SMARTER DATA

HUGH DURRANT-WHYTE
wants to change the way you think, bit by bit

Crop circles
The path from fuzzy logic to precision agriculture

Flying solo
How drones are taking the danger cut of rail jobs

Beyond 3D
Young innovator turns the formwork world on its head
The Institute of Railway Technology at Monash University has a long history, a stellar global reputation and major clients on almost every continent. Chris Sheedy talks to a world leader in the railway industry.
Railway technology doesn’t immediately occur to some young engineers as cutting edge, or as a rewarding field in which to spend a lifetime of work. After all, most countries have long had established railway systems for the movement of goods, people and resources, and the basic technology behind the transport has not changed for decades ... or has it?

During a recent event at Monash University, one that brought together final year engineering students and representatives of 20 Australian rail entities, impressions were changed as students realised the significant opportunities, exciting developments and engineering achievements in the vitally important rail industry.

The event was organised by the Institute of Railway Technology (IRT), a business unit within Monash University. Ravi Ravitharan, the IRT’s Director, said the enthusiasm shown by industry representatives and by final-year engineering students was overwhelming. Considering the scope of the work being undertaken by the IRT, it’s not difficult to understand why.

“The students generally fed back to us the fact that they never realised the industry was so interesting or that there was so much challenging work available in railways,” Ravitharan says. “It is a growing industry in Australia, and an important industry globally. At IRT we work with industry bodies to help them overcome issues with maintenance and with the management of railway operations. Our group is set up to deal directly with industry, and to link industry to solutions that we have developed over the last 44 years.”

Currently a team of Ravitharan’s researchers is in Hong Kong helping solve an issue with a recently opened track on the city’s MRT system. Others deal with Australia’s major heavy haul businesses, such as BHP, Rio Tinto, Fortescue Metals Group, Australian Rail Track Corporation and Roy Hill. Some work with public transport providers such as Victoria’s government-owned V-Line and MTM, others with engineering contractors such as John Holland, and others with PT MRT Jakarta on Indonesian railway projects.

“Over the last 16 years we have worked with over 150 entities around the world on about 1500 projects.”
ATTACK OF THE DRONES
Culverts (drainage tunnels under railway lines) are vital for the ongoing health and performance of the railway line. But with the enormous weight of the trains passing overhead, they also require regular inspection and maintenance.

The confined space means it is often uncomfortable, or dangerous, for a maintenance person to enter. Once inside, it is difficult for a person to perform a thorough analysis of the space to ensure the culvert has maintained its shape. That’s where drones come in.

“We came up with a way to use drones specifically developed for this purpose,” Ravitharan says. “They can be remotely piloted into a culvert and, using LiDAR, can accurately construct a 3D model of the space.”

“People are now interested in using the same technology to look at railway tunnels. In the past they have used a hi-rail car – a normal four-wheel-drive converted with wheels to travel on rail and conduct surveys. But now we are developing ways to utilise drones to fly in to the tunnels and do the surveys. They typically don’t necessitate stoppage of rail traffic and also don’t have so many safety requirements.”

Specialised drones are also being developed for track inspection purposes in disaster zones or in regions where the rail is difficult to access. Flying drones that also have wheels can land and run on rails autonomously to conduct inspections.

“Another of the most basic methods these days is to send a person to walk the track,” Ravitharan says. “They look at the rail to pick up any major visual problems, just things they can see. It is often in the middle of the night when the trains are not running and the lighting is not great.”

“A drone can capture detailed images and send them back to a central station for analysis. The images can be compared to those from the previous run. It is so much better in many ways.”

450 projects,” Ravitharan says. “We are a group of engineers from various specialties including civil, mechanical, electrical, electronics, metallurgy etc., and industry partners come to us to figure out how they can do things better.”

Transformers
In Australia, South America and deep into Asia the work of IRT is changing the way railways operate. But, if not for a passionate group of railway researchers deciding to carry on their work in a new environment at Monash University 16 years ago, one of the world’s leading railway research bodies would not exist today.

Monash University Chancellor Simon McKeon says in the past he often wondered what happened to BHP’s Melbourne Research Laboratory (MRL, aka ‘BHP Technologies’), which turned out so much ground-breaking and influential work from the 1960s to the late ‘90s. More recently, in early 2016 when he assumed his new position at Monash University, he was thrilled when he realised he was working very closely with the new iteration of the MRL, and it was still a major influence on industry.

“BHP Technologies disappeared and then, one of my great joys this year was not only connecting with Ravi and seeing where his team is physically located, but actually connecting the dots together and realising that some inspired people, 16 years ago, arranged for the rail institute, ex BHP Technologies, to be housed inside Monash. The IRT really is a jewel.”

When BHP shut down its research division during difficult financial times in the late ‘90s, Ravitharan and his team moved a few kilometres down the road to Monash University. He says, they came to be seen as more independent in terms of their research strategy.

“Most university institutions develop through academic specialists who are entrepreneurs or who have a connection to industry, and they build a team around them,” Ravitharan says.
Traditionally the monitoring of the condition of the track has been conducted on an annual, or six-monthly, or quarterly basis by operators. It has simply not been practical to do the maintenance testing more often as it involves the use of a special dedicated track geometry car (worth around $10-$15 million), running along the track, taking a traffic path that other traffic could use.

The process has a number of inefficiencies. One is the fact that all traffic must be stopped when a dedicated track geometry car is in use. Another is the excessive time between monitoring. A third is the special track geometry car not being the same weight or not having the same suspension characteristics as the usual rolling stock, resulting in the monitoring taking place in atypical conditions.

“We have been working with the heavy haul industry, the benchmark railways who run trains that are approximately three kilometres long with 40-tonne axle loads, to develop the ‘instrumented revenue vehicle’ technology,” Ravitharan says.

“We retro-fit normal revenue cars, ones that are made to carry passengers or iron ore or coal, with instrumentation and then collect the information using advanced technologies including sensor, power generation, communication and data analytics technologies.”

By using instruments on the rolling stock and advanced analytics to understand the condition of the track in real time and record the measurements more often. This way they can help the operators to understand where to target their maintenance.

“In a passenger network we can obtain the measurement five of six times each day,” he says.

“So we understand on a daily or hourly basis, as opposed to an annual basis, how the condition of the track is changing, and the effect of this change on the rolling stock performance.”

“We do not teach students at this point in time. Instead, we focus our efforts towards industry. We have created a rail research atmosphere that is academic, and which specialises and brings other academics into the rail industry. The industry benefits from having that connection to academia, as well as having a group like ours that understands their challenges.”

The IRT has been very busy solving problems for the industry since its move to Monash University. It has revolutionised the way rail inspections are conducted, developing systems and hardware that allow inspections to become continuous during normal operation and real-time, rather than a sporadic or scheduled event, and making predictive maintenance a reality.

The researchers are also planning to introduce drones into the railway workflow, making maintenance and condition reporting safer and more accurate for rail businesses.

**Point of difference**

Another major advance has been in the area of management of wheel-rail interaction. When rolling stock moves along a track, the contact point between wheel and rail is tiny, meaning any changes in condition are of enormous importance. When wheels or rails wear unexpectedly or too much movement occurs, serious issues can develop.

“When you’re moving along a straight track, the wheels are sitting symmetrically,” Ravitharan says. “But as soon as you go around a sharp curve, because of the inertia, the outside wheel flange starts moving towards the rail, which is called ‘flanging’. On the other hand, the inside wheel flange moves away from the rail. That dynamic can be improved by changing...
the shape of the wheel and rail profiles. Rail shape can be controlled by grinding or milling. Every railway is unique in this respect. You cannot take the wheel-rail profile we developed for Hong Kong’s MTR and use it in V-Line in Victoria, for instance."

He says they look at each individual operating environment and come up with a solution that covers all requirements specific for that operation.

Getting the wheel-rail interface right brings major benefits including safety, a reduction in defects, extended wheel and rail life, and reduced noise and vibration.

Another significant area of IRT research and capabilities has been around the improvement of rail welding techniques and solutions to minimise broken and cracked welding joints.

"Welding has always been regarded as the weakest link in railway track." Ravitharan says.

"You cannot take the wheel-rail profile we developed for Hong Kong’s MTR and use it in V-Line in Victoria, for instance."

"In the majority of railways, 70 to 80 per cent of broken rails come from welds."

Particularly under heavy haul conditions, the quality of the weld is of vital importance. IRT has become a global knowledge leader around flashbutt and aluminothermic welds.

"Welding has been going on for a long time, but we’re learning a lot more about particular areas to improve weld quality, including heat treatment of welds and weld collar design etc," Ravitharan says. "The cooling process in welds is important. When you finish welding, if there are rough spots then they become crack initiation points. So many different aspects have an effect on weld quality."

Quiet engineering
IRT is engaging young engineers to continue the work that has been going on for 44 years, and the future appears promising. McKeon describes it as a truly international business.

"I think it is such a great success story, and I suspect that one of the most important parts of the entire story is the fact that we can say to Australians that we can do this," he says.

Chris Stoltz, a civil engineer and Engineers Australia’s Victorian President, says bodies such as IRT are now more important than ever as infrastructure businesses and councils lose their engineering DNA.

"A lot of infrastructure-related organisations that were once managed by engineers are now headed up by accountants and economists," says Stoltz, also founder of Spatial Partners, which works with the NBN and its design and construction partners. "They have become investment businesses rather than engineering services serving the community. This has inevitably led to corners being cut – sometimes for good reason in the name of efficiency and sometimes in order to cut costs – and not always having an engineering-based understanding of the results of those cut corners."

"IRT is a great example of quiet engineering. They don’t go around blowing their own trumpet, but they have done such a great job that they have earned international recognition. They deserve every bit of it." 

Welding is regarded as the weakest link in railway track.