Mining Magazine Congress 2010

Drill & Blast... Load & Haul... Crushing & Conveying... Processing

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Focus on Operational Improvement – Grinding Optimisation using Simulation

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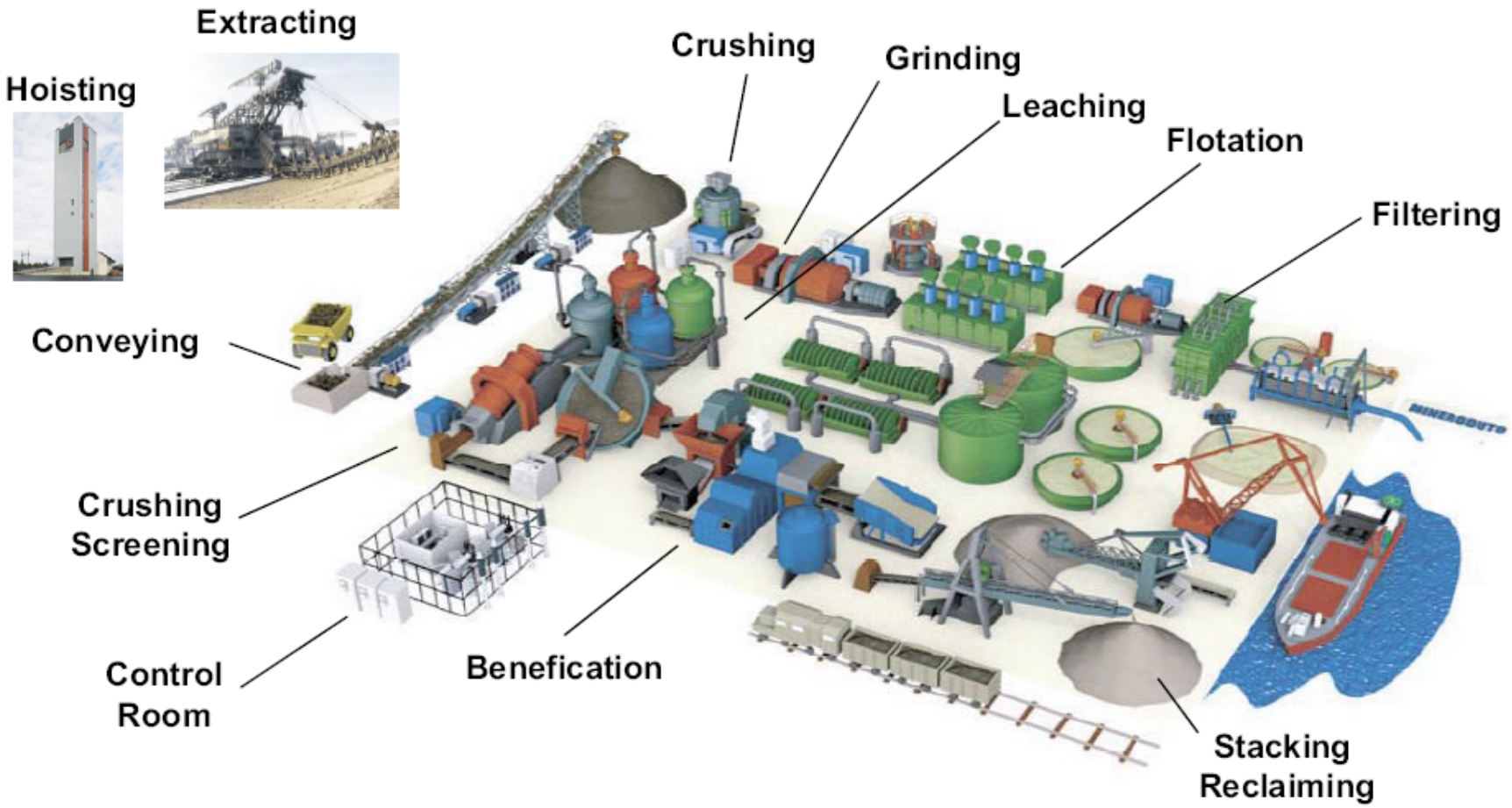
Modelling and Simulating Crushing and Grinding Circuits

- Why ?
  - Crushing and Grinding are two of the most energy intensive processes - Reduction energy cost – i.e. improve efficiency
  - Improve performance of crushing and grinding (comminution) circuit
  - Provide training platform for operator/engineers

- What are we trying to do
  - Save energy by reducing amount of material ground below target size
  - Reduce the quantity of material being wasted as slime
  - Improve production and quality of product
  - Optimise process via validated models

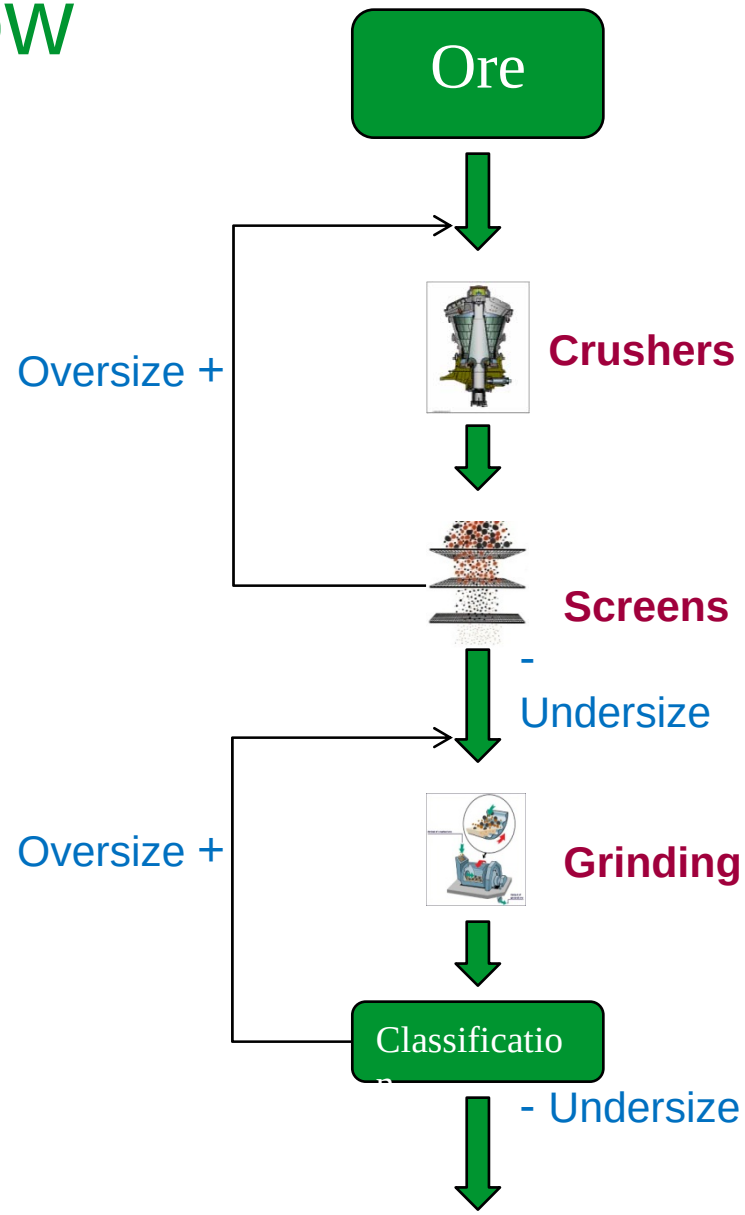
Mining and Minerals

Vijeo Citect + UAG + Unity + dedicated mining library!



Process Flow

Flow sheet



Modelling and Simulation

- Issues which impact modelling and simulation

  - Changes in the nature of feed properties
    - Feed density
    - Particle size
    - Material hardness
    - Impurity/Valuable material ratio

  - Upstream/downstream disturbances that can be measure or unmeasured

Modelling and Simulation

- The Model – Static or Dynamic?
  - Key factor to developing the process model are;
    - Profile the process – collection of key data
    - Understand the process dynamics
    - Understand process interactions
- Validation of Process Model
  - How does the model reflect the process?

Process Dynamics

Understanding the process and interactions

Disturbances may be measured

- Understand the impact of disturbances on the process
- Be aware of changes in the nature of feed properties
    - Feed density
    - Particle size
    - Material hardness
    - Impurity/Valuable material ratio
- Mine production rate – Need for feed stockpile

Process Dynamics

First Order Dynamics

Definition: A system whose output is modelled by a a first order differential equation. In the Laplace Domain, general first-order transfer functions are described by Equation.

First-Order Process $$G_p(s) = \frac{Y(s)}{X(s)} = \frac{K_p}{\tau_p s + 1}$$

Where:

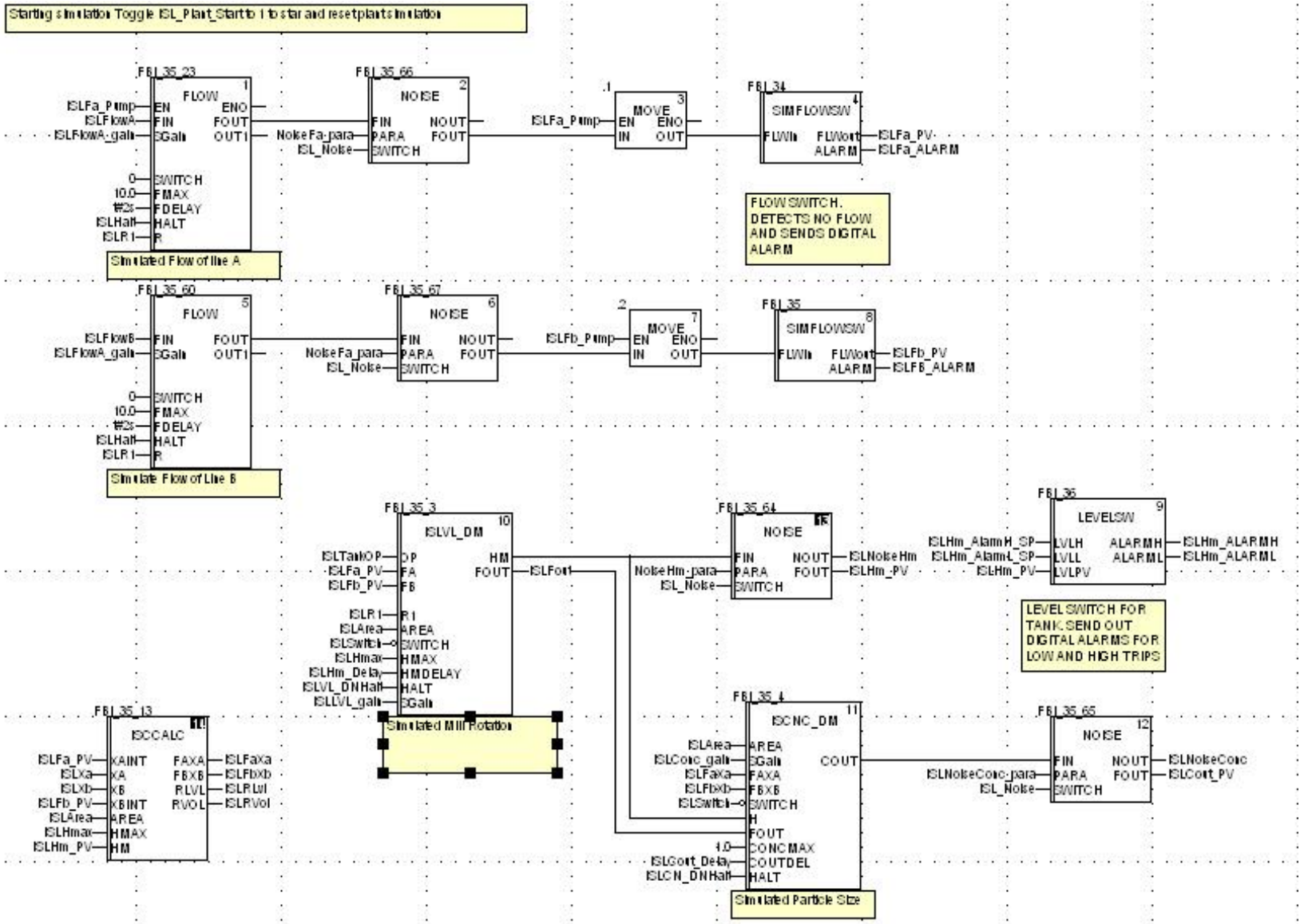
Kp: Process gain

τ_p: Time Constant

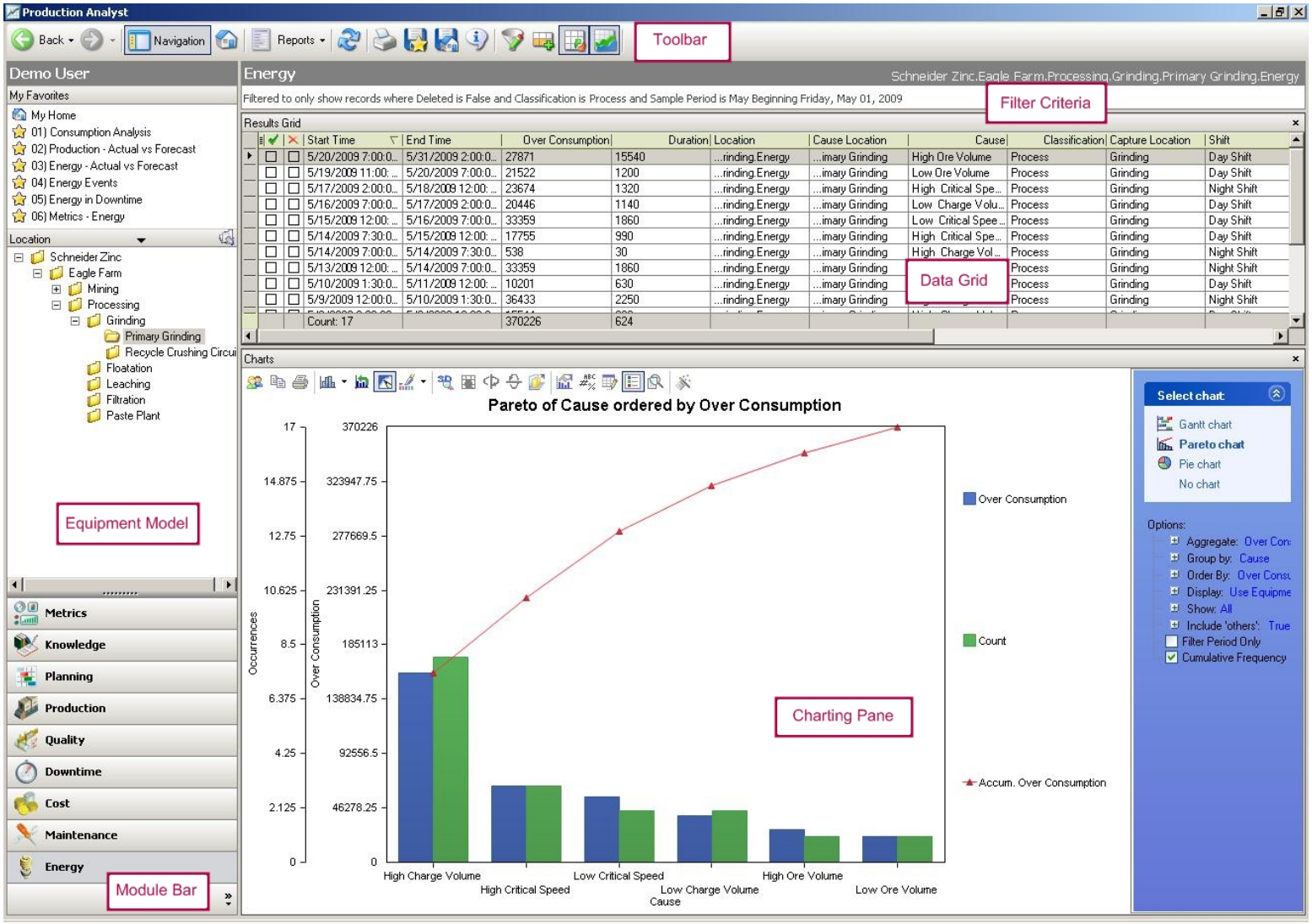
Modelling and Simulation

- Modelling packages
  - A number of simulation environments are available which will integrate with process control systems (PLC, PAC, DCS) through OPC or native drivers
- Model base control tools
  - There are a range of MPC (Model predictive control) function blocks design for implementation with Modicon PLC or PAC (Form part of dedicated mining libraries)

Modelling and Simulation Example



Modelling and Simulation Example



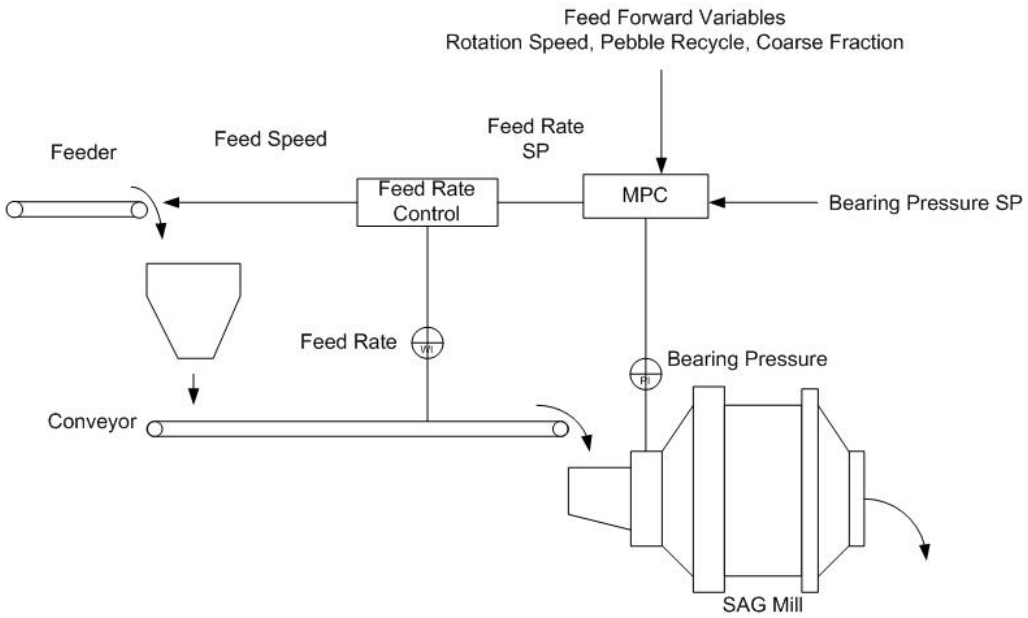
Example - Model Predictive Control

Typical SAG Mill MPC Control

Typical applications of model-predictive controller for a SAG Mill is for the control of the mill load

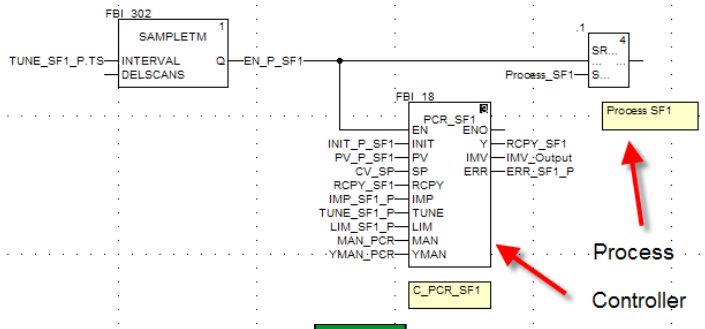
Mill load can be inferred from either direct weight measurement or bearing oil pressure

Example



PCR Control Library

Design of the Control – Implementation



Conclusion

- Modelling and simulation can provide a robust method for optimising the comminution process
  - Need to have reliable process data – Reliable measurements
  - Need to understand the process dynamic and disturbances
- Models and simulation can provide a bench mark for the process
  - Process optimisation – Energy efficiency
  - Process control optimisation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Questions

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