Conversion of Conventional Manufacturing Setup Into Cellular Manufacturing Setup

Chinmay Samant[1], Tejas Patil[2], Chaitanya Nehete[3], Mahesh Patil[4]
[1, 2, 3, 4] Dept of Mechanical Engineering
[1, 2, 3, 4] DMCE, Navi Mumbai, India.

Abstract- *In the era of automation, various types of industries are now converting into fully automatic production houses. However with the help of cellular manufacturing a conventional setup can be converted into a semi-automated one by using some material handling devices and re-arrangement of the machines. The aim is to use the existing machines and to place them into cells where they can be handled by one or more than one worker. Various mathematical techniques along with simulation models are been used to convert the conventional setup into cellular setup. The main aim is to increase productivity with maximum utilization of existing machines.*

Keywords- cell, conventional, machine, manufacturing.

I. INTRODUCTION

After industrial evolution global market is available for each and every industry form small scale industries to large scale industries so things have escalated from national competition to global competition. The aim is to satisfy the global demand, we need to develop a production system in which there is less production cycle time with more production in less time. There are some main conventional manufacturing systems; Job production system has a high flexibility of product but production rate is very low similarly, in batch production and flow manufacturing rate of production is high but it has less flexibility due to fixed set of machines and more production rate is the priority. Due to limitations of job shop, batch shop and flow shop manufacturing systems to accommodate changes in production rate and product demand manufacturing systems need to reconfigure and respond to changes in product layout, product design, product, etc. So to overcome these problems Cellular Manufacturing System is considered as the best alternative production method to deal with these problems of manufacturing methods.

Cellular manufacturing is an advance system of lean manufacturing. Cellular manufacturing system consists of a cell which is a type of layout in which different type of products can be formed with limiting waste of material in less time. Cellular manufacturing consist of different cells in which various work stations, machine tools, material handling systems, etc. are involved. The major use of cellular manufacturing is in process methods, cellular manufacturing system work on the principle of group technology. Different parts of assembly are produced in different cells independent to other batch production and as per the customer needs we can increase or decreases the units of cells. The major advantage of cellular manufacturing is that to reduce the transportation of material from storage department to work station and this in return reduces lead time. Cellular manufacturing reduces setup time and give the worker tool to multitasking. Worker can handle different machines at same time. It gives us an improvement in quality of product with low cost, in a flexible way and on time. Goal of lean manufacturing is to reduce waste materials to match proper use of resources properly setup cells not only achieve the goal of lean manufacturing but also it meets costumer demand, proper worker utilization and make scheduling very efficiently.

II. CASE STUDY OF CONVENTIONAL MANUFACURING SETUP

Spartans Manufacturers and Exporters manufactures bicycle which fall in mountain bicycle category. From several years, the industry followed a conventional manufacturing system with high inventory and with unnecessary extra machines. To analyze the process, the case study is concentered to bicycle workshop. In this workshop assembly of different parts of bicycle is carried out based on the demand of the customer.

Table 1- Machines used in the workshop

Name of Machine	No. of Machines
Cutting Machines	4
Bending Machines	2
Roll Form Machines	3
Welding Machines	4
Horizontal Milling Machine	14
Vertical Milling Machine	4
Lathe Machine	16
Spray Painting Machine	4
Total Machines	51

The workshop needed more transportation time because of the arrangement of machines according to machine type and

also they were not being arranged according to the sequence of operation. Due to this arrangement floor space required is much high 16500 sq. ft. this arrangement can produce an average 6200 bicycles per month by utilization of 51machines.

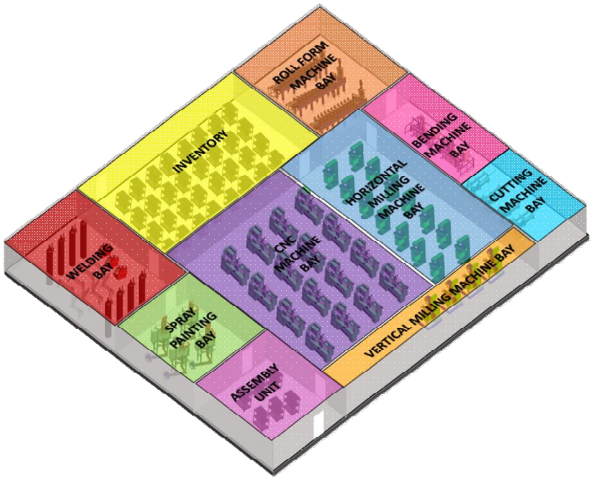

Figure 1- Conventional setup of the workshop.

Conventional Manufacturing Procedure used in the workshop-

There are four main components of the bicycle they are chassis, handlebar, rim and chainwheel. The process starts simultaneously for the main components. For the chassis and handlebar raw material remains the same, pipes from the inventory are supplied into cutting section in which they are cut according to the dimensions required using pipe cutter and hydraulic clampings are used as jigs. Then cut pipes of the chassis are sent to lathe machine for facing operation in which right hand cutting tool is used then it is sent to horizontal milling machine for profiling purpose where end mill cutter is used, then pipes are sent to welding section in which TIG welding is carried out for joining the chassis and then grinding is done on the additional weld beads for clean look and afterwards sent to painting section where first primer is sprayed as a base coat then desired color is sprayed then chassis is forwarded to assembly section. For handlebar after cutting it is also sent to lathe section where facing is done in which right hand cutting tool is used then sent to bending section for bending using bending dies the ends then is sent to painting section where first primer is sprayed as a base coat then desired color is sprayed then forwarded to assembly section. For rim manufacturing the raw material i.e. sheet metal is sent to roll forming section where flattening of the sheet metal is carried out in which sheet is flattened up to the required dimensions then roll forming is done for giving curvature to the sheet metal in which sheet achieves its circular shape and the sheet is rolled in one coil ,then this sheet metal is sent to cutting section for cutting sheet according to rim dimensions then to welding section for joining the two ends of the rim in which TIG welding is carried out and then sent to assembly section For chain wheel raw material is sent to lathe machine for facing and turning operations then to send to cutting section for cutting of teeth and then to vertical milling machine for cutting slots in the chain wheel, then sent to assembly section. Initially the assembly section remains empty after certain parts start to come in assembly section. Handlebar is installed inside the chassis at front using clamping devices and spanner ,then assembly is flipped then chainwheel and chain is installed then comes wheels for installation at last again the assembly is flipped and brakes and brake cables are installed then companies put there logo and stickers at last.

III. MATHEMATICAL MODEL

Parts are given to part families according to the same resemblance in processing requirements between two parts.Let's see the way to group parts-

Step.1] Compute the resemblence coefficient between all parts according to the following Equation (a):

Where

R_{ab}= resemblance coefficient between part type a and b, $N_a(t)$= need of part type *a* at time t,$N_b(t)$=need of part type *b* at time t, *L* = number of machines in the manufacturing system, R_{ab}=number of machines that both part *a* and *b* visit,T_a=processing time part *a* takes on machine,$T_{b=}$ processing time part *b* takes on machine,U_{ab}=1, if part type *a* and *b* visit machine, U_{ab}=0, otherwise, S_{ab}= if part type *a* or *b* visit machine, S_{ab}=0,otherwise,below is equation -(a)

$$R_{ab}=\frac{\sum_{i=1}^{n} maximal\,[T_a N_a(t),\ T_b N_b(t)]U_{ab}}{\sum_{i=1}^{n} maximal\,[T_a N_a(t),\ T_b N_b(t)]U_{ab} + \sum_{i=1}^{n} maximal\,[T_a N_a(t), OR\ T_b N_b(t)]S_{ab}}$$

T_a=30sec, T_b=40sec, $N_a(t)$=2 machines, $N_b(t)$=2 machines

Substituting all the values we get

R_{ab}=0.7

Step.2]Find required no. part families-

Number of part families= c/ c_{min}

c = number of parts in existing manufacturing system, $c_{min=}$ min number of parts in part family

c=4, c_{min}=1

Number of part families=4

Step.3]Assignment of machines:

Similar machines are allotted to the part families according to the value of the resemblance coefficient to take advantage of their common operations.

Step.4] Checking balancing time for machine:

Each machine has a capacity of [$cap_1(t)$, $cap_2(t)$,……., $cap_n(t)$] to produce products for demands [$N_1(t)$, $N_2(t)$,….., $N_n(t)$]
The Balancing time for machine *n* at any given time *t* is given by:-
BM(t)= $\sum_{i=1}^{n} TkDk(t)$

Step.5]To find required no. of machine cells:-

Number of machine cells =L/ L_{max}
L_{max}=max no.of machines in cell
L=36machines
L_{max}=5machines
Number of machine cells=7.

IV. CONVERSION OF MODEL

After considering the conventional layout and doing all the calculations and taking a note of the flow of material inside the conventional setup was converted into various cells.

WIP- Work in process.
HMC- Horizontal machining center Milling Machine.
VMC-Vertical machining center Milling Machine.

Table 2- Cell arrangement

Name of Cells/ Processes	Number of Machines/ Sub Areas	Name of Machines/ Sub Areas along with the sub categories	Number of Cells/ Sub areas
Chassis Cell	8	Lathe- 1, HMC-4, Cutting- 2, Welding- 1.	2
Handle Bar Cell	2	Cutting- 1, Bending- 1	2
Chainwheel Cell	7	Lathe- 4, HMC- 1, VMC- 2.	2
Rim Manf. Cell	3	Roll forming- 3	1
Painting Cell	2	Spray Painting- 2	2
Assembly Belt	1	-	1
Inventory	3	WIP, Raw Material, Finished Goods	1

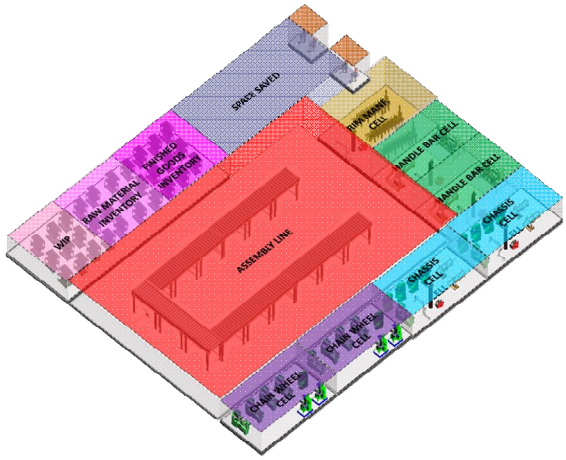

Figure 2- Cellular Setup.

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V. SIMULATION OF CELLULAR SETUP

Now stimulate the different process we conclude or found out which simulation software reduce the time by reduce the material handling. Also it gives the proper utilization of machines, which helps for the reduction in the number machine and increasing profit inform of money and decreasing scrape and other losses, which in return increases the productivity.

Simulation of conventional layout:-

Simulation is the method of which simulate the layout and the information about the time reduction machine reduction. It is the imitation of real world process. We have used Arena Software for simulation which gives the output of layout.In Arena consist differentiation optionwhich are used for simulation of the process. Differentiation method is applied to get the output.

1. Create: Arrival or start of the procedure.
2. Assign: Designate a command to a machine.
3. Separate: Bifurcates a particular command into a number of operations.
4. Record: Tracks flow processes and time of the procedure.
5. Dispose: Ends the flow of the material and stops the process.

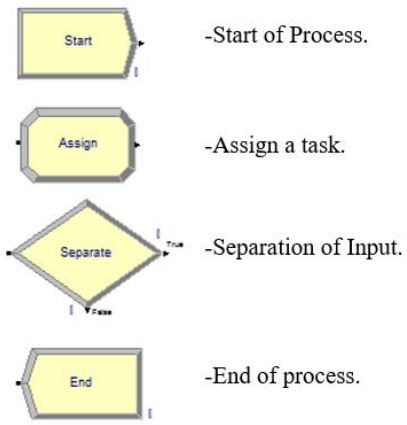

Figure 3- Simulation Commands.

Now we can use this software for dissection flow process this process relates to the setup which is been used. Now, simulate the processes of chassis, chain wheel, handle bar, rim and assembly line in the arena software. Simulation was used in order to identify the time which is saved due to introduction of cellular manufacturing. The main components in which time was saved were idle time and transportation time. Software uses various analytical techniques in order to complete the process in the minimum time possible. All the prior machining times were given as an input to the software. Below diagram represents a flowchart which shows the simulation which is been done on the process in order to calculate the minimum time possible.

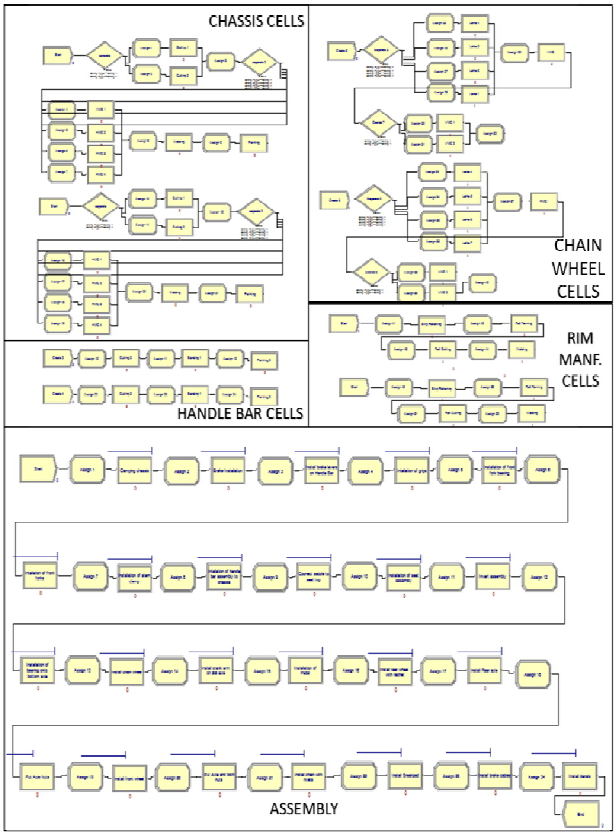

Figure 4- Simulation flowchart of Cells.

VI. RESULT

After applying simulation to the cellular model there was a considerable reduction in the production time. The total production time reduced from 12.276 seconds to 11,564 seconds which is a reduction of 5.8%. Also the number of the machines were reduced from 57 to 43. Lathe machines were lying idle for longer period of time so the machines were reduced to a greater extent. The results overall show that considerable amount of time is been saved.

Table 3- Results

Total number of machines		Total Production time (seconds)	
Conventional Setup	Cellular Setup	Conventional Setup	Cellular Setup
57	43	12,276	11,564

VII. CONCLUSION

Cellular manufacturing can used as an efficient way in order to convert the existing setup into a modified setup just by making a few key arrangements of machines and introduction of faster material handling systems. The key parameters which are cellular manufacturing targets are idle time and transportation

time. As the machine as kept close to each other these times are been significantly cut down.

VIII. ACKNOWLEDGEMENT

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