New Trends in Optical Sorting
Beneficiation and Recovery of Metals and Minerals

Presented By:
Pieter Wolmarans & Dr. Alexandre A. Capita
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I. Advantages of Optical Sorting

- Increase:
  - Productivity
  - Throughput
  - Recovery efficiency ...

- Decrease:
  - Yield
  - Civil & Building costs
  - Energy costs
  - Maintenance costs
  - Operational costs
  - Transportation costs
  - Screening costs ...

- Environment friendly

- Contops operation ready
I. Advantages of OptoSort®

- A Mature Technology within the mining industry
- Compact system with very few hardware components (increase Availability and Reliability)
- 16 millions colors discriminated with sophisticated sorting algorithms allow for very accurate sorting
- Automatic teach-in function to create your own sorting algorithms
- Intelligent ejector control system
- Standard Hardware & Software platform.
- Software platform WINDOWS®
  - Standard software for networking, remote diagnostics, visualisation etc.
- Up to 12 sorters operated by one server connected to the PLC of the plant
The OptoSort® systems consists of 3 modules:

Module 1: **Material Conditioning** (screening, washing, de-watering)
Module 2: **Monolayer Preparation** (creation of a single-layer product stream for presentation purpose)
Module 3: **Separation / Sorting** (image analysing with lighting and mechanical separation with compressed air valves & nozzles)

Module 2 can either be a Belt Assy. or Gravity Feed Assy. depending on the requirement.

Module 3 comprise of three main components:
1. Lighting unit with auto-cleaning lens system (*proprietary development by Kammann OptoSort*)
2. Image analysing system developed by Fraunhofer Institute IITB
3. Material separation based on pneumatic solenoid valves and nozzle bar (*proprietary development by Kammann OptoSort*)
II.a. GemStar 600 / GemStar 300

- Belt models
- Working width 300 or 600 mm
- Particle size +1 to -30mm
- Throughput up to 30 t/h* 
- Centrino Technology
- Compact Design
- Sorting cabinet is enclosed (IP65) and air conditioned
- Stand alone system
- Client server architecture
- Interface for plant automation
- Up to 12 sorters operated by one server (CC Sort)

<table>
<thead>
<tr>
<th>Fraction</th>
<th>X-Ray Sorters</th>
<th>Optosort GemStar</th>
</tr>
</thead>
<tbody>
<tr>
<td>+1 - 2mm</td>
<td>0.6t/ hr</td>
<td>4t/ hr</td>
</tr>
<tr>
<td>+2 - 4mm</td>
<td>1t/ hr</td>
<td></td>
</tr>
<tr>
<td>+4 - 10mm</td>
<td>1.5t/ hr</td>
<td>10t/ hr</td>
</tr>
<tr>
<td>+10 - 30mm</td>
<td>3.5t/ hr</td>
<td>30t/ hr</td>
</tr>
</tbody>
</table>

* Depends on material and particle size distribution

KAMMANN OPTOSORT REPRESENTED BY IMPULSE TECHNOLOGIES cc
II.b. Gravity Sorters

- Working width 600, 900, 1200 or 1800 mm
- One or two camera system
- True color detection
- 96, 128 or 192 nozzles
- Particle size 4 - 300 mm
- Throughput up to 200 t/h*
- New 20 Mhz Technology
- Container solution
- Client server architecture
- Up to 12 sorters remotely operated from single server

* Depends on material and particle size distribution

'cause we can'
II.c. µGemStar®: The Sorter for µGemstones

Latest machine development from the OptoSort® R&D Lab

Sorting GemStones and other minerals from 0.5mm !!!

A camera with a resolution of 0.15mm/pixel

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III. The OptoSort® System: Software

*Imaging Methodological Concept*

- Image acquisition
- Color Classification
- Morphological Filtering
- Run Length Coding
- Region Analysis
- Object Classification

**Object description**

*Feature list*

- Area: 9725
- 84.7% good
- 15.3% bad

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III. The OptoSort® System: Software

Sorting decision - Classification

Each Classifier makes an independent decision. The respective result is logically linked with the results of the other.

Linkage possibilities:
- And
- Or
- Exclusive Or
IV. Sorting Applications

- **Gold**
- **Diamonds**
- **Nickel**
- **Talcum**
- **Calcite/Dolomite**
- **Copper**
- **Salt**
- **Limestone**
- **Size control**
- **Quartz**

*Diamonds, Base Metals, Industrial Minerals and many more .... 'cause we can*
V. Extended Application: Recognition of rock salt

1. Camera
2. Scan Line
3. Lights (incident)
4. Material – Flight curve
5. Belt
6. Lights (Transmitted)
7. Background

- Combination of incident and transmitted light
  - Simultaneous evaluation of reflection and transmission
  - Recognition of dark areas inside the salt

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<tbody>
<tr>
<td>+10 - 25mm</td>
<td>25t/h</td>
</tr>
<tr>
<td>+25 - 60mm</td>
<td>60t/h</td>
</tr>
<tr>
<td>+60 - 150mm</td>
<td>140t/h</td>
</tr>
</tbody>
</table>
Belt Speed = 3m/sec
Up to 30,000 particles analyzed per second!!

Real-time adaptation

Real-time View

Sorting statistics

'cause we can'
V.a. Special : Diamonds & Precious Minerals

<table>
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<tr>
<th>Fraction</th>
<th>Optosort GemStar 600</th>
</tr>
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<tbody>
<tr>
<td>+1 - 4mm</td>
<td>4t/ hr</td>
</tr>
<tr>
<td>+4 -10mm</td>
<td>10t/ hr</td>
</tr>
<tr>
<td>+10 -32mm</td>
<td>30t/ hr</td>
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Average yield: 
- < 0.8% on -4+1 mm
- < 0.3% on -10+4 mm
- < 0.1% on -30+10 mm

Recovery

Gems & Type IIa : ρ>99%
Near Gems : ρ>98%
Boarts : ρ>80%
V.d. Special : Diamonds & Precious Minerals

Near Gems of 1, 2 and 3mm

Kimberlite

'cause we can'
VI. Where to apply the OptoSort®

- Primary Sorter
- Secondary Sorter
- Re-concentrator
- Scavenging to complement existing technology
- Waste Sorting
VI. Flowsheet with OptoSort®: Extraction

<table>
<thead>
<tr>
<th></th>
<th>DIAMOND</th>
<th>GOLD</th>
<th>NICKEL</th>
<th>COPPER</th>
</tr>
</thead>
<tbody>
<tr>
<td>ca. 1 carat / ton</td>
<td>3.29 grams / ton</td>
<td>ca. 3 % / ton</td>
<td>ca. 2.59 % / ton</td>
<td></td>
</tr>
<tr>
<td>ca. 15000 tons / day</td>
<td>ca. 19000 tons / day</td>
<td>ca. 8600 tons / day</td>
<td>ca. 3500 tons / day</td>
<td></td>
</tr>
</tbody>
</table>

Typical ratio of resource material

Mass flow from ROM to processing plant without optical sorting

Assumed reduction of waste material in ore

Mass flow from ROM to processing plant with optical sorting

ca. 60 %
VI. OptoSort® processes your waste to Money

Problem for the mines (Diamonds, Gold, other Base Metals ... etc):
- there are billions of tons of waste dumps because waste has been stored since the beginning
- there is still product present in the waste dumps
- this product is not enough concentrated to be processed with conventional technologies

OptoSort® is the solution to maximize processing profitability:
- waste dumps can be reduced significantly at low costs
- maximize recovery first time around

'cause we can'
## VI. OptoSort® processes your waste to Money

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<th>NICKEL</th>
<th>COPPER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical resource ratio</strong></td>
<td>0.5 carat / ton</td>
<td>3.29 grams / ton</td>
<td>3% / ton</td>
<td>2.59% / ton</td>
</tr>
<tr>
<td><strong>Average ROM material</strong></td>
<td>15,000 tons / day</td>
<td>19000 tons / day</td>
<td>8600 tons / day</td>
<td>3500 tons / day</td>
</tr>
<tr>
<td><strong>Average recovery rate</strong></td>
<td>95%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td><strong>Average recovery with</strong></td>
<td>7125 carats / day</td>
<td>50 kg / day</td>
<td>206 tons / day</td>
<td>73 tons / day</td>
</tr>
<tr>
<td><strong>Product loss in waste</strong></td>
<td>375 carat / day ~ $1Mil/ month</td>
<td>12.5 kg / day</td>
<td>52 tons / day</td>
<td>18 tons / day</td>
</tr>
</tbody>
</table>
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