# OPTIMAL 2D BOARD CUTTING USING GENETIC ALGORITHM

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**ABSTRACT**

The problem of two-dimensional shredding is important in the industry as it aims to reduce waste and waste materials resulting from the manufacturing processes carried out by the individual or the company. The importance of this matter pushed researchers and engineers towards this matter greatly This research resulted in many hypotheses and methods that could help us in solving this dilemma Perhaps the most important thing that has been mentioned in this field is the methods of research and deducing the relationships between the cut materials and finding a satisfactory solution that meets the business needs in a short time and cost. The genetic algorithm has been adopted with the formula for displaying the rectangles and arranging them in a large slab in an optimal way to find the best positioning of the pieces.

**KEY WORD:** Two-Dimensional Stock Cutting Problem(2DSCP), Cutting Pattern, Rectangle-packing Problem, Genetic Algorithm.

## 1. INTRODUCTION

### 1.1 Background

The problem of cutting rectangles means that we distribute these rectangles on large plates in a regular and accurate manner in order to obtain the least possible waste resulting from the distribution of these rectangles on the plate. This problem is not a newcomer today, but they began to study it a long time ago, but they could not find a logical distribution using the traditional research methods because of the large amount of data that is based on addressing this problem, so they moved from linear programming methods to programming by genetic and evolutionary algorithms, The traditional methods could not find a sufficient solution to this problem, which led them to rely on guessing functions that reduce the time required to implement the processing. This idea was a starting source for many researchers and engineers to focus their efforts to develop algorithms that work with high efficiency (Malaguti et al., 2014).

The issue of packing for rectangles has become a wide application at the level of industries in the world to enter into application in the papers and industries, aluminum and glass, and even floors, in addition to stones, The nature of this issue is that it gives a large number of variables that negatively affect the performance of the algorithm as a whole and produce the best possible distribution of rectangles. In the past, these issues were known as Hilton, in relation to the first to develop a true description of this problem

Subsequently, the research continued, and the desired goal became in the methods of estimating this issue(Leao et al., 2017).

### 1.2 Research Motivation

It is relatively easy if we were to cut one board or use one shape to cut and repeat it on many boards, but what usually happens is otherwise. Because the required quantity of each serving is different, we need to use multiple slicing shapes. (Aksu & Durak, 2016). This is what makes choosing the optimal solution by trial and error almost impossible, this problem is considered one of the difficult issues to calculate by manual methods and they have entered into many industrial fields.(de Queiroz et al., 2012)

Support the industrial sector with advanced software to design the system and display the optimal results for cutting as reports and two- and three-dimensional geometric shapes. Achieving a real-time issue in terms of providing geometric shapes that show the optimal slicing result for each.(Kallrath et al., 2014)

Two-dimensional raw material separately for a single product or for an order Relying on the corners of the vacant areas to reserve cutting positions on the board instead of a mechanism, Slide the pieces until they are stable on the board.

### 1.3 Problem statement

This problem is characterized by the following: The main concern is to reduce the waste of metal while neglecting other losses such as machine tuning losses Minimum Widths Required When a roll is cut crosswise, the entire roll must be cut, meaning that we may need to cut the roll crosswise to form rolls of a specific weight. When cutting transversely.

We can only cut with the width of the entire roll. What is required is an integrated solution that consists of:

creating cut shapes, choosing cut shapes and determining the number of rolls that are cut in each shape, and determining the number of rolls required, the required quantity may decrease or increase within the limits of what is contracted.

This article will review published studies that consider solving the 2D Cutting Stock problem (2DCSP) as well as propose a heuristic method for solving this problem based on a genetic algorithm

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## 2. LITERATURE REVIEW

(Pierini & Poldi, 2021) developed a formulation that tries to minimize production costs, setup, inventory, and waste costs while also taking into account restricted capacity in the manufacturing process. The authors used two heuristic solution approaches based on LaGrange relaxation to tackle the problem. (Sarper & Jaksic, 2019) explored two linear programming models to reduce total cut paper length and overproduction, and proposed a heuristic solution strategy based on the impex method, which comprised the simplex method with column construction and a rounding heuristic mechanism. procedure ((L. T. Oliveira et al., 2020)) was the first to provide a pattern-based solution to the Stock Cutting problem (Cherri et al., 2014).
This formulation has a unique structure that classifies it as a column-dependent-rows problem, a type of problem developed by (Kwon et al., 2019). Gilmore and Gomery (Mobasher & Ekici, 2013) also looked at the k-staged form of the problem, as well as boards of various sizes (see Figure 1).
In the instance where boards of various widths are available and item demands vary widely, (Furini & Malaguti, 2013), (de Armas et al., 2012) looked at a variety of 2D Cutting Stock Problems involving guillotine cuts and its variants in which orthogonal rotations are allowed and boards of various dimensions are offered the first pattern-based solution to the Stock Cutting problem was proposed by (Silva et al., 2014).
This formulation has a distinct structure that distinguishes it as a column-dependent-rows issue, a kind of problem popularized by (Delorme et al., 2016)

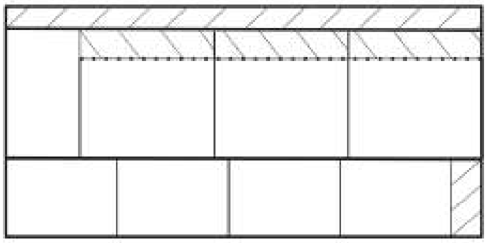

**Figure 1**. Guillotine cut

Gilmore and Gomery (W. A. Oliveira et al., 2021) looked at the issue in its k-staged version as well as boards of various sizes (see Figure 2). (Parreño & Alvarez-Valdes, 2021) looked at a variety of 2D Cutting Stock Problems involving guillotine cuts and their variants in which orthogonal rotations are allowed and boards of various dimensions are offered in the case where boards of various widths are available and item demands vary widely.

## 3. PROBLEM DESCRIPTION

The cutting plan that consists of 3HL patterns, in which a set of m types of rectangular items are cut from stock plates of dimension L⊗W, with each item type I ∈ I= {1…, m} having a length li, a width $w_i$, a demand di, and a value vi. If the thickness of the saw is not specified, we presume that, Otherwise, the saw thickness is added to the plate and item dimensions.

### 3.1 Pattern generation

The researcher (Berberler et al., 2011) implemented the algorithm based on the upper left corner. For the vacant area of the board, it is the greedy algorithm, whose idea is to apply the principle of shearing from One edge of the board to the other edge (guillotine) where the longest piece is chosen and placed on the board, so that the upper left corner of both the board and the piece matches, then the board is cut along the edge.(Muter & Sezer, 2018) The right of that piece placed and from one edge to the other edge of the board and then the remaining pieces are selected, descending according to the lengths and placing them in the vacant area that best suits them. (In Figure 2), This process continues until it is completed,

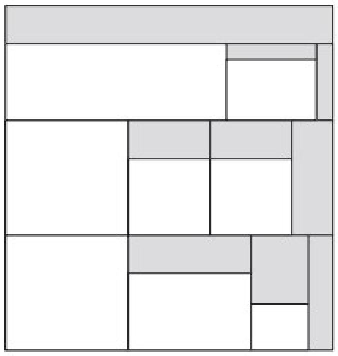

**Figure 2**. An illustration of a full-pattern

then put all the pieces and then small damaged pieces scattered are obtained.

The Pierce algorithm now enables the production of complex patterns from and more optimized for the positioning of rectangular pieces on the board. In addition, it significantly reduced the wastage compared to similar methods.

### 3.2 The Genetic Algorithm

Genetic algorithms are designed to fit the idea of slicing, The chromosomes of the first generation are randomly arranged by randomly arranging the cut-off symbol.
The first chromosome is arranged in descending order of length, Then the target function is calculated for each chromosome, The least number of panels and the least available space is the best solution for one generation.
Primary solutions: are the solutions that are created in order to find subsequent solutions that affect the optimal solution,(de Armas et al., 2012) each bit of these solutions, called a gene, contains the data of the rectangular segment, Merging and mutation are two methods of generating new solutions that depend on a specific ratio and a specific methodology that is fully explained by(Jagadish, 2015).

## 4. CONCLUSION

A two-dimensional panel cutting system, considered an optimization problem, was built. It is difficult to solve this problem using traditional methods of optimization. The high number of orders received by factories prevents that throughout the working hours and days. A modern virtual cutting system was used to achieve optimization by adopting intelligent techniques. We chose a genetic algorithm for its suitability for solving this problem.

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