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Inventions Ease the Plight of Trapped Miners

From Copper-Fiber Socks to Fiber-Optic Cable, Innovation and Improvisation Make Time More Bearable for 33 Chileans

By **MATT MOFFETT**

SAN JOSÉ MINE, Chile—The 33 Chilean miners who have been trapped deep underground for eight weeks watch movies on a projector built into a cellphone. They avoid athlete's foot and other infections thanks to socks made with a bacteria-killing copper fiber. And they communicate with rescuers and relatives over an ultra-flexible fiber-optic cable that maintains transmission capacity while twisting through hard rock nearly half a mile below ground.

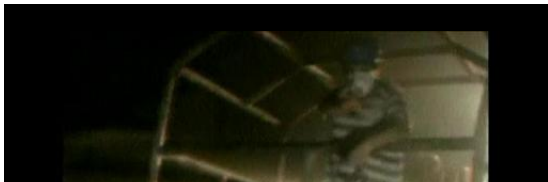
Smart application of technology has made life underground more tolerable for the miners, who have been buried beneath 2,200 feet of rock and earth since a cave-in on Aug. 5. Rescuers are using three different drills to bore shafts to reach the trapped men; one of the drills is making exceptionally rapid progress, raising hopes the miners could be brought back above ground in October rather than the government's stated goal of November.

Technology Provides Ray of Light for Miners



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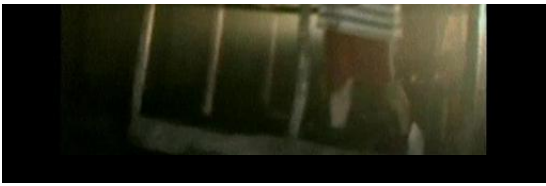
Until then, rescuers are tending to the miners' needs by deploying an array of jury-rigged mining equipment, micro-electronics and brand new contraptions dreamed up by Chilean engineers, scientists and submariners.

"A lot of people were willing to help and many of those ideas were very good," said Jaime Manalich, Chile's health minister, who has been in charge of caring for the miners.

Perhaps the most ingenious device developed by rescuers is the *paloma*—or pigeon, as in carrier pigeon—a five-foot-long hollow cylinder that works like a pneumatic tube. Rescuers stuff the paloma with supplies, then lower it via a pulley through a four-inch-diameter shaft leading down to the miners' refuge.

About 40 palomas a day go down to the mine, carrying food and other essentials—and coming back with miners' letters and dirty laundry.

Even though the paloma was dreamed up on the spot,



Miners trapped underground in Chile clear debris created by rescue workers, who are drilling through the ground to reach them. Video courtesy of Reuters.

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which has a built-in projector.

"I never realized that kind of thing actually existed," marveled Mr. Manalich, the health minister.

Mr. Ibarra also brought Divoom Technology Co. iTour-70 speakers that are almost eight inches long and less than two inches wide.

In addition, he sent the miners a tiny DC-AC power inverter, which converts power from a vehicle battery into 220 volt AC power. It served the miners well until they later got an electrical hookup.

The rescue team won't allow just any gadget into the mine. Roberto Iturra, chief psychologist of the rescue effort, banned iPods because they would isolate individual miners rather than integrating them into the team. He said iPods might also impair the user's awareness in the event of a sudden underground emergency.

Technology is helping with another big challenge: hygiene. When they were found by rescuers after 17 days cut off in a humid underground chamber, many of the miners had body fungi.

At first, before rescuers could bring running water to the miners' chamber through another narrow shaft, the trapped men were sent dry shampoo and soap-embedded hand towels that allowed them to bathe without water. The miners have also been supplied with socks made with a copper fiber that attacks bacteria, thus eliminating both odor and infection. "The products themselves are self-sterilizing," said Jeffrey Gabbay, founder of the company that produces the socks, Cupron Inc. of Richmond, Va., which makes a line of copper-based clothing primarily for medical use. "Negative odors are caused by toxins emitted by bacteria and if you self-sterilize there's no odor" and no infection risk, he said.



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The capsule is displayed and tested by the daughter

the resupply process "is functioning like they've been doing it for years," said Clinton H. Cragg, principal engineer of the NASA Engineering and Safety Center, who visited the San José mine at the invitation of Chile's government.

The paloma has been big enough to carry several diminutive electronics devices to the miners. Alexis Ibarra, the technology writer of the Santiago newspaper, El Mercurio, visited the mine in late August bearing a cornucopia of tiny gadgets donated by electronics companies who were moved by the miners' plight. Among the products were three tiny projectors, allowing the miners to see films or videos of loved ones, including a Samsung Electronics Co. i7410 cellphone,

Rescuers say one of the most significant contributions to bolstering the miners' morale was the installation of the fiber-optic communications link.

Despite being unfamiliar with fiber optics, the miners managed to hook up the lines to the videoconferencing equipment even faster than technicians above ground did, said Luis Felipe Mujica, chief of technological development at Micomo, a joint venture between Chile's national copper company and Japan's Nippon Telegraph & Telephone Corp.

of one of the trapped miners.

Rescuers say the troubleshooting never seems to end.

"Every morning there's a new problem and the solution has to be invented right then and there," says Alejandro Pino, a workplace-safety expert who is part of the rescue team.

He recalls how communication specialists had to work quickly to patch together a phone link when a miner needed to speak to one of his children in southern Chile who was in the middle of an emergency.

Now the men are counting the days until they can use the government's most elaborate piece of hardware, a rescue capsule dubbed the Phoenix, which the men hope to ride out of the mine. The capsule stands about 10 feet tall, weighs more than 900 pounds and is equipped with an oxygen supply and communication system. It was designed and built by Chile's navy.

NASA provided some design requirements. "They are crossing new thresholds here," said NASA's Mr. Cragg, a former U.S. Navy submarine captain. "If they could buy a rescue capsule like that I'm sure they would. But they don't exist, so they've got to start from scratch."

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