CUTTING STOCK PROBLEM: SOLUTION BEHAVIORS

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ABSTRACT

Many products are produced in rolls or sheets, are cut into sizes required by the client. The paper describes possible solution to reduce row products from the cutting process losses. This problem is a known problem in the science of operations research to Cutting Stock Problem, a problem is not simple to solve, also known as the problem of autopsy Coil Slitting Problem. This problem has many forms, there is cut in one dimension, and there is cut in two Dimension like cutting cloth or paper, to cut rectangular and these are more complex. This article touch on the application you have done to reduce losses to the problem of cutting in one dimension.

Be relatively easy if we will cut off the panels and one or we will use one form of cutting and repeat on many boards, but that usually occurs is not. Result because the required quantity of each show is different from the other, we need to use multiple forms of hacking. This is what makes the selection of the optimal solution by trial and error almost impossible.

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Keywords: *Autopsy Coil Slitting, Cutting Stock.*

1. INTRODUCTION

The Cutting Stock Problem (CSP) is an integer linear programming problem, and to overcome this problem, save the world hundreds of millions of dollars annually, and there is no standard certain resolve this problem and you there is an agreement to create such a thing as the best solution minimized optimization and maximized optimization, and had to be to identify innovative ways of linear programming as a way of simplex method, which helped a lot in finding the best solution in the process of cutting the stock.[1]
This problem is a known problem in the science of operations research to Cutting Stock Problem, a problem is not simple to solve, also known as the problem of autopsy Coil Slitting Problem. This problem has many forms, there is cut in One Dimension such as hot rolled coils and sheets of wood, and there is cut in Two Dimension like cutting cloth or paper to cut rectangular and these are more complex. Here will be offered a one-dimensional problem and will address the application you have done to reduce wastage of the problem of cutting in one dimension.
Suppose that the product in the form of panels and display each panel is 600 cm, and customers is required to view the 200 cm and 360 cm display. If we cut these requests of the panels produced, we would go 560 cm 600 cm, it remains cut view 40 cm. This may be very small and will not offer one had asked. In this case, we lose 40 cm from each panel puzzle. In this example we can not do anything to reduce waste, but in fact, we have many different applications for different offers and we determine how to cut so that to reach the minimum value.

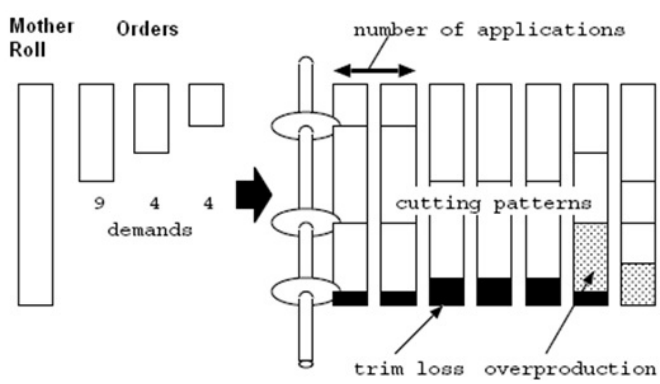

Fig 1: An instance of one-dimensial cutting stock problem [2]

Initiated research on this issue before more than 45 years has been more than a formula to resolve the problem of cutting inventory, has been preparing a lot of research on this topic. In the simplest picture of the problem of cutting inventory is one-dimensional. [2]
As shown in the drawing, we need to reduce the size of the pieces lost to as little as possible and as soon as possible, and that the problem of cutting stock has some characteristics, which make it difficult to solve, and some solutions are not general but in particular to a specific situation, and these characteristics:

- Limited lengths available in the store: the lengths of pieces available in limited and sad 60 cm, 80 cm., 100 cm. - In some Orders may not be available a certain length, although this length is best suited to solve the problem, so it should not take this length into account in the process of resolving the problem.

- - Order Customer: the customer may be asked different lengths are not available in the store the same lengths, and often what happens, it sends the customer to the factory Talpeth different lengths and quantities are also different.

- - The process of storytelling: storytelling in the process there is a part of the piece goes along in the process of storytelling during the respective cut by machines, although these parts are simple in length does not exceed a few cm in but I need to be taken into account in calculating the cutting process, known as the problem of cutting the stock.

- - Cm lost: while searching for the ideal solution to solve this problem of cutting stock would have to lose a portion of the lengths to reach the optimal solution, so to find a solution to the problem of cutting inventory must identify the length lost, which cannot be bypassed.

- There is no optimum solution: may find that there is no optimum solution in very rare cases, these cases may address the problem of cutting stock to infinite loop.

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2. LITERATURE REVIEWS:

Many papers working on the one Diminution cutting stock problem, the papers may express some of them as follows:

2.1 The Delayed Column-Generation Technique (Gilmore and Gomory, 1961). [1]

First try to solving this problem was accomplished in1961 by Delayed Column Generation Technique (Gilmore and Gomory).
Assuming that DM be the required numbers of retail items lm

Where m {1,…,M} to be cut from stock length Lk
k   {1,…,K} and the number of stock k is unlimited,
Ck can be the cost per unit of the stock.
Length k, Xkp can be the numbers of times at stock k and patterns p where p {1,..,P}.

For the stock size k with a length Lk a cutting patterns (p) indicates how times each order length lm has to be cutting off from the stock size. Any feasibility cutting pattern p for stock size k could be represented by M-dimensional (may by more then one dimensional) a nonnegative integer vectors, fulfilling This model could be formulated as Integer Linear Programming (ILP) model with objective that minimize the total cost of all stock lengths founded.
Important hint that the sum of all cutting patterns must be less then or equal the sum of original patterns that founded in stock, or the formula well be fail, and give wrong results and more complexity.

2.2 Sequential Heuristic Procedure (SHP). [1]

The Sequential Heuristic Procedure (SHP) (Gradi ar et al., 1999) is a neighborhood search for a local optimum defined as z(C) that in a sets of feasible solutions that's defined as N(C). The steps can be described as following:

1. Generating the initial feasible solutions Cinit with objectives z(Cinit)
2. Let C* = C initial and z(C*) = z(Cinit)
3. Find z(Cs) such that z(Cs) = min{z(C):CN(C)}
4. If z (Cs) <z(C*) then C* = Cs and z(C*) =z (Cs) else terminated the procedures and C* and z(C*) are the solutions and the objectives of The Sequential Heuristic Procedure SHP, respectively.

In this cases, to determined Cs from the step 3 of the above steps procedure, solving the continuously relaxation of one diminution cutting stock problem (1D-CSP) is determined and searching for a cutting patterns that is minimized as can as possible in an. ascending orders. Hence, the cutting patterns must be added until the demands of all that's required items are fulfilled. After that, the one diminution cutting stock problem is decomposed into sub-problems, called new pattern procedure, new patterns generate sub-problems. These sub-problems apply the Column-Generating Technique to the search that essential cutting patterns for this problem.

3. SOLUTION WAYS:

3.1 Factorial:

Solve the problem of cutting inventory starting to solve a number of ways in the beginning it was resolved by using factorial, where he is to use possibilities to resolve the problem as follows:

$$\frac{m!}{k!(m-k)!}$$

- Is to know the available stock in warehouses.
- Knowing the lengths available in stores.

As well as knowledge of customer order and content of length
How many are there? (|i|a) = |i|!a!(|i|−a)! , i.e. a lot !
Where: |i| is the number of different types (lengths) required
Where: a is the average number of cut sizes in each of the patterns. [2]

This is a very real problem: Even if we had a way of generating all the legal cutting patterns, our standard simplex algorithm will need to calculate the "efficient" variables, but we will not have memory to contain the variables in the algorithm.

3.2 linear programming:

Linear programming problem may be defined as; a problem of maximizing or minimizing.

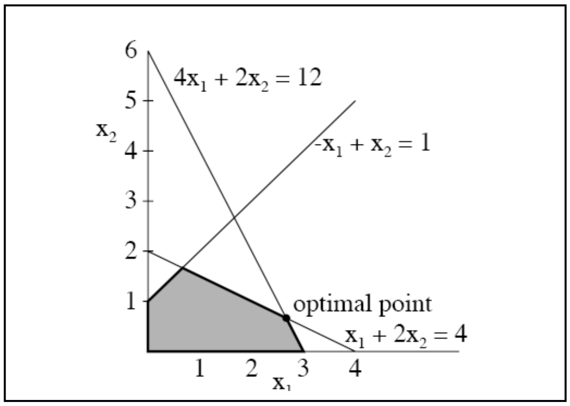
Ideal problems; often come in the form of words, and determines the method of solution in portray, the problem in the form of a mathematical model reflects the problem, and then solve this model different methods. And can follow the steps below to build the mathematical model. 1) Select the quantities that you need to twice the values. And defined as a variable to take the symbols x1, Xn. 2) known to target the problem and expressed mathematically using variables. 3) Select and such as restrictions in the form of inequalities, using the variables. 4) Add to the mathematical model on condition that the negative (that all variables must be greater than or equal to zero).

Linear function, subject to linear constraints, that these constraints may be equalities or may be inequalities. Here is a simple's example.
Find number x1 and number x2 that maximize the sum of x1 + x2 subject to following constraints:

$x1 \geq 0$, $x2 \geq 0$, $x1 + 2x2 \leq 4$, $4x1 + 2x2 \leq 12$

As see in this problem there are two unknowns defined, and five of constraints. All the constraints as show are inequalities and they are all of them linear in the sense that each involves the inequality in some linear function of variables. The first two constraints; the $x1 \geq 0$ and the $x2 \geq 0$, are specialist. These are called non negativity constraints and are always found in linear programming problems. The other constraints are then called main constraints. The function to be minimized or maximized is called the objective function. Here, the objective function is x1 + x2. [4]

That is easy to see in general way that the objectives function, being linear, always takes on its maximum or minimum value at a corner point of the constraint set, provided the constraint set is bounded. Occasionally, the maximum occurs along an entire edge or face of the constraint set, but then the maximum occurs at a corner point as well. [4]



3.3 The Simplex Method:

Simplex method is economic viable in this regard to their ability to deal with a large number of variables and a simplified manner.

The problem is resolved by using the simplex method designated by a number of steps aimed at the rank of staff identified for the possible solutions. And assess the revenue from each corner, and move from one corner to another best of it until a corner - or solution -which deliver the best possible return: -

- First: the formulation of the problem mathematically.
- Second: The conversion of variants to the equations.
- Third: Show the objective function and constraints as well as the equations in terms of all the original variables and inactive.
- Fourth: create a table simplex.
- Fifth: Steps To repeated and completed within a table up simplex and to solve optimization.

In the Simplex method that a method that proceeds from one BFS or extreme point of a feasible region of the LP (Linear Programming) problem expresses in tableau form to another BFS , in such a way as to continually increase (or decrease) the value of the objective functions until the optimality is reached. The simplex method moves from the one extreme point to one of its neighboring extreme point. Let consider the following Linear Programming in feasible canonical form. That is mean its right hand side vector

$b > 0$: [4]

$$\min \quad z = \sum_i x_i$$

$$\text{s.t.} \quad \sum_i a_{ij} x_i = b_j , \quad j = 1,2,..m$$

$$\sum_{j=1}^{m} a_{ij} l_j \le l \ , \quad i = 1,2,...$$

$$b_j > 0, \ a_{ij} \ge 0, \ x_i \ge 0$$

Where non-negative integer vector

$$P_{i,l} = (a_{i1}, a_{i2}, ..., a_{im})^T$$

If suppose that we can not solving this problem easily because there is at least one as see negative entry on the last column or in the last row, “exclusive of the corner”. Let us pivot about a11 (Let suppose a11 _= 0), including that the last column and last row in pivot operations. We can obtain this tableau: [5]

	x_1	x_2	$\cdots$	x_s	$\cdots$	x_n	x_{n+1}	$\cdots$	x_{n+r}	$\cdots$	x_{n+m}	b
x_{n+1}	a_{11}	a_{12}	$\cdots$	a_{1s}	$\cdots$	a_{1n}	1	$\cdots$	0	$\cdots$	0	b_1
x_{n+2}	a_{21}	a_{22}	$\cdots$	a_{2s}	$\cdots$	a_{2n}	0	$\cdots$	0	$\cdots$	0	b_2
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$
x_{n+r}	a_{r1}	a_{r2}	$\cdots$	a_{rs}	$\cdots$	a_{rn}	0	$\cdots$	1	$\cdots$	0	b_r
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$
x_{n+m}	a_{m1}	a_{m2}	$\cdots$	a_{ms}	$\cdots$	a_{mn}	0	$\cdots$	0	$\cdots$	1	b_r
x_0	$-c_1$	$-c_2$	$\cdots$	$-c_s$	$\cdots$	$-c_n$	0	$\cdots$	0	$\cdots$	0	0

Here is xn+i, i = 1 …. m that are the slack variables. Then the original variables xi, i = 1 …. n are called the structural or decision variables. Since all bi ¸ 0, we can read it directly from the table a starting. [6]

4. CONCLUSION

This step aims to synthesis all possibilities of cutting possible regardless of the value of waste. They may ask why we take into account the forms of cutting losses very high. The reason is that we aim to reduce the total losses. It may be the best solution is to carve the fifty panels very few waved one large. In this case, this solution will not be selected unless the form of cutting a big waste be taken under consideration at all. In spite of that it is possible to determine the maximum value allowed in the form of cutting, so we neglect any forms within this limit.

Thought the beginning of the creation of forms of objects can be any style manual trial and error, but I discovered that this is very difficult as the number of possible forms may amount to hundreds of permutations according to the laws.

Reasons for the success of this application is great cooperation shown by the users of this application were almost daily discussions with us to reach an appropriate solution and easy to use is the cause of my ability to develop the solution. At first I was surprised that the wonderful jewelry seems difficult to use and it is not suitable for reality of the problem. Began to change; in the way the solution to suit the particular circumstances of the problem. And began to improve the way the data entry and display the solution to be easy and understandable. With improvement and come to a satisfactory.

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