Contribution ID: **339**                                    Type: **Oral Presentation**

# HyMAS: A Hybrid Multi-Agent Framework for Autonomous Steel Production Planning

*Thursday 9 October 2025 10:40 (20 minutes)*

Steel is a cornerstone of global infrastructure but its production faces inherent complexity due to high energy consumption, strict quality demands, and sophisticated production process. While traditional planning methods rely on rigid, centralized frameworks, they struggle to adapt to disruptions like equipment failures or material defects, leading to inefficiencies and financial losses. These complexities require autonomous, intelligent solutions that rapidly generate and propose optimized schedules, enabling swift, data-driven rescheduling in response to disruptions. To address this, we present HyMAS, a Hybrid Multi-Agent System, which enables dynamic, resilient decision-making in steel manufacturing. HyMAS employs a hierarchical network of autonomous agents: resource agents govern separate lines, process agents manage entire production stages, and process chain agents coordinate sequential operations. This modular structure allows localized adjustments to production plans without requiring full-scale re-planning, significantly reducing decision time and increasing flexibility. Integrated with Industry 4.0 frameworks, the system interfaces with Manufacturing Execution Systems, leverages digital twins to simulate disruption impacts, and applies machine learning to predict material quality and process mining to monitor performance. In a case study involving a cold rolling mill, three annealing lines, and intermediate storage, HyMAS achieved an 18% efficiency gain and an 8% improvement in on-time delivery. These results demonstrate the system's ability to improve operational performance while maintaining high levels of adaptability. By leveraging autonomous, intelligent agents, HyMAS rapidly generates and proposes optimized schedules, empowering manufacturers to mitigate financial risks, reduce decision time, and enhance operational agility. Additionally, planning adjustments can now be implemented much more swiftly than before, ensuring a more resilient and responsive production environment. By gradually integrating autonomous, intelligent rescheduling into production planning, HyMAS unlocks the potential of real-time data to systematically enhance efficiency, responsiveness, and operational resilience.

**Primary author:**   IVANOV, Anton (PSI Software SE)

**Co-authors:**    WOLF, Heiko (PSI Software SE - Process Industries & Metals);   Dr LENZ, Ralf (PSI Software SE)

**Presenter:**   IVANOV, Anton (PSI Software SE)

**Session Classification:**   Digital transformation - Steel materials and their application

**Track Classification:**   Digital tranformation