

CUTTING STOCK OPTIMIZATION PROBLEM FOR PRODUCTION OF CARTON BOARD BOXES

María Analía Rodríguez* and Aldo Vecchietti**
INGAR – Instituto de Desarrollo y Diseño
UTN-CONICET

Avellaneda 3657 – Santa Fe – Argentina

*e-mail: r_analia@santafe-conicet.gov.ar - **e-mail: aldovec@santafe-conicet.gov.ar

Problem Statement

Raw material to produce board boxes consists of a set of paper reels having different properties and size depending on the board needed in the final product. Paper rolls of different width and lengths provided by several suppliers are employed to produce the corrugated board and cut the sheets.

The corrugated board is composed by several paper layers. There are two main kinds of layers: liner and fluted. The board structure and its physical properties are mainly influenced by the number of layers and the paper type selected for each one. The most used boards in the industry are the *single wall*, that it is a rigid structure, which has two external liner layers and one middle fluted and the *double wall board*, which is also a rigid structure, formed by three liner layers, two external and one central, and two fluting layers located between the others.

Corrugated sheets are produced in a special machine called the corrugator, which first glues the paper layers to produce the board sheet, and then it goes through the cutting section where board sheets are finally obtained. Figure 1 shows this process.

The cutting machine has N_{long} knives to cut the boards lengthwise and N_{trans} knives for the transversal cuts. Those characteristics limit the number of different sheets to cut per time and therefore the number of orders to produce at the same time. Using N_{long} knives $N_{long}+1$ board parts are obtained; the two external ones must be discarded because the layers are not perfectly glued. This allows the cutting of at most $N_{long}-1$ sheets per wide and for limitations in the cutting process it has a minimum trim-loss value (*permin*). The N_{trans} knives limit to N_{trans} the different lengths to cut. Fig. 2 shows a corrugator with five longitudinal knives and two transversal ones, a machine with these characteristics is able to produce board sheets with different type of cutting patterns as follows:

1. Patterns corresponding to a single sheet order: the possible number of sheets to cut varies from one to four; the final value depends on the order and the paper reels width used in each layer. A sketch of this pattern type can be observed in Figure 3.

2. Patterns 1-1: corresponds to two sheet orders having different width and length. When combining sheets of different orders both of them must be of the same board type. In this case

only three of the slitting knives and two transversal ones are used. A scheme of this pattern type is illustrated in Figure 4.

3. Patterns 2-2: these patterns have two sheets of one order and other two of a different one; it is shown in Figure 5.

4. Patterns 1-2: these patterns cut a sheet of one order and two of another one, which is illustrated in Figure 6.

5. Patterns 1-3: these patterns cut a sheet of one order and three of another one. A representative scheme of this pattern type is shown in Figure 8.

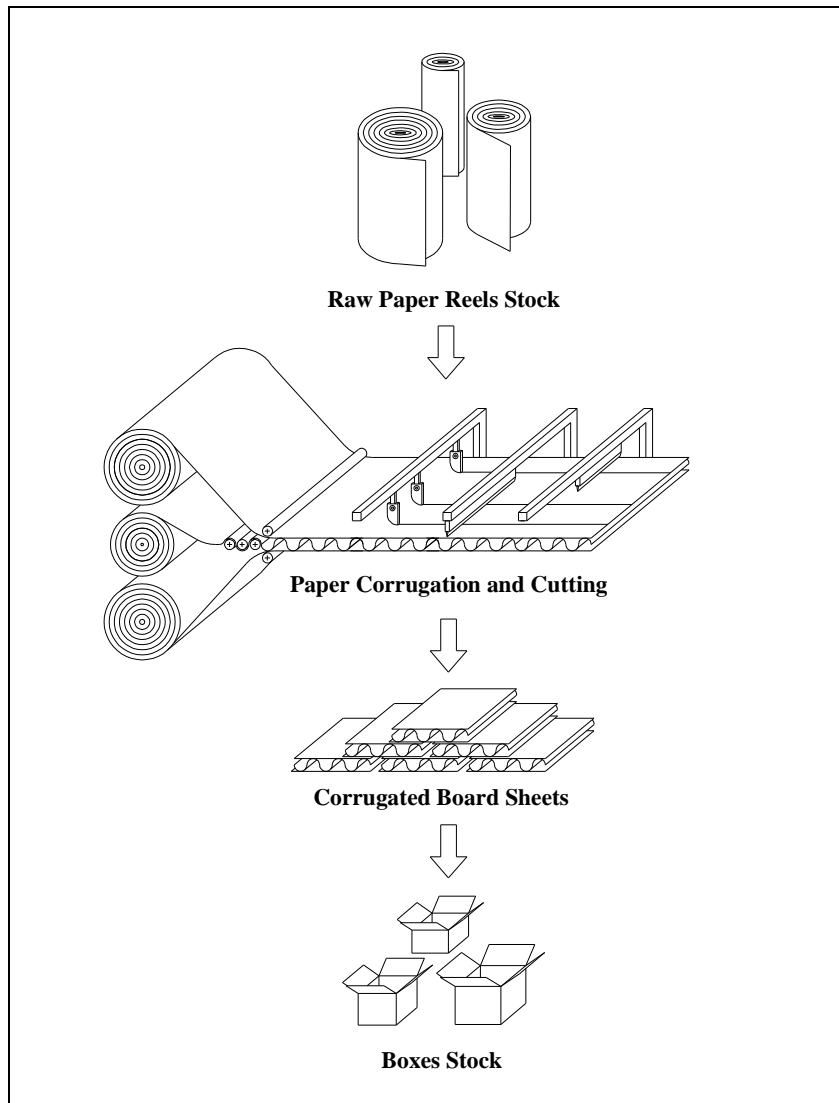


Fig. 1. Board boxes production process.

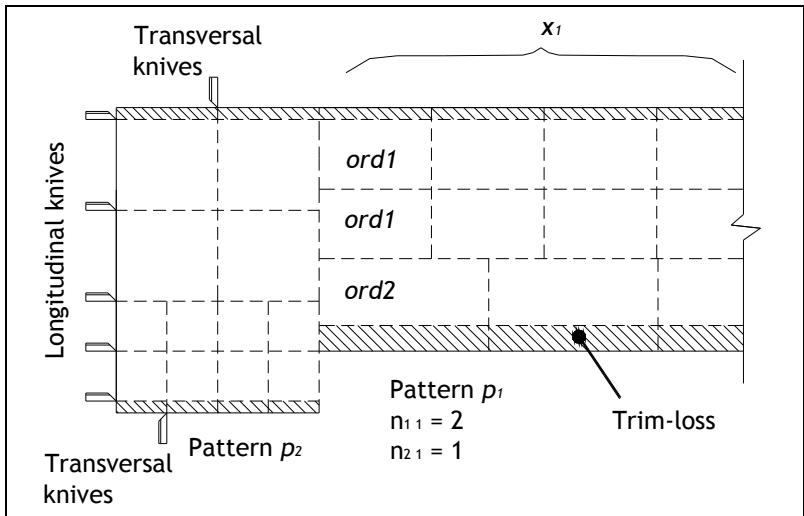


Fig. 2. Cutting process.

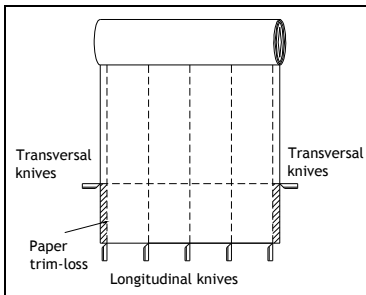


Fig. 3. Patterns with same order sheets

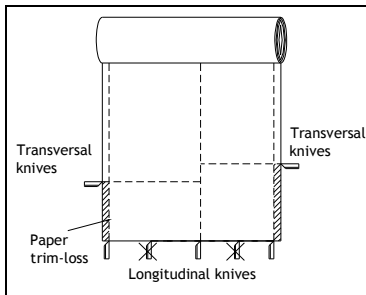


Fig. 4. Pattern type 1-1

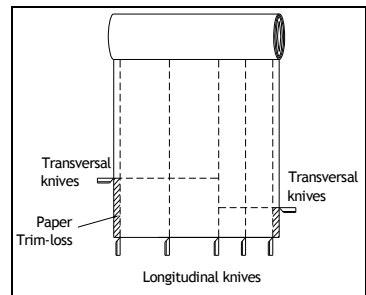


Fig. 5. Pattern type 2-2

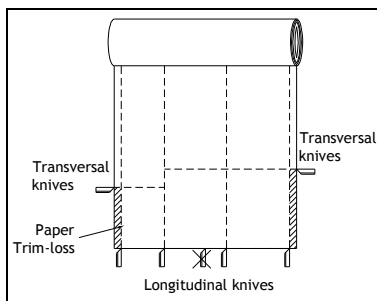


Fig. 6. Pattern type 1-2

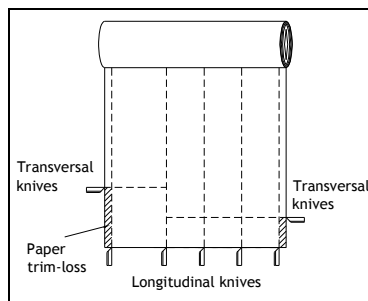


Fig. 7. Pattern type 1-3