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Design of wash unit line assembly trial layout

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Abstract
The objective of paper is to design and optimize the washing machine manufacturing assembly line. To optimize the manufacturing of the plant layout and assembly line has been briefly studied, and also the advantages and disadvantages of the assembly line and plant layout are noted. Dimension of the plant is measured to design and set up the Assembly line layout.
According to the dimensions of the plant, the layout has been designed for the assembly line layout for wash unit. To reduce the man power in the assembly line, the Special Purpose Machines are used. The Special Purpose Machines used will reduce the human error and also the delay time, through which the product can be produced efficiently and faster with less cycle time. Hence attempt has been made for construct 3D model of Assembly layout using Technomatix Simulation package to analyze the characteristics of assembly line with respect to cycle time.

Keywords: Assembly line layout, plant layout, SPM (Special Purpose Machines), delay time

Introduction
Plant layout is a mechanism which involves knowledge of the space requirements for the facilities and also involves their proper arrangement so that continuous and steady movement of the production cycle takes place.

Types of Plant layout
a. Product or Line Layout
If all the processing equipment and machines are arranged according to the sequence of operations of the product, the layout is called product or line layout. In this type of layout, only one product of one type of products is produced in an operating area. This product must be standardized and produced in large quantities in order to justify the product layout.

b. Process or Functional Layout
The process layout is particularly useful where low volume of production is needed. If the products are not standardized, the process layout is lower desirable, because it has creator process flexibility than other. In this type of layout, the machines are not arranged according to the sequence of operations but are arranged according to the nature or type of the operations. This layout is commonly suitable for non-repetitive jobs.

c. Fixed Position layout
This type of layout is the least important for today’s manufacturing industries. In this type of layout the major component remain in a fixed location, other materials, parts, tools, machinery, man power and other supporting equipment’s are brought to this location.

d. Combination type of Layout
Now a day in pure state any one form of layouts discussed above is rarely found. Therefore, generally the layouts used in industries are the compromise of the above mentioned layouts. Every layout has got certain advantages and limitations. Therefore, industries would to like use any type of layout as such.

Assembly Line
An assembly line is a production process that breaks the manufacture of a good into steps that are completed in a pre-defined sequence. Assembly lines are the most commonly used method in the mass production of products. They reduce labor costs because unskilled workers are trained to perform specific tasks.

Fig 1: Assembly line

Understanding of assembly line

An assembly line is where semi-finished products move from one workstation to another workstation. Parts are added in sequence until the final assembly is produced. Today, automated assembly lines are machines with minimal human supervision. The introduction of the assembly line drastically changed the way goods were manufactured. Henry Ford, who set up an assembly line in 1908 to manufacture his Model T cars. Before, workers would assemble a product (or a large part of it) in place, often with one worker completing all tasks associated with the product's creation. Assembly lines, on the other hand have workers (or machines) complete a specific task on the product as it continues along the production line rather than complete a series of tasks. This increases efficiency by maximizing the amount a worker could produce relative to the cost of labor.

Mass Production

Mass production is the manufacturing of large quantities of standardized products, often using assembly lines or automation technology. Mass production facilitates the efficient production of a large number of similar products. Mass production is also referred to as flow production, repetitive flow production, series production, or serial production. In mass production, mechanization is used to achieve high volume, detailed organization of material flow, careful control of quality standards, and division of labor.

Literature review

Buchari, U. Tarigan, M B Ambarita [1]

In the production process, it can be seen that the production line is not balanced. The imbalance of the production line is caused by the difference in cycle time between work stations. In addition, there are other issues, namely the existence of material flow pattern is irregular so it resulted in the backtracking and displacement distance away. This study aimed to obtain the allocation of work elements to specific work stations and propose an improvement of the production layout based on the result of improvements in the line balancing. The method used in the balancing is Ranked Positional Weight (RPW) or also known as Helgeson Bernie method.

Amit Yadav, Anuj Garg, Gautam Yadav, Rahul Chadhokar, Swapnil Bhurat [2]

The development of new methods for design for manufacture and assembly, the need to incorporate quality during the design phase and the recent focus on transparent design work and communication have all created a need for a more structured approach to design. DFMA is a structured method of analyzing a product and reducing the number of parts, improving their manufacturability and ease of assembly, in order to reduce product cost and manufacturing time.

Okpala, Charles Chikwendu and Chukwumuanya, Okechukwu [3]

The paper provided a detailed definition of plant layout; and listed efficient labor utilization, manufacturing and maintenance ease, enhanced productivity, manufacturing flexibility, effective utilization of staff, machines, materials, and equipment, as well as reduction of accidents, hazards, and inventory handling cost as some of the benefits of a well-designed plant layout. Due to ever changing market requirements, stiff competition, more variety of products, reduced life cycle of products, and high cost of manufacturing, companies that have just one product may find it difficult to break even.

Sanjeev B Naik [4]

Facility layout design involves a systematic physical arrangement of different departments, work stations, machines, equipments, storage areas and common areas in a manufacturing industry. In today's competitive global environment, the optimum facility layout has become an effective tool in cost reduction by enhancing the productivity. It has become very essential to have a well-organized plant layout for all available resources in an optimum manner to achieve the maximum returns from the capacity of facilities. The objective of this paper is to review the contributions in the field not only for plant layout but re-layout also. Based on the above survey information it is clear that several researchers have contributed their ideas in the area of plant layout design Material Handling using different optimization tools and technique. Here in this work cycle time data is collected from the shop layout with reference to that simulation experiment is carried out using Technomatix software.

3. Problem Statement

We have studied about the assembly line, for which the plant layout has to setup, so we have selected assembly line layout for our project. To design and optimize the assembly line for production of front load washing machine. To carry out the process initial setup layout has to be done. So, the design of wash unit line assembly trial layout has to be done. There are three types of plant layout as listed below:

1) Product Layout
2) Process Layout
3) Fixed Position Layout

Among three products or line layout is preferred in this project work

3.1 Product or line layout

3.1.1 Reasons for Line layout

- Lowers total material handling cost.
- Better utilization of men and machines.
- Greater simplicity of production control.
- Total production time is also minimized.
- There is less work in processes.
- Less floor area is occupied by material in transit and for

temporary storages.

Methodology

Site Mobilization & Material Identification

The very initial stage of the plant is the selection of the site. The selection of the site is the most important factor for setting up the plant. The main factors for the selection of the site location are as follows

1. Identification of region
2. Choice of a site within a region
3. Dimensional analysis
4. Location Choice for Existing Organization
5. These are some of the important factors for setting up a Plant.

Location Choice for Existing Organization

In this case a manufacturing plant has to fit into a multi-plant operations strategy. That is, additional plant location in the same premises and elsewhere under following circumstances

1. Plant manufacturing distinct products.
2. Manufacturing plant supplying to specific market area.
3. Plant divided on the basis of the process or stages in manufacturing.
4. Plants emphasizing flexibility.

Data and Observation from Trial Line Assembly

Data for the trial run layout

Formula for the theoretical cycle time

Cycle Time = Net Effective Production Time/Number of units made

The speed of the conveyor running is 21 Metres/minutes

Speed of conveyor = 21 m/min

Where,
M = Meter
Min = minutes

Cycle time calculation

Length of the conveyor = 44 mts
Speed of the conveyor = 21 M/m

Time taken for conveyor to complete

Full length = total length of the conveyor/speed of the conveyor

= 44/21 = 2.09 minutes
= 125.4 seconds

The above time is calculated based on the running of the conveyor on the theoretical basis without calculating the time required for different work stations and Special Purpose machines used.

The time taken for the conveyor to complete one cycle with various work stations: In this section various workstation timing are shown in table 1

Table 1: Process time calculation

Operation carried out	Time (seconds)	Total time consumed (seconds)
Lifter	0 – 5	5
Bearing insert machine	5 – 105	100
90° Drum rotator	105 – 165	60
180° Drum rotator	165 – 225	60

Table 2: Cycle time calculation

Product name	Tub assembly
Net production time	8 hrs x 60 mins = 480 mins
Number of units made	82
Cycle time (minutes/product)	5.84mins/ unit
Cycle time (seconds/product)	350 sec/unit

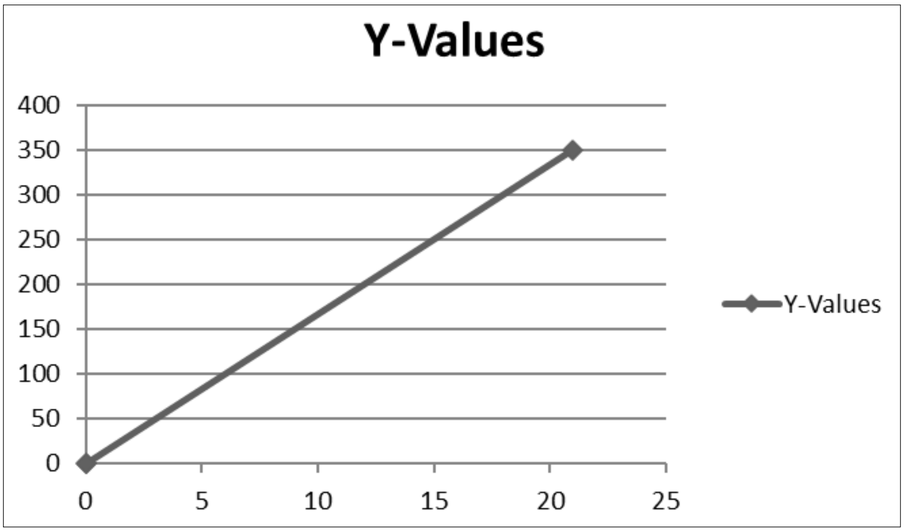
Cycle time of the layout = 350 sec/ unit

Graphs

Table

Table 3: Conveyor v/s Cycle time

Conveyor Speed (M/min)	Cycle time (sec/unit)
21	350



Graph: Conveyor v/s cycle time

Graph 1: Shows the relation between conveyor speed and cycle time of Assembly line.

3D Modelling

In this section the 3D models of Assembly sections are constructed using CATIA as shown here.

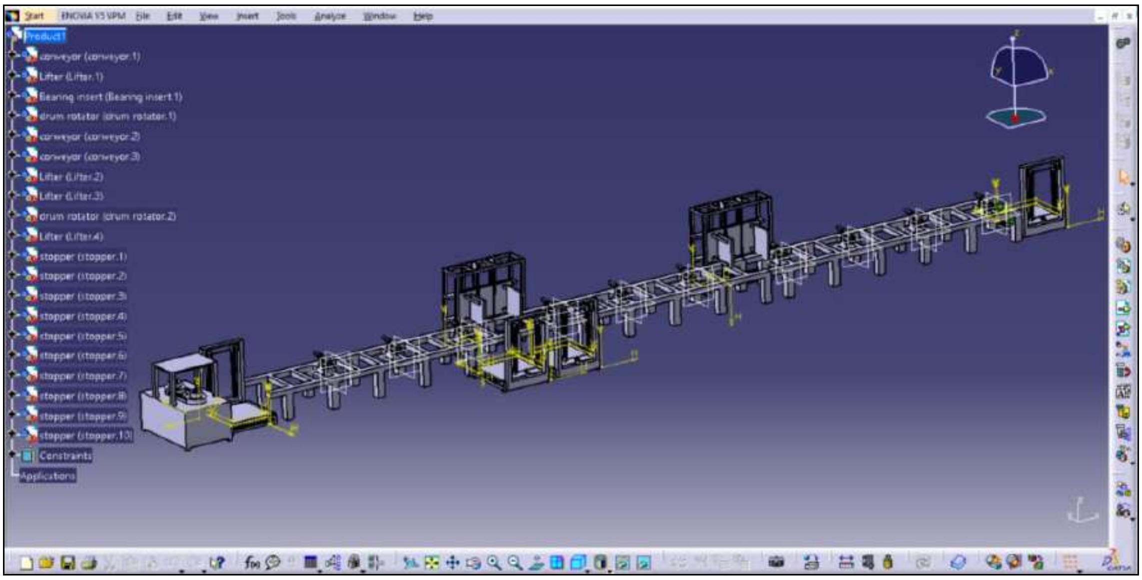


Fig 2: Assembly line

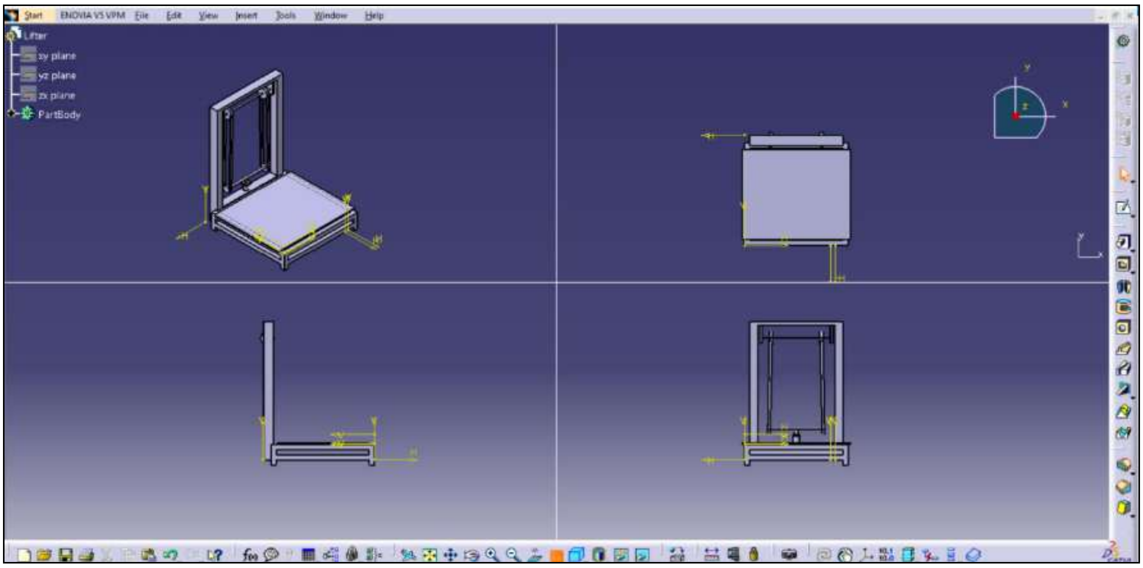


Fig 3: Lifter

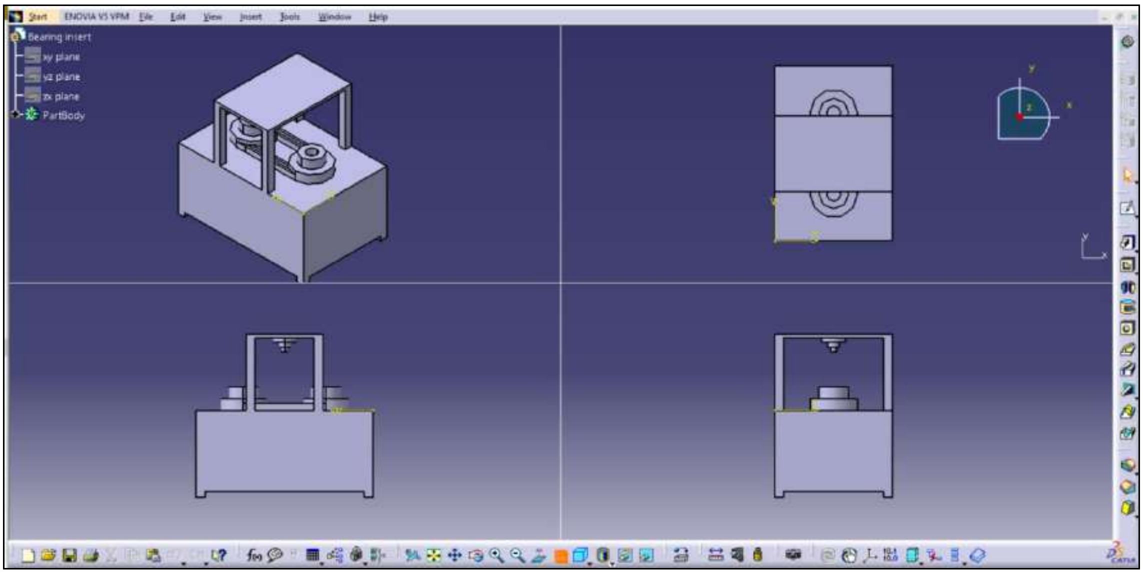


Fig 4: Bearing insert machine

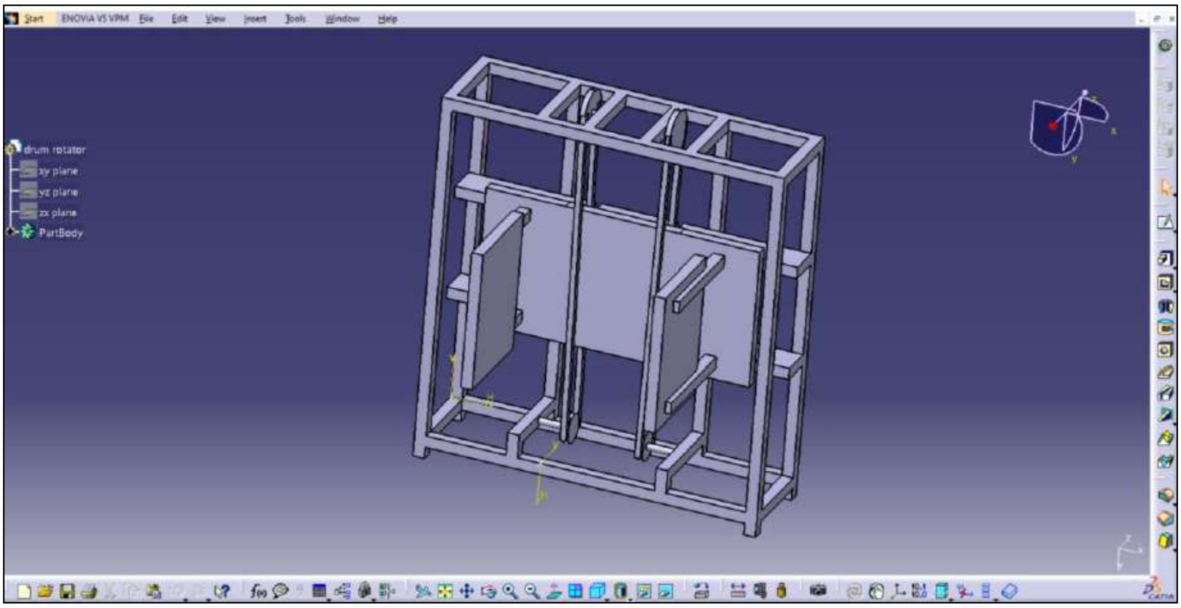


Fig 5: Drum rotator

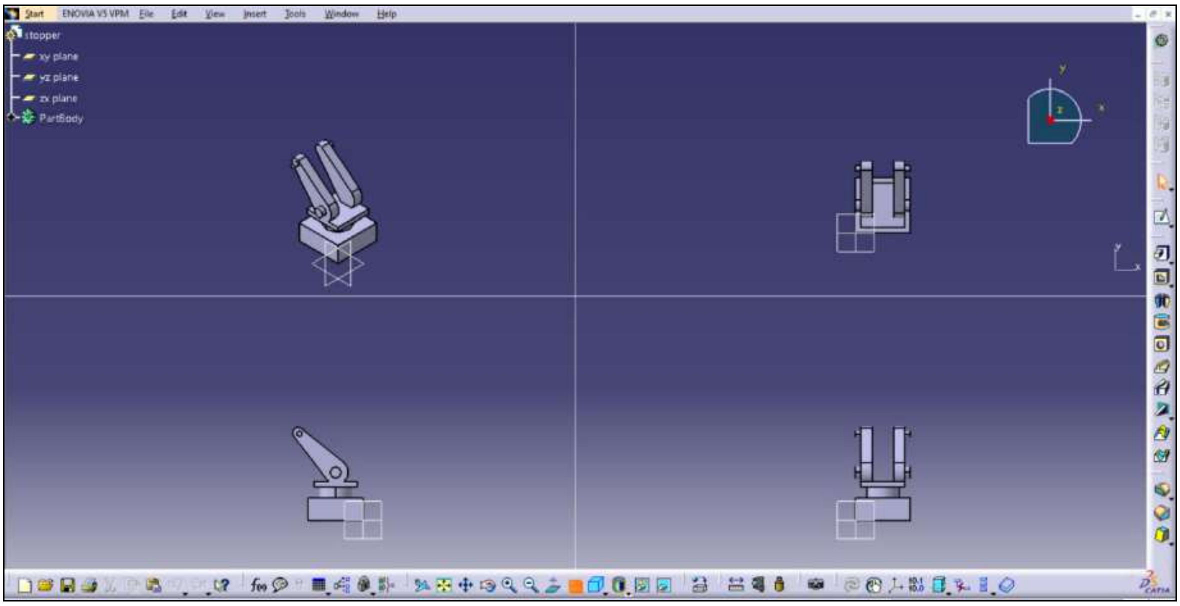


Fig 6: Stoppers

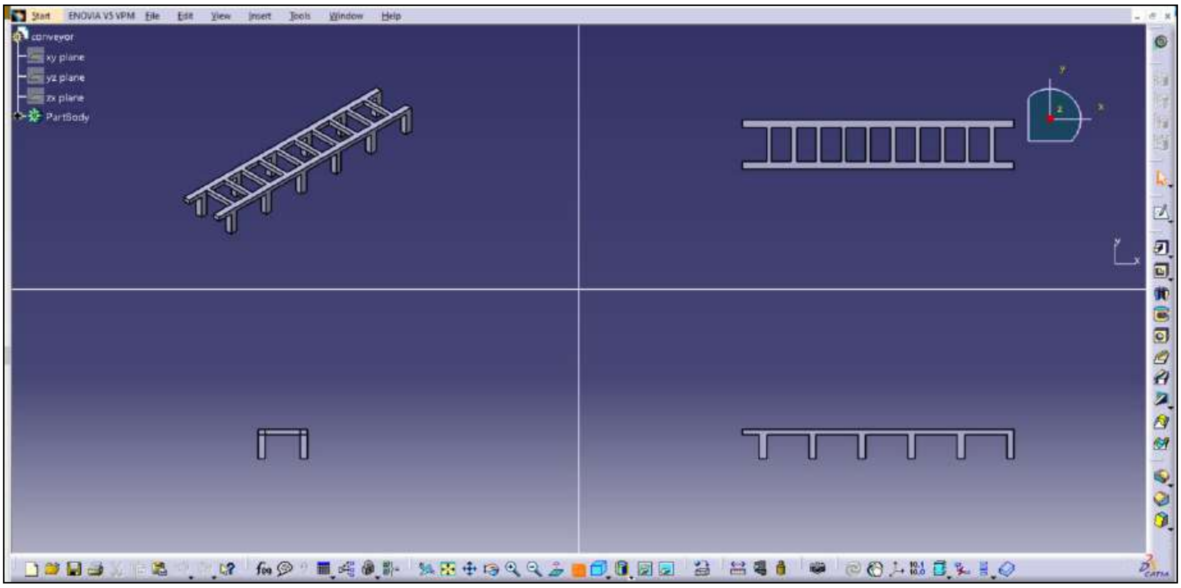


Fig 7: Conveyor

Cycle Time
The cycle formula

Cycle time = total time required per shift/number of products produced per shift

Total shift time = 8hrs = 480 mins = 28,800s

Total products to be produced per day = 156 units

Cycle time calculation

Cycle time = Tt/Pr

Where
Tt = total time required per shift
Pr = number of products produced per shift

Total products produced per shift = 52 units
Cycle time = 28,800/52

= 553sec

Cyce time calculation for china plant
Cycle time = Tt/Pr

Where
Tt = total time required per shift
Pr = number of products produced per shift

Total shift time = 8hrs = 480 mins = 28,800s

Total products produced per shift = 45 units

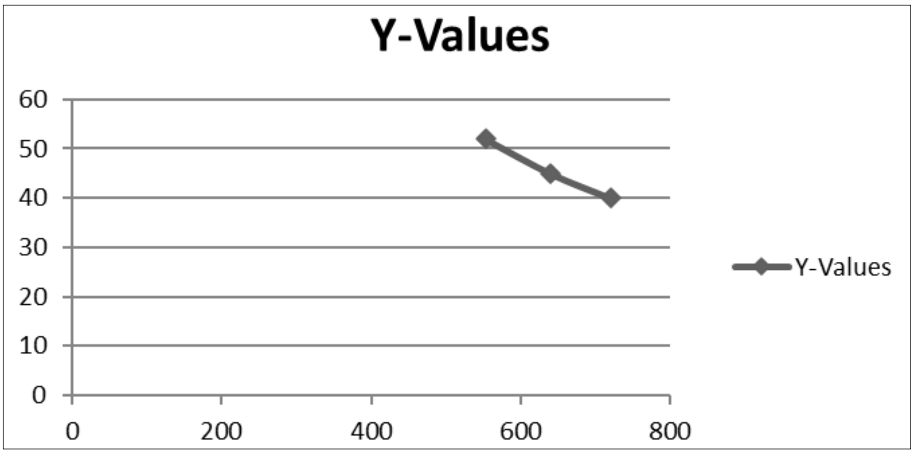
Cycle time = 28,800/45

= 640sec

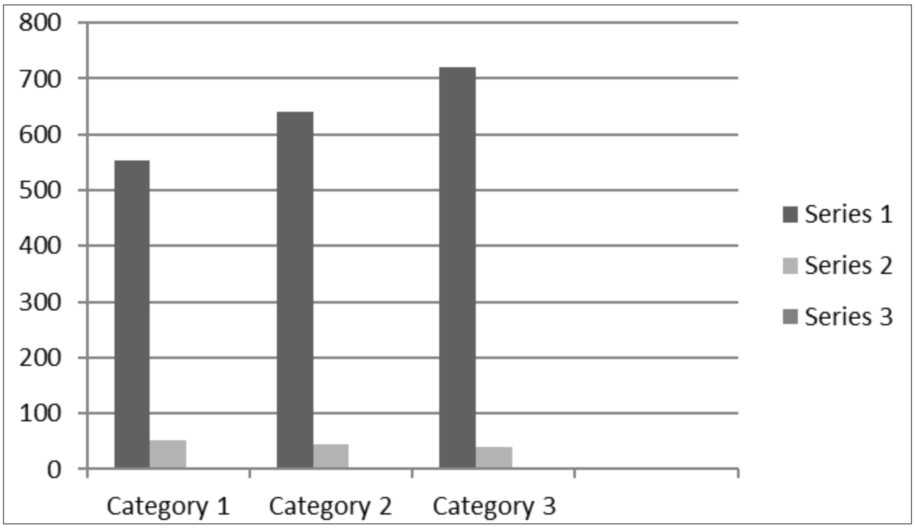
Cycle time calculation for Top load plant
Cycle time = Tt/Pr
Where, Tt = total time required per shift
Pr = number of products produced per shift
Total shift time = 8hrs = 480 mins = 28,800s
Total products produced per shift = 40 units
Cycle time = 28,800 / 40
= 720sec

Table 4: Cycle time Comparison between plants that are implemented

Contents	Cycle time	Products produced per shift
Front load	553	52
China plant	640	45
Top load plant	720	40



Graph 3: Cycle time Comparison between plants that are implemented



Graph 4: Cycle time Comparison between plants that are implemented

Plant Simulation

Simulation experiment is modeled using Technomatix software to analyze the flow characteristics with reflect to speed and cycle time.

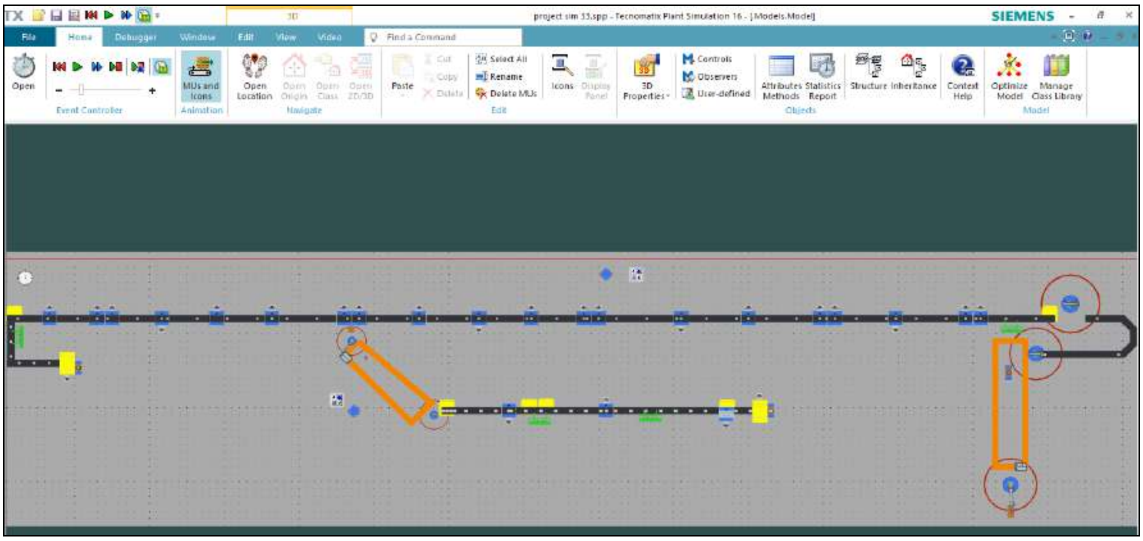


Fig 8: 1simulation of conveyor

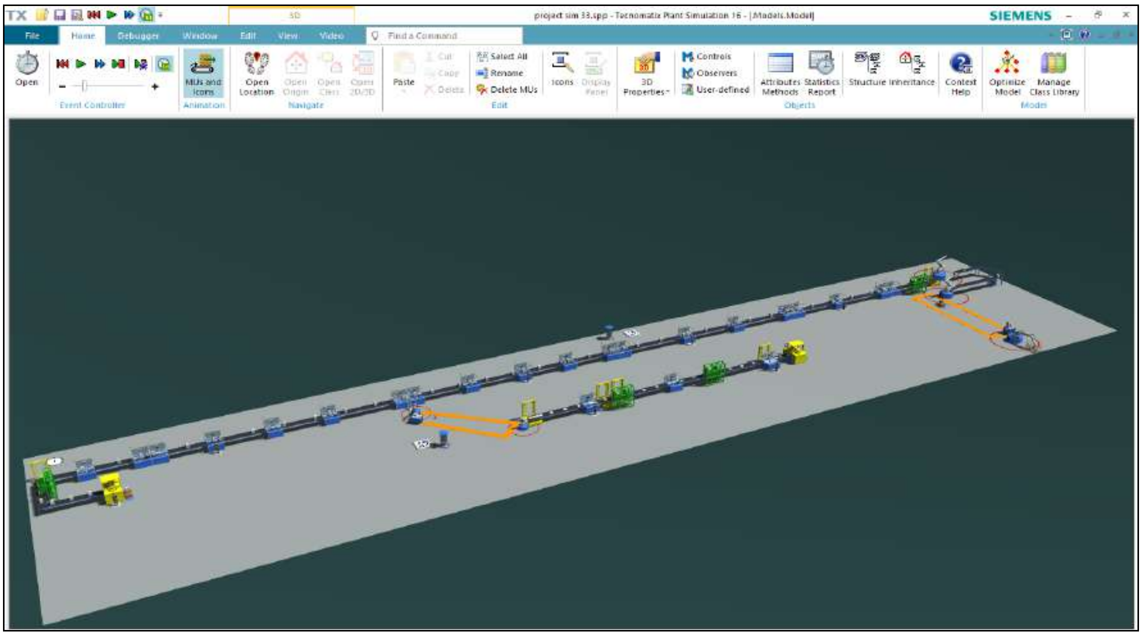


Fig 9: 3D simulation of conveyor

Results and discussions

In this section the relative comparison is made between the theoretical and practical cycle time. In theoretical cycle time is calculated based on the conveyor speed. In actual practice cycle time is calculated based on work which is processed in each station. Also in this Project cycle time is compared by means of number of units produced in each plant as shown in table 5. Then at last the simulation is done by using Technomatix software for assembly line of conveyor as shown in fig 1 and 9.

Conclusion

In this project work cycle time estimation of conveyor assembly line unit in washing machine application is discussed by comparing two different estimates of cycle time say theoretical cycle time and practical cycle time. The entire 3D layout was modeled using CATIA and then given 3D layout is simulated using Technomatix plant simulation software. In this software logical flow movement of material in the conveyor assembly is studied for given assigned cycle time using different trials run with the help of simulation. But however simulation results and actual results show some significant variation in the cycle time. In future the same problems can be extended by Quantitative models like mathematical models and algorithms.

References

1. Naik Sanjeev B, Shrikant Kallurkar. A literature review on efficient plant layout design. International Journal of Industrial Engineering. 2016;7(2):43-51.
2. Buchari U Tarigan, Ambarita MB. Production Layout Improvement by Using Line Balancing and Systematic Layout Planning Iop Conference Series Materials Science and Engineering. 2018 Feb 1;309(1):012116. IOP Publishing.
3. Charles Chikwendu, Chukwumuanya, Okechukwu. Plant Layout Analysis and Design, Okpala CC, Chukwumuanya O. Int. J Adv Engg Tech2016. July-Sept;7(3):201-206.