.204	15.239	24.035	85.978	14	11	13	11	3
Iteration11	20.5	14.926	15.239	24.035	74.7	14	12	13	11	2
Iteration12	36.04	28.586	30.829	26.22	121.68	14	12	13	12	4
Iteration13	25.2943	28.5857	30.8293	26.22	110.929	15	12	13	12	1
Iteration14	25.294	28.586	18.81	26.22	98.91	15	12	14	12	3
Iteration15	25.294	17.308	18.81	26.22	87.632	15	13	14	12	2
Iteration16	40.8343	30.9679	34.4	28.405	134.607	15	13	14	13	4
Iteration17	30.0886	30.9679	34.4	28.405	123.861	16	13	14	13	1
Iteration18	30.089	30.968	22.381	28.405	111.84	16	13	15	13	3
Iteration19	30.0886	19.69	22.3807	28.405	100.564	16	14	15	13	2
Iteration20	19.343	19.69	22.381	28.405	89.819	17	14	15	13	1

Results

1) Maximum number of stations =14
2) Updated final cycle time =14 Min
3) Number of stations =14
4) Number of solutions =252
5) Idle time = (129.32-61.766) = 67.56 min
6) Optimum Quantities of M1,M2.M3 and M4 =13,11,12 and 10

Conclusion

The developed model is used for another problem to derive the total idle time of different quantity combinations of M1, M2, M3 and M4 (jobs) models. For the combination of 10, 10, 10 and 10 quantities of M1, M2, M3 and M4 (job) models respectively the result obtained is 129.32 minutes as total idle time. The developed algorithm has predicted the combination as 13, 14, 12 and 10 quantities of M1, M2, M3 and M4 respectively with an idle time of 61.76 seconds, which will save and reduce the total idle time by 67.56 seconds. Fifty two percent of the idle time is saved from the developed model.

The developed model is used for predicting the optimum combination of job models for minimum total idle time along with minimum number of stations and cycle time. This model analyses all the possible feasible solutions and compares each other and determines the best feasible solution as optimum solution. Hence an iteration solution like this can provide the best feasible, optimum and faster solutions. Finally the developed model is applied to a real industrial problem and demonstrated the application.

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