Agenda

• Welcome & Introduction to CQMS Razer (CR)
• Historical Loading practices
• Excavator Payload systems
• Introduction to Titan 3330™
  • Overview
  • Core Functionality
  • Proven Performance
  • Case Studies
  • Advanced Features
• Questions?
Who is CR?

Surface Mining Technology
- Cast Lip + GET systems
  - Excavator, Rope Shovel, Wheel Loader, Dragline Buckets + Rigging.

Mining Information Technology
- Productivity Software

Wear Protection and Processing
- Total Wear Solutions
  - Advanced Plate Block & Wear, Fixed + Mobile Plants, Processing Conveyor systems, Underground Stone Dusting.
Global presence
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History of Loading Practices

Load & Haul Fleet’s Lack 21st Century Tools

Operators Struggle with?
- Mixed Truck Fleets
- Light Trays, Heavy Trays
- Waste, Ore, Rehandle densities
- Truck OEM loading rules 10:10:20
- Overload Truck bunching

There has to be a better way!
Hang on… But what about trucks?

Trucks have payload systems, right?

• OEM mining haul trucks do have payload measurement systems, but these have a number of fundamental shortcomings:
  1. They are a lagging indicator of previous actions & outcomes from loading, requiring the 2nd gear re-weigh technique after exiting the loading zone
  2. They are highly variable in accuracy
     • This can be influenced by strut calibration routine
     • Haul road/loading zone road quality
     • Load positioning within the tray

OEM Specification quote:

“A load position shift of 2% to 4% can result in the VIMS report being incorrect by 5% to 7% - and maybe more than 10%. ”
Shovel Operator Expectations

A few simple rules, from your truck OEM

• The mean (average) of the payload distribution shall not exceed the OEM target payload
• No more than 10% of payloads may exceed 110% of truck target payload
• No single load shall exceed 120% of the truck target payload
• The average payload shall not exceed the target

Without a real time tool for the Shovel Operator, what hope do they have? What do these expectations breed?
• Inclination to underload?
• Poor loading fleet efficiency?
• Risk averse culture?
• Blaming culture, for overloads?
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Improving Mining Efficiency by Accurately Measuring Loader Payload
Excavator Payload systems

The challenges of measuring bucket payload

- Complex Kinematics
- Payload – Centre of Gravity
- Inertial effects when in motion
- Friction and hydraulic losses
- Multiple configurations
- Fit for Purpose hardware
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Real-time Operator Feedback + Operator Performance

Operational Performance

Real time production data
• Accurate payloads
• Individual truck targets
• Live performance guidance

High resolution data, for
• Fatigue Duty / Cylinder Pressure
• Operator performance analysis
• Training & development
Loader Measurement

Non-invasive, Highly effective Technology
Real-Time Operator Feedback

Titan 3330 Operator Interface
Titan Core Service Reporting

Daily shift performance reports | Daily Status Reports | 3 Hourly production updates

Excavator Summary

SHIFT: 2017-01-16 19:00

MACHINE STATS

<table>
<thead>
<tr>
<th>MACHINE STAT</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TONS MOVED</td>
<td>05950 t</td>
</tr>
<tr>
<td>ESTIMATED VOLUME</td>
<td>26250 BCM</td>
</tr>
<tr>
<td>INIT. PROD.</td>
<td>2678 BCM/h</td>
</tr>
<tr>
<td>OP. PROD.</td>
<td>2191 BCM/h</td>
</tr>
<tr>
<td>AVG. BUCKET PAYLOAD</td>
<td>87.8 t</td>
</tr>
<tr>
<td>AVG. BUCKET PASS TIME</td>
<td>31.2 sec</td>
</tr>
<tr>
<td>AVG. SWING ANGLE</td>
<td>30.0 deg</td>
</tr>
<tr>
<td>PRODUCTION TIME</td>
<td>09:48 hrm</td>
</tr>
<tr>
<td>TRAVEL TIME</td>
<td>00:07h/h</td>
</tr>
<tr>
<td>TOTAL IDLE*</td>
<td>00:45h/h</td>
</tr>
<tr>
<td>SHUTDOWN*</td>
<td>00:00 hrm</td>
</tr>
<tr>
<td>TOTAL OPERATIONAL TIME</td>
<td>11:59 hrm</td>
</tr>
<tr>
<td>TRUCKS DURING PRODUCTION</td>
<td>24.3/h</td>
</tr>
<tr>
<td>MEDIAN SPOT TIME</td>
<td>43.7 sec</td>
</tr>
<tr>
<td>FIRST BUCKET TIME</td>
<td>19:09:55</td>
</tr>
<tr>
<td>LAST BUCKET TIME</td>
<td>06:50:16</td>
</tr>
</tbody>
</table>

TRUCK STATS

<table>
<thead>
<tr>
<th>TRUCK STAT</th>
<th>VALUE</th>
</tr>
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<tbody>
<tr>
<td>MODEL</td>
<td>793F</td>
</tr>
<tr>
<td>RATED</td>
<td>227</td>
</tr>
<tr>
<td>TARGET</td>
<td>238</td>
</tr>
<tr>
<td>EH4500 RATED</td>
<td>267</td>
</tr>
<tr>
<td>TARGET</td>
<td>276</td>
</tr>
<tr>
<td>EH4500 [light]</td>
<td>285</td>
</tr>
<tr>
<td>RATED</td>
<td>54</td>
</tr>
<tr>
<td>TARGET</td>
<td>205</td>
</tr>
</tbody>
</table>

HISTOGRAM

<table>
<thead>
<tr>
<th>SUMMARY</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDIAN</td>
<td>240 t (155.7% of rated)</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>236t</td>
</tr>
<tr>
<td>SPREAD*</td>
<td>7.0%</td>
</tr>
<tr>
<td>OVER 110%</td>
<td>5</td>
</tr>
<tr>
<td>OVER 120%</td>
<td>0</td>
</tr>
<tr>
<td>OVER 130%</td>
<td>0</td>
</tr>
<tr>
<td>OVER 140%</td>
<td>0</td>
</tr>
<tr>
<td>AVG. FILL TIME</td>
<td>79.9%</td>
</tr>
<tr>
<td>AVG. PASSES</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Chart: Track Load %

Chart: Activities
## Shovel Cycle Reporting

### Excavator Summary

**Date:** 18/07/2016 7:00 AM - 19/07/2016 7:00 AM

<table>
<thead>
<tr>
<th>Machine Name</th>
<th>Model</th>
<th>Payload (t/cycle)</th>
<th>Boom</th>
<th>Stick</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Max</td>
<td>Max</td>
<td>Max</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average</td>
<td>Day</td>
<td>Day</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R9800</td>
<td></td>
<td>91</td>
<td>275%</td>
<td>215%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>67</td>
<td>89%</td>
<td>90%</td>
</tr>
</tbody>
</table>

### Graphs

- **Payload (t/cycle)**
- **Boom (°)**
- **Stick (°)**
Operator Technique Comparisons

DAILY EXCAVATOR STATUS

Payload (t/cycle)

Boom

Stick

OPERATOR A

OPERATOR B

OPERATOR A

TITAN 3330
LOAD HAUL OPTIMISATION
Accuracy Check Against Scales
Typical Performance Trend

Case Study - The Effect of Using Titan on Truck Load Spreads and Production Rates

Graph showing the effect of using Titan on truck load spreads and production rates.
Repeatedly, Multiple Machines & Sites

TITAN - The Effect of Tightening Truck Load Distribution
Weekly Averages over ~6 Months - 4 machines at different sites
Can’t we remove the system?

Aren’t our operators trained now?

Site has multiple Titan systems. All operators are trained to use Titan.

- Tightest spreads and Highest production rates across our customer base
- Trial of Experienced Titan Users – Without Titan
- Turn Titan screen off for two weeks
- Same crews, same pits, same trucks

Let’s Take a look
Can’t we remove the system?

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Another Example

Bottom Line efficiency gains

<table>
<thead>
<tr>
<th></th>
<th>Screen Off</th>
<th>Titan Active</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100%</td>
<td>77.8%</td>
<td>20.2%</td>
<td>Improved Load</td>
</tr>
<tr>
<td>100-110%</td>
<td>20.3%</td>
<td>74.7%</td>
<td>Distribution</td>
</tr>
<tr>
<td>110-120%</td>
<td>1.6%</td>
<td>4.9%</td>
<td></td>
</tr>
<tr>
<td>&gt;120%</td>
<td>0.3%</td>
<td>0.2%</td>
<td>+8.5%</td>
</tr>
<tr>
<td>Avg Truck Load (% Rated)</td>
<td>94.1%</td>
<td>102.6%</td>
<td>+8.5%</td>
</tr>
<tr>
<td># Trucks</td>
<td>1,561</td>
<td>1,624</td>
<td>Data Set</td>
</tr>
<tr>
<td>Avg Trucks/Shift</td>
<td>112</td>
<td>116</td>
<td>+4 Trucks</td>
</tr>
<tr>
<td>Spread</td>
<td>9.8%</td>
<td>5.3%</td>
<td>4.5% Tighter Spread</td>
</tr>
<tr>
<td>Tonnes/Shift</td>
<td>29,524</td>
<td>32,017</td>
<td>8.4% Increase</td>
</tr>
</tbody>
</table>

**Value of Extra Production**

- $3,117 per shift
- $2,007,621 per year
Hang on?

That’s outside the OEM Payload Average specification?

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<tr>
<td>Tonnes/Shift</td>
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<td>32,017</td>
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Oh, wait... Now I see how.

Increased Efficiency, without the risk

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<td>Tonnes/Shift</td>
<td>29,524</td>
<td>32,017</td>
</tr>
</tbody>
</table>

Loading Accuracy with Titan allows this result:
✓ Tighter load spread
✓ No more than 10% of loads over 110%
✓ Improved 120% compliance
The new benchmark

Loader based measurement is allowing new targets

- With Accurate Loader Payload measurement, in Real Time, our customers are increasing payload targets for truck fleets.
- Drastically improving load haul productivity, loading accuracy, operator efficiency, machine duty and maintenance

Whilst, loading more accurately, with Tighter payload spreads – allows mining teams to re-think historical approaches to payload & fleet targets
CHALLENGES

- Optimise load haul circuit
- Mismatched fleet EX9600, EX5500 & EX3600

OUTCOMES ACHIEVED

- Daily Production (t) increased by 5%
- Average Truck Payload increased by 18%
- Payload Spread improved by 56%
- Number of Overloaded Trucks (120%) decreased by 98%

RESULTS

A decrease in truck payload spread was achieved on all machines. This made it possible to target the rated capacity of the trucks, resulting in a significant increase in Daily Production. In addition, significant overloads were eliminated, reducing the wear and impact on the trucks.

<table>
<thead>
<tr>
<th></th>
<th>EC3600 Without Titan</th>
<th>EC3600 With Titan</th>
<th>EC5500 Without Titan</th>
<th>EC5500 With Titan</th>
<th>EC600 Without Titan</th>
<th>EC600 With Titan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Prod (t)</td>
<td>52,798</td>
<td>59,456</td>
<td>69,492</td>
<td>72,565</td>
<td>75,134</td>
<td>78,434</td>
</tr>
<tr>
<td>Avg Load as %</td>
<td>76%</td>
<td>100%</td>
<td>81%</td>
<td>99%</td>
<td>98%</td>
<td>102%</td>
</tr>
<tr>
<td>Load Spread</td>
<td>16%</td>
<td>6%</td>
<td>16%</td>
<td>7%</td>
<td>11%</td>
<td>6%</td>
</tr>
<tr>
<td># Trucks &gt;120%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>3.70%</td>
<td>6.19%</td>
</tr>
</tbody>
</table>

This study demonstrates the benefit of Titan is independent of machine size and how well the excavator and bucket is matched to the truck fleet.
APPLICATION BACKGROUND

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Coal Overburden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digging Conditions</td>
<td>Moderate</td>
</tr>
<tr>
<td>Machine</td>
<td>Hydraulic Excavator</td>
</tr>
<tr>
<td>Make &amp; Model</td>
<td>Liebherr Ultra Class</td>
</tr>
<tr>
<td>Customer / Site</td>
<td>Hunter Valley, Australia</td>
</tr>
</tbody>
</table>

CHALLENGES

A leading contract miner targets increased productivity and improved pass matching with reduced overloads.

OUR SOLUTION

A Liebherr Ultra Class excavator was configured with a Titan 3330 Load Haul Optimisation system, integrated with the contractor’s existing Fleet Management System to enable automatic truck recognition and other advanced data capabilities.

OUTCOMES ACHIEVED

The Titan 3330 system delivered the following performance outcomes:
- 6.6% average truck payload increase
- Decreased truck overloads by 89%
- 8.98% normalised productivity increase
- 25% tighter payload spread

Titan 3330 Load Haul Optimisation can improve your fleet's performance today.
Titan Advanced Add-Ons

Configurable Add-on options

- **Titan 3620 GET Optimisation**
  Advanced Face Shovel GET system insights + lost GET alerting

- **Fleet Management System (FMS) Integration**
  Ties Titan Data channels geospatial map & allows Dig to Plan analysis

- **Strategic Structural**
  Targeted 6 Channel Strain Gauge monitoring & fatigue analysis

- **FMS Integration**
  Excavator dig to plan alignment, using mine plan uploads to Titan

- **Precision GPS**
  Near Field RFID powered Automatic Truck Recognition

- **Dig to Plan**
  NEW

- **Truck ID**

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**Titan 3330 LOAD HAUL OPTIMISATION**

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**CQMS RAZER**

PRODUCTIVITY TECHNOLOGY

G.E.T. viewing and detection capability, through real-time laser scanning and alert functionality

Optimise G.E.T. via real-time comparison with dig energy & production performance

Data intelligence & advanced reporting to improve asset and operator performance

Built to support face shovel operations
Increased Payload  ✔
Decrease Overloads  ✔
Real Time Decision Making  ✔
Improve Haul Fleet Productivity  ✔