

Bentley MX road design tool has been at the heart of design work for a complex interchange near Brisbane, Australia

An Australian interchange

Multiple iterations of the design for a highway upgrade project in Queensland, Australia, and particularly the big interchange at the heart of it, have been vital to reduce the impact of the scheme on commuters, long-distance drivers and the communities it passes through.

The scheme is an upgrade of two highway sections in countryside near Brisbane close to the town of Ipswich, a growth area in the expanding Australian state. Both the Ipswich highway and the Centenary highway need upgrading, the latter in quality and the former in capacity and size. Some 5.5km of the Centenary highway is being widened from a dual two-lane highway to a dual three-lane with capacity for a future four lane each way. The Ipswich highway is being improved and will have room for expansion on a 2.5km stretch.

The general road network and links into the roads are also in need of improvement, to increase traffic capacities and improve flows, but also to reduce the impact of the roads on the local

communities. The roads also need safety improvements to reduce a high local accident rate.

But the heart of the project is the interchange between the two roads, which needs to accommodate the extra capacity and new on and off ramp connections, as well as improving the traffic paths and flows, and safety.

Complicating matters is a new railway link into the area as well. Meanwhile embankments for the line and a bridge connection run through the interchange to further increase the layout of some 30 bridges, underpasses and trunk drainage structures. To make the project more challenging still, the entire crossover and the highways have to maintain existing services, as well as cutting commuter times as the project proceeds. A well planned temporary work design forms a key part of the overall task and the staging of the works around the live traffic flows. Furthermore, the client, Queensland Department of Transport & Main Roads, wanted to reduce the impact of the interchange, with tight constraints

The software even allows the design team to model differences in light intensities between night and day at the site as well as the angle of the sun at particular times of the day

on land take and corridor spread.

"The client provided a base reference design," said Ben Schnitzerling, a Brisbane based Arup road engineer with the project from the beginning. "It was a large three-level interchange with a lot of structures stuck one on top of another."

The reference design provided an initial base costing of the project, but was then re-evaluated in a second phase. "The visual and environmental impact of the base design was considerable," said Schnitzerling. A major effort was made by the engineering team therefore to re-work the design of the interchange into a novel design making effective use of space. Schnitzerling said, "That meant rather than use the vertical, you spread the footprint of the interchange to flatten it out, re-distributing the interconnecting ramps and curves."

Of course that had to be balanced with the overall possibilities of the land take, and project costs, with some complicated geometry to be worked out and then priced for

each option. Better flood control was also part of the remit along with drainage improvement, better noise management and more efficient use of lighting.

"It means weaving the ramps through one another in some unusual configurations, maintaining necessary design radius standards and the like. But that is not all," said Schnitzerling, "Much of the focus was on improving the experience of the junction for all the users including the drivers upon it. There are after all 80,000 of those daily, compared to the 1,000 or so people who live in the area."

"To begin with you don't want them distracted from the driving by the presence of large flyover structures, which are visually intrusive. That is a safety issue of course but much more, it relates to whether the driver has a good experience of the junction. This is a more intangible engineering issue but vital."

The design team's intention was to achieve a completely intuitive feel for drivers entering the interchange and then needing to turn off in various directions.

"There is a point in the junction where there is a 50-50 bifurcation in the traffic flow for example," explained Schnitzerling. "In some junctions that might mean turning off on one side and then moving

up and over to the other side. We wanted to get as much as possible the exit side to be the same as the final direction in which the driver would be heading so that it did not need any thinking."

That is easier said than done and in some cases it is still necessary for ramps to climb up and over. That raised new questions; for example one curving ramp would bring drivers head on into the setting sun at certain times of day, which would prevent them seeing line markings, so it was altered, which in turn meant juggling with other parts of the structure.

To work through these possibilities the design team used Bentley MX road design software, running several hundred of different iterations. "That is fairly straightforward to do for a skilled user by altering the input files" said Schnitzerling.

The complex software creates a 3D string based road model which can be rendered into a sufficiently usable representation to make the engineering judgements necessary. Sight-lines can be assessed in the model and aquaplaning, Powerdraft software was used for the engineering team. There were more high grade visualisations made using Autodesk's 3DS Max and the interconnecting plug on

programme, Dynamite, which simplifies and automates road design visualisation from an engineering model into 3D Max.

The 130-strong design team also found the interoperability of the software with other tools highly useful, in particular Bentley's Triforma structural software and lighting software. Bentley Structural and Bentley Rebar have been used for the interchange structures.

The 3D model produced by MX is also easily used inside traffic simulation programs. On the project two main tools were used, SATURN for initial studies and SIAS Paramics for microsimulation runs of the different junction layouts to explore the impact of the changes in detail.

Once the concepts had been worked through and final design was completed for the structure the 3D was also used for construction. The entire project is a pegless site using 3D machine control primarily with software from Terra and Trimble used for the construction model and information.

The huge A\$845 million scheme has been in construction since late in 2007. ■

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The interoperability of the Bentley software tools have come in useful on the Ipswich project

