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# IFAC 2017: Open Invited Track: Advanced control of comminution processes

## 1. Abstract

This session focusses on the modelling, control and optimisation of comminution processes in the mineral processing industry. Cost pressures and a competitive economic environment provides a challenge to process engineers to seek operating conditions where the largest economic benefit is achieved. Although plant-wide control and economic optimisation is becoming more prevalent in other process industries, it has yet to be extended to the mineral processing industry. Part of the challenge is to establish reliable models applicable over large ranges of operation, to obtain sufficient real-time information from sensors and soft-sensors to apply control, and subsequently to implement advanced process control strategies in industry. In relation to the aim of economic optimisation, the session aims to discuss the development and application of models and soft-sensors suitable for advanced process control of comminution processes.

## 2. Technical Committee

TC 6.2 Mining Mineral and Metal Processing

## 3. Organizers

Mr Derik le Roux
University of Pretoria
Email: derik.leroux@up.ac.za

Prof Ian Craig
University of Pretoria
Email: ian.craig@up.ac.za

## 4. Description

The general control objectives for a comminution process is to improve the quality of the product, to maximise the throughput, to decrease the power consumption, to reduce the usage of grinding media and to improve process stability. However, these objectives are interrelated and necessitate certain trade-offs to be made (Craig and MacLeod 1995, Edwards et al. 2002). To achieve the control objectives for a comminution process, three issues need to be resolved (Qin and Badgwell 2003, Dochain et al. 2008, Craig et al. 2011):

- The realistic approach to control system analysis and synthesis for complex systems.
- The development of advanced control strategies which can be implemented with relative ease.
- The design of accurate process models to be used for model-based control and observer design.

The increased pressure from markets necessitates economic optimisation of processing plants. However, economic optimisation requires a function capable of encapsulating the economic performance of the plant. A systematic approach is required not only to identify the relevant process variables of the comminution process which influence the economic performance of the plant, but how to relate these variables to the economic performance of the entire plant. Once the relationship between the comminution process and the economic performance of the plant is formalised, a control structure is required which is capable of achieving the plant-wide control objective (Skogestad 2004).

Traditionally milling circuits are controlled by decentralized PID controllers, despite the multivariable nature of the circuits (Pomerleau et al. 2000). Significant improvement in product quality, throughput and power consumption is possible through multivariable control techniques. However, these techniques have not yet found traction in industrial circuits. One of the challenges is to find relatively simple non-linear models relevant for model-based process control (Powell and Morrison 2009, Le Roux et al. 2013). Linear models are limited to a narrow range of operations, and complex non-linear models require too many parameters to estimate. Even in the case of simple non-linear models, the lack of real-time measurements on industrial plants (Wei and Craig 2009) creates a challenge to estimate states and parameters to update controller models (Le Roux 2016).

The aims of the session includes, but are not limited to, the development and application of models and soft-sensors suitable for advanced process control of comminution processes. The session also aims to address suitable controller design techniques including fault-tolerant control for the autonomous operation of comminution processes.

Proposal submitted to 20th IFAC World Congress. Received September 15, 2016.

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