



## A World's First— the stringless automation of CMI concrete pavers

**O**ne of the most impressive and interesting achievements on the Westlink M7 project, claiming a number of world's firsts, was the conversion of two of Abigroup's CMI 4500 and 6500 concrete pavers from string line to automatic total station control.

As far as machine control is concerned, this is really the pot of gold at the end of the rainbow. It's the final stage of roadmaking automation, and the most difficult. Preparation of road layers and the subbase by GPS and laser is now commonplace, with great benefits in speed of construction and higher quality outcomes. On the M7, that standard of quality has been translated through onto the finished road surface.

### Longest Stringless Pour in the World?

By the end of the paving phase, the two Abigroup machines had completed virtually the whole of the 10.8 metre dual carriageway in both directions, a total distance of about eighty kilometres. Certainly the longest stringless concrete pour in Australia, and probably in the world.

The technical feats involved in achieving this outcome reflect great credit on the team that put it together. Brian Rowland of 3DX Australia was at the coal face with the Abigroup guys who worked day and night to overcome complex challenges, vigorously backed by Brian's supplier of the brilliant GeoRog 3D product, Sven Vejde of SBG, Sweden.

### What Abigroup Wanted

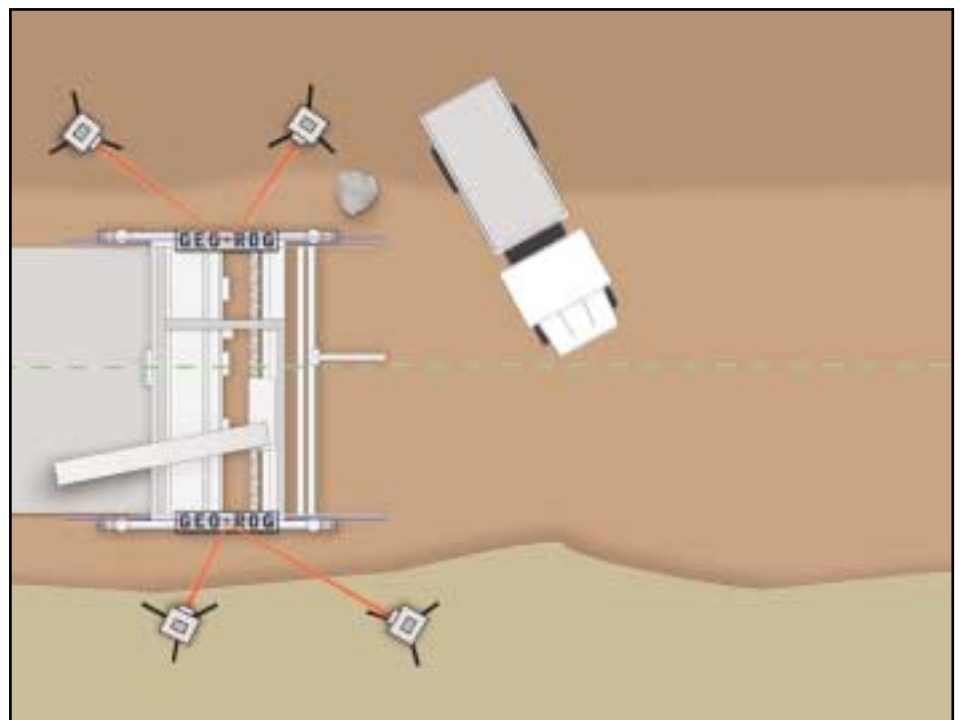
Pavers are not replaced without good reason. They commonly go through cycles of rejuvenation because there's nothing on them that can't be restored to new condition.

Says Carl Ryan, survey pavement manager on the M7 project; "The CMI equipment had proved its value, and we have a team that's experienced at getting the best out of it. You become accustomed to the characteristics of the machines you use, and it's time consuming and expensive to have to re-learn the process. So we wanted these pavers automated, not replaced."

Abigroup found no-one prepared to tackle the job until Brian Rowland of

3DX Australia stepped up to the plate. He's a machine control specialist with a wealth of hands-on experience. And he was convinced that Sven Vejde's GeoRog system had the capacity to command a CMI paver. In fact, GeoRog has handled similar paving tasks and contains much of the required computer code—but nothing quite so challenging.

There's no electric-over-hydraulic control on the CMI, thus nowhere to wire up conventional 3D products. Electrically controlled high precision proportional valve banks with specialised CanBus valve driver hardware had to be produced in record time, a task at which Sven's SBG company excels.



## Benefits of Total Station Control of a Paver

The benefits are significant, of replacing string line control of a paver with total station control direct from the digital road design. Foremost, there's the huge saving of expenditure in setting up the pegs and strings on an eighty-kilometre pour. Then there's accuracy; with the most dedicated guys in the world, human nature dictates that no-one is going to get it 100% right. In places, the string is going to be too high or too low. Or someone thought the bottom of the string should be on the mark, not the top.

These errors have a habit of compounding. Two millimetres become five millimetres.

In one place 5mm high, further along 5mm low. When too low, you could have a section that doesn't meet specs. There's an obvious quality issue, and Abigroup's comparison with previous string jobs clearly demonstrates that the M7 project achieved pavements with a more consistent and uniform surface. A standard deviation within very fine tolerances on the M7 gave far better results than previously experienced.

However, the risks involved in this automation exercise can't be minimised.

On Abigroup's side, a forced instruction at any time to shut down the batch plant would have stranded twelve trucks in the pipeline feeding each paver. And this was steel-reinforced pavement, an expensive proposition to rip up. Whilst Abigroup required that the electronic controls be cut into the hydraulic system in such a way that manual control could be instantly restored, where were the string lines suddenly going to materialise from, before concrete started setting? Clearly, reverting to stringlines was only an option if the electronic machine control system was out of action for at least a day—a very costly day.



**At left, the graphic shows how total stations were staggered, permitting one to leapfrog another and keep pace with the constantly moving CMI paver. Top: The first trial run. At any given time, a dozen concrete trucks were 'in the system' supplying each paver—pressing the stop button was not an option. Centre: CMI paver moving forward under continuous control of four Leica total stations, a pair on each side. Bottom: Brian Rowland of 3DX Australia worked many a night to refine the operation of the GeoRog guidance system.**

Continued on Page 22



Continued from Page 21

For 3DX Australia and SBG, the risk of failure was accentuated by having to perform on the fly. Normally, a 3D control product is thoroughly tested behind the scenes for months, before it's released. In this case, their shirts were hanging right out.

### The Challenge

Automating a dozer is a piece of cake, compared with a paver. Each track leg of a paver can be, and is, raised and lowered independently of the other four legs. Its angle of attack is adjustable in the vertical plane. It can be steered on its path horizontally either by turning the tracks, or by accelerating one side. It is in fact a great hunk of steel hovering over the top of the subbase whose orientation is infinitely adjustable.

The scheme settled upon by 3DX Australia and SBG, in conjunction with project survey manager Brett Lehmann, was to employ four total stations—initially a pair of Abigroup's Leica 1102s controlling each end of the paver. An alternative was to use a pair at one end with a cross-slope sensor on the paver, but tests showed that dual control is far more accurate.

As shown in our diagram, the total stations controlling each end of the paver are 'staggered', that is, not positioned directly opposite each other. About fifteen minutes are needed to move and set up a total station, so this staggering allows one TS to be leapfrogged ahead whilst keeping the moving machine under the control of the remaining three. Non-stop continuous movement of the paver is thereby achieved, essential for eliminating humps in the pavement.

SBG wrote some very fancy software to prioritise the data coming in from the total stations. The farther the 360 degree prism is from a total station, the lower the accuracy. So GeoRog was instructed to track on each station, but to place more reliance on data from the TS that was closest and less reliance on the more distant TS—and obviously to swap that priority automatically at the appropriate moment.

Those familiar with paving machines will know that they have a tendency to 'skew' as they negotiate a radius, and this had to be dealt with in the software to a tolerance of better than 20mm.

Amongst the many precautionary features built into the system by SBG, at Brett Lehmann's suggestion, is an alarm that sounds when a total station is 'lost' supplemented by a flashing light on the corner of the paver closest to that TS.

To guard against the possibility of a non-compliant subbase (pretty rare on an Abigroup job, says Carl Ryan!), a complex warning system comes into action. An alarm sounds if GeoRog detects that the subbase is out of spec when that situation has continued for a pre-set distance. For instance, if a section is encountered where the trimmed surface is too high, the side forms could be expected to dig in, causing the travel legs to lose traction as they lift—the paver would be trying to dive the pan down to the design level. Clearly that possibility, and several others, needed to be addressed.

If no action is taken in response to warnings in a variety of circumstances, GeoRog will stop the paver—a very expensive event that fortunately didn't

**At left, machine automation pioneer Sven Vejde of SBG Sweden oversees another of his GeoRog systems, used to guide a Terex trimmer preparing the M7 subbase.**

arise, but with the potential to be even more expensive if the appropriate safeguards weren't in place.

### The Human Input

To say that this was a rush job is an understatement. 3DX and SBG had only two months to come up with the goods. Night-time pictures of Brian Rowland show him burning the midnight oil, along with Abigroup's Carl Ryan. And Sven flew out numerous times from Sweden to address issues on the spot, many times entering new code into his GeoRog from a keyboard balanced on the control panel of the paving machine. Peter Lundgren, Sven's programming whiz kid, came up with many complex mathematical solutions.

From the outset 3DX Australia was on notice from Brett Lehmann that payment from Abigroup was subject to successful performance. Naturally, nothing so complex can be put in place without a few glitches, and everyone concerned admits to having more grey hair that when they started out. But the problems were ironed out in time for the second Abigroup CMI paver to be automated by the time it was needed, and thereafter the two machines proceeded to lay the whole of the main M7 carriageway.

"I think that what's clearly demonstrated here is the enormous power, flexibility and stability of the GeoRog system," says Brian Rowland. "It can be configured to run a dozer, excavator, trimmer, scraper, grader and many other types of equipment simply by selecting options on its screen. To that, we can now add the CMI paver."

Indeed, on the Westlink M7 project Abigroup had up to ten GeoRog systems operating at one time, and they did in fact control all the equipment types Brian mentioned.

Brett Lehmann's slant is that 3DX and SBG are the right size companies to be dealing with on complex issues. "When we had something to say or something that required urgent attention, we needed the right bloke to be listening. And taking instant action. That's not common with large organisations." 