Off-Highway Equipment Efficiency and Productivity Improvements

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Industry demands for Continuous Improvements

- Economic and world growth drive off-road equipment demand
- Businesses that utilize this equipment have strong drivers to stay competitive by reducing owning and operating costs
- Social / environmental responsibility pressure
- Availability of skilled machine operators
- Need for increased productivity and efficiency – TCO improvements
- Demand for developing technologies and methods for continuous Off-highway improvements
Strategies for Efficiency & Productivity Improvements

**Product optimization**
- Continuous improvement in component performance
- Highly integrated machine subsystems

**Efficient equipment operation**
- Applying machine technology enabled solutions
- Deploying operator assist features

**Efficient intelligent machines + site solutions**
- Operator coaching
- Connected assets and autonomous technology
- Comprehensive site solutions
Product Optimization via Components and Systems Improvements

- **Component performance improvement**
  - More efficient and programmable valves
  - Electronic Programmable Pumps
  - Continuous Variable Transmissions (CVT)
  - Hydrostatic transmission, etc.

- **Highly integrated machine subsystems**
  - Programmable hydraulic systems
  - Efficient and integrated drivetrain systems
  - EH steering and brake systems
  - Energy recovery and reuse systems
  - Engine downsizing with peak shaving
  - Engine speed and power management strategies
Highly Efficient and Integrated Systems (336 EH Hydraulic Hybrid Machine)

Hybrid Excavator Technologies:

- **Conserve**
  - ESP pump
  - Lower engine speed (1500 rpm)

- **Optimize**
  - Adaptive Control System with IMV

- **Reuse**
  - Hydraulic hybrid system
Efficient Equipment Operation

CAT® Grade with Assist (CGA)
- Operator assist feature for HEX enabling **productivity** and **efficiency** enhancement for less skilled operators and experts due to fatigue elimination.
Efficient Intelligent Machines and Site Solutions

Operator coaching tools and technologies:
- help minimize number of machine cycles
- provide instantaneous operator feedback

Example: Payload Monitoring technology

Site solutions for productivity and efficiency improvements
- Technology that combines:
  1) digital site design data
  2) in-cab operator guidance
  3) automatic machine implement adjustments

Cat ACCUGRADE™ Laser Grade Control gains:
~ 40 % fuel savings
~ 90% lower site surveying cost
~ 50% less time to complete identical job
**Connected Assets and Autonomous Technology**

**Cat Connect**: uses data from machines to:

1. Measure payloads and cycle times
2. Optimize production @ construction & quarry site
3. Reduce loading and hauling costs

**Cat MineStar™** - lowest cost/ton of material moved through:

1. Mine site optimization for productivity improvement
2. More efficient equipment management and better uptime
3. Autonomous technology that minimizes interruptions
Summary

• Methods and technologies for **efficiency** and **productivity** improvements:
  – Components and system improvements
  – Deep subsystems integration and energy recovery and reuse
  – Intelligent machine technologies
  – Operator assist and coaching features
  – Connected assets, autonomy and suite of site solutions

• Solutions that **minimize energy** and **time** to complete a job

• “**Inside the machine**” and “**Outside the machine**” solutions

• Developed with **focus** on **sustainability** and **environmental** responsibility