

# Advanced Process Control: Product Quality Improvement by controlling operating limits of sensors using Advanced Machine Learning techniques & Stochastic Optimization – Application to Paper/Paper board manufacturing process



## SITUATION

Manufacturing industry is undergoing a sea change with changing times and the pressure to reduce costs without compromise on quality has become the order of the day. In order to reduce production costs, it's imperative that the processes be mathematically understood and controlled so that best of the benefits is realized. The objective was to help Business and Process Owners reduce cost of paper manufactured while keeping quality of product at its best.

## IMPACT

The engagement provided quantified savings in terms of reduced expenditure on overheads consumed and less raw material (pulp) for achieving the same quality of paper. It also gave clear insight on operational parameters influencing paper quality.

## RESOLUTION

Paper is a thin material produced by pressing together moist fibres of cellulose pulp derived from wood, rags or grasses, and drying them into flexible sheets. It is a versatile material with many uses, including writing, printing, packaging, cleaning, decorating, and a number of industrial and construction processes. Paper is characterized by properties like caliper (thickness in  $\mu\text{m}$ ), GSM (grams per square metre) and moisture content (%) which determine properties like stiffness (ability for a sheet of paper to resist bending), bulk (weight per unit volume), tensile strength (maximum stress to break a strip of paper sheet, depends on fibre orientation), edge wick (Water absorption at the edge) and many others. Regression model that explained the statistical relationship between moisture content and operational parameters was established. Once established and validated, the model parameters operating ranges to achieve a specific range of moisture was arrived at by an optimization algorithm and the same were implemented during the production process.

## The Customer

One of the largest Paper/Paperboard Manufacturers in India

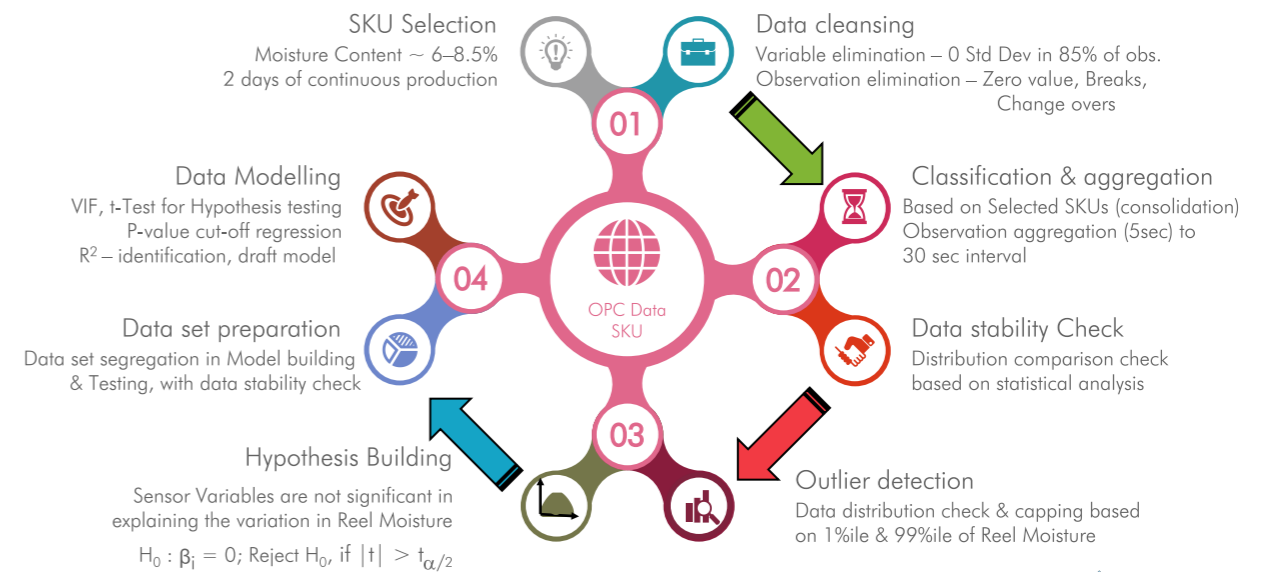
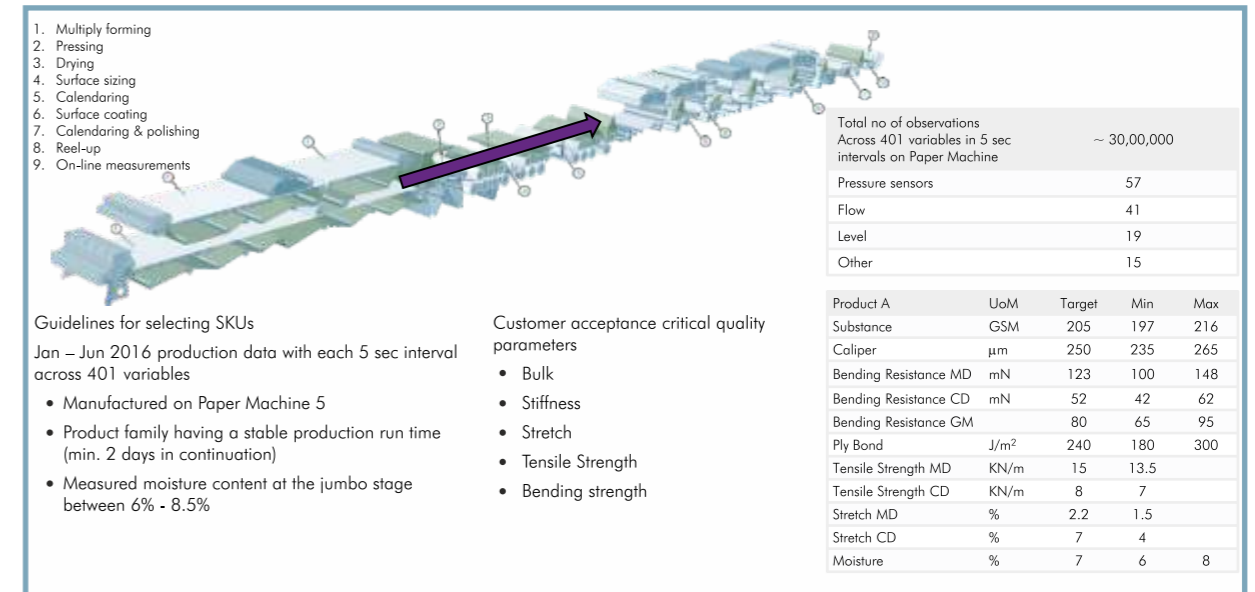
## The Need

The ever-competitive landscape of the manufacturing industry strives towards reduction in costs to drive up margins without impact on the quality. The improvement in quality will also result in significant cost savings in the overheads, raw materials and wastage. Thus, the customer sought a cost-effective analytics solution to improve and maintain the quality of the product manufactured along with the reduction in the manufacturing costs. For such needs a reliable, robust and process optimization technique using Machine Learning was essential to build and deploy the solution.

## The Solution

The methodology used can be broadly summarized as Business Understanding of the Production process, Data Understanding, Data Pre-processing, Data Quality Checks, Data Munging and Analytical Dataset Preparation, Model Development and Validation and Model Parameter Optimization. The end objective was to find the optimal operating ranges of operational parameters, significantly impacting end product moisture content, thus, enabling the end users to save on multiple cost avenues. Reel Moisture was modelled as the dependent variable whose behaviour would be explained by several sensors capturing real time information on Differential Steam Pressure, Stock Flow, and Machine Speed to name a few (operational parameters). For each Paper grade various models were developed viz. Multiple Linear Regression, Multivariate Adaptive Regression Splines, Generalized Additive Model, Neural Networks, and Support Vector Machines in order to establish the mathematical relationship between Reel Moisture and Sensor Variables. Once a particular model was finalized for a given product, the operational parameters that had a significant influence on the end product, the Operational Ranges, i.e. the range in which the particular operating parameter needs to be maintained to realize desired level of Moisture Content % consistently were determined using Stochastic Optimization through Genetic Algorithm. For a given desired range of output of Moisture Content %, the corresponding ranges for the operational parameters was determined. These mathematically arrived at ranges were then implemented on a real time basis on the paper machine and the outcome was found to be in consensus with the expected range of Moisture Content %.

## Schematic Representation of Paper Manufacturing process sections, associated functionalities and model development approach



## Business Benefits

The impact of operational parameters on the end product moisture has been statistically proven and the operational ranges prescribed had a profound impact in restricting/ controlling the moisture percentage in pre-defined range. The cost savings realized by the business in terms of reduction in steam consumption and material saved (pulp) had been proven in the trial phase and that the business continues to use the recommendations is a testimony to the same.

### Results showing consistency in the Moisture Content % post model deployment in the production through recommended operating limits of the sensors controlling the production process



- Range of Stiffness before & after conditioned for after engagement has been narrowed as compared to before
- Trial stiffness shows consistency in stiffness across the Jumbo IDs, as the spread is low compare to earlier results

## About ITC Infotech's IT Solutions Practice for Retail Industry

ITC Infotech provides Analytics, Big Data and Information Management services through its "Data – Infrastructure to Insights" line of business. Driven by strong leadership in domain and technology consulting, ITC Infotech provides modern solutions to help organizations harness the value of data. With a strong focus on design and differentiated delivery, ITC Infotech provides cost effective solutions, innovative offerings and customer delight.

In the areas of Industry 4.0 or IoT, ITC Infotech focuses on Analytics and Business Intelligence solutions that help organizations provide superior quality of care, enhanced patient engagement, accurate regulatory reporting, and laicnanfiand operational excellence.