

2015 Haulage & Loading
Freedom Shovel “Level 3”
May 19, 2015

Frank Wickert
Product Management

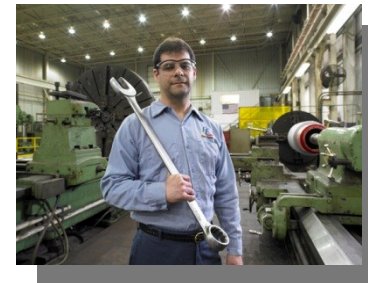
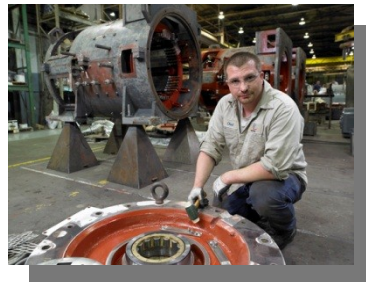
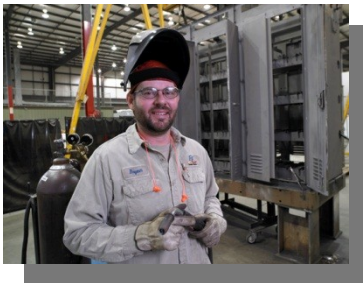


FLANDERS

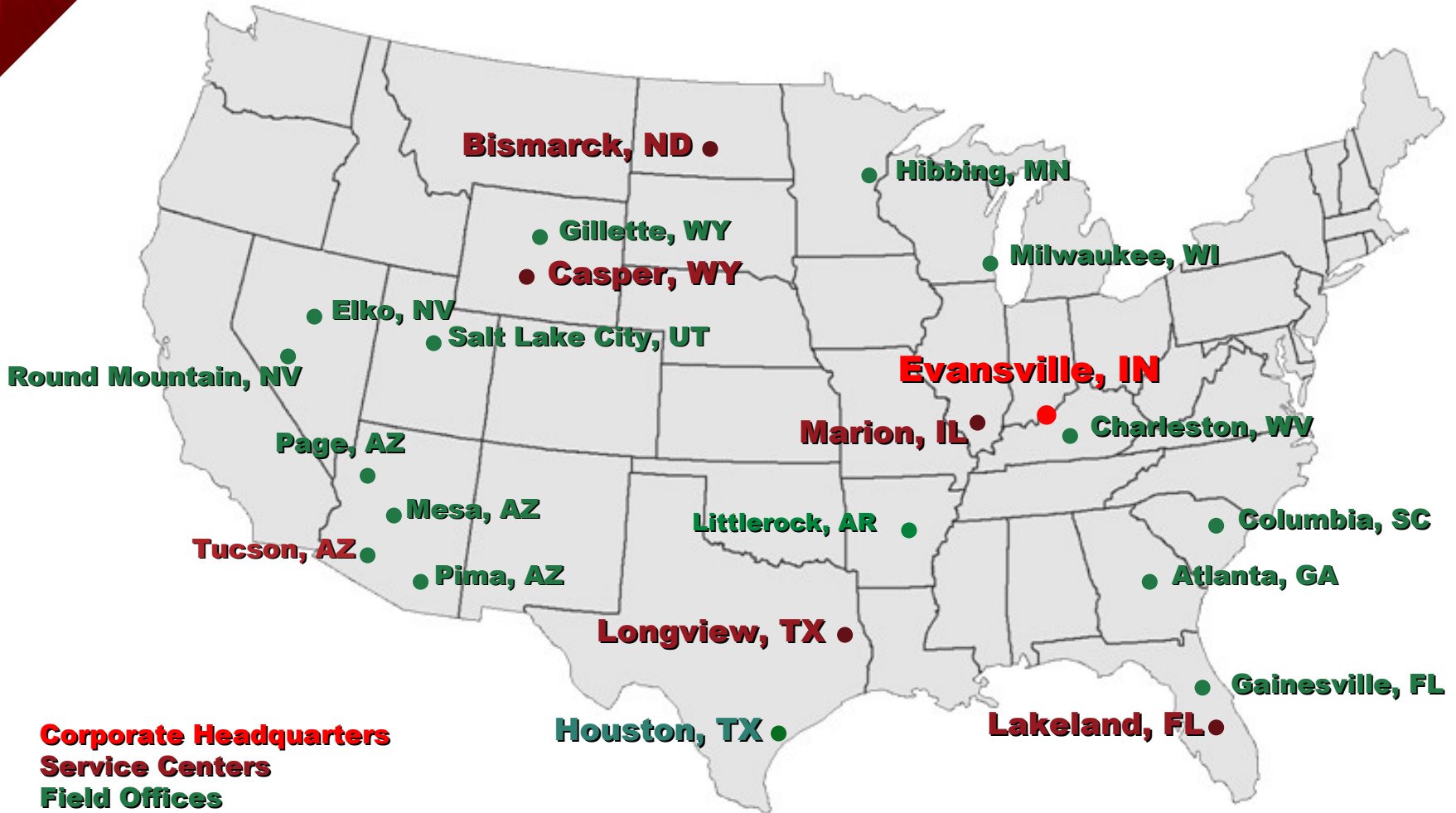
Listen. Innovate. Serve.

Flanders Company Overview

- Originally founded in 1947
- **Family-owned** for three generations
- Over 1 million square feet of repair, office, and inventory
- **Over 800 employees** working “To bring life and renewal to all we serve around the world.”



U.S. Locations



FLANDERS

International Offices



Alberta, Canada

Antofagasta, Chile

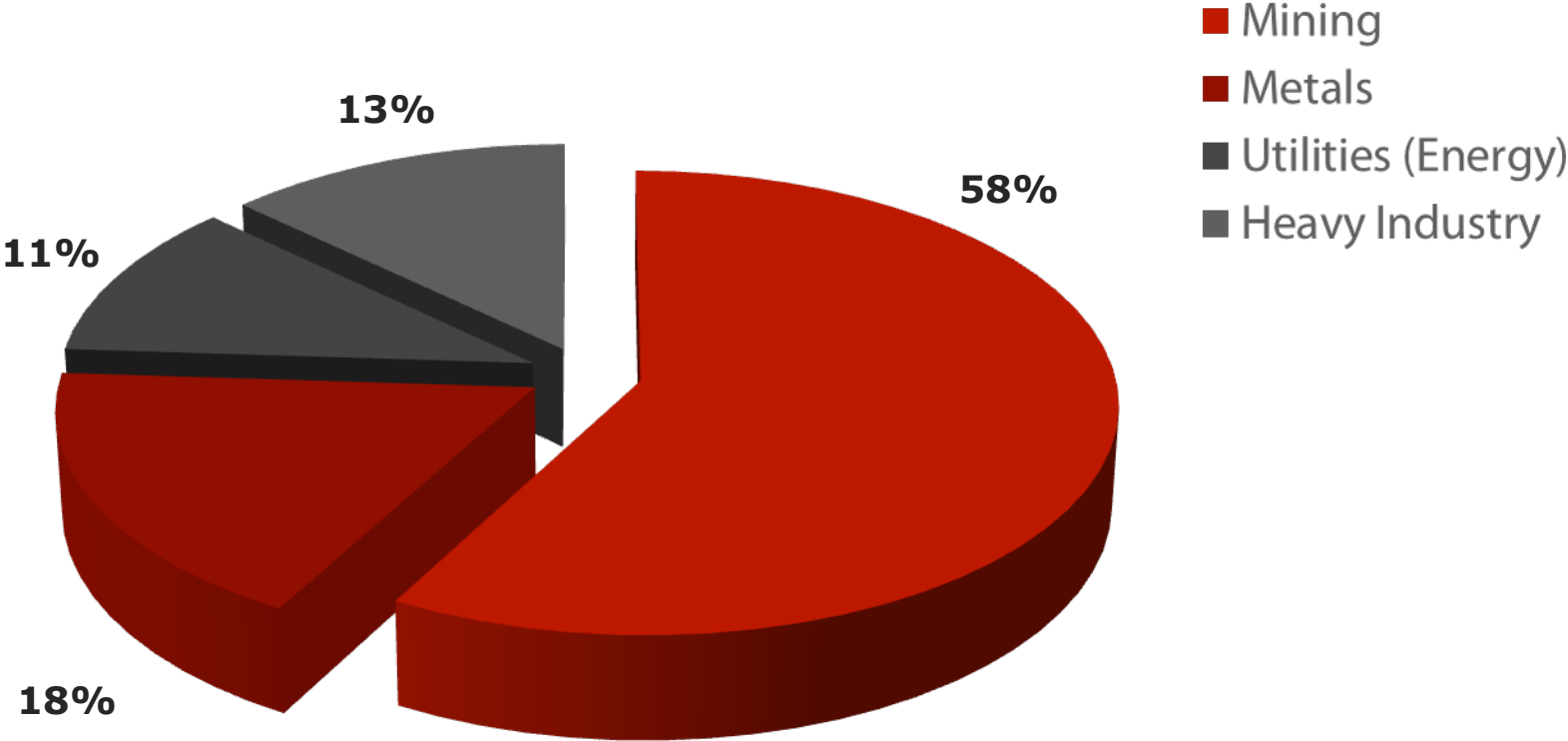
Middelburg, South Africa

Queensland, Australia

FLANDERS

Industries Served

% of Annual Sales (>\$150M)



Expanding Capabilities



1950

1970

1990

2010

2015

Future

FLANDERS

ARDVARC® AUTOMATED DRILL SYSTEM

Improved Safety

Increased Productivity

Improved Machine Life Management

Predictable Fragmentation

AUTOMATED ROD HANDLING

AUTOMATIC MACHINE LEVELING

ENGINE HEALTH MONITORING:

- ▶ Able to diagnose equipment problems before a serious failure occurs

INTEGRATED SYSTEM:

- ▶ GPS guided blast hole system
- ▶ No onboard human interaction required

WORLDWIDE DEPLOYMENTS:

AUSTRALIA, BRAZIL, CHILE,
INDONESIA, SOUTH AFRICA,
UNITED STATES



ARDVARC® COMMAND CENTER



Remote Monitoring and Control

AUTOMATIC DRILLING :

- ▶ Collars, drills and cleans borehole to $\pm .05$ feet

SAFETY:

- ▶ Bit stuck protection
- ▶ Sensorless vibration detection
- ▶ HazCam obstacle detection
- ▶ Removes operator from the machine

MACHINE HEALTH MONITORING:

- ▶ Faults and alarms
- ▶ Dynamic machine status

HAZCAM SYSTEM:

- ▶ Provides real-time imaging of surrounding area
- ▶ Simple to use and understand
- ▶ No moving parts
- ▶ High reliability
- ▶ Easily integrated

DATA COLLECTION:

- ▶ Machine health
- ▶ Machine performance
- ▶ Down the hole data



AC & DC DRAGLINE UPGRADES

Precision Control

Increased Efficiency

Improved Safety

Higher Productivity

FLANDERS HAS DEVELOPED EQUIPMENT SPECIFICALLY FOR UDD MACHINES TO IMPROVE PRODUCTIVITY.

NEW AC & DC MOTORS:

- ▶ Excavator-duty
- ▶ Hoist, drag, swing, propel
- ▶ Complete class H (200° C) insulation
- ▶ Complete MG sets for draglines

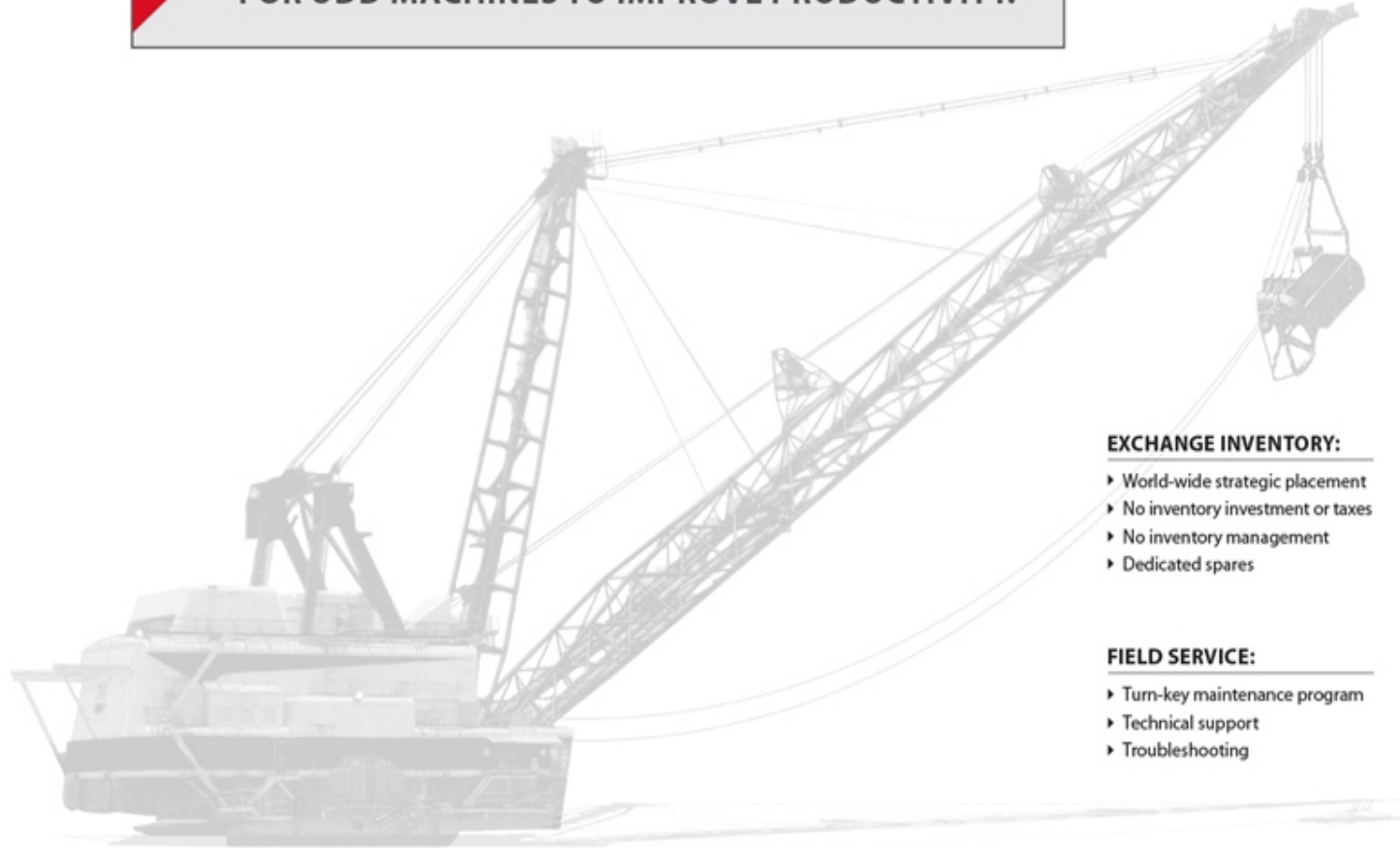
AC DRIVE SYSTEMS:

- ▶ Easy-to-replace power module
- ▶ Designed for purpose to improve productivity and reliability
- ▶ Simplified diagnostics screens and troubleshooting

HIGH OUTPUT MOTORS & MG SETS:

- ▶ Reduced cycle times
- ▶ Increased production
- ▶ High reliability and safety

**NORTH AMERICA'S
FIRST DC TO AC
POWER UPGRADE**



EXCHANGE INVENTORY:

- ▶ World-wide strategic placement
- ▶ No inventory investment or taxes
- ▶ No inventory management
- ▶ Dedicated spares

FIELD SERVICE:

- ▶ Turn-key maintenance program
- ▶ Technical support
- ▶ Troubleshooting

REPLACEMENT GRID BOX:

- ▶ Retard grid box
- ▶ AC blower motor
- ▶ Decrease mechanical brake wear
- ▶ Independent grid match to each motor
- ▶ Dynamic retard to zero speed

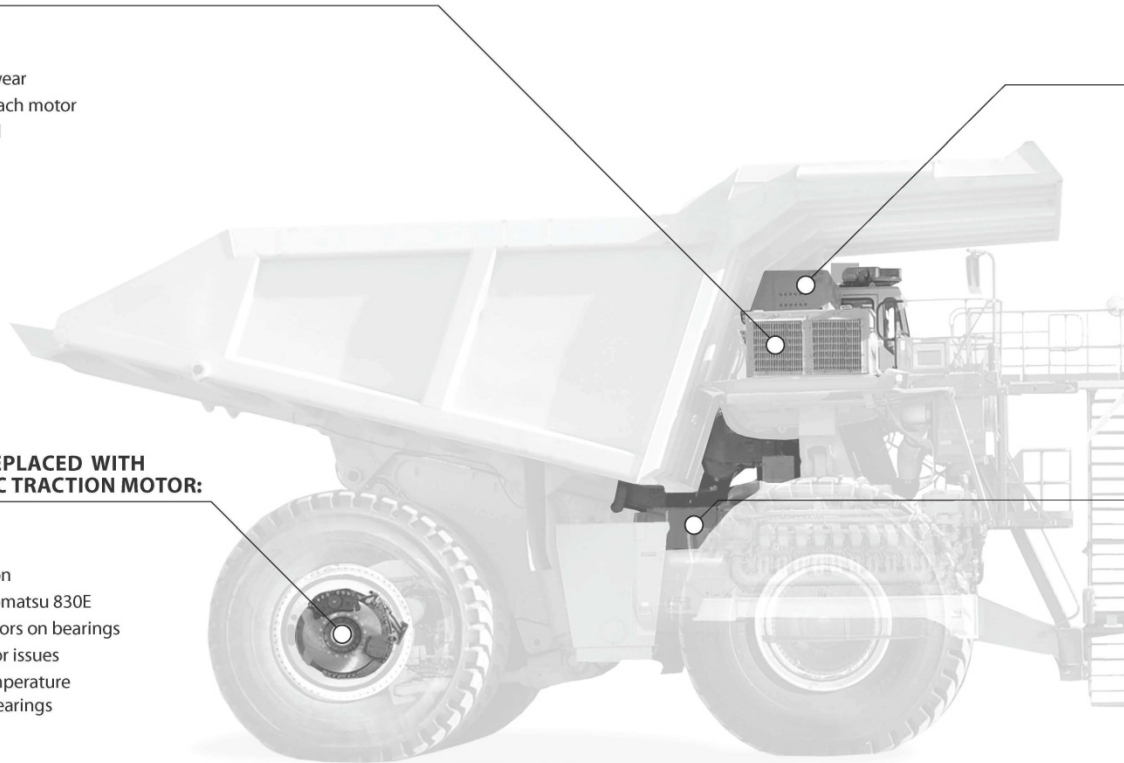
DC TRACTION MOTOR REPLACED WITH FLANDERS-DESIGNED AC TRACTION MOTOR:

- ▶ 30% higher speeds
- ▶ Efficient, long lasting wear
- ▶ Improves energy consumption
- ▶ Engineered specifically for Komatsu 830E
- ▶ Equipped with vibration sensors on bearings
- ▶ Eliminates commutator/motor issues
- ▶ Equipped with resistance temperature detectors on windings and bearings
- ▶ Reuse existing gear box

DC CONTROLLER IS REPLACED WITH AC CONTROLLER:

- ▶ Open architecture design
- ▶ Front wheel speed sensors
- ▶ Independent control of motors
- ▶ Limited slip traction control
- ▶ New alternator voltage regulator
- ▶ Hill holding zero speed (anti-rollback)
- ▶ Separation of power and control reduce arc flash exposure
- ▶ Liquid cooled drive provides for dust-free sealed power components
- ▶ New enclosures

REUSE EXISTING ALTERNATOR & BLOWER



FLANDERS' AC Haul Truck Upgrade Offering is Currently Under Development



FREEDOM™ Si:

- ▶ Digital drives
- ▶ Customizable control programming
- ▶ Enhanced diagnostic HMI
- ▶ FLANDERS motors
- ▶ Open control architecture

FREEDOM™ Se:

- ▶ DCS 800 upgrade with open architecture
- ▶ FLANDERS motors
- ▶ Open control architecture

NEW MOTOR MANUFACTURING CAPABILITIES:

- ▶ In-house design engineering
- ▶ Resin rich, class H insulation systems
- ▶ Proprietary field coil insulation system
- ▶ Drop-in replacements and retrofits
- ▶ Horsepower upgrades
- ▶ Crowd, hoist, swing applications

MARK II AIR-COOLED CONVERTER UPGRADE:

- ▶ Diverter protection
- ▶ Increased safety

REACTIVE POWER COMPENSATION:

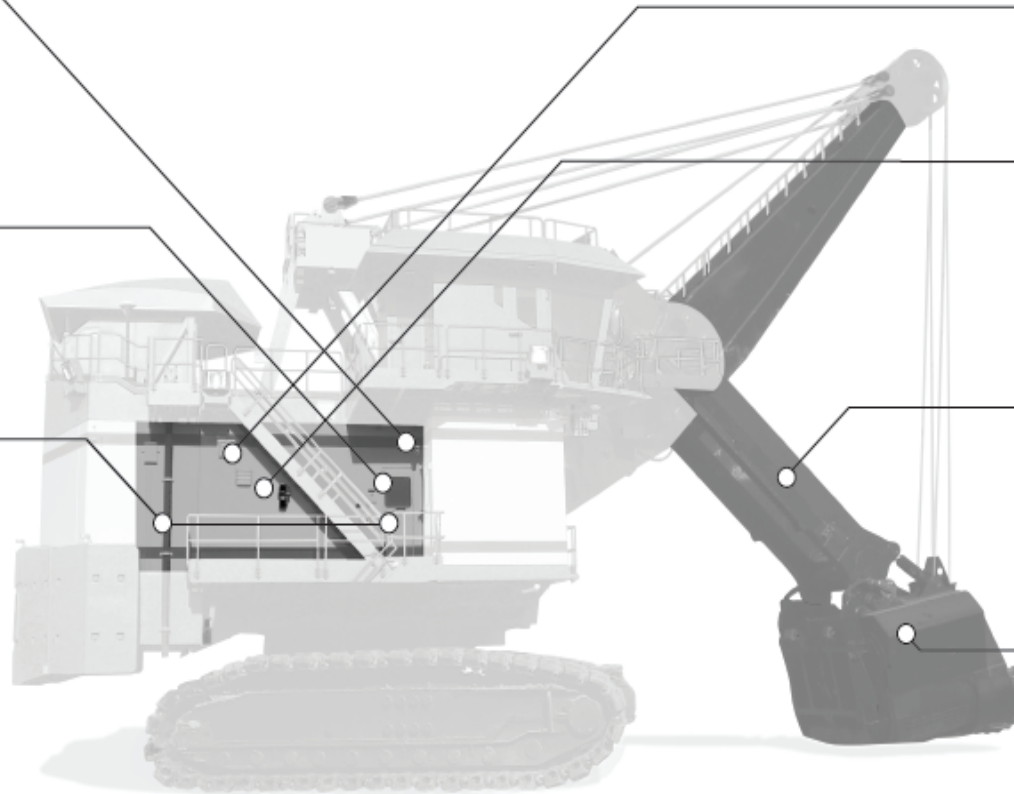
- ▶ Reactive power compensation
- ▶ Easy to commission
- ▶ Higher reliability
- ▶ Modular and flexible to your configuration
- ▶ Capacitors

DIG OPTIMIZATION SOLUTION:

- ▶ Optimal power delivered at and through bank engagement
- ▶ Reduced cycle times
- ▶ Improved machine performance
- ▶ Increased dipper fill factor

SURETRIP™:

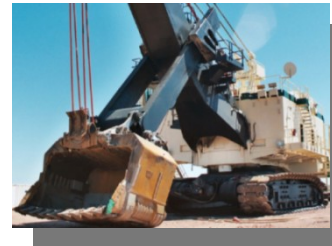
- ▶ 99% activation reliability
- ▶ Active front end technology
- ▶ Modular drive technology
- ▶ Excavator-duty gear and motor assembly
- ▶ Increases productivity, extends rope life and reduces maintenance needs
- ▶ Complete drop-in in replacement to minimize installation cost



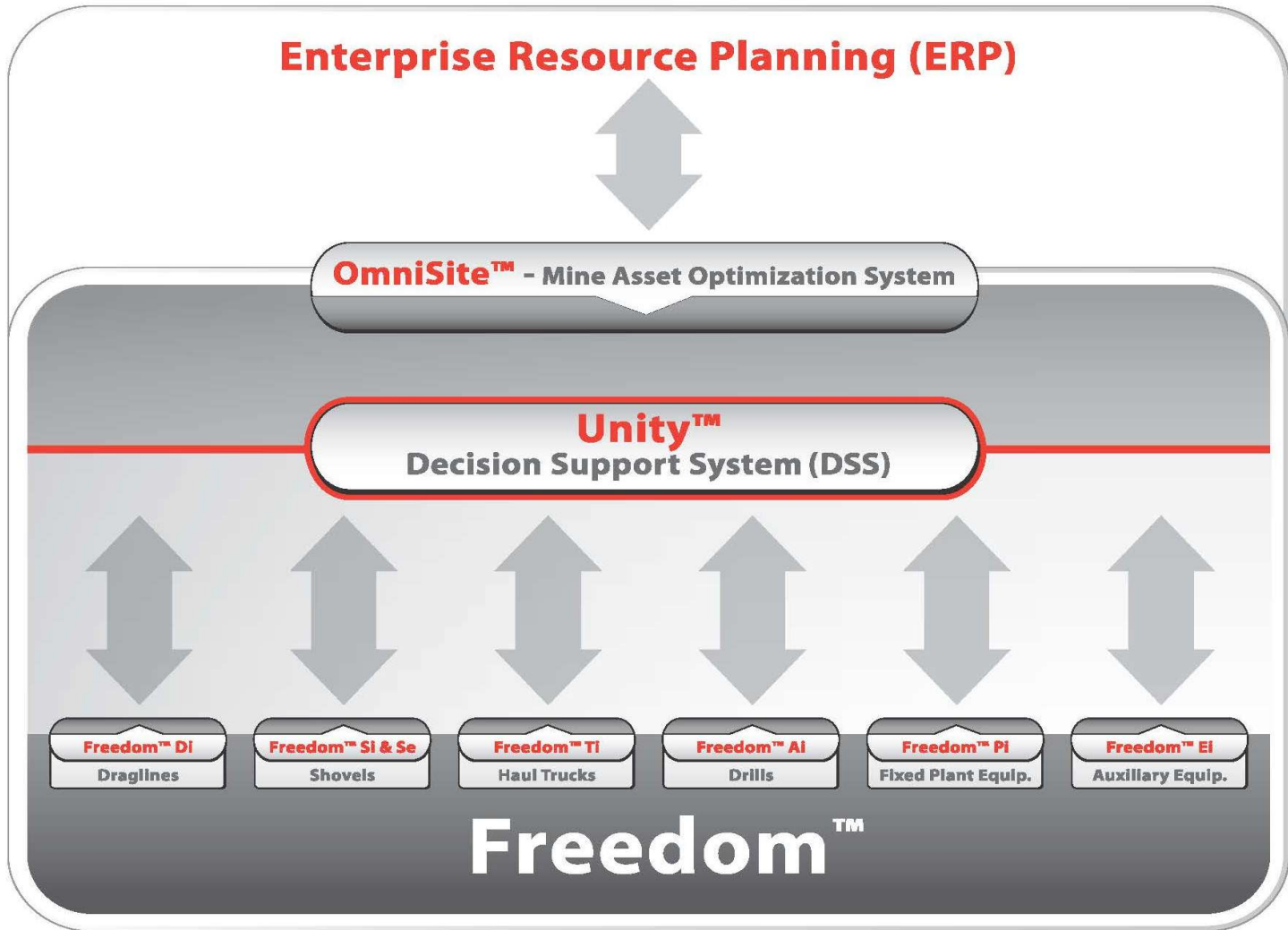
Surface Mining Performance

- System solutions
 - Motors, drives, and control systems

ACROSS OEMS!!!



FLANDERS Optimizes Mining Assets



FLANDERS

FLANDERS Freedom™ Platform for Shovels

Open Architecture for Ultimate Flexibility

FLANDERS Freedom™ Se	
Level 1 Freedom™ Control System	<ul style="list-style-type: none"> Freedom™ Platform
Level 2 Crowd Motor Performance	<ul style="list-style-type: none"> Freedom™ Platform FLANDERS M21 Crowd Motor
Level 3 Crowd Motor with Optimized Bank Performance	<ul style="list-style-type: none"> Freedom™ Platform FLANDERS M21 Crowd Motor Optimized Bank Performance
Level 4 Hoist Motors Performance	<ul style="list-style-type: none"> Freedom™ Platform (2) FLANDERS M24 Hoist Motors
Level 5 Hoist Motors with Optimized Bank Performance	<ul style="list-style-type: none"> Freedom™ Platform (2) FLANDERS M24 Hoist Motors Optimized Bank Performance
Level 6 Hoist/Crowd Motors Performance	<ul style="list-style-type: none"> Freedom™ Platform FLANDERS M21 Crowd Motor (2) FLANDERS M24 Hoist Motors
Level 7 Hoist/Crowd Motors with Optimized Bank Performance	<ul style="list-style-type: none"> Freedom™ Platform FLANDERS M21 Crowd Motor (2) FLANDERS M24 Hoist Motors Optimized Bank Performance

FLANDERS Freedom™ Si	
Level 1 Freedom™ Control System	<ul style="list-style-type: none"> Freedom™ Platform
Level 2 Crowd Motor Performance	<ul style="list-style-type: none"> Freedom™ Platform FLANDERS F22 Crowd Motor
Level 3 Crowd Motor with Optimized Bank Performance	<ul style="list-style-type: none"> Freedom™ Platform FLANDERS F22 Crowd Motor Optimized Bank Performance
Level 4 Hoist Motors Performance	<ul style="list-style-type: none"> Freedom™ Platform (2) FLANDERS M22A Hoist Motors
Level 5 Hoist Motors with Optimized Bank Performance	<ul style="list-style-type: none"> Freedom™ Platform (2) FLANDERS M22A Hoist Motors Optimized Bank Performance
Level 6 Hoist/Crowd Motors Performance	<ul style="list-style-type: none"> Freedom™ Platform FLANDERS F22 Crowd Motor (2) FLANDERS M22A Hoist Motors
Level 7 Hoist/Crowd Motors with Optimized Bank Performance	<ul style="list-style-type: none"> Freedom™ Platform FLANDERS F22 Crowd Motor (2) FLANDERS M22A Hoist Motors Optimized Bank Performance



FLANDERS Freedom “Level 1”

- **Freedom Se**

Feature	Benefit
Open System – FREEDOM!!	Capacity to use either OEM or FLANDERS Motors
Single Point Hoist/Crowd Limits	Reduced down time to reset limits
Enhanced Current, Speed, and EMF Regulators	Improved motion control
Open Architecture designed software	No “Black Boxes”






Limits Screen

Freedom Se - Machine Limits NO COMMUNICATION TO PLC Excavator ID: 0 9/18/2012 10:29:00 AM


To begin Limits Setup please login, set the program keyswitch to 'Program' and then press the Bypass Limits pushbutton.

Step #1 - Login


 



 **Logged Out**

Step #2 - Program Key

 **Program Key = Off**

Step #3 - Bypass Limits

 **Limits Enabled**

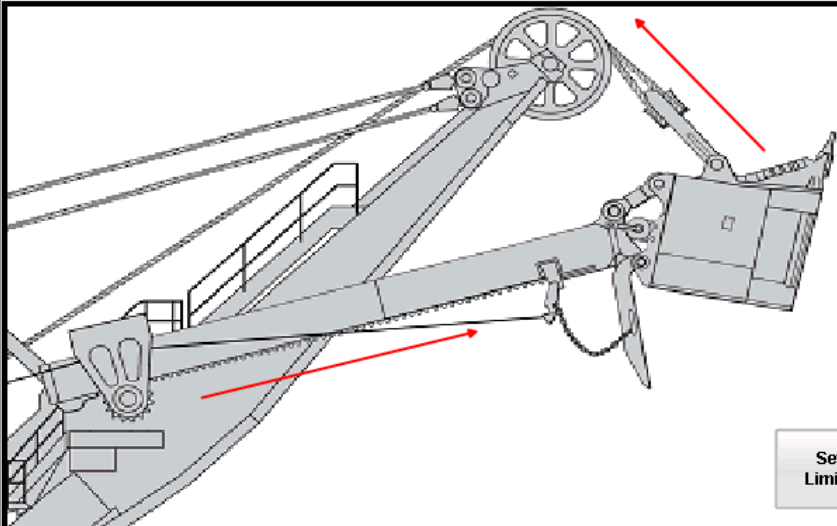
 


Resolver Counts


Hoist: Crowd:



Step #4 - Set Machine Limits

- 1.) Hoist and Crowd until the ball is at the point shieves, and the Green Horn is touching the Crowd pinion.
- 2.) Set the Hoist and Crowd Brakes.
- 3.) Press the Set Limits Button. (The Hoist and Crowd Resolver Counts will reset to 8,000)
- 4.) Enable Limits and Test.





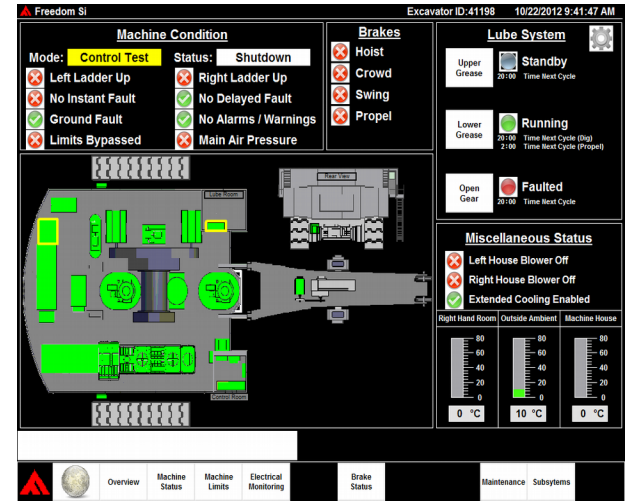


  Overview Machine Status Machine Limits Electrical Monitoring Temperature Monitoring Brake Status Maintenance Subsystems Alarm Summary

FLANDERS

Freedom Se

- Scope of Supply
 - New DCS800 drives
 - New HMI
 - New PLC program



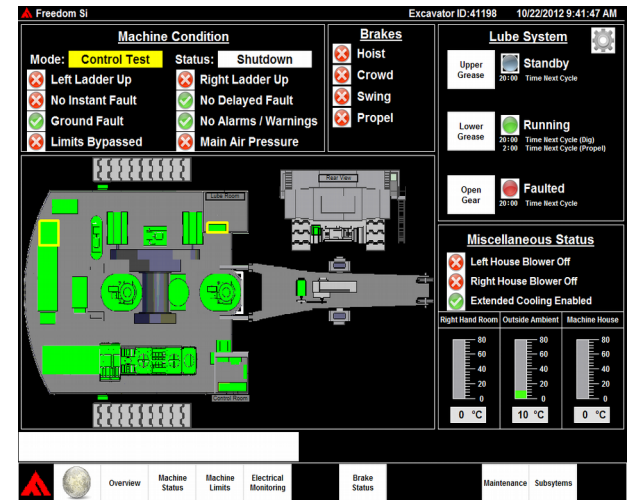
Freedom Se

- Scope of Work
 - Remove DCS600 armature cards & field drives
 - Install DCS800 drives
 - Install PLC programs
 - Install HMI
 - Commissioning
 - Approximately 24-30 hours

Freedom Si

- Scope

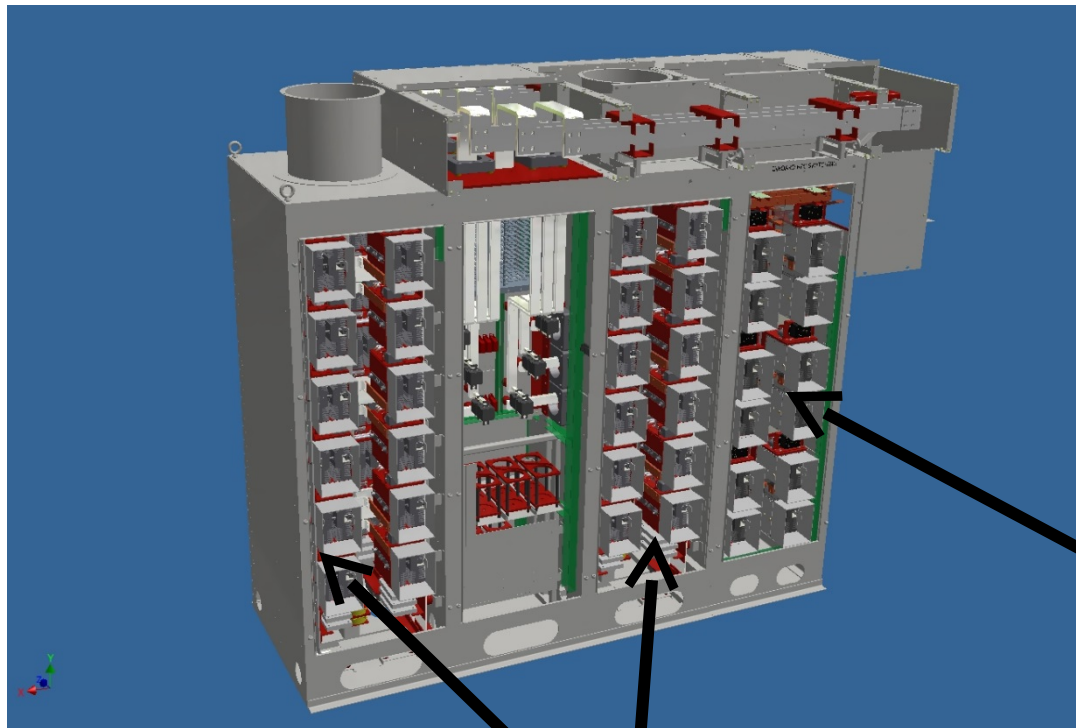
- Upgrades Obsolete Analog-Controlled Machines to new Digital Control.
- Includes new control cabinet with ABB DCS800 drives and PLC, RPC firing circuits, new pulse transformers



Freedom Si

- Scope of Work
 - Remove existing control cabinet
 - Install new control cabinet & terminate cables
 - Install HMI
 - Check I/O
 - Drive/RPC commissioning
 - In-Bank testing
 - Approximately 5 day outage

Freedom Si w/ Air-Cooled



RPC Switching Cabinet

Converter Motion Section



Freedom Si w/ Air-Cooled

- Scope of Supply
 - Freedom Si System w/ Control cabinet, PLC & drives
 - New air-cooled converter cabinet
 - New air-cooled RPC cabinet
 - Overhead bus and bus covers
 - Approximately 14-15 day outage

Freedom Se

- Candidate machines
 - 4100XPB
 - Non-Centurion
 - Centurion
 - 4100XPC
 - 2800XPB/C

FLANDERS Freedom “Level 2”

Freedom Se

Feature	Benefit
Same as Level 1	Same as Level 1
M21 Crowd Motor	<ul style="list-style-type: none">- Enhanced crowd performance- Reduced cycle time- Improved motor reliability- Interchangeable with OEM crowd motor (K700B).



M21 Crowd Motor

- Replaces K700B Crowd Motor
- Integrates with existing Control System
- Allows for higher stall current = more torque when combined with Freedom Se
- Designed for Reliability
 - Class H Insulation - 125°C Rise
 - DE Double-Spherical Roller Bearing
 - 2700A stall-capable



FLANDERS Shovel Motors

FLANDERS Motor Model No.	OEM/P&H Motor Model No.
FE1620A	K558A (Swing)
FE2121	K925 (Hoist)
F20 / F20S	K408/K489 (Crowd)
F20SP	K408/K489 (Propel)
F22	K700 (Crowd)
M21	K700B (Crowd)
M22A	K1010/K1250 (Hoist)
M24	K1690/K1980 (Hoist)



FLANDERS AC Shovel Motors

FLANDERS Motor Model No.	OEM/Bucyrus/Cat Motor Model No.
FA 1420	509YZ (Crowd)
FA 1514UPZ	507UPZ (Swing)
FA 1926	588YZ (Propel)
FE 8011YZ	8011YZ (Hoist)



FLANDERS Freedom “Level 3”

Freedom Se

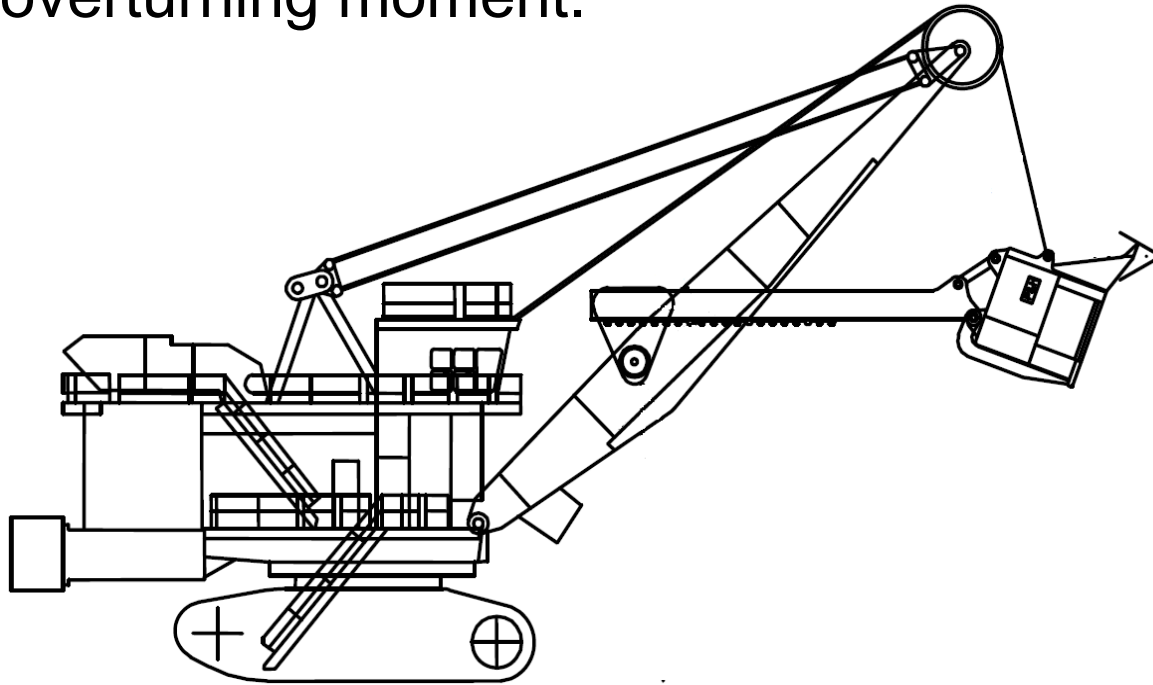
Feature	Benefit
Same as Level 1	Same as Level 1
Same as Level 2	Same as Level 2

OBP – Optimized Bank Performance	<ul style="list-style-type: none">- Enhanced productivity while staying within the OEM mechanical limits of the machine.- Reduced cycle time.- Hoist performance boost at the optimum point in the dig cycle
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Assumptions Limiting Productivity

- The machine Mechanical design constraint limits the maximum hoist rope tension (Electrical Limits) based on the single load case for maximum overturning moment.

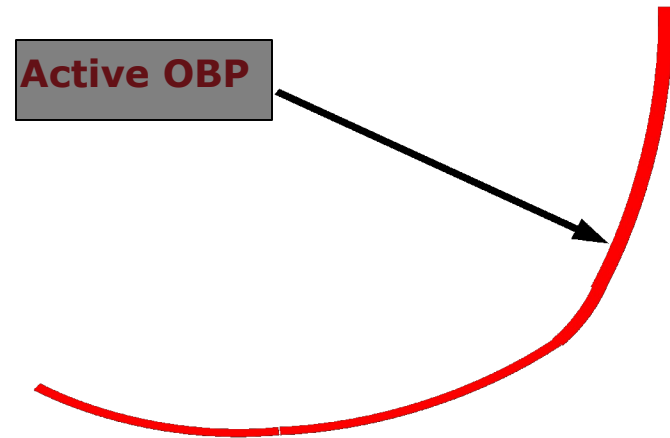


OBP - Optimized Bank Performance

- **Allows for Increased Hoist Rope Tension within the Dig Cycle.**
- **Incorporates Crowd Force into the Algorithm.**
- **Results in Increased Digging Power low in the Bank.**
- **Monitors Boom Structural Response throughout the Dig Cycle.**
- **Stays within the Conservative OEM Structural Loading Envelope of the Shovel.**



Active Zone of OBP

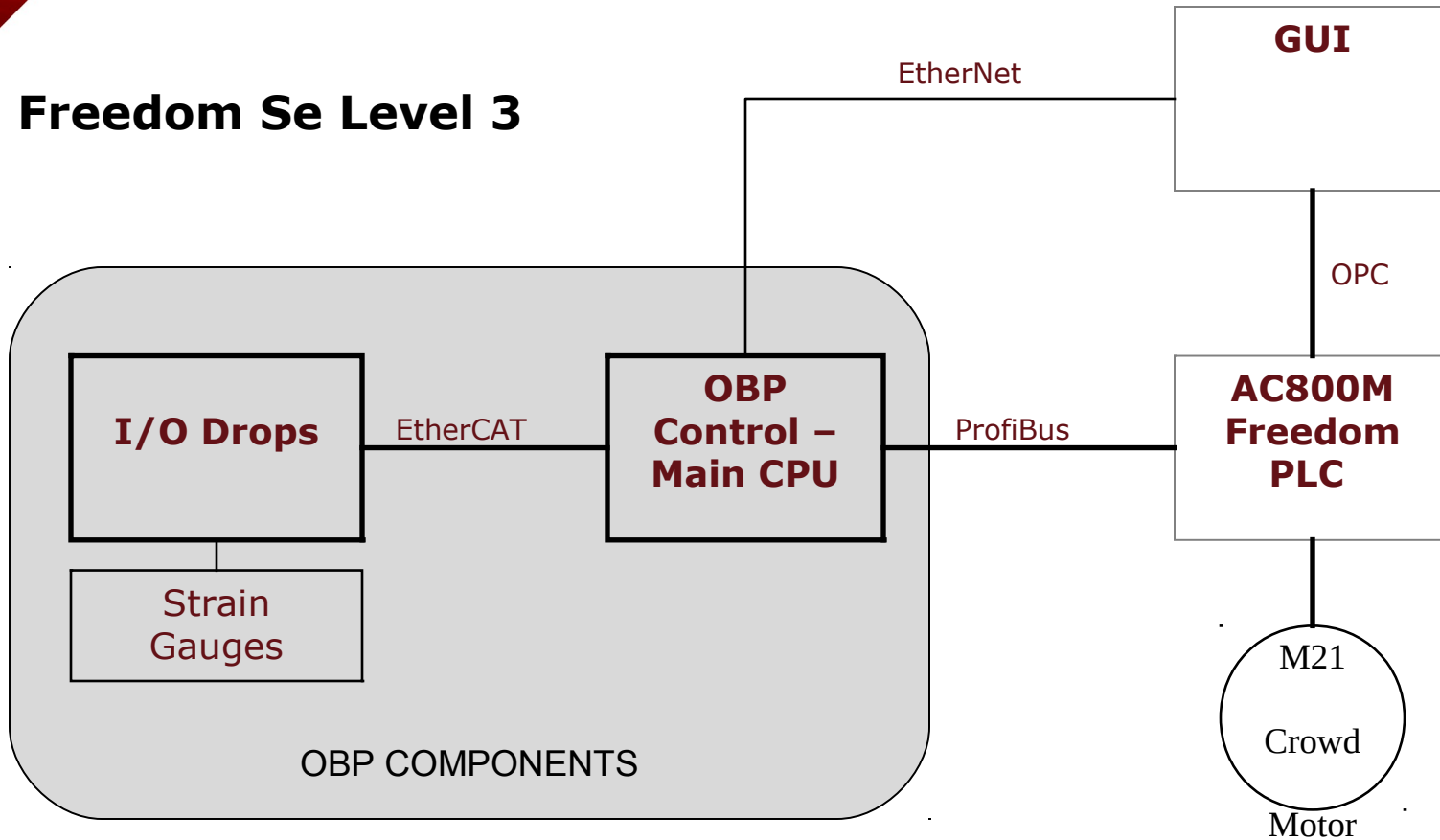


+10% Increase in Hoist Power!



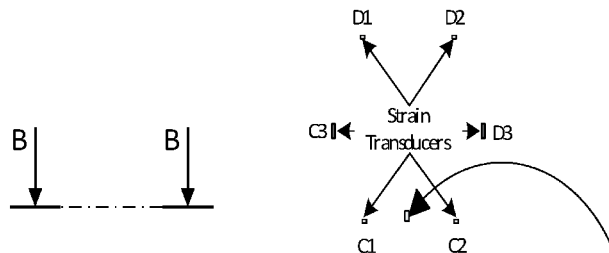
OBP Diagram

Freedom Se Level 3

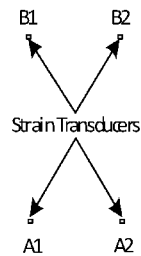


OBP Sensors

Boom Instrumentation



Instrumented Cross-Section B-B



Instrumented Cross-Section A-A

Triaxial Accelerometer

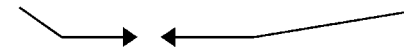
A-Frame Tension Leg Instrumentation

Outside Edge
Left and Right Legs

Bottom Edge
Left and Right Legs

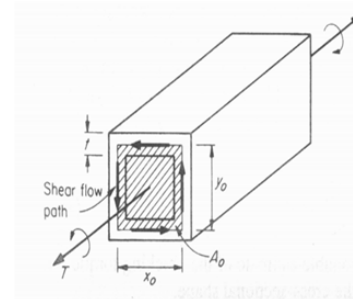
A1

A2

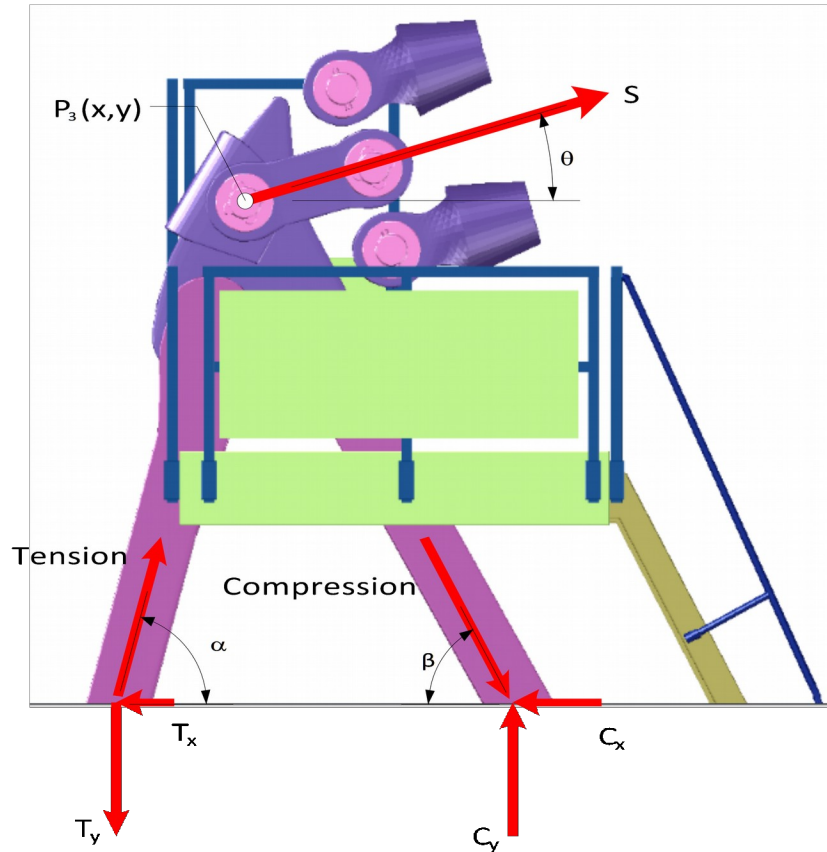


A3

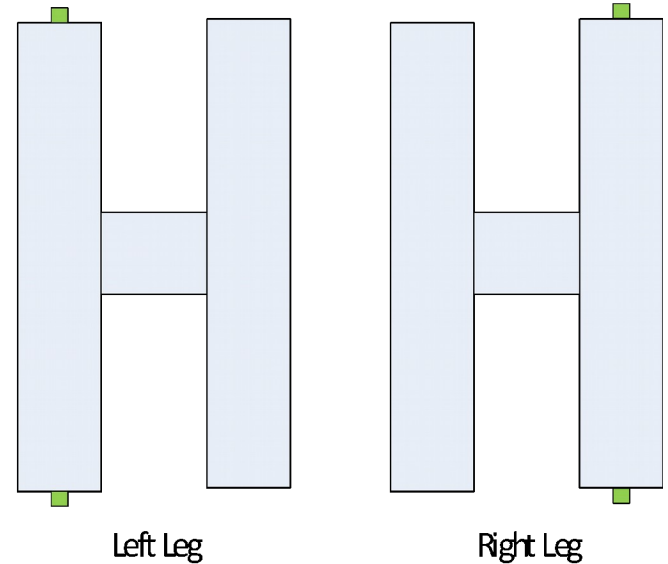
A4



Gantry Tension Legs

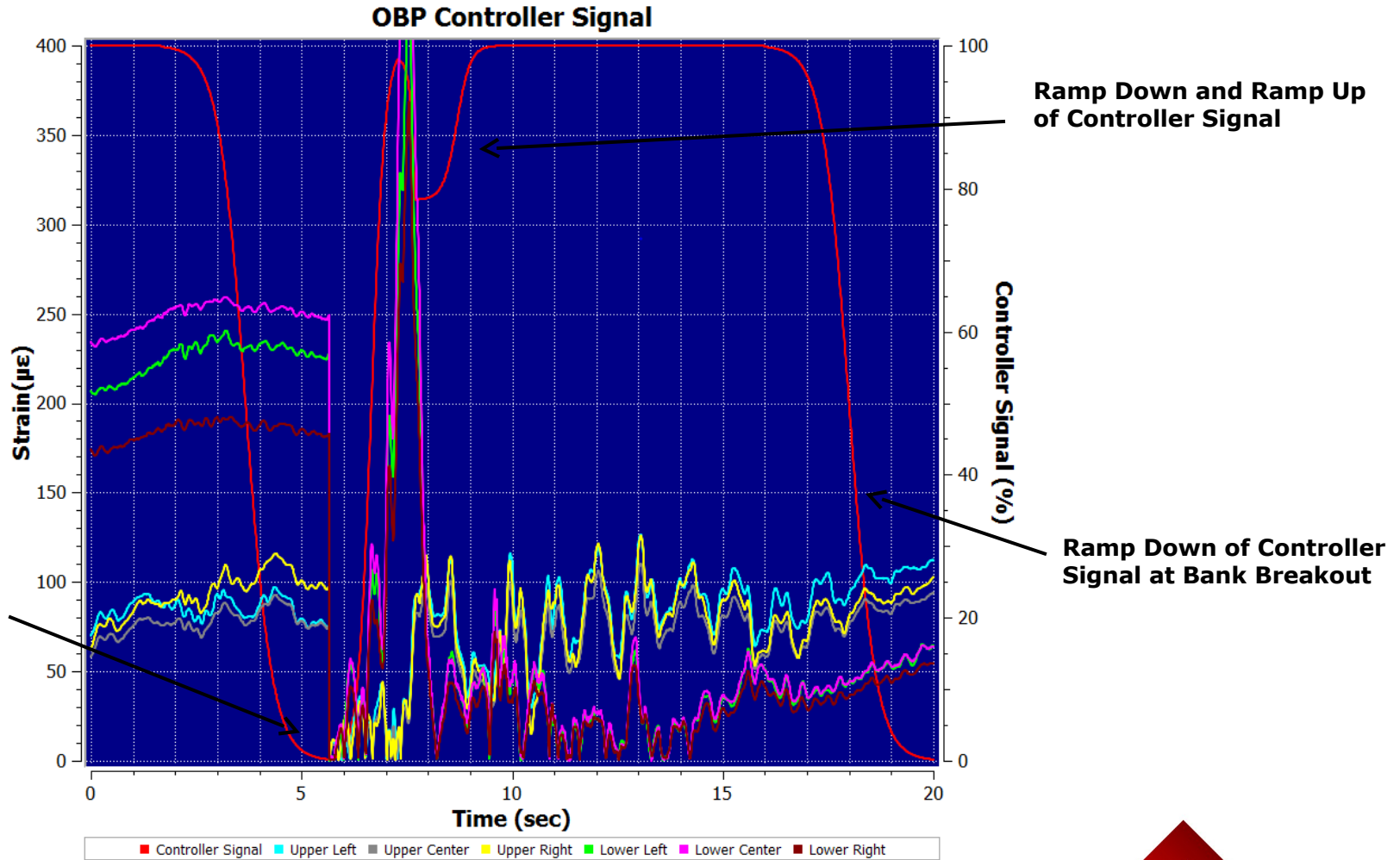


Gantry Leg FBD



Strain Transducer Locations on Tension Legs

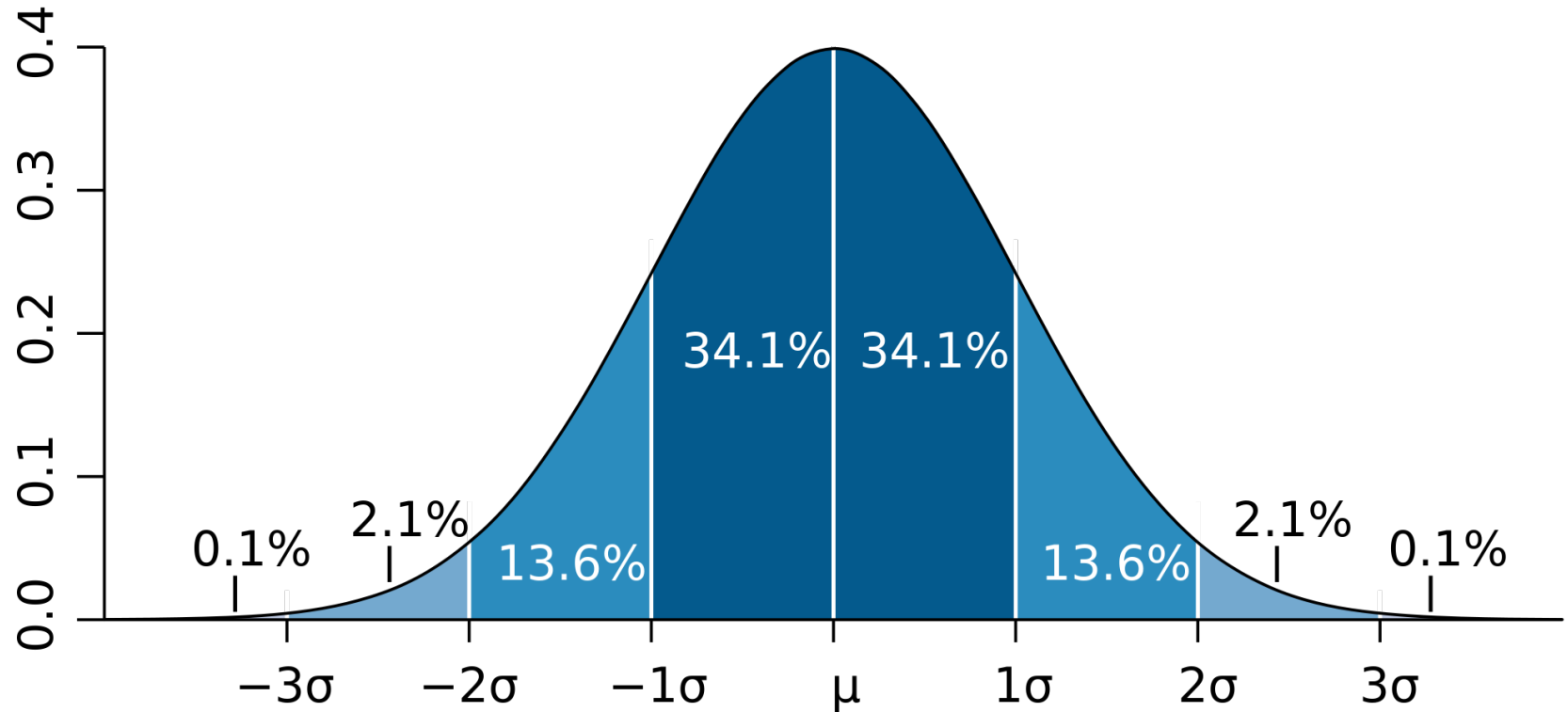
OBP Signal



OPR Active



Conservative Deployment



A maximum 1σ strain setting results in excluding the top 15.8% of the measured differential strain (or boom loadings) from OBP control. Rule of thumb, 90% of damage is done by 10% of the loads.

Shovel Operator

- Tricep
- Biceps

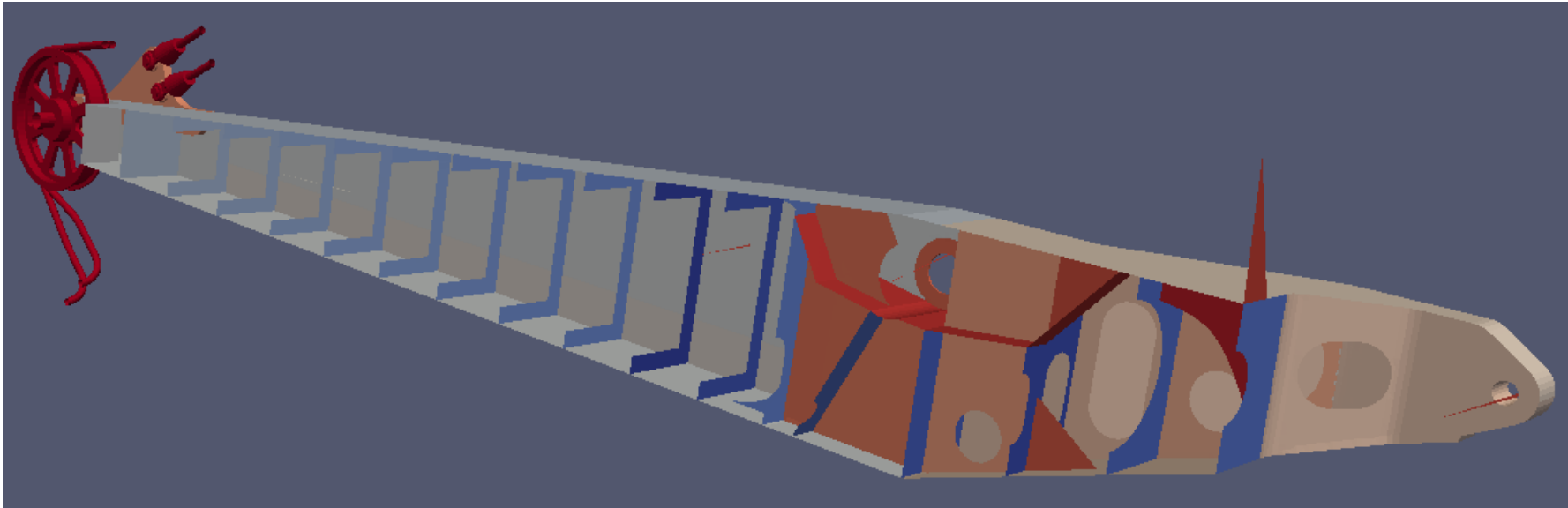


Strain Feedback



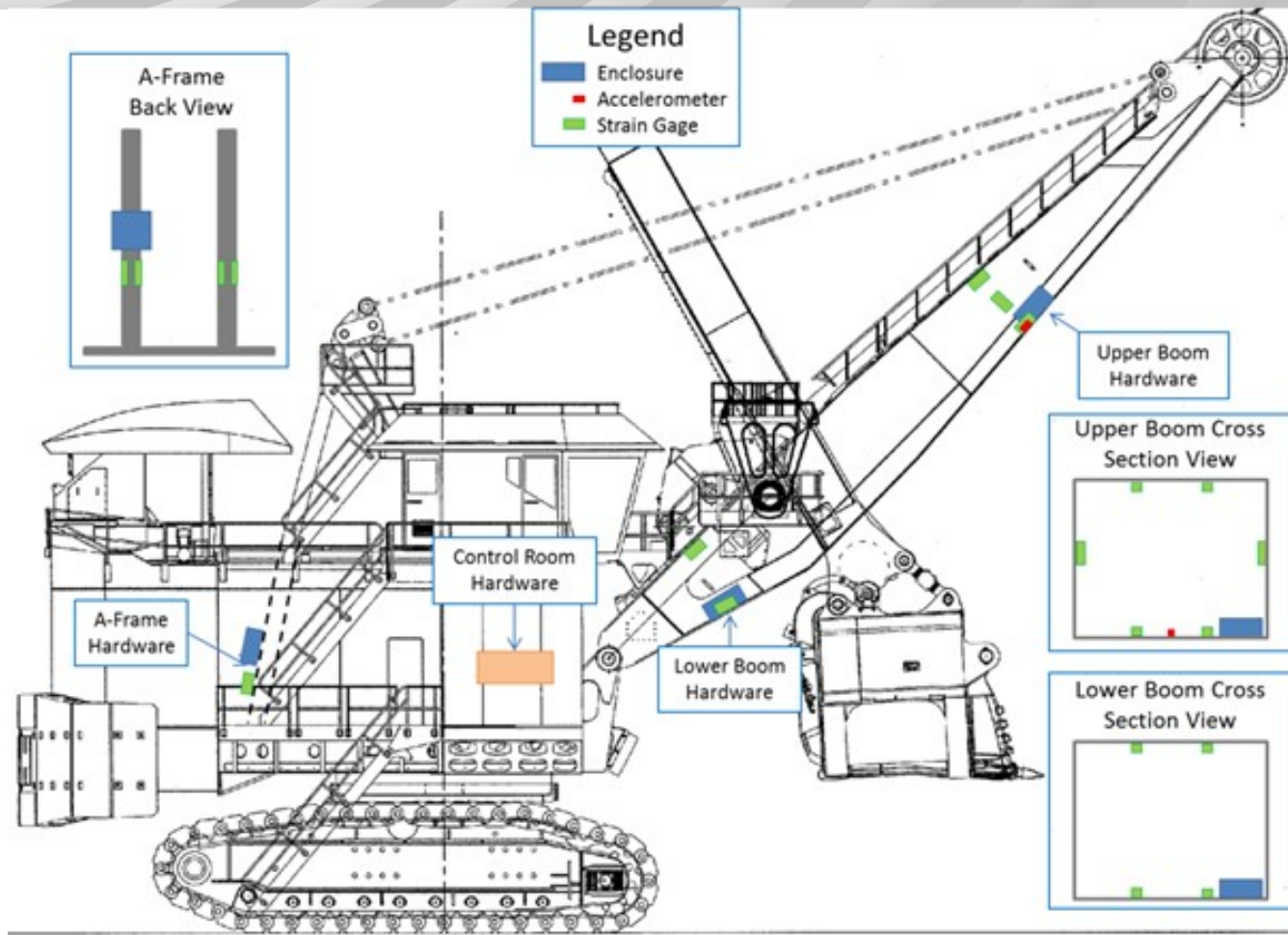
10msec
sampling

4100 XPC Boom Model



Developed from field measurements of interior and exterior of boom

OBP Hardware



Freedom Shovel Level 3 ROI

Deployed at US coal mine on a customer's 4100XPC

Product	Productivity Increase
OEM Control System w/ M21	6.0%
Freedom Se w/ M21	10.4%
Freedom Se Level 2	17.6%
Freedom Se Level 3	24.3%



Freedom HMI

Freedom Se - Machine Status NO COMMUNICATION TO PLC Excavator ID:0 9/18/2012 1:08:00 PM

		Overview	Machine Status	Machine Limits	Electrical Monitoring	Temperature Monitoring	Brake Status		Maintenance	Subsystems	Alarm Summary
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Visit us online at flandersinc.com

