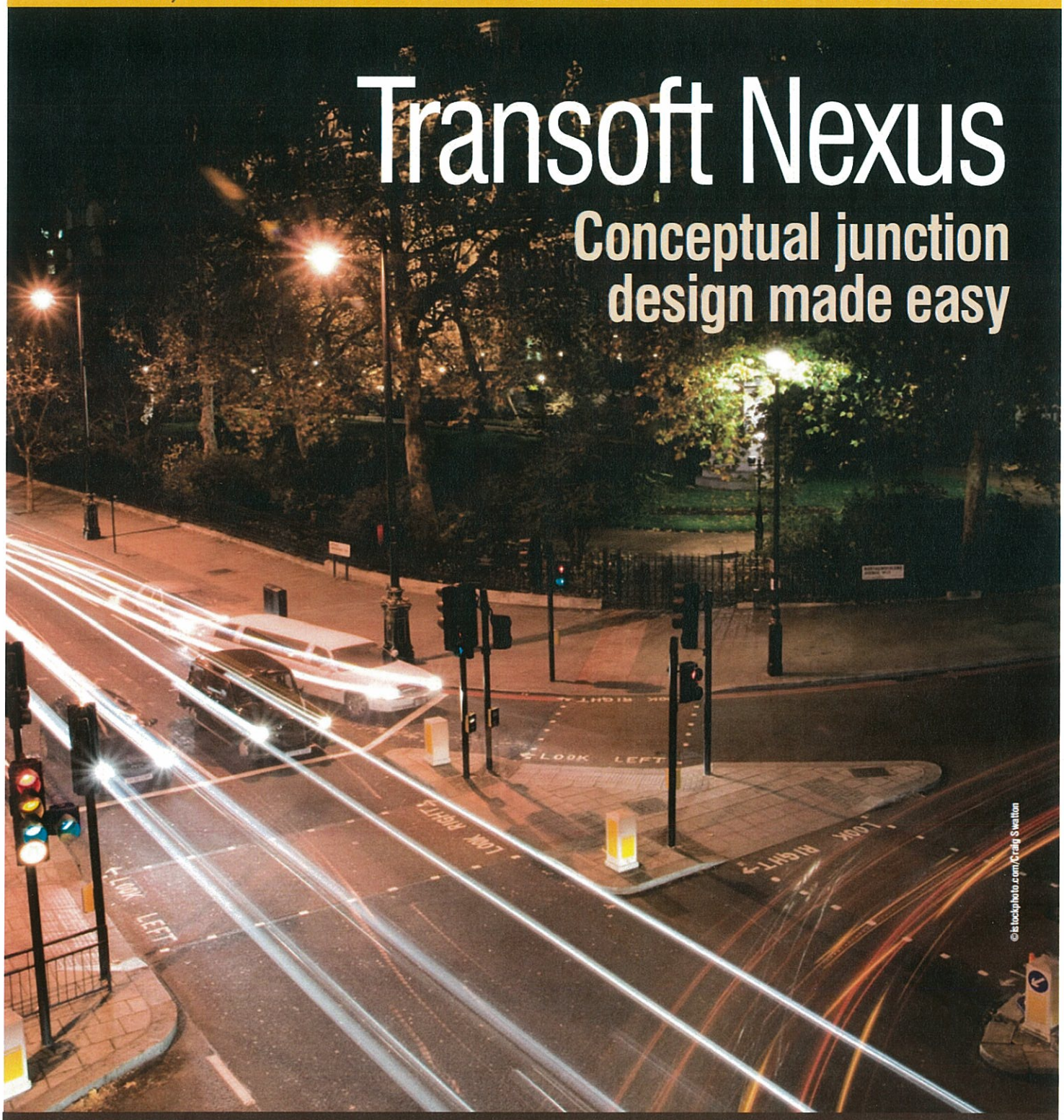
March/April 2011 >> Vol.53

AECMAGAZINE

DESIGN, MANAGEMENT & COLLABORATION IN THE BUILT ENVIRONMENT



Transoft Nexus

Conceptual junction design made easy

AutoCAD WS on the iPad | Workstation warranties | Nova Studio

Nexus 1.0 for AutoTurn

Nexus is a brand new software from Transoft Solutions that is designed to help engineers quickly create and evaluate conceptual designs for road junctions. Greg Corke reports.

Canadian software developer Transoft Solutions started out in the 1990s with a software tool called AutoTurn. This 2D application enables engineers and architects to evaluate vehicle movements at junctions, roundabouts, in car parks, and for any vehicle-based project that requires access, clearance and manoeuvrability checks. This is better known as swept path analysis.

While AutoTurn is primarily a checking tool, in recent years Transoft has focussed its efforts on producing software that uses its swept path technology earlier on in the design process.

ParkCAD started this trend with an application that helps engineers or architects quickly design and review multiple car park designs. In 2010 Transoft turned its attentions to roundabout design with Torus, a brand new tool that uses swept path analysis for the conceptual phases of the design process. The company has now followed this up with Nexus, which applies to same principles to junction design.

While there are many established tools for junction design — AutoCAD Civil3D, Bentley MXRoad, and Bentley InRoads, to name but a few — Transoft believes there is a gap in the market for a tool that focuses specifically on the conceptual or preliminary stages of the design process. Nexus is specifically designed for developing junction design concepts very quickly. It enables engineers to try out multiple options to see which makes most engineering sense, taking into account traffic operations, geometric design and safety performance.

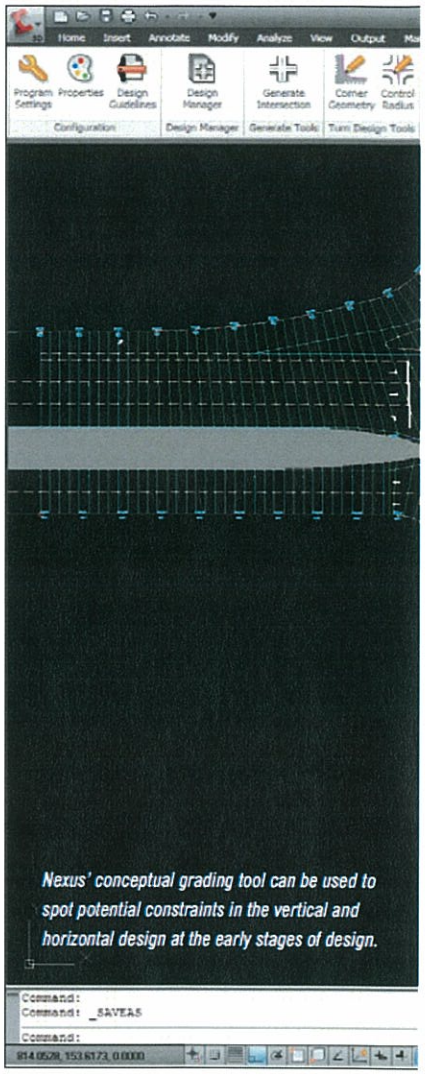
Three-tiered platform

Nexus is part of a three-tiered platform. It works alongside AutoTurn, which gives it its swept path analysis functionality, and sits on top of the two key AEC CAD platforms — AutoCAD and MicroStation. It also works with the major vertical civil / highway design software tools that sit on top of these CAD platforms, namely MXRoad, InRoads, Geopak and AutoCAD Civil3D. Working with these applications offers the added advantage of a smooth transition should the engineer want to progress the junction design from the preliminary stages to the detailed design phase.

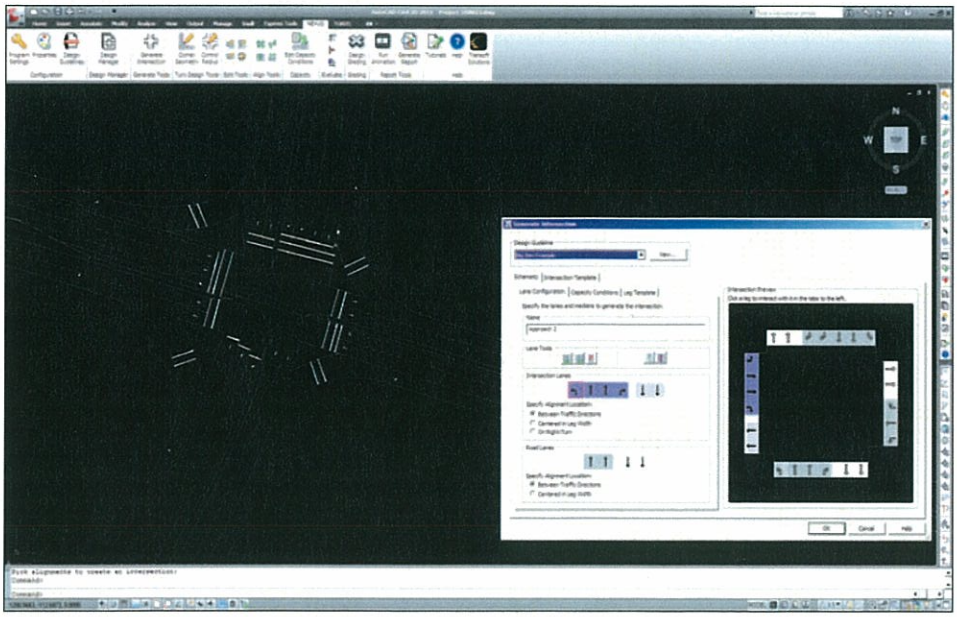
Design guidelines

Design Guidelines are a key part of Nexus and can be used to set a range of default values used throughout the design process. They don't form a rigid set of rules, and can be edited at any point, but by using them it means engineers don't have to worry about every single element of the design.

In setting the design guidelines, the engineer can specify some of the key geometric parameters that would typically be recommended by regional design standards, such as lane widths, corner geometry, or corner radiuses. During this process, he or she should take into consideration the constraints, rights of way, and building envelopes. Design guidelines can be set up as part of a company-wide standard or applied on a project-by-project basis.



Nexus' conceptual grading tool can be used to spot potential constraints in the vertical and horizontal design at the early stages of design.



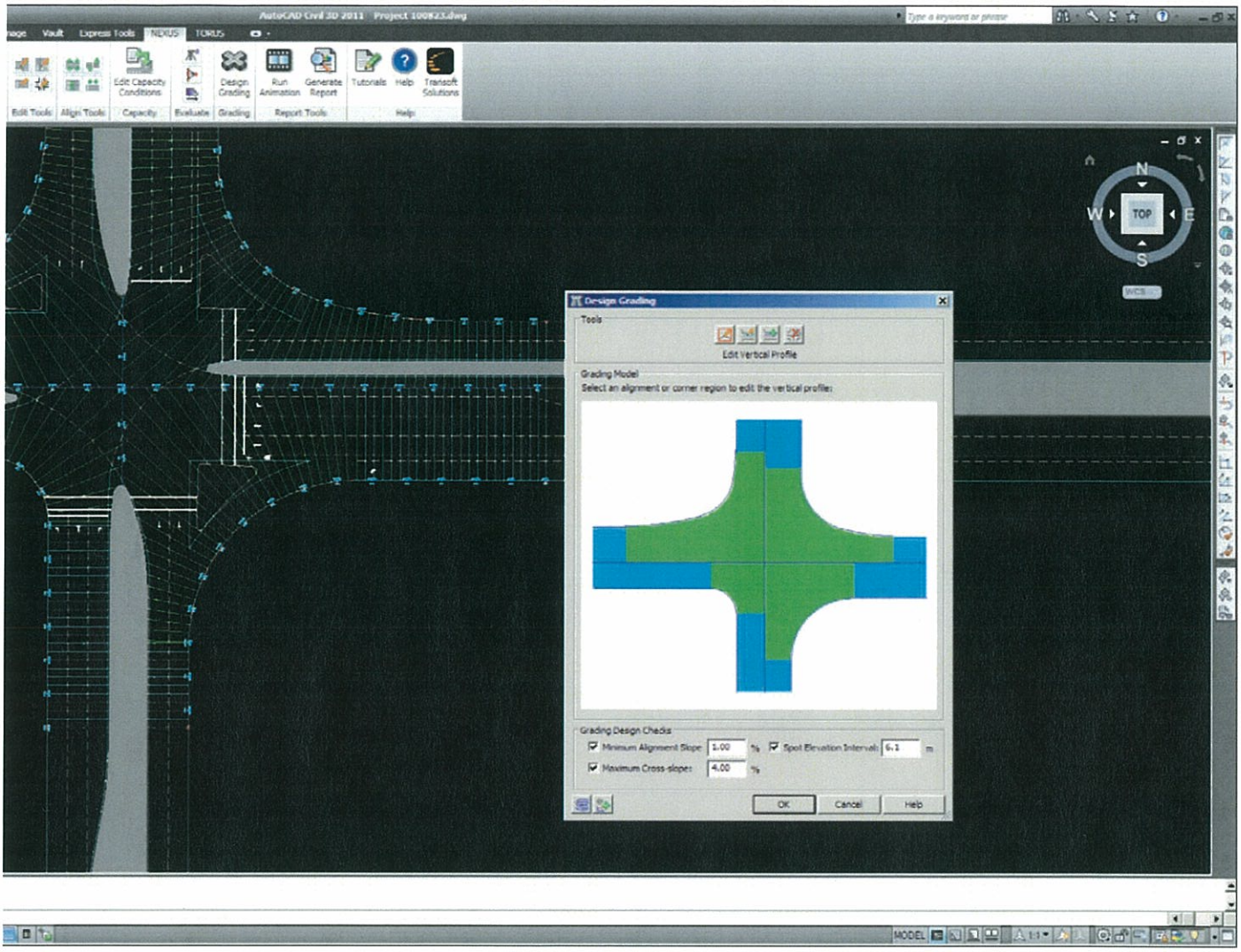
The Generate Intersection Tool is used to define the lane configurations at the junction.

Generating junction layouts

The design process starts by the engineer selecting the 2D reference lines that will define the junction. These can be standard lines or arcs which, at the preliminary stage of the design process, could be traced from aerial photos or satellite images. However, if actual survey data is available then a 3D alignment could be created in Civil3D or MXRoad and used instead. Here, the horizontal alignment would be used to generate the initial junction design, while the vertical alignment could be used downstream for conceptual grading in Nexus.

There are four methods of generating a junction layout and all of these can be accessed through a single 'generate intersection' dialogue box.

Schematic lane configuration method: this is the most flexible of the four and allows the engineer to toggle between each leg, defining the



number, type and position of entry and exit lanes. All options are shown in a preview of the junction and then applied to the drawing directly.

Capacity conditions method: Nexus can generate an initial junction design based on capacity analysis data. This can be imported directly from HCS+ (Highway Capacity Software). While this software is popular in North America, it is less so in other geographies, so traffic volumes can also be manually input from other traffic analysis software.

Using capacity conditions data upfront in the design process can be a quick way of defining how many lanes are required as well as the storage lengths that are needed — i.e. how many vehicles will need to stay within their own lane to wait for a right turn.

Leg template method: this enables the initial junction design to be generated from predefined leg templates. These can be taken from an industry-standard library or defined by the engineer for re-use.

Intersection template method: this is similar to the leg template but instead of looking at one leg at a time, the engineer can define a template for the entire junction. The template can be orientated to the road alignment.

Vehicle envelope design method

The driving force behind the design process in Nexus is the 'vehicle envelope method'. This uses swept path analysis to determine how a vehicle would manoeuvre in a junction and how much space it would require to perform its turns.

There are two tools within Nexus for swept path analysis. The first is 'design vehicle', which can be used to help dictate the junction geometry. Design vehicles are defined as those that are frequently used for that junction, such as a van or a bus. Definitions of these vehicles are typically taken from design standards, such as the Freight Transport Association or DETR DB32 (Residential Roads and Footpaths, Design Bulletin 32). These types of vehicle would usually be guided by the islands at a junction.

The 'checking vehicle' is for large, less frequent vehicles, such as semi trailers or oversized vehicles, which typically use more than one lane to turn. Here, Nexus can check for oversteering. Designs can also be checked against specialist vehicles. These would typically be defined in AutoTurn and imported into Nexus.

Each method can also be combined. For example, capacity conditions could be used to set up the initial design and then the initial junction layout can be refined using the lane configuration tools.

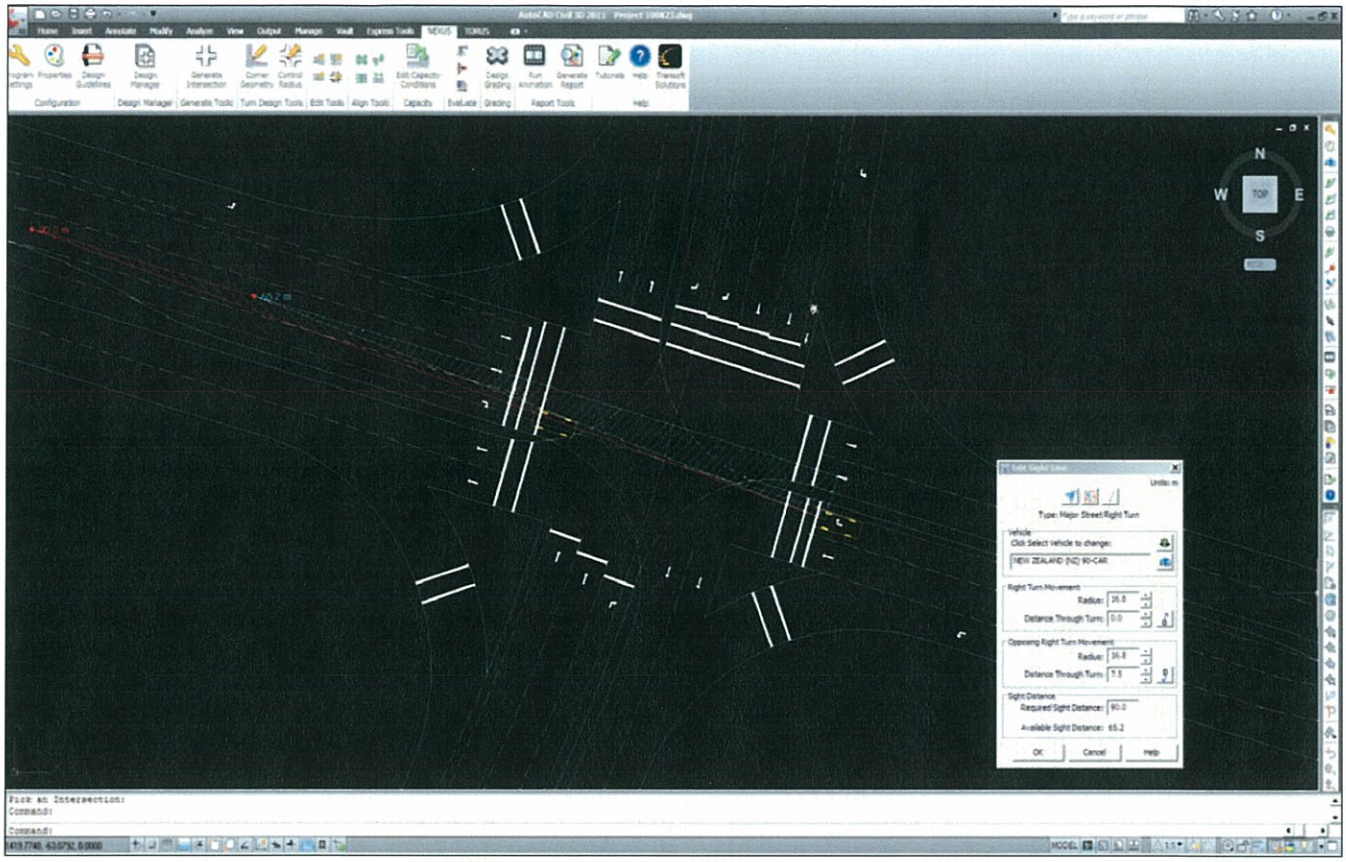
At this stage the engineer can also define many other elements of the junction including crosswalks, islands, medians and bike lines.

Corner geometry

Once the basic concept has been generated the next step is to refine the corner radii. If working closely to design standards these can all be set up in the design guidelines so it automatically pulls in the right values. However, a big benefit of Nexus is that corner geometry can also guided by design vehicle movement at a pre-defined speed or turning radius. Here, vehicle paths are highlighted on the design and the user can then adjust corner radii to fit, adjusting each arc in a simple to use dialogue box.

Similar principles, relating to design standards and vehicle path movements, can be applied when designing an intersection leg's control radius. This helps determine the nose median position and stop bar location.

Preliminary designs can also be checked against



movement of more specialist vehicles and then the whole layout adjusted if needs be.

Sightline and conflict points

Once a preliminary junction design has been created, the engineer can assess it in terms of safety performance. This involves checking sightline and conflict points. There are three types of sightline checks: sight triangles, major street (or opposing) right turns and critical points.

Sight triangles are used to check that the driver of an approaching or departing vehicle has an unobstructed view of a junction.

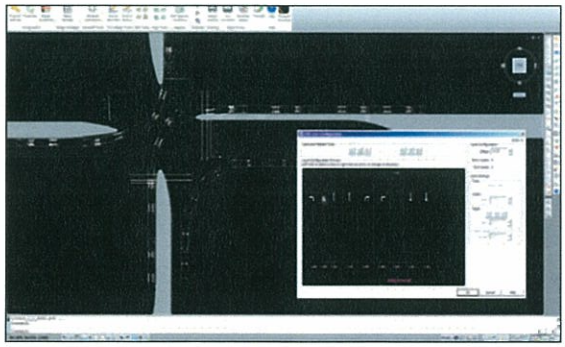
It can be used to evaluate both left and right hand turns and also to check that drivers are not being given excessive sightlines, which may encourage them to approach the junction too quickly.

Major street right turns enables engineers to dynamically check if there is adequate sight distance for right turns. Critical point checks allows engineers to pick any point near a junction, such as a pedestrian waiting to cross, the corner of a building or a particular sign, and check the driver has an unobstructed view.

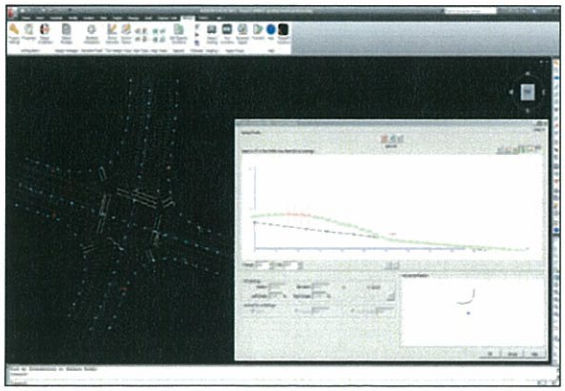
Conflict points refer to vehicle-to-vehicle conflicts. Nexus takes all the lane and turning information and forms a grid that is used to identify where conflict points occur (where two paths cross).

The engineer can then assess which are most critical and give each conflict point a weighting to help assess how safe an intersection is.

Above: Various types of sight lines can be evaluated including opposing right or left turn manoeuvres, sight triangles, and critical points of interest.



Powered by the AutoTurn engine, design vehicles can be used to derive the key intersection geometry including lane configurations with channelising islands .



As the vertical alignments are defined in Nexus, immediate feedback on the cross slopes is graphically shown on the plan and profile view.

Interactive editing

At any point in the preliminary design process changes may need to be made to the design. When these are made, Nexus can help engineers assess how they impact other areas of the design by providing real time feedback.

For example, when assessing safety performance it might become clear that sightlines are being obstructed and by shifting a leg a metre or two to the left, the problem will be resolved. In some junction design software once these edits had been made, everything would need to be checked again., but with Nexus you don't have to redo your sightlines again, as these are updated dynamically to show you the impact of these design changes.

Conceptual grading

Grading is emphasised in the UK standards as this can affect adjacent properties and identifying problems early on can reap dividends as the design progresses. As a result, one of the most valuable features of Nexus is its ability to consider the vertical element of a design without having to develop a detailed 3D model. Transoft calls this conceptual grading.

To start, the engineer can define the vertical profiles by creating or editing VPIs (vertical points of intersection), or use 3D alignments from Civil3D or MXRoad, for example.

The software can automatically compute all the crossfalls and highlight areas that don't comply with specific conditions that have been set in the design

guideline. For example, anything steeper than a four percent grade will be highlighted in red. Any subsequent adjustments to the vertical profile will instantly update the crossfalls, giving the user good feedback.

Design manager

Nexus includes a Design Manager that helps users manage all of the different design concepts. Typically, in order to manage multiple designs, users would have to save individual drawings, and when comparing concepts would have to load up each one in turn.

Design manager lets you control all of that in one drawing so each concept is saved as an object on its own. You can toggle each one on and off, and overlay them on top of each which makes them easy to compare.

Conclusion

In the preliminary stages of junction design engineers typically want to evaluate as many concepts as they can in the shortest amount of time. Nexus is designed to do just that — by keeping things simple, linking the geometric layout to design vehicles and helping engineers continually monitor the performance of an entire junction design as changes are made.

The software can help engineers identify the best engineering solution from a conceptual standpoint, and bid for projects by giving an idea of cost. Then the model can be ported over to a vertical CAD platform — such as AutoCAD Civil3D or InRoads — to develop the detailed design.

From a software licensing perspective I can imagine some engineering firms may find it hard to justify two sets of tools for what they may deem to be the same process — particularly as Bentley and Autodesk have recently improved the ease of use of their junction design tools.

However, when you consider that, at the early stages of a project, you have the potential to make the biggest changes, investing in a dedicated tool for conceptual design could be money well spent. Trial versions of Nexus are available for download so you can see if the software works for you.

Product information

Product: Nexus 1.0
Supplier: Transoft Solutions
Price: £1,550 (a copy of AutoTurn is also required which costs £1,640)
Web: ***www.transoftsolutions.co.uk***

Moving onto detailed junction design

Once a preliminary design has been created inside Nexus, the junction can be further developed using one of the many vertical CAD applications. Data is commonly transferred using LandXML, but it can also be transferred using less intelligent formats such as DWG and DGN. Here is a run down of some of the major vertical CAD applications used for detailed highway and junction design, which feature the ability to carry out accurate cut/fill volumes for earthworks balancing as well as project costings.

AutoCAD Civil 3D

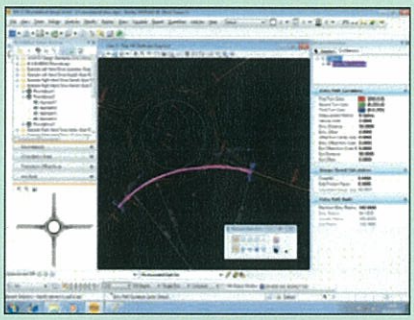
Built on top of AutoCAD, Civil 3D is a multi-purpose civil engineering design tool, but also has dedicated features for highway design.

It can be used to design roads, corridors, junctions and roundabouts, and can calculate cut and fill volumes. In 2009 Autodesk introduced a dedicated wizard for junction design, which was designed to accelerate the entire process. ***www.autodesk.com/civil3d***

Bentley Geopak Civil engineering suite

Part of an integrated civil design and engineering software family, the software offers a range of intelligent roadway design tools. It can handle all types of highway design and includes tools for junctions and roundabouts as well as earthworks balancing and project quantities calculation.

The software is widely used in the US and other geographies, but the favoured applications of UK civil and transportation engineers have historically been MX and InRoads. ***www.bentley.com/geopak***



Bentley MXRoad Suite V8i

MXRoad started out life in the UK in the 1970s as MOSS (Modelling Of Surfaces with Strings). In the 1990s it was bought by US company Infrasoft and is now owned by Bentley Systems.

It was the first software to model each feature in the road as an individual entity, named a string. Junction design is just part of MXRoad, which includes road and alignment design, quantities and reports and earthworks design. It features the same advanced roundabout design functionality as found InRoads and Geopak. ***www.bentley.com/MXroad***

PDS Alignment/Highway Design

This string-based design package is designed for all types and scale of highway and route alignments.

An optional Highway package is aimed at major routes, grade separated junctions, complex junctions, and roundabout design. ***www.causeway.com***

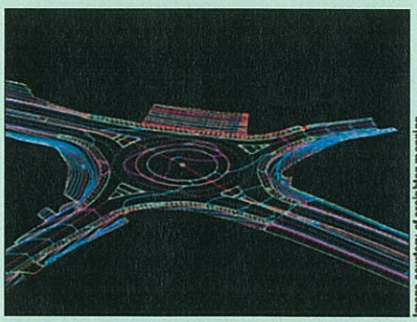


Image courtesy of creighton manning

Bentley InRoads Suite V8i

Bentley InRoads is a full civil design system, handling roadway, site, storm and sanitary design, survey data management, right up to geometric bridge modelling. InRoads has evolved from products originally developed by Intergraph in the 1980s.

Bentley has introduced a new suite of tools for developing and checking complex roundabout designs, which are common across its entire road design portfolio including Geopak, MX and InRoads. ***www.bentley.com/inroads***

12d Model

12d Model is a terrain modelling, surveying and civil engineering software package. It has a dedicated module for roads and highways, which provides tools for detailed alignment design. ***www.12d.com***

CGS Civil 3D Road Extensions 2011

CGS Civil 3D Road Extensions works ontop of AutoCAD Civil 3D. It contains several roadway design, earthworks and road signage features that are designed to expand and improve the capabilities of Civil 3D. ***www.cgsplus.com***