THOROUGHTEC™
simulation

CYBERMINE™
simulator system

LHD SIMULATORS

" When manoeuvring an expensive LHD in the confines of an underground mine, you'll be glad your operator has had the best simulator training available."

> *Physically accurate vehicle cab*
The trainee operator executes all loading, hauling and dumping tasks from a highly accurate replica of the cab interior. The seat is surrounded by fully functional controls including joysticks, switches, gauges, levers and pedals. The vehicle's functionality is also customisable to match the customer's OEM equipment for even greater simulation accuracy.

A SIMULATED VEHICLE THAT LOOKS AND FEELS REAL

Operating a load-haul-dumper in the complex, continually changing environment of an underground mine requires skills honed through intensive training. The quickest and most cost-effective way to achieve this level of training is with a CYBERMINE LHD training simulator.

CYBERMINE LHD simulators use sophisticated simulator technology and highly advanced training techniques to train, re-train and evaluate correct loading, hauling and dumping techniques in an underground mining environment, to increase efficiency, productivity and safety.

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. The CYBERMINE LHD operates in a high-fidelity 3D mine world where the operator can perform the same full range of LHD functions as the OEM machine, interacting with artificially intelligent ADTs, pedestrians, LHDs and LDVs. Dedicated areas are provided within the operational mine world to allow for the training of specific loading and dumping tasks, as well as emergency situations.

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

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

Authenticity and accuracy
The simulated load-haul-dumper cab makes use of original components and specifications to create an ergonomically correct and accurate replica of the original vehicle. All simulated vehicle behavioural dynamics, including those of vehicle articulation and boom/bucket operation, are based on detailed mathematical models that use vehicle manufacturer specifications to provide accurate behavioural realism. As a result, full tramming, loading, mucking and dumping tasks are an accurate reflection of reality.

Highly customisable
CYBERMINE LHD simulators can be customised to include any client-specific procedural or operational features. For example, steering and bucket control levers can be configured to meet the behavioural characteristics on the mine site, while optional line of sight remotes can be fitted, as can CCTV driving aid systems or simulated two-way radios. Any LHD model from any OEM manufacturer can be simulated, along with OEM specified optional features.

> *Advanced ground modelling*
Complementing the equipment simulation are ThoroughTec's advanced simulated ground interaction models which require the operator to exercise correct mucking and loading techniques for the terrain type and slope in order to obtain efficient bucket fill factors.

> *Advanced vehicle behavioural models*
All simulated LHD behavioural dynamics are based on detailed mathematical models that use vehicle manufacturer specifications to provide realistic behavioural responses of the machine to operator inputs. In addition, the LHD simulation models physical interactions such as vehicle articulation and bucket-terrain interaction. As a result, all mucking, loading, hauling, dumping and tramming is simulated with realistic visual and tactile feedback for a complete immersion into the training scenario.

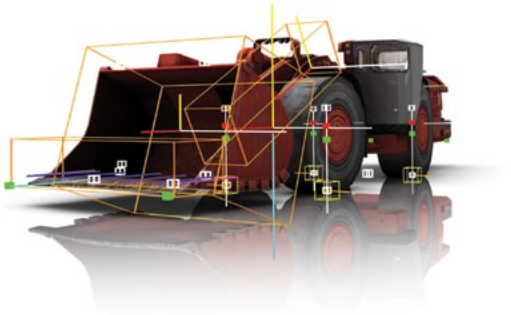
> *Multiple configurable load-haul-dump scenarios*
Depending on the LHD procured, the virtual world includes a number of possible scenarios, each set in an appropriate area for the training objective, including:
- Muck piles for loading and hauling
- Crusher areas for dumping
- Elevated area for loading of dump truck
- Workshop area for parking
- Interlinked tunnels for tramming exercises
- Brake test area

> *Variable world settings*
Trainees are exposed to a number of scenarios that they may encounter under real operating conditions, including:
- Emergency situations
- Critical vehicle failures
- Rock slides
- Rubble spillages
- Water pools
- Artificially Intelligent traffic

PHYSICALLY ACCURATE VIRTUAL MINE WORLD

Trainee LHD operators are immersed in an extensive high-fidelity 3D mine world projected on screens surrounding the cab. The mine site is based on a typical mining operation complete with tunnels, loading points, chutes, dumping areas and other essential features typically encountered underground. Artificially intelligent vehicles and miners may be activated in the world in support of the LHD training and evaluation process. World specific parameters and interactive events can be varied for a broader operator experience, such as rock slides or rubble spillages.

A custom mine site can also be created: A world that looks identical to your mine and operates in accordance with your unique operating scenarios and procedures.

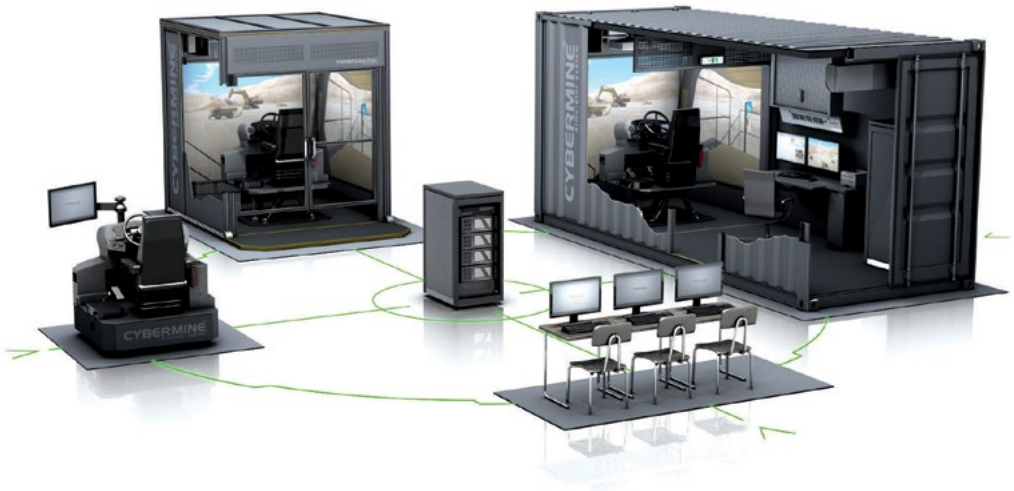


TRAINING AND EVALUATION TOOLS TO MAXIMISE SIMULATOR EFFECTIVENESS

Exercises can be configured to address various training requirements, including operations with traffic, rubble or water on the road, sub-system failures (such as a steering failure) and advanced emergency situations such as brake failures, engine fires or burst tyres.

The operator's loading, hauling and dumping exercises are continually monitored and recorded, as are instrumentation states, controls interaction, adherence to safety procedures, correct equipment handling techniques and responses to emergency situations and failures. The instructor is able to monitor, in real time, controls and parameters such as vehicle speed, steering lever position and service brake position. At the end of each exercise the instructor is provided with a set of reports covering various aspects of operation that may be used to quantify operator performance. For example, a productivity report details quantifiable returns for each loading, hauling and dumping cycle, as well as a summary of productivity related information for the exercise. Factors such as bucket fill factor, number of passes taken to load, time to load, tonnage loaded and dumped, as well as average tonnage and number of cycles per hour, are recorded.

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 LHD 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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ISO 9001 · ISO 14001 · MIL STD

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