Image Captions and Descriptions
for the
5DT Shovel/Excavator Training Simulator

Short form descriptions of the above simulator are supplied below. Image captions and image descriptions are also supplied.

Shovel/Excavator Training Simulator

Introduction
The 5DT Shovel/Excavator Training Simulator teaches the trainee shovel/excavator operator how to operate a large mining shovel or excavator. It is expected of the trainee operator to load several trucks. For this purpose autonomous (computer controlled) trucks have been implemented. These trucks arrive continuously and position themselves for loading. The autonomous trucks position themselves at random positions to ensure that the trainee operator is subjected to many different loading challenges.

Simulator Setup
The system consists of a mock-up cabin that is mounted on a motion base, in the midst of three large projection screens. The three screens (left, middle, right) provide the trainee with a wide field of view (approximately 180 degrees). This is the same out the window (OTW) view that a real operator would experience in a real shovel or excavator. The mock-up cabin is equipped with controls and instruments that mimic real controls and instruments in a shovel/excavator. The motion base provides realistic motion cues to make the trainee feel as if he/she is operating a real shovel/excavator.

Interchangeability
The mock-up cabin may easily be interchanged with mock-up cabins of other mining vehicles. The simulator hardware (computers, large projection screens and motion base) may therefore be used for several different 5DT Training Simulators.

Virtual Environment
The virtual shovel is operated in a photo-realistic virtual environment that emulates reality very closely. The virtual surface mine emulates a real mine. Realistic computer graphics (visual) models of entities like haul trucks, wheeled loaders, water cars and light delivery vehicles were also developed. These models do not only look like the real thing, but they also sound like the real thing - real sound recordings were used for this effect.

Material Interaction
A sophisticated material interaction model has been developed for the shovel simulator. If material (e.g. ore) is removed from the mine, other material slides down to fill the empty space. This ensures realistic filling of the shovel/excavator bucket by the trainee.

Performance Measurement
The instructor monitors the performance of the trainee. This is achieved by means of real-time graphs, reports and a record/playback module. The trainee is presented with a detailed, categorized report after each session. The record/playback module records the entire training session. The session can be played back for detail analysis and evaluation.

Team Training
The 5DT Surface Mining Training Simulators may be networked together. A Shovel Training Simulator may be networked with a Haul Truck Training Simulator so that two human operators, in two separate simulators, can work together to complete a task. The 5DT Simulators are *'Network-Ready'*, which means that it has been designed to function together and that it can be networked without any problems.

Conclusion

The 5DT Shovel Training Simulator is the closest thing to reality you can get! The main advantages offered by the simulator is that one does not have to use a production-capable shovel for training, that the trainee cannot damage or destroy the virtual shovel and that the trainee can be exposed to life-threatening conditions and situations without putting either the trainee or the shovel at risk.

MINE_Surface_Shovel_001
Simulator Setup: Close-up of Shovel Controls
The simulator shovel controls mimic the real controls exactly. Shown here are the left- and right-hand joysticks and the three foot pedals.
The operator seat and controls are mounted on a base plate that may be mounted on the motion base with ease. One hardware setup, consisting of computers, projection screens and a motion base, may therefore be used for several different simulators. To change from one 5DT Surface Mining Simulator to another, one simply has to exchange the base plates and run the other software program.

MINE_Surface_Shovel_002
Hydraulic Shovel: Outside View
Photorealistic computer graphics models provide for a very real learning experience. The simulator also includes other vehicles like computer controlled haul trucks, a wheeled loader, water cars and light delivery vehicles.

MINE_Surface_Shovel_003
Hydraulic Shovel: Bucket Details
This image shows a close-up of the shovel's bucket.

MINE_Surface_Shovel_004
Hydraulic Shovel: Cabin View
View from the cabin of a hydraulic shovel.

MINE_Surface_Shovel_005
Rope Shovel: Outside View
Close-up view of an electric rope shovel. The shovel may propel forward or backward, or it may swing on its axis. The bucket may be lifted or lowered, as well as opened. It may also be crowded or retracted.

MINE_Surface_Shovel_006
Rope Shovel: Cabin View
View from the cabin of an electric rope shovel while it is loading a haul truck. The shadow is important for proper orientation.

MINE_Surface_Shovel_007
Filling the Bucket: Material Interaction
A sophisticated material interaction model has been developed for the simulator. If material is removed, other material will slide down to partly fill the empty space. This ensures realistic filling of the bucket by the trainee.

MINE_Surface_Shovel_008
Loading a Truck: Cabin View
It is expected of the trainee shovel operator to load several trucks. For this purpose autonomous (computer controlled) trucks have been implemented. These trucks arrive continuously and position themselves for loading. The autonomous trucks position themselves at random positions to ensure that the trainee shovel operator is subjected to many different loading challenges.

MINE_Surface_Shovel_009
Instructor Screen: Top-Down View
The instructor may select any viewpoint, and may also navigate around a viewpoint. This does not only enable the instructor to see top-down views, but he/she can also select side views, front views, back views, or any viewpoint that may be needed for a specific scenario.

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