



Technology News

From the Bureau of Mines, United States Department of the Interior



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Controlling a Thin-Seam Continuous Miner Hundreds of Feet Outby the Underground Face

Objective

Provide the technology to remotely control a thin-seam continuous mining machine from a safe location hundreds of feet outby the working face in an underground room-and-pillar mine.

Background and Approach

Hard-wired or radio remote control of continuous mining machines has been commercially available since the early 1970's. This type of remote control, in low and high coal seams, situates the machine operator offboard, but within direct view of the underground coal face. Although positioned under supported roof, the operator can still be exposed to face area hazards that include roof-rib falls, dust, methane explosions, and equipment congestion. The U.S. Bureau of Mines approach has been to put the operator into a protected compartment at a location away from the working face.

Since 1979, the Bureau has investigated innovative methods to better protect face area workers in underground room-and-pillar mines. In 1989, the Bureau demonstrated an offboard, computer-based remote control system in a West Virginia highwall mining operation that stationed the operator hundreds of feet away from the working face. In late 1992, much of this technology, plus improvements, was used to demonstrate, on the surface, how a thin-seam continuous mining machine could be remotely controlled 200 feet from the machine in a 36-inch working height.

How It Works

In current practice underground, the mining machine operator using remote control is in direct sight of the machine and cutting face. Situated behind (outby) the mining machine, the operator controls it by sight, sound, and other human senses. Equivalent operational cues are necessary if the machine is to be controlled from a distant location. By using computer-based technology, sensory input, and other equipment, the Bureau designed, fabricated, and surface tested a system to operate the continuous miner from a safe operator compartment located elsewhere on the mine section.

Although a complete mining system would include other modular units and equipment, the heart of the prototype system is a Bureau-built operator compartment, shown in figure 1, that measures 33 inches high by 61¼ inches wide by 96½ inches long. Inside, the operator controls the continuous miner and has available the controls for a continuous face haulage system. Other functions in the overall mining system, which include roof bolting, rock dusting, and ventilation, would need to be controlled in a similar fashion to relocate all workers who routinely enter the hazardous face area of the mine section.

The prototype equipment fabricated and tested includes (1) a human-engineered, low-profile operator's compartment, (2) a Jeffrey model 101MC continuous miner that was heavily modified for teleoperation, (3) electronic control hardware that is based on a programmable logic controller (in the operator's compartment) with a remote base (located on the continuous

miner), (4) an integrated control and display panel located in the operator's compartment, and (5) machine control and operator interface software that runs on the electronic control system.

Test Results

Test results at Bureau facilities showed that an operator stationed inside the protective compartment could manipulate the continuous miner as needed in near real time. That is, only 21 milliseconds of delay occurred from the time the operator moved a control switch in the compartment until the time that a component started to move on the continuous mining machine. This small delay is not noticeable to the machine operator.

Benefits

This surface testing of hardware and software shows the potential of remote controlling or teleoperating thin-seam (36-inch operating height) coal extraction equipment in the hazardous face area of room-and-pillar mining from a safe operator station that can be located hundreds of feet away. However, the demonstrated system for remotely operating a continuous miner is only a part of an entire mining system. Other mine equipment on the section would need to be controlled remotely to relocate most or all of the face area workers away from the hazards. Although this technology has been developed for application in thin seams, it can be applied to other seam heights as well. Since this technology requires other developments to mature (remote roof bolting, etc.) for a complete system to be applied underground, the Bureau is currently using these project results to apply to extended-cut mining in underground room-and-pillar coal mines.

Patent Status

The U.S. Department of the Interior holds two patents associated with this research: U.S. patent 5,121,365 entitled "Cutting Sound Enhancement System for Mining Machines," which involves a special auditory sensory input provided to the operator, and U.S. patent 5,161,857 entitled "Teleoperated Control System for Underground Room and Pillar Mining," which involves the specialized equipment and the electronic control system for teleoperating the mining system. Additional patent information may be obtained by contacting the Office of Technology Transfer, U.S. Bureau of Mines, 810 Seventh St. NW, Washington, DC 20241 (telephone: (202) 501-9323).

For More Information

A copy of RI 9420 entitled "Teleoperation of a High-wall Mining System" can be obtained from Publications Distribution, U.S. Bureau of Mines, Cochrans Mill Rd., P.O. Box 18070, Pittsburgh, PA 15236. Review the article published in "Mining Engineering" magazine, October 1992, entitled "Teleoperated Cutting and Haulage for Thin Seams." For additional information, contact any of the project personnel listed below at the Pittsburgh Research Center, U.S. Bureau of Mines, Cochrans Mill Rd., P.O. Box 18070, Pittsburgh, PA 15236:

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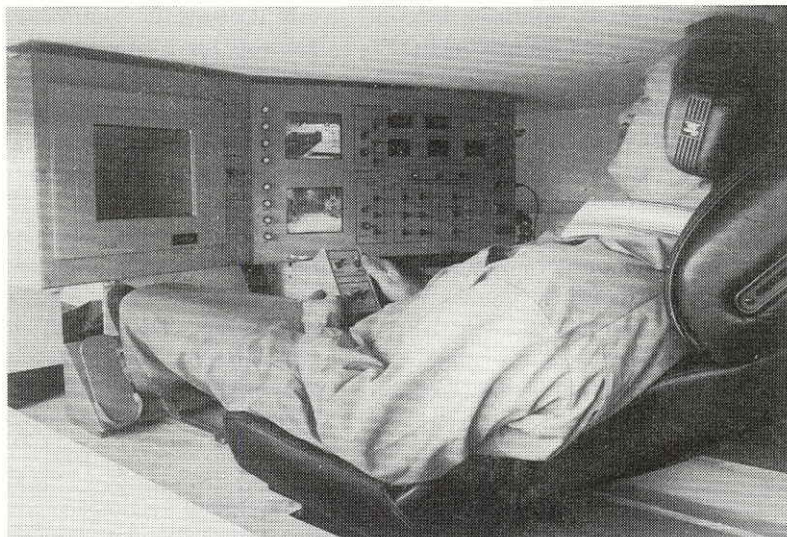


Figure 1.—Teleoperator within the Bureau's 33-inch-high control station.