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Optimization of Assembly Line of An Eicher Tractor Unit

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Abstract: **Line balancing is about arranging a production line so that there is an even flow of production from one work station to the next. Line balancing also a successful tool to reduce bottleneck by balancing the task time of each work station so that there is no delays and nobody is overburden with their task. This thesis presents a case study on a line balancing problem in an eicher company and the study focused on assembly line. This study aims to improve the productivity and line efficiency also to recommend improvement activities based on the line balancing and analysis done in the simulation model. The simulation was done by using Tecnomatix Plant Simulation. All the data needed for the line balancing analysis was collected and a line balancing model equipped with manual calculation was done. This data gathered is then simulated in Tecnomatix Plant Simulation. Among the improvement activities conducted in order to balance the line was combining a few process into one, transformation from manual process to mechanization, and removing waste from the line. Throughout the study, three layouts were proposed. Among these three layouts only one will be proposed to the company. The layout proposed has a better line efficiency and rate of productivity.**

Keywords: management, organization, production system, plant simulation, digital manufacturing, material flow**.**

I.INTRODUCTION

"Tecnomatix" is the complex portfolio of digital solutions for the production process that unites all production disciplines with the assembly processes of engineering products, from design and planning to simulation and process verification. . With the "Teamcenter" product, it is one of the most universal products for manufacturers on the market.

A wave of massive innovation in Germany is known as the fourth industrial revolution for 260 years. It is based on the use of advanced information and communication technologies in all industrial sectors of management, processing and delivery of products to customers. The ability to obtain the amount of data on real processes and their treatment offers researchers the ability to create a virtual image of industrial processes. This virtual image of reality is provided by experimenting with the real system in a virtual environment without the risks that would jeopardize the functioning of real systems. When the real world and the virtual world transmit digital models and techniques that provide tools for dynamic analysis such as simulation, emulation and meta modelling, there is a completely new kind of environment. This type of environment has become a basic idea of Industry 4.0. Industrial philosophy has become a blow to the German economy. Part of this philosophy is also a digital business. It is an information technology that replaces the model of the real world. Industry 4.0 is the theme of the future of digital businesses.

At present, manufacturing companies have to adapt to changing customer demands, which causes problems in the planning of production logistics and material flow. Internal information systems often cannot predict the exact needs and personnel, inventory, number of vehicles, footprint and other parameters as conditions change. From a business point of view, you need a planning tool that takes changes into account and provides results that indicate how you should behave like a logistics system.

In the background, planning tools, consumption standards, working time analysis or other studies are developed. The task is to define the user input parameters, e.g. Production schedule, lot size, etc.

Figure 1 Tecnomatix and its characteristics

According to solution is Tecnomatix used for:

- Planning and verification of component.
- Planning and verification of assembly procedures.
- Planning in the field of robotics.
- Design and optimization of plants.
- Quality management.
- Production management.
- Production process management.

1.4 APPLICATION OF TECNOMATIX

Installation simulation the modeling of technological processes and the creation of simulation models of real production systems of Tecnomatix Plant Simulation can be performed in 2D and 3D environments. Modeling in a 2D environment shown in Figure 1 applies to complex optimization problems mainly related to the timing of the technological process, ie the analysis of the production process from time to time (production time, additional and additional times, times of intermediate ends, production cycles).

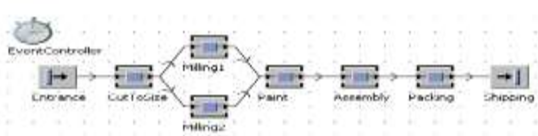


Figure 2 - Modeling of process planning in 2D environment

Application of Tecnomatix Plant Simulation to the process plan model for "corpus" production unit in the work area with two milling machines - milling1 and milling2. The main objectives of the simulations are to minimize processing and installation times, maximize utilization, minimize inventory and increase delivery times. The following data were used as basic parameters for the simulation and modeling process with the Tecnomatix Plan Simulation program system: production process plan for "corpus" parts (sequence of operations, production time, additional time and list of machines) and number of units per year.

II. LITERATURE REVIEW

Borojevic et al. [1] In this document, the planning of the process has been modeled and simulated in concrete conditions. This program system was applied in a 2D and 3D environment and the optimal production parameters were also determined. The construction of production systems from the point of view of the resources needed to carry out the production process for several years constitutes an important set of technical tasks. In the context of the design of production systems, in addition to the planning of the process planning, it is necessary to determine the regulatory parameters with which the efficiency of the production process reaches a high level. **Rajashekar Patil et al. [2]** In this study, production systems are one of the key applications of simulation, which has been used successfully to facilitate the design of new production facilities and to evaluate the proposed improvements to existing systems. Many simulation tools are available on the market.

Olivier Martin et. al. [3] This report describes how the simulation of discrete events can be used to optimize the production of electronic assembly lines. At the moment, many production decisions are based on workers' experience. However, understanding the parameters that influence production is a difficult task, especially for systems with a variety of products. Exploitation could be improved by analyzing bottlenecks and their impact on the overall capacity of the line.

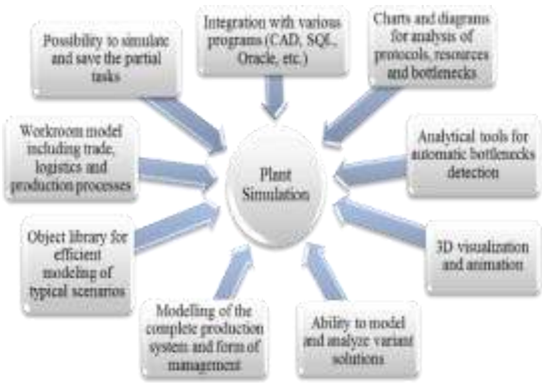
A Gatsou et al. [4] This article produces fitness equipment commonly used in gyms. Some variants of these machines are produced in stock, but the total delivery time was considered too long. Therefore, although the structure of the production system was considered stable, it was examined using discrete event simulation software to validate the initial explanations and also to test new control rules.

III.OBJECTIVES

Main objectives of this project work are described below:

- Design a concept of the digital factory and its utilization.
- Get acquainted with the process simulation software from Siemens.
- Model a 2D simulation of production processes in simulation software. This simulation will be adapted to be used with external controller.
- Find a way how to connect simulation to an external controller performing the control of the transfer line
- Select a suitable method to define to simulated transfer line.
- Optimize the machining time to improve the production line of plant.

- To improve the overall productivity of the plant.



VI.RESEARCH METHODOLOGY

The briefly describes basic terms relating to the digital factory environment, which is called Siemens Tecnomatix.

1) Utilization of The System Module Plant Simulation

Plant Simulation allows creating digital models, which are then used for simulation of specific conditions within the production process while changing selected parameters and characteristics of the process.

Figure 3: Modules of Tecnomatix considering the utilization

Simulation of various set conditions of the production process allows optimizing before the real starting, the inputs and outputs of the production process. During the optimization of the selected production process we decided for Plant Simulation, because of its ability to create plans or scenarios for the future in the planning phase of the project to the benefit of different production systems models. This module allows the hierarchical construction of models in 2D and 3D interface, with respect to production, storage and distribution mutually linked chains of objects. The possibilities of Plant Simulation utilization

During simulating the production process is evaluated the achieved output, respectively the operation of the production system during certain period, on the basis of statistical data. The performance characteristics of the production systems can be summarized as follows:

- Utilization of resources,
- Stock size in terms of the number of pending parts,
- Machine failure statistics,
- Machine blocking time,
- Return on investment,
- cost indicators of production,
- the amount of scraps,
- the number of parts that were faulty, respectively require repair,
- trouble-free operation,
- time during which work is stopped due to device inactivity,
- waiting time of the product before workplace,
- monitoring of production performance, which indicates, how many products are produced during the simulation,
- continuous production time for a particular product,
- the amount of inventories and work in process of production.

Figure 4: Examples of Plant Simulation exploitation

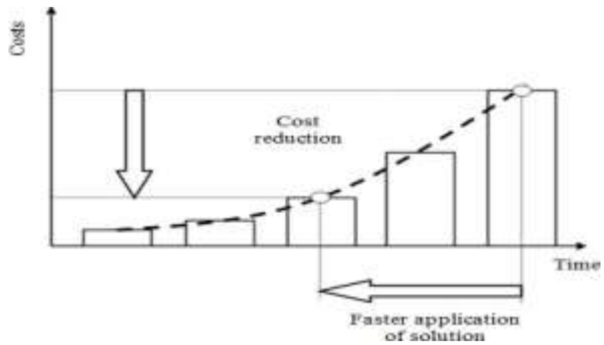
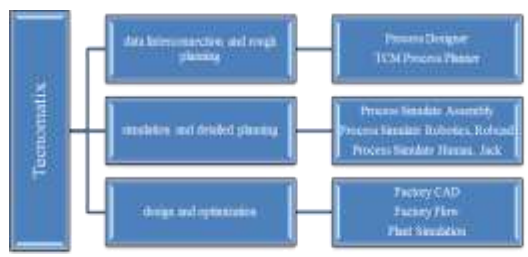


Figure 5: Cost savings resulting from the early utilization of Plant Simulation



2) Product for Simulation Process

Products we have chosen for the simulation process are tapered roller bearings. Fig. 4 shows the tapered roller bearing with its main parts. The components, from which they consist, are:

- inner ring,
- rolling element (in this case cones),
- outer ring (in the case of tapered roller bearings it is separable),
- Ball cage (the purpose is to avoid contact/friction of individual cones with another cones).

Their typical characteristic, compared to other types of bearings, is the ability to transmit big axial and radial forces simultaneously

3) Assembly Methods

Before going to Assembly line we have to familiar to the Assembly line and terms related to it. There are two primary methods of assembly in the industry, which are bench assembly and line assembly. In bench assembly, the work-piece stays stationary on a bench; all required parts and equipment for assembly are brought to the bench and assemblers move around the bench to perform the assembly. Line assembly is an assembly method where work-pieces move through a sequence of stations for assembly one piece at a time. An assembly line is the production system in which assembly stations are organized in a serial layout and line assembly method is applied. At Eicher Engines line assembly is adopted for assemble engines.

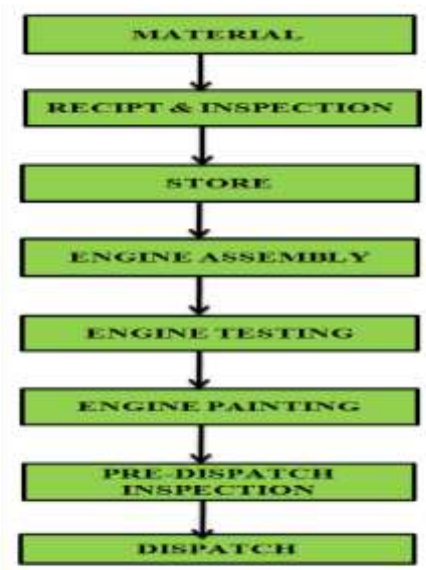


Figure 6: Engine Assembly Process Flow Chart

4) Assembly Line Balancing

Balancing an assembly line indicates distribution of total workload of the line among each station at the line equally so that idle times and the difference between the idle times at different stations are as low as possible. The key here is to balance the workload of operators at every station; reducing operator idle times at stations over a takt means reduction of unused station capacity, which is the expected result of line balancing and which helps minimization of losses and costs. In other words possible results of an assembly line balancing process might be maximized efficiency, minimized time to finish a process, or minimized number of work stations necessary within a certain time frame. Each manufacturing process might be quite different from another, so a company balancing unique workloads must work within the constraints and restrictions affecting its specific assembly line.

5) Assembly Line Methods

Depending on the production strategy, assembly lines can be designed such that assembly of different products can be held at same line. According to the diversity of products assembled at the line, assembly lines are divided into three main categories:-

1. Single Model Assembly Lines
2. Mixed Model Assembly Lines
3. Multi Model Assembly Lines

Single-Model Assembly lines have been used in single type or model production only. There are large quantities of the products, which have the same physical design on the line. Here, operators who work at a workstation execute the same amount of work when a sequence of products goes past them at a constant speed.

Figure 7 Single Model Assembly lines

Mixed-Model Assembly lines are usually used to assemble two or more different models of the same product simultaneously. On the line, the produced items keep changing from model to model continuously.

Figure 8 Mixed-Model Assembly lines

Multi-Model Assembly lines. Several (similar) products are manufactured on one or several assembly lines. Because of significant differences in the production processes, rearrangements of the line equipment are required when product changes occur. Consequently, the products are assembled in separate batches in order to minimize set-up inefficiencies. While enlarging batch sizes reduces set-up costs, inventory costs are increased.

Figure 9 Multi-Model Assembly lines

6) **Parameters Related to Assembly Line Balancing**:-

Takt Time

Assuming a product is made one unit at a time at a constant rate during the net available work time, the takt time is the amount of time that must elapse between two consecutive unit completions in order to meet the demand. Takt time can be first determined with the formula:

$$T = \frac{T_a}{D}$$

Where,

T = Takt time, e.g. [work time between two consecutive units] Ta = Net time available to work, e.g. [work time per period]

D = Demand (customer demand), e.g. [units required per period]

Example:

If there are a total of 8 hours (or 480 minutes) in a shift (gross time) less 30 minutes lunch, 30 minutes for breaks (2 × 15 minutes), 10 minutes for a team briefing and 10 minutes for basic maintenance checks, then the net Available Time to Work = 480 - 30 - 30 - 10 - 10 = 400 minutes.

If customer demand was, say, 400 units a day and one shift was being run, then the line would be required to output at the rate of a minimum of one part per minute in order to be able to keep up with customer demand.

7) Verification of Operations Lists

Individual operations lists for the bus models of interest have been completed and verified by applying four different data gathering methods;

- Data mining
- Time studies
- Observations
- Interviews

The theoretical basis and the application of these methods are described in the following sections.

a. Data Mining

Data mining can be defined as collecting the information that will be used throughout the work to be conducted. Quality of collected information, which is defined by McGilvray. “the degree to which information and data can be a trusted source for any and/or all required uses”, is the most crucial aspect of data mining since it directly affects the outcome of the project.

The data of pre-assembly operations of vehicles of interest has been collected from the summary sheets provided by the Work Preparation Group and different databases within the factory. However, encountered unconformities between different sources indicated problems with updating of the databases, which reduced the reliability of the collected data for a line balancing procedure. Therefore, having the data from these sources as the guideline, three additional data gathering techniques have been applied to complete and verify the information to be used throughout this study.

b. Time Studies

Glassey defines the purpose of time study as “to determine the time that a worker, or group of workers, should take to do a specified job at a defined level of performance.” He uses the term “performance” as a rate of output expressed as an average over the working shift, and “specified job” as a job where there is a written specification that concerns standard quality to be achieved, the tools and materials to be used, the working conditions under which the job should be performed, and the method to be followed by the operator. Glassey from these definitions, it can be concluded that the primary objective of making time studies at the pre-assembly line is to determine the standard times –total time in which a job should be completed at standard performance- of assembly operations at the line.

Standard operation times for tasks held at the stations are provided by the Work Preparation Group as Standard Operation Forms (SOF). An SOF is a company-specific data sheet that includes detailed analysis of individual operations with their steps and times. For tasks that do not have this information, time studies are made at the stations by using stopwatch and applying the procedure given by Glassy, which is explained in the following section.

c. **Observations**

Observations have been a supplementary method to double-check the data of operations lists that was provided by the Work Preparation Group, and to make time studies for operations whose times were not recorded/updated on the summary sheets.

Observation method is also used to measure the duration of operations whose time data is missing on the summary sheets. Glassy explains how observation method can be used in standard operation time measurement and briefly divides the process into three main stages. In the preparatory stage, the observer determines the operation to be timed and its steps, and makes sure that the operator is aware of the time study and all necessary equipment for the operation is available. The second stage, which is the time study itself, is where the observer records the time of day when the measurement started, the duration of each step and evaluates the performance of the operator. In the concluding stage, the observer records the time of day that the study ended, calculates the total time of the operation and completes the summary sheet. Time measurements at the pre-assembly line are made by applying the procedure explained by Glassey.

d. Interviews

Interviews have been the greatest investigation tool for verification of the operations lists and provided the critical ideas that affected the decisions taken throughout this study.

Closed questions, which can be regarded as yes-no questions, were used during the initial interviews held at the line with the operator team leaders while performing the verification of operation lists. The purpose of those interviews was to check if there is an inconsistency with the acquired operation lists from the management and the assembly operations at the stations.

The second set of interviews aimed to receive more detailed information from the team leaders and assembly operators about operations, and to dig deeper in order to reveal as much about the limitations as possible. Being the most experienced about the operations, each of the ten team leaders were asked about indeterminate constraints that define precedence, and the operations whose times were not possible to reduce by increasing number of operators. Besides, assembly operators that were selected randomly at the line according to the complexity of the operations they handled were asked about the steps of their work and if they had any suggestions for improvement. Therefore, the prepared questions for these interviews were open, which allowed them to tell as much about the operations as possible.

Figure 10: Crank gear pressing

8. Line Balancing

In order to achieve and a well-balanced assembly line, it is important to eliminate factors that cause losses; the wastes. For that purpose, of balancing time study of various stations should be carried out, method to do a particular operation should be analyzed , minimization of idle time the production system is also analyzed for determining wastes and the factors that create losses.

V.RESULTS

Assembly line is a manufacturing process (most of the time called a progressive assembly) in which parts (usually interchangeable parts) are added as the semi-finished assembly moves from work station to work station where the parts are added in sequence until the final assembly is produced. By mechanically moving the parts to the assembly work and moving the semi-finished an assembly from work station to work station, a finished product can be assembled faster and with less labour than by having workers carry parts to a stationary piece for assembly. Assembly lines are the common method of assembling complex items such as automobiles and other transportation equipment, household appliances and electronic goods

1) Models Related Multi Cylinder Engine Assembly Line:-

In multi cylinder engine assembly air cooled engines are assembled, there are various types of engine model, model matrix of the multi cylinder engines are stated as below :-

Table 1 MAIN BEARING PRESSING

S. No.	Operation 's Name	Time(s)
1	Inspection of foreign materials	18
2	Centre bolt Fitting	24
3	Fuel Injection Pump stud Fitting	20
4	Drain plug Fitting (2 threads)	10
5	Suction tube Fitting (2 threads)	2
6	Tightening of drain plug	7
7	Tightening of Suction tube	13
8	Adjust Torque of drain plug	26
9	Adjust Torque of Suction tube	13
10	Rotation of crank case 90 º anticlockwise	5
11	oil gallery plug Fitting with favicol and tightening	14
12	Torquing of oil gallery plug	9
13	Oil gallery tube Fitting and tightening	53
14	Oil gallery tube bolt torqueing	15
15	History card filling	18
16	Lubrication of crank hole & cam hole	7
17	Bush pressing of crank shaft & cam shaft	73
18	Inspection of hole after pressing	11
19	Shifting of engine to the next stage through indexing	14
Total time		**352**

2) Overview

The result obtained from production failure investigation in many areas and identify is a consequence of investigation by plant simulation tool and considering real environment of transfer line.

Figure 11: Single Transfer Line for Material Operation

In a simple production line (transfer line) a model is created in simens technomatrix plant simulation where it observe the analytical results to improve the real environment in the production line as shown in above figure 5.1.

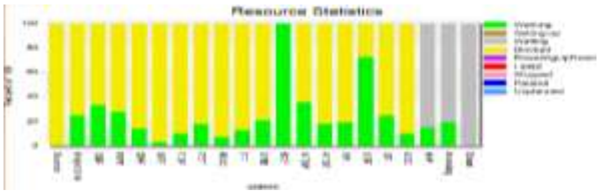


Figure 12 Chart of Single Transfer Line for Material Operation

Simulation time: 1:00:00:00.0000

Cumulated Statistics of the Parts which the Drain Deleted

Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
Drain	Entity	22:10.4673	1179	49	100.00%	0.00%	0.00%	26.46%	

The analysis is done on the single transfer line where the model is created here there is a source and the number of process in the single transfer line and which is ending at drain now rename it as the process which needed to create by renaming the object as the source as the raw material and other as process by the help of event controller has to be drawn for the analysis the whole process and it set for the 1 day in this model as (1:0:0:0) it also show the simulation summary report and the simulation speed also be controlled by the help of it and the results of statistics report show that and adding any processing time in this model.

TABLE 2 CRANK SHAFT FITMENT

Station No. -02 (CRANK SHAFT FITMENT)		
S. No.	**Operation 's Name**	**Time**
1	thrust washer fitment inside crank case	21
2	F.I.P. stud tightening	10
3	cap fitment on crankcase with anabond	22
4	clean cavities of crank shaft through air gun	17
5	open internal bearing housing (I.B.H.) and fit on crank case	14
6	I.B.H. tightening on crank case	22
7	I.B.H. torquing on crank shaft	20
8	crank shaft mounting on the hook and placed it over engine	45
9	crank shaft placed in the crank case	23
10	I.B.H. stud fitment and tightening on crank case	43
11	I.B.H. stud torquing	13
12	marking with marker	2
13	centre bolt tightening	9
14	Centre bolt torquing	7
15	crank shaft tackle fitment	33
16	indexing	5
Total time		**306**

Figure 13: Single Transfer Line for Crank Shaft Fitment

Simulation time: 1:00:00:00.0000

Cumulated Statistics of the Parts which the Drain Deleted

Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
Drain	Entity	22:10.4673	1179	49	100.00%	0.00%	0.00%	26.46%	
Drain1	Entity	9:44.2530	1913	80	100.00%	0.00%	0.00%	54.09%	

Figure 14: Chart of Single Transfer Line for crank shaft fitment

In a crank shaft fitment as per the simulation it is found that the total throughput of the day is 1913 and the some block and waiting are identify.

Table 3 Crank Gear Pressing

Station No. -3R(2) (CRANK GEAR PRESSING)		
S. No.	**Operation 's Name**	**Time (s)**
1	Shift engine from pedestal mounting station to the running line	37
2	Balancing weight tightening with D.C. Tool	100
3	Balance weight torquing	100
4	Marking on balance weight	10
5	90 degree rotation to the block	2

6	Fit thrust washer & crank gear on the crank shaft	42
7	Gear pressing on the crank shaft	29
Total		**320**

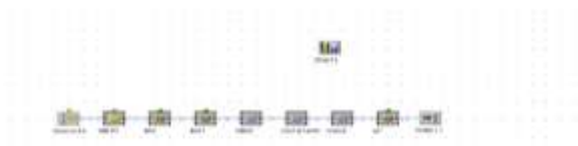


Figure 15 Single Transfer Line for Crank Gear Pressing

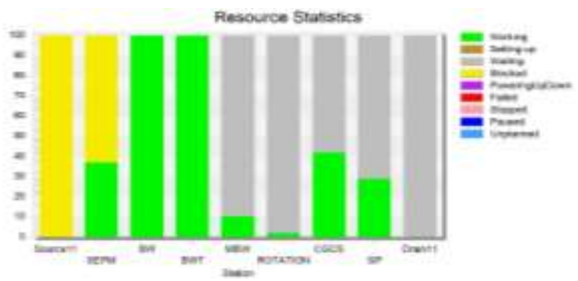


Figure 16 Chart of Single Transfer Line for crank gear pressing

Simulation time: 1:00:00:00.0000

Cumulated Statistics of the Parts which the Drain Deleted

Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
Drain	Entity	22:10.4673	1179	49	100.00%	0.00%	0.00%	26.46%	
Drain1	Entity	9:44.2530	1913	80	100.00%	0.00%	0.00%	54.09%	
Drain11	Entity	8:02.7375	861	36	100.00%	0.00%	0.00%	66.29%	

In a crank gear pressing as per the simulation it is found that the total throughput of the day is 861 and the some block and waiting are identify.

Table 4 Bearing Housing Fitment

Station No. - 4L (BEARING HOUSING FITMENT)		
S. No.	Operation	Time (s)
1	Left pedestal picking	10
2	left pedestal tightening	32
3	crank shaft tackle de assemble	9
4	bearing housing fitment	26
5	bearing housing bolt hand tighten	29
6	bolt tighten with Electronic torque wrench	31
7	Oil seal fitment	14
8	oil seal pressing	32
9	Lifter guide picking	14
10	lifter guide fitment	17
11	Clamp fitment and hand tighten	22
12	clamp tightening with electronic torque wrench	12
Total time		**248**

Figure 5.7 Single Transfer Line for Bearing Housing Fitment

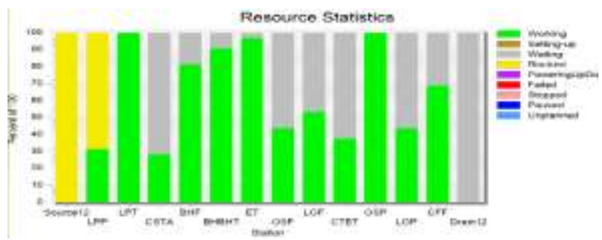


Figure 17: Chart of Single Transfer Line for Bearing Housing Fitment

Simulation time: 1:00:00:00.0000

Cumulated Statistics of the Parts which the Drain Deleted

Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
Drain	Entity	22:10.4673	1179	49	100.00%	0.00%	0.00%	26.46%	
Drain1	Entity	9:44.2530	1913	80	100.00%	0.00%	0.00%	54.09%	
Drain11	Entity	8:02.7375	861	36	100.00%	0.00%	0.00%	66.29%	
Drain12	Entity	5:01.9718	2693	112	100.00%	0.00%	0.00%	82.13%	

In a bearing housing fitment as per the simulation it is found that the total throughput of the day is 2693 and the some block and waiting are identify.

So to achieve the optimum results at same running cost there is some buffer is needed as shown in fig at last row in this production line the throughput is increase from the previous upto 24%

Then to identify the optimum buffer size the experimental manager is created the check the capacity of buffer by using drain the output values are selected which show simtalk value as per the simens technology than the three simulation in run for each experiment and there is a predefined confidence level that is upto 90% then each experiment is done by the upper and lower limit of 5 to 50 at the increment of 5 once the experimental manager finish its process it generate the report as shown in the table as the output values shows show how many parts created form these results we observer the maximum throughout at the n number of experiment the highest throughout show the size of buffer.

Overview of all executed experiments, their parameterizations and the mean values of the target values.

	buffercapacity	buffercapacity1	throughput
Exp 001	5	5	1179
Exp 002	5	10	1179
Exp 003	5	15	1179
Exp 004	5	20	1179
Exp 005	5	25	1179
Exp 006	5	30	1179
Exp 007	5	35	1179
Exp 008	5	40	1179
Exp 009	5	45	1179
Exp 010	5	50	1179
Exp 011	10	5	1179
Exp 012	10	10	1179
Exp 013	10	15	1179
Exp 014	10	20	1179
Exp 015	10	25	1179
Exp 016	10	30	1179
Exp 017	10	35	1179
Exp 018	10	40	1179
Exp 019	10	45	1179
Exp 020	10	50	1179
Exp 021	15	5	1179
Exp 022	15	10	1179
Exp 023	15	15	1179
Exp 024	15	20	1179
Exp 025	15	25	1179
Exp 026	15	30	1179
Exp 027	15	35	1179
Exp 028	15	40	1179
Exp 029	15	45	1179
Exp 030	15	50	1179
Exp 031	20	5	1179
Exp 032	20	10	1179
Exp 033	20	15	1179
Exp 034	20	20	1179
Exp 035	20	25	1179
Exp 036	20	30	1179
Exp 037	20	35	1179
Exp 038	20	40	1179
Exp 039	20	45	1179
Exp 040	20	50	1179
Exp 041	25	5	1179
Exp 042	25	10	1179
Exp 043	25	15	1179
Exp 044	25	20	1179
Exp 045	25	25	1179
Exp 046	25	30	1179
Exp 047	25	35	1179
Exp 048	25	40	1179
Exp 049	25	45	1179
Exp 050	25	50	1179
Exp 051	30	5	1179
Exp 052	30	10	1179
Exp 053	30	15	1179
Exp 055	30	25	1179
Exp 056	30	30	1179
Exp 057	30	35	1179
Exp 058	30	40	1179
Exp 059	30	45	1179
Exp 060	30	50	1179
Exp 061	35	5	1179
Exp 062	35	10	1179
Exp 063	35	15	1179
Exp 064	35	20	1179
Exp 065	35	25	1179
Exp 066	35	30	1179
Exp 067	35	35	1179
Exp 068	35	40	1179
Exp 069	35	45	1179
Exp 070	35	50	1179
Exp 071	40	5	1179
Exp 072	40	10	1179
Exp 073	40	15	1179
Exp 074	40	20	1179
Exp 075	40	25	1179
Exp 076	40	30	1179
Exp 077	40	35	1179
Exp 078	40	40	1179
Exp 079	40	45	1179
Exp 080	40	50	1179
Exp 081	45	5	1179
Exp 082	45	10	1179
Exp 083	45	15	1179
Exp 084	45	20	1179
Exp 085	45	25	1179
Exp 086	45	30	1179
Exp 087	45	35	1179
Exp 088	45	40	1179
Exp 089	45	45	1179
Exp 090	45	50	1179
Exp 091	50	5	1179
Exp 092	50	10	1179
Exp 093	50	15	1179
Exp 094	50	20	1179
Exp 095	50	25	1179
Exp 096	50	30	1179
Exp 097	50	35	1179
Exp 098	50	40	1179
Exp 099	50	45	1179
Exp 100	50	50	1179

VI.CONCLUSION

The primary goal of my project is to learn the standard procedure of 'Line Balancing'. I have been made to study cycle time of all the stations in the assembly line. This study shows that an unbalanced assembly line may generate significant capacity loss in a cumulative pattern, which requires a continuous waste elimination and balancing approach in production.

In order to achieve maximum gain over the current system in terms of reduced operational costs and resource utilization, the existing line should be re-organized such that,

1. Idle Time to be reduced on the station by shifting the operation from one station to another station.
2. Components to be relocated near the assembly stations.

By comparing both the assembly line layouts it was found that the proposed design has better and delivers good efficiency of the assembly lines. The results for both the layouts are taken to find the real time efficiency and manpower which also has a bearing on optimal working area for assembly lines. We can improve the efficiency of any manufacturing unit by applying improved technique and design methods. Good conveyor can improve the efficiency of plant Plant Simulation simulations are used to optimize throughput, relieve bottlenecks and minimize work-in-process. The simulation models take into consideration internal and external supply chains, production resources and business processes, allowing you to analyze the impact of different production variations. You can evaluate different line production control strategies and verify synchronization of lines and sub lines. The system lets you define various material flow rules and check their effect on the line's performance. Control rules are chosen from libraries and may be further detailed to model highly sophisticated controls. The Plant Simulation experiment manager allows you to define multiple experiments at one time, providing an efficient way to analyze and optimize your system. Based on user-defined parameters, Plant Simulation executes different simulation runs and provides you with the results of these experiments. Plant

Simulation analysis tools allow for easy interpretation of simulation results. Statistical analysis, graphs and charts display the utilization of buffers, machines and personnel. You can generate extensive statistics and charts to support dynamic analysis of performance parameters including line workload, breakdowns, idle and repair time and proprietary key performance factors. At the click of a button, Plant Simulation's bottleneck analyzer shows the utilization of resources, thus indicating bottlenecks as well as underworked machines. Material flow may be visualized in a Shunky chart that, at a glance, shows transport volume in the context of the layout. Plant Simulation also generates a Gantt chart of the optimized production plans that can be modified interactively.

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