Rolling into the Future by Digitalization of Long Rolling Control Systems

Paul Riches
Future requirements of the Metals Industry

Customer requirements

FUTURE
- End-customer integration
- Lot-size 1
- New business models
- Know-How management
- Supplier integration
- New steel grades
- Availability of information
- Ergonomy / Operator support

Achieved by Holistic Automation

TODAY
- Communication Technologies
- Computational power
- Internet technologies
- Cloud technologies
- Big data analytics
- Self-learning systems
- Mobile devices
- Augmented reality

MAJOR STEEL PRODUCING REQUIREMENTS
Portfolio to meet the Industry’s requirement

TODAY

- Smart Sensors
- Condition Monitoring
- Data-Based Services

Equipment – Zero Failures

TOMORROW

- Cyber-Physical Systems
- Data-Based Services
  - SMART Work
  - Connectivity

Production – Flexibility and Efficient

- Though-Process Quality Control / Productivity Control

Product – Zero defects
Digitalization of Long Rolling Control Systems – Smart Sensors

New INNOVATIVE MEASUREMENT SYSTEMS for IMPROVED PROCESS CONTROL

- Know more – understand, measure, automate and improve your processes

Provide additional information about the process or the entire plant.

Directly measure physical values or use existing measures to indirectly calculate additional information.

Smart sensors are the enablers for the implementation of advanced automatic functions, process models, as well as condition monitoring.

Example:
Camera-based measurement systems, non contact speed measurement systems. RFID tracking systems, Intelligent Temperature Measurement

- Non Contact Speed Measurement
  - Crop optimization
  - Pinch roll Control
  - Tension Control
  - Dynamic Mill Set up

- Imaging Technology
  - Bar Counting
  - Product measurement
  - Billet Positioning
  - Coil positioning

- Intelligent Temperature Measurement
  - Thermomechanical Rolling Control
  - Control of Product transition point
  - Enhanced Temperature control

- Finished Product Tracking and Logistics
  - Coil Tracking
  - Bundle Tracking
  - Coil and bundle yard logistics
  - Shipping logistics
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Smart Sensors Hydraulic Expert – Soft Sensor

- Soft sensor monitors critical Actuators of the Mill Stand and Auxiliary Equipment
- Warning to Operator in case of bad conditions for Rolling (e.g. high friction by wear, leakages etc)

Example: Monitoring of Hydraulic System, servo control of cylinders (Leakage)

```
Servo valve with hydraulic cylinder:
Control spool position yv
Pressure A-Side pa
Pressure B-Side pb
Piston position sk
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internal leakage HGC-cylinder between A and B-side (caused by worn cylinder seal)

Nominal Servo valve flow by estimate of an trust-region to detect the control spool edge erosion

Example Loop:

True value
lower boundary
upper boundary

Source: Isermann
Digitalization of Long Rolling Control Systems
– Automated Functions

• More focus on the essentials

Repetitive, labour-intensive and dangerous work is supported by fully-automated mechatronic solutions.

This gives more time to focus on the critical tasks.

Allows OPERATORS to focus on operating

Example:
Automated laying head pipe change robot, roll change robot, shear blade change
Digitalization of Long Rolling Control Systems
– Cyber Physical Systems

Your plant and its digital twin

Process models, digital “twins” of the plant, enable process optimization in real-time as well as offline simulation.

This means perfect process guidance and full support for further process development.

PROCESS CHANGE with CONFIDENCE

Example:
ROPES, RollMaster, ETCS, IDRa

Cyber-Physical System

Modelling
Optimization
Simulation

VIRTUAL PLANT

REAL (physical) PLANT

Simulation allows pre-visualization of what will happen in the real plant

Temperature Control Simulation
RollMaster Simulation
Knowing how your plant “feels”

Comprehensive information about the condition of the equipment and the respective processes enables predictive maintenance, which will help to avoid unplanned outages.

This means improved plant availability and therefore increased plant productivity.

Example:
No Twist Mill Condition Monitoring
RSM Conditioning Monitoring,
Mill Stand Monitoring System
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– Smart Work

To ensure best possible operation and maintenance of a plant, a vast array of information sources is required. The core concept of “smart work” is that all personnel will automatically receive exactly the information they need at the time to get their job done. This means that all information is automatically tailored to the actual needs of the staff.

Example:
Online-documentation retrieved via QR-coded equipment,
Augmented reality applications to guide maintenance work

Any data – Anywhere – Anytime

Increased efficiency in Maintenance
Digitalization of Long Rolling Control Systems

– Connectivity

Get connected – anytime – anywhere

Advanced communication technologies now allow for information to be transported beyond former limitations.

From the collection of sensor data in harsh environments or from mobile equipment to displaying the information on smart personnel devices.

From the shop floor to the „manager’s pocket“

Example:
Wireless control of Coil Handling Systems, KPI dashboards for mobile devices
Process Expert

„What if to compare and optimize plants and/or components … ?“
Digitalization

– Typical Wire Rod Mill

<table>
<thead>
<tr>
<th>FURNACE</th>
<th>RM</th>
<th>IM</th>
<th>FM</th>
<th>STELMOR COOLING</th>
<th>COIL HANDLING</th>
<th>RESULT</th>
<th>Pre-coat Sensor</th>
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<tbody>
<tr>
<td></td>
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<td>SMART WORK</td>
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<td>Height and width measurement</td>
<td>Height and width measurement</td>
<td>INFORMATIION AVAILABILITY WHEN REQUIRED</td>
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</table>
|         |    |    |    | STOCK CONTROL IN RMBL / IMILL CONSISTANCY IN MTC AND MILL SETUP PREDICTIVE COOLING | Vision / Non Contact Laser
|         |    |    |    | YIELD IMPROVEMENT [SHEAR CONTROL], MASS FLOW CALC MTC BETWEEN FINISHING BLOCKS (IMPROVE PRODUCT TOLERANCE DYNAMIC MILL SET UP PINCH ROLL CONTROL LOYING HEAD CONTROL) | Non Contact Laser |
|         |    |    |    | Auto coil Position | IMPROVE QUALITY | Vision System |
|         |    |    |    | Temperature Control | IMPROVE QUALITY, DEFINE PRODUCT TRANSFORMATION POINT | Thermal scan |
|         |    |    |    | Auto coil shape control | COIL PACKAGE IMPROVEMENT | Vision |
|         |    |    |    | Intelli Coil | LOGISTICS IMPROVEMENT IN COIL YARD | Wireless TAG |
|         |    |    |    | AUTOMATIC-FUNCTIONS | REDUCE LABOUR INTENSIVE OPS | Auto Functions |
|         |    |    |    | CONDITION MONITORING (CMS) | INCREASED EFFICIENCY OF MAINTENANCE AND REDUCED DOWNTIME | |
Digitalization of Long Rolling Control Systems

– Digital Unity

**Production Management System**

**PMS** dynamically plans and tracks your production to utilize your production facilities in an optimized manner, from the customer order, down to each individual production step.

It optimizes productivity and ensures maximum flexibility to meet your customer requirements.

**Through Process Optimization**

**TPOpt** provides know-how based identification of non-conformities, identifies the related root-cause and provides corrective and compensational actions throughout the entire production chain.

It effectively helps to achieve the intended product specifications and supports your quality management.

**Computerized Maintenance Management System**

**CMMS** assists you to manage and execute your maintenance in an entirely new way. Built in know how generates actionable items, according to your strategy, increases efficiency of your maintenance personnel and unleashes the true value of you assets.
Digitalization of Long Rolling Control Systems – Production Management System

MANUFACTURING EXECUTION
Realtime information about the production process
Transparency across the whole process chain
Logistics

ORDER & LINE SCHEDULING
Cross-plant scheduling of the order book
Throughput optimization

PRODUCT DEFINITION, ORDER DRESSER
Transformation of sales orders to process and quality instructions
Centralized process knowledge base

PLANNING
Holistic planning from melt shop to shipping, from demand planning to material planning

Benefits
• Increased utilization of production facilities
• Higher productivity with increased flexibility and better quality
• Reduced inventory
Digitalization of Long Rolling Control Systems – Through Process Optimization

- TPOpt is an important element for the horizontal integration in the Smart Factory
- TPOpt = Quality Management + Root-Cause Identification + Corrective Action
- Data analysis is combined with an rule-based expert system
Digitalization of Long Rolling Control Systems
- Computerized Maintenance Management System

**MAINTENANCE MANAGEMENT**
Real time transparency on work, material, assets
Automatic work order suggestions based on your asset strategies
Advanced planning, mobile work execution
Data History for every asset
Link business data to ERP

**PREDICTIVE MAINTENANCE**
Pre-set link to CMS
Analytics on CMS data and maint history enables predictive maintenance

**MAINTENANCE KNOW HOW PACKAGES**
Actionable items for your team from condition monitoring information
Analytics on your growing maintenance kno how base
Select maintenance strategy to maximize asset performance Based on advanced analytics
Increase productivity through smart networking with plant data and PMS

**Benefits**
- Smart Maintenance schedule adjusted to order scheduling and vice versa
- Trim your expenses according to the best maintenance strategy for your plant
- Maintenance data available for analytics and deep learning
Digitalization of Long Rolling Control Systems
- Fully Automated Factory
Digitalization of Long Rolling Control Systems

– SUMMARY

SUMMARY

• Industry 4.0 is not available “off the shelf”
• Digitalization started years ago and will not be finished within a few years
• Each steel plant must define their own particular implementation strategy for Industry 4.0 readiness
• Suppliers should actively assist plant operators in the digital transformation of their production plants, with portfolio elements and services based on their future requirements and strategy
• Products, systems will have immediate customer value
• Implementation will be phased, step-by-step, e.g. in modernization projects
• Developments in all directions - Quality, Productivity and Flexibility
CONCLUSION

• In many ways Industry 4.0 has arrived
• Elements of this approach are already developed, installed and being tested globally
• Long rolling customers can access the expertise of suppliers in the digital transformation of their production plants
• A phased approach will enable customers to establish both their short and long term goals.
• This approach will enable customers to optimize the implementation of these ever-evolving technologies and harness the full power of Industry 4.0.

Is this a REVOLUTION or EVOLUTION!
Thank You “For your attention”

Paul Riches