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Problem 3. Optimal Cutting Problem

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Company's overview. STOBET is a structural engineering bureau that was set up in 2003 in the city of Sofia by Georgi Evtimov Evtimov. Since its very start the bureau has been dealing with structural design of buildings and facilities. The bureau designs a variety of structures: reinforced concrete, metal, wood and – recently quite often – combined types of structures: steel and reinforced concrete, metal and wood. Combined structures provide very flexible and cheap solutions.

Definition of the problem. Making the project by part "Constructions" contains many drawings. Plotting the project – drawing by drawing – is a laborious work, which is repeated for each printing. The number of drawings can reach 700-800 numbers in one project. For this reason it is necessary to arrange all "small" drawings in the "big" paper in the plotter with a minimum wastage of paper.

Task for optimization

Task 1. We have a large piece of paper $X = 1000$ mm, $Y = 15000$ mm. In this paper many small rectangles (drawings) with dimensions (a_i, b_i), $i = 1, \ldots, n$ should be arranged (see Fig. 1). The goal is to arrange the rectangles in such a way that they fill the entire width of the paper (1000 mm) and use the least possible length of the sheet (i.e. the rectangle that contains all the small drawings has the least possible length). In the process of arranging the "small" rectangles (drawings) can be rotated at any angle (0, 90, or any).

Task 2 (Linear cutting). We have in stock N pieces of rods with section X and length L meters. After the design is given, we need to obtain M_j rods with section X and lengths P_j meters, $j = 1, \ldots, m$. The question is how to combine the rods available so that the minimum possible spolage is obtained.

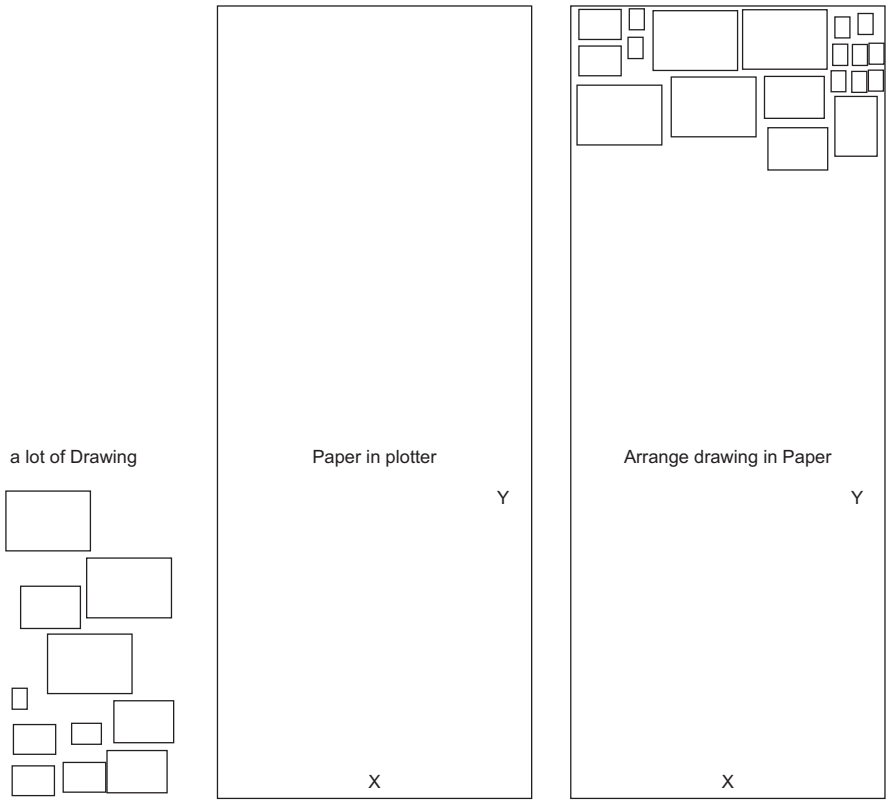

Fig. 1

Example

We have in stock $N = 12$ pcs with section $X =$ IPE200 and length $L = 12000$ mm.

After the design we have to obtain $M = M_1 + M_2$ profiles with section $X =$ IPE200:

1. $M_1 = 18$ pcs with length $P_1 = 7350$ mm,
2. $M_2 = 53$ pcs with length $P_2 = 121$ mm.

The width of cut is 5 mm.