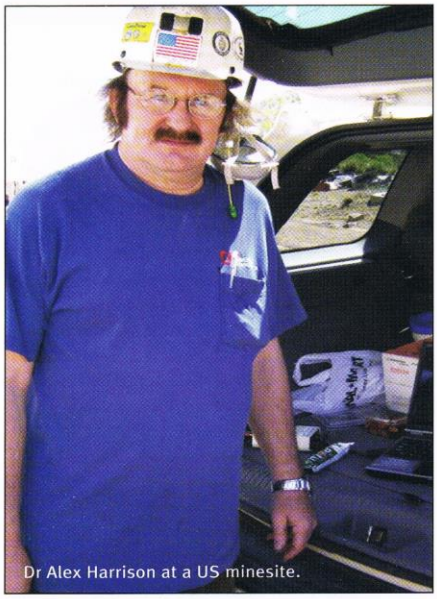
downtime. And thirdly, the inherent safety risk that conveyor breakage can pose. Pictured is a South American belt, which is remotely scanned by Conveyor Technologies' system.

Expert's 35-year conveyor monitoring journey

Conveyor strain expert and entrepreneur Alex Harrison spoke to *AJM's* Oliver Probert about his company's growth since its founding in 1993, and his experience in the conveyor monitoring industry since getting started in 1979.



Dr Alex Harrison at a US minesite.

CONVEYOR TECHNOLOGIES specialises in the remote scanning of steel cord belts for strength testing. Located in the Central Coast city of Gosford in NSW, the company is run by its founder, Dr Alex Harrison, who has been working on belt strength monitoring systems since he first came up with the initial concept while working with the CSIRO in 1979.

"The system was the first in the world to test and measure strength in a steel cord belt," Harrison told *AJM*. "It happened because mines were trying to determine where damage was located in a belt."

Miners, who were looking to find ways to predict the deterioration of their belts before catastrophic failures occurred, initially looked to X-ray technology as the solution.

"Their first attempt was to use an X-ray fluoroscope to image the cables onto a flat screen, and then video-record what they see, but the persistence of the signal was way too long to be useful," Harrison explained.

"So we developed what we call the conveyor belt monitor."

The monitor developed by Harrison at the CSIRO was licenced to three companies, two of which failed. One, Harrison said, continues to use the initial technology, but that technology is not the same as that used now by his business, Conveyor Technologies.

"I went to the United States in 1991, and the upshot of that was I developed a new and alternative monitoring system to what we developed at CSIRO. It's more portable, it's lightweight; it's a different system. So the system we have at Conveyor Technologies, that I've used in the US for 20 years, is a different system to what we developed originally in Australia."

In one application, Conveyor Technologies' system works by placing a transmitter and receiver roughly 10cm apart from each other

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on the same side of a conveyor. The transmitter transmits an electromagnetic signal, and depending on the strength of signal received by the receiver, the technology behind the devices determines how much steel there is in the belt.

The technology records up to 1,000 12-bit samples each second, meaning Conveyor Technologies can measure down to a resolution of 1 millivolt of signal. "We can detect a fifth of one broken cable in a steel cord belt," Harrison said.

"It's an electromagnetic, non-destructive test. Our device detects a signal from the belt at normal speed, which is a function of the amount of steel. If there's any rusted out cables, or any damage, we can detect the loss of steel.

"Our software converts those detected signals into a safety graph. First of all we detect the signal from the belt, which relates to the damage level, and we convert that using stress analysis into a safety factor graph, and that indicates closeness to failure."

Those graphs, Harrison said, give the business' clients a good idea of how long it will be before they will need to shut down their belt and fix the damage that's been detected. When that does occur, Harrison said, the company can design a cable repair plan for that issue.

"It's real-time monitoring which works with the belt at full speed. We can detect events to within half an inch of where they are on the belt, and the system can be calibrated to an exact level of damage. Our stress analysis program will be invoked at that level."

Harrison was quick to define the difference between his system and a rip detection system, which is often installed into conveyor belts by their manufacturers.

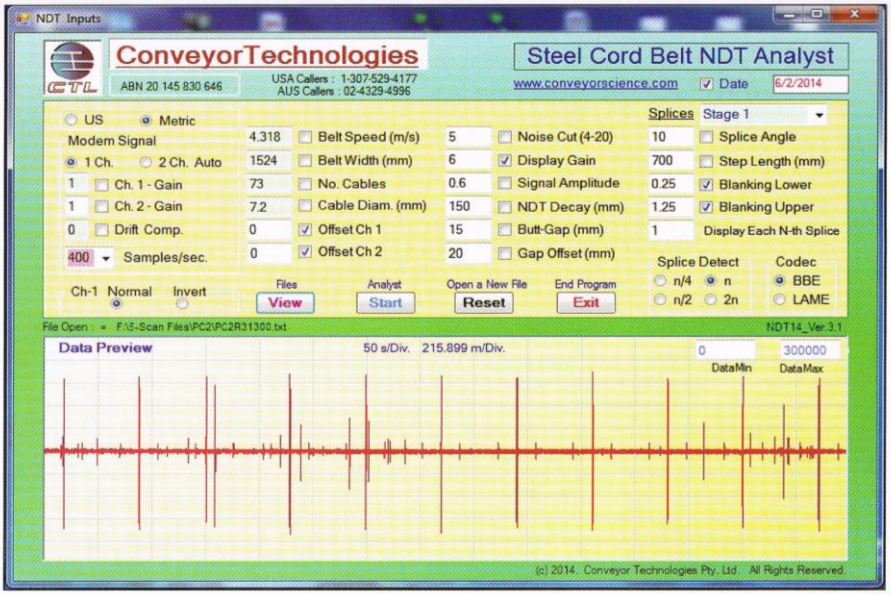
"Various belt manufacturers have rip detection systems – a series of embedded loops which detect things impinging a belt – but that's a different type of monitoring system to ours," he explained. "Ours does continuous monitoring of the length of belt, while a rip detection system is only as good as the amount of sensors placed in the belt."

After leaving the CSIRO in the mid-80s, Harrison took a role as a professor of engineering at the University of Newcastle, where he is still a conjoint professor of engineering.

In 1991, Harrison moved to the US, to grow his business there. And it is in the US that Conveyor Technologies now has systems installed on some of the world's longest, widest, strongest and fastest conveyors.

The company's strongest is an ST6600 in Alabama, which moves coal. The 3km long conveyor is powered by four 2,000 horse power motors, giving it a total output of 8,000 horse power.

The longest belt on Conveyor Technologies' books is in Colorado, and measures 16km centre to centre. The company does test a longer one, which is 19km long according to Harrison, but is not doing so at the moment.



(above) Conveyor Technologies' software gives accurate readings of belt strength at a high frequency, Harrison said. (below) Harrison's business hopes to detect severe breakage before it happens.

A 2.13m-wide belt in Ohio makes for the company's widest, and the fastest is another North American belt which Harrison told *AJM* runs at more than 7.5m/sec.

And all of them are tested by Conveyor Technologies remotely, via the internet.

"From about the year 2000 all of our scanning technology was computerised, all our signals were digitised, and made adaptable to sending over a telephone line for remote monitoring, using the telephone line and the Ethernet systems in the mines.

"All our remote scans are done with internet protocol where possible. If you just use a telephone line it can be noisy, and it can be expensive."

Conveyor Technologies supplies all the equipment involved in the monitoring process, free of charge. From there, Harrison said, the company charges around $2,500 to $3,500 per test (typically). Tests occur once every two to three months, so long as no faults are predicted.

"Some belts with higher damage rates we do test monthly," he noted. "Also, if we find a splice that's bad, for example, but the operator doesn't want to shut the belt down for whatever reason, we will scan the belt every day. We'll do that right up to the point when it's about to break, and we call them and say 'Right, better shut it down now, boys, it's about to break.'

"We've been doing these tests remotely for 15 years, and we've never had a belt go down the hole … our system is cost effective."

The company also plays a role keeping manufacturers accountable for the belts they produce.

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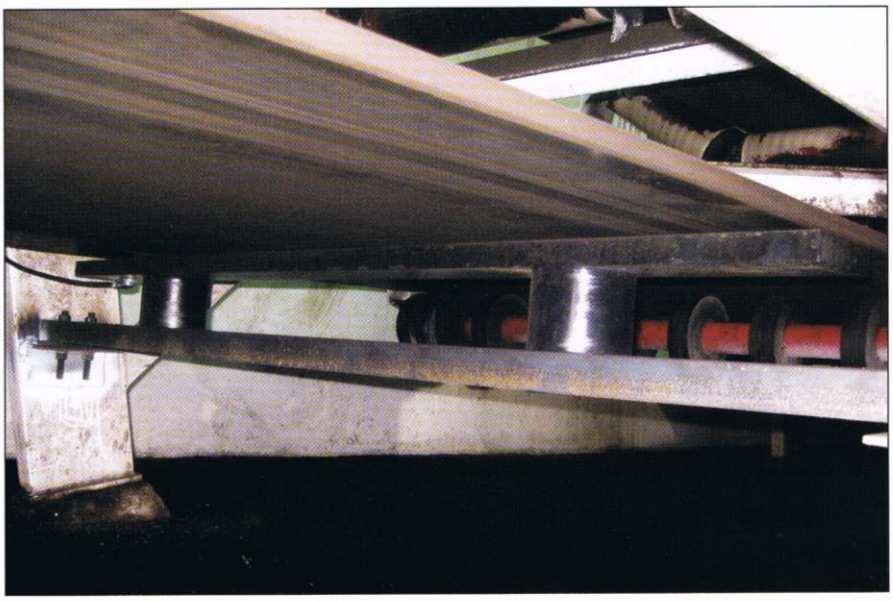
"Manufacturers which make steel cord belt usually do so to AS1333/4 Standards. We've had belts that haven't lasted nine months; brand new belts that have fallen apart in nine months' time, because of defects in the alignment of the cables, in the cord plane of the belt. You end up with rapid fatigue and bending, and the cable can break spontaneously."

For that reason Conveyor Technologies will test a new belt for a customer, and tell that customer if they've bought a quality product, or if they've been sold a belt with issues.

"We're not liked much by belt manufacturers," Harrison joked. "A lot of belt manufacturers have now developed a technology which is similar … we have run into these instruments in the past.

"When there's no human intelligence involved, and they've programmed the software to do automatic testing, you can get severe errors in calibration and reporting, to the point where the client will get an automatic email every five seconds or five minutes … It doesn't help the client detect real problems."

Also, Harrison pointed out, there's a conflict of interest issue when belt manufacturers design systems aimed at testing the quality of their own product. "Once a belt manufacturer makes a belt, and puts it into operation with his own scanner on it, it's not in their best interest to tell the mine that they've made a bad belt, that they've laid the cords slightly misaligned or something. So it's a conflict of interest."



The belt scanner in action.

> *Right, better shut it down now, boys, it's about to break.*

Harrison said his experience with US mines was that they recognised this as a conflict of interest, and they were keen to work with an independent tester. But he's not so sure Down Under.

"The Australian mines … I'm not too sure what they think yet. In the United States the mines definitely understand the issue of conflict of interest, and they come to us for the testing."

Harrison said his company's technology often shows up with different results to the manufacturers' test systems. He recalled one scenario where a pair of belt manufacturers put their equipment on a belt.

"One manufacturer's system said there were about 10 errors in the belt, and one's thought there was only two or three," he said. "So the miner was left with the dilemma, if the belt was going to break tomorrow, or is it not a problem?"

When Conveyor Technologies tested the belt, it found four to six errors, then cut the belt open and found all errors as they predicted.

"I put that down to the inability to calibrate, or an inability to understand the physics of the equipment they've got. It's not really their core business; they make belts, they don't scan belts. We're independent mechanical engineers, and we don't have a conflict of interest in this regard."

Harrison said that belt users often fall into the trap of just scheduling a belt replacement every two or three years, and said that in some cases this can cost upwards of a million dollars to do.

"With our program, we know we can double and triple the expected life of a belt … when we find localised damage, we can design a repair, which entails cleaning out the damaged spot, cutting cables in the belt where the damage is and getting rid of all the rough ends, then laying cables again."

One of the more impressive things Harrison has done is convert an idea which was developed through academic research, and commercialise it. He put his success in this way down to two factors.

First, he said that it was important to have the best interest of the clients at heart, despite the fact that the very nature of commercialisation might suggest that you have to be in it for the money.

And second, he said, was that you had to know the industry like the back of your hand. "You need to have a rapport and an interaction with the industry you're working with," he said.

"I was brought up on a farm. I'm practical, I can weld; I can build things. So when I talk to the mining people I'm not just seen as an academic. Part of being successful is knowing the industry you want to work in, and have them help you and work with you." □

Contact: www.conveyorscience.com.au

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Using high-tech monitoring systems to avoid catastrophic conveyor failure

Feature starts page 13

Conveyor monitors keep mines' blood pulsing

Charles Macdonald
EDITOR
Australian Journal of Mining (AJM)

OVERLAND CONVEYORS are the arteries of mines across Australia. Snaking many kilometres from mines to process plants to ports, they carry the ore that is the life blood of the nation's mines. Racing along at many metres per second, the conveyors carry tens of thousands of tonnes per day. Often operating in hot and dusty conditions, it's a war of attrition for the rollers, pulleys, rubber covers and steel cords that make up the conveyor.

Catastrophic failure of a conveyor is a mine manager's worst nightmare. With the clock ticking, losses in revenue can run into hundreds of thousands of dollars per hour. Plus, contractors and belt manufacturers have the mine over a barrel when it comes to negotiating prices.

Neil Freeman, mining specialist at measurement and automation giant Honeywell estimates that 50% of unplanned downtime on mineral handling sites is due to conveyor faults such as ripped conveyor belts, failed idlers and worn pulleys.

The multinational has developed a range of monitoring systems, described on page 20, that can provide mines with early warning of incipient conveyor component failure.

High-tech conveyor monitoring systems aren't just the preserve of corporate gorillas like Honeywell, though, with entrepreneurs and inventors sometimes coming up with the goods.

As described on page 15, Alex Harrison started out at the CSIRO where he invented an innovative conveyor belt monitor as far back as 1979.

Subsequently, the accomplished engineer and mathematician has successfully commercialised a variant of his original invention. His system uses software to convert electromagnetic signals into safety factor graphs that show steel cord belts' closeness to failure.

Decamping to the USA in 1991, Harrison used his system to remotely scan via the internet a plethora of the country's big belts. These included one of the strongest – an ST6600 in Alabama – as well as a 16km specimen in Colorado, a 2.13m wide one in Ohio and a pacy 7.5m/sec belt.

In over 15 years of testing, Harrison's clients have never experienced a belt failure. Instead, he reckons he's helped them double and triple belt life by using his invention to find localised damage before designing repairs. He's also kept conveyor manufacturers honest by identifying faults in new belts.

On page 13, entrepreneurial company Intium Solutions has developed a clever system to monitor the health of conveyor rollers. It uses vibration sensors, a smart mesh network and some clever algorithms to detect rollers in need of attention. □