

TECHNOLOGY PRODUCTS

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INTRODUCTION

In Cat machines you'll discover a unique combination of iron and electronics. Powerful, productive — equipped with the latest in proven information technology. A full line of systems that will work harder, last longer, and help you move more material at a lower cost.

At Caterpillar, we've applied technologies selectively — incorporating only those that deliver intelligent solutions. So if it doesn't improve performance, increase productivity, extend component life, help the operator, reduce service time, lower operating costs, enhance resale value, address an environmental challenge, or make your time more efficient, you won't find it on our machines. Utilizing these technologies provides the most advanced systems available to keep your site running at peak efficiency and productivity, at the lowest possible owning and operating costs.

Earthmoving Solutions products are centered around robust position awareness technologies and rugged on-board systems, revolutionizing the movement of material. Guidance products provide real-time job progress with centimeter-level accuracy to the operator, eliminating guesswork that leads to rework

or constant surveying, slowing progress and driving up costs. Control products take this technology a step further by integrating position awareness to automatically adjust the work tool. This results in accurately meeting the design plan while reducing the number of passes needed.

- AccuGrade™ Grade Control System
- Computer Aided Earthmoving System (CAES) for Landfill

Mining Technology Products continue to have a positive impact on mining operations around the world. Caterpillar offers a complete suite of technology products purpose built for the harsh mining environment. Our products combine the latest GNSS positioning technology with sophisticated electronic control modules and software to help miners increase productivity, monitor fleet health and lower operating costs.

- MineStar™ FleetCommander
- MineStar™ Health
- AQUILA™ Drill System
- AQUILA™ Dragline System
- CAES*Ultra* for Mining
- Cat Integrated Object Detection System™
- MINEGEM™ Underground Mining Automation System
- Work Area Vision System (WAVS)
- VIMS™ System

Fleet Management products and services provide data and information about multiple aspects of equipment, such as machine location, hours and health, to help customers more effectively manage down-time and plan maintenance. Offerings in this category are:

- Product Link
- EquipmentManager

For more information on these and other Cat technology products, visit www.cat.com/technology.

| PRODUCT | APPLICATIONS | MACHINES |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Link | On-board machine hardware that gathers and wirelessly transmits data to EquipmentManager. | Entire fleet (Cat and other) |
| EquipmentManager | Fleet management application that allows users to remotely monitor and manage their equipment using data from Product Link. Data includes machine utilization information, machine location, machine health and repair/preventive maintenance information. | Entire fleet (Cat and other) |
| AccuGrade™ Cross Slope Grade Control | Stand-alone grade control on an AccuGrade Attachment Ready Option (ARO) machine. Ideal for crowned roads and shoulders. Automatic system to control one end of motor grader blade to correlate with manually controlled slope of the other end. | M and K Series Motor Graders |
| AccuGrade Laser Grade Control | Finish grading. Use indoors or outdoors. Tolerances as tight as ± 4 to 6 mm (0.16 to 0.24 in) depending on material. Use with integrated on-board AccuGrade ARO. | M and K Series Motor Graders; E, K, N, and T Series Track-type Tractors; Skid Steer Loaders; Multi Terrain Loaders |
| AccuGrade Site and Laser Reference System | Indicate-only system. Provides depth and slope guidance for trenches and excavations. | 416E, 420E, and 430E Backhoe Loaders and Hydraulic Excavators |
| AccuGrade Sonic Grade Control | Sonic sensor controls blade elevation referenced off stringline or curb. Another configuration to use with the AccuGrade ARO. | M and K Series Motor Graders |
| AccuGrade GNSS Grade Control | Positioning information via the Global Navigation Satellite System (GNSS) for complex contours, bulk earthworks, design files. Add machine mounted components to AccuGrade ARO for GNSS-based grade control. Tolerances of ± 30 mm (1.18 in). | Automatic control for M and K Series Motor Graders; E, K, N, and T Series Track-type Tractors; Indicate only for Hydraulic Excavators; CS56E, CS57E, CS66E, and CS68E Compactors; and 613G Wheel Tractor-Scraper |
| AccuGrade UTS Grade Control | Positioning information via a Universal Tracking System. Grade control for high precision 3D applications using universal total station for positioning. Each machine requires a dedicated system. | M and K Series Motor Graders, Track-type Tractors and Hydraulic Excavators |
| Computer Aided Earthmoving System (CAES) for Mining | Surface Control, Machine Guidance and Ore Control. Uses high precision GNSS plus on- and off-board software to maximize machine productivity and ore extraction. | Track-type Tractors, Wheel Dozers, Wheel Tractor-Scrapers, Wheel Loaders, Shovels and Excavators |
| Computer Aided Earthmoving System (CAES) for Landfill | Uses high precision GNSS plus on-and off-board software to maximize landfill airspace and machine productivity. Ideal for landfill planning, engineering, surveying, grade control, and production monitoring applications in dump areas. | Landfill Compactors, Track-type Tractors, Wheel Tractor-Scrapers, and Motor Graders |

| PRODUCT | APPLICATIONS | MACHINES |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AQUILA™ Drill System | For mining customers that value machine and operator performance reports, precise placement and depth of blast holes, and detailed strata information on each drill hole. Requires radio network and ability to receive GNSS signals. | Blast hole drills |
| AQUILA™ Dragline System | Monitor performance and improve machine productivity. Uses a pair of high precision GNSS receivers for accurate bucket positioning. | Draglines |
| MineStar™ FleetCommander | A modern decision-support tool based on industry standard open systems allowing mines to understand, test, and capture events in their mine. Features an advanced truck assignment system, alarm definition, charting and reporting, field machine communication, machine control, productivity, and machine and materials tracking. | Entire mining fleet (Cat and other) |
| MineStar Health | Provides machine health data and reports. | Mining machines equipped with VIMS™ |
| VIMS™ System | Provides operators, maintenance, and engineering with vital machine health and production information. VIMS Guardian, a retrofit product, excludes operator display and payload information. | Optional on: 773, 775, 777F Standard on: 784, 785, 789, 793, and 797 Off Highway Trucks; 854 Wheel Dozer; and 992, 993 and 994 Wheel Loaders Retrofit on: 777D and 776D Off Highway Truck VIMS Guardian is available for D9T, D10T, D10R and D11R Track-type Tractors |
| MINEGEM™ Underground Automation System | This automation system removes the operator from dangerous situations and allows them to work in a more comfortable, ergonomic environment. Using technology to automate and enhance operations, the system provides safety and productivity benefits for underground mines. | Available as an attachment to all Underground Loaders: R1300G, R1600G, R1700G, R2900G, R2900G XTRA |
| Cat Integrated Object Detection System™ | Combines cameras, radar, and alarms to notify the operator when something is close to the machine but not within an immediate viewing range. The system is configured with zones around the equipment and objects in those zones trigger various levels of alarms. | 785, 789, 793, and 797 Off Highway Trucks |
| Work Area Vision System (WAVS) | One, two, or three camera system providing operator in machine with optimal viewing angles all around equipment. | Entire fleet (Cat and other) |

PRODUCT LINK

For more information see www.cat.com/pl

Product Link provides two-way information flow between machine on-board systems and your computer through your dealer's website and EquipmentManager. Cat® Product Link enables the use of EquipmentManager to keep you in touch with your machines. Product Link transmits important data such as machine location, hours and health information wirelessly via satellite technology.

PL121SR is a satellite transmitter/receiver installed on the machine to provide machine operating hours and location. It will also automatically send alerts when machines operate beyond owner-defined time and location limits. PL321SR provides machine operating hours and location as well as health, fuel and performance information.

This quick reference will help you determine which Product Link model will provide the information you need to effectively and efficiently manage your equipment. Please refer to the EquipmentManager chapter for additional information.

EquipmentManager Information

Product Link Solutions

| EquipmentManager Watch Levels | Feature | PL121SR | PL321SR |
|-------------------------------|---------------------------------------------------------|---------|---------|
| Asset Watch | Machine Location | X | X |
| | Machine Location Mapping | X | X |
| | Machine Location History | X | X |
| | Non-reporting Machine Identification | X | X |
| | Machine Hour Reading | X | X |
| | Machine Idle Hours | | X |
| | Start and Stop Times | | X |
| Maintenance Watch | Time and Geo-fencing | X | X |
| | Next Planned Maintenance (PM) Due (date and hour based) | X | X |
| | PM Notes | X | X |
| | PM History | X | X |
| | PM Alerts | X | X |
| | PM Checklist | X | X |
| | PM Parts List | X | X |
| | Customized PM Checklist | X | X |
| | PM and Repair Planner | X | X |
| | On-line Parts Ordering | X | X |
| | Manage Major Repairs | X | X |
| | Repair History | X | X |
| | PM or Repair Request for Quote | X | X |
| Health Watch* | Event and Diagnostic Codes | | X |
| | Event and Diagnostic Code Troubleshooting Procedures | | X |
| | Event and Diagnostic Code History | | X |
| | Fuel Level | | X |
| | Fuel Used | | X |
| | Idle Fuel Used | | X |
| | Refueling History | | X |
| 4 Digital Switch Channels | | X | |

*NOTE: Health Watch information delivered with PL321SR is dependent upon the machine model and year of manufacture. Machines produced with electronic engines and transmissions normally can provide this information. Consult machine specifications to determine if systems are manual or electronic.

EQUIPMENTMANAGER

For more information see www.cat.com/pl

EquipmentManager simplifies fleet management by providing valuable information in order to increase machine usage and manage the entire operation more efficiently. EquipmentManager is the software on a dealer's website used to review data transmitted from the machine's on-board Product Link hardware. With Product Link hardware installed on a machine, customers may subscribe to EquipmentManager through their Cat dealer. Refer to the Product Link Chapter for more information on the on-board hardware required to transmit data to EquipmentManager.

EquipmentManager has three levels of machine status — red (requires immediate action), yellow (requires monitoring), and green (normal). Customers access the information shown below from the dealer website. They may search and categorize information by alert level, their own selected groupings of equipment, machine ID, make or model. They can also set custom preferences for how information is viewed. Alerts may be emailed or sent to a pager, cell phone or other device.

Machine Management Options:

Equipment can be monitored based on defined parameters. When a machine operates outside these parameters an exception occurs. These exceptions include the following:

- Time-fencing and geographical fencing alerts
- Maintenance due
- Major repair due
- Diagnostic events
- Diagnostic code alerts
- Fuel level alert

Information is displayed by machine, along with descriptions of what caused the alert, and the ability to obtain further information about it. You can search and categorize information by alert level, group, equipment ID, make and model. EquipmentManager can also send text-message alerts in the form of email (such as a PM is due) to pager or cell phone.

By Machine-specific information — EquipmentManager also provides a search function that lets you search for specific information by machine. You can perform a search by group, equipment ID, make and model. Or you can conduct an advanced search, (for example you might search for all machines within 100 miles of a given location that have PMs due next week). After initiating either search, you receive results in an Event Summary report.

NOTE: Health Watch information is dependent upon the machine model, year of production and Product Link model installed. Machines with electronic engines and transmission equipped with Product Link model 321SR normally can provide this information.

ACCUGRADE™ CROSS SLOPE, SONIC, GNSS AND UTS GRADE CONTROL PRODUCTS

Meet Your Production Needs

For more information visit www.cat.com/technology and click on the Earthmoving Solutions link.

The AccuGrade Attachment Ready Option (ARO) is designed into the machines. The backbone of AccuGrade systems, it includes harnesses, controls, valves, and a Controller Area Network (CAN) architecture to support cross slope, sonic, laser, GNSS and Universal Tracking Sensor (UTS) grade control systems. AccuGrade's sensor-independent design allows you to easily change sensors, receivers and displays and choose the right technology for the job. The AccuGrade GNSS Grade Control System (see Figure 1) is an advanced machine control and guidance system that enables operators to grade with increased accuracy, without the need for survey stakes. Great for complex contours and bulk earthworks, it uses satellite positioning data and off-board site infrastructure to grade to a digital design plan. The digital design data, in-cab operator guidance features and automatic blade controls help the operator achieve grade faster, meaning higher productivity, lower operating costs, and greater profitability.

AccuGrade Cross Slope is the foundation system for motor graders and controls one blade tip without any off-board infrastructure. AccuGrade Cross Slope can be combined with Sonic, Laser, GNSS or UTS technologies to make fine grading more efficient and productive. AccuGrade Sonic uses a sonic sensor and a string line or curb to achieve grade easier and with greater accuracy. AccuGrade UTS uses an advanced tracking sensor for precise positioning in high-precision 3D applications. Note: each machine using UTS must have its own UTS unit.

Site and Laser Reference

The AccuGrade Site Reference System for backhoe loaders and hydraulic excavators is an entry-level grade and depth check system that provides accuracy, productivity, and lower operating costs.

The AccuGrade Laser Reference System can be added to the Site Reference System to create an even more advanced grade and depth check system. It works with laser transmitters to accurately grade or excavate to a site plan without the use of grade stakes.

AccuGrade Laser Reference System is an indicate only system that is used in conjunction with the Site Reference System for hydraulic excavators and E-Series backhoe loaders.

AccuGrade Compaction Measurement System

The AccuGrade Compaction Measurement system measures drum movement to determine soil stiffness. This new Compaction Measurement system provides operators, contractors, and project owners with a variety of benefits that increase production and simplify job-site documentation.

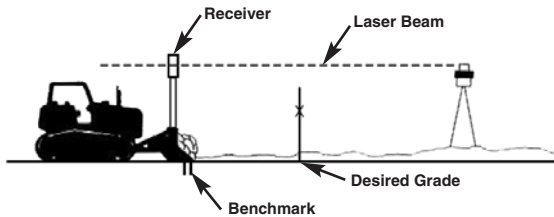
AccuGrade Office Software

This system joins previously released Cat on-board machine solutions to make a total solutions package for end users. Cat on-board machine solutions include 3D technologies, such as AccuGrade GNSS and AccuGrade UTS, as well as the 2D technologies, such as AccuGrade Laser, AccuGrade Cross Slope, and AccuGrade Sonic.

The AccuGrade Wireless Option permits AccuGrade Office software to communicate wirelessly with machines equipped with the Cat AccuGrade GNSS and UTS systems. AccuGrade Office also accommodates the AccuGrade Compaction Measurement system.

ACCUGRADE™ LASER GRADE CONTROL

Manage Fine Grading Tolerances for Maximum Profit



The AccuGrade Laser Grade Control System is designed for a wide range of construction earthwork applications requiring tight tolerances and high production rates. Field-proven and versatile, the dual laser system is ideal for fine grading of sites with flat, single or dual slope surfaces, such as industrial, commercial and residential building sites. An AccuGrade Laser consists of the AccuGrade ARO on the machine, laser masts and receivers, the cab control display, plus a laser transmitter. It can be used indoors or outdoors and several machines can work off a single laser transmitter. Depending on the material, AccuGrade Laser can work to a finish grade accuracy of ± 4 to 6 mm (0.16 to 0.24 in).

AccuGrade grade control systems offer these advantages and cost savings:

- Fuel savings of up to 40%
- Increase productivity by up to 50%
- Reduce guesswork and costly rework by moving material correctly the first time
- Reduce survey costs up to 90%
- Increase material utilization
- Reduce operating costs
- Reduce labor requirements and costs
- Reduce need for staking, string lines, and grade checkers
- Extend the work day
- Finish jobs faster

Conventional Staking Method Costs vs. Laser Grade Control System Savings

The AccuGrade Laser Grade Control System provides process control for the fine grading operation, affecting costs not typically associated with the machine. Some of the cost areas controlled by the system can be analyzed with an example:

Example Job Site Specifications (Metric)

- Pad Size: 3716 m²
- Metric Tons of Base Material: 1376 metric tons
- Cost of Base Material Metric Ton: \$7.26
- Cost of Concrete per Cubic Meter: \$57.34
- Grade Stakes: \$6 per stake
- Grade Checker Daily cost: \$100
- Laborer Daily cost: \$75
- Daily cost of owning and operating Dozer: \$536
- Daily cost of owning and operating Compactor: \$250
- Daily cost of owning and operating Loader: \$350



Example Job Site Specifications (English)

- Pad Size: 40,000 ft²
- Tons of Base Material: 1517 tons
- Cost of Base Material Ton: \$8.00
- Cost of Concrete per Cubic Yard: \$75
- Grade Stakes: \$6 per stake
- Grade Checker Daily cost: \$100
- Laborer Daily cost: \$75
- Daily cost of owning and operating Dozer: \$536
- Daily cost of owning and operating Compactor: \$250
- Daily cost of owning and operating Loader: \$350

Conventional Staking Method Costs (Metric)

Conventional Production per Day: 1394 m²
 Days to Fine Grade: 2.7
 Standard Grading Tolerance: ± 19.1 mm
 Material Base Costs: \$12,133
 Material Overage Costs (10% of base material): \$1213
 Grade Stakes Costs (85 stakes with 7.62 m spacing): \$510
 Material Costs (Concrete 152.4 mm specified + 19.1 mm tolerance): \$62,500
 Grade Checker Costs (3-4 men per machine): \$267
 Labor Cost (3.25 men): \$650
 Dozer Costs (2.7 days): \$1429
 Compactor Costs (1 day): \$250
 Loader Costs (2.7 days): \$940
Conventional Cost Estimate: \$79,892

Conventional Staking Method Costs (English)

Conventional Production per Day: 15,000 ft²
 Days to Fine Grade: 2.7
 Standard Grading Tolerance: ± 0.75 in
 Material Base Costs: \$12,133
 Material Overage Costs (10% of base material): \$1213
 Grade Stakes Costs (85 stakes with 25 ft spacing): \$510
 Material Costs (Concrete 6.0 in specified + 0.75 in tolerance): \$62,500
 Grade Checker Costs (3-4 men per machine): \$267
 Labor Cost (3.25 men): \$650
 Dozer Costs (2.7 days): \$1429
 Compactor Costs (1 day): \$250
 Loader Costs (2.7 days): \$940
Conventional Cost Estimate: \$79,892

Laser Grade Control System Savings (Metric)

Laser Grade Production per Day: 2787 m²
 (double production)
 Days to Fine Grade: 1.3
 Laser Grading Tolerance (12.7 mm improvement): ± 6.4 mm
 Grade Stake Savings (3 vs. 85 stakes): \$492
 Material Savings (60% Material Overage Saved): \$728
 Concrete Savings (12.7 mm saved due to tighter tolerance): \$4630
 Grade Checker Savings (not needed): \$200
 Labor Savings (1 vs. 3.25) \$550
 Dozer Costs Savings (1.3 vs. 2.7 days): \$715
 Loader Costs Savings (1.3 vs. 2.7 days): \$470
Savings Resulting from Laser Grade Control System: \$7768

Laser Grade Control System Savings (English)

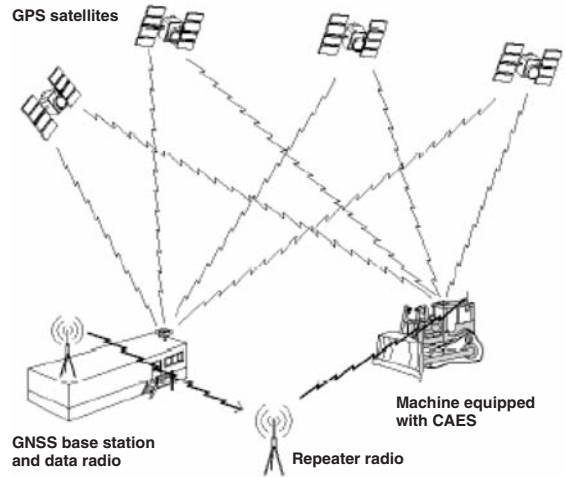
Laser Grade Production per Day: 30,000 ft²
 (double production)
 Days to Fine Grade: 1.3
 Laser Grading Tolerance (0.5 in improvement): ± 0.25 in
 Grade Stake Savings (3 vs. 85 stakes): \$492
 Material Savings (60% Material Overage Saved): \$728
 Concrete Savings (0.5 in saved due to tighter tolerance): \$4630
 Grade Checker Savings (not needed): \$200
 Labor Savings (1 vs. 3.25) \$550
 Dozer Costs Savings (1.3 vs. 2.7 days): \$715
 Loader Costs Savings (1.3 vs. 2.7 days): \$470
Savings Resulting from Laser Grade Control System: \$7768

COMPUTER AIDED EARTHMOVING SYSTEM (CAES)

The Right Material in the Right Place for Maximum Machine Productivity

Cat CAESultra uses high precision GNSS technology to help customers maximize machine productivity and job efficiency. Traditionally, an engineer working in the office creates a site plan on a computer. This information is then transferred to paper, and the surveyor goes out and stakes the area to identify elevation, grade, slope, or material type. Once the machine operator has completed the job, the surveyor resurveys the area and updates the office plan. This process is labor intensive and is prone to a check, rework, recheck approach. CAES revolutionizes this process. Its high precision GNSS system allows the machines to act as surveyors. Changes to a digital terrain model (the engineering design file) are recorded as it occurs. The engineer can work with the updated design and modify it further without stopping the machine. It also provides machine operators and site managers information to eliminate rework, reduce field surveying and more accurately complete the earthmoving plan. CAES combines centimeter-level accuracy with Real Time Kinematic (RTK) initialization times for fast and accurate positioning.

Figure 1. Overview of the System



High Precision Positioning using Global Navigation Satellite System (GNSS)

Site Requirements

- Line of site to multiple satellites that are part of the GPS or GLONASS constellations. These transmit signals that are used to determine position.
- Base Station with a GNSS receiver and radio. The base station compares its known (or surveyed) position to the position calculated from the GNSS signals. The difference is used to produce a Compact Measuring Record (CMR).
- A radio network to relay the CMRs to machines equipped with CAESultra system.

On-board Requirements

- Antenna to receive low-precision signals from the GNSS constellation.
- Radio to receive the CMR corrections from the base station.
- Receiver that combines the GNSS signals and CMR corrections to calculate the vehicle position with centimeter accuracy.
- Display running software that provides real-time feedback on job progress and design plan to the operator.

CAESultra On-board

CAESultra on-board components keep the operator informed with real-time information, which provides greater control and empowerment. Caterpillar has designed the on-board components to meet harsh environmental demands of equipment in mining applications. Easy-to-use software provides the operator with critical information required to get the job done quickly and safely. The on-board system also monitors and logs specific parameters that can be used to determine site productivity as well as individual operator and machine performance.

CAESultra for Landfill

CAESultra helps the landfill industry conserve airspace. For a landfill compactor, each time the wheel travels over a surface, the CAESultra screen changes color to acknowledge the compaction pass. CAESultra indicates finished areas. The operator achieves maximum effective compaction, by making only the necessary number of passes. Track-type tractors in landfills benefit from CAESultra because it indicates lift thickness of cover material and trash.

Additionally, CAES permits the recording of site-specific storage areas such as hazardous waste, medical, industrial, organic, and other materials which require special handling or a record of placement. All of this information is monitored and managed in the landfill office with CAESultra Office Software.

CAESultra for Mining

CAESultra moves the material identification file and survey system into the machine, eliminating the need for survey stakes or pin flags. A touch screen monitor displays the location of pit boundaries, material type, bench height, and design grade, eliminating operator guesswork. With material types and locations displayed, ore identification and recovery are optimized.

The CAESultra for Mining system is an ideal tool for mine planning, engineering, surveying, grade control and production monitoring applications. For example, the CAES system can be used for:

- Haul road and bench construction and maintenance
- Production dozing
- Leach pad construction and maintenance
- Reclamation
- Ore grade control and material identification
- Coal load out terminals

The system can be used on scrapers, loaders, dozers, shovels, motor graders, hydraulic excavators and track-type tractors.

AQUILA™ DRILL SYSTEM

Production, Strata Recognition and Guidance

AQUILA Drill Systems are designed for installation on electric and hydraulic rotary blasthole drills. It provides production and performance monitoring, strata recognition and GNSS guidance. Typically provided as field retrofit to machines already operating at mine sites, the AQUILA Drill System uses on-board computing integrated with sensors to monitor critical machine performance characteristics. System modules help the operator and site managers enhance drill performance and improve the drilling and blasting operation. The AQUILA products use a GNSS and radio infrastructure common to CAES.

The **Production** module offers a graphical user interface to provide the operator with immediate feedback on drilling productivity and performance. The product minimizes operator input by an array of sensing hardware to detect:

- the end of hole
- reaching target depth
- recognition of steel changes

The **Strata Recognition** module analyzes the monitored drilling variables in real-time, determining variability in the hole geology. The different strata horizons are presented on the display. The system provides useful and concise information from the start of drilling — not large amounts of raw data that typify traditional drill monitoring systems. A Blastability Index is determined by the Strata Module and approximates the in-situ hardness of the ground. The hole-loading requirements and ore grindability predictions are then based on measured rock hardness enabling improved blending and optimized mill throughput rates.

Combining the **Production** module with the **Strata Recognition** module logs:

- bit rotary speed
- penetration rate
- depth
- rotary torque or pressure
- pull-down pressure
- bailing air pressure

Drilling practice, efficiency and productivity can then be analyzed and assessed.

The **GNSS Guidance** module adds high precision GPS to help precisely position a drill on a blast pattern without the need for surveying or staking. The Guidance module uses a moving map display that shows the 3D (Northing, Easting and Elevation) of the drill and drill bit relative to the designed position of the blastholes. Once the drill is positioned and leveled over a hole, the system automatically determines collar elevation and then calculates the designed target depth. Guidance improves the drill's production and utilization, and the operator's ability to drill to the plan. This leads to better rock fragmentation for easier loading. Since holes are drilled to the correct elevation leading to a flatter post-blast surface, the result is smoother pit floors. This helps eliminate rework, enhances the mobile equipment's performance and reduces its wear and tear.

AQUILA™ Drill Office Software

AQUILA™ Office Software integrates planning and design operations. Engineers can transmit designs to the machine's on-board computer, which show the machine location relative to the design area, current surface, final design surface, and material map (for loading machines). The software package allows you to create customized reports on productivity data, cycle times, volume and material type. It is powerful enough to allow the engineering process to change.

AQUILA™ DRAGLINE SYSTEM

Precision Tub Placement

The AQUILA Dragline System combines on-board computing and high precision GNSS with the machine's Programmable Logic Controller for data acquisition. On-board productivity reports summarize progress of the shift. GNSS-driven 3D plan and section views of both the dragline and cut guide the operator in excavation and spoil placement. The system eliminates the need for survey support to ensure proper tub placement and optimal range. The results are reduced rehandling, precise recording of each dig and dump location, and load weight for each cycle.

Centimeter-level GNSS enhances positioning of the dragline tub to assure the machine digs to plan. Hoist, drag and swing position data is used with GNSS positioning to create section views of the bench and cut profile. A graphical display shows the dragline body, boom, hoist and drag ropes and bucket position in real-time as the machine operates. These machine features are displayed as an animated overlay on top of a design file. The design files are customizable and consist of any design features relevant, i.e. toe and crest locations, tub center-line target positions, key cut, dig limits, no-swing areas, avoidance zones, final design limits, target dig depths, etc.

The dragline system can interface with a third party boom stress measurement system to display boom stresses during the complete dig and dump cycle.

Dragline System Features and Benefits

- Provides full 3D bucket and machine positioning capability based on GNSS.
- Includes comprehensive, customizable production reporting.
- Monitors up to 35 parameters on each dig cycle.
- Uses the same infrastructure and robust on-board components as the AQUILA Drill and Computer Aided Earthmoving Systems (CAES).
- Consistent digging process along bench.
- Spoil side slopes cut to design grade.
- Field survey dependency is greatly reduced or eliminated, allowing for extended bench designs to be more accurately followed.
- The display of a design centerline ensures accurate tub placement and optimizes the designed range capability of the machine.
- Spoil management ensures proper placement, reducing rehandling and spoil pushing, freeing dozers for other productive work.
- Increased production leads to more tons of coal uncovered in less time and lower operating cost by minimizing rehandling.
- Material placed in the right place the first time eliminates unproductive dragline and support equipment use, lowering overall mining costs.
- Lower coal dilution.
- Rehandle is reduced by enabling control of spoil height through accurate design execution.

AQUILA Dragline Office Software

The AQUILA Dragline System is packaged with office software tools that enable mines to track production, monitor operators, create reports and communicate with machines in the pit. The software suite is common across other Cat technology product office software, such as CAES and AQUILA Drill System, reducing training and IT costs.

MINESTAR™ FLEETCOMMANDER

MineStar FleetCommander is the Cat fleet management system developed to maximize mining process productivity while simultaneously maximizing equipment and fleet productivity.

FleetCommander is a modern decision-support tool enabling mines to manage and administer installation, user interface, configuration, security, system administration, database administration, disaster recovery, logging and diagnostics, software updates, calendars, charting and reporting, alarming and scheduled jobs.

The MineStar platform communicates to the mine and integrated process entities with PitLink, the component which manages field communications with machines and fixed plant as well as operators. It also ensures the delivery of the latest on-board software files to all MineStar equipment.

The key office components that are built into the MineStar office to suit the host mine's complexity and needs are:

- **Machine Tracking** provides position analysis of MineStar equipment as it is moved around the travel network.
- **Material Tracking** uses the mine's mining block model for equipment assignment and for loading material according to local blending and production requirements.
- **Operator Management** manages and monitors site personnel for machine licenses, pre-start checklists, scheduled breaks and shift change optimization.
- **Production** monitors site activities, delays, cycles, payload monitoring, Key Performance Indicator (KPI) summaries, fluids and tire management as well as Service Meter Unit (SMU) interpolation.
- **Assignment** applies FleetCommander's assignment engine to provide the best allocation solution when all trucks are considered so that every assignment provided to each truck is always computed considering the most relevant, current information.

FleetCommander provides a proven solution suite based on a single trusted set of data for real-time KPI and for standard and ad-hoc reports. It provides the mine with information to:

- identify and quantify performance improvement opportunities (within and post shift)
- develop strategies to capture performance improvement initiatives
- support engineer and operator performance
- assign equipment and fleets for maximized fleet production or achievement of material management goals. Capability scales from simple assignment to full truck assignment with linear programming to ensure maximal flexible loader, truck and material capacity utilization
- blend materials in order to meet preparation plant quality, tonnage and timing requirements
- track machines and materials to ensure correct delivery of materials from sources to planned sinks and to monitor equipment routing
- manage operators (licensing, shift allocation and rostering)
- manage equipment fluids and tires
- track equipment productivity capability, consumption and variance
- monitor equipment health including alarms and sensor channel monitoring, pre-start checklists
- determine "what if" impacts of making specific changes to the product plan

Cost reduction of 10% and greater can be achieved and sustained using MineStar FleetCommander. Cost reductions are typically realized through reduced equipment, manning, lower fuel and service requirements, while achieving the same levels of productivity.

MINESTAR™ HEALTH

Equipment failures, excessive wear rates, over-temperatures, overloading and degrading operating conditions are all examples of machine health information that when correctly acquired, managed and analyzed can improve a mine's efficiency and lower operating costs.

Caterpillar's MineStar Health system constantly records information on critical machine parameters fleet-wide. Linked with on-board monitoring systems like VIMS, MineStar Health provides wireless or wired transfer of this critical data to the service center for processing and review. It uses VIMS data to remotely monitor events and alarms, allowing focused channel polling to log condition-based event tracking and Application Severity Analysis calculations. It allows service personnel and maintenance planners to track health changes on a large array of on-board components while completing mine duty cycles. Some of the data collected by MineStar Health includes: system voltages, component performance overloading and load/dump/travel/delay times.

MineStar Health is designed to work seamlessly with MineStar FleetCommander or is available as a stand alone health reporting system from your Cat dealer. It can also be integrated into a production database for expanded analysis.

Key benefits of MineStar Health include:

- Saved component failures
- Extended component life
- Reduced phantom breakdowns
- Full fleet health monitoring
- Efficient data analysis
- Improved maintenance practices

VIMS™ System

VIMS™ is an advanced diagnostic and equipment management tool. By continuously monitoring a wide range of vital machine functions, this high-tech electronic monitoring system improves machine availability, component life, and productivity while reducing both repair costs and risk of catastrophic failure.

By integrating numerous machine sensors into each machine design, VIMS monitors over 250 machine functions and health statistics. Essential machine functions are displayed for the operator via the message center. If a parameter falls outside of the specification, VIMS sends a warning message to the operator and depending on the severity of the event recommends an appropriate course of action. VIMS not only provides important machine and system information to the operator, it also stores a large amount of data about the machine for proactive health and production management.

The third generation of the VIMS System — VIMS 3G — is now available for select Cat Mining equipment, offering enhanced convenience and functionality, along with updated communications capabilities.

Analysis tools help turn data into decisions.

The software applications of the VIMS Off-Board System include a number of data analysis file types. Each file type analyzes different kinds of information and is used to produce specific results.

- **Event List** records, categorizes and stamps up to 500 system “events” that occur during machine operation.
- **Event Recorder (Snapshot)** helps technicians troubleshoot a specific event by capturing detailed data before and after the event occurs.
- **Data Logger** enables the operator to trigger recording of real-time machine data that can show service personnel exactly what is happening when an event occurs.
- **Payload** helps enhance truck and loading tool effectiveness and improve total fleet production by collecting payload, cycle-time and haul-distance data.
- **Trends, Cumulatives and Histograms** provide a variety of reporting and analysis tools for monitoring specific machine parameters.

Value of VIMS System

- For the machine operator VIMS establishes two-way communication between the operator and the machine. Real-time machine information allows the operator to make informed decisions that directly affect safety, machine availability, and ultimately the productivity of the mine.
- For maintenance VIMS provides an in-depth view of operator and machine performance. This allows maintenance managers and technicians to maximize component life, reduce catastrophic failures, minimize unscheduled downtime and improve asset management.
- For production VIMS collects the information needed to monitor equipment usage, personnel performance, and productivity levels. Payload information can be used as an accounting tool, an indicator of cycle time efficiency and truck overloading or under loading.

VIMS Wireless Interfaces

VIMS information can be transmitted wirelessly using VIMS Communicator or Health Interface Module. These units download VIMS data at user programmable intervals and send it back to the office via various telemetry systems.

VIMS Analysis Tools

VIMS information can be downloaded and viewed by VIMS pc and VIMS Supervisor using a laptop at the machine or wirelessly. VIMS information is also available with MineStar Health System.

CAT INTEGRATED OBJECT DETECTION SYSTEM™

The Cat Integrated Object Detection System™ is designed for large mining and quarry trucks to reduce blind spots and increase perimeter awareness. This robust system includes both radars and a vision system providing optimal awareness around the machine. With both audible and visual indications of a detected object, the Caterpillar Integrated Object Detection System™ helps prevent work area injuries caused by limited awareness. Using a combination of short range radars, medium range radars, four cameras, and a high-resolution touch screen display, operators can view the areas immediately surrounding their machine, helping to prevent collisions and accidents.

The Cat Integrated Object Detection System is highly integrated with the specific machine configuration to optimize radar and camera coverage. The system has been calibrated to provide appropriate fields of view and range. Unlike basic camera systems, the Cat Integrated Object Detection System provides operators with audible and visual types of warnings that enable the operator to make informed decisions when moving or operating the machine. When a camera system is running at all times, it's easy for the operator to overlook the screen when performing job tasks. This system alerts the operator when an object is in close proximity so they can decide if action needs to be taken to avoid it.

Features

- Provides coverage on four sides of machine.
- Robust components designed and tested to work in heavy duty off-road applications.
- Radar detects both moving and non-moving objects.
- After 20 meters of travel, radar system automatically becomes idle
- Automatically activates radar warnings when machine stops.
- Camera views available at all times.
- System uses visual and audible means to alert operator to objects.
- Cameras allow operator to identify objects detected by radar.
- On-board diagnostics monitor system health and alert operator to any issues.
- Configurations allow operator to adapt system to local conditions.

Benefits

- Improves site safety by enhancing operator's situational awareness.
- Reduces cost and machine downtime due to accidents.
- Does not require any off-board infrastructure.
- Easy to learn display interface.
- Minimizes nuisance audible alarms.
- Scalable solution allows user to start with camera system and later add radars.

MINEGEM™ UNDERGROUND MINING AUTOMATION SYSTEM

Developed out of the need to reduce human exposure to injury, the system removes the operator from dangerous situations and allows them to work in a more comfortable, ergonomic environment. Using technology to automate and enhance operations, the Cat MINEGEM system will increase productivity and make a measurable impact on your mine's bottom line.

MINEGEM offers 2 levels of control:

- Co-pilot: operator-assisted automatic steering
- Auto-pilot: machine is operated under its own self-guidance system

MINEGEM consists of four major sub-systems that support the functionality of the system.

Operator Station

The Operator Station allows machines to be operated from an ergonomically designed seat in a variety of locations. The operator can safely operate the machine from a mine control room or mobile office, either above or underground. This removes the operator from potentially dangerous environments in the mine drives underground. The Operator Station consists of a computer, three monitors, a seat and two joysticks; one controlling the movement of the machine, the other controlling the bucket.

Machine Automation System

The Machine Automation System consists of the on-board hardware components that make the MINEGEM system function. LADAR, cameras, lights, sensors, antennas, and control modules combine to create a system that provides safety and productivity for your underground mining operation.

Area Isolation System

Ensures that personnel cannot enter or equipment cannot leave the Operations Area while the machine is in autonomous mode. The operator has the ability to arm and disarm the system to compensate for changing business needs. A barrier control panel is located at each entry to the Operations Area. These are connected to barriers to ensure the area is secure. The status of each barrier control panel is reported to the programmable logic controller via the Local Area Radio Network (LARN). The programmable logic controller then determines whether the Operations Area should be armed.

Local Area Radio Network (LARN)

The LARN is a wireless Ethernet data network that enables communication between the machine and the operator station. The network uses the 802.11 b/g protocols and requires exclusive use of the 2.4 GHz RF spectrum.

Signals from the Machine Automation System roam between LARN antennas as the machine moves within the operations area. The signals work primarily over line-of-sight, but can reach a short distance around corners. Video images and data are sent via the LARN.

WORK AREA VISION SYSTEM (WAVS)

Cat WAVS is offered in one, two or three camera configurations for Caterpillar machines and your entire fleet. WAVS meets Caterpillar's rugged testing to function in tough environments and to withstand harsh climates.

Operators are finding that the use of a reliable camera system allows them to efficiently accomplish the job with minimal risk of machine incidents. Less risk on the job reduces liability and maximizes profit.

Site Assurance

Position the cameras to view blind spot locations; this reduces machine incidents due to poor visibility. Cameras will reduce the guessing of machine surroundings.

Work Efficiency

Enhanced visibility around machines increases up-time, operator efficiency and productivity.

Ergonomics/Comfort

Operator maintains forward direction as display shows machine surrounding and reduces operator's positional motion.

WAVS improves productivity by increasing the operator's field of visibility. The closed circuit camera system can be integrated so the camera view will be automatically prompted based on machine motion. For example, when the machine is placed in reverse the rear camera is automatically displayed.

7" Color LCD Display

- Auto-sensing illumination for changes in light conditions
- 2 Camera views available
 - Panoramic 115°
 - Narrow 78°
- Splash-proof
- Adjustable mounting

Camera

- Robust design withstands 15G's of vibration and protection from high-pressure washing
- Includes internal heater for removal of condensation, snow, and ice
- Photochromic lens darkens in ultraviolet light exposure