

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

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## Study and Analysis of Optimal Layout in Green Manufacturing

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**ABSTRACT:** The main aim of this project is to study and make optimal facility layout design in a machine shop at apple industry by reducing total material handling cost (TMHC) and CO<sub>2</sub> emission in the shop floor. The most recent development regarding simulated approximately is being review. This study is based on the analysis of existing layout in workshop. The arrangement of machine is simulated using the software and layout is analyzed based on the products variety and production volumes. An attempt is to be made to simulate the existing layout of the industry using the MATLAB software. This aim of this project work is to find the most efficient arrangement of machines in the machine shop that will improve the efficiency of workflow in the shop floor allowing workers and equipment being more productive.

**KEYWORDS:** Simulated Annealing, Detail Layout Design, Facility layout problem

### I. INTRODUCTION

The project work deals with the physical arrangement of a given number of department or machines within a give configuration. In the context of manufacturing, the objective is to minimize the total material handling cost of moving the required material between the departments. An economic activity center is any entity occupying space. Most layouts are designed properly for the initial conditions of the business, although as long as the company grows and has to be adapted to internal and external change, a re-layout is necessary. The main objective of this project is to find out the most efficient arrangement of machines in the machines shop to reduce the non-value added time.

The problem identify in the factory includes the following:

- The productivity has been reduced due to improper shop floor layout.
- Improper positioning of the machine in the shop floor with regard to the sequence of the operation.
- Raw materials and finished products are randomly stored without any proper allocation of space.
- Improper material handling design for the moment of raw material to finished products.

Nearly a third of the world's energy consumption and 36%<sup>[2]</sup> of carbon dioxide (CO<sub>2</sub>) emissions are attributable to manufacturing industries. The large primary materials industries, i.e., chemical, petrochemicals, iron and steel cement paper and pulp, and other minerals and metals, account for more than two-thirds of this amount.

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## II. METHODOLOGY

- Step1: Data collection.
- Step2: Design and analyze the existing Layout.
- Step3: Simulate using MATLAB Software.
- Step4: Select the appropriate layout that would minimize the drawbacks of existing layout.

## III. DATA COLLECTION

### 3.1. Details of the shop floor of APPLE cooker industry

Apple cooker industry is one of the leading manufacturing of cooker in Tamil Nadu. It was established in December 2015. Moreover, there are several products manufactured such as Pressure cookware, stainless steel cookware, Non-stick cookware etc. These products are exported across the countries. The main raw materials used are Aluminum, stainless steel etc. These are around 500-600 products are being manufactured per day. These products are exported to various countries and still expanding its growth towards excellence.



Photographic view of machine shop

### 3. 2: Machine dimensions:

The machine shop has 11 departments placed in the shop floor of Height = 26.5 meter, Width = 37.8 meter.  
The details of each department is given hereunder

Table: 1: Machine dimensions

S.NO	Department Name	Length(m)	Width(m)
1	Hydraulic holing	1.57	1.35
2	Hydraulic cutting	1.50	1.25
3	Hydraulic press	2.25	1.60
4	Hydraulic press	2.7	1.87
5	Open/close(3mach)	2.70	1.20
6	Bending	1.8	0.70
7	Holding	1.65	0.65
8	Cutting	1.6	0.95
9	Stamping	2.70	0.85
10	Fitting machine	1.80	0.86
11	Fitting machine	1.80	1.40
12	Emering	0.30	0.30
13	Emering	0.30	0.30
14	Emering	0.30	0.30
15	Emering	0.30	0.30

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### 3.3: Production Quantity flow between machines / departments

The material flow between each pair of departments is calculated and then used to make the flow matrix table.

### 3. 4: Existing shop floor layout

The existing shop layout is given here in the figure: 1

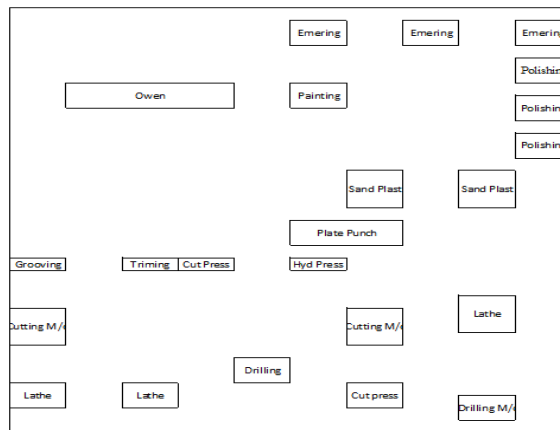


Figure: 1: Existing shop layout

## 4. Solution methodology

### 4.1: Sequence pair

Unlike graph-based representations, a sequence pair is a pair of permutations (orderings) of the N machines. The two permutations capture geometric relations between each machine. Recall that since machines cannot overlap, one of them must be to the left or below from the other or both. In sequence pair

$$\langle \dots, a, \dots, b, \dots \rangle, \langle \dots, a, \dots, b, \dots \rangle \Rightarrow a \text{ is to the left of } b \quad (1)$$

$$\langle \dots, a, \dots, b, \dots \rangle, \langle \dots, b, \dots, a, \dots \rangle \Rightarrow a \text{ is above } b$$

(2)

Every machine constrains each other in either vertical or horizontal direction, and only these constraints are recorded. Therefore, placements produced from sequence pair must be aligned to given horizontal and vertical axes, e.g.,  $x = 0$  and  $y = 0$ . In this paper, we used sequence pair to find the actual placement of departments.

### 4. 2: Simulated Annealing Algorithm

Simulated annealing (SA) is a probabilistic technique for approximating the global optimum of a given function. Specifically, it is a metaheuristic to approximate optimization in a large search space. It is often used when the search space is discrete. For problems where finding an approximate global optimum is more important than finding a precise local optimum in a fixed amount of time, simulated annealing may be preferable to alternatives such as gradient descent.

The simulation of annealing can be used to find an approximation of a global minimum for a function with a large number of variables to the statistical mechanics of equilibration (annealing) of the mathematically equivalent artificial multi-atomic system

#### Pseudo code

Initialize (temperature T, random starting point)

While cool\_iteration  $\leq$  max\_iterations

    cool\_iteration = cool\_iteration + 1

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```

temp_iteration =0
while temp_iteration =temp_iteration + 1
select a new point from the neighborhood
compute current _cost (of this new point)
 $\alpha$  = current_cost -pervious _cost
if  $\alpha < 0$ ,accept neighbor
else,accept with probability  $\exp(-\alpha / T)$ 
end while
 $T = \alpha * T$       ( $0 < \alpha < 1$ )
end while

```

## V. RESULTS

The test problem is given in the section 3.1 and 3.2 with this input data and the mathematical model taken from Jerin etal (2012) [6]; SA algorithm is developed. The parameters used in SA are

(i). Initial Temperature. (ii) Number of iteration.

The testing of these parameters is essential. Therefore, a test experiment was conducted to find out the best temperatures for the proposed FLP

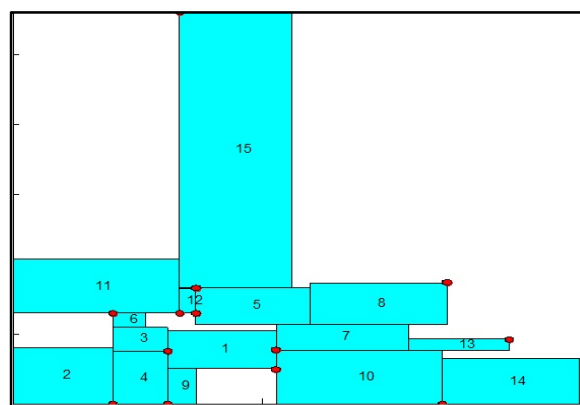
Initial temperature ( $T_i$ ) = [100,500,1000]

Number of iteration ( $N_i$ ) = [1,5,10]

Ten experiments was conducted for each pair of combinations of  $T_i$  and  $N_i$

**Table: 1**

$T_i$	$N_i$	Best TMHC
1000	10	21600



**Figure: 3 – Layout**

## VI. CONCLUDING REMARKS

The paper represents an application of the simulated annealing algorithm in layout design. A case study is described in the paper referring to a machine shop designated for maintenance of tag boat / ship's. From the result of this study we have selected an optimal layout design with minimal total material handling cost for different initial temperature and

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number of iteration values. This study not only reducing the material handling cost for production, also identify the unwanted movements of operator / material in a shop floor and re-locate the machines layout to improve production efficiency.

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