

Cat Command: Take Control of On-Site Safety

Deploying Caterpillar Command machine remote control systems keep users out of harm's way in the pipeline industry

About Caterpillar:

Since 1925, Caterpillar Inc. has been helping our customers build a better world – making sustainable progress possible and driving positive change on every continent.



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Abstract & Challenges

Abstract:

Caterpillar's Command enables remote machine operation, keeping users out of harm's way. This file shares the latest technology available to enhance jobsite safety in the pipeline industry whereby:

- Machines are operated by remote control in **line-of-sight** operation:
 - An onsite user, physically separated from the machine, controls all machine functions with a portable, handheld console
- Machines are controlled remotely, far from the trench in **non-line-of-sight** operation:
 - Users work remotely in a comfortable, seated "virtual cab" with familiar machine displays and universal controls. Located in a command center onsite or many miles away, this non-line-of-sight technology also reduces operator fatigue due to an improved working environment

Challenges on the Pipeline Jobsite:

- **Steep Slope operation:** Substantial risks to crew safety, project costs and in-service timelines
 - Yo-yo'ing an excavator with a winch tractor down a steep slope requires skilled, experienced operators to safely execute a slope plan
 - Completely removing the operators from their cabs on steep slopes mitigates the operators' physical risk on a slope
 - How much safer are operators if they were controlling the machine from an air-conditioned trailer in the lay-down yard?
- **Extreme Ambient, Remote Operations:** Risk to crew safety and performance
 - How to remove operators from weather related environmental risk with Non-line-of-sight remote machine operation
 - Removing the operator from extreme ambient conditions is simply better and safer for the operator and job performance
 - Remote control users can work from a jobsite trailer or from a far distance, broadband connected office building
- **Cost control on long trenching applications / Reducing operating costs:** Appropriate application of technology can reduce project costs
 - Continuous and relatively homogenous long-distance trenching applications open opportunities for cost controls by identifying and executing trenching process automation
 - Requires new project design and construction strategies to minimize ground crews
- **Hiring and retention of skilled equipment operators:** A company wide cultural and safety challenge
 - Labor represents 40-60% of a project's cost; solutions needed to improve top operator retention
 - Attracting and retaining the right people who are aligned with your corporate safety and operation culture is critical and a continuous challenge
 - Remote control solutions limit an operator's exposure to vibration, dust, noise and ingress/egress of the machine
 - Remote control may extend a career for operators no longer able to climb on/off equipment or endure harsh work environments

Possible Solutions:

- Relocating equipment operators to safe work environments
- Safe and comfortable operator work environments improve fleet productivity

Introducing Cat® Command: Available For Pipeline Construction

Cat Command provides remote control and semi-autonomous system solutions

- Onboard electronics, vision systems and off-board controls help users deliver consistent quality of work
- Jobs become safer, more comfortable and more precise – without sacrificing user control, feel or accuracy

Remote Control Options: Scalable and flexible system choices for pipeline projects

- **Command Console: Line-of-Sight operation**
 - Allows user to work safely and comfortably outside the machine, onsite and in direct visual contact
 - Ideal for short-term use and requires no onsite communication infrastructure
- **Command Station: Non-Line-of-Sight control**
 - Enables the user to work remotely in a comfortable, seated “virtual cab” with familiar machine displays and universal controls
 - Located in a command center onsite or many miles away, this non-line-of-sight technology reduces operator fatigue due to an improved working environment

Cat Command helps:



Boost
Safety, Efficiency, Quality



Reduce
Overall Costs



Improve
Machine Utilization, Jobsite Consistency,
Project Accuracy, Profitability



Line-of-Sight dozer operation



Non-Line-of-Sight excavator operation

Cat Command Console: Line-Of-Sight Operation

The **Cat Command Console** for Dozing and Excavation allows users to work safely and comfortably outside the machine, while remaining onsite and in direct visual contact by line-of-sight. It's ideal for short-term and emergency use and requires no onsite communications infrastructure.

Cat Command Console Benefits Pipeline Projects

- Users control the machine with the same level of performance and precision as if they were in the cab
- Remote Winching allows tractor operators to position themselves physically closer to the load point, improving field communications, jobsite situational awareness and visibility to the winch load
- Users can activate machine on-board operator assist features including;
 - Auto dig cycles automatically maintain grade and blade/bucket loads, minimizing cycle times without user intervention
 - Automatic Ripper Control automatically changes ripper depth in hard or rocky ground conditions
 - eFence working envelop management can limit excavator swing and boom/stick height motion
 - Cat Grade Control delivers desired, pre-loaded grade design in 2-and 3-dimensions with single joystick functionality

Customer Experience: Improved Operator Performance With Remote Control And Operator Assist Functions

- A US-based pipeline customer tested and recorded the value of placing the equipment operator on a safe, stable area near the slope, or in a covered environment near the machine operation zone
- Additional customer's recorded remote control benefits include;
 - Removing the operator from steep slope environments
 - Reducing trips and falls over uneven terrain during ingress/egress to the machine
 - Bring the user closer to the actual work zone where appropriate for improved communications and precision control of the machine
 - Command informs the user of all on-board vital machine information including fuel level, fluid temperatures, engine hours and machine fault codes



Cat Command Station: Non-Line-Of-Sight Operation

Cat Command Station enables the user to work remotely in a comfortable, seated “virtual cab” with familiar machine displays and universal controls. Located in a command center onsite or many miles away, this non-line-of-sight technology also reduces operator fatigue due to an improved working environment.

Cat Command Station Brings Mining Operator Efficiency to Pipeline Projects

- Mining and heavy construction operations have experienced the same benefits of line-of-sight remote operation, but from any location in the world
- Supplemental vision systems for the Command user station enable non-line-of-sight remote control
- Provides views of critical areas around the machine not seen from the cab

Customer Experience: Long Distance Remote Control Offers Additional Safety Benefits:

- A US based contractor is currently remotely controlling a 40-ton excavator in a fly ash pit
 - Users employ the same machine controls along with a battery of high definition cameras and video screens to see and control the excavator
 - Extremely low latency using local point-to-point radios and highspeed broadband gives users the same level of productivity and feel as if in the cab, but in a climate-controlled environment, anywhere in the world
- Customer recognized benefits include;
 - Increased operator safety by removing the operator from the cab and unpredictable ground surfaces encountered during machine entry/exit
 - Increased productivity from working in a temperature-controlled environment
 - Enables physically/medically challenged operators to continue to do their job
 - Ability to provide real-time equipment operation coaching outside the cab
 - Machine onboard operator-assist features offer grade control, payload management, work zone parameters and machine performance feedback to the non-line-of-sight user
 - Job design dependent, trenching may be completed remotely / multiple shifts using the same machine through non-line-of-sight operation

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Command Operator Station Remotely Controlling Excavator



Issue: Safety Performance

Results: Keep the operator out of harm's way

Safety is the number one consideration in the development of the Command product lines

- In the US, insurance/worker compensation is 86% higher for construction workers vs. office workers
 - Command station users may experience insurance savings vs. onsite operators of \$4,000 per operator (chart)
- Command product line provides several safety benefits for both the user and jobsite
 - Familiar control icons enable users to switch between standard in-cab machine operation to remote control with minimal training/orientation
 - The technology is integrated directly into the machine's on-board electronics

Command Safety Features:

- Eight customers running 33 mid-sized machines recorded the following safety benefits of remote-controlled machines:
 - Reduced operator safety risks in the event of a trench collapse, machine drop/roll-over and long-term exposure to vibration, dust, and noise
 - Decreases the potential for injury from slips, trips, and falls when climbing on and off the machine
 - Users experience reduced fatigue, due to fewer machine commands and user station ergonomic advantages
 - High definition cameras improve user visibility beyond normal eyesight in some dust/inclement environments
 - Command can be disabled at any time and revert to standard, in-cab manual operation
 - Remote stop switches installed on machines, console and station to stop the machine
 - All Stop (A-Stop) fobs available for user and ground crews, remotely stop all Command equipped machines operating within 200m of fob
 - Multiple, redundant safety features can stop all machine motion should any of the following events occur;
 - Any multiple machine mounted or remote fob stop switches pressed
 - Detection of a severe machine fault code where continued operation will result in machine damage
 - Console loses wireless communications or is detected to have fallen, not be present, or excessively inactive
 - Station seat sensor does not detect the user

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\$/hour	Construction	Office	Difference
Insurance	\$3.22	\$2.23	\$0.99
Workers' Comp	\$1.34	\$0.22	\$1.12
Total	\$4.56	\$2.45	\$2.11

Potential annual cost savings from lowered insurance & workers comp premiums per operator: **\$4,000 per year per operator**
Based on 8 hours a day, 5 days a week, 50 weeks a year



Issue: Skills Crisis

Result: Retain/Attract talented operators

Pre-COVID19 construction activity worldwide has depleted the existing pool of skilled workers

- Construction labor median age is 40 and women represent only 4% of the workforce
- Labor shortages will create a void in personnel and professional knowledge that will be felt throughout the industry – where 400,000 construction industry jobs remain unfilled (Source: US Bureaus of Labor Statistics)

Construction industry being more aggressive with people and talent retention

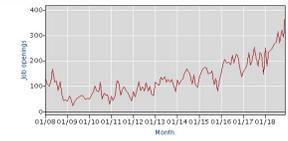
- Customers are experimenting with reduced number and higher retention rates of equipment operator crews through semi-autonomous equipment
- Retaining construction employees avoids the estimated \$15,000 cost to recruit and hire new crew and the associated retraining costs of \$4,000 to \$12,000 (Source: US Bureau of Labor Statistics, Employer Cost of Employee compensation)
- By adding remote control capability, current skilled employees can be deployed to other positions while semi-autonomous and remote control reduces the gap
- Remote control and semi-autonomy may also play a role in attracting a new generation of employees

Customer Reported Benefits:

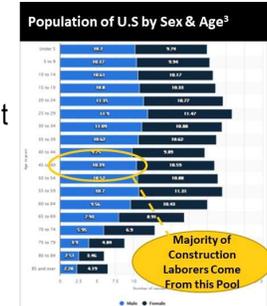
- Remote controlled/semi-autonomous machines with operator-assist features enable physically/medically restricted users to be re-engaged with equipment by removing them from the machines, thereby reducing lost time and lost crew talent
- US landfill pilot test site: An equipment operator was able extend his career by not climbing on/off equipment and enduring the harsh work environment

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Series Id: 7712700000070L
Not seasonally adjusted
Industry: Construction
Region: Total US
Date Element: Job openings
Rate/Level: Level - In Thousands



Nearly 400,000 unfilled US construction jobs



Issue: Machine Performance / Productivity

Results: Increase scheduled uptime through remote control

Ergonomic Command Console/Station Controls:

- Command consoles and stations use familiar components, resulting in reduced training/familiarization time
- In some cases, users can control one or more machines, optimizing production between multiple machines
- Distant jobsites achieve significant time savings because the user does not travel from the laydown yard to the work zone for non-line-of-sight
- Identified tangible benefits include
 - Quick shift changes – no more travel to/from office to machine
 - where project designs allow, maximize asset utilization by having multiple work shifts via a command center

Onboard Machine Operator Assist Features Available to Command User

- When trenching or dozing, operator-assisted functions help generate consistent cycle times and improve grade quality while ensuring the equipment operates within prescribed parameters
- Command is fully integrated into the basic machine structure and allows for future innovations and sensing, data processing and wireless technology evolves



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Global Pipeline Division

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