Slab Casting Automation
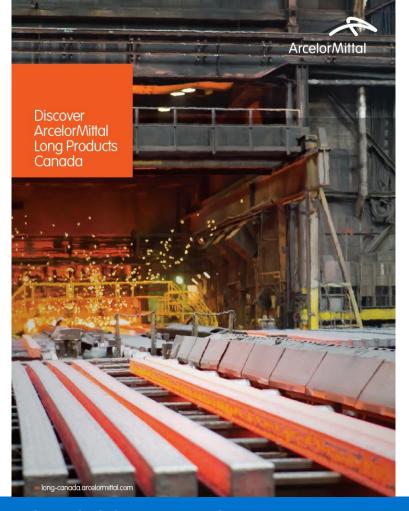## Contextualize Raw Data into Operational Intelligence

Presented by **Jean-Yves St-Onge**

Alexandre Côté

Agenda

- About ArcelorMittal & ATS Process Automation Solutions

- Business Challenge

- Solution & Innovation

- Results and Benefits

- Future Plans

- Conclusion

Discover
ArcelorMittal
Long Products
Canada

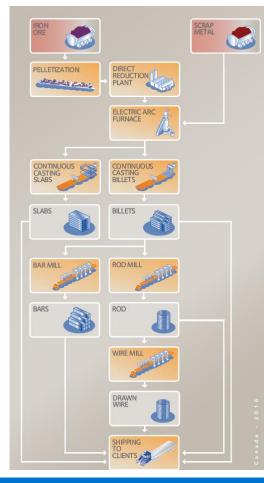»» long-canada.arcelormittal.com

About ArcelorMittal

ArcelorMittal is the world's leading steel and mining company, with some 232,000 employees in more than 60 countries. ArcelorMittal leads in all major global steel markets, including automotive, construction, household appliances and packaging, with strong R&D and technology, as well as sizable captive supplies of raw materials and outstanding distribution networks.

To contact us:

ArcelorMittal Long Products Canada
4000, route des Aciéries
Contrecœur (Quebec) J0L 1C0

Telephone:
450 587-8600 or 1 800 361-2605

4

ArcelorMittal Long Products Canada

Most important Canadian company in iron ore mining and processing.

Over 1,700 employees.

2 million tons of steel per year.

Iron ore is processed 6 to 11 times before it is finally used.

From ships to skyscrapers steel is truly the fabric of life

Steel for round Edge Automotive Leaf Springs (REALS) →

Concrete Reinforcing Bar (Rebar) →

Special and Merchant Bar Quality (SBQ & MBQ) →

Wire Rod →

Drawn Wire →

About ATS (Automation Tooling System)

Automation

Integration

Products

Services

- 3,500 Employees
- 22,000 Projects Deployed
- >1,000 contracts per year
- Revenues ~$1.0 B
- Fortune 500 Customers
- 90% Repeat Customers

About ATS Process Automation Solutions

PROCESS
AUTOMATION
SOLUTIONS ™

an ATS company

- Part of ATS since September 2014
- Founded in 1986
- Presence in 16 countries
- Network of 47 offices
- 1300 employees (77% Engineers)

Industry pie chart:
- Other industries 17%
- Automotive 41%
- Oil & Gas 3%
- Pharma & Biotech 13%
- Chemicals 26%

PA SOLUTIONS

Pyramid:
- ERP
- MES
- Process Control System DCS, PLC, SCADA Systems
- Robotic Solutions, System Integrations, Process Upgrades, Retools, Field Devices (Actuators/Sensors)

Regional pie chart:
- Asia 3%
- Americas 27%
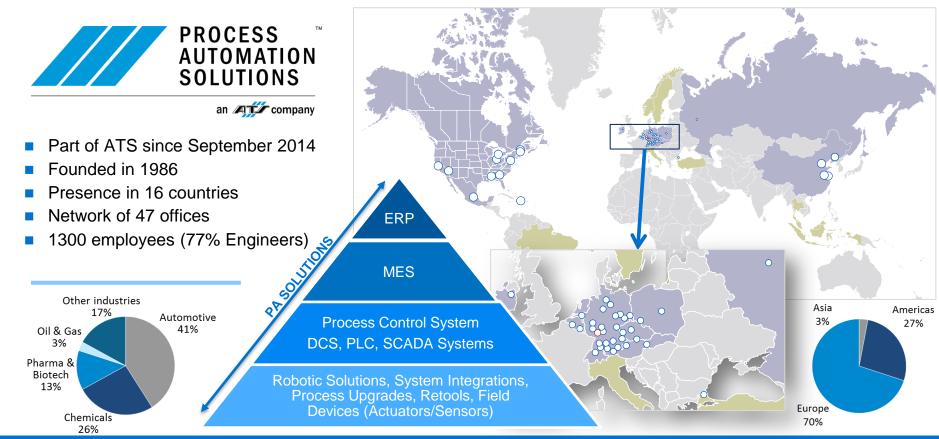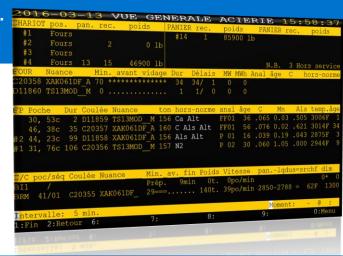- Europe 70%

Business Challenge

Sustainability issue with legacy VAX-VMS systems in place since 1985.

- Highly stable all-In-One system with proprietary network,
- Hard to maintain with Fortran experts retiring.

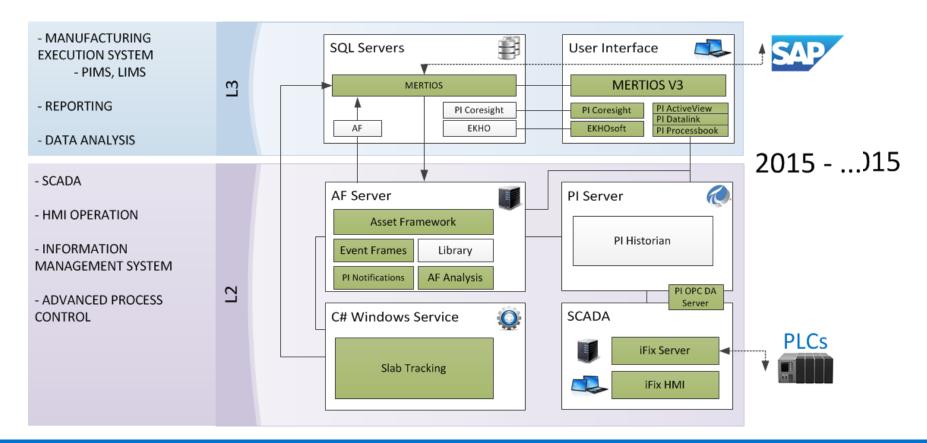Migrate to multi-layer open Windows integrated system

Business Challenge

- Modelize Level 2 process in an **open** and **reliable** architecture driven by data and events.

- Empower **production** people to access all **system** data for process analytics and real-time decision making.

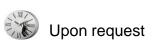- **Control** the process events to define **the product quality**.

Solution & Innovation

ArcelorMittal Automation Systems Architecture

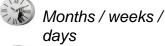## Understand our strategy, how it works and why it exists

Architecture based on standard ISA95

			Pyramid Level	Description	Systems
🕐	Upon request	5	**Decisions**		Systems involved are SAP BW (Business Warehouse), Ekho, SAP BPC (business planning & consolidation), Intranet and Excel, SmartTalk
🕐	*Months / weeks / days*	4	**Corporate Management / Production Planning**		SAP and VIP (payroll and human resources) Also 60 satellite systems with various technologies
🕐	*Days / hours*	3	**Production Scheduling and Performance**		**ME**RTIO**S** (MES System developed by the Automation and Integration Service) Standard system in all our plants
🕐	*Minutes / seconds*	2	**Production Monitoring and Optimization Models**		ME**RTIO**S and its Real Time components (PI Data Archive, PI AF, Event Frames, Windows real-time Services)
🕐	*Seconds / Real time*	1	**Direct Control of Production and Data Collection**		iFIX, Operating interface and data collection (SCADA) ABB control system, Standard programmable controllers at each plant
	Real time	0	**Process – Sensors, valves, actuators, regulators and motors…**		Many components that monitor temperature, pressure, speed, vibrations etc..
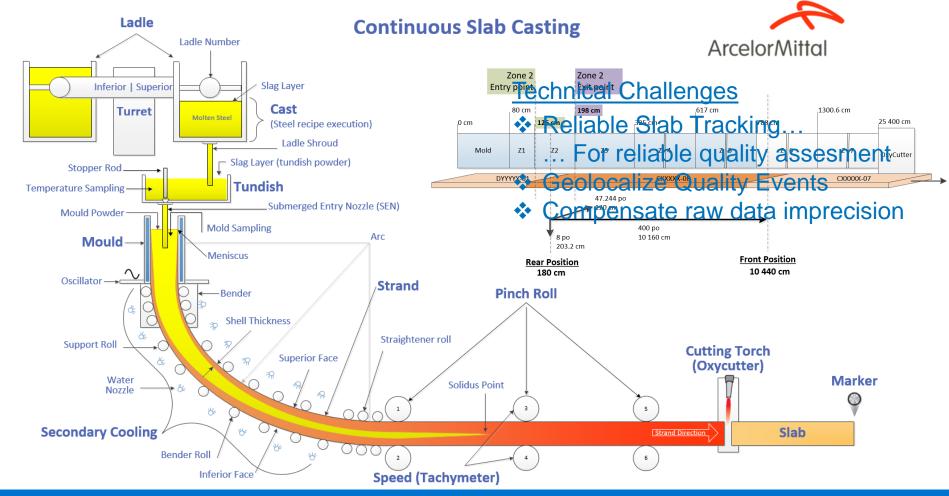
Continuous Slab Casting

Technical Challenges
- ❖ Reliable Slab Tracking...
  - ... For reliable quality assesment
- ❖ Geolocalize Quality Events
- ❖ Compensate raw data imprecision

Solution & Innovation

MERTIOS
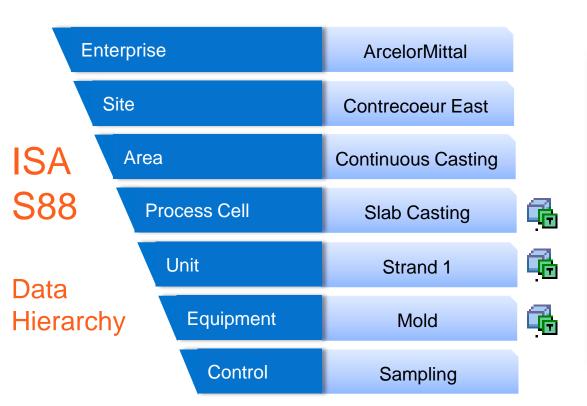
iFix
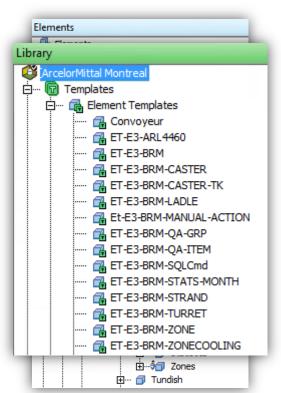
PI System

Advanced Process Control

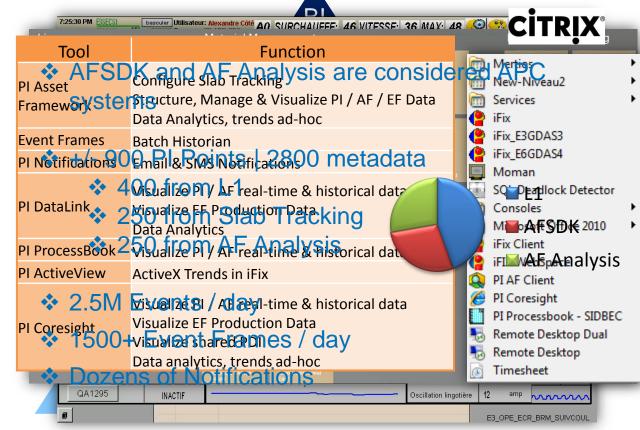| Tool	Function
PI Asset Framework	Configure Slab Tracking Structure, Manage & Visualize PI / AF / EF Data Data Analytics, trends ad-hoc
Event Frames	Batch Historian
PI Notifications	Email & SMS Notifications
PI DataLink	Visualize PI / AF real-time & historical data Visualize EF Production Data Data Analytics
PI ProcessBook	Visualize PI / AF real-time & historical data
PI ActiveView	ActiveX Trends in iFix
PI Coresight	Visualize PI / AF real-time & historical data Visualize EF Production Data Visualize shared PDI Data analytics, trends ad-hoc

- ❖ AFSDK and AF Analysis are considered APC systems
- ❖ +/- 900 PI Points | 2800 metadata
  - ❖ 400 from L1
  - ❖ 250 from Slab Tracking
  - ❖ 250 from AF Analysis
- ❖ 2.5M Events / day
- ❖ 1500+ Event Frames / day
- ❖ Dozens of Notifications

L1

AFSDK

AF Analysis

AF Data Structure using Templates

ISA S88

Data Hierarchy

Enterprise	ArcelorMittal
Site	Contrecoeur East
Area	Continuous Casting
Process Cell	Slab Casting
Unit	Strand 1
Equipment	Mold
Control	Sampling

Elements

Library

ArcelorMittal Montreal
Templates
  Element Templates
    Convoyeur
    ET-E3-ARL4460
    ET-E3-BRM
    ET-E3-BRM-CASTER
    ET-E3-BRM-CASTER-TK
    ET-E3-BRM-LADLE
    Et-E3-BRM-MANUAL-ACTION
    ET-E3-BRM-QA-GRP
    ET-E3-BRM-QA-ITEM
    ET-E3-BRM-SQLCmd
    ET-E3-BRM-STATS-MONTH
    ET-E3-BRM-STRAND
    ET-E3-BRM-TURRET
    ET-E3-BRM-ZONE
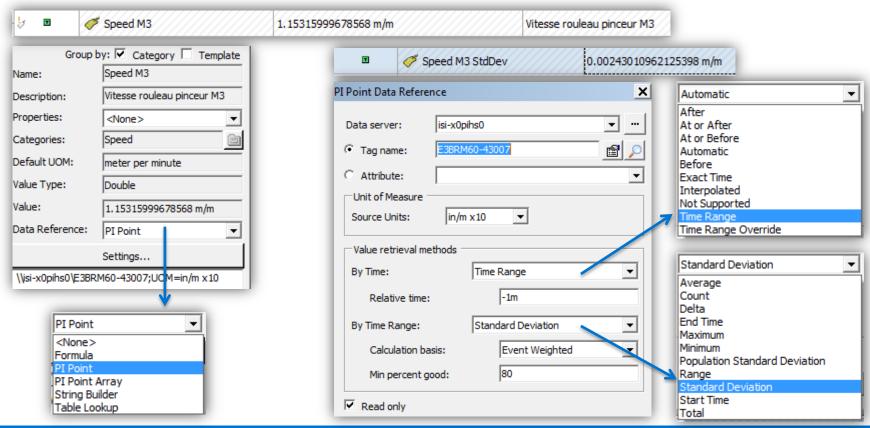   ET-E3-BRM-ZONECOOLING
        Zones
      Tundish

Steer and organize all data into AF Attributes

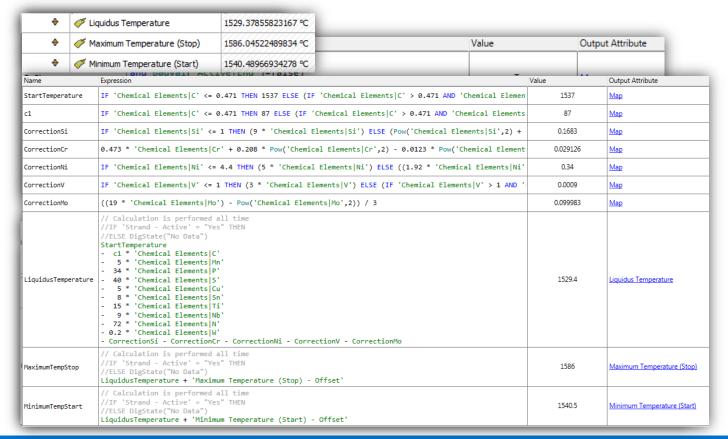# Use AF Attributes capabilities to clean-up raw data

Interpret Raw Data with AF Analysis

❖ Real-Time Simple Calculations:
   ❖ Ex: Water In/Out temperatures to calculate Heat Removal (MW/m2)

❖ Monitor the conditions and signal informative and quality events
   ❖ Ex: Casting speed StdDev generates micro-fractures within steel.

❖ Calculates KPIs
   ❖ Ex: Normalized Casting Current (A) over 30 days is a good indicator of machine health.

❖ Calculates Statistics
   ❖ Ex: Easely generates tons produced per shifts, week, month, year.

❖ Prepare data for any usage
   ❖ Ex: PLC requires Heat Number (7 chars) but does not accept String type.

Interpret Raw Data with AF Analysis

				Value	Output Attribute
	Liquidus Temperature		1529.37855823167 ℃		
	Maximum Temperature (Stop)		1586.04522489834 ℃		
	Minimum Temperature (Start)		1540.48966934278 ℃		

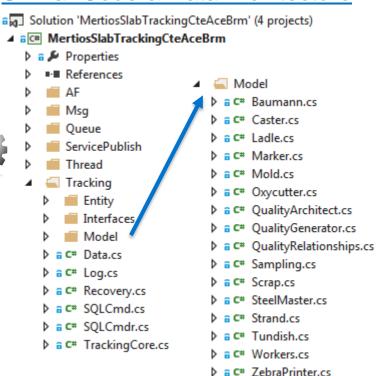| Name	Expression	Value	Output Attribute
StartTemperature	IF 'Chemical Elements|C' <= 0.471 THEN 1537 ELSE (IF 'Chemical Elements|C' > 0.471 AND 'Chemical Elemen	1537	Map
c1	IF 'Chemical Elements|C' <= 0.471 THEN 87 ELSE (IF 'Chemical Elements|C' > 0.471 AND 'Chemical Elements	87	Map
CorrectionSi	IF 'Chemical Elements|Si' <= 1 THEN (9 * 'Chemical Elements|Si') ELSE (Pow('Chemical Elements|Si',2) +	0.1683	Map
CorrectionCr	0.473 * 'Chemical Elements|Cr' + 0.208 * Pow('Chemical Elements|Cr',2) - 0.0123 * Pow('Chemical Element	0.029126	Map
CorrectionNi	IF 'Chemical Elements|Ni' <= 4.4 THEN (5 * 'Chemical Elements|Ni') ELSE ((1.92 * 'Chemical Elements|Ni'	0.34	Map
CorrectionV	IF 'Chemical Elements|V' <= 1 THEN (3 * 'Chemical Elements|V') ELSE (IF 'Chemical Elements|V' > 1 AND '	0.0009	Map
CorrectionMo	((19 * 'Chemical Elements|Mo') - Pow('Chemical Elements|Mo',2)) / 3	0.099983	Map

LiquidusTemperature	// Calculation is performed all time
	//IF 'Strand - Active' = "Yes" THEN
	//ELSE DigState("No Data")
	StartTemperature
	- c1 * 'Chemical Elements|C'
	- 5 * 'Chemical Elements|Mn'
	- 34 * 'Chemical Elements|P'
	- 40 * 'Chemical Elements|S'
	- 5 * 'Chemical Elements|Cu'
	- 8 * 'Chemical Elements|Sn'
	- 15 * 'Chemical Elements|Ti'
	- 9 * 'Chemical Elements|Nb'
	- 72 * 'Chemical Elements|N'
	- 0.2 * 'Chemical Elements|W'
	- CorrectionSi - CorrectionCr - CorrectionNi - CorrectionV - CorrectionMo
		1529.4	Liquidus Temperature

MaximumTempStop	// Calculation is performed all time
	//IF 'Strand - Active' = "Yes" THEN
	//ELSE DigState("No Data")
	LiquidusTemperature + 'Maximum Temperature (Stop) - Offset'
		1586	Maximum Temperature (Stop)

MinimumTempStart	// Calculation is performed all time
	//IF 'Strand - Active' = "Yes" THEN
	//ELSE DigState("No Data")
	LiquidusTemperature + 'Minimum Temperature (Start) - Offset'
		1540.5	Minimum Temperature (Start)

Interpret Raw Data with AFSDK / C# Windows Service

❖ Real-Time Complex Calculations:
  ❖ Ex: Integrate speed and use the distance to follow the virtual slabs movement.

❖ Monitor the quality signals and generates Event Frames
  ❖ Ex: Casting speed StdDev is active between 2016/02/29 10:02:26 to 2016/02/29 10:13:04.

❖ Monitor multi-variables process events and generates Event Frames
  ❖ Ex: Campaign Start, Ladle Open/Close, Slab X head reaches zone 3 rear position, etc...

❖ Push production data to MERTIOS using Stored Procedures
  ❖ Ex: Create campaign, request batch information, create batch, create slabs, etc…

❖ Has built-in recovery / backfilling capability
  ❖ Ex: Reprocess 8h of production data in 2-3 minutes, On-Demand L3 data is resent, etc…

Interpret Raw Data with AFSDK / C# Windows Service
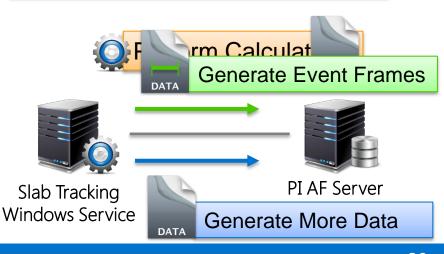
Similar Code & Data Architecture

Solution 'MertiosSlabTrackingCteAceBrm' (4 projects)
- **MertiosSlabTrackingCteAceBrm**
  - Properties
  - References
  - AF
  - Msg
  - Queue
  - ServicePublish
  - Thread
  - Tracking
    - Entity
    - Interfaces
    - Model
  - Data.cs
  - Log.cs
  - Recovery.cs
  - SQLCmd.cs
  - SQLCmdr.cs
  - TrackingCore.cs

- Model
  - Baumann.cs
  - Caster.cs
  - Ladle.cs
  - Marker.cs
  - Mold.cs
  - Oxycutter.cs
  - QualityArchitect.cs
  - QualityGenerator.cs
  - QualityRelationships.cs
  - Sampling.cs
  - Scrap.cs
  - SteelMaster.cs
  - Strand.cs
  - Tundish.cs
  - Workers.cs
  - ZebraPrinter.cs

Simplified Data Flow

Load Config in AF

Subscribe to AF Attributes using Event Pipe. Await data events.

Perform Calculat...

Generate Event Frames

Slab Tracking Windows Service

DATA

PI AF Server
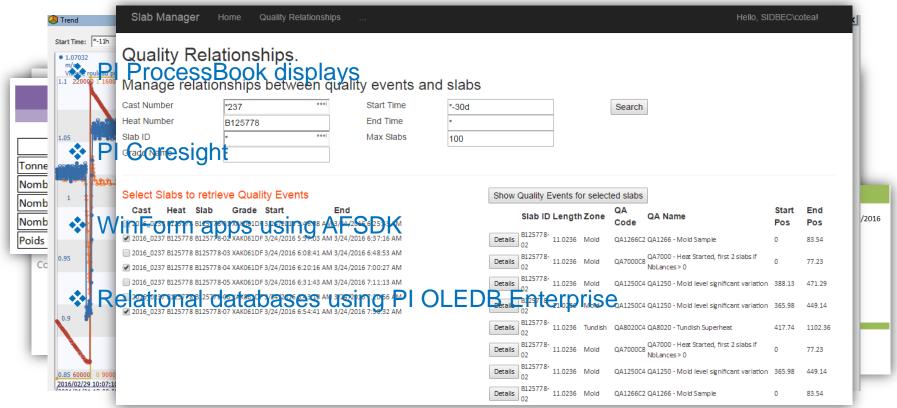
Generate More Data
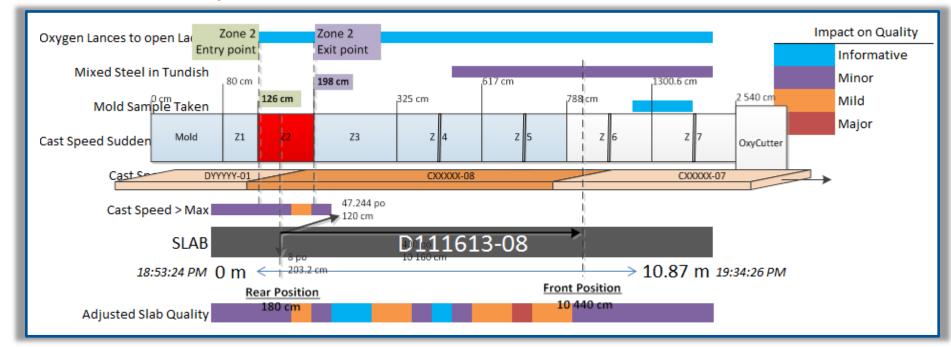
Contextualize data into batch using Event Frames

Correlate time-context data from Event Frames

Its all about Quality!

Build Operational Intelligence

… and other open architecture
Web Applications, configurations
& open data to users

- PI ProcessBook displays
- PI Coresight
- WinForm apps using AFSDK
- Relational databases using PI OLEDB Enterprise

Results & Benefits

- Success story in terms of process improvement, system quality, flexibility and reliability.
    - Project delivered in time and budget,
    - Zero downtime since go-live.

- Wide approval from operators & engineering users

- Process knowledge made available with open data history.

- Critical components for success

Future Plans & Takeaways

- Capture production knowledge and increase analytics,

- Take advantage of PI AF Templates for multiple-strands billet casting automation system,

- Awaits OSIsoft release of
  PI OPC DA Server connected to AF,

- Hope for EA with Corporate ArcelorMittal,

- Awaits PI Coresight 2016 with buildable dashboards using HTML5

Slab Casting Automation – Contextualize Raw Data into Operational Intelligence

COMPANY and GOAL

ArcelorMittal Long Products Canada produces Steel and wanted to **migrate its legacy system** while **improving the quality of its processes**.

CHALLENGE

Migrate legacy « all-in-one » system into next generation L2 standard platform.

- Open data to engineers & specialists for ad-hoc analytics.
- Build a flexible and re-usable architecture with standardized calculation, models, and platforms.

SOLUTION

Slab Tracking uses the AF Process Data Structure and the AFSDK to generate batches in Event Frames.

- Real-time calculations using Asset Analytics.
- System interfacing facilitated with PI OPC DA and AF Tables.
- PI Notifications to enable operational communication.

RESULTS

In production since October 2015 with zero loss time and wide-approval from all users.

- PI Asset Framework and Event Frames becoming a center piece of the production system.

Contact Information

Jean-Yves St-Onge

jean-yves.st-onge@arcelormittal.com

Director of automation

Alexandre Côté

Alexandre.Cote@pa-ats.com

Automation | Software Engineer

Questions

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

State your **name & company**

Please remember to…

Complete the Online Survey for this session

Download the Conference App for OSIsoft Users Conference 2016

- View the latest agenda and create your own
- Meet and connect with other attendees

Download on the App Store

GET IT ON Google Play

HTML

search **OSISOFT** in the app store

http://ddut.ch/osisoft