



Contribution ID: 31

Type: not specified

## Reinforcement Learning-Based Decision Support for Maintenance Optimization in the Steel Industry

Scrap-based steel production plays an essential role in promoting sustainable industrial practices by significantly reducing energy consumption and greenhouse gas emissions compared with conventional ore-based steelmaking. Despite these benefits, maintaining high operational efficiency, reducing the costs associated with recycling operations, and ensuring product quality in scrap-based production lines remain challenging. In particular, critical machines such as shredders and processing units operate within interconnected production systems, where failures or maintenance interventions can affect the overall performance of the system. This study proposes a deep reinforcement learning (DRL) framework to support inspection and maintenance decision-making in a scrap-based steel production line modeled as a multi-component system with interdependent components. The proposed approach dynamically recommends inspection time and maintenance actions based on the observed operational conditions of the production system, including machine productivity, buffer levels, and production demand. To represent the stochastic behavior of the production line, a simulation environment was developed incorporating practical industrial features such as variable production rates, uncertain maintenance durations, and component degradation processes. This environment enables the training of DRL agents capable of learning adaptive maintenance policies under dynamic operating conditions. The effectiveness of the DRL-based policies is evaluated by comparing them with commonly used maintenance strategies, including corrective maintenance, time-based maintenance, and condition-based maintenance. Results from the case study demonstrate that the DRL approach can effectively learn adaptive maintenance strategies that balance inspection frequency, maintenance timing, and production requirements. Compared with conventional maintenance policies, the DRL approach demonstrates strong potential to reduce operational costs while enhancing system reliability and production efficiency. These results highlight the potential of reinforcement learning as a decision-support tool for maintenance management in complex industrial systems. By enabling adaptive and data-driven maintenance planning, the proposed framework contributes to improving both the operational performance and sustainability of scrap-based steel production.

**Primary authors:** Dr ALBERTI, Alexandre (Universidade Federal de Pernambuco); Dr RODRIGUES, Augusto (Universidade Federal de Pernambuco); Prof. CAVALCANTE, Cristiano (Universidade Federal de Pernambuco); Dr FERREIRA NETO, Waldomiro (Universidade Federal de Pernambuco)

**Presenter:** Dr FERREIRA NETO, Waldomiro (Universidade Federal de Pernambuco)

**Track Classification:** Spring Meeting