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Line Balancing in the Apparel Industry Using Genetic Algorithm

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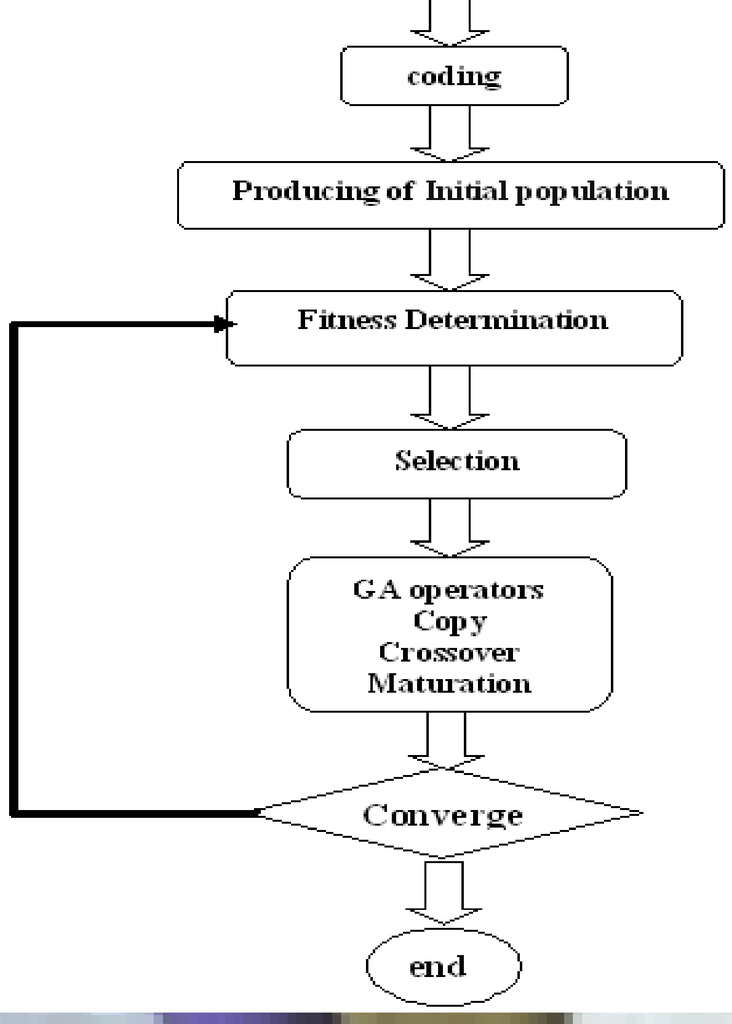
Introduction

In the apparel industry, it is essential to form a new production line for each order, and also the number of workers is changed according to the complexity of the order, the number of operations, throughput etc. The things which should be done during the installation of an assembly line are as follows :

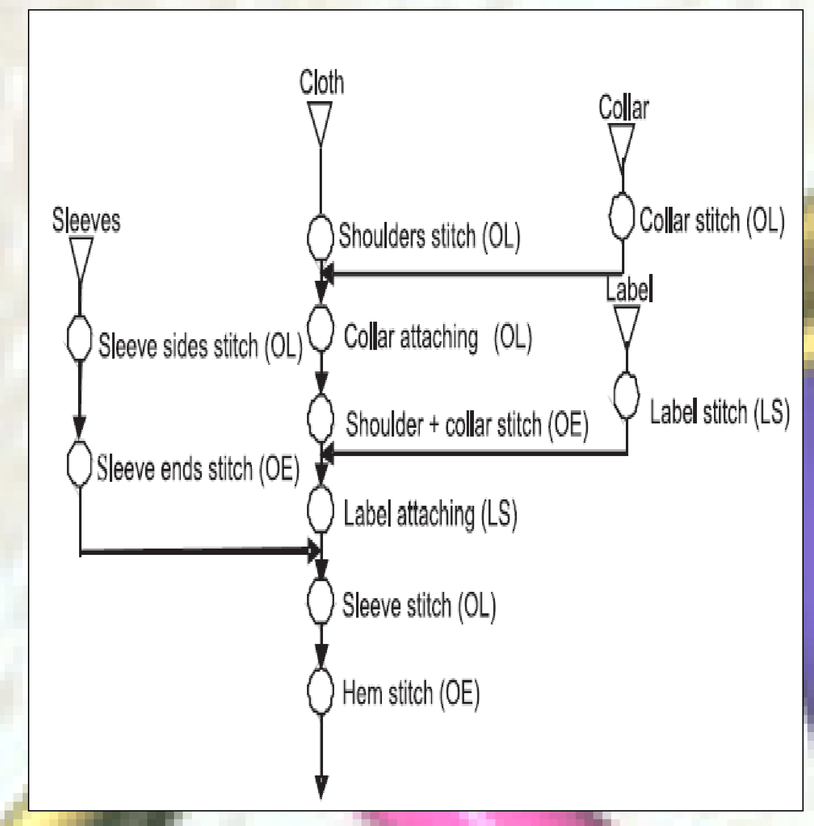
✓To define a standard time for each operation,
✓To balance the production line for each order,
✓To keep the utilization rate at a maximum for each operator,

Genetic algorithm

Genetic algorithms are search algorithms based on the principles of natural selection and survival of the fittest .GA's were first introduced by John Holland .A GA attempts to develop a solution using a population of potential solutions. Each solution has a fitness value associated with it.



Genetic Algorithm structure



Production diagram of a t-shirt;
(OL: Overlock sewing Machine,
OE: Overedge Stitch sewing Machine,
LS: Lockstitch sewing Machine)

Problem Description

The following notation is used to search for the optimal operative assignment for an apparel assembly process:

W set of workstations {1, 2, . . . , w}
T set of tasks {1, 2, . . ., t}
O set of operators {1, 2, . . . , o}
S_j set of workstations that are able to handle tasks j
x_{ij} workstation state variable
SI_n skill inventory, which represents the number of tasks
that each operator can handle
a(i) task skill level of operator i (i = 1, 2, . . . , o)
T_i set of tasks which can be carried out by operator i
E_i set of efficiencies which operator k achieves for handling different tasks in T_i
ST_j standard time of task j, which is the time to complete task j
with 100% operator efficiency
PT_j processing time of task j by operator i

Coding and Initial population

In this paper, integer chromosome representation is used. In an integer string, each gene represents the skill level, $a_i(i)$, i = 1, 2, . . ., n, of each operator's current task, and the length of the chromosome is the number of operators. Therefore, the whole genetic code which represents all operators' task skills is shown by the following equation:

$a_h = [a_h(1)\ a_h(2) \ldots a_h(o)]$

Fitness Function

The fitness score assigned to each individual in the population depends on how well that individual solves a specific problem. In this line balancing optimization problem, minimizing operator idle time, which is equivalent to makespan minimization, would be the prime objective. Let P denote the set of feasible solutions. For a given sequence a ∈ P, fitness Φ(a) can be defined as:

$$\Phi(a) = T_{target} / T_{makespan(a)}$$

Conclusion

In this paper, genetic algorithms (GA) are used to optimize the operator assignment so that overall idle time, and thus makespan, can be minimized. The proposed method re-adjusts the operator assignment at fixed time intervals according to the most updated production status.