D-PCO

Plate Cut scheduling Optimization

BENEFITS

Deterministic monitoring of defect presence in plate production

Minimization of scrap material

Efficient feedback to the operator and fast decision-making

Reduction of plant stoppages preceding production exceptions

PROCESS

A possible layout of a Plate Finishing Area (PFA) is depicted in Figure 1. In the PFA, the motherplates are processed first by a Hot Plate Leveler (HPL) to regularize flatness, and then they are quick-cooled through suitable cooling beds, or slow cooled in a storage area before the subsequent finishing processes.
The cold mother plates are subject to visual inspection, wherein the detection of possible external defects is performed manually while the detection of possible internal defects is performed automatically through a possible Ultrasonic Testing Sensor (UTS). Another source of automatically detected defects are profile measurement devices based on X-Ray and plan-view sensors, based on cameras capable of measuring the rectangularity of the plates.
Defects are collected together with their co-ordinates, extension and severity evaluated according international standard classifications.
Cutting of mother plates into daughter plates is preliminarily planned before the defect detection process. After the defect detection, the cutting schedule needs to be re-planned in order to avoid the presence of some unacceptable defects in the final products, in this way minimizing the amount of wasted material and optimizing the quality.

EQUIPMENT

The feedback collected from the UTS is exploited by an optimization technology based on advanced solution optimization engines, referred to as Mixed-Integer Linear Programming (MILP) technologies.
A MILP problem is an extension of LP (Linear Programming) where some of the decision variables are additionally required to be integer, where these integer variables can be exploited to represent typical production decisions to be optimized. The mixed-integer solver is equipped with a pre-processing engine and cut generation algorithm. Pre-processing is useful to reduce the scope of problems, thus keeping the computational effort at acceptable levels. The introduction of cuts allows quickly eliminating non-integer feasible regions. A generic MILP can be formulated as follows: given matrices A_1, A_2 and vectors f_1, f_2, b, the general MILP is given by

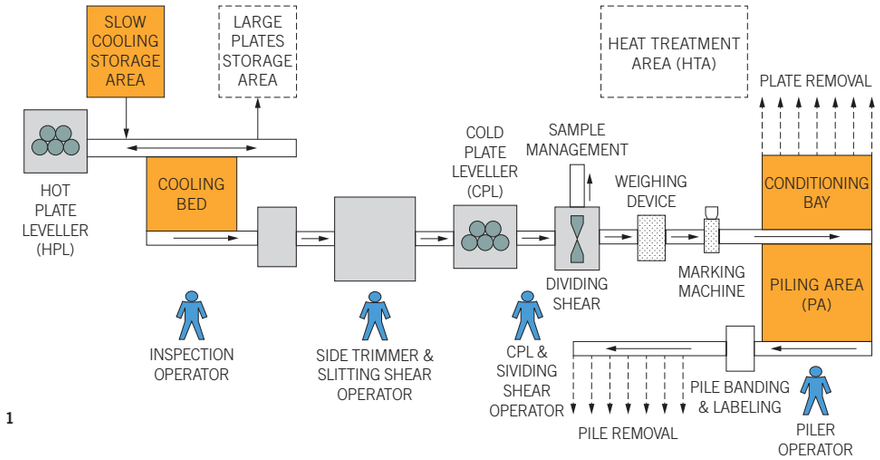
$$\min_{x,z} f_1^T x + f_2^T z$$

subject to :

$$A_1 x + A_2 z \leq b$$

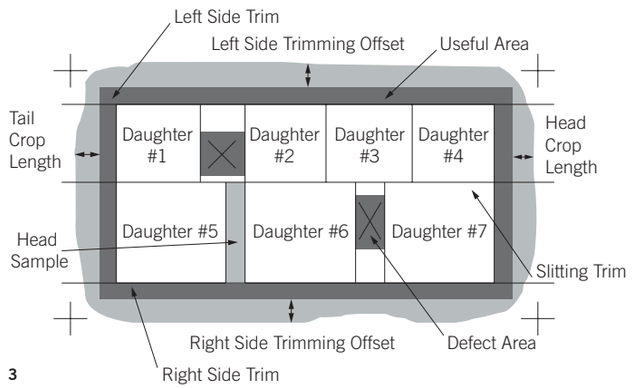
and z is integer.
Such systems can be exploited to optimize the cutting plate of a mother plate knowing its dimension, the selling production program and the presence of defects to be eliminated (see Figure 1).

1 Typical plate finishing Area (PFA) layout.
2 HMI for cutting decision making of a mother plate.
3 Example of mother plate cutting program.



1

2



3

PERFORMANCE ACHIEVEMENTS

The mother plate cut-schedule optimization problem can be faced with modern optimization technologies guaranteeing deterministic mistake avoidance and fast decision making. In a typical case with 10 daughter plates to be realized from a mother plate, the computation is always limited to a few seconds (less than 5 seconds), giving to the operator an efficient and fast tool for plate production.
The obtained optimized result is the proposed to the operator though a suitable HMI, as illustrated in the example proposed in Fig. 3.