Facility and Plant Layout using Tecnomatrix Plant Simulation

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Abstract *Layout planning is an important practical problem for manufacturing companies. Today's market conditions is characterized with continuously changing product portfolio and shortening product lifecycles frequent reconfiguration is requested if the primary goal for the company is to remain competitive. The key to win customers is to widen the product portfolio and customize the products. However, this leads to the problem that the manufacturing system has to be reorganized several times during its life cycle that requires solving design problems frequently. In this a paper layout planning method for assembly line is introduced that can be applied efficiently to solve real industrial problems.*

Key Words: Digital Manufacturing, Layout Planning

1. INTRODUCTION

Simulation provides a comprehensive perception of the studied process or product allow to conduct multi-criterion analysis, and to simulate different scenarios. Advanced analytic tools in Plant Simulation, such as bottleneck analyzer and charts, can be used to evaluate different production scenarios. The results ensure information necessary for quickly making good decisions at early stages of production planning. In addition, this way it is possible to optimize material flow, the use of resources and logistics at each level of planning – beginning with global production facilities, through local enterprises, up to individual lines. Important feature of program is the possibility to model and simulate processes following the paradigms of object-oriented-programming. Also listed optimizations wizard in the program. (Genetic Algorithm wizard, Layout optimizer, Neural network, Experiment manager).

By simulating model, statistical data and bottlenecks are observed for further improvement in the production line, for improvement workstations are added to get required production

With the help of Plant simulation software, we can,

- Optimize material flow/handling
- Utilization of resources
- Improve Supply chain

1.1 Benefits of Plant Simulation

- Maximum utilization of production machinery
- Reduce investment cost of the new system by 5-20%
- Collection of positive results and identify consequences
- Testing of innovative strategies in a safe virtual environment
- Reduce capacity for personnel and handling equipment
- Optimize the size of systems and storage space

1.2 Tecnomatrix Plant Simulation

VDI (Verein Deutscher Ingenieure, Association of German Engineers) Directive 3633 defines simulation as the emulation of a system, including its dynamic processes, in a model one can experiment with. It aims at achieving results that can be transferred to a real-world plant. In addition, simulation defines the preparation, execution, and evaluation of carefully directed experiments within a simulation model.

Plant Simulation is a discrete, event-controlled simulation program, i.e., it only inspects those points in time, at which events take place within the simulation model.

On the other hand, time elapses continually. When watching a part move along a conveyor system, you will detect no leaps in time. The curve for the distance covered, and the time it takes to cover it, is continuous, it is a straight line [16].

Benefits of Tecnomatix Plant Simulation:

- Enhance the productivity of existing production facilities.
- Reduce investment in planning new production facilities.
- Cut inventory and throughput time.
- Optimize system dimensions, including buffer size.
- Reduce investment risk by early proof of concept.

2. NISCO System case study

NISCO Systems is a small-scale industry engaged in manufacturing and assembly of Digital Balance Indicator (DBI). The company requires to setup new plant where, this product is being manufactured and assembled on separate assembly line. The industry assigned the task as project to design plant and facility layout.

2.1 Product Information

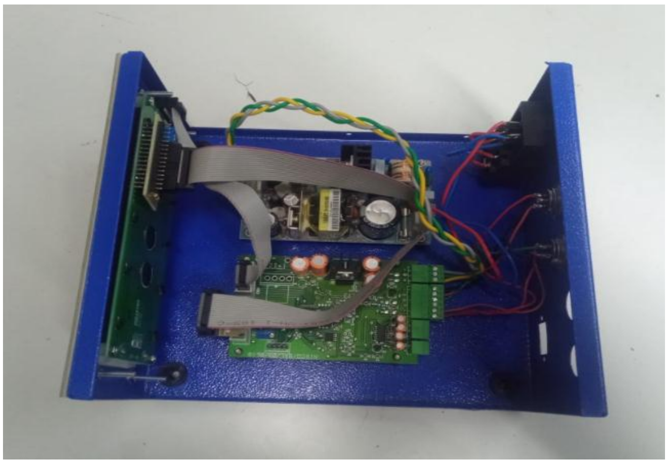

Fig -1: Open view of Digital Balance Indicator

Balance indicator is specially designed to satisfy equilibrium condition of rotating parts, especially rotor. The machine uses principle of 'balancing of rotating parts' to satisfy both vertical and horizontal condition. PD 2505 SPMS (Mean well) is used to provide constant voltage of +5V & -5V supply as input to control card. Machine can be operated on both left and right or either signal to indicate output on the display. The machine gives direct indication of left and right value, revolution per minute and left and right degree of rotation in order to decide whether the part is within specified range or not.

Fig -2: Final Digital Balance Indicator

Table -1: Components of DBI

Sr. No	Component Name
1.	Top and bottom cabinet
2.	SMPS PD 2505(Mean well make)
3.	Control card
4.	Front PCB (display and keyboard)
5.	Isolated spacers
6.	Bushing
7.	Steel grips
8.	ELCOM power socket
9.	Connectors and cables
10.	Steel grip connectors for relay port, speed port and signal port
11.	9 pin D-type connector for RS232 communication

Table -2: List of assembly steps for DBI

Task	Process	Time (Sec)
A	Pre-Assembly Process	
B	Make Connections to ELCOM Power Socket to Connect SMPS	180
C	Fuse Insertion into Socket	30
D	Check electrical connection with Multimeter	180
E	Prepare for Assembly	30
F	Connect 5.5mm Wire to steel grip signal port of 1234 followed by +ve -ve signal and ground	30
G	Connect 5.5mm Wire to steel grip Speed port of 123 followed by +ve -ve Speed	30
H	Connect 5.5mm Wire to steel grip Relay port	30
I	Connect wires to 9PIN D Type Connector of PIN 2,3,5 followed by +VE -VE & COM	30
J	Connect Jumbo Display to front PCB	30
K	Connect Isolated Spacer to Bottom Cabinet	90
L	Mount SPMS on the spacer	180
M	Mount Control card on the spacer	30
N	Fasten NUTcon Spacer	30
O	Connect Front PCB to Bottom Cabinet	45
P	Connect Power Socket to Bottom Cabinet	45
Q	Connect Busing to Bottom Cabinet	45
R	Connect signal port to Bottom cabinet	45
S	Connect Speed port to Bottom cabinet	45
T	Connect Relay port to Bottom cabinet	45
U	Connect 9PIN D Type connector	45
V	Connect 9PIN D type to RS232 Port on Control Card	45
W	Connect all connectors	60
X	Mount the Top Cabinet	60
Y	Screw the Cabinet	60

Z	Paste Sticker	60
A1	Send to Testing	45
B1	Paste Sticker	45

3. Methodology

3.1 Largest-Candidate Rule (LCR):

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

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

Step 3: - Repeat step 2.

3.2 Kilbridge & Wester's Method (KWM):

It is a heuristic procedure which selects work elements for assignment to stations according to their position in the precedence diagram. *This overcomes one of the difficulties with the largest candidate rule (LCR), with which elements at the end of the precedence diagram might be the first candidates to be considered, simply 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).

3.3 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.

4. Analytical Solution

4.1 Precedence diagram

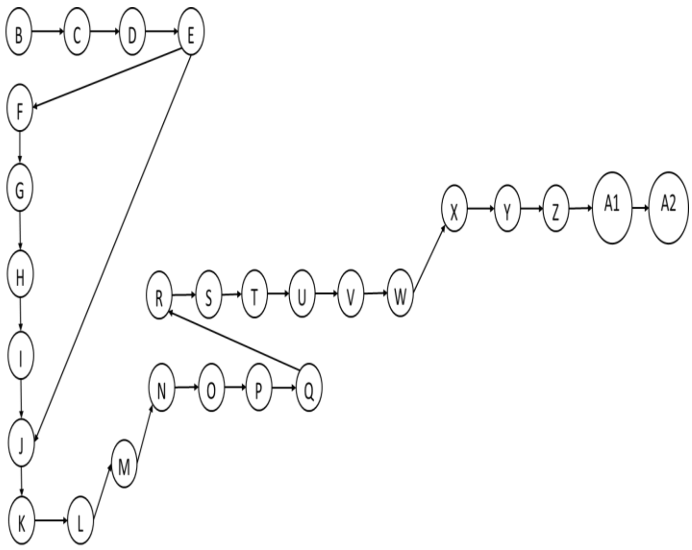

Fig -3: Precedence diagram for DBI

4.2 Solution by LCR

Ws	Eligible tasks	Assigned tasks	Available time	Idle time
1	B	B	718	0
	C	C	538	0
	D	D	508	0
	E	E	328	0
	F	F	298	0
	G	G	268	0
	H	H	238	0
	I	I	208	0
	J	J	178	0
			88	**88**
2	K	K	718	0
	L	L	538	0
	M	M	508	0
	N	N	478	0
	O	O	448	0

	P	P	403	0
	Q	Q	358	0
	R	R	313	0
	S	S	268	0
	T	T	223	0
	U	U	178	0
	V	V	133	0
	W	W	88	0
			28	**28**
3	X	X	718	0
	Y	Y	658	0
	Z	Z	598	0
	A1	A1	553	0
	B1	B1	508	
			508	**508**

4.3 Solution by RPM

Ws	Eligible tasks	Assigned tasks	Available time	Idle time
1	B	B	718	0
	C	C	538	0
	D	D	508	0
	E	E	328	0
	F	F	298	0
	G	G	268	0
	H	H	238	0
	I	I	208	0
	J	J	178	0
	K	K	148	0
			58	**58**
2	L	L	718	0
	M	M	538	0
	N	N	508	0
	O	O	478	0
	P	P	433	0
	Q	Q	388	0
	R	R	343	0
	S	S	298	0
	T	T	253	0
	U	U	208	0
	V	V	163	0
	W	W	118	0
			58	**58**
3	X	X	718	0
	Y	Y	658	0
	Z	Z	598	0
	A1	A1	538	0
	B1	B1	493	0
			448	**448**

4.4 Solution by K&W Method

Ws	Eligible tasks	Assigned tasks	Available time	Idle time
1	B	B	718	0
	C	C	538	0
	D	D	508	0
	E	E	328	0
	F	F	298	0
	G	G	268	0
	H	H	238	0
	I	I	208	0
	J	J	178	0
	K	K	148	0
			58	**58**
2	L	L	718	0
	M	M	538	0
	N	N	508	0
	O	O	478	0
	P	P	433	0
	Q	Q	388	0
	R	R	343	0
	S	S	298	0
	T	T	253	0
	U	U	208	0
	V	V	163	0

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	W	W	118	0
			58	**58**
3	X	X	718	0
	Y	Y	658	0
	Z	Z	598	0
	A1	A1	538	0
	B1	B1	493	0
			448	**448**

4.5 Calculation

Total weeks	50
Shifts per week	6
Shift hrs	8
Total units	12000
Time (sec)	8'640'000
Total time	1590
Production rate	5
Cycle time	720
Assembly time	2.4
Station time	718
Worker required th	2

4.6 Comparison

Comparing LCR, K-W, and RPW it can be seen that all methods indicate same no. of workstation i.e.3, hence optimum no. of workstation to be added is 03. Further idle time is less in RPW and K-W i.e. 448 sec. Any method of this two can be used for input of simulation.

5. Plant layout using Tecomatrix Plant Simulation

5.1 3D Plant Layout Model

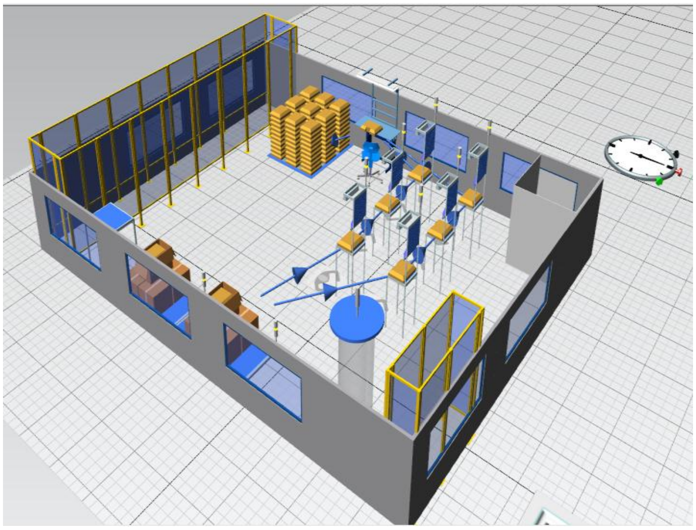

Fig -4 3D Plant Layout

5.2 2D Plant Layout Model in Plant Simulation

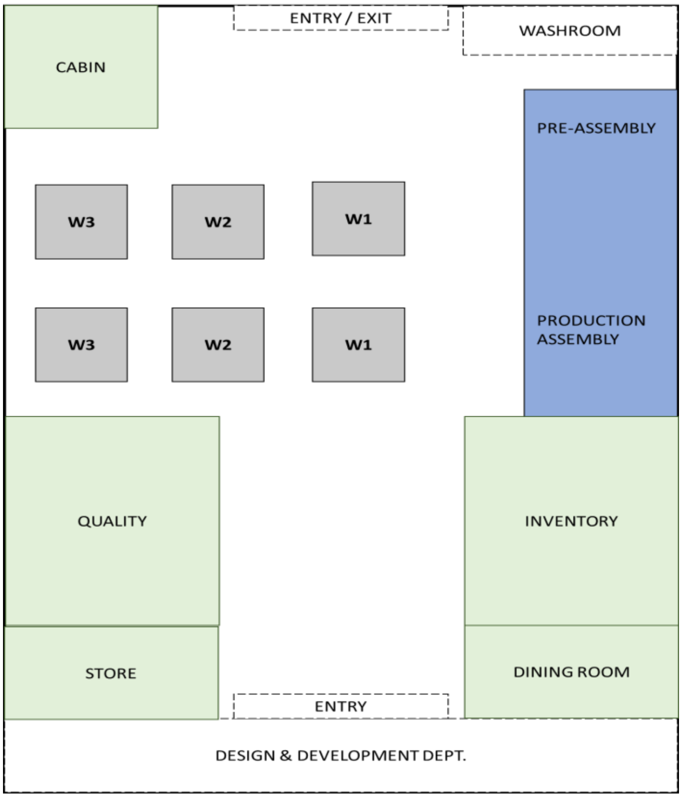

Fig -5 2D Plant Layout

5.3 Planning view Layout Model in Plant Simulation

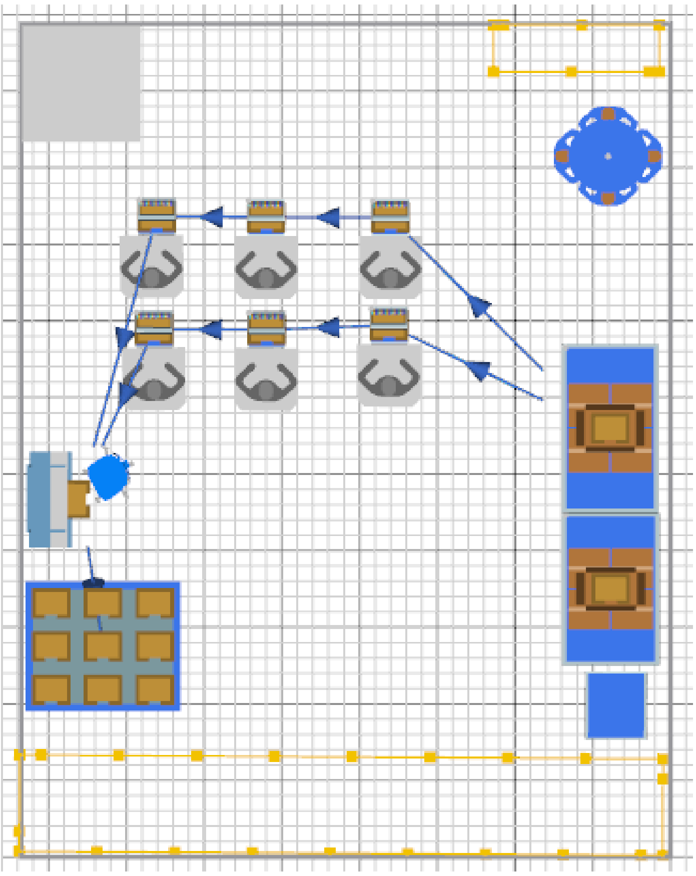

Fig -6 Layout in Planning View

6. Conclusions

It can be observed that Digital Manufacturing Approach helps to get prior solution to the industry and contribute to save the time being spent on planning. In this project LCR method gives optimum solution as by reducing no. of workstations and hence reducing cost associated with the production. Therefore two separate Assembly lines can be constructed in given plant layout as shown in fig.3.

Further it can be stated that, Tecnomatrix plant Simulation allows manufacturers to take decisions about plant layout, facility utilization and production activities by simply performing simulation by using software.

Overall Digital Manufacturing Approach by using Tecnomatrix Plant Simulation helps manufacturers to increase the productivity and maximize the utilization of resources.

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