

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

## Amalgamation in Coil Winding Process

Manojkumar R<sup>1</sup>, Manojpriyadharon K<sup>2</sup>, Bala Murugan N<sup>3</sup>, Murugan S<sup>4</sup>.

Assistant Professor, Department of Automobile Engineering, Dr.Mahalingam College of Engineering and  
Technology, Pollachi, Tamil Nadu, India. <sup>1</sup>

UG Scholar, Department of Automobile Engineering,, Dr.Mahalingam College of Engineering and Technology,  
Pollachi, Tamil Nadu, India. <sup>2,3,4</sup>

**ABSTRACT:** Nowadays, shorter product life cycles and increased product varieties make it difficult to produce some products on Batch production lines. The best that can be done to manufacture the products is ONE – PIECE FLOW production method. Batch processing production method focuses on production of large number of products at one time – sending them together as a group through each operational step. In contrast, one – piece flow production method focuses on product or on the transactional process, rather than on the waiting, transportation and storage of either. The predominant goal to achieve higher productivity in one – piece flow method is: designing production process layout and time study. This project aims at implementation of one – piece flow production method instead of batch production at reputed industry. The results are simulated using SIEMENS PLM (Product Lifecycle Management) Software.

**KEYWORDS:** Batch production, One – piece flow method, Time study, Value stream mapping (VSM), Technomatix plant simulation software.

### I. INTRODUCTION

Manufacturing layouts in any discrete industries lay the foundation for performance in regard to production, customer demands, and also employee's involvement. Lean manufacturing is an operational strategy oriented towards achieving the shortest cycle time by eliminating wastes. The basic idea behind the system is eliminating wastes. Waste is defined as anything that does not add value to end products from the customer's perspective. This project focuses on implementation of one – piece flow manufacturing method instead of batch production method in a discrete industry. One – piece flow manufacturing method also comes under one of the lean manufacturing methods. On implementation of this method, we can achieve customers' demands on time by eliminating non-value added process. Also we can see improvement in respect to production unit. The objective is to systematically demonstrate how lean manufacturing tools when used appropriately can help the process industry to eliminate waste, have better inventory control, better product quality, and better overall financial and operational procedures. The initial step in this research is to systematically study and define the history of the lean manufacturing concept and its different tools and techniques. It will then examine where most of the lean tools and techniques have been used. This will be followed by a literature review of the process industry and a study of the findings regarding applications of lean concepts to continuous manufacturing. The next step is to conduct time study and develop a proper documentation current situation in the industry. Major one is calculation of takt time that determines an entire state of process.

To study the effect of lean tools in the process sector the manufacturing industry is used to illustrate the procedures of implementing lean tools at a process facility. First, value stream mapping is used to map the current state for coil manufacturing line. This is used to identify sources of waste and then identify lean tools to try to reduce this waste. The future state map is then developed for a system with lean tools applied to it. Second, a simulation model is developed for coil manufacturing line to quantify the benefits gained from using lean tools and techniques in the value stream mapping. For those lean tools that cannot be directly quantified by the simulation, a proposed methodology to implement them at reputed industry is developed, and a subjective evaluation of its benefits is provided.

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## II. RELATED WORK

Initially, Time study was carried out at industry and the whole overview of the manufacturing layouts, processing time, customer demands, total productivity were studied. Time study is an initial step in achieving any manufacturing methods. Also, it briefs the entire process to be done on implementation of manufacturing methods. Value stream mapping is a tool used to convey the idea of process presently and also future one. Value stream mapping can also be done in the software (Technomatix Plant simulation). Then, comes the calculation of takt time. Takt time calculation also plays an important role in implementation of any manufacturing layouts or altering any layouts so that we can see improve in productivity. Takt time is defined as the ratio between planned production time and customer demand. Takt time calculation tells us about what type of wastes occur in the manufacturing industry. After calculation, we can come to a clear idea about what wastes occurs. After identifying, certain tools and techniques are to be used in order to solve that wastes. After selecting an appropriate tool, selective layout has been designed. The simulation is carried out in TECHNOMATIX PLANT SIMULATION software. Finally results are displayed in the form of graph. The figure.1 shows the methodology in form of a flowchart.

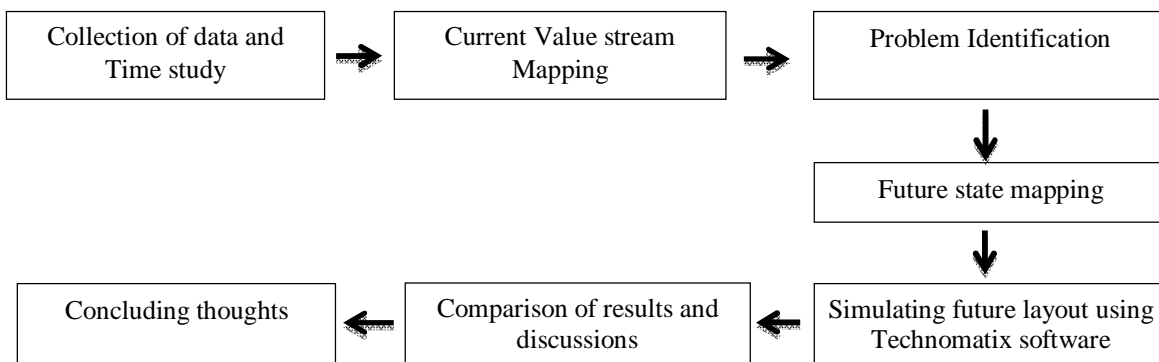


Figure1 Flow chart with methodology

**2.1. Time study:** Time study is defined as a work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions, and for analyzing the data so as to obtain the time necessary for carrying out the job at a defined level of performance. A time study has been carried out for all operations on the manufacturing line by direct observation method and the observed data is listed in Table.

Table 1: Details of Time study

M/C NO	PROCESS	TYPE		MACHNING TIME (sec)	HANDLING TIME (sec)	TOTAL TIME (sec)	JOB/HR
		CS	RS				
1.	Winding	Y	Y	4	1	5	18
2.	Hot sealing	Y	N	4	1	5	18
3.	Enamel removing	Y	Y	6	1	7	18
4.	Injection moulding	N	Y	3	1	4	18
5.	Dispatch	Y	Y	0	10	10	*****

Where, CS = Circular Spool, RS = Rectangular Spool, Y = Yes, N = No

**2.2 Current Value stream mapping:** Once a commitment has been garnered from top management, it is time to begin collecting and analyzing data to structure the transformation. The process begins by documenting the flow of material and information of the existing process, called the current state. This involves following the product from the ordering

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Vol. 5, Issue 5, May 2016

and delivery of raw material, components, and core (remanufactured product), through to shipping and delivery to the customer. It begins with a single product family, but may be expanded to the entire plant and ultimately multiple plants and across companies as warranted. Major product families are determined by comparing individual product flows through the required processing steps, transportation methods. The current state is typically drawn by hand, illustrating the major outside sources of material and core including order lead times, mode of shipment of materials including transportation frequencies and time, receiving and inventory points (including the warehouse for received material, work-in-process, and finished goods inventory), production processes, flow of work-in-process between production processes, mode of shipment of finished product to the customers including transportation frequencies and time, and major customers or distribution system.

The current state of Value stream mapping that was observed during the process is shown below:

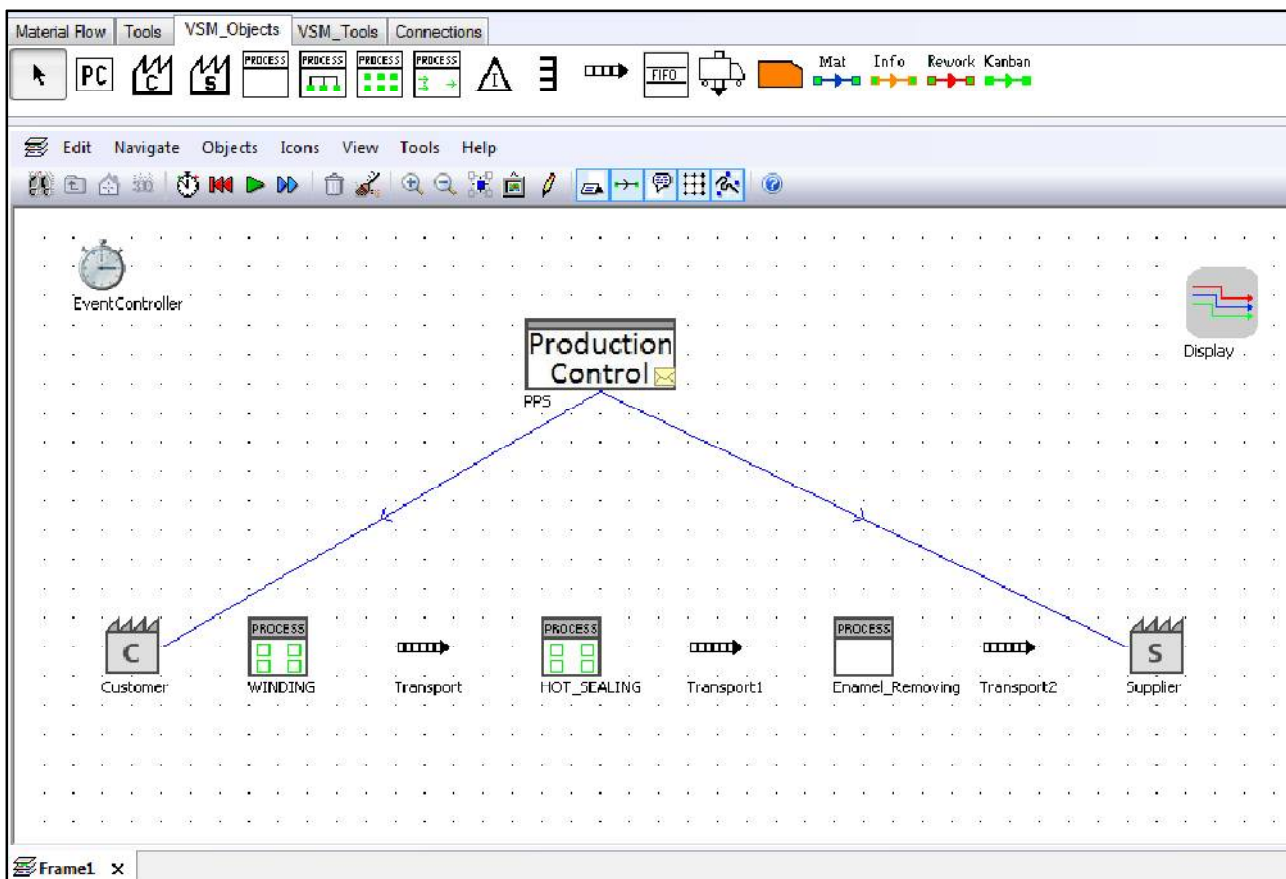


Figure 2 Current value stream mapping for Circular spool

**2.3 Takt time Calculation:** The second step is to establish the Takt time. Takt time is the average time allowed to produce unit production to meet customer demand and the process time should be less than or equal to the Takt time. Takt time is calculated based on machine available time and the required number of units.

$$\text{TAKT TIME} = \text{PLANNED PRODUCTION TIME} / \text{CUSTOMER DEMAND}$$

Planned production time = 32400 sec per shift

Customer demand = 588000 pieces per month

Assuming the working days as 28 days by considering week offs.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

$$Takt\ time = \frac{28 * 32400 * 2}{588000}$$

$$Takt\ time = 3.0\ secs.$$

Approximately 3 sec per piece  
1200 pieces per hr.  
10800 pieces per shift  
21600 pieces per day

Actual scenario is 21000 pieces per day.

From the calculation of takt time, we can see low production exists in the manufacturing industry. Low production is also one of the wastes in industry. We decided to change the current layout of manufacturing industry (Batch production to one – piece flow method). So future layout is designed and simulation is carried at Technomatix software.

**2.4 Simulation:** The Technomatix Plant simulation package was used for the simulation. Simulation is 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 installation. In addition, simulation defines the preparation, execution and evaluation of carefully directed experiments within a simulation model. Developing your simulation model is a cyclical and evolutionary process. You will start out with a first draft of your model and then refine and modify it to make use of the intermediary results the simulation runs provide. Eventually, after several cycles, you will arrive at your final model. The steps involved in this software are as follows:

**Creating Value Stream Mapping:** Value stream mapping is considered as one of the main lean tools. It has to done first. To perform this action, we have switch to MANAGE LIBRARY in file option and have to activate VALUE STREAM MAPPING mode.

**Creating Layout:** Layout can be created in 2D as well as 3D mode. As we didn' t get license for some tools in 3D mode, we came with 2D layout. The required tools will be in tool bar, by dragging it into frame, we can perform our action.

**Providing Inputs:** After creating layout, necessary inputs have to be given for further action. We can double- click on the required box; a dialog box appears where we can provide processing time, handling time, setup time, availability and many more options. The simulation runs accordingto inputs provided by the user.

**Creating Worker Pool:** Main one in simulation process is creating workers, worker pool and their footpath. To create worker pool, drag the worker pool from toolbox and place it on the frame. To simulate worker, broker has to be provided. The main function of broker is to simulate the worker during job arrival. Also footpath is provided by dragging it from toolbox and placing it on frame. The functions of worker pool, worker can be given in the dialog box that appears while making a click on required tool.

**Inserting Chart:**Technomatix plant simulation provides an option for describing results in the form of charts. Charts are available in the toolbar. It has to be dragged and place it on frame. Charts give a clear idea about the results whether manufacturing layout is advisable or not advisable.

**Inserting Event Controller:** An event controller is main tool in plant simulation software. If it is available in the frame, then only simulation takes place otherwise simulation doesn't takes place. We can set up our timing in the event controller. According to that time, only simulation runs. After exceeding that timing, simulation automatically stops. Finally these are the tools in plant simulation software that are required to perform simulation.

**2.5 Implement a Simulation Project:**As already mentioned, developing simulation model is a cyclical and evolutionary process. You will start out with a first draft of your model and then refine and modify it to make use of the intermediary results the simulation runs provide. Eventually, after several cycles, you will arrive at your final model.

**Plan the project:**Create a concept of your model, with its initial values, its model elements, variables, logic of proceeding and a preliminary description of the simulation experiments. Make a list of all functional units that the installation you are modelling will contain. Define and describe the interfaces for material and information flow.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

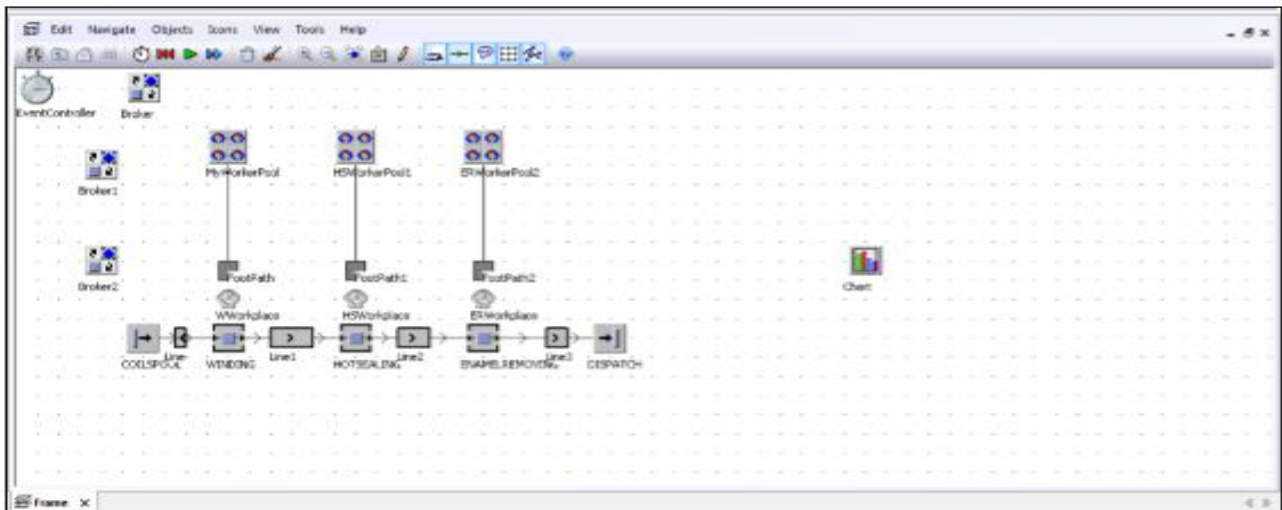


Figure 3 Future model planned in software

**Find out about the data you need and how to acquire it:** Ensure early on that the data you need to run the simulation experiments is going to be available. Frequently a lot of time and effort is involved to acquire the data. Make sure that you have the name of a person who responsible for acquiring the data from your client, which may, for example, be another department of your company.

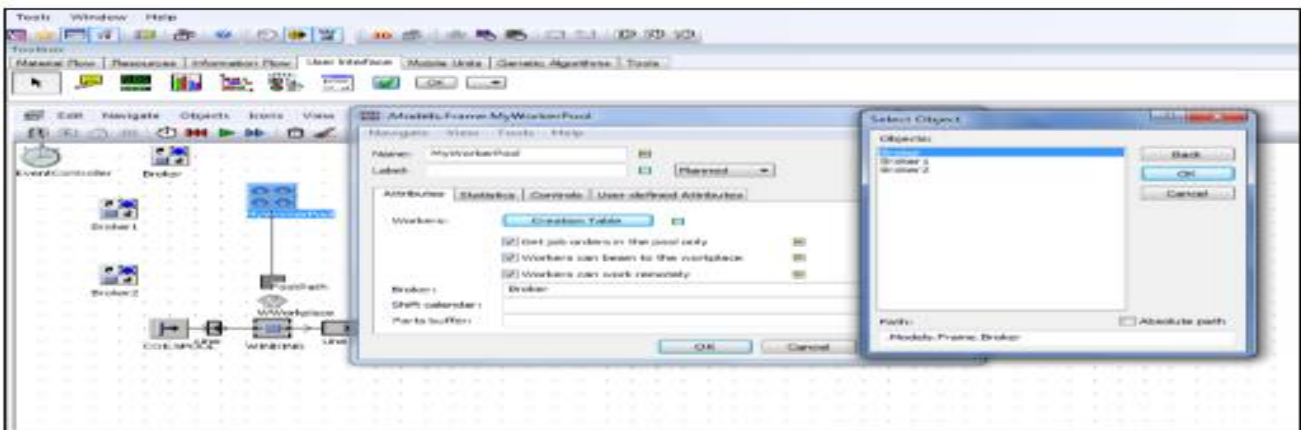


Figure 4 Creating workers in the software

**Build the simulation model:** Build a first version of the simulation model in its simplest, most basic form. Build the application objects you need and test them one by one. After you are sure that all objects work the way they are supposed to do, put together the overall model. Document the model in a clearly arranged manner, as six months or a year from the time you modelled you might not remember how you accomplished a certain task or why you solved a specific problem the way you did.

**Verify the simulation model and check its validity:** After you are finished building the simulation model, you have to verify it, i.e., check if the components you modelled perform the tasks you programmed them to do. Test each and every object you created. Check for the correct functioning and for concurrence with the specifications. Test the objects in combination with other objects and then in the overall model. Make sure that all parameters are set to the correct values. Once you have verified the model, check it for its validity: Make sure the functionality of the model is as expected and conforms to the functionality of the planned or real installation and see if the results are plausible and credible. Make an estimate of the most important results and compare them with the results of the simulation.



# International Journal of Innovative Research in Science, Engineering and Technology

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**Execute simulation experiments and collect the results:** Execute simulation experiments according to your final trial plans to arrive at the desired data. Plan a number of simulation runs and prepare for the variation of parameters and models to get reliable results.

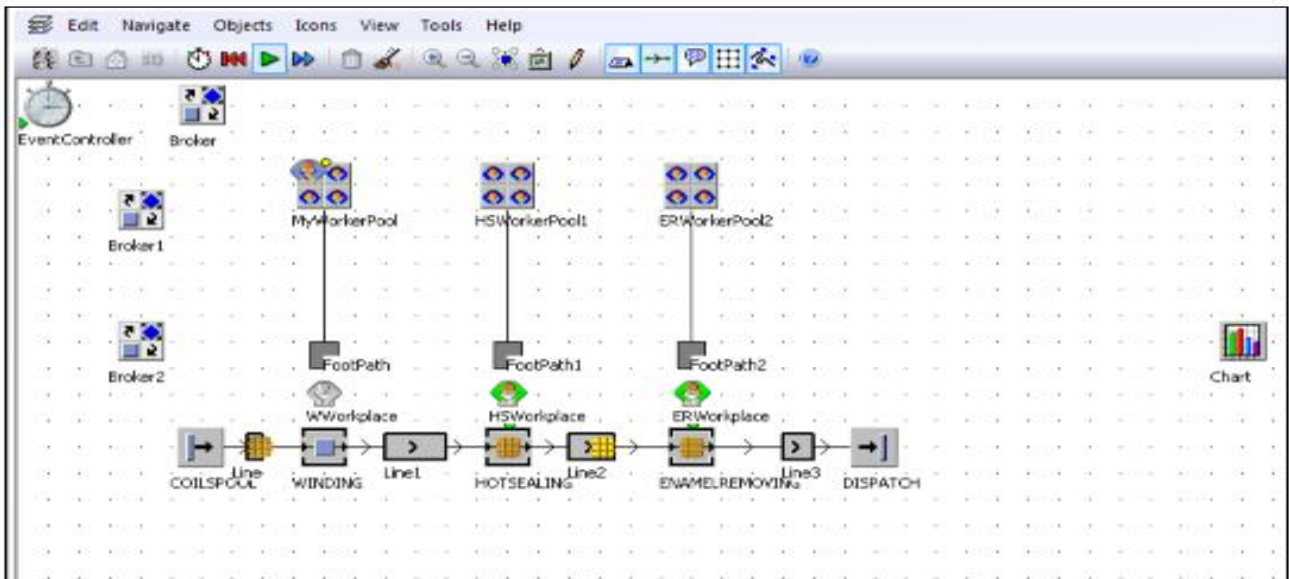


Figure 5 Executing simulation in software

**Analyze the results of the experiments:** Analyze and interpret the results of the simulation experiments. Conduct a sensitivity analysis of the most important parameters, data and results. This graph clearly shows working up of new manufacturing layout in an industry. With respect to given inputs, results are plotted in the form of graph. With the help of graph, we can come up with a solution.

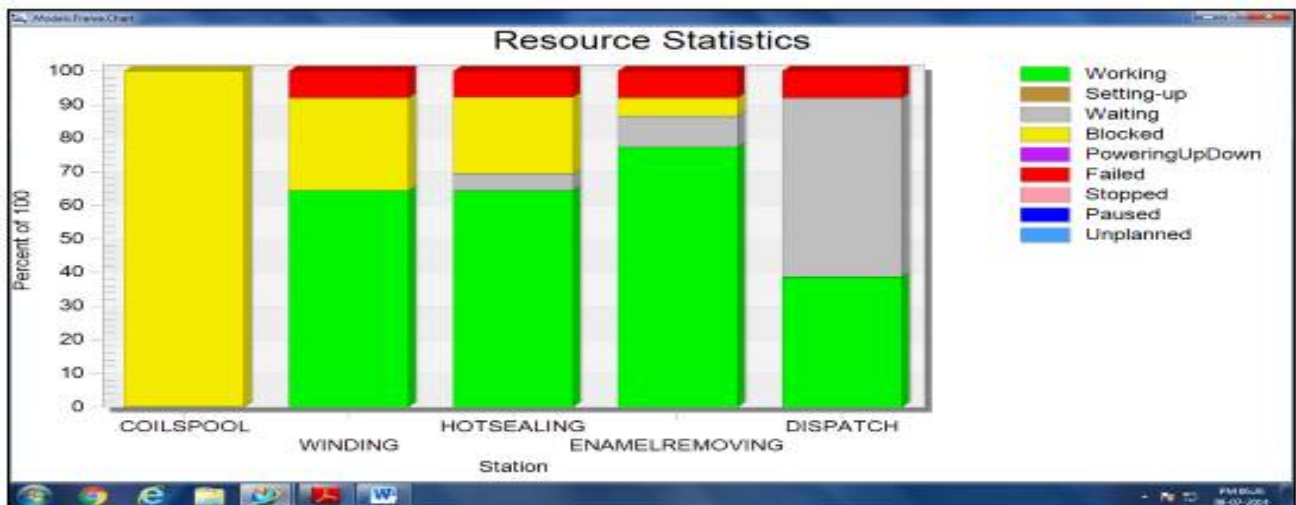


Figure 6 Graph resulting the final results

# International Journal of Innovative Research in Science, Engineering and Technology

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## III. RESULTS AND DISCUSSIONS

The verification of the simulated results from the computer software can be done with the help of physical testing of prototype of one – piece flow manufacturing system. Due to time constraints and financial constraints, the physical testing for verification of simulated results was not done. With the help of takt time calculation, we came to know about the defects found in the manufacturing layout. The main defect is low production. Several lean tools and techniques can be performed to reduce low production. But we took one – piece flow manufacturing method to be employed in order to minimize low production. Technomatix plant simulation software plays a major role in simulating larger manufacturing layouts from small scale industries to large scale industries. As the software was new to us, we took one month to learn about tools and objects in the software. We also performed some tutorials which helped us in doing project. The future state value stream mapping was created. The manufacturing layout was modelled in 2D and corresponding inputs and commands was provided. We done simulation for 1 hour only and with the help of that data, we can calculate it for the rest of the results. Simulation was done and the results were obtained. Technomatix plant simulation software provides an option for displaying the results in the form of graphs and charts. The obtained results were displayed in the report. In the chart, different parameters were shaded with different colours. Those parameters are achieved by referring to inputs given by the user. From the results, we come up with a solution that nearly 420 pieces can be manufactured from one cell of one – piece flow manufacturing layout.

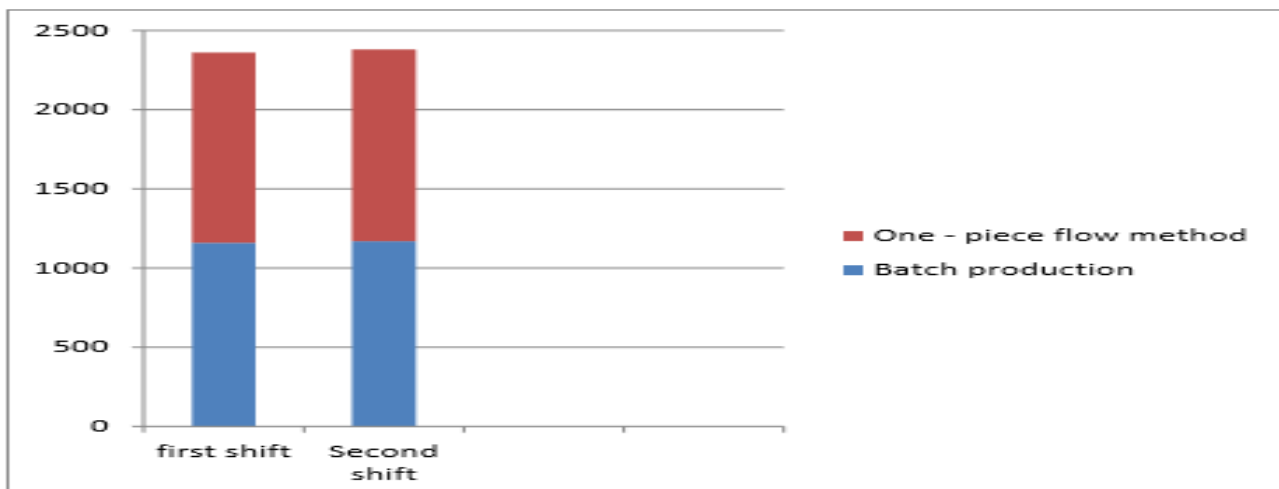


Figure 7 Graph representing improvement in production due to implementation of one – piece flow method

## IV. CONCLUSION

In this Project, the various activities were carried out such as time study, calculating Takt time for the observed time study, creating future value stream mapping for scenario and also executing simulation for future layout in TECHNOMATIX PLANT SIMULATION software. It is found that the theoretical value of Takt time that was obtained is more than the actual production which leads to low production. Low production is also a type of waste which is to be either eliminated maximum or it should move by making necessary proper changes in the layout. So, implementation of one – piece flow method is been taken into an account. The future manufacturing layout is modelled in the software and essential data requirements are fed into the software. The corresponding results are plotted in the graph. From the graph, we can see improvement in the production slightly. On implementation of one – piece flow manufacturing method we can reduce number of workers. On overall, implementation of one – piece flow manufacturing method is advisable.

# International Journal of Innovative Research in Science, Engineering and Technology

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**Vol. 5, Issue 5, May 2016**

## ACKNOWLEDGEMENTS

The software support by the Dr.Mahalingam College of Engineering and Technology, Pollachi, Tamil Nadu for this project “Amalgamation in coil winding process” is gratefully acknowledged.

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