Flexibility in Manufacturing through Integration & Layout Optimization

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Abstract: ***The paper is to deals with various types of flexibility in automobile industries to cope uncertain demands & products categories. The purpose of this study is to investigate various research issues related to manufacturing flexibility & Flexible manufacturing system (FMS). To find out the various components of manufacturing flexibility. To find out the relationship between manufacturing flexibility and organizational performance. This study emphasizes on necessity for flexibility in Manufacturing for Cost savings ,improving efficiency & productivity in mass production .Flexibility today means quickness in delivery and high quality at reasonable prices.The research attemts to develop a framework for flexibilty implementation in automobile industries in scenarios of fluctuation in market demands & manucturing capabilties within required times .It starts with examining the different efforts of manufacturing flexibilty improvement in various firms to understand the current focus and use of flexibilty and investgate the problems they are faced with .The study deals with variors scenarios of volume flexiblty and as well mix flexibilty . Manufating flexibilty in automobile industries where there are high variations in product categories enforces the need of capcity enhancements & intergrations through layout optimizations .The static version of facilitis layout problem(FLP) where given planer region is divided into departments assuming that material flows in between department & unit cost of transportation is given and will remian same during the planning horizon***

Keywords: Flexible manufacturing system (FMS), Facilities layout problem (FLP), Line integrations, Layout optimizations, capacities enhancement.

1. Introduction

1.1 A flexible manufacturing system (FMS

FMS is a manufacturing system in which there is some amount of flexibility that allows the system to react in the case of changes, whether predicted or unpredicted. This flexibility is generally considered to fall into two categories, which both contain numerous subcategories.

The first category, *machine flexibility*, covers the system's ability to be changed to produce new product types, and ability to change the order of operations executed on a part. The second category is called *routing flexibility*, which consists of the ability to use multiple machines to perform the same operation on a part, as well as the system's ability to absorb large-scale changes, such as in volume, capacity, or capability.

Most **FMS** consist of three main systems. The work machines they are often automated CNC machines are connected by a material handling system to optimize parts flow and the central control computer which controls material movements and machine flow.

The main advantages of an FMS are its high flexibility in managing manufacturing resources like time and effort in order to manufacture a new product. The best application of an FMS is found in the production of small sets of products like those are from a mass production.

The purpose of this study is empirically investigating four research questions related to manufacturing flexibility.

- To find out the various components of manufacturing flexibility.
- To find out the relationship between manufacturing flexibility and organizational performance.
- Do integrated strategies strengthen the relationship between manufacturing flexibility and organizational performance?
- To find out is there any organizational characteristics that strengthen the relationship between manufacturing flexibility and organizational performance.

1.2 Necessity for Flexibility in Manufacturing

- Cost savings
- Efficiency
- Mass production
- Time

2. Literature Survey

- SETHI, A. K. and SETHI, S. P., 1990 et al [1] made an extensive survey of flexibility in manufacturing. Their research is devoted to understanding the concept of flexibility in manufacturing and defining the various types of flexibility found in the literature. According to their survey, there are two types of uncertainties. The first type is due to internal disturbances, such as equipment breakdowns, variable task times, queuing delays, rejects and rework. The second type is caused by external forces such as uncertainties in the level of demand, product prices or product mix. We focus on the second type of uncertainty, termed the fundamental uncertainty of the competitive environment, and how to design facilities robust to manifestations of this uncertainty.

- Rosenblatt (1986) et al, [2] in the facility design literature, uncertainty has been studied as either the dynamic FLP and/or the stochastic FLP. As first studied by Rosenblatt (1986) and then by others (Balakrishnan et al. 1992, Urban 1992, 1993, 1998, Yang and Peters 1998, Kochhar and Heragu 1999), the dynamic FLP primarily addresses minimizing the combination of material handling costs and rearrangement costs over all production periods. For a survey of dynamic FLP algorithms, see Balakrishnan and Cheng (1998). On the other hand, the stochastic FLP uses the idea of probabilistically changing demand patterns in the same production period and/or from one period to another (Rosenblatt and Lee 1987, Kouvelis and Kiran 1991, Kouvelis et al. 1992, Palekar et al. 1992).

- Gupta (1986) et al [3] considered the FLP by obtaining the material flow matrices using simulationrandomly to generate the flow between all pairs of departments. He used equalarea, square-shaped departments and assumed that individual flow volumes areindependent and normally distributed. In our simulation, the mean, variance andcovariance of interdepartmental flows are estimated, and then these estimations are usedin the design process. This approach is computationally efficient since the simulationis performedonly once before starting the optimization process.As a solution technique in this paper, a tabu search-based heuristic for the stochastic FLP is presented.The methodology presented in this paper differs from previous research effortsbecause it proposes an efficient solution methodology for the FLP considering bothrouting flexibility and volume uncertainty. Moreover, the volume uncertainty canfollow any general form and is not limited to certain classes of distributions.

- Smith & Norman (2000) et al [4] that models production uncertainty on a continuous scale under the assumption that product demands are independent. Using that idea, we relax product independence and allow correlated product demands. Correlation does not permit a closed form expression, as was developed by Smith and Norman for independent demands; therefore we develop and use an alternative method of evaluation.

- Chan (2001) et al [5] studied the effects of different levels of routing flexibility on the performance of FMSs with and without the factor of machine breakdowns. Routing flexibility was defined as 'a measure of the average number of choices of machine that an individual product can choose'. Five levels of routing flexibility were studied. To measure system performance, three criteria were considered: make span, lead time and machine utilization. It was found that increasing routing flexibility does not always improve system performance.

3. Experimental Details

3.1 Objective of Study

- Modification for closing second shift in Hall B Lines Expansion of A6 line by 3 tact's
- Expansion of common line by 3 tact's
- Implementation of seat manipulator for Hall B models in common line
- A6 door area shifting nearer to A6, M100 area
- A6 knuckle area integration in front axle area
- A6 straight line extension
- A4 Knuckle area shifting to sub assembly area.

3.2 Hall B : Modification for closing second shift

Shift closure benefits
- Energy saving : 840000 /year
- Direct Manpower saving : 19 (A6--7+A4--12)
- Indirect Manpower saving : 8

Line	Capacity before	Capacity after	% Increase
A6	7 cars/shift	14 cars/shift	100%
A4	12 cars/shift	18 cars/shift	50%

Capacity Enhancement of A6 Line
- Expansion of A6 line by increasing 3 tact's.

Capacity Enhancement of A4 Line
- Utilization of Foaming Station for line operations.
- Expansion of common line by 3 tact's

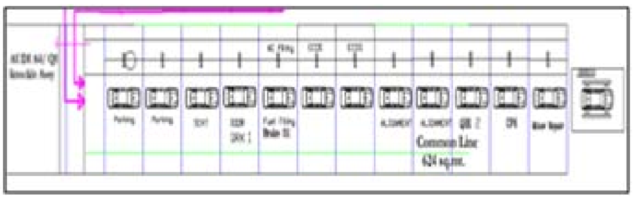
3.3 Hall B Layout Before Change

3.4 Common line modification in Hall B- straight line

U-line is converted into straight line with integration of door/ seat of both lines
Manpower saving : 3 operators
Reduced car movement by string, Smooth straight car flow – better production control & quality.

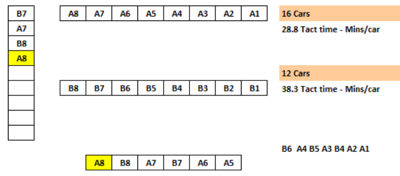
Before

After



3.5 Simulation workout for Common line

Number of Car	Time	Std. Car loading sequence	Sequence 1=A4 2=A6
	6.30	Start	
1	6:58	A4	1
2	7:08	A6	2
3	7:27	A4	1
4	7:46	A6	2
5	7:56	A4	1
6	8:25	A4	1
7	8:40	A6	2
8	9:08	A4	1
9	9:18	A6	2
10	9:37	A4	1
11	9:56	A6	2
12	10:06	A4	1
13	10:35	A4	1
14	10:35	A6	2
15	11:03	A4	1
16	11:13	A6	2
17	11:32	A4	1
18	11:51	A6	2
19	12:01	A4	1
20	13:00	A4	1
21	13:00	A6	2
22	13:28	A4	1
23	13:38	A6	2
24	14:07	A4	1
25	14:26	A6	2
26	14:36	A4	1
27	15:05	A4	1
28	15:05	A6	2



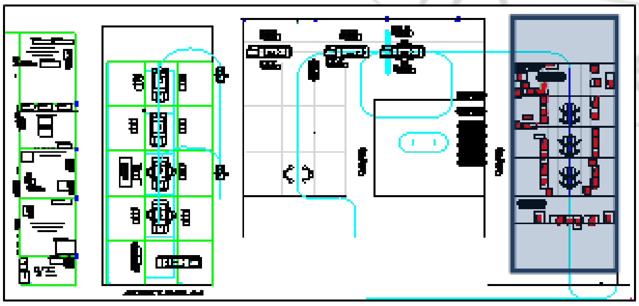
3.6 A4/A6 Seat manipulator

Utilization of technology due to shifting benefits in hall A
Cost utilization: 2220000
Benefits: Time saving of 3 min. per car per operator. Improved ergonomics, in- house modification of VW seat manipulator to make suitable with A4/A6 models with 0-investment
Area Saved – 3000 Sq.m

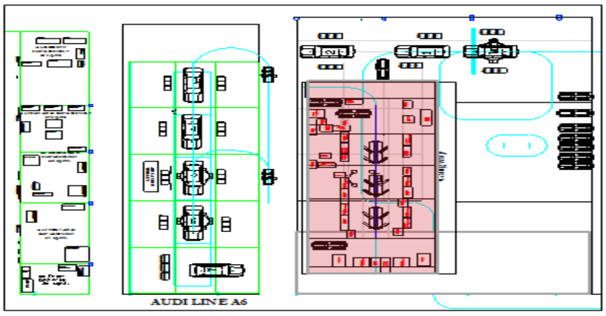
3.7 Door area shifting near to assembly line –A6

Door A6	*Improvement team*
Problem	Door area away from line
Root cause	Due to previous setup layout
Solution defined	Door line nearer to door removal tact
Benefit	1. Less movement from removal to door sub assembly
	2. Less Movement from sub assembly to door fitment

Before



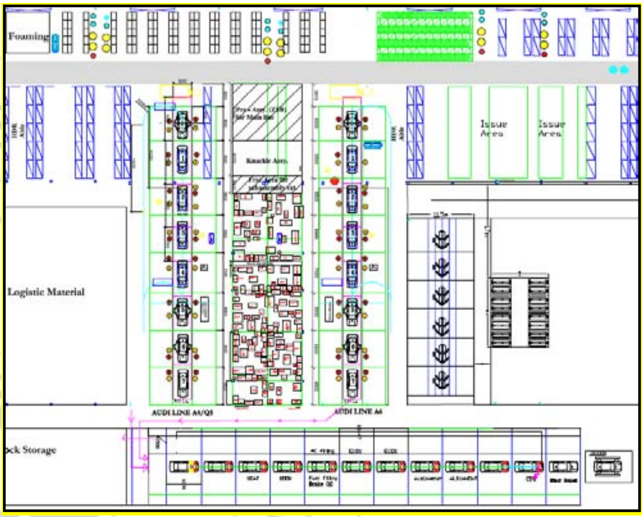
After



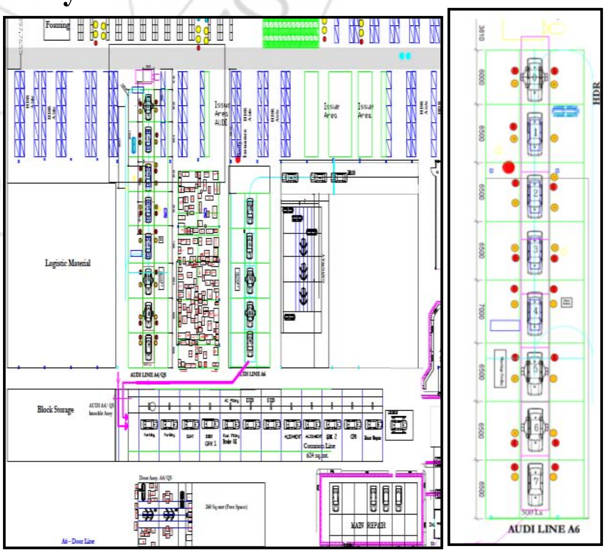
3.8 Hall B Layout after Change

Area Saved – 3000 Sq.m

3.8 Hall B- After Change with A6 Straight line



4. Hall B - Existing & proposed assembly line layout

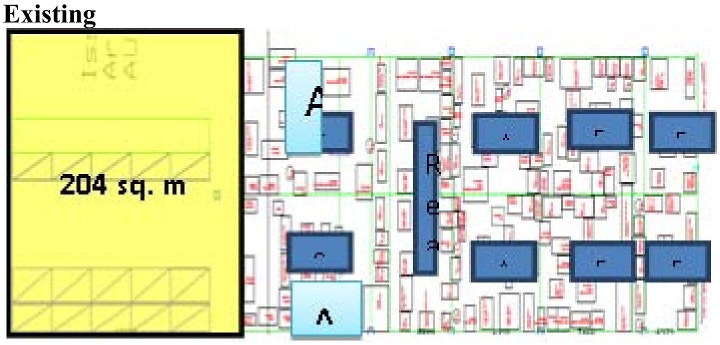


5. Advantages of A6 straight line extension

- Standardization of line layout
- Better material handling
- Better movement of man and machine
- Improves Quality

5.1 Hall B - Existing & proposed pre assembly area layout

Existing

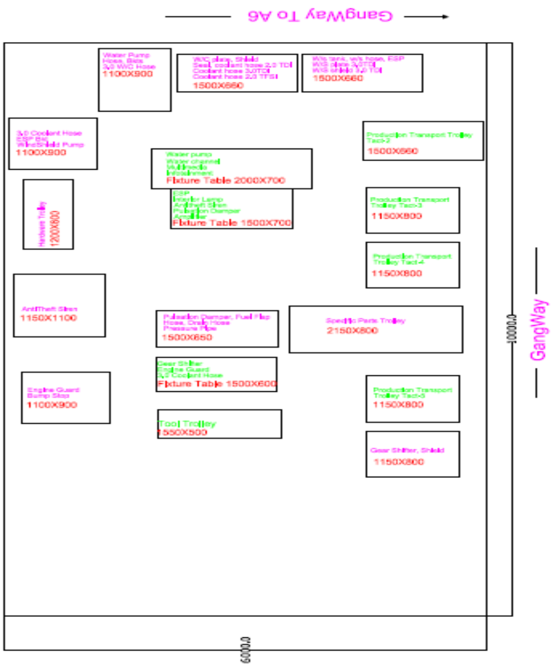


Proposed

5.2 Knuckle shifting

Shifting knuckle area from logistic area with the structure and AMT in sub assy line

6. Hall B – Small pre-assemblies layout for A6



7. Conclusions

- Standardization of pre assembly layout possible
- Smooth flow of the line by taking pre assemblies out of mainline
- Less movement of knuckle transportation as compare to existing
- Better material handling
- Better movement of man and machine
- Utilization of existing technology & structure
- Production capacities per day increased from7 to 14cars per day of A6 line & 12 cars/shift to 18 cars/shift

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Author Profile

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Prof. Ramakant Shrivastava is graduate in 1987 from Shri G. S. institute of Tech. & Sc, Indore (MP), awarded M Tech by Indian Institue of Technology, Madras in 1989 and PH. D. by Indian Institue of Technology, Roorke (UK) in 2008.He is currently working as Professor & HOD, Mech Engg. Government College of Engg. Aurangabad (India). His research interest are Heat Transfer, refrigeration, fluid flow, nano flow, system balancing, He has 25 international publications. 06 candidates are pursuing their doctorate research under his supervision.