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A PRAGMATIC REVIEW ON IMPROVEMENTS IN THE ASSEMBLY LINE STOPPAGE

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ABSTRACT

An 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 assembly from work station to work station, a finished product can be assembled faster and with less labor 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. Consider the assembly of a car: assume that certain steps in the assembly line are to install the engine, install the hood, and install the wheels (in that order, with arbitrary interstitial steps); only one of these steps can be done at a time. In traditional production, only one car would be assembled at a time. If engine installation takes 20 minutes, hood installation takes five minutes, and wheels installation takes

10 minutes, then a car can be produced every 35 minutes. In an assembly line, car assembly is split between several stations, all working simultaneously. When one station is finished with a car, it passes it on to the next. By having three stations, a total of three different cars can be operated on at the same time, each one at a different stage of its assembly. After finishing its work on the first car, the engine installation crew can begin working on the second car. While the engine installation crew works on the second car, the first car can be moved to the hood station and fitted with a hood, then to the wheels station and be fitted with wheels. After the engine has been installed on the second car, the second car moves to the hood assembly. At the same time, the third car moves to the engine assembly. When the third car's engine has been mounted, it then can be moved to the hood station; meanwhile, subsequent cars (if any) can be moved to the engine installation station. In this research task, an effective algorithm for avoidance in the assembly line stoppage is proposed to be designed and implemented using honeybee algorithm.

Keywords - Production Assembly Line, Avoidance of Assembly line Stoppage, Manufacturing Assembly Line Performance

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I. INTRODUCTION

Assembly lines are designed for the sequential organization of workers, tools or machines, and parts. The motion of workers is minimized to the extent possible. All parts or assemblies are handled either by conveyors or motorized vehicles such as fork lifts, or gravity, with no manual trucking. Heavy lifting is done by machines such as overhead cranes or fork lifts. Each worker typically performs one simple operation.

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According to Henry Ford:

The principles of assembly are these:

(1) Place the tools and the men in the sequence of the operation so that each component part shall travel the least possible distance while in the process of finishing.

(2) Use work slides or some other form of carrier so that when a workman completes his operation, he drops the part always in the same place—which place must always be the most convenient place to his hand—and if possible have gravity carry the part to the next workman for his own.

(3) Use sliding assembling lines by which the parts to be assembled are delivered at convenient distances.

In his autobiography Henry Ford (1922) mentions several benefits of the assembly line including:

- Workers do no heavy lifting.
- No stoping or bending over.
- No special training required.
- There are jobs that almost anyone can do.
- Provided employment to immigrants.

The gains in productivity allowed Ford to increase worker pay from $1.50 per day to $5.00 per day once employees reached three years of service on the assembly line. Ford continued on to reduce the hourly work week while continuously lowering the Model T price. These goals appear altruistic; however, it has been argued that they were implemented by Ford in order to reduce high employee turnover: when the assembly line was introduced in 1913, it was discovered that "every time the company wanted to add 100 men to its factory personnel, it was necessary to hire 963" in order to counteract the natural distaste the assembly line seems to have inspired

II. PROBLEM FORMULATION

The existing methods of cost reduction or optimization are not effective and should be processed using specialized algorithms of metaheuristic techniques. Metaheuristics are used to solve Combinatorial Optimization Problems, like Bin Packing, Network Routing, Network Design, Assignment Problem, Scheduling, or Industrial Manufacturing Problems, Continuous Parameter Optimization Problems, or Optimization of Non-Linear Structures like Neural Networks or Tree Structures as they often appear in Computational Intelligence.

Metaheuristics are generally applied to problems for which there is no satisfactory problem-specific algorithm or heuristic; or when it is not practical to implement such a method. Most commonly used Metaheuristics are focused to combinatorial optimization problems, but obviously can handle any problem that can be recast in that form, such as solving Boolean equations.

The Bees Algorithm mimics the foraging strategy of honey bees to look for the best solution to an optimisation problem. Each candidate solution is thought of as a food source (flower), and a population (colony) of *n* agents (bees) is used to search the solution space. Each time an artificial bee visits a flower (lands on a solution), it evaluates its profitability (fitness).

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The Bees Algorithm consists of an initialisation procedure and a main search cycle which is iterated for a given number *T* of times, or until a solution of acceptable fitness is found. Each search cycle is composed of five procedures: recruitment, local search, neighbourhood shrinking, site abandonment, and global search.

III. THE PSEUDOCODE FOR THE STANDARD BEES ALGORITHM

```
1 for i=1,…,ns
   i  scout[i]=Initialise_scout()
   ii flower_patch[i]=Initialise_flower_patch(scout[i])
2 do until stopping_condition=TRUE
   i   Recruitment()
   ii  for i =1,…,nb
         1 flower_patch[i]=Local_search(flower_patch[i])
         2 flower_patch[i]=Site_abandonment(flower_patch[i])
         3 flower_patch[i]=Neighbourhood_shrinking(flower_patch[i])
   iii for i = nb,…,ns
         1 flower_patch[i]=Global_search(flower_patch[i])}
```

In the initialisation routine *ns* scout bees are randomly placed in the search space, and evaluate the fitness of the solutions where they land. For each solution, a neighbourhood (called flower patch) is delimited.

In the recruitment procedure, the scouts that visited the $nb \leq ns$ fittest solutions (best sites) perform the waggle dance. That is, they recruit foragers to search further the neighbourhoods of

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the most promising solutions. The scouts that located the very best $ne \leq nb$ solutions (elite sites) recruit *nre* foragers each, whilst the remaining *nb*-*ne* scouts recruit $nrb \leq nre$ foragers each. Thus, the number of foragers recruited depends on the profitability of the food source.

In the local search procedure, the recruited foragers are randomly scattered within the flower patches enclosing the solutions visited by the scouts (local exploitation). If any of the foragers in a flower patch lands on a solution of higher fitness than the solution visited by the scout, that forager becomes the new scout. If no forager finds a solution of higher fitness, the size of the flower patch is shrunk (neighbourhood shrinking procedure). Usually, flower patches are initially defined over a large area, and their size is gradually shrunk by the neighbourhood shrinking procedure. As a result, the scope of the local exploration is progressively focused on the area immediately close to the local fitness best. If no improvement in fitness is recorded in a given flower patch for a pre-set number of search cycles, the local maximum of fitness is considered found, the patch is abandoned (site abandonment), and a new scout is randomly generated.

As in biological bee colonies, a small number of scouts keeps exploring the solution space looking for new regions of high fitness (global search). The global search procedure re-initialises the last *ns*-*nb* flower patches with randomly generated solutions.

At the end of one search cycle, the scout population is again composed of *ns* scouts: *nr* scouts produced by the local search procedure (some of which may have been re-initialised by the site abandonment procedure), and *ns*-*nb* scouts generated by the global search procedure. The total artificial bee colony size is $n=ne \bullet nre+(nb-ne) \bullet nrb+ns$ (elite sites foragers + remaining best sites foragers + scouts) bees.

IV. APPLICATIONS

The Bees Algorithm has found many applications in engineering, such as:

- Optimisation of classifiers / clustering systems
- Manufacturing
- Control
- Bioengineering
- Other optimisation problems
- Multi-objective optimisation

V. PROPOSED WORK AND OBJECTIVES

- The classical work shall be improved using bees algorithmic approach.
- The reduction in assembly line stoppage and prior analysis will be optimized using HB techniques
- Honeybee Algorithm with association of greedy approach based simulation shall be integrated for the industrial manufacturing related to labor cost.

VI. CONCLUSION

The proposed algorithm for the assembly line stoppage is providing effective and better results, still the usage of techniques including ant colony optimization, genetic algorithm, and neural networks can give optimal results in terms of greater accuracy and integrity. In the results, it is predicted that the honeybee based implementation shall be effective as compared to the classical approaches of assembly line root cause analysis, prediction and avoidance.

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