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Evolution of Operational Data to Support Excellence in Paper Manufacturing

Presented by **Laurent Watremetz, QC Manager &
Data System**

Quality in Paper Manufacturing

Main Characteristics

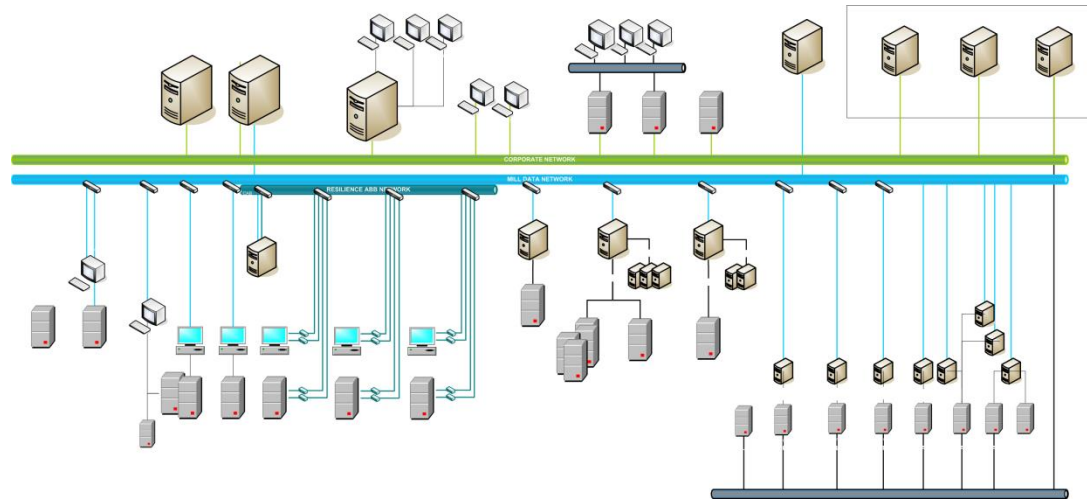
- Long-established manufacturer of security paper
- Specific products, with complex design
- Challenging quality requirements
- Low volume production orders

 High volume of spoil from Machine Start Up and Out-of-Control processes

Data Systems Expansion

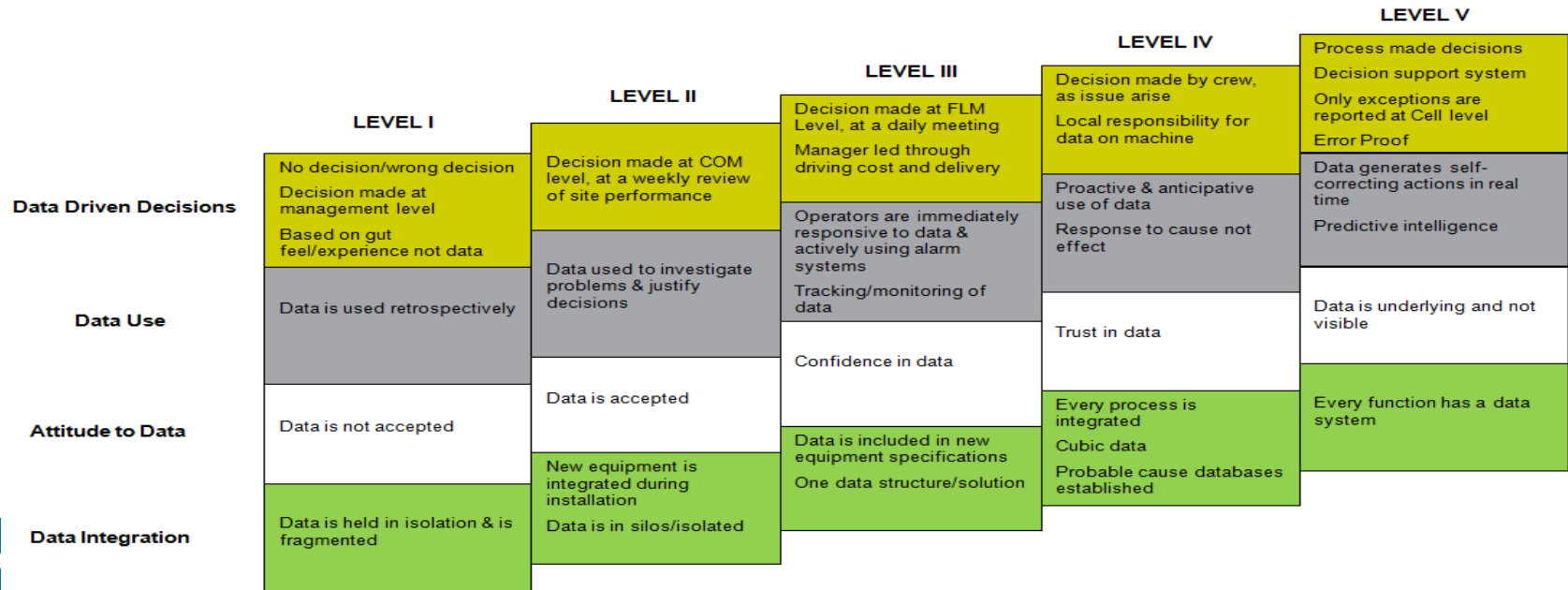
The PI System has been deployed throughout the mill, not only collecting process data but also online and offline product inspection information.

Having seen process engineers resolving issues through data exploration and analysis, operations managers and operators are now demanding data-driven solutions.



Data & Operational Excellence

- The Business is deploying Operational Excellence, focussing on Built-in Quality:
 - Defects are no longer created rather than detected
 - Decisions are taken within the manufacturing cells rather than by managers
 - Processes are planned to achieved Quality rather than reactive
- The Data Systems team developed a vision to support this journey



Project Overview

A joint project with Global IT and OSIssoft to communicate vision to the Site and Company Leadership Teams, to prove benefit realisation and to justify an Enterprise Agreement

- **Opportunity**

- Spoil is the most significant cost to the business, with two-digit spoil level not usual

- **Obstacles**

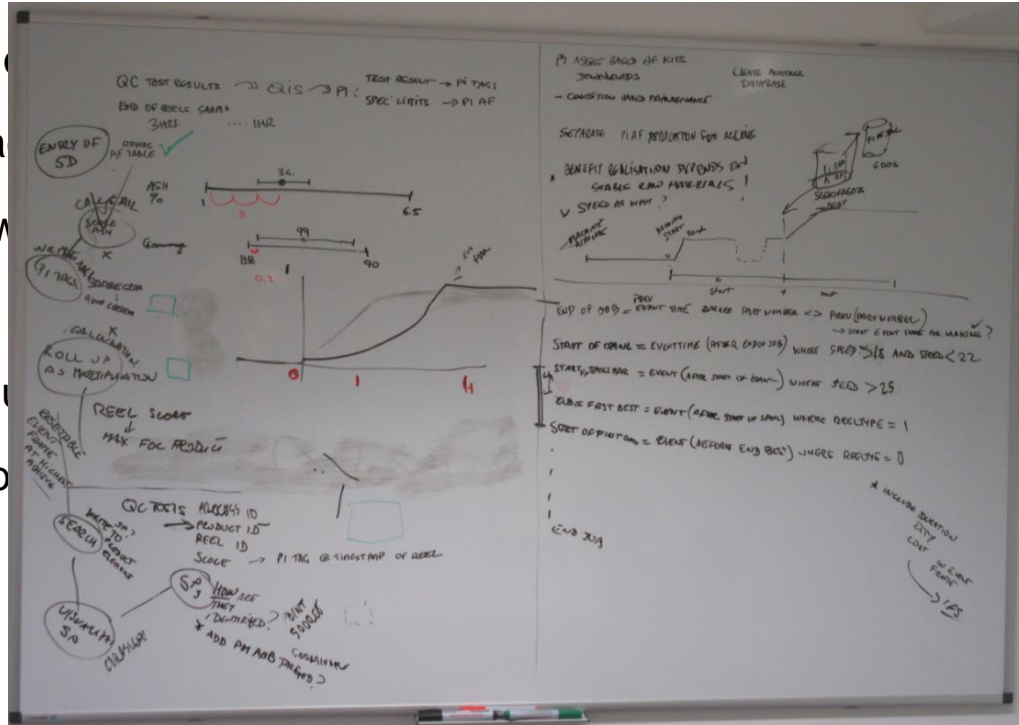
- The product quality is determined by laboratory testing, sometimes hours behind manufacturing
- Two systems are being used, the PI System and the Quality Database
- Operators are not trained in trend review and data analysis
- Approximately 200 process inputs, and 20 quality parameters would need to be monitored
- The impact of process inputs on quality parameters is not fully understood
- Numerous different products are being made, with varying specifications
- Operators are proud of their “art” and can feel threatened by automation



Solution Design

Contracting Data into simple and actionable messages for machine crews

- A single point of contact
- A clear message
- Investigation with
- Crews should
- The product quality
- Trends and ab



Solution Development-*Guiding to optimal Quality*

- PI Asset Analytics scores each reel for its quality, retrieves the point in time when the best product was manufactured and the machine set points
- PI AF enables more complex analytics than Performance Equations, quick replication across elements, and easy backfill

The screenshot displays the PI Asset Analytics configuration interface. It shows three main configuration windows:

- PM_QC_Test_SCA**: Configuration for the QCTestScore element. The Name field is set to "QCTestScore".
- PM_StartUp**: Configuration for the FindBestReel element. The Name field is set to "FindBestReel".
- QIS_vMSPEC**: A data table with columns: idProcess, idProduct, idvariable, nm, noUCL, noLCL, noUSL, noLSL, and noTarget. The table contains 15 rows of data.

Below the configuration windows, there are two "Example Element" sections:

- Example Element: Select an example**: A table with columns Name and Expression.

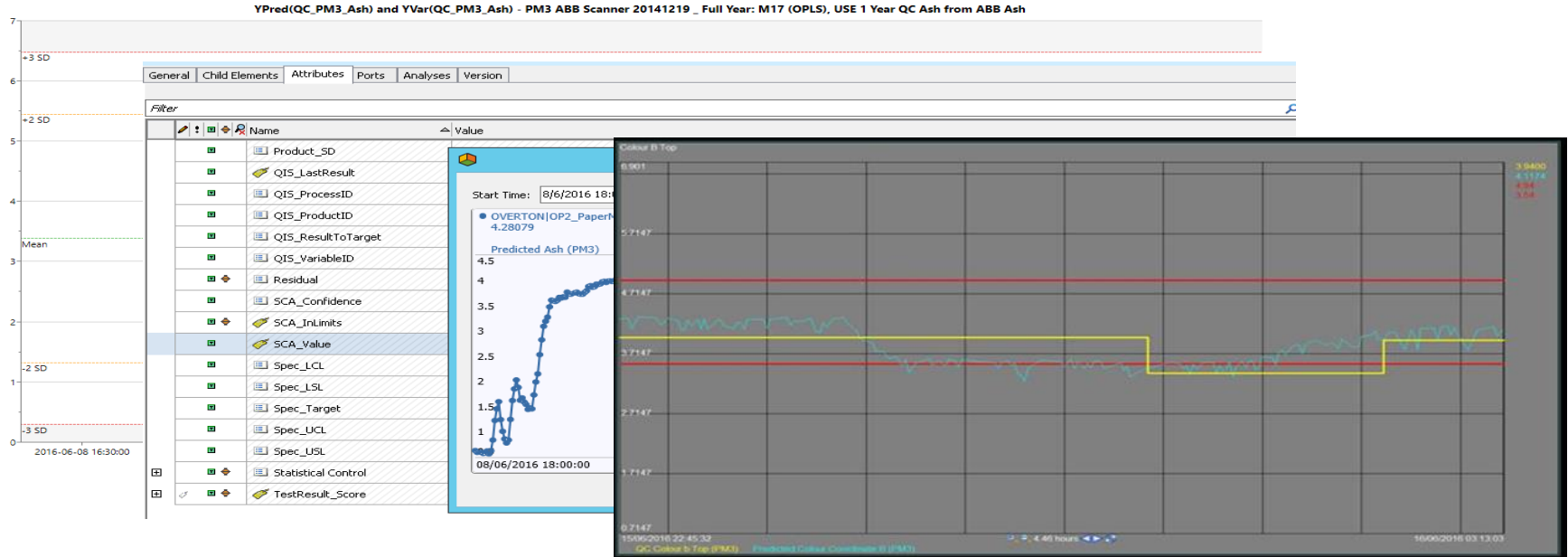
| Name | Expression |
|-----------|-------------------|
| LowerSide | IF 'Spec_LSL' <> |
| UpperSide | IF 'Spec_USL' <> |
| NbSD | Min (lowerside, U |
| Score | if NbSD <= 0 ther |
- Example Element: OVERTON_OP2_PaperMaking/PN**: A table with columns Name and Expression.

| Name | Expression |
|-----------------|---------------------------|
| EndLastMaking | FindEq('PartNumber', '* |
| StartLastMaking | FindNE('PartNumber', En |
| BestScore | TagMax('...QCTestScore Te |
| BestScoreTime | IF TimeStamp(TagMax('. |



Solution Development - Predicting Quality

SIMCA-online from MKS Data Analytics Solutions (OSIsoft business partner) is used to build PLS predictive models, providing real time estimations of QC test results against the specification



Solution Development - Monitoring Quality

QC test results are archived in the PI System and PI Asset Analytics derives SPC-type alarms, tuned to the business specifics

The screenshot shows the configuration interface for a 'StatisticalWarning' template. The interface includes a navigation pane on the left with tabs for 'General', 'Attribute Templates', 'Ports', and 'Analysis Templates'. The 'Analysis Templates' tab is active, showing a list of analysis elements: 'In Limits Status (1=OUT)', 'Prediction Residual', 'QCTestScore', and 'StatisticalWarning' (which is selected). To the right of the list, the 'Name' is set to 'StatisticalWarning' and the 'Description' is 'SPC type rules'. The 'Analysis Type' is set to 'Expression', and the checkbox 'Start analyses when created from template' is checked. Below the configuration pane, there is an 'Example Element' section with a table of analysis elements.

| Name | Expression | Value at Eva | Value at Last 1 | Output Attribute | |
|----------|--|--------------|-----------------|----------------------------------|---|
| Diff1 | 'QIS_LastResult'-PrevVal('QIS_LastResult','*') | | | Map | ⊗ |
| Diff2 | PrevVal('QIS_LastResult','*') - PrevVal('QIS_LastResult',pre | | | Map | ⊗ |
| Diff3 | PrevVal('QIS_LastResult',prevEvent('QIS_LastResult','*'))-Pi | | | Map | ⊗ |
| Diff4 | PrevVal('QIS_LastResult',prevEvent('QIS_LastResult','*'))-Pi | | | Map | ⊗ |
| Trending | if (Diff1>0 and Diff2>0 and Diff3>0 and Diff4>0) or (Diff1< | | | Statistical Control 4 Trending | ⊗ |
| Last3Avg | Avg('QIS_LastResult',PrevVal('QIS_LastResult','*'),PrevVal(| | | Map | ⊗ |
| Out2SD | if ('QIS_LastResult'>(Last3Avg+3*'Product_SD') OR 'QIS_Lastf | | | Statistical Control 1 Outside3SD | ⊗ |
| Out3SD | if 'QIS_LastResult'>(Last3Avg+2*'Product_SD') AND PrevVal('(| | | Statistical Control 2 Outside2SD | ⊗ |
| Overall | Max(Trending,Out2SD,Out3SD) | | | Statistical Control | ⊗ |

Solution Deployment - *Replication through PI AF*

- All analytics, retrieval of specification limits, archiving of predicted test result was made easy with PI AF templates.
- PI AF also enabled solution to escalation using PI Notifications

The screenshot displays the PI AF interface. On the left is a tree view of elements, including 'P20 - Chemicals & Colours', 'P30 - VAT & Former', 'P40 - Press Section', 'P50 - Drying Section', 'P60 - Size Bath', 'P70 - AFD', 'P80 - Calenders', 'P90 - Scanner & Reel Up', 'Planned Maintenance', 'PM3_Q15_Alert', and 'QC_Tests'. The 'QC_Tests' folder is expanded, showing sub-elements like 'Ash', 'CD_Doc', 'CD_Dry', 'CD_We', 'Cobb_T', 'Colour_T', 'Colour_U', 'CR_Op', 'Crumple', 'Elrepho', 'MD_Dry', 'MD_We', 'Plain_P', 'Printing', 'Roughr', 'Roughr', 'Thickne', and 'Thickne'.

The central pane shows the 'Colour_L_Top' element with a table of data:

| Name | Value |
|------------|---------|
| Product_SD | 0.29528 |

Overlaid on the right is an email notification window with the following details:

From: PI_Notifications@
To: Watremetz, Laure
CC:
Subject: PaperMaking\PM3\QC_Tests

Trigger Time: 12/06/2016 13:13:00 GMT Daylight Time (GMT+01:00:00)

Notification: PaperMaking\PM3\QC_Tests\ Notifications[QC_SCA_Specificaton14]

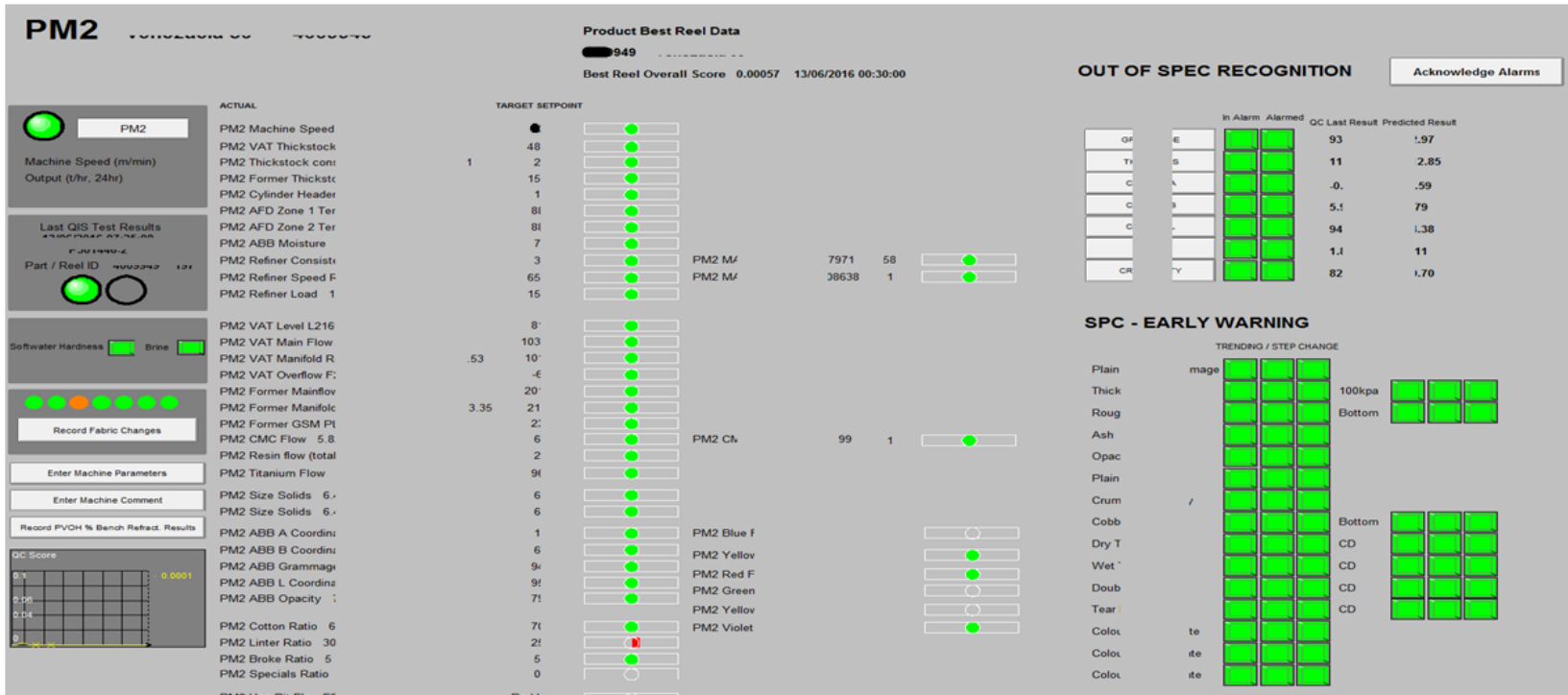
Below the notification is a table of specification limits and test results:

| LSL | LCL | QC Last Result | SIMCA Estimation | UCL | USL |
|-----|--------------------------|------------------|------------------|--------------------------|-----|
| 1 | {Error inserting result} | 4.09999990463257 | -99 | {Error inserting result} | 5 |

At the bottom of the interface, a 'TestResult_Score' is shown with a value of 0.73276580251719825.

Solution Deployment - *Processbook Display*

A unique PI ProcessBook display provides clear color coded indicators, and enables operators to “drill” into process parameters for further investigation



Solution Deployment - *Records*

Crew decisions are recorded within the PI System

- Decision made are communicated to next shift
- Effectiveness of system (alarms) can be reviewed and tuned

The screenshot displays the 'PEC RECOGNITION' interface. At the top, there are two buttons: 'Acknowledge Alarms' and 'Response Log'. Below these is a table with columns for 'In Alarm', 'Alarmed', 'QC Last Result', and 'Predicted Result'. The table contains several rows of data, including dates and times. A 'PI Comments' dialog box is open in the foreground, showing the date '29 Jun 16' and time '11:37:37'. The dialog box has a 'Comments' text area and two buttons: 'Confirm Entries' and 'Exit'.

| In Alarm | Alarmed | QC Last Result | Predicted Result | |
|----------|---------|----------------|------------------|--|
| | | 94.11 | 92.93 | |
| | | 116.50 | 113.60 | 25/06/2016 18:35:31 Restart |
| | | -0.55 | -0.55 | 23/06/2016 11:44:17 No adjustment made for colour a trending down as out of spec recognition is predicting more favour |
| | | | | 23/06/2016 09:55:58 1st cal eased for SPC early warning top side roughness |
| | | 5.86 | 5.87 | 20/06/2016 19:24:28 Crumple porosity alarm PVoH solids tested 5.38 dilution water added to reduce solids |

Solution Deployment - *Acceptance*

- Solutions are presented as 'tools' to the operators, improving on practices
- Operators are involved in projects from conception
- Alerts and data provided by the PI System are presented as indication
- Lower value PI System–enabled solutions are encouraged and delivered
- Solution can be aligned to existing processes from supporting functions
- Solution and concept are easily transferable

Results

Deployment was conducted following Agile principles, and a prototype released to Operations for a period of 8 weeks, during which benefits were monitored and significant improvements observed

| Start Up | Baseline start-up time | Actual Time compared to baseline | Improvement |
|----------------|------------------------|----------------------------------|-------------|
| PIMP Product 1 | 100 | 60.81 | 39% |
| PIMP Product 2 | 100 | 33.78 | 66% |
| PIMP Product 3 | 100 | 90.09 | 10% |
| PIMP Product 4 | 100 | 33.78 | 66% |
| PIMP Product 5 | 100 | 31.53 | 68% |
| Overall | | | 50% |



Conclusions

Contracting Data into simple and actionable messages for machine crews

- **PI System:** alignment of data system development to corporate strategies
- **PI Asset Analytics:** complex calculations and logics to be built and standardised
- **PI Asset Framework:** convergence of multiple data sources and quick roll out of solutions
- **PI ProcessBook:** high level of customization to satisfy end-user requests and gain acceptance

Next steps

- Integration into existing systems of work
- Improvement of predictive models
- Deployment to other paper machines
- Development for other process areas of the mill, other sites of the business

Evolution of Operational Data to support Excellence

COMPANY and GOAL

The Business wanted to prove the PI System as an Enterprise solution for improvements and data-driven decisions and demonstrate financial benefits



CHALLENGE

The papermachine process is set by testing product during start up

- The crew adjust the machine during start up to reach good quality product
- Product is sent to the lab to provide feedback and further adjustments

SOLUTION

Product and process data are aligned and analyzed to provide the right information

- Complex calculations and logic are created in PI Asset Analytics and SIMCA
- Deployment is done using PI AF templates
- PI ProcessBook provides a single point of visualization

RESULTS

The time, and waste, required to start and set the machine up has been reduced by 50%

- Other benefits includes increased speed, increased availability, reduced testing requirements
- Solution is transferrable to other machines, and other processes



Contact Information

Laurent Watremetz

lwatremetz@yahoo.com

QC Manager & Data System



Questions

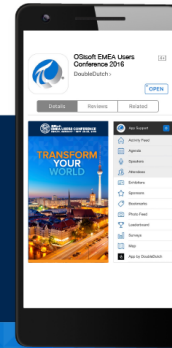
Please wait for the **microphone** before asking your questions



State your **name & company**

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谢谢

Danke

Merci

Gracias

Thank You

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Спасибо

Obrigado