Modern integrated pulp mills sometimes fail to reach full economic potential, by relying on manual approaches for scheduling. Greycon’s recently-introduced PulpPlan is a new, optimisation based, scheduling system for pulp mills.

It combines a state-of-the-art graphical user interface, with what-if capability & industrial-strength optimisation into an innovative and unique software platform.

Effective planning and scheduling is a key factor in the success of any such operation and one of the few internally-controllable levers for influencing profitability. The planning and scheduling functions can be divided, depending on the time horizon, into four levels:

1. Strategic planning where the time horizon is from months to several years.
2. Production planning where the time horizon is from several days to a few months.
3. Production scheduling and control with the time horizon from minutes to a few days.
4. Process control from seconds to minutes sometimes perhaps hours. This article focuses on level 3.

Somewhat surprisingly, to the best of our knowledge, there is no commercially-available standard software using optimisation to address the quite specific needs for pulp mills. There have been various ad hoc local solutions, but these have not become configurable products, in the manner similar to, e.g. trim optimisation solutions for paper machines, where there are several vendors.

Even in a modern integrated mill that employs sophisticated automation systems, the production schedule is typically crafted in a manual or semi-manual fashion, unsupported by a global constraint model and without the assessment of a specialised software tool with optimisation capability.

Production schedulers typically make decisions on the basis of their experience, calculating set points and storage tank levels heuristically. It is common to find operators belonging to different shifts to have quite different views as to what these settings (for the same schedule) might be. But manual scheduling traditionally lacks visibility, is time consuming and relies too much on the planner’s uncertain expertise. ‘What-if’ analysis is precluded as the act of creating a single schedule consumes all available time. Thus any response to a new situation becomes a hit-and-miss affair.

Given this situation, there has been academic interest in pulp mill scheduling optimisation since the 80s (Leiviskä, 1984; Figueira, Santos, & Almada-Lobo, 2013; Santos & Almada-Lobo, 2012). Studies that analyse how these algorithms perform in comparison to traditional scheduling suggest remarkable potential improvements, e.g. (Lasslett, 2004) found potential production improvements...
One particular aspect needs further attention: any complex but sequential multi-stage operation needs to mitigate against failures of any one stage. A stochastic failure model can provide the basis for determining optimal levels for intermediate storage tanks. If the system finds the processes downstream of any storage tank are very unreliable compared to those that are upstream, it will set a low target stock level for that storage tank.

**Integration & key functionality**

Integration is a key requirement for successful implementation. PulpPlan accepts information from the different production areas across the mill. The distributed control system (DCS) provides, either directly or via a data historian, current stock levels and process rates of all the production areas. This includes the pulping, recovery and recaustization lines. Similarly, an interface with the block scheduling system allows importing the schedule of the paper machines.

The operator uses a graphical user interface to understand, experiment with and decide on the schedule.

Another area targeted by the optimisation is the brown-stock washing efficiency. The optimisation engine calculates the optimal dilution factor so as to minimise cost. This calculation considers the costs of bleach chemical consumption, soda loss and evaporator steam versus dilution factor. However, the optimal dilution factor is affected by evaporator performance; the latter can reduce the throughput of the whole mill. Thus efficiency depends on the dynamic load of the recovery system as well as the paper machine block schedule. The resulting increases of 5% simply by better coordinating pulp and recovery lines.

The actual benefits obtained will of course vary from mill to mill. Mills where production constraints are dynamic and pulp production is directly linked with the block schedule for the paper machines are the ones which have the most potential for improvement. But other pulp producers can also benefit. Their expected gains will depend mainly on mill complexity and market dynamics.

In coming up with PulpPlan we decided to exploit today’s computational power, in order to deliver the required operational efficiency improvements using a combination of: a familiar user interface that includes a graphically-configured mathematical model of the whole pulp mill, non-linear mathematical optimisation technology that can determine realistic optimised schedules in just in few seconds and what-if capability to allow uninhibited scenario exploration (as well as forming an educational platform).

In general, the goal of pulp production scheduling is to ensure that production targets are met while production costs are minimised. PulpPlan takes that concept a step further, as it is designed to produce perfectly coordinated production plans for the whole mill so that: Production is maximised with respect to demand; Production costs are minimised; Process rate changes are minimised; Target stock levels are reached; Even distribution of available stock in times of shortage and Constraints are respected.

Optimising the performance of any system under a dynamic environment can be challenging and time-consuming. Production scheduling can be used to identify quickly current and future constraints and take the proper actions to maximise production under the current scenario. For instance, in the case of high demand periods, scheduling can be used to detect the need to build stock and also to make the best use of the available capacity in the storage tanks in these critical scenarios.
Cost analysis plan maximises efficiency for the whole mill, not just the sub-processes.

In mills where steam generation takes place in two or more boilers and/or using different fuels, cost optimisation can be a challenging task without the proper software tool. Optimisation algorithms use production plans to determine the optimal fuel load for each boiler, thus helping to save costs and meet environmental constraints (such as limit in the total reduced sulphides). If optimising carbon dioxide emissions takes precedence over reducing expenses, then the optimisation engine can be easily reconfigured to reduce CO$_2$ instead of costs.

While the economic value of increased output and reduced production costs is evident, there are other less obvious benefits that would result from more stable operation. Fewer and smaller production rate changes (i.e. stabilizing continuous digesters, washers and bleach plant operation) will result in less variability in pulp quality. Operational costs are also expected to be reduced by better pulp inventory management. For example, lowering the level of pulp on offline storages will reduce the amount of double handling and energy required to press pulp, dump it and reclaim it.

PulpPlan promises a ROI of less than two months based on: higher production throughput, reduced cost and fast, accurate response to changing conditions.

References