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Formation of the Guillotine Cutting Card of a Sheet by Guillotine Layout Functions

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Abstract—An extension of the concept of the guillotine layout function has been proposed for solving the problem of rectangular orthogonal packing; this extension is a function that assigns a triple of values to the sheet width. In addition to the standard effect for the guillotine layout function (the sheet with a given width has a minimum length), which is sufficient to arrange a given set of rectangles in a guillotine manner, two additional values have been used. They describe the method of cutting this sheet to uniquely form a guillotine cutting card and a guillotine layout card of the set of rectangles. These data involve the characteristics of the first cut of the sheet as well as the partition of the set of rectangles corresponding to the cut into two subsets, which is uniquely determined by the number of one of these subsets. The description of the first cut is modeled by a single numerical value that reflects both the size of the offset from the lower-left corner of the sheet and the orientation of the cut: a cut is required along or transverse of the sheet. It has been shown that this information is sufficient for the recovery of the guillotine cutting card and the guillotine layout card for a set of rectangles. Modifications of the algorithms for calculating the sum of two right-semicontinuous monotonically nonincreasing step functions with a finite number of steps and the minimum of two functions of this type have been proposed to determine additional information about the first cut and calculate the extension of the guillotine layout function. Also, an algorithm for the formation of a guillotine cutting card and a guillotine layout card for rectangles has been proposed that uses the calculated extensions of guillotine layout functions for all subsets of the required set of rectangles.

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INTRODUCTION

Problems of rational cutting of materials have long attracted the attention of theoretical and experimental researchers [1–3]. Generally, these problems can be formulated in the following way: there is a material of a given size (such as boards, pipes, sheets, and rolls) in a limited or unlimited quantity as well as a cutting order, i.e., a list of details with specified forms, sizes, and required quantities of each type of the details. The problems are divided into linear, planar, and three-dimensional cutting types. The problems of linear cutting have been well studied, and there are methods ensuring an exact solution for many practically important cases. The situation is much worse for problems of planar and three-dimensional cutting. As noted in the review [4], even for problems of cutting of sheet or roll materials to rectangles, most studies address the development of heuristic algorithms, which is due to the NP-complexity of these problems. Rather interesting heuristics can be found in [5, 6]. Among domestic developments, the constructive heuristics published in [7, 8] can be mentioned.

It should be noted that a special case of sheet or roll cutting to rectangles is the technologically driven class of guillotine cutting problems. For the case of the guillotine cutting, there exists an exact algorithm for the guillotine cutting card of a sheet of a maximum total value (see [9–11]), which is

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