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# AN ANALYSIS OF OPTIMIZATION TECHNIQUES FOR PLANT LAYOUTS IN IMPROVEMING THE PERFORMANCE – A CASE STUDY

**Raju. G.S[1], Paul Vizhian. S[2], Vijay kumar. M[3] and Aswini. V [4]**

1. **Research Scholar, Department of Mechanical engineering, University Visvesvaraya college of Engineering,Bangalore University, Bangalore, Karnataka, India**
2. **Professor, Department of Mechanical Engineering, University Visvesvaraya college of Engineering,Bangalore University, Bangalore, Karnataka, India**
3. **Associate Professor, Department of Industrial Engineering and Management, JSS Academy of TechnicalEducation, Bangalore, Karnataka, India**
4. **Research Scholar, Department of Mechanical engineering, University Visvesvaraya college of Engineering,Bangalore University, Bangalore, Karnataka, India**

**Abstract: Plant layout is the art and science of bringing together men, machines, materials, methods and supporting facilities in form of given arrangements that sits individual industrial activity to have benefits maximizations through economy, efficiency, effectiveness and productivity. To have better performanceoptimizing product movements is essential, for this the relative techniques are needed. There are optimizationtechniques are available namely simulation technique, Heuristic techniques such as Genetic Algorithms (G A). Simulated Annealing (SA) and Tabu Search are the fundamental and commonly used heuristic methods for optimization of the plant layout design. The idea of this paper is to analysis' the few plant layout techniques in order to improve the overall performance of the production system at large. The various measures of the plant layout viz; bottleneck rate, idle time and percentage utilization of men, machines, space and equipment can be improved by effective analysis of plant layout techniques. The researchers have been attempted in order to find optimum plant layout design by using the various plant techniques. At large the simulation abased optimization techniques is more suitable and preferable plant layout technique. This paperpresent literature, findings and important research direction on plant layout methods proposed a combination of heuristic method base on simulation.**

**Keywords: Plant layout, optimization techniques, review, simulation**

## 1. Introduction

In any manufacturing facility, the layout is extremely important as it decides how the Assembly line will work and how the parts will flow. Plant layout is the essential part of any organization. Over the years, plant layouts have evolved into different types namely as:
i). Product Type .ii) Process Type .iii). Fixed Position.
iv) Combination Type.

Maximization of production with minimum cost is the main focus of the any industry, and production and demand goes together, for increasing the production there are some methods like increase in number of machines, by using automated machines, minimizing manufacturing time, and minimizing the distance movement etc, The main aspect is the arrangement of the facilities needed for poriction.Plant layout /facility layout directly affect the production rate. Therefore it is mandatory to be successful in today's competitive manufacturing scenario. It has become evident that every industry more so manufacturing industry where in look for new techniques or methods for facilities planning.

Usually material handling activities account for 20 to 30percent of manufacturing company's total operating budgets .In otherwards if companies would arrange the facilities optimally, the costs of total product cost can be reduced. Slavendy stated that an effective layout may minimize the material flows and distance between the department locations which lead to the reduction of material handling costs and improvement in cycle time.

## 2. Plant Layout design

An Ideal Plant layout should provide the optimum relationship among output, floor area and manufacturing process. It facilitates the production process, minimizes material handling, time and cost and allows flexibility of operations, easy production flow, makes economic use of the building, promotes effective utilization of manpower, and provides for employee's convenience, safety, comfort at work maximum exposure to natural light and ventilation. It is also important because it affects the flow of material and process, labor efficiency, supervision and control use of space and expansion possibilities etc.

According to Huang facility layout design determines how to arrange, locate and distribute the equipment and support services in a manufacturing facility to achieve minimization of overall production time, maximization of operational and arrangement flexibility, maximization of turnover of work ;in process and maximization of factory output in conformance with productionschedules.

Facility layout is one way to reduce the cost of manufacturing and increase the productivity also creases good work flow in production rout. Facility layout design determines how to arrange, locate and distribute the equipment and support services in a manufacturing facility to achieve minimization of operational and arrangement flexibility, maximization of turnover of work in process and maximization of factory output in conformance with production schedules.

The modern facility layout experiences many changes in designs of product, process plans, market demand, product life cycles and production routings etc..Flexible manufacturing systems that possess process and product flexibilities are being extensively used improvements in shop floor control technology and material handling systems have reduced the impact of travel distance and inter operation separation on the type of physical layout designed for a facility. The traditional facility layouts are usually not suitable for these changes; manufacturers nowadays have been seeking for systematic and efficient methods to layout their facilities that werepreviously developed using traditional design strategy of process layout or the principle of place of where space is available.

## 3. Literature Review

Sanjeev B. Naik et al,[1] takes about 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. To achieve the optimization objectives a lot of techniques are developed by many researchers in the domain area. The objective of this paper is to review the contributions in the field not onlyfor plant layout but re-layout also.

Sanjeev B. Naik et al. [2] tells about the tools for optimizing layout design: heuristic methods,the most well known heuristic methods in optimizing layout design are Tabu Search (TS), Simulated Annealing (SA), and Genetic Algorithms (GA). The popularity of these heuristics has flourished in recent years and several published studies can be found in the literature. Arostegui, et al, classify heuristics methods into tailored and general. While tailored heuristics have a limited applicability to a specific problem while general algorithms define a strategy for obtaining approximate solutions and thus are widely applicable to various forms of combinatorial optimization problems. Tabu

Search (TS) is a mathematical optimization method, belonging to the class of local search techniques. Tabu search enhances the performance of a local search method by using memory structures. Once a potential solution has been determined, it is marked as taboo, so that the algorithm does not visit that possibility repeatedly. A genetic algorithm (GA) is a search technique used in computing to find exact or approximate solutions to optimization and search problems. Genetic algorithms are categorized as global search heuristics. Genetic algorithms are a particular class of evolutionary algorithms (EA) that use techniques inspired by evolutionary biology such as inheritance, mutation, selection, and crossover. Simulated annealing (SA) is a generic probabilistic meta heuristic for the global optimization problem of applied mathematics, namely locating a good approximation to the global minimum of a given function in a large search space . It is often used when the search space is discrete. Forcertain problems, simulated annealing may be more effective than exhaustive enumeration, provided that the goal is merely to find an acceptably good solution in a fixed amount of time, rather than the best possible solution.

Sanjeev B. Naik et.al [3] talks about Simulation technique is also recommended in the facility planning analysis. Nica, et al, reported that queuing phenomena of parts before entering assembly area is in uncertainty arrival time. Simulation is an appropriate tool to help the designer to define the storage spaces of assembly system in this stochastic situation. In this research, a concept of ordered parts buffer is proposed for sequencing parts arrived in the assembly process by robot systems. Simulation based on experimental design is developed by Ekren and Ornek, for the purpose of job-shop type of manufacturing. They investigated the effects of layout types and their interactions with other manufacturing parameters that can affect performance of the system.

A simulation model has been developed as an analysis tool for line reconfiguration to accommodate the future demand fluctuation. Line balancing becomes the main issue in the research and fuzzy knowledge base of technique was proposed to help define more realistic scenarios. The necessity of sequence coordination within a complex assembly system is reported.This is due to the fact that the complex assembly system generally includes preassembly section for part preparation and this can only be determined by computer aided simulation.

Amir Sadrzadeh [6] the paper presents a genetic algorithm-based meta-heuristic to solve the facility layout problem (FLP) in a manufacturing system, where the material flow pattern of the multi-line layout is considered with the multi-products. The matrix encoding technique has been used for the chromosomes under the objective of minimizing the total material handling cost. The proposed algorithm produces a table with the descending order of the data corresponding to the input values of the flow and cost data. The generated table is used to create a schematic representation of the facilities, which in turn is utilized to heuristically generate the initial population of the chromosomes and to handle the heuristic crossover and mutation operators. The efficiency of the proposed algorithm has been proved through solving the two examples with the total cost less than the other genetic algorithms, CRAFT algorithm, and entropy-basedalgorithm.Greasley, 2008 [7] A discrete event simulation model was developed and used to estimate the storage area required for a proposed overseas textile manufacturing facility. It was found that the simulation was able to achieve this because of its ability to both store attribute values and toshow queuing levels at an individual product level. It was also found that the process ofundertaking the simulation project initiated useful discussions regarding the operation of the facility. Discrete event simulation is shown to be much more than an exercise in quantitative analysis of results and an important task of the simulation project manager is to initiate a debate among decision makers regarding the assumptions of how the system operates.

## 4. Simulation Technique

Simulation is a tool for analyzing and testing solutions before implanting in the real system. Concept of simulation technique is to imitate the real system as a model and after that use the model to work in any conditions and study the effects to evaluate the solution strategies for the teal system, Arena, simu18, QUEST, IGRIP, PROMODEL, Flexsim and witness, are some simulation tools commonly use in facility layout planning.

WITNESS provides a powerful tool to implement simulation models de voted to analyze plant ;layouts and to perform feasibility analysis in particular it supports decision makers in formulating “what if” analysis before performing significant investments like a new plant layout, Simu18 is used for the design of a steel works facility. This stochastic model allows handling the uncertainties that arise from stochastic elements in the environment and in the objective function evolution process..Flexsim is discrete event simulation software, use for evaluating planning or designing manufacturing, warehousing, logistics and other operational and strategic situations.

## 5. Analysis and Simulation of Factory Layout usingARENA

The arrangement of the machines is not according to the flow of work. The layout of the machineshop is shown below

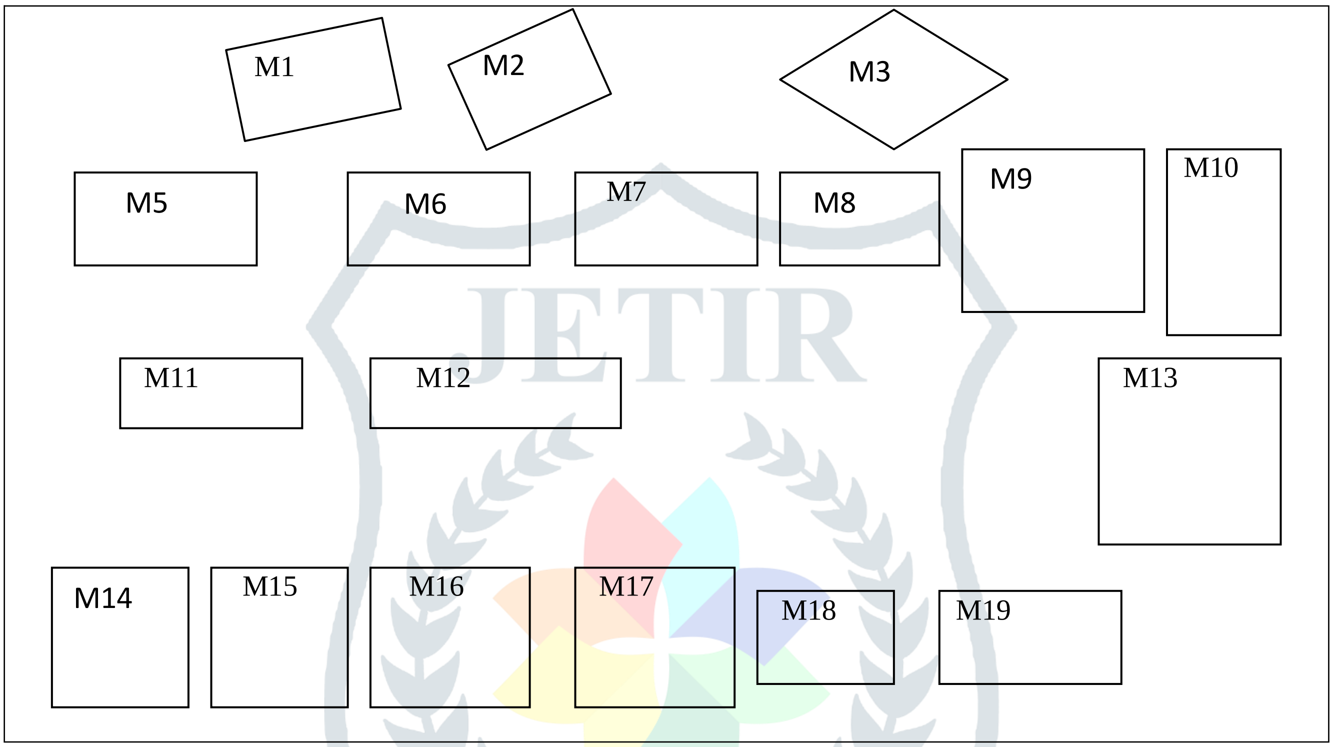



**Figure 1: Layout of New Machine Shop**

## 6. Data collection

**Figure2: Flow of 4.5 KW alternator shaft**

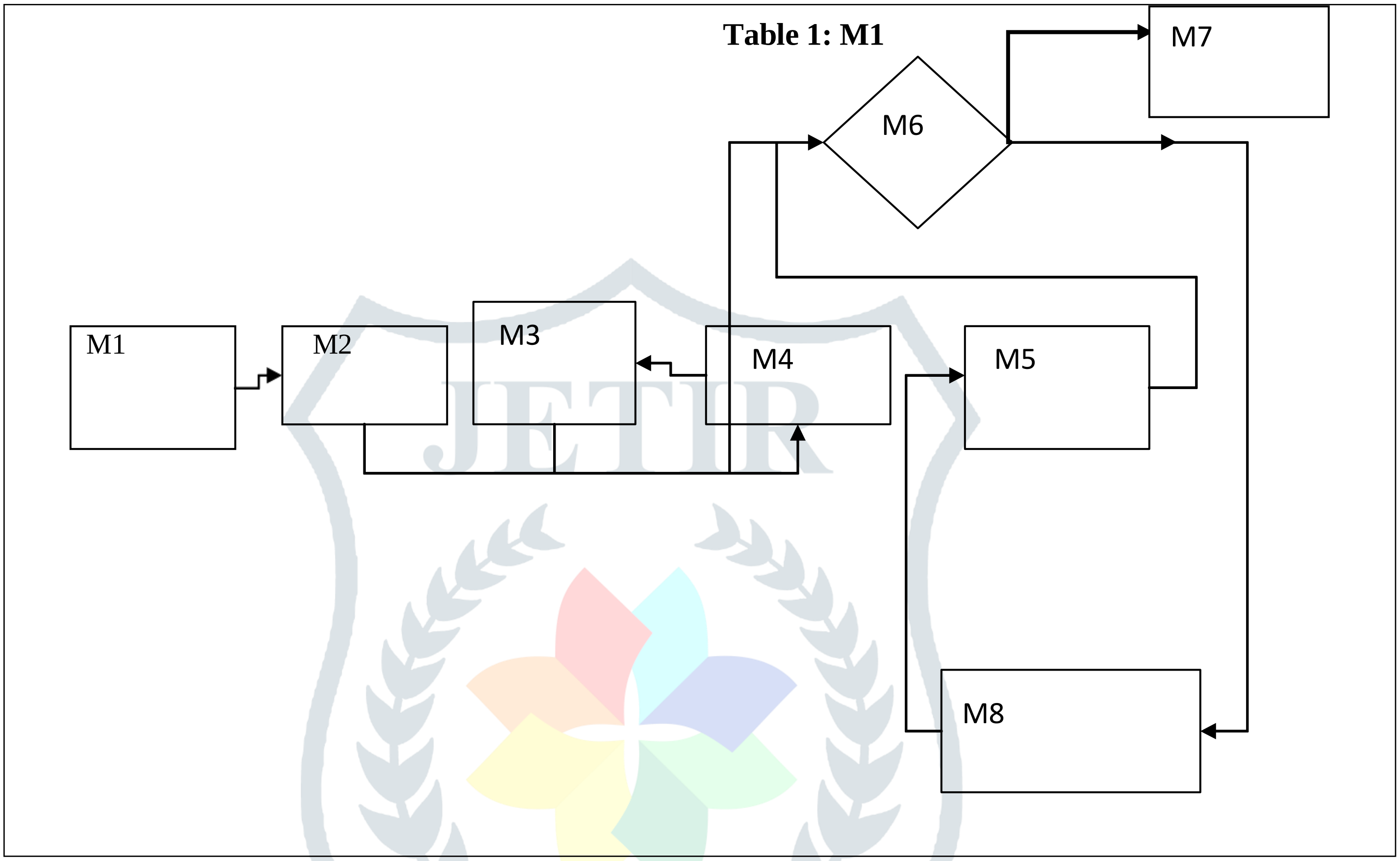



**Table 1: M1**

| CUTTING TIME | INTERARRIVAL TIME |
|---|---|
| 20mints 54s | 2mints 01s |
| 18mints 26s | 1mints 57s |
| 21mints 02s | 2mints 13s |
| 20mints 21s | 2mints |
| 18mints 47s | 2mints 02s |

| | |
|---|---|
| 19mints 54s | 2mints 10s |
| 18mints 50s | 1mints 55s |
| 20mints 47s | 2mints 02s |
| 20mints 30s | |
| **Avg 20mints10s** | **2mints.05s** |

**Table 2: M2**

| MILLING TIME | INTER ARRIVAL TIME |
|---|---|
| 51 mints.25s | 1 mints.56s |
| 50 mints.20s | 1 mints.55s |
| 50 mints.45s | 2 mints.02s |
| 51 mints.04s | 1 mints.50s |
| 50 mints.29s | 1 mints.48s |
| 50 mints.27s | 1 mints.54s |
| 51 mints.43s | 1 mints.55s |
| 50 mints.12s | 1. mints 52s |
| 51 mints.02s | |
| **Avg 50 mints.56s** | **1 mints.59s** |

**Table .3: M3**

| TURNING TIME | INTER ARRIVAL TIME |
|---|---|
| 88. mints 56s | 1 mints 56s |
| 89 mints.32s | 1 mints 52s |
| 90 mints 54s | 1 mints 54s |

| | |
|---|---|
| 89 mints 24s | 1 mints.45s |
| 90 mints 44s | 2 mints 01s |
| 90 mints 39s | 1 mints 46s |
| 88 mints 57s | 1 mints 49s |
| 89 mints 43s | 1 mints 55s |
| 90 mints 34s | |
| **Avg 90 mints 04s** | **1 mints.57s** |

**Table 4: M4**

| STACKING & PRESSINGTIME | INTER ARRIVAL TIME |
|---|---|
| 28 mints.26s | 2. mints 02s |
| 27. mints 53s | 2 mints.14s |
| 28. mints 17s | 2. mints 15s |
| 27. mints 58s | 2. mints 10s |
| 28. mints 13s | 2 mints.17s |
| 28 mints.25s | 2 mints 09s |
| 28 mints.10s | 2. mints 16s |
| 28 mints.21s | 2 mints.12s |
| 28 mints.20s | |
| **Avg 28. mints 04** | **2 mints.11** |

**Table 5: M5**

| BALANCING TIME | INTER ARRIVAL TIME |
|---|---|
| 38 mints.29s | 2. mints 56s |
| 38. mints 56s | 3. mints 01s |
| 37 mints.24s | 2 mints.11s |
| 37 mints.35s | 2 mints.45s |
| 37. mints 45s | 2. mints 54s |
| 36 mints.58s | 2. mints 22s |
| 37 mints.38s | 2. mints 49s |
| 37 mints.54s | 2. mints 37s |
| 37 mints.29s | |
| **Avg 37. mints 52s** | **2. mints 46s** |

## 7. RESULTS AND DISCUSSION

The production efficiency depends on how well the various production facilities, employee's amenities and, machines are located in a plant. Only the properly laid out plant can ensure the smooth and rapid movement of material, from the raw material stage to the end product stage. Plant layout study helps much in improvement in the existing layout.

**The 4.5 kW shaft flow is simulated and the results are given below**

**Figure 3**

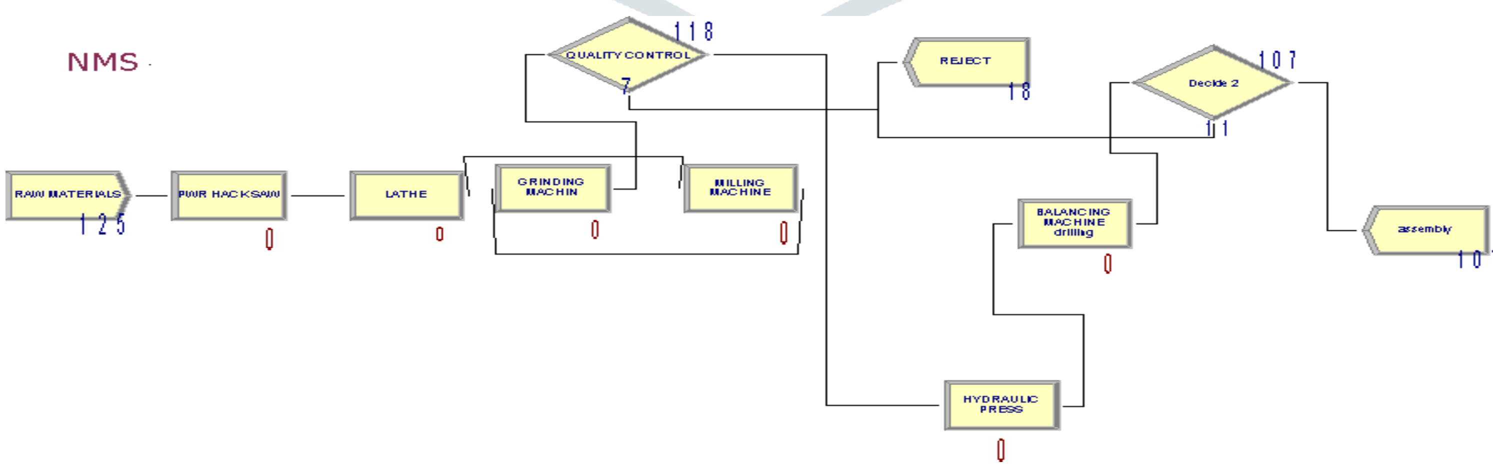
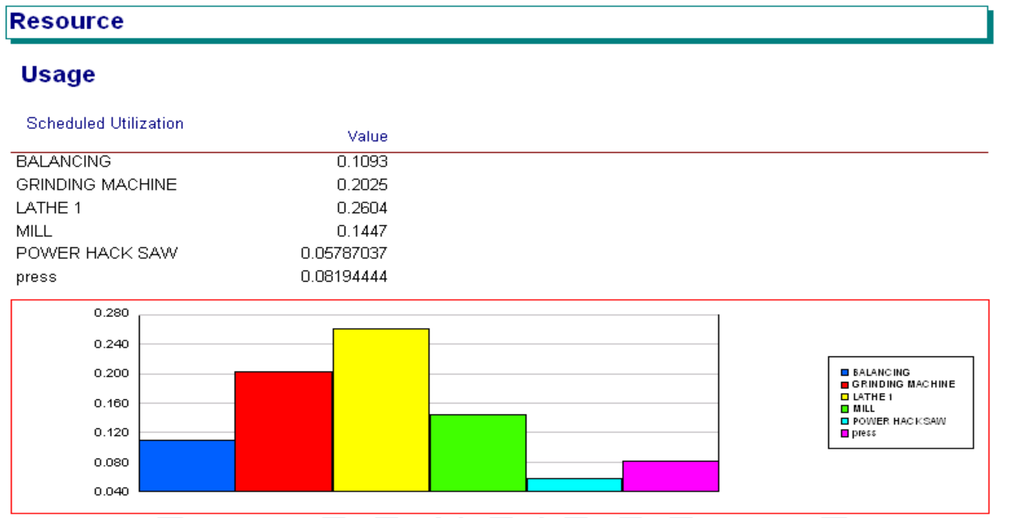


**Figure 4**

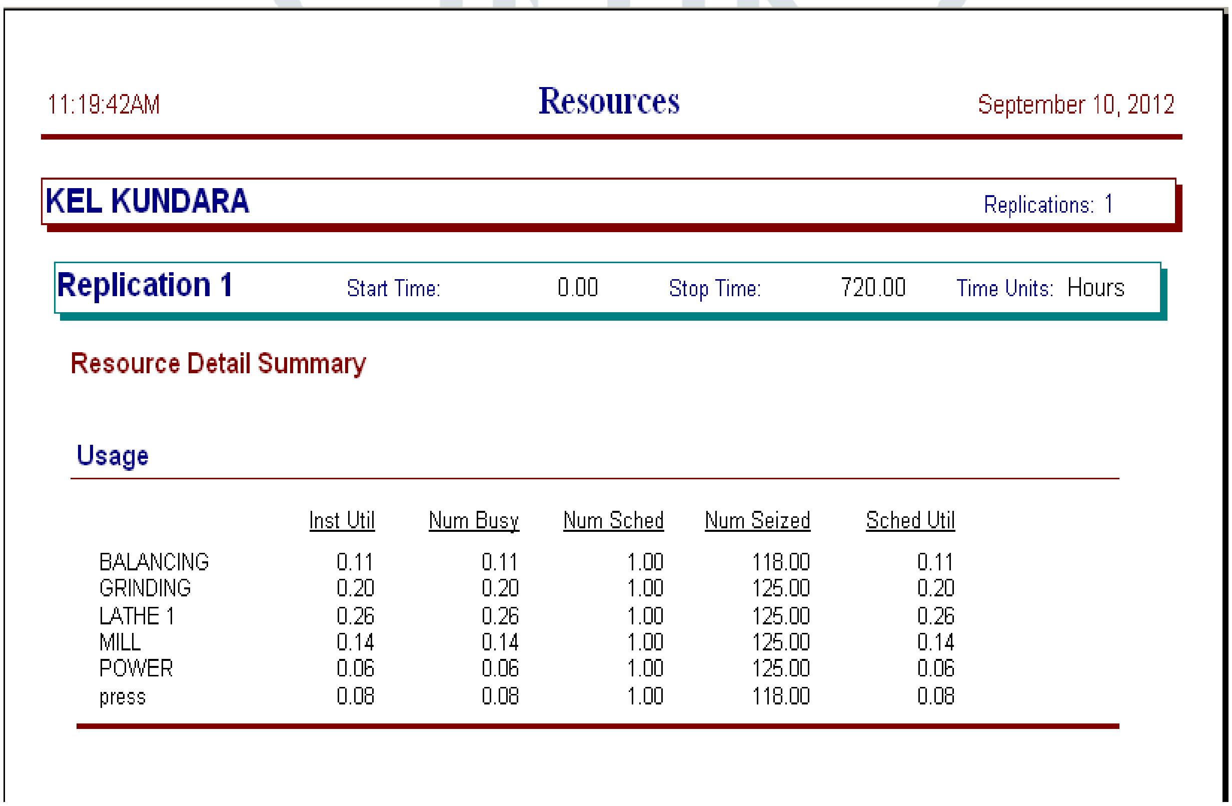


Resource

Usage

| Scheduled Utilization | Value |
|---|---|
| BALANCING | 0.1093 |
| GRINDING MACHINE | 0.2025 |
| LATHE 1 | 0.2604 |
| MILL | 0.1447 |
| POWER HACK SAW | 0.05787037 |
| press | 0.08194444 |





11:19:42AM Resources September 10, 2012

KEL KUNDARA Replications: 1

Replication 1 Start Time: 0.00 Stop Time: 720.00 Time Units: Hours

Resource Detail Summary

Usage

| | Inst Util | Num Busy | Num Sched | Num Seized | Sched Util |
|---|---|---|---|---|---|
| BALANCING | 0.11 | 0.11 | 1.00 | 118.00 | 0.11 |
| GRINDING | 0.20 | 0.20 | 1.00 | 125.00 | 0.20 |
| LATHE 1 | 0.26 | 0.26 | 1.00 | 125.00 | 0.26 |
| MILL | 0.14 | 0.14 | 1.00 | 125.00 | 0.14 |
| POWER | 0.06 | 0.06 | 1.00 | 125.00 | 0.06 |
| press | 0.08 | 0.08 | 1.00 | 118.00 | 0.08 |

**Figure5: simulation results**

The utilization of the different machines is given above. The results show that out of these machines lathe has highestutilization 26% which is very low. All other machines have very lowutilization

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