CITY KNOWLEDGE

THERE'S MORE TO SMART CITIES THAN INTELLIGENT TECHNOLOGY – MODELLING, PLANNING AND MANAGEMENT ARE ALL VITAL, TOO. TIM HUGHES LOOKS AT JUST SOME OF THE GEOSPATIAL TECHNIQUES ON WHICH SMART CITIES WILL BE BASED

A 'smart city' uses technology to enhance quality, performance and interactivity of urban services, whilst optimising resources to improve contact between citizens and government. With connectivity a vital element of smart city development, location is key.

Elliot Hartley, managing director of Garsdale Design, a company spearheading smart city modelling, explains, "Our world's ever expanding urban population means that now, more than ever, we need to look at solutions that help us better plan and manage our cities. Smart cities is not just about an embedded sensor network or intelligent traffic lights; it is also about management and planning. This fits neatly with the emerging field of geodesign, which is about a holistic approach to design that includes responsive and iterative analysis, ideally in real-time."

The 'smart city map' involves creating a 3D model of a city, which is sometimes described as the fusion of GIS and CAD. As Hartley points out, a core part of smart-city initiatives is in the planning and management of cities – looking at everything together from energy and water to transport, public safety and buildings, as well as people's needs such as education and care. The 3D city model provides all those involved in developing and managing cities – municipal authorities, planners, developers and so on, to take the holistic view. Different scenarios can be modelled for a new building development, with models that can simultaneously reveal almost everything about the surrounding environment, from transport networks and power supplies, traffic and pedestrian flows, to line of sight calculations and flood risk.

Getting down to building level

The city-wide models are powerful visual aids, but many users want to explore areas in more detail – at street and building level. A model might contain 100,000 buildings with truly unique and complex architectures, many of which are connected with shared walls and related structures but appear as one structure.

Some clever technology and techniques have evolved in recent years that allow 3D city models to be created from existing aerial mapping data. The company CyberCity 3D uses a 3D modelling process to generate high resolution building models from stereo imagery. The smart buildings automatically contain valuable measurement data such as height and roof slope to centimetre-level accuracy.

As well as high resolution aerial survey or UAV imagery, the huge improvements in modern satellite imagery mean CyberCity 3D can also model from satellite imagery 'off limits' areas where aerial or UAV data is unavailable. The company has now created the world's largest smart 3D GIS building library, covering more than 80 cities.

CyberCity 3D was approached by the city of Cambridge, Massachusetts, US to create a 3D map based on unique addresses and building footprints. This required that the buildings be shown individually, so software was developed to 'split' buildings with shared walls. This is now offered as a CyberCity 3D service called building split areas generation, so city departments can manage and share 3D models at property level.

Elsewhere, Hartley's company Garsdale Design has started creating building models that show the actual use of buildings, floor by floor. In a project in the Middle East involving city master planning and urban design, buildings are procedurally generated from their GIS/planning datasets, with information such as land use, gross floor area and floor area ratio calculated and embedded in the 3D models.

"Our use of ESRI CityEngine, with its procedural modelling capabilities, has allowed our urban planning to be more dynamic. It has also enabled us to quickly deliver a range of 3D visualisation products for a variety of offline and online platforms," says Hartley.

Smart transport

With increasing environmental concerns, such as reducing pollution and cutting traffic congestion, better connected transport and improved

passenger transport are high on the agenda. Some innovative technologies are being developed for roads, such as glow-in-the-dark markings that absorb energy in the day and emit it as light at night, and dynamic road markings that can, for example, add or reduce the number of lanes for traffic capacity management.

Meanwhile cities are already installing charging infrastructure for electric vehicles and new innovations include electric priority lanes, which allow electric vehicles to charge while driving. Driverless vehicles are also being tested and it is predicted that these vehicles will be used mainly as part of the public transport network as an on-call taxi service. Since the vehicles will be on the move most of the time, city roads will be less congested with parked vehicles.

At the heart of the control of these fleets will be intelligent geospatial systems that rely on 3D mapping (to send a vehicle to the correct level on a concourse), along with live data feeds such as bookings, traffic flows and auto-location. That will be 4D GIS in action.

Water matters

Climate change means there is an increasing threat of severe weather putting the growing numbers of urban inhabitants at risk. Sustainable development is essential and initiatives such as 'urban forestry' are increasingly seen as important elements in urban planning. Trees allow run-off water to be absorbed, as well as reducing pollution and enhancing the urban environment.

A map of all the trees across Britain, which provides height and canopy measurements and is offered as a CyberCity 3D layer, is already being used by city planners.

In Florida, CyberCity 3D created life-like 3D visualisations showing different flood scenarios in the area around Fort Lauderdale. With models accurate to 15cm showing the scene before and after a storm surge, the models provide invaluable information to authorities, developers and insurers.

Modelling of the city of Cambridge in the US involved 20,000 properties and 40,000 drains throughout the city. The goal was to visualise them all and export the data in formats that could be imported into standard 3D GIS and mapping systems. Drains are critical to city hydrological management.

Access

In developing 3D models like this, CyberCity 3D realised that easy open access to the models would be vital for the future of smart city projects. It has created a streaming service based on the Cesium platform. This open architecture 3D globe is freely downloadable and runs on all mobile and desktop devices, allowing anyone to visualise the 3D streaming map. The 3D buildings are optimised for web-streaming all delivered via a 3D building server. The overall 3D streaming map includes multiple image layers, including OSM and Bing, and also shows trees and zoning layers.

In Cambridge, Massachusetts, US, 20,000 properties and 40,000 water catchment systems were modelled to visualise rainwater run-off and catchment

Smart city 3D model of Canary Wharf, London, UK showing building and attribute data

Garsdale Design's use of procedural modelling tools such as ESRI CityEngine allows the creation of 'geo-typical' 3D models with dynamic reporting based on underlying 2D GIS data, illustrated here for a project in the Middle East

Technology is providing access to the plethora of data that grows daily, and the development in smart cities geospatial applications make this data truly useful. It presents a huge opportunity to engage with increasing connected inhabitants through their smartphones and tablets. Inhabitants are the eyes and ears of the city, and they will become a valuable source of intelligence – able to share information instantly to help authorities improve services, security and the environment. It is a brave new world, but not quite as we imagined.

AT THE HEART OF THE CONTROL OF THESE FLEETS WILL BE INTELLIGENT GEOSPATIAL SYSTEMS THAT RELY ON 3D MAPPING

Tim Hughes is managing director of CartoConsult (www.cartoconsult.co.uk)