# On-Line Pulp Quality Information

*Olli Saarela*

VTT Technical Research Centre of Finland, P.O. Box 1000, FI-02044 VTT, Finland

Tel: +358 40 540 8791, E-mail: olli.saarela@vtt.fi, http://www.vttresearch.com/

*Ari Poukka*

Metsä Fibre, P.O. Box 30, FI-02020 Metsä, Finland
Tel: +358 50 598 8059, ari.poukka@metsagroup.com, http://www.metsafibre.com/

KEY WORDS pulp manufacturing, quality, industrial internet

## 1 INTRODUCTION

Production of pulp from wood is a significant industrial activity in Finland. In 2015, more than 7 million tonnes of pulp was produced in Finland. Important pulp quality parameters include brightness, dirt level, fibre length distribution, and the potential of forming strong and even fibre network. On-line measurements for the first three are available, but the fourth one related to bonding and fibre strength can only be measured in laboratory. In laboratory analyses, the pulp sample is first refined, then made into a paper sheet, dried, and finally measured. This takes time and incurs expenses, both factors limiting the number of analyses that can be carried out. Furthermore, laboratory analyses have been found to include a level of measurement noise that is not small enough in relation to the actual quality variation of pulp. All these factors together make the laboratory analyses less than ideal for pertinent quality control. Hence, first, laboratory results are available only after most of the pulp has already been used at paper or board mills, as depicted in Figure 1. Second, laboratory analyses are too sparse for monitoring uniformity of quality, which in some cases is even more important than the actual quality level. A new on-line measure of pulp quality was thus developed and named Botnia FOX. The on-line display of the quality index is shown in Figure 2.

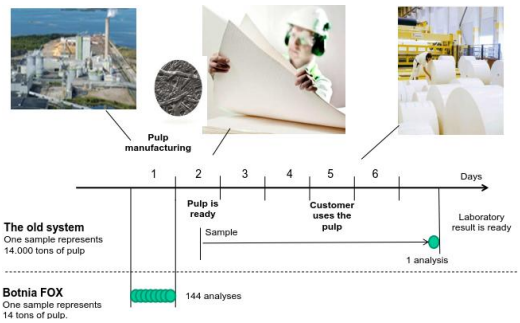


**Figure 1**. Time scales of pulp quality measurements.

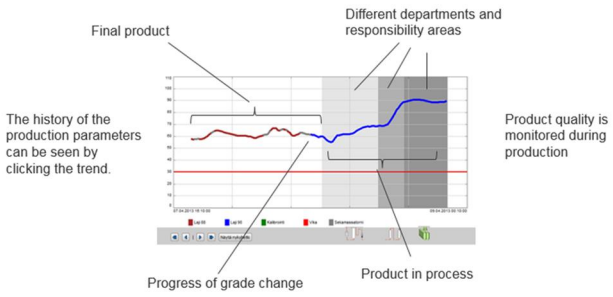


**Figure 2**. On-line display of the Botnia FOX index.

## 2 MODELLING PULP QUALITY

The Botnia FOX was developed as a hybrid model combining knowledge of pulp manufacturing chemistry and data-driven modelling. A relatively large number of pulp mill process variables affects the bonding potential. Data-driven identification of a suitable non-linear model covering the impacts of all of them would require either a considerable amount of data from a normal operation or an extensive set of designed experiments. As data from laboratory analyses was available only on a weekly basis, purely data-driven modelling was not possible. Theoretical knowledge of the impacts of several process variables gave a solid basis for modelling, however,

requiring in some cases a data-driven scale-up from laboratory to industrial scale. With adequate theoretical basis for several process variables, the data-driven identification of the other impacts became possible. Qualitative customer feedback was used in validating the model. Because of the basis in chemical theory, there has been no need to re-identify the computational model after initial work in 2008.

In order to synchronize the Botnia FOX index in pulp bales produced, the process delays had to be taken into account. The process delays vary continuously depending on the production rate, on how the storage towers are operated, and on any local production disturbances. The most significant delays come from the storage towers. They were modelled as a three-dimensional array of small cells, through which pulp passes, mixing slightly with the pulp in the neighboring cells.

## 2 QUALITY MONITORING AT THE PULP MILL

The developed Botnia FOX indicator has, by now, been successfully deployed at all four of Metsä Fibre's pulp mills. It is in practice used for pulp quality monitoring. Faster sample rate facilitates quality deviations to be detected and addressed sooner. For reliable detection of smaller quality deviations, the measurement uncertainties for quality-related variables have to be reduced by averaging consecutive values. As depicted in Figure 3, the confidence intervals of on-line measurements narrow down much sooner than those of laboratory analyses.

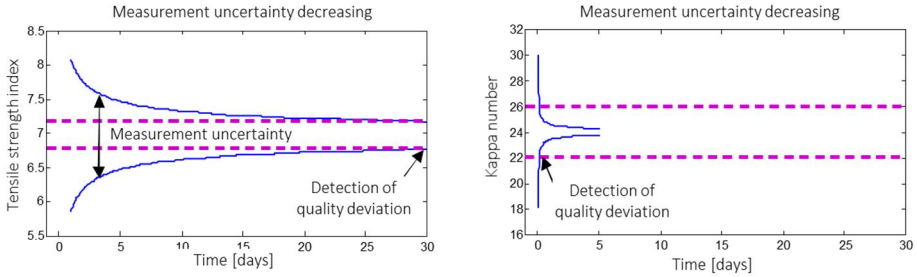


**Figure 3**. The confidence intervals (solid blue) of quality related parameters decrease as more data points are averaged. For on-line measurements (the graph on the right) this occurs much faster than for laboratory analyses (left graph). The purple dashed lines indicate roughly corresponding quality limits.

## 3 QUALITY INFORMATION IN INDUSTRIAL INTERNET

Pulp is typically shipped to paper and board mills as bales. Due to logistics reasons the transport and storage times of individual bales can vary greatly, from days to months. In order to keep track of quality information Metsä Fibre has begun to attach an RFID tag to each bale. Select paper and board mills have installed RFID gates that read the tags as each bale is used, and can thus access the corresponding quality information at Metsä Fibre's customer portal. This information is available before a bail is refined at the paper or board mill, facilitating feedforward control to compensate for any variations.

Evident connections have been demonstrated between Botnia FOX and paper/board machine operation. Depending on the control strategy of each paper/board machine, e.g. whether pulp is refined to constant freeness or with constant specific energy consumption, the connections have been observed in one or more parameters like pulp consumption, paper/board machine runnability, energy consumption, and quality variables of the produced paper.