

On-line Analysis – Fast Return of Investment

Mining Process Industry



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Global Product Manager – Malvern Panalytical



- Chemical Engineer
- Over 30 years in process and quality control
- Commissioning plants and retrofits
- Global Product Manager – Process Control Products

Conclusions



- Increased Control provides the value
 - Very Site Specific
 - Problem/Solution
- Increased focus on **on-line /at-line analyzers**
 - More Frequent Analyses
 - Faster Analyses
- **Control** early in the process
- **Sort** / Blend / Monitor
- **Neutron** (Elemental) **NIR** (Mineral), **Laser** (Size), **Process Lab** (any)

Conclusions

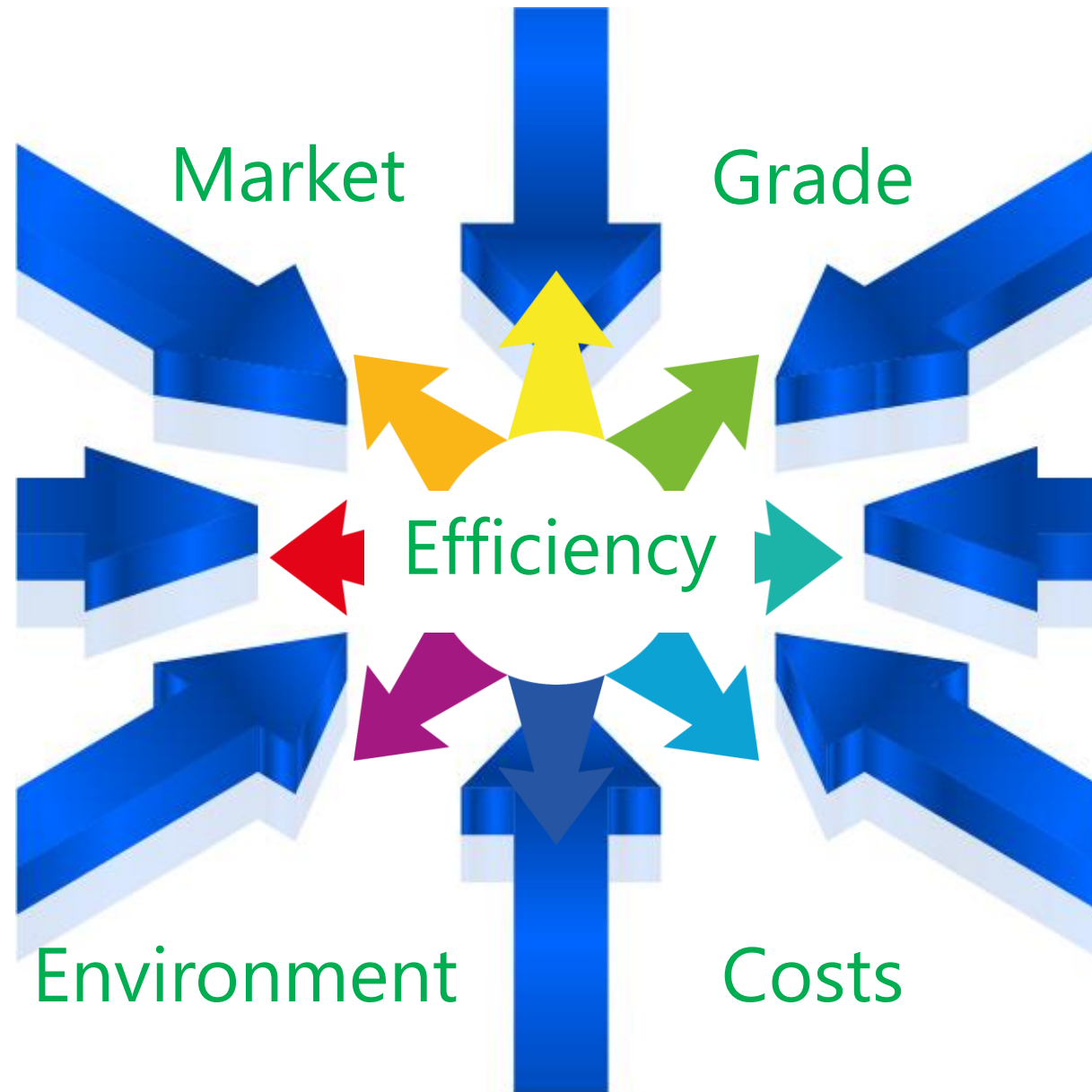
- Measuring is not Controlling
- Define **problem before** defining **solution**



Pressures on Business



Pressures on Business



Efficiency via Process Control

Quality Control

Many Common Challenges

Brazil –2019



- Iron Pelletizing Plant
- Cement Plant

Problems/Challenges

Iron Ore

- Varying Quality from Mine
- Limited information from hourly manual samples
- Slow analytical results
- Need to improve stability/cost/quality

Cement

- Varying Quality from Quarry
- Limited information from manual samples
- Slow analytical results
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Control efforts
limited by the
Laboratory

Laboratory Information

Challenges to Process Control



- Sampling Ratio
- Too Few Samples (hourly composites)
- Results too slow for effective control

A large, layered rock specimen, possibly a sedimentary rock like shale or sandstone, showing distinct horizontal bands of different colors (reddish-brown, grey, and dark brown). It is surrounded by a pile of smaller, irregularly shaped red rock fragments.

Online Analysis for Control



In the process

On-line Analysis

- **Intermediate Streams**
 - Particle Size
 - Chemistry
- **Concentrate/Tailings**
 - Chemistry
- **Effluent**
 - Chemistry
 - Particle Size

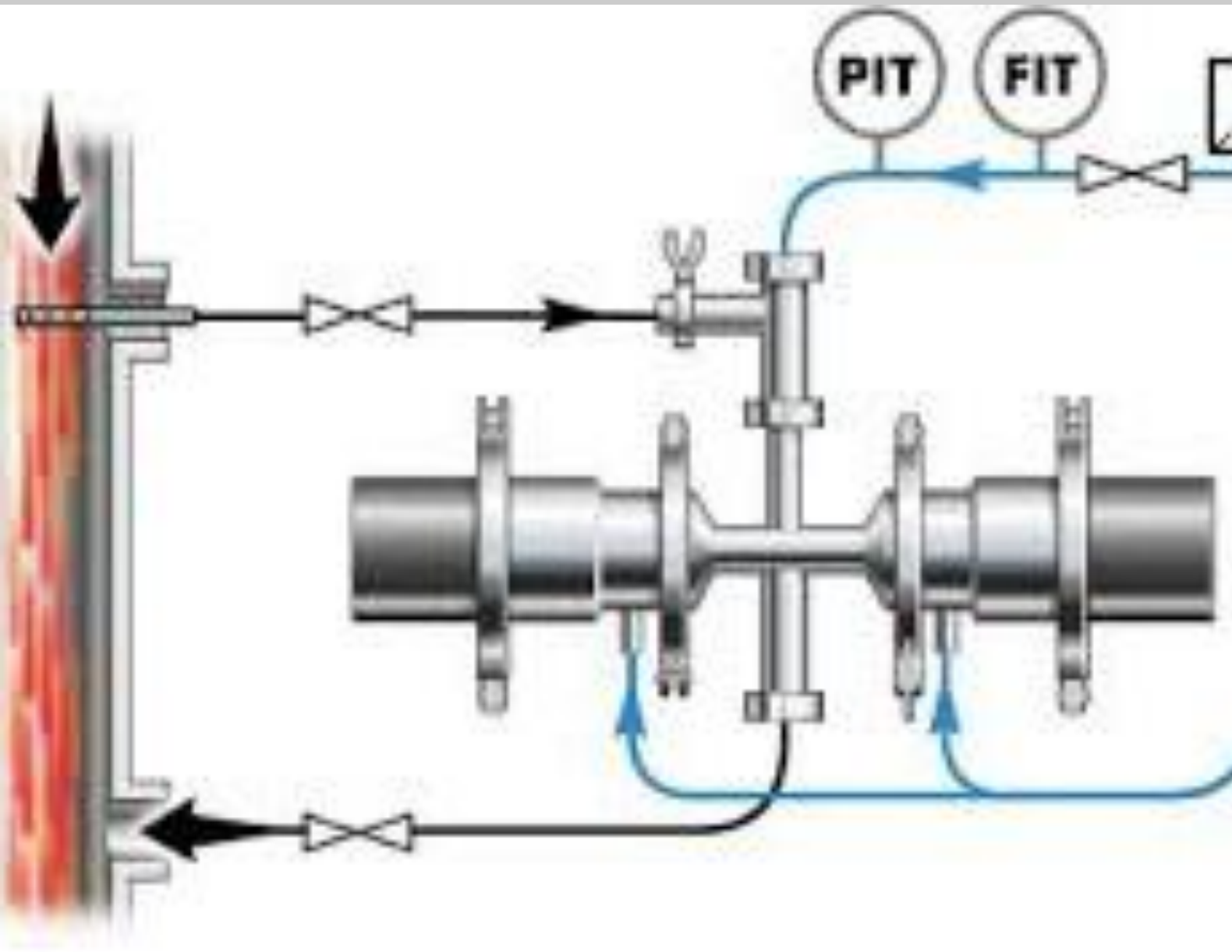
Move to on-line / at-line

- **ROM**
 - Bulk Material Analyses
- **In Process**
 - Particle Size
 - On-line Chemistry
- **Concentrate/Tailings**
 - Bulk Material Analyses
- **Effluent**
 - On-line XRF
 - On-line Particle Size

No Magic Instrument



- Each technique/instruments has strengths and weaknesses
- Craft a solution for a problem



At-line Sampling

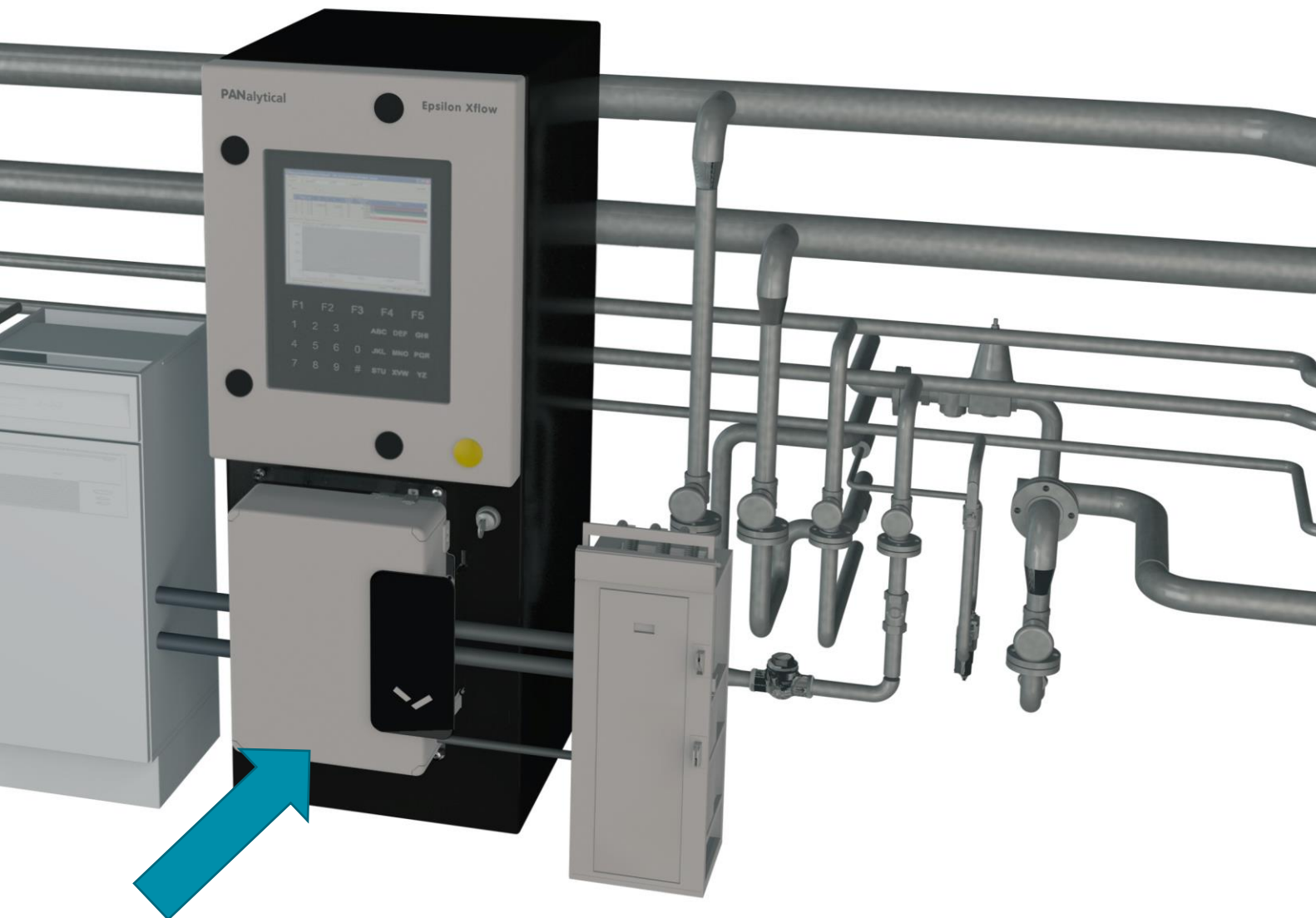
Insittec

- Continuous Sample
- Representative ?
- Speed – seconds
- First Principles – no calibration

At-line Liquid Sampling

Xflow - XRF

- Continuous Sample
- Representative ?
- Speed – minutes
- Basic Calibration
- Not for slurries





Pre-process (mine) measurements

Challenging

- Difficult / expensive to sample
- Large particle size
- Heterogenous material

Bulk Material Analysis

CNA – Controlled Neutron Analyzer

- Elements
- Sample – 80 - 100%
- Speed – 2 minute average
- Moderate Accuracy
- Moderate Precision
- Plus
 - Bulk Analysis
 - Low Maintenance
 - Stable Calibration
 - Electrical Source
- Minus
 - Can't measure all elements
 - Matrix important
 - Blinded by some elements
 - Calibration difficult
 - Radiation Safety
 - Hard to Verify



Bulk Material Analysis

QS7000

- Minerals
 - Surface Measurement - < 10%
 - Speed – seconds
 - Moderate Accuracy
 - Moderate Precision
- Plus
 - Light – no radiation
 - Offline Calibration
- Minus
 - Calibration Difficult
 - **Calibration Stability**
 - Not all spectrally active



Bulk Material Analysis

Dedicated Process Laboratories

- Minerals or Elements
 - Requires Sample
 - Speed – 15 minutes
 - Good Accuracy
 - Good Precision
- Plus
 - Laboratory Techniques in Field
 - Better “Accuracy”
- Minus
 - Maintenance
 - “Representative Sample”
 - Relatively Slow





Analysis Speed

- CNA – 30 sec – 2 minutes
- NIR – seconds
- Sample – 15 min



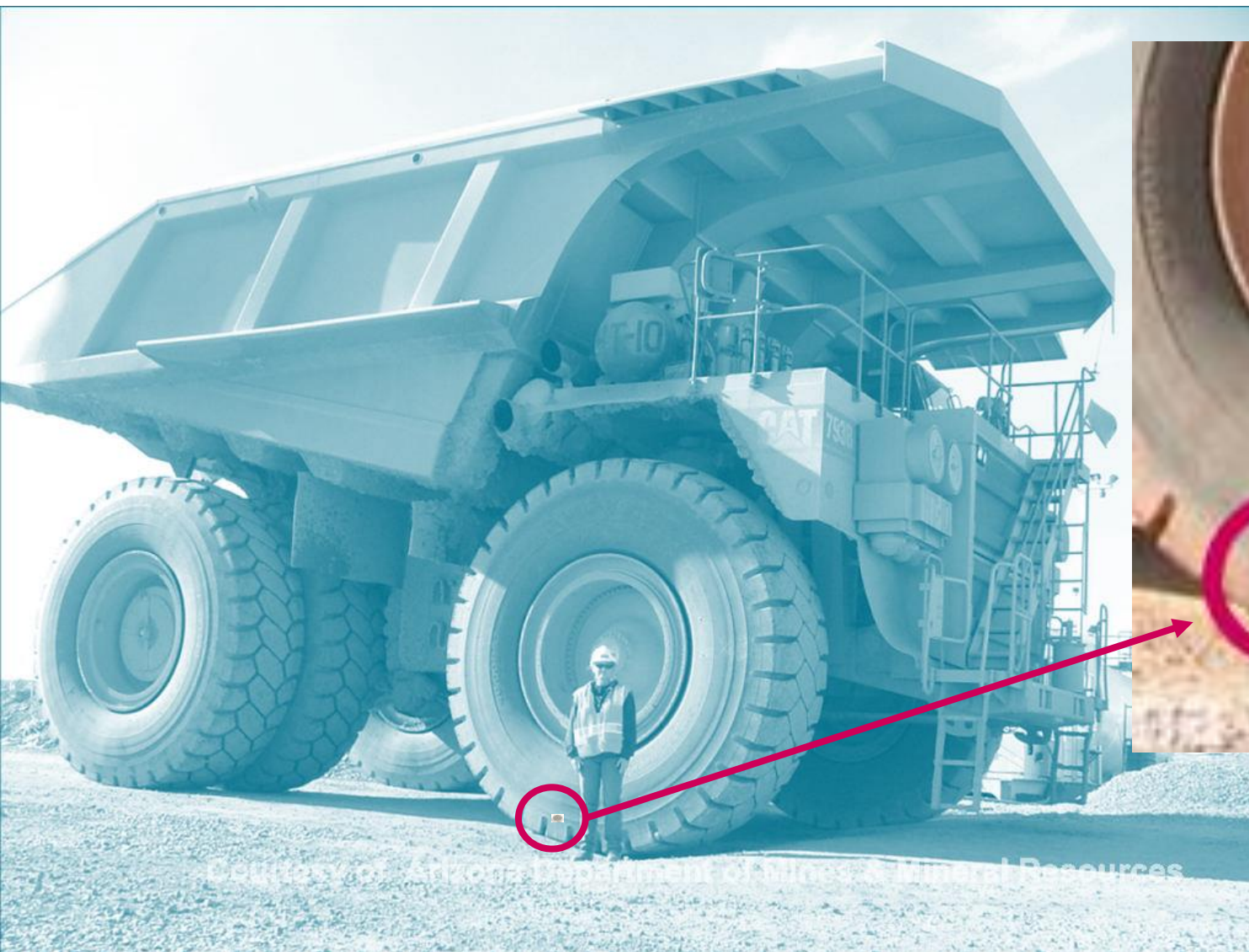
Accuracy - Which is better ?



0.0x %

**300 – 400 MT
<2 minutes !**

Accuracy - Which is better ?



0.00x %



What will you do with the analyses ?

Measurement is not Control !



Process Control – before the Process !

What to do with analyses ?

- Monitor (Feedback)
- Blend
- Sort

Where is the Value ?

Problem First, Then Solution

A few typical examples

Focusing on Mine Output

Blending

- Multiple Mines (Faces)
- High Grade/Low Grade
- Stabilize Composition
- Maximize use of Low Grade

Sorting

- Remove Low Grade
- Remove Contaminants
- Create High Grade Product
- Need Infrastructure

Monitor

- Follow Trends
- Alarm Upsets
- Feedback to Mine
- Feedforward to Process

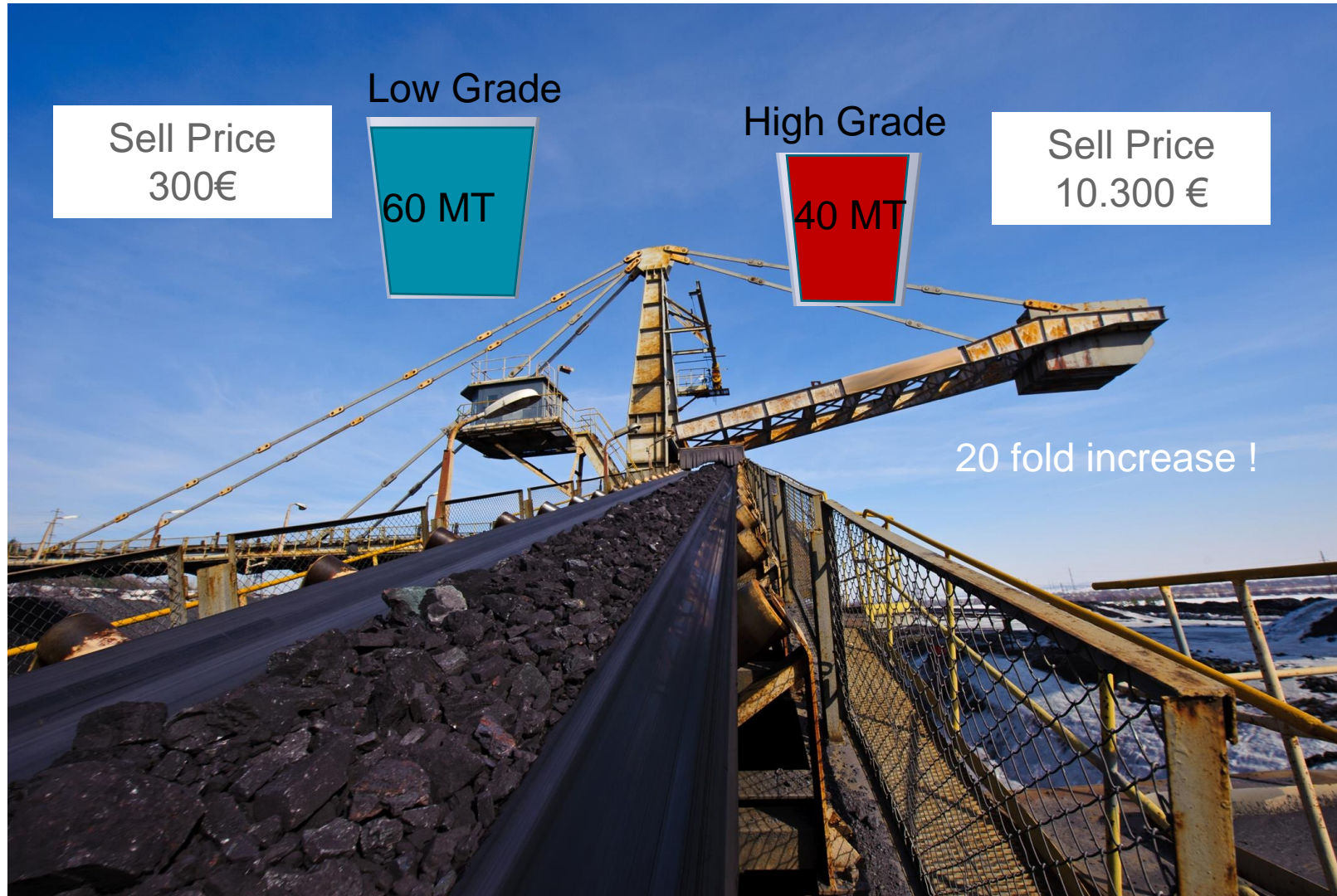
Why sort ?

Without sorting



Why sort

40 % high grade



Benefit

100 tonne basis



Sorting

Remove 20% of low-grade ore



Sorting

Remove 20% of low-grade ore



Sorting

Remove 20% of low-grade ore



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