PSI Metals – 5 Steps Towards Autonomous Scheduling

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Plans are Nothing
Planning is Everything

*Dwight David „Ike“ Eisenhower*
Poll

Do you think that investing in new IT technologies should be:

👍 Rather done in crises
👎 Better wait for bull market times
 tvb Not sure
Digital Transformation

The Journey
Ever Faster Market Changes Require Rapid Adaptation and Innovation!
Industry 4.0

- Autonomous Robots
- Simulation
- System Integration
- Internet of Things
- Cybersecurity
- Cloud Computing
- Big Data
- Augmented Reality
- Additive Manufacturing
Ever Faster Market Changes Require Rapid Adaptation and Innovation!

Know-how: ferrous & nonferrous, process knowledge, consulting

Software: products, IT-technology

People: metals expertise, global network
Poll

Do you think that AI (Artificial Intelligence) will be relevant for Aluminium business within the next 5 years?

👍 Yes
👎 No
👋 Not sure
Typical Reaction to Unplanned Events – Time is Money

- Event
- Insights about event become available
- Analysis completed
- (Counter-)measure approved
- (Counter-)measure takes effect

Reducing latencies provides great potential to reduce value losses

Delays/Loss of Value

Value of Reactive Adjustment

Insight latency
Analysis latency
Decision latency
Action latency
Culture
Most defects are related to the early stages of the production process but often only discovered at the finishing stages.
The REAL Value Behind Digitalization – Reaction Time is Money

„Through agile value chains errors can be identified early and productivity can be increased incrementally!“ (Stich, FIR)

Technological drivers of Industry 4.0
- Real-time capability
- Systems integration
- Big Data Analytics
- Machine Learning and Artificial Intelligence
- Decision support systems
- Automated decision making
- Vertical and horizontal process and systems integration
- Cyber-physical systems

Value of adaptation vs. t: Event, (Counter-)measure takes effect, time saved / increased value
Reaction Time is Money

Technological Drivers of Industry 4.0

- Real-time capability
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Value of adaptation

Organizational structure

Culture

Event

(Counter-)measure takes effect

Insights about event become available

time saved / increased value
Integrated Planning
The base for Industry 4.0
Seamless integration of the latest Artificial Intelligence (AI) and Machine Learning Services

The base for flexible processes
Flexible orchestration of Standard Services fulfilling individual business process requirements

The base for extensibility
Open concept for Services from PSI as well as partners, customers, or 3rd parties

The base for scalability
Improved solution scalability and non-disruptive solution extensions or service updates due to Service Architecture
Enhancing Existing PSImetals Solutions With the PSImetals Service Platform

- Existing PSImetals solutions can be connected to the PSImetals SP
- New value-added services become available immediately
- Existing services can be migrated as needed

This approach is used for the standard product PSImetals as well as for specific customer implementations
Changing market circumstances create new challenges for our customers. Whole business models are under pressure. PSImetals FutureLab is the new approach for developing solutions for today’s and future challenges by supporting our customers to overcome them.
PSImetals FutureLab – Areas of Innovation

- Autonomous Agents
  - Autonomous Planning Services
  - Schedule Execution Services
  - Reactive Scheduling Services
  - Monitoring Services

- FutureLab RESEARCH AREAS
  - Reactiveness
  - Autonomy
  - Intelligence
  - User Experience

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Use Case – Autonomous Deviation Detection and Reactive Scheduling
Autonomous Scheduling Packages – 5 Steps

1. PRO-ACTIVE CONFIGURATION
2. PRO-ACTIVE SCHEDULING
3. OPERATIONAL AGENTS
4. ADAPTIVE SCHEDULING RULES & TUNING
5. SELF EXPLAINING
Step 1 – Pro-Active Configuration

COIL YARD REACHABILITY MONITORING

TRIMMING KNIVES MONITORING

SLAB SIZING PRESS MONITORING

ADJUST CIRCUMSTANTIAL SCHEDULING RULES

RE-OPTIMIZE SCHEDULE

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Step 2 – Pro-Active Scheduling

BLOCKED COIL

AVAILABILITY CHECK

TRANSPORT CHECK

DE-SCHEDULE COILS

CHECK SCHEDULE QUALITY

Valid schedule

Invalid schedule

RE-OPTIMIZE SCHEDULE
Step 3 – Operational Agents

Re-assign Agent

UNASSIGNED MU → MATCH & SELECT CANDIDATE PO → ASSIGN PO TO MU → ASSIGN

MATCH MU TO PO → FORWARD DRESSING

Unblocking Agent

MATERIAL BLOCKED → QUALITY DECISION → UNBLOCK

RE-ASSIGN

GENERATE REWORK ORDER

UN-ASSIGN & SCRAP

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HyMAS – Hybrid Multi-Agent System – Research Project

Produktionsmanagement in Stahl und Aluminium

Virtuelles Stahlwerk

Koordinationsmechanismen

Software Framework & Steuerungsarchitektur

Methoden/Algorithmen

Selbstmodell und Test-Bench

NextGen PMS4Metals

Data analytics & visualization

Process Mining

Entwicklungs-

umgebung

Implementierung MAS

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Step 4 – Adaptive Scheduling Rules and Tuning – Based on Reinforcement Learning and AI Research Project with VUB and UCL Universities

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Step 5 – Self Explaining – Chatbot to Help Users Understand Results of Planning Solvers

Chatbot

Alright, I will need the **production line number**, please.

2

Okay, production line **LAL_CRM2** is used **21.0%** of the time, during **7/30** time buckets. More information is available on the ‘flow results’ screen.

which orders will be late?

**5733** orders out of **5733** orders will be late. Here are the names of the first 3 ones: 0000000073-000010_F0201508 0000000073-000010_F0201509 0000000073-000010_F0201516

Note that **1907** orders that won’t be completed are actually forbidden (i.e. **33.3%** of the unplanned orders).

why is the hot strip mill used only **7%** of the time?

Okay, the production line **LAL_HSM** is actually used at **26.7%** of its capacity because some orders have their due date after the time horizon (the end time of the last time bucket), therefore the solver decided not to plan them.
Poll

What would convince you to think about implementing planning and scheduling optimization tools?

👍 ROI within 1 year

👎 ROI less than half a year

👏 Planning and scheduling optimization is not our current focus
What Improvements are Possible?

- **Planning time reduction**: > 80%
- **Longer schedules**: 20%
- **Material availability**: 99.9%
- **Service rate**: 10%
- **Due date fulfilment**: > 90%
- **Inventory Levels**: Improved visibility
- **Order book**: > 80%
- **Planning time reduction**: 29%
- **Inventory Levels**: Improved visibility
- **Material availability**: > 80%
- **Service rate**: 10%
- **Due date fulfilment**: > 90%
- **Order book**: > 80%
- **Planning time reduction**: 29%
What Improvements are Possible?

50,000 t/a

2,000 EUR/t

> 1 Mio

Better Performance

< ½ year ROI

Improvements

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Made by PSImetals Logistics.

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50,000 t/a

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> 1 Mio

Better Performance

< ½ year ROI

Improvements

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Made by PSImetals Logistics.
Failing To Plan Is Planning To Fail!
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