Das virtuelle Walzwerk – Weg zum Cyber-Physical System

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(1) Achenbach Buschhütten – a family company

(2) Rolling mill - challenges in optimization

(3) Cyber mill - architecture

(4) HiL possibilities - R&D and problem solution tool
Achenbach is one of the oldest family companies in Germany.

Today Achenbach is a system supplier for non-ferrous rolling mills and foil slitting machines:
Objective:
- Stable processes
- Short commissioning time

Challenges:
- Machine complexity
  - mechanical
  - electrical
  - hydraulic/pneumatic aggregates
  - and measurement components

Rolling mill - challenges in optimization (1)
Rolling mill - challenges in optimization (2)

Objective:
- 7/24 availability
- Highest quality by fast production

Challenges:
- Highly dynamic process (fast speed 2500 m/min, huge masses 32t coils)
- Minimum failure tolerances - high costs (scrap material, outage)
Cyber mill architecture (1)

Data records

Process Data Acquisition (PDA)

Mill Model

Database of Virtual Coils

Rolled Coils Data

Mill Controller

Model

Simulink Coder & M-Target

MathWorks

Mill Model Task

Mill Controllers
Cyber mill architecture (2)
HiL possibilities - R&D and problem solution tool

HiL possibilities - R&D and problem solution tool

**R&D**
- New controllers design and test
- Generation of virtual data
- Better understanding of rolling physics
- Faster commissioning
- Failure probability reduction

**Troubleshooting and Learning tool**
- Modeling and replaying of new situations
- Validation of detected problems
- Scrap free practice for mill Operators
- Maintenance personal
Thank you for your kind attention – Keep On Rolling!

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Process data acquisition

**Entry Thickness (time)**

**Entry Thickness (length)**
Mill HMI and coils handling DB

Database of Virtual Coils
Mill model - time varying model (1)
Mill model - time varying model (2)

**Internal model**

1. Xuncoil
   - Hen_upstream
     - Vcoil
     - Tens_up_str
   - UncMtorque
     Unit: N.m
   - Xentry_strip

2. Inter threaded element Strip
   - Tens_down_str
   - Hen_down_str
   - GapSetting
     Unit: mm

3. Xstand
   - Ventry
   - RollSpeed
     Unit: m/s

4. Inter threaded element Strip
   - Xexit_strip
   - RecMtorque
     Unit: N.m

5. Xrecoil
Controller models constructed based on:
- physical principles (mill stand, actuators and sensors dynamics)
- heuristic principles (speed effect – disturbance model)

Regulator algorithm computes a sequence of future actions (MV's):
- to minimize an "objective" function (Gauge error)
- to respect the constraints (actuators)
Mill controllers

THE VIRTUAL ROLLING MILL

Mill Controllers