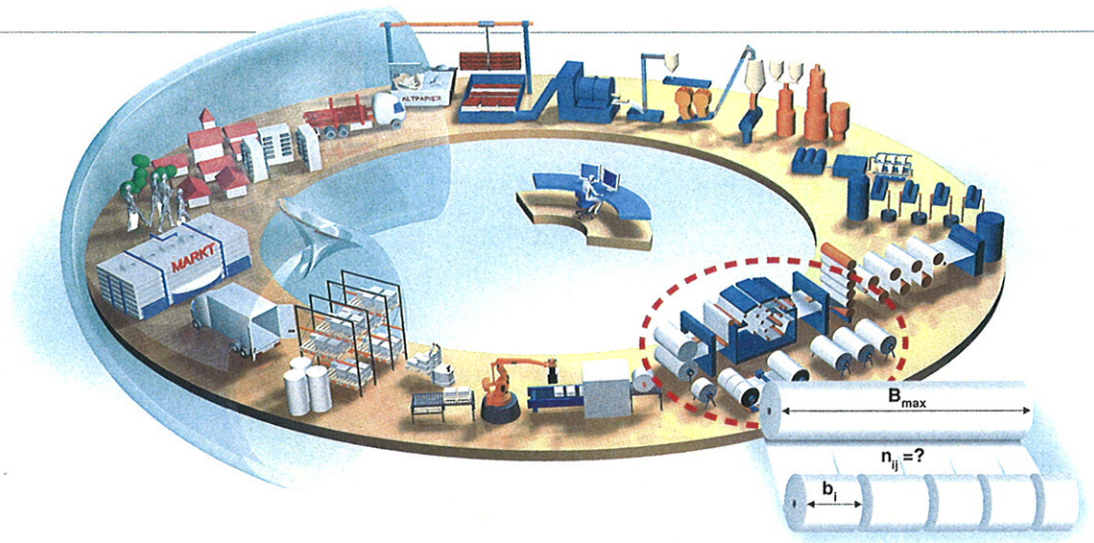

A new equation for quality-based re-trimming optimization

ABB has developed a new solution for roll cutting. This quality-based Re-Trimming Optimization Solution is based on new mathematical models resulting in less waste.

The primary objective for cutting problems in paper production is trim loss minimization. A typical example is the cutting of a wide paper reel (jumbo-reel) into smaller paper rolls, which are either end-customer rolls or intermediate products waiting for further processing, such as printing, coating or cutting. The main objective is to produce the required roll widths using as little material as possible, i.e. minimizing the trim loss. Secondary objectives are minimization of the number of cutting patterns or the knife-setup actions.

Problem in trim-loss

The standard trim-loss problem is a discrete problem due to the fact that only an even number of rolls can be represented in reality. Because of this, the problem size explodes easily with the number of rolls considered. Consequently, there exist lots of heuristic-mathematical approaches to solve the problem efficiently but not guaranteeing a global optimal solution. These include rounding heuristics, column generation and other knapsack-type of algorithms

In modern paper mills, the trim-loss problem for the paper machine/winder is solved as an integrated part of production planning already long before the jumbo-reels are actually being produced. During the papermaking process, product quality data is collected from various on-line measurement devices.

Currently, the typical workflow is as follows:

- Before production: Optimal cutting patterns are determined assuming uniform quality distribution
- During production: Quality Management and Web Inspection Systems perform quality analysis for jumbo reels with on-line sensors
- After production: If quality defects are encountered, the reels need to be manually re-trimmed to guarantee quality requirements for customer orders

In case of quality deviations, the predetermined cutting plan may be far from optimal. For instance, the most valuable customer roll might have been assigned to the worst position with respect to product quality of the reel and must thus be rejected. Many providers of trim optimization packages/solutions allow the user to perform a quality check on the trim solution and to manually adjust cutting patterns to better meet the customer requirements and to react to quality deviations or defects. However, the available time for doing manual changes to the cutting patterns of a large number of jumbo-reels operations is often very limited.

Most of today's existing modeling approaches for trim optimization are not able to meet the requirements for quality-based re-trimming. Therefore, a modeling approach was developed, which is able to map the measured quality to the requirements of each customer roll.

Benefits

By solving the re-trimming problem using an optimization approach, optimal or at least close-to-optimal solutions can be obtained, which reduces the quality loss – or – the economical loss based on degraded quality. The developed mathematical model and algorithms have been tested on a MATLAB-based prototype with real plant data and are ready for integration as a module to the ABB CPM solution.

To summarize, the potential paper manufacturer's main benefits are:

- High potential to optimally deal with quality deviations
- Improved profitability (maximum quality yield)
- Better quality reliability towards end customers

The method is also applicable in other industries such as metals, and flat sheet chemicals. It was developed with cooperation between ABB's R&D Center in Germany and the Center of Excellence of Collaborative Production Solutions, Finland.