International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075, Volume-8, Issue-6S3, April 2019

# Application of Discrete Event Simulation Towards Production Improvement

**Sachin N K, B S Shivakumara, V Sridhar**

***Abstract— Simulation modelling is an exceptional tool for exploring and optimizing dynamic processes. Specifically, when mathematical optimization of complex systems becomes infeasible, and when leading experiments within tangible systems is too expensive, time consuming, or dangerous, simulation becomes a powerful tool. In real world manufacturing, simulation empowers the visualization, exploration and optimization of production structures and logistics processes. Simulation aids to construct digital replicas of production systems so we can sightsee system characteristics and boost their performance. The digital superlative not only empowers users to track experiments and what-if circumstances without distressing a present production system. This paper illustrates how Discrete event simulation may be used to evaluate throughput, relieve bottlenecks, minimize work-in-process, energy usage of machines and also dynamic impact of enactment parameters, including production workload, idle, repair and breakdowns time and special vital recital factors. So that problem can be easily identified, analyzed and modified within a petite time.***

***Keywords—Discrete event simulation, productivity, utilization, optimization***

## I. INTRODUCTION

Discrete-Event Simulation (DES) is a tool seemly for the study of production systems and increases overall efficiency. The production system can be demonstrated in a simulation environment to analyze the different prospects for enlightening the system both to forecast the influence of changes to a current system as well as a tool to foretell performance of new systems. In many circumstances the efficiency of the production systems has to be enhanced due to high investment costs and affluent development of both products and processes. The amplified interest in lean production has finely tuned a need for even more efficient manufacturing systems which also contributes to new tools as Simulation. Production systems of today be disposed to be built to expedite production in a more rapidly time-to-market pace. A high degree of automation and augmented investments in new production systems best part of the high complete utilization. The productivity can be succeeded when a company advances its operational usefulness by identified, analyzed and modified the parameters such as throughput, breakdowns, machine energy usage and line balancing.

Most of the Indian manufacturers are still lagging in achieving excellent production effectiveness as compared to Japan, USA, Germany and china. Analyzing the production enhancement in the plant is difficult for a human because of inadequate knowledge about machine and its parameters. Production should always depends on customers and their satisfaction. To make easy and modest manufactures can simulate with no time and gratifies the customer to help to achieve a great initiative in the globalization.

## II. APPLICATION OF SIMULATION

Simulation as a procedure, used more often for different type of production systems. Plenteous studies have existence issuing enactment different solicitations of simulation which, as a practice permit to enrich the production facility to make strategic and operative decisions regarding new decision sustenance tool on an everyday basis. Generally the Discrete Event Simulation can be used in the design and analysis for manufacturing system. DES as a valuable practice for working out workers and managers in how the tangible system activates, endorsing the things of changes in structure variables and evolving new methodologies about managerial relationships for value-added functionality of the system. In the examination and estimate of a current and proposed manufacturing system the simulation has demonstrated to be a nominal technique. Throughout the Design phase for the implementation of a production system, simulation incline to application on equipment and material handling requirements. The output of the simulation studies aids the design of the system requirement and the estimate of system concert. Simulation can be used also to test different control and remitting tactics. In this perspective, there is a prerequisite for system routine forecast rather than system failure valuation after the hitches incident. The more hitches can be predicted, the better the flutter of passing timely and operative solutions. For example this can be done through the combination of simulation competencies with the current production planning and control system. Simulation can best bit which desires due to resources restrictions will be late or if bulk is available to completion of the manufacturing plans. Thus the model of simulation subsidize to decisions with reference to an operational tactic to influence the distinct target to the production system.

## III. LITERATURE SURVEY

Simulations [3] allow several disputes within manufacturing to be communicated without the weaknesses of experimenting with an actual production system. Characteristic issues addressed are the need for and the

**Revised Manuscript Received on April 12, 2019.**

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quantity of equipment and personnel, performance assessment, and evaluation of operational procedures [7]. A role of the simulation study of sequence-in need of set-up times in verdict making at the order release level of a workload controlled make-to-order flow-shop [1]. They specified that the limited approach, which was been conventionally embraced in run-through and in peak of the studies allocating set-up times with structure-dependent, will not give continuously the better results. Simulation has been implemented successfully in a lot of research allied to manufacturing system operation and design. Simulation using computers proposals very operative tools for envisaging, minimizing, and analyzing the changing aspects of manufacturing systems [2]. Owing to its complication and prominence, the allocation of buffer has been a problem deliberate plentiful and widely publications are obtainable in the literature. In production system effectiveness of cyclic time and repair time has evaluated [5]. Setup time has no effect on the overall effective equipment (OEE), increase in the intensity of queue and critical load leads to decrease OEE. Now a days customer demands Changing and anticipations, as well as developments of technology, are the activities of indicators for enterprises that need to vigorously react to changes in the aspect of market. Fetching fresh products into the market, or enlightening current ones, entails variations not only in the human resources and financial areas, but also at the glassy of the distribution and production processes. Manufacturers can validate that the strategic production orders can be accomplished on time using the simulation systems, [4, 2].

## IV. METHODOLOGY

"Cycle time is defined as the time it takes to do a process". It includes when an operator starts a process until the work is ready to be next process. It includes process time, setup time and recovery time. Collection of data using Method Time Measurement (MTM). Determination of the problem occurred in current production line which will helpful to analyze so to do improvement. Evaluation of the modeling and simulation for present problem and help to examine solution effectively.

### *A. Data Collection:*

Data collection has done by using work study and work measurement using Method Time Measurement (MTM). Table I, data samples comprises process time, setup time and cycle time. Failure of machines has neglected since no machines will able to give 100% efficiency, when the efficiency has reformed, especially when efficiency was decreased, the machines were blocked. Cycle time calculated using Equation 1.

$$\text{cycle time} = \frac{\sum_{i=1}^{n} \text{Job completion time}}{\text{Total number of jobs}} \quad [1]$$

Takt Time calculation:

Net shift per day = 3

Net hours per shift = 8 hours

Net time available per shift = 480 minutes

Tea break per shift = 1breaks * 10 minutes = 10 minutes

Mid break per shift = 20 minutes

Dejected time per shift = 10 minutes

Networking time per shift = [available time-(breaks + break down)]

= 480-40

= 440 minutes

= 26400 seconds

Networking time per day = 79200 seconds

Customer demand per day = 300 pieces

Takt time = Net working time per day/ Customer demand per day

= 79200/300

Takt time = 264 seconds

**Table I: Data samples of each machines**

| Descriptions | Process time (min) | Setup time (min) | Cycle time (min) |
|---|---|---|---|
| Facing & centering | 2.00 | 0.30 | 2.50 |
| Turning | 2.40 | 0.25 | 3.05 |
| Keyway Milling | 1.00 | 0.40 | 2.00 |
| Rough CAM Milling | 2.45 | 0.30 | 3.45 |
| Hardening1 | 5.30 | 0.20 | 6.10 |
| Hardening2 | 5.30 | 0.20 | 6.10 |
| Tempering | 3.00 | 3.00 | 7.15 |
| Check for Bending | 1.15 | 0.10 | 1.28 |
| OD Grinding | 2.00 | 0.30 | 2.46 |
| Finish CAM Grinding | 2.30 | 0.30 | 3.14 |
| ODGrinding1 | 4.00 | 0.30 | 4.45 |
| Slotting & Reaming | 2.00 | 0.30 | 2.40 |
| MP Inspection | 1.20 | 0.20 | 1.55 |
| Drilling | 5.00 | 0.20 | 5.32 |
| Final Inspection | 2.00 | 0.10 | 2.23 |

**Table II: Energy consumption in different processes**

| Resource | Working | Set-up | Waiting | Blocked |
|---|---|---|---|---|
| Drilling | 97.19 | 0.03 | 2.79 | 0 |
| .RoughCAMMilling | 90.15 | 0.04 | 0.58 | 9.23 |
| Turning | 89.94 | 0.03 | 0.2 | 9.83 |
| Hardening1 | 88.85 | 0.03 | 0.84 | 10.28 |
| Hardening2 | 88.66 | 0.03 | 1.06 | 10.26 |
| ODGrinding1 | 83.47 | 0.04 | 2.1 | 14.39 |
| Tempering | 70.21 | 0 | 1.3 | 28.48 |
| Facingcentering | 68.4 | 0.04 | 0.08 | 31.48 |
| FinishCAMGrinding | 53.39 | 0.04 | 2.52 | 44.05 |
| ODGrinding | 43.66 | 0.04 | 4.83 | 51.47 |
| SlottingReaming | 39.87 | 0.04 | 6.51 | 53.58 |
| FinalInspection | 38.77 | 0.01 | 61.22 | 0 |
| KeywayMilling | 33.25 | 0.05 | 21.54 | 45.15 |
| CheckforBending | 28.27 | 0.01 | 12.44 | 59.28 |
| MPInspection | 27.21 | 0.03 | 13.69 | 59.07 |
| .Source | 0 | 0 | 0 | 100 |
| Drain | 0 | 0 | 100 | 0 |

### *B. 2D & 3D Production Line Visualization*



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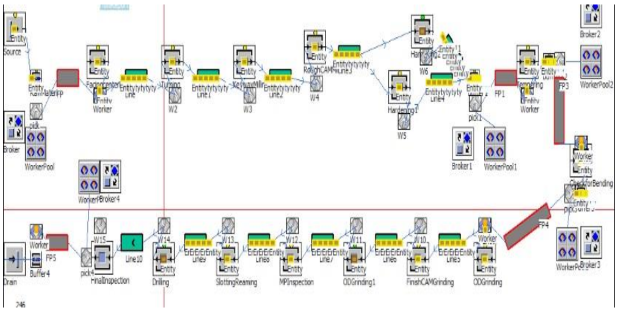

**Figure 1: 2D model visualization**

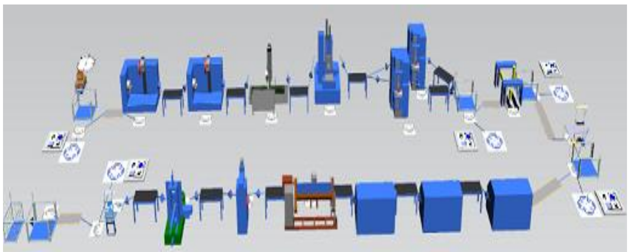

**Figure 2: 3D model visualization**

From the above Fig 1&2 indicates the clear visualization of the production line which will be help full for space accuracy, layout shape and machine assembled space, space for worker movement and space for storages (source and Drain). Layout can be influenced directly in visualization, material low and discrete event simulation programs, they offer substantial time savings.

## V. RESULTS AND DISCUSSIONS

*A. Workstations (Machines) Utilization.*

Fig. 3 shows the utilization of each machine in the production line for the data samples shows in Table I. we observed that for the current production line working efficiency has not up to the satisfaction, about 60% of the machines are waiting, 86% of the machines are overloaded and, 40% of the machines both (waiting & overloaded) in the production line. Hence where the maximum machines are blocked or waiting, the operators in idle and in overloaded operators have burden.

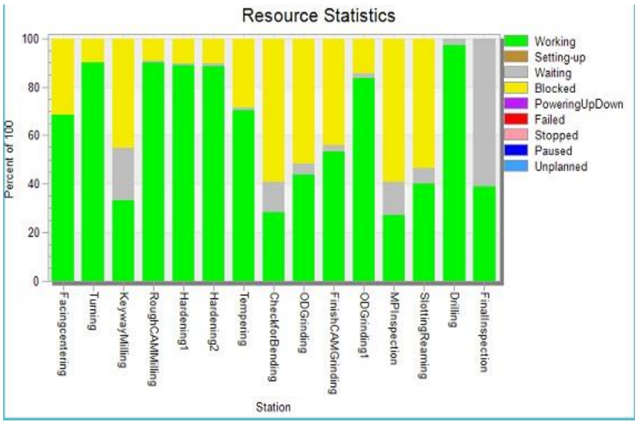


**Figure 3: Utilization of Machines in Production Line**

*B. Occupancy of Workstations.*

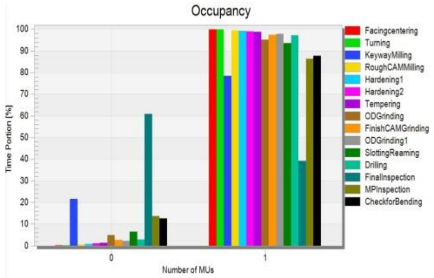


**Figure 4: Utilization of Machine Occupancy in Production Line**

$$\text{Occupancy rate} = \frac{\Sigma \text{ Handle time}}{\Sigma \text{ Handle time} + \text{Available time}} \quad [2]$$

Occupancy directly ensures the productivity, higher the % of occupancy, higher will the % of productivity. Fig 4. Shows the poor utilization of entities (product) with respect to the time. Calculation of occupancy using Equation (2).Initially occupancy percentage was currently very low only final inspection has around 65%, gradually it was increased after number of entities moved complete production line. Hence constant material flow throughout the production line increase the occupancy percentage of the workstations.

*C. Bottleneck Analysis*

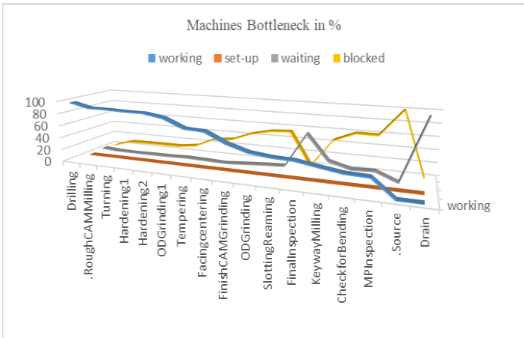


**Figure 5: Bottleneck of each workstation**

Bottleneck analysis will help to identify where exactly the load has more, stumpy and balanced. So that we can take action immediately. Fig. 5 shows initially it was smooth, after few entities there was unbalanced due to variation in the Process time and setup time of machines so that some worker are overloaded some are idle.

*D. Energy consumption and power input*

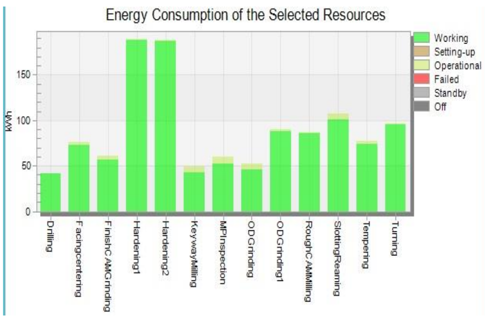


**Figure 6: Energy consumption by each workstation**


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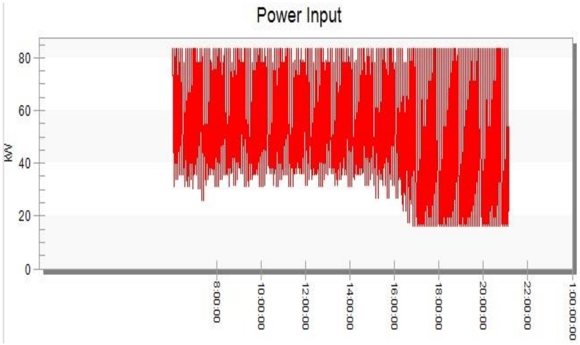


**Figure 7: Variation of power input with respect to time**

$$Pc = P_i + CV \quad [3]$$

Pc = power [KW] used for machining process,

$P_i$ = power [KW] used for all machine modules for a machine operating at zero load (powered machined which is not cutting),

c= requirement of specific energy in cutting / mm operations.

v = rate of material removal (MRR).

The energy consumption for the machining process is in need of the power used and specific energy in the cutting operations. Fig 7. Illustrate increase in the work hours will increase the input power for the machines, we can also observe upto 16 hours power has constant, after that it was increased about 20%. Fig 6. Shows energy consumption is more at hardening workstations due to high cycle time compare to other workstations. Hence energy consumption will be more at high process time and setup time.

*E. Throughput Analysis.*

**Table III: Details of Throughput data**

| Name | Mean Life Time | Throughput | Throughput per Hour | Production | Transport | Storage | Value added | Portion |
|---|---|---|---|---|---|---|---|---|
| Entity | 5:46:48.3137 | 246 | 11.63 | 15.82% | 40.86% | 43.32% | 10.67% | |

$$TH = I_n / T_i \quad [4]$$

Where TH= Throughput of production line

$I_n$ = Inventory used over a period of time

$T_i$ = Total time required. It includes PT, IT, MT, QT

Throughput analysis shows the overall production rate. We observe there is very low production rate in the current production line. Value added is only 10.67% due to improper line balance, variation in the process and setup time in different workstations. Failure percentage also more (red). About 246 entities can be produce per day so that approximately 12 entities per hour. We can improve production rate by improving total time i.e. process time (PT), Inventory time (IT), move time (MT) and Queue time (QT).

## CONCLUSION

In attire industries sometimes it is challenging to recognize the key areas and practices, which can be used to progress the current system & circumstance in the processes. Delivering high quality at low cost in petite lead times are the major challenges encountered by the attire manufacturers. Discrete event simulation help to detect major issues in production line, it shows where precisely the non-value added occurred with major and minor issues, so that eliminate the intolerance situations. Form this research we observed setup and process time leads huge dissimilarity in the production system. Reducing the setup time makes major impact on the resource consumption, workstation station occupancy, Energy and Input Power. Bottleneck was more in the production line due to improper assignment of work. In CNC machines, it was quite difficult to eliminate the bottleneck because of some restricted parameters. Reducing setup time and non-value added in process time we can reduce energy consumption during process, which helps in increasing profit. Approximately 20% of the buffer can be reduced by reducing bottleneck in each machines. Form throughput analysis we observed only 10.67% value added in the production line. Storage utilization about 43.32%, transportation 40.86% and production utilization only 15.81%. With this cycle time throughput was 11.63 per hour.

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