THOROUGH**TEC**
simulation

CYBERMINE™
simulator system

SHOVEL AND EXCAVATOR SIMULATORS

> _"Efficient excavating plays a key role in the productivity of our mine, and increased efficiency comes from proper training. Our operators are all trained on CYBERMINE simulators."_

> **Physically accurate vehicle cab**
> The trainee operator executes all propulsion, digging and loading tasks from a highly accurate replica of the cab interior. The seat is surrounded by fully functional controls including switches, gauges, control pedals and joysticks. The vehicle's functionality is also customisable for even greater accuracy, taking into account factory options such as the configuration of joysticks.

A SIMULATED VEHICLE THAT LOOKS AND FEELS REAL

When shovels and excavators are operating efficiently, the mine site is at its most productive. Using a blend of advanced simulator technology and industry leading training techniques, CYBERMINE shovel and excavator simulators are designed to train, re-train and evaluate correct digging and loading techniques and propulsion methods, to increase efficiency, productivity and safety on the surface mine site.

ThoroughTec's high-fidelity simulators are true to the original vehicle in every way, from the ergonomics of the cab with authentic replication of the operator interfaces, to highly accurate behavioural characteristics of the equipment being simulated.

CYBERMINE shovels and excavators operate in a high-fidelity 3D mine world where the operator can propel, dig, slew, swing and load, interacting with artificially intelligent haul trucks, dozers and other support equipment. Dedicated areas are provided within the operational mine world to provide for the training of various loading and digging tasks as well as maintenance and emergency situations. The vehicles, the world and even the operating procedures are highly configurable to a customer's specific needs.

It's in this world that your operators will develop their skills and experience, so that your mine site operates as safely and productively as possible.

Operating a CYBERMINE shovel or excavator is like operating the real vehicle, but without the high costs and inherent risks.

Authenticity and accuracy
The simulated excavator or shovel cab makes use of original components and specifications to create an ergonomically correct and accurate replica of the original. All simulated vehicle behavioural dynamics are based on detailed mathematical models that use vehicle manufacturer specifications to provide accurate behavioural realism. As a result, bucket and boom control, digging behaviour and loading methodology are an accurate reflection of reality.

Highly customisable
CYBERMINE shovel and excavator simulators are extremely accurate replications of the original vehicle, including custom procedural or operational features that have been included on the customer's own equipment. Any vehicle model from any OEM manufacturer can be simulated, along with optional factory features such as CCTV visual aid systems and simulated two-way radios.

> *Advanced soil modelling*
> Complementing the equipment simulation are ThoroughTec's advanced soil interaction models incorporating incline, gravity, soil cohesion and density. Dynamic terrain responds to weather conditions, affecting the vehicle's propulsion and braking, while deformable soil allows for realistic digging and dumping.
> As a result, the trained operator is able to exercise correct digging techniques for the local terrain type in order to obtain efficient bucket fill factors.

> *Advanced vehicle behavioural models*
> All simulated shovel and excavator behavioural dynamics are based on detailed mathematical models that use vehicle manufacturer specifications to provide realistic behavioural responses of the machine to operator inputs. For rope vehicles, the complex interactions between booms, dippers, links, cables, couplings and bucket structures are authentically modelled, as are booms, sticks and bucket structures for hydraulic vehicles. Bucket-terrain interaction and the complex interactions that take place in tracked vehicle propulsion are also integrated into the modelling.

> *Multiple configurable scenarios*
> The virtual world includes a number of digging and loading scenarios set in an appropriate area for the objective, such as:
> * Single-sided loading
> * Double-sided loading (blind-side and visible-sided loading)
> * Side loading
> * Rear loading

> *Variable world settings*
> Trainees are introduced to a number of scenarios that they may encounter under real operating conditions, including variations of:
> * Light levels
> * Visibility
> * Weather
> * Emergency situations
> * Critical vehicle failures
> * Soil hardness
> * Insertion of overhang and loose material
> * Artificially Intelligent traffic
> * Rocks in soil bank

PHYSICALLY ACCURATE VIRTUAL MINE WORLD

Trainee operators are immersed in an extensive high-fidelity 3D mine world featuring full digging and loading functionality. The shovel or excavator is surrounded by a world populated with artificially intelligent dozers and other support equipment with which to interact. A cable bridge can also be included in the mine world. Advanced soil modelling is used for highly realistic interaction between the shovel or excavator and the terrain. Soil is also modelled for visual accuracy, including scenarios such as the re-formation of the face after soil extraction, and visual indication that the operator has dug unacceptably deep into the bench level. The weather and time of day can be manipulated to cover various operating conditions, while world specific parameters and interactive events can be adjusted for a broader operator experience.
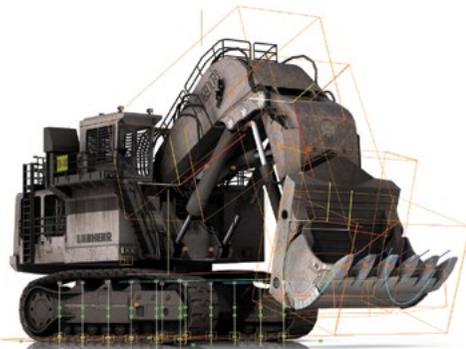

TRAINING AND EVALUATION TOOLS TO MAXIMISE SIMULATOR EFFECTIVENESS

Exercises can be configured to address various training requirements, including operations with different soil characteristics, sub-system failures (such as swing brake system abnormality, motor protection relay shutdown, hydraulic pipe failure and hydraulic oil faults) and advanced emergency situations such as engine fires.

The operator's dig, swing, dump and return phases are continually monitored and recorded for each pass, as are instrumentation states, controls interaction, adherence to safety procedures, correct equipment handling techniques and response to emergency situations and failures. The instructor is also able to continually monitor, in real-time, controls and parameters such as the bucket's fill factor and orientation, the vehicle's slew angle, arm angle and track speeds. At the end of each exercise the instructor is provided with a set of reports covering various aspects of operation. For example, a productivity report details quantifiable returns such as number of trucks loaded, tons moved, number of cycles per hour, time to load, total cycle time and sub-cycle times. Operator evaluation is against a set of predefined checks for the cab type and each is categorised into affecting one of health and safety, machine use or productivity enhancement.

These multifaceted performance reports, together with the instructor's after-action review capability, provide a complete training and evaluation system for shovel and excavator operators.
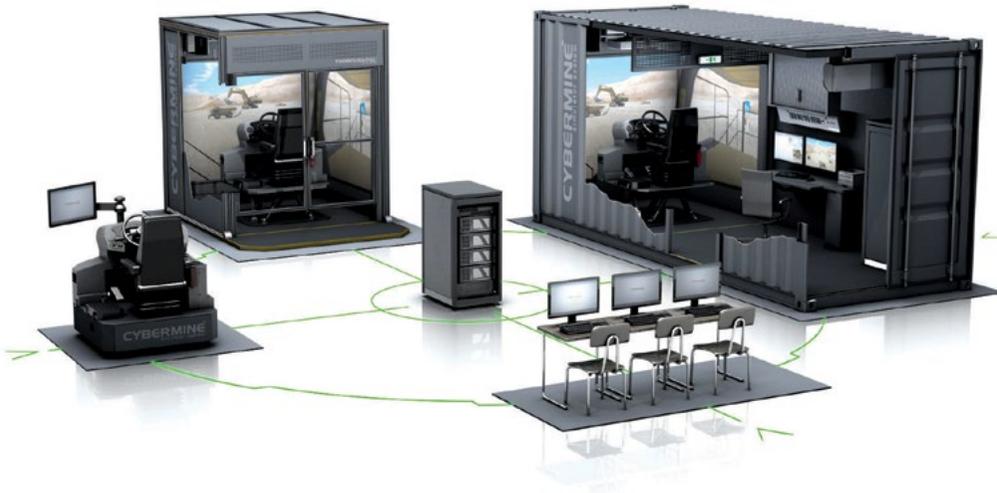
The Complete CYBERMINE Training Solution

A range of ISO 9001 certified and MIL-STD design engineering compliant training tools linked to a central student database for a seamless progression from new recruit to productive operator

> *Computer Based Training (CBT)*

- Developed in collaboration with recognised training specialists
- Fully interactive multimedia content including photographic still shots, 2D and 3D computer animations and video with audio overlay
- Integrates fully with CYBERMINE FMS and OFT systems
- Wide variety of course topics: Machine introduction, roles and responsibilities, standard operating procedures, occupational health and safety, production techniques and machine operation in emergency situations

> *Operator Familiarisation Trainer (OFT)*

- Familiarises operators with new equipment
- Identification and basic operation of the instruments and controls of a specific machine type
- Utilises interchangeable CYBERMINE vehicle cabs
- Fully adjustable touch-sensitive HD screen
- Exploration, Training and Evaluation modes of operation
- Video and audio feedback to the trainee

> *Full Mission Simulator (FMS)*

- High fidelity simulation for comprehensive operator training
- High resolution projected displays with 270° or 360° field of view
- Utilises interchangeable CYBERMINE vehicle cabs
- Active force feedback steering (as required)
- 6DOF or 3DOF motion platforms
- Spacious instructor station with dual HD screens
- Single base unit provides both surface and underground vehicle simulation
- Containerised or fixed facility units

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