



The Impact of Technology in Mining

Terry Vance
North America
Technology Solutions Manager
Caterpillar Global Mining

WHEREVER THERE'S MINING




Agenda

- Mining Business Drivers
- Core Technologies
- Mining Technology Today
- The Value of Automation
- The Future

Impact of Technology on Key Mining Issues

1. **Safety & Sustainability**
2. **Productivity / Asset Utilization**
3. **Remote Regions**
4. **Shift to Underground**
5. **Technology Integration**
6. **Energy Costs**
7. **Financial Performance**
8. **People – Skilled Resources**
9. **Demand for Innovation**
10. **Infrastructure (rail, ports, etc.)**



Technology can
impact many of
these issues

Key Core Technologies

- Positioning Systems
 - GPS/Glonass
 - Inertial systems (Gyroscopes/Accelerometers)
 - LADAR
- Radio Communications
 - Broadband (802.11, 802.16)
- Detection
 - RFID, Radar and LADAR
- On-board computing
- Off-board software

MACHINE INTEGRATION

CAT® MINESTAR® SYSTEM



FLEET



TERRAIN



DETECT



HEALTH



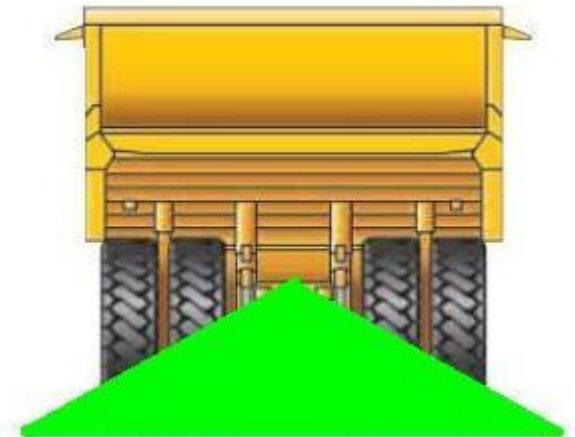
COMMAND

PRODUCT AVAILABLE
PRODUCT IN DEVELOPMENT



Object Detection

- Backup Cameras



Initial proximity alert systems were comprised of simple backup camera systems to show operator what was behind the vehicle

Integrated Detection Systems

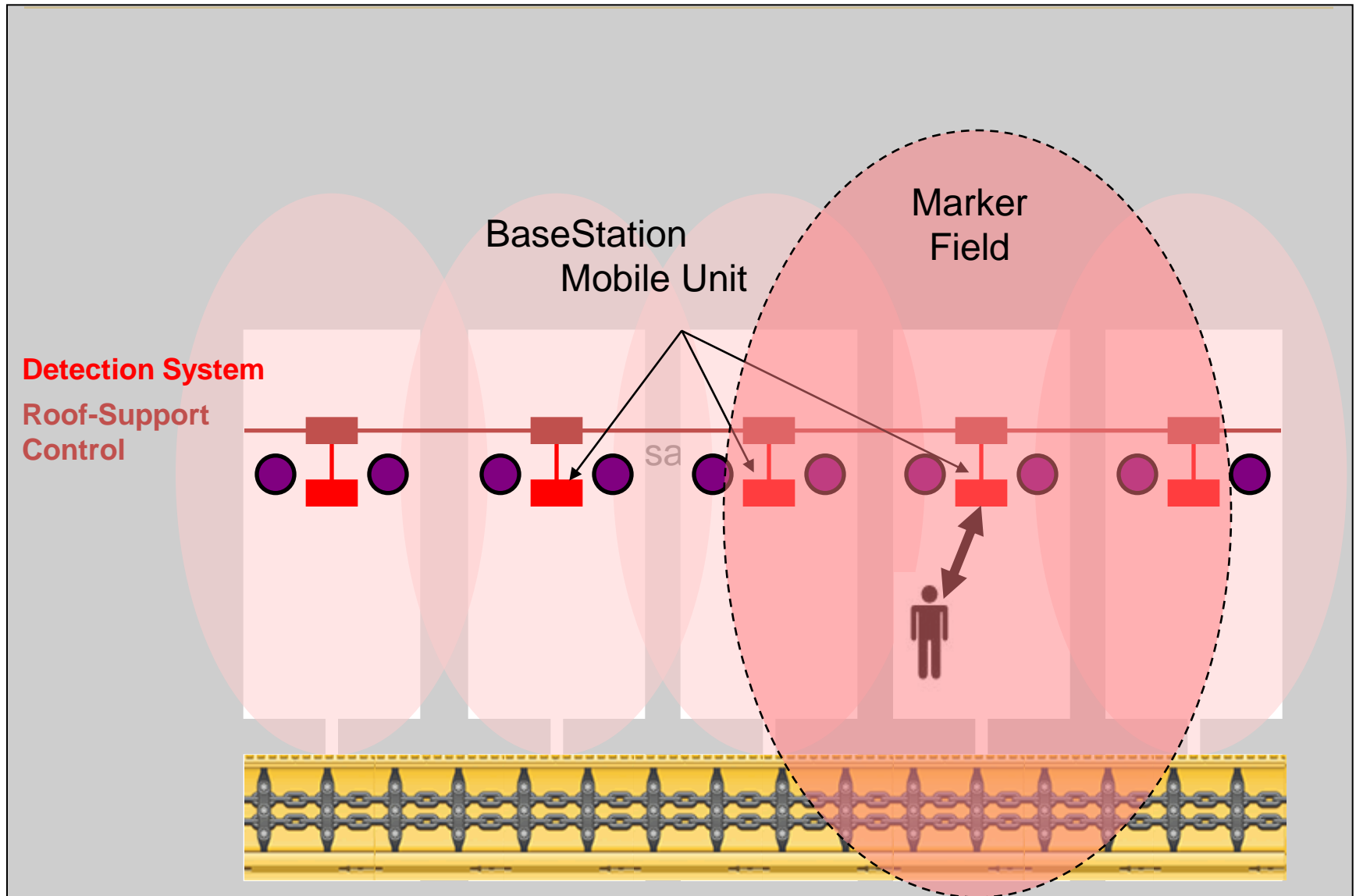


- The integration of onboard computers, **radars** and **cameras** provide the in-cab operator with a wider field of coverage and automated alarm generation.

- Integrated **GPS Proximity** Systems that allow machines and other vehicles to know each others location.



Longwall Safety - Proximity



Remote Control Dozer

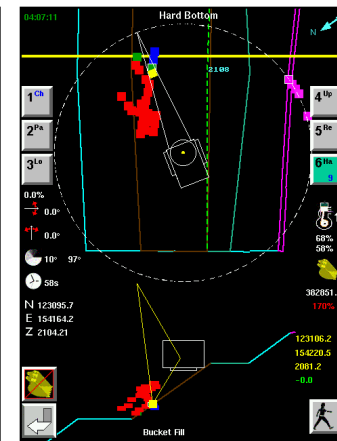
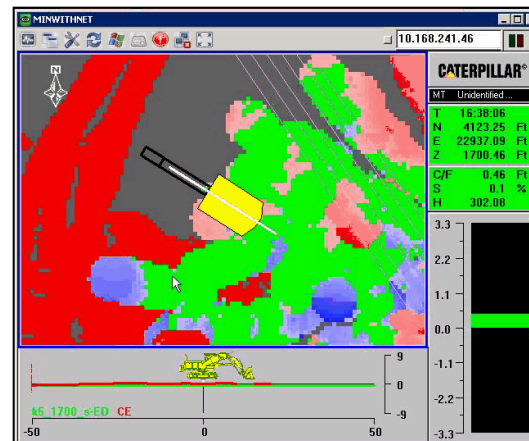


- Reduces risk to operator
 - Stockpile Dozing
 - Cleaning up after a slide
 - Dozing material into tailings dam
 - UG – removing the operator from hazardous environment
 - Ripping



Machine Control and Guidance

- Loaders/Dozers/Drills & Draglines
- Utilizes High Precision GPS
 - Centimeter accuracy
- Provides operator with design in cab
 - Ore types and waste
 - Mined out area
 - Elevation of machine
 - Hole pattern
 - Spoil Pile management
- Real-time productivity updates
- Reduces dilution
- Results in smoother pit floors
- 25%+ Increase in dozer productivity
- Safety
 - Avoidance zones, Geo fences

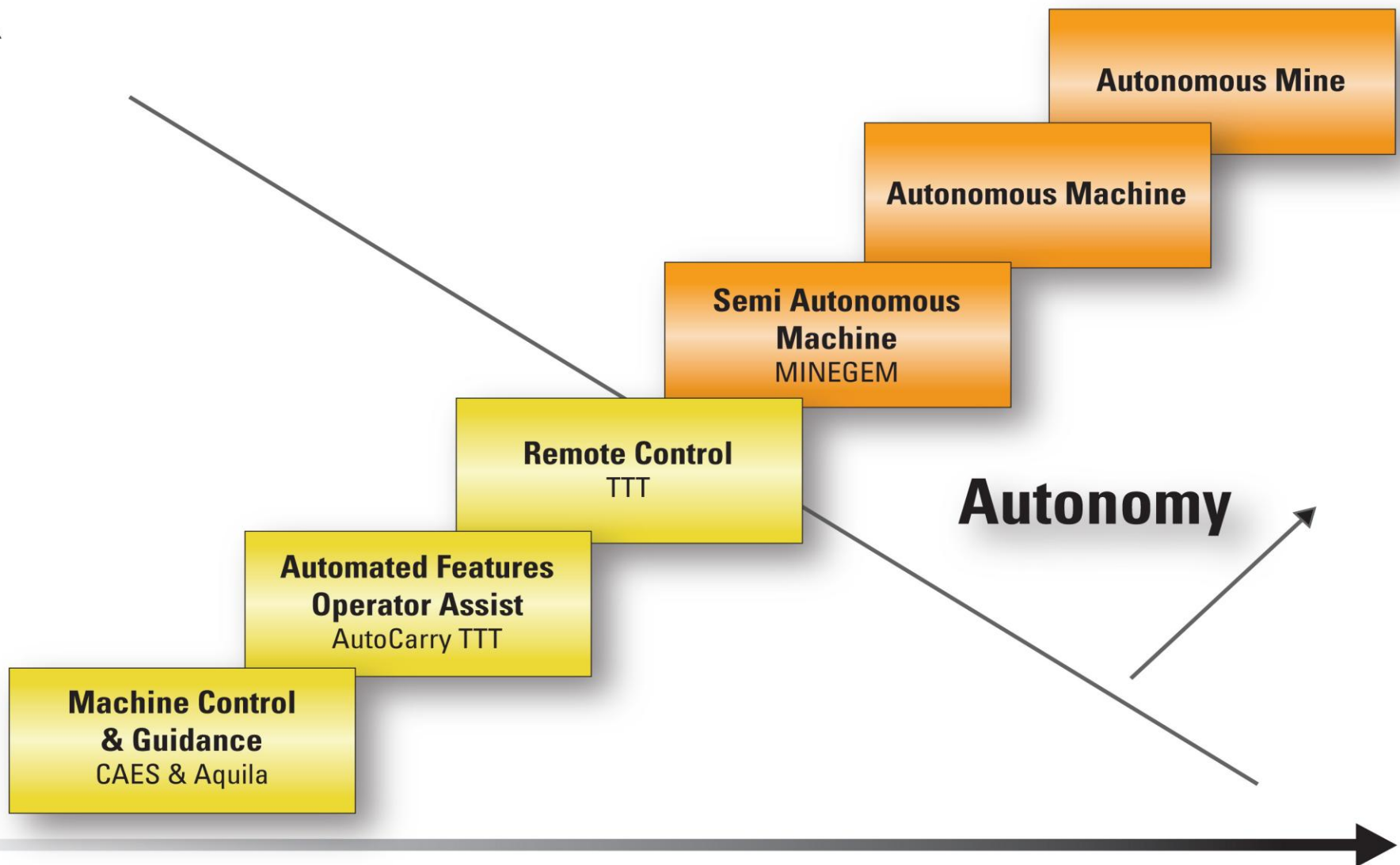


Fleet Management Systems

- “Conductor” at the Mine
- Truck Assignment
- Automatic Reporting
 - Cycle times
 - Locations
 - Delays
 - Operators
- Safety
 - pre-operation check list
 - mayday capability
 - Messaging
 - Machine Awareness
- Significant productivity improvements
 - 10 –15% typical increase in productivity
 - 5%+ Payload Increase via Payload Management focus
 - 3%+ End shift/beginning shift production increase

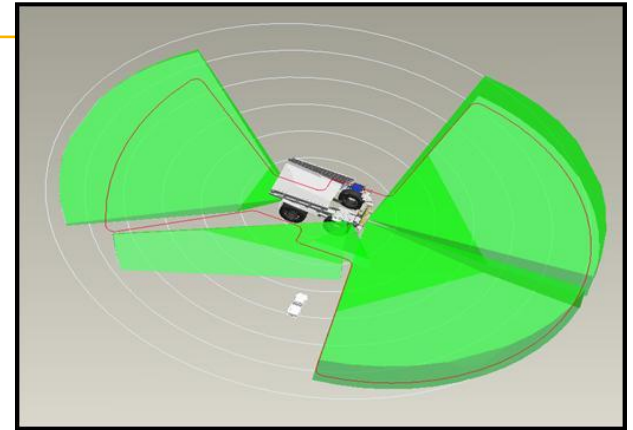


Autonomy ...



Key components of an Autonomous Mining Machine

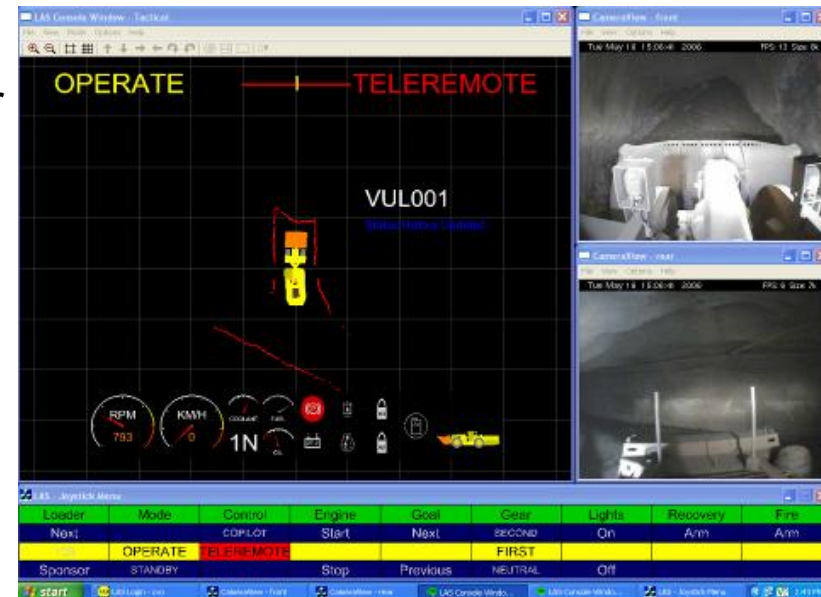
- Drive by wire
 - Ability to control machine digitally
- Detect objects
 - Rock, vehicle
- Position
 - Where am I?
 - What is my heading?
 - What is my speed?
- Machine Health
 - What is not right? Engine, Tire, Transmission
- Safety
 - Where are the other machines relative to me?
 - Where are the light vehicles?
- Navigation
 - Where do I need to go?
 - What is my path?



Value of Autonomy - Underground



- Safety
 - People removed from machine
- Productivity and Utilization
 - Machine can be controlled from surface
 - Improved machine utilization
 - Machine can be worked during shift change
 - Can start earlier after a blast
 - FASTER -- Runs in 2nd gear vs. 1st gear
- Maintenance
 - Less machine damage



Longwall Automation

- PMC – Programmable Mining Controls
 - Enhanced control of drives, roof supports and plow or shearers
- Plow System
 - No plow operator required at longwall during automatic operation
- Shearer – Focus on more semi-autonomous mode
 - Operator as more of an observer
 - Less noise & dust
 - Dome Cameras – reduce need to walk the face



Prototype of Dome-Camera (Shield): FLP Housing



Value of Autonomous Drilling

- Safety
 - Operator not on machine
 - Driving over highwall
- Consistency
 - Hole location
 - Consistent hole elevation vs. hole depth
- Increased productivity
 - Automated control of drilling process
 - More consistent operation with new operators



Value Autonomous Haulage

- Safety
 - Barriers for people
 - Less climbing on and off machines
 - Consistent operation
- Sustainability
 - Less environmental footprint at mine
- Increased productivity and utilization
 - Virtual shift change
 - Truck does not take breaks
- Ability to re-engineer mining processes



Image courtesy of Caterpillar

Implementing Autonomy

- Autonomy is a lot more than removing the operator
- Provides an opportunity to significantly change processes
- Requires focus on Culture change management i.e. People
- Multi- year process to implement with many stakeholders
 - Mining company employees
 - Government Safety Authorities
 - Community

Conclusion

- Mining Technology has been evolving for over 20 years
- Significant step changes are occurring
 - Safety, Productivity and Utilization
- Semi Autonomous / Autonomy is a reality if not requirement
 - Underground LHD's, Surface Trucks and Drills
- What's next ...

SPACE



NASA's LER



Caterpillar's MTL



Caterpillar and NASA partnership in developing multiple use technologies for use with Cat customers and NASA's SEV (Space Exploration Vehicles).

CAT® MINESTAR™ SYSTEM

The industry's broadest suite of integrated mine operations and mobile equipment management technologies configurable to suit your operations needs. It lets you integrate products, processes and people like never before – so you can define what the next generation means for your operation.



FLEET



TERRAIN



DETECT



HEALTH



COMMAND

WHEREVER THERE'S MINING.

