mineware

MONITOR | ACTION | IMPROVE

Haulage & Loading, Phoenix AZ

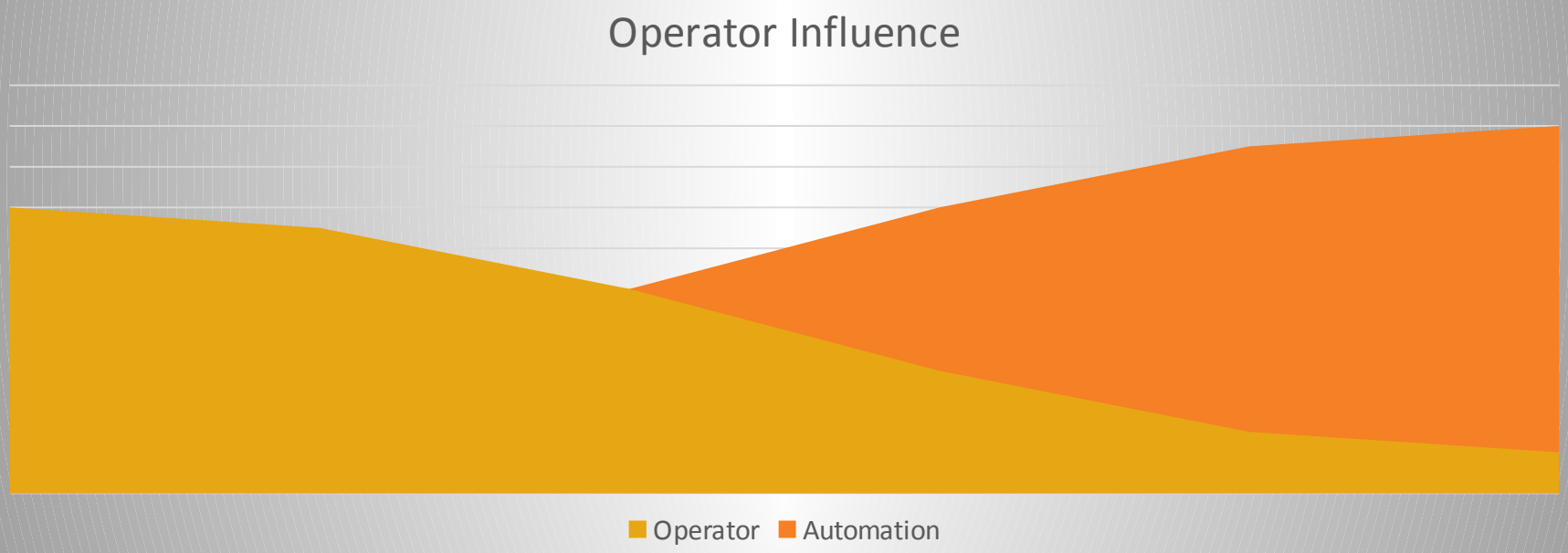
- Greg Ladewig

Agenda

- Safety Share
- Front-end Inefficiencies
    - Payload
        - Case Study
    - Plan
    - Pain
- Control

Mine to Mill

Load → Haul → Crush → Conveyor → Process → Product



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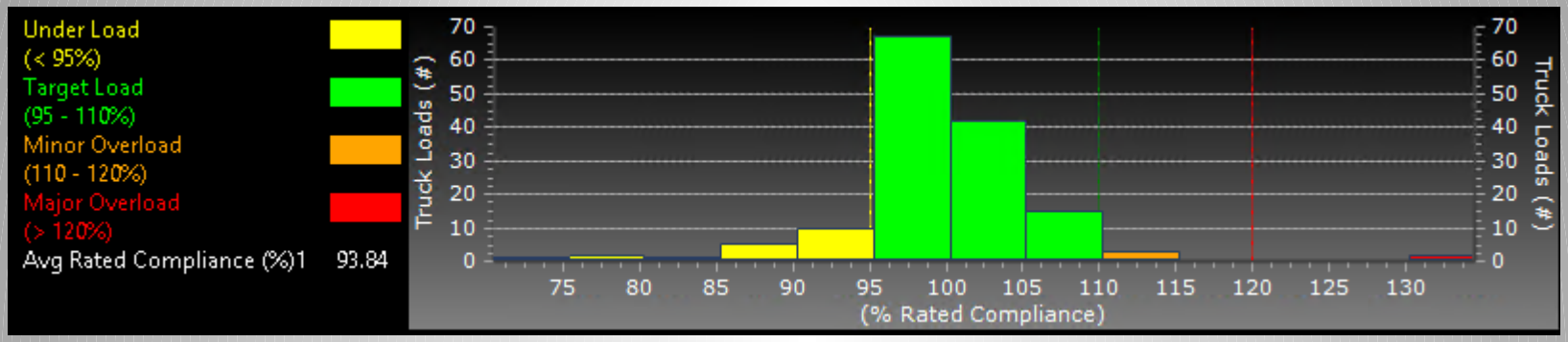
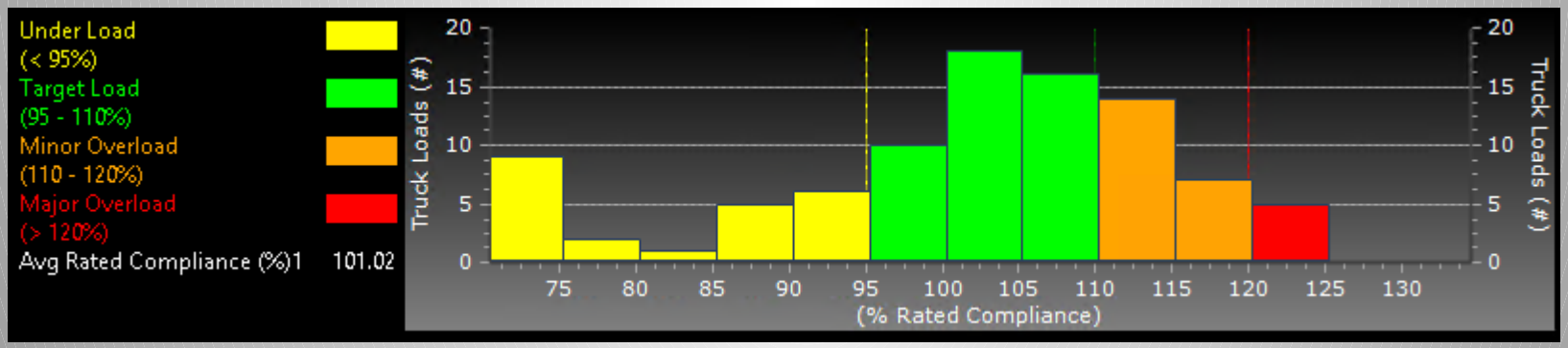
Front-end Inefficiencies

pegasys

Front-end Inefficiencies - Payload

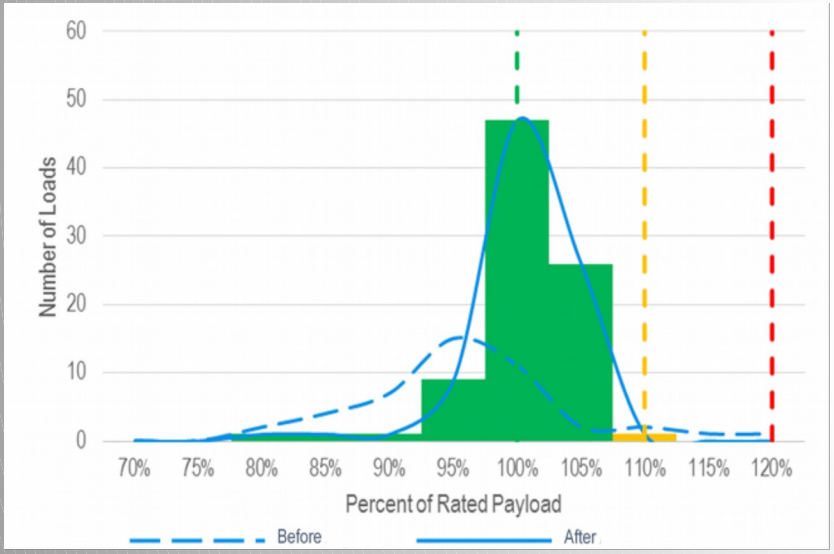


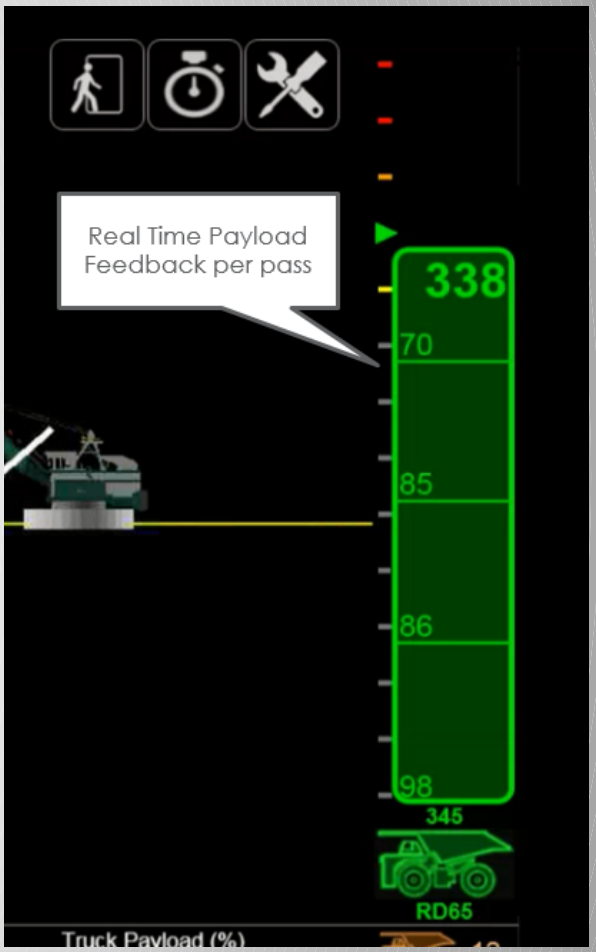
- Variation in Operator Performance from one shift to the next.
- How do we control this?



Front-end Inefficiencies - Payload

- Payload improvement on loaders can also occur by providing accurate, real-time feedback.
- Letting operators know in real-time what is in a truck allows them to better load to target

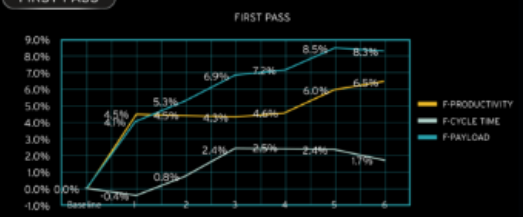




Front-end Inefficiencies - Payload

- Why Shovel based performance monitoring?

FIRST PASS



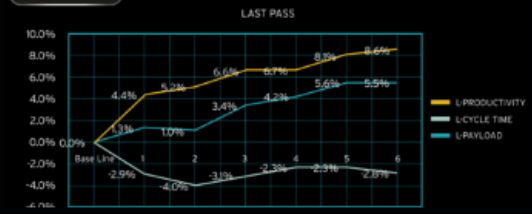
The first bucket the shovel loads into the truck.

Generally the first pass has the largest payload because its cycle time is not governed by the shovels speed, but rather it is limited by the truck backing into the shovel. This gives the operator ample time to fully load the bucket to capacity while it waits for a truck to manoeuvre into position.

Key Progress

- Cycle Time: Increased by **1.7%**
- Payload: Increased by **8.3%**
- Productivity: Increased by **6.5%**

LAST PASS



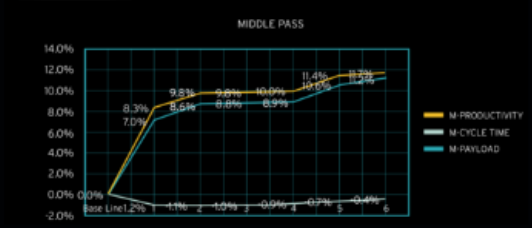
The last bucket that goes into the truck before it is signalled out.

The last pass differs from the first in that it is mainly limited by payload and not cycle time. Using Argus, a clear target is displayed to the shovel operator after each pass, showing how many tons should be loaded in each truck. Argus provides the operator with the ability to judge the best last pass fill for optimum payload compliance without impacting the speed of the shovel cycle.

Key Progress

- Cycle Time: Decreased by **2.8%**
- Payload: Increased by **5.5%**
- Productivity: Increased by **8.6%**

MIDDLE PASS



This category is any bucket that is neither the first nor the last.

It is an exception to the above two categories because it has no constraints. Both its cycle time needs to be minimized and its payload needs to be maximized, meaning it is the clearest reflection of an operator's loading skills because there are no constraints.

Key Progress

- Cycle Time: Decreased by **0.4%**
- Payload: Increased by **11.2%**
- Productivity: Increased by **11.7%**

Front-end Inefficiencies - Payload

Case Study

The following case study shows the application of some of our techniques to address improvements in the ‘payload dimension’ of shovels in a Centinela Mine, a copper mine in Chile.

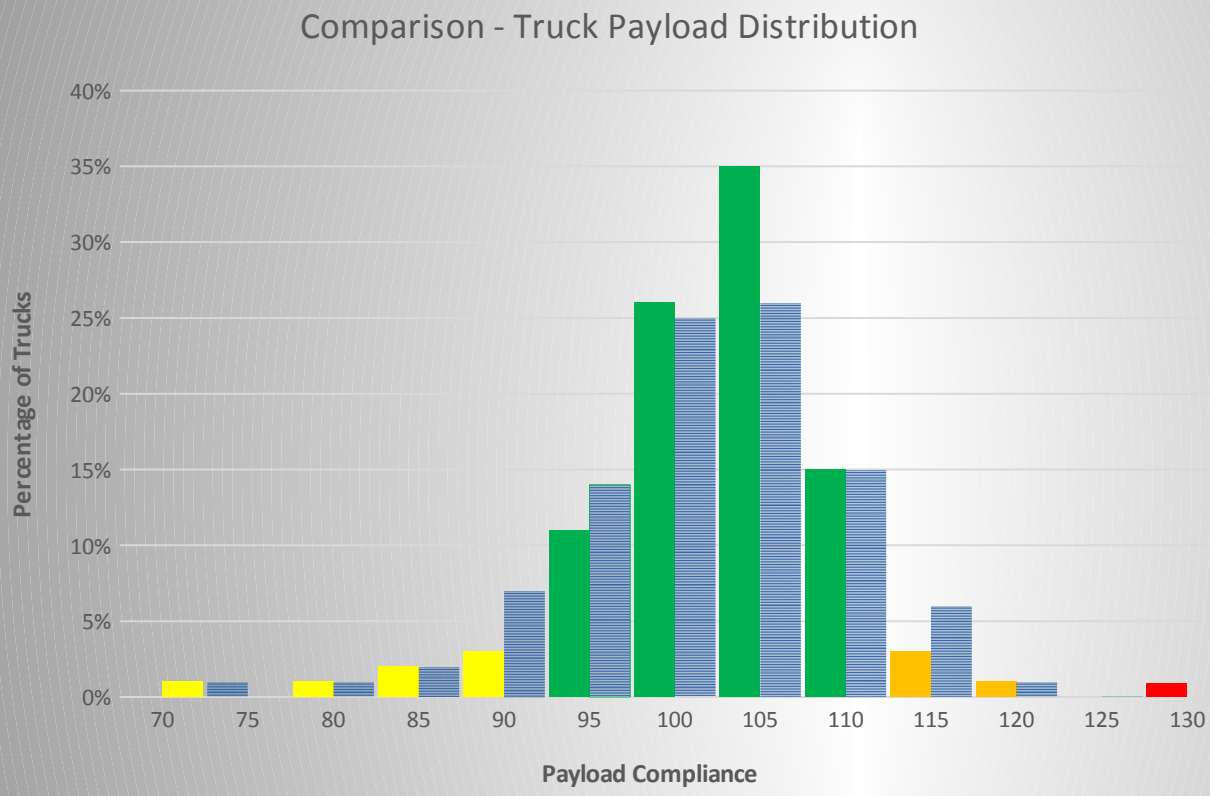
Specifically, the use of real-time payload feedback for improving productivity.

Case Study - The Story

- Centinela Mine
- Formed in 2014 with a merger of the Esperanza and El Tesoro mines.
- Centinela is located in Chile's Antofagasta region, 1,350 km north of Santiago,
- It produces copper concentrate (containing gold and silver).

- Trial Contained 2 Phases with/without feedback:
- **Blind Study period**, the system is collecting data, and the screen is blacked out to prevent influence.
- **Post Blind Study period**, System goes fully live with the operators being training and interacting with it.

Case Study - Before/After

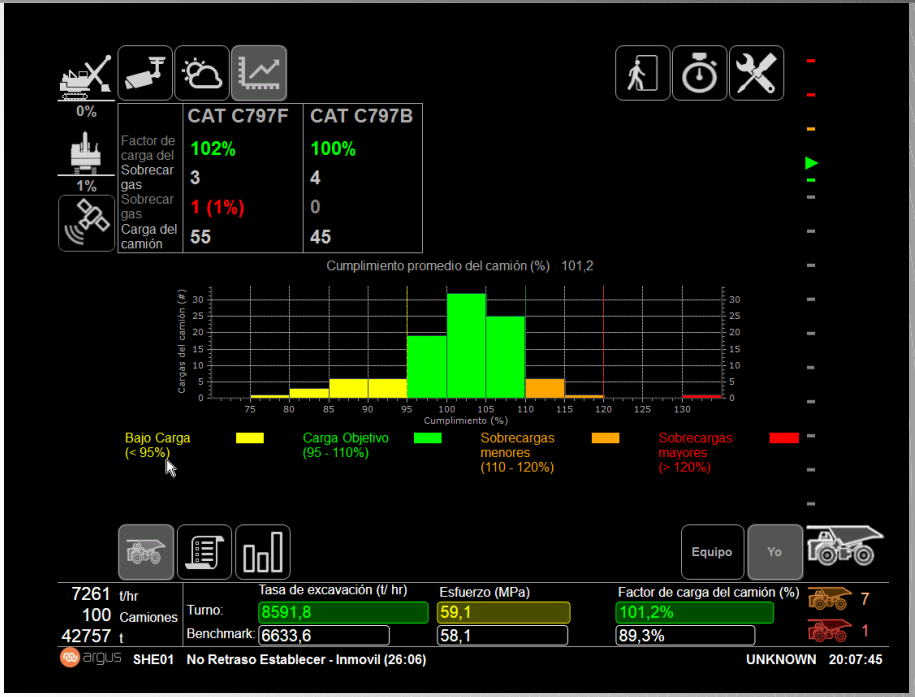


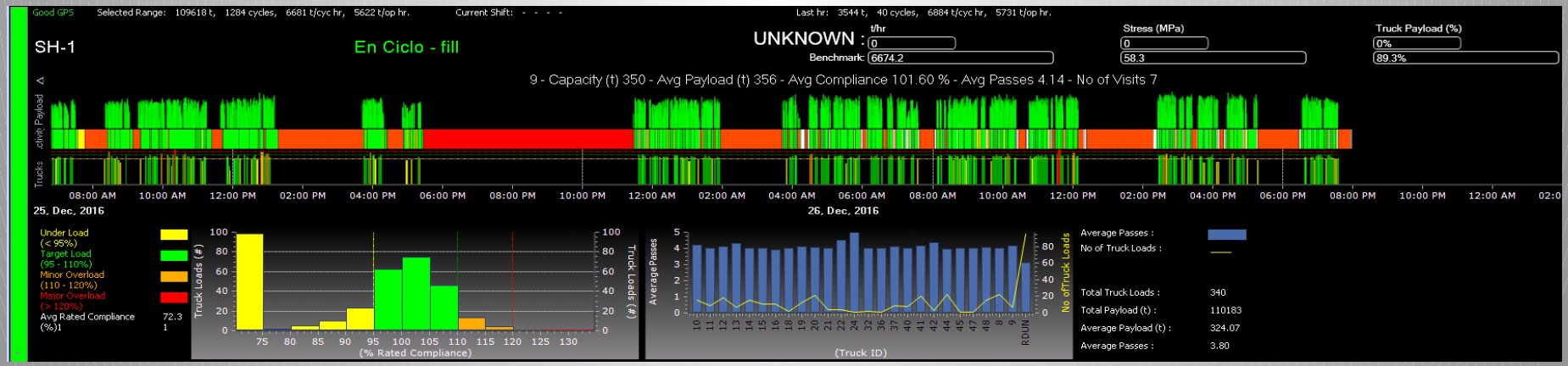
	Underloads	Compliant Trucks	Minor Overloads	Major Overloads
Post Blind	7%	88%	4%	0.9%
Blind Trial	11%	81%	7%	0.6%
Change	**-4%**	**+8%**	**-3%**	**-0.3%**

- Average Truck Payload increased **by 3.5%**
- Underloads decreased by **4%**
- Variance in Truck Compliance, decreased and the standard deviation fell from **41t to 27t**
- A decrease in overloads both major and minor observed
- # of Compliant Trucks Increased by **8%**

Case Study - Achieving the Results

- Real Time Feedback to both the Operator and Management facilitated the improvement.
- On the shovel the operators get immediate & accurate feedback on how much capacity available in each truck.
- Management able to view comprehensive up to date dashboards, allowing issues to be identified and corrected immediately





Case Study - Outcome Achieved

Results achieved are:

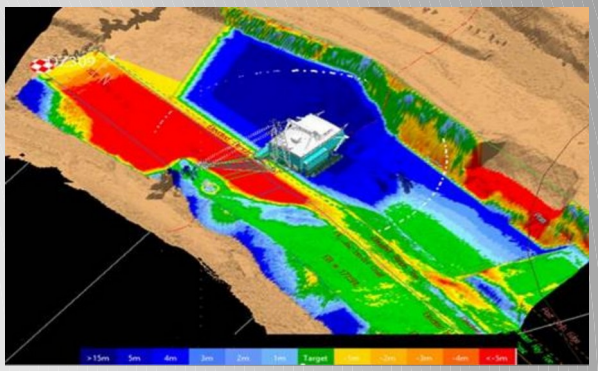
AVG Tonnes	930E	797B	797F
Before	255.1	332.0	356.6
After	295.2	355.0	369.4
Difference	40.0	23.0	12.8
	16%	7%	4%

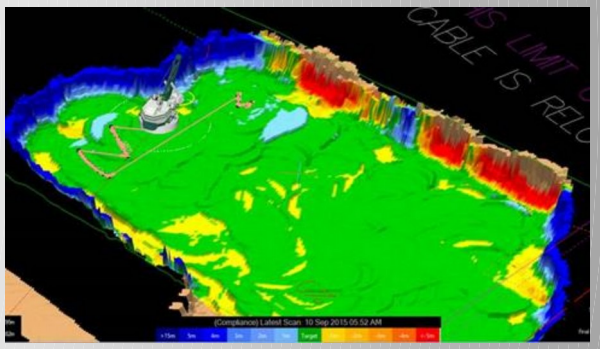
Projected improvements over 12 months:

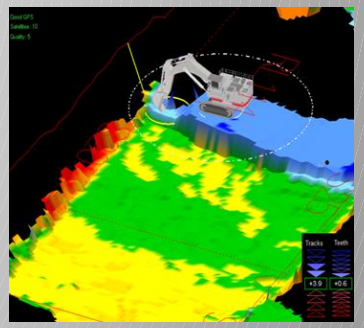
	Total Tons Moved/Year
Without Feedback	7,800,000
With Feedback	8,500,000
Difference	700,000
	8.4%

Front-end Inefficiencies - Plan

- *Real-time feedback*
- *Accurate tooth based feedback*
- *Open data sources*
  - *Lidar*
  - *UAVs*
  - *Other equipment*

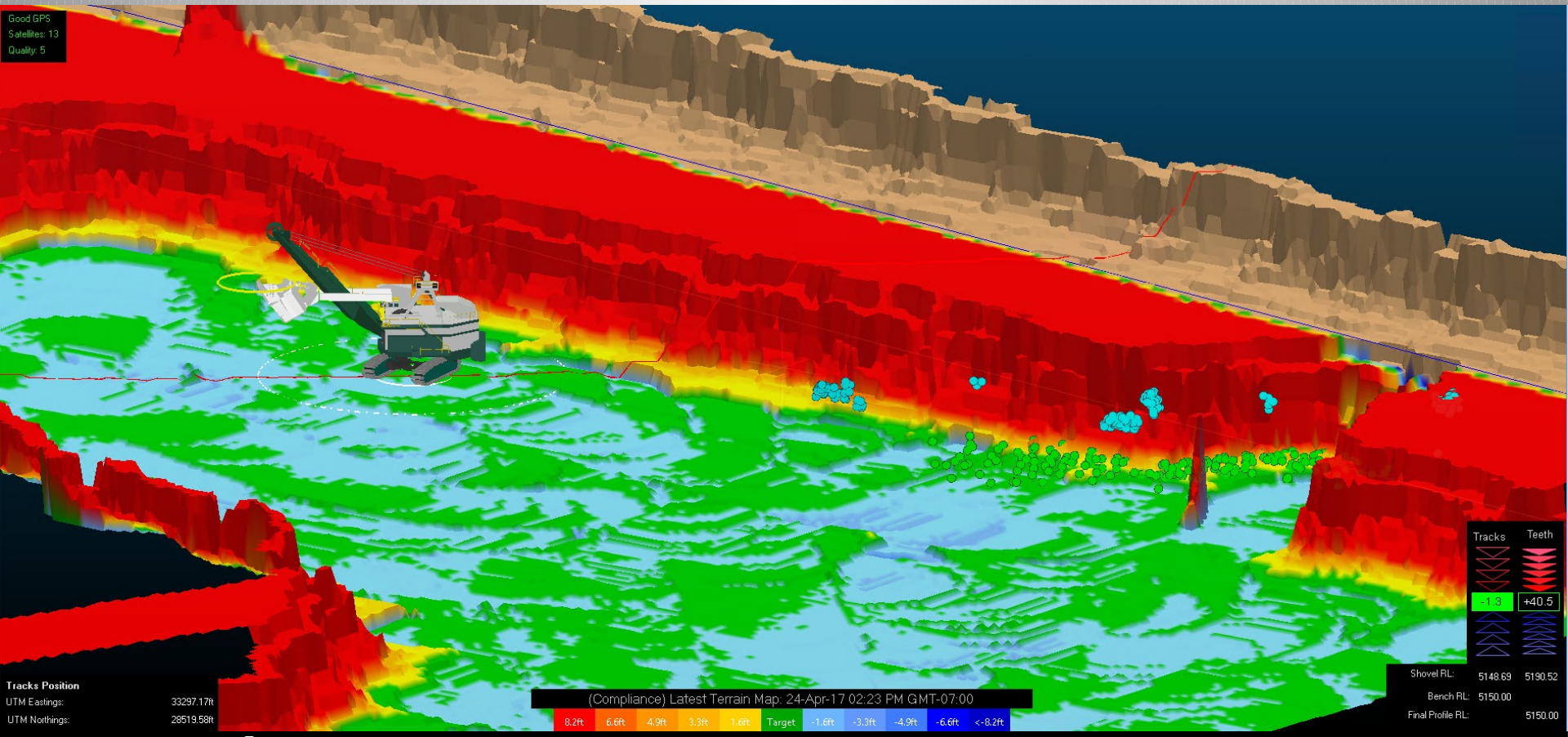






Front-end Inefficiencies - Plan

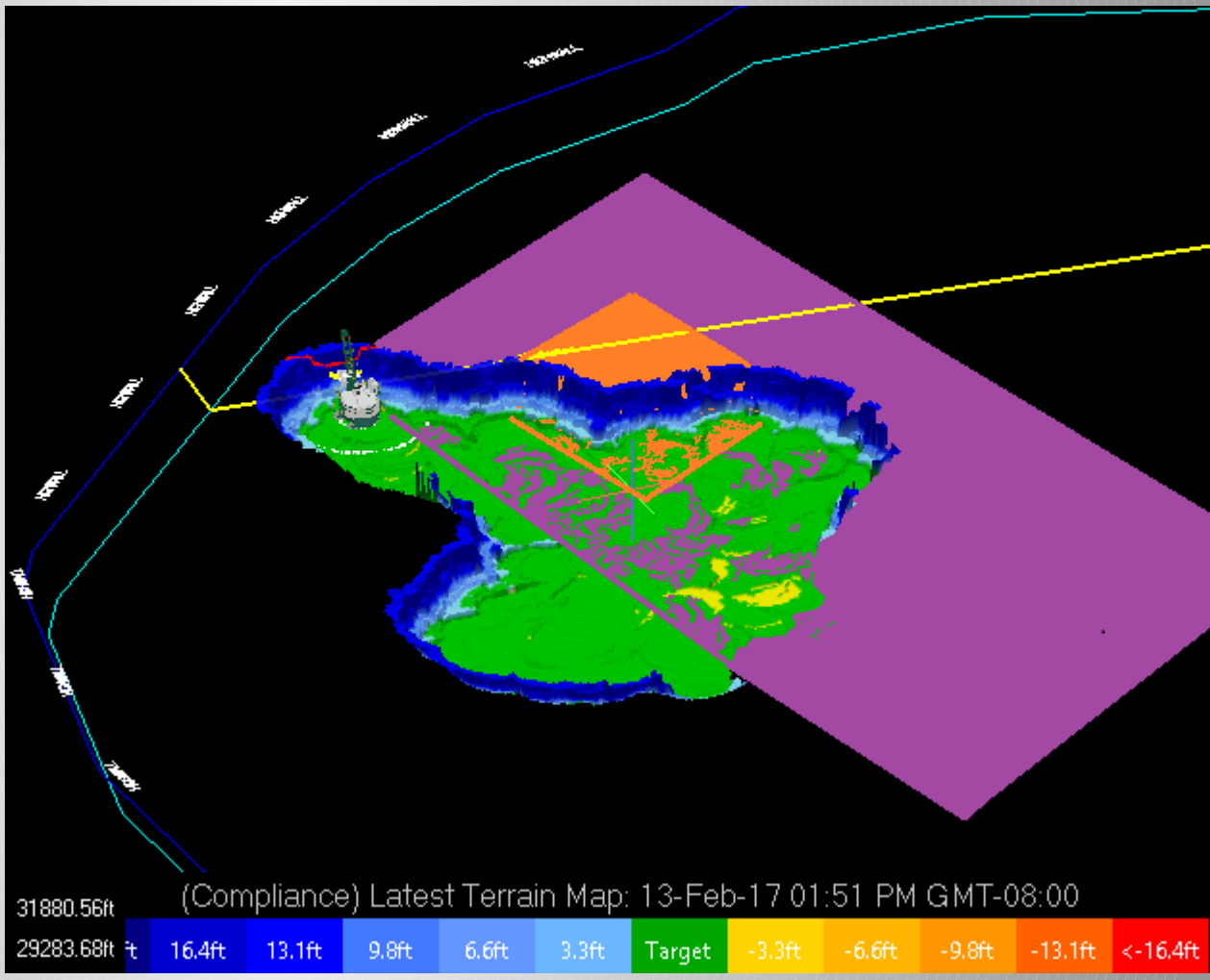
- Who needs to care about plan compliance?
  - Ore recovery, floor control, scheduling, interactions, drill-blast



Front-end Inefficiencies - Plan

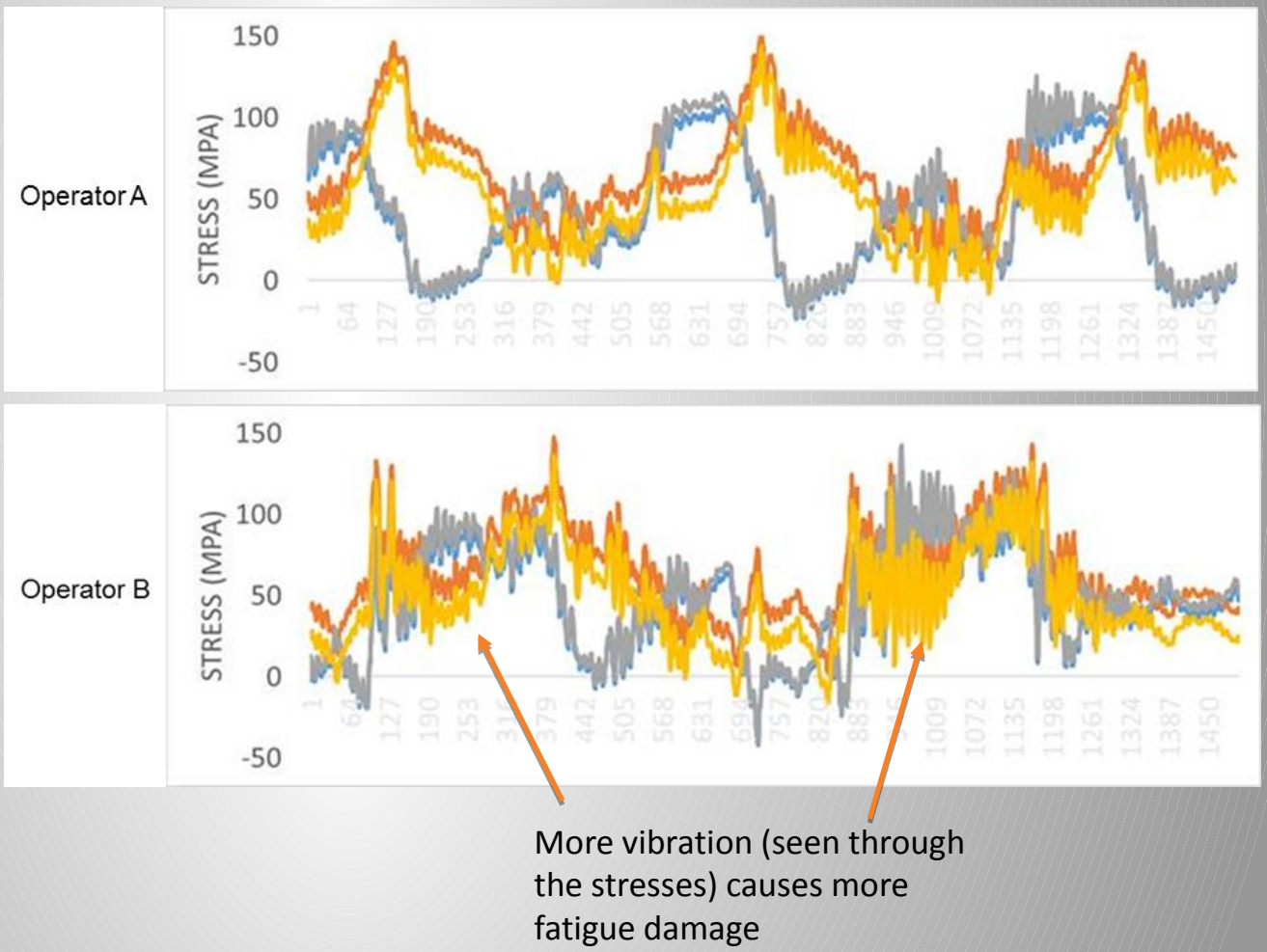
- *Ore control*
- *Block model*

  or
- Pass-by-pass
- Tooth accuracy
- Conceptural



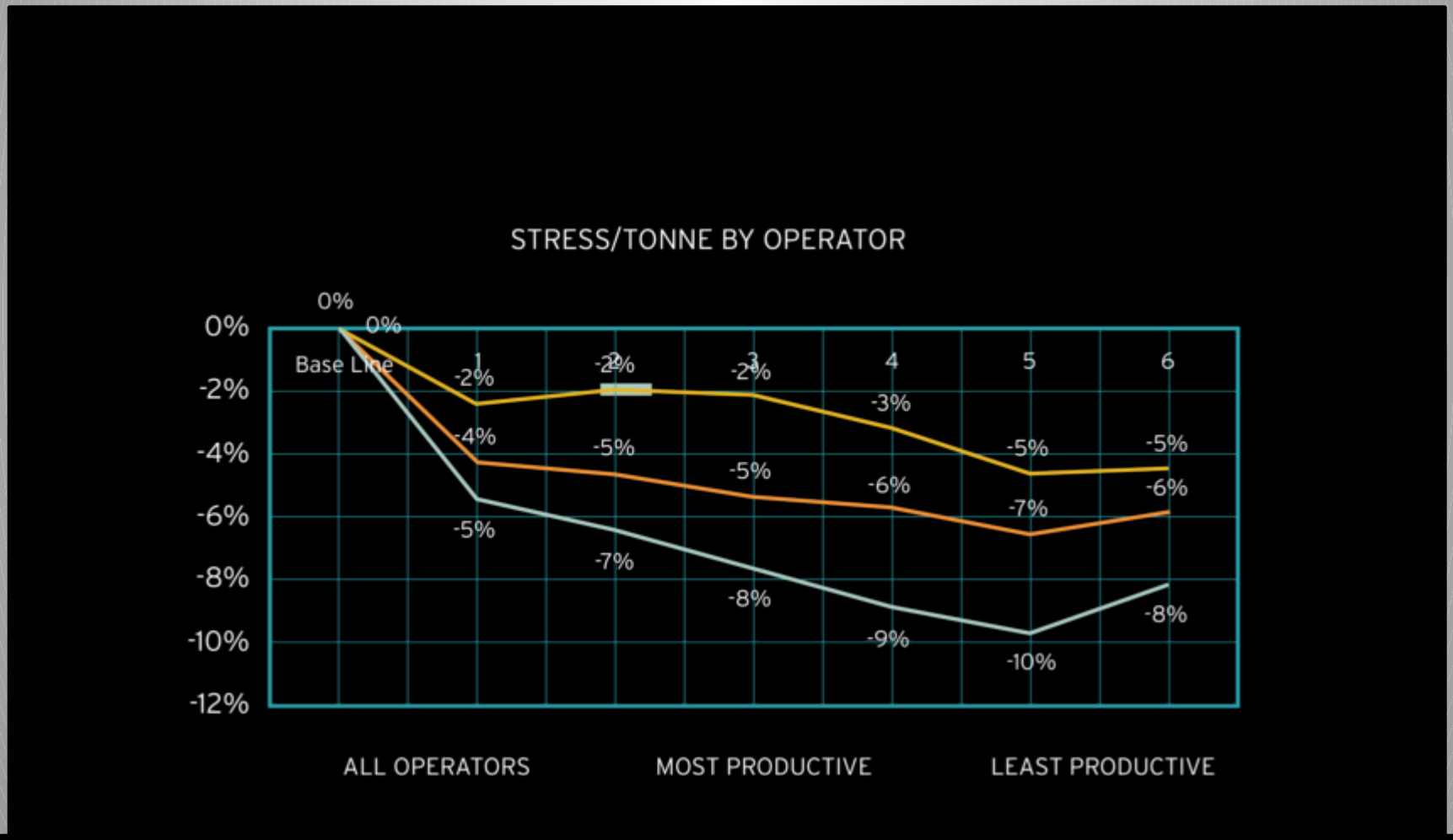
Front-end Inefficiencies - Pain

- These plots show data from strain gauges off an operating loader.
- There are around 2-3 loading cycles in each plot
- Data is collected before / after a single operator change.
- Note how different the ‘signatures’ are for the same operating conditions
- Op B in this case is doing much more fatigue damage to the machine



Front-end Inefficiencies - Pain

- Does production come at the cost or maintenance?



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Control

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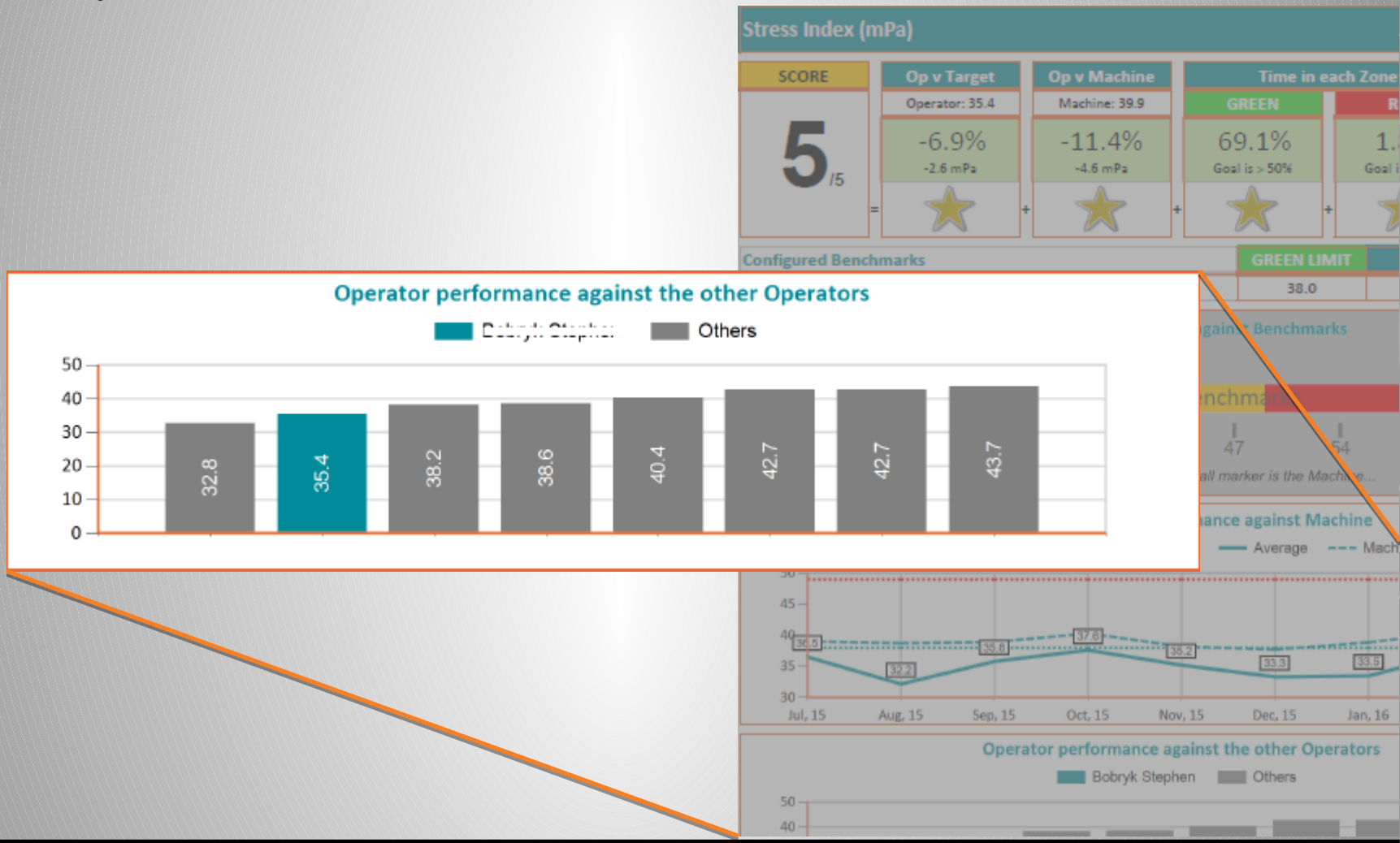
Confidential

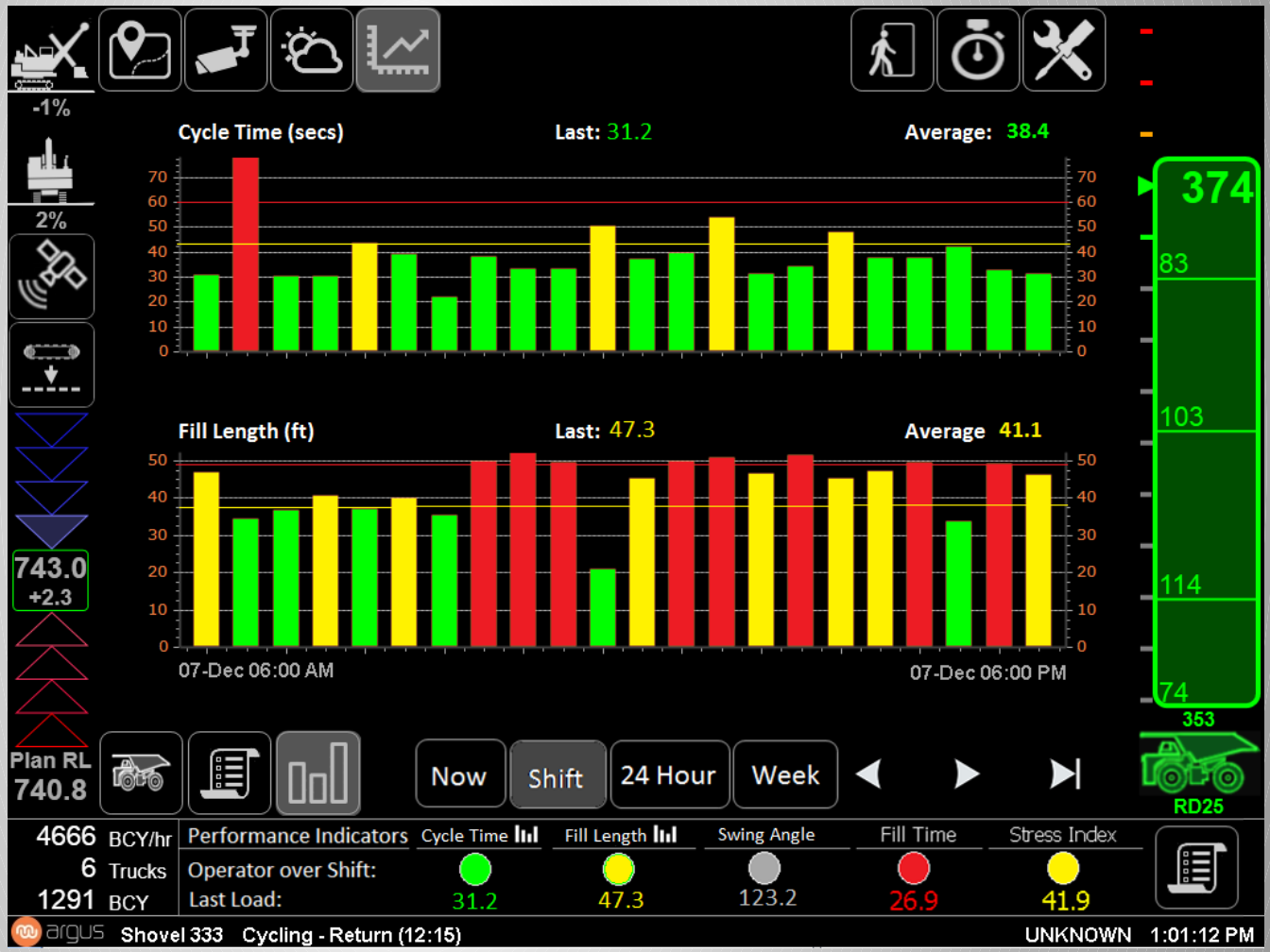
Front-end Inefficiencies - Control

- *Commonly see 25% variation between best and last across KPIs*



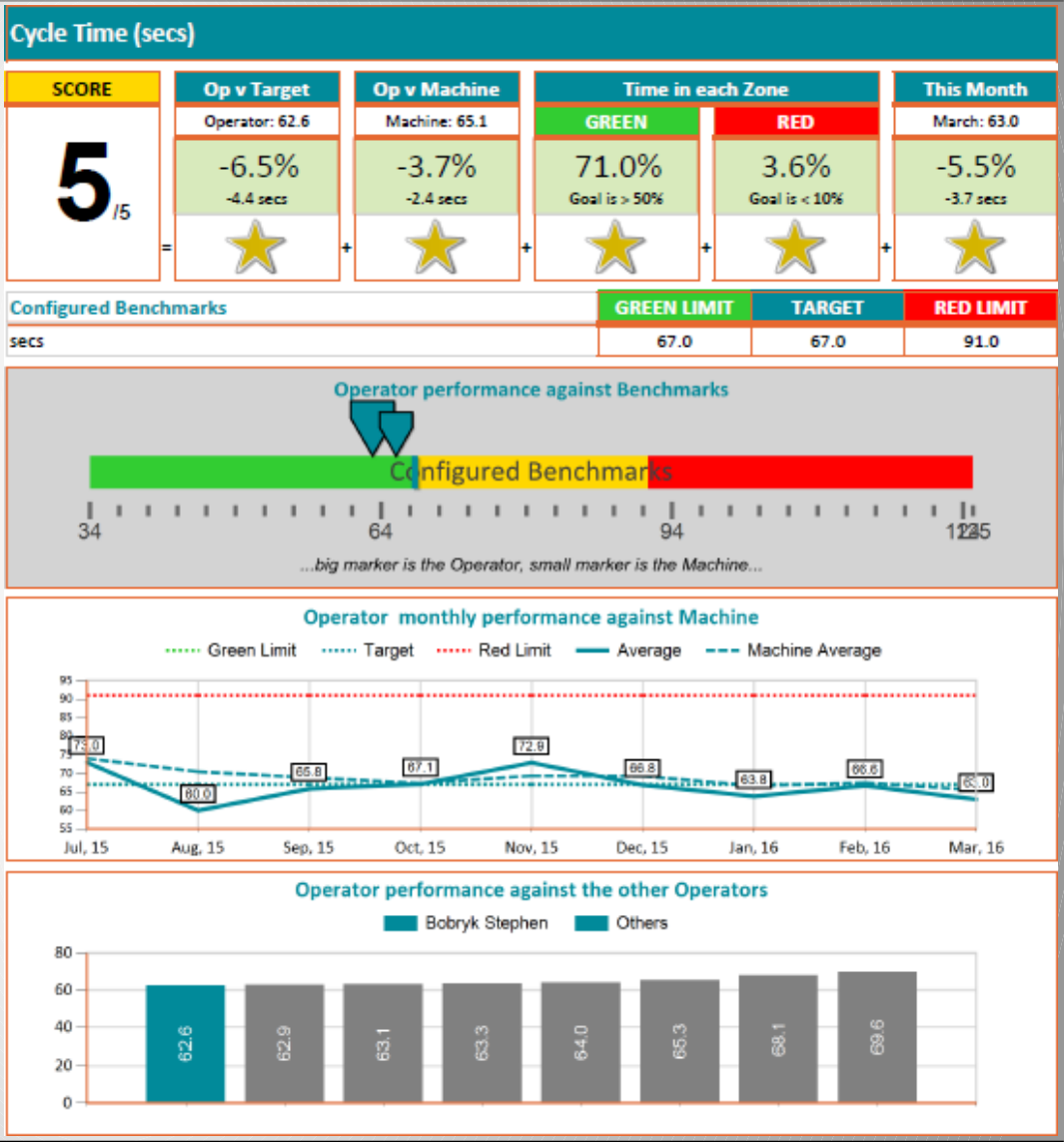
Front-end Inefficiencies - Control

- Basic, ‘Traffic light’ style feedback has proved useful for influencing operator behaviour
- Done in real-time, through-out the shift, it quickly lets operators know how they are travelling against the benchmark
- ‘Peer based benchmarking’ has proved powerful for setting targets people can believe in



Front-end Inefficiencies - Control

- *Anonymous peer based KPI score cards.*
- *Production balanced with maintenance*
- *Progress against tagets*
- *Achievable targets*



Thank You!

For further information contact:

Your Name
Mobile: +XXX XXXX-XXXX

www.mineware.com
email: mwsales@mineware.com