



North Sydney sets the world stage for 3-D urban modelling

A digital urban model created for North Sydney Council has projected the future of urban management into reality. Leica Geosystems, with its combined strengths in GIS systems development, offers such solutions supporting state-of-the-art city development. Their comprehensive program of terrestrial and global positioning systems, together with the advantages of the photogrammetric aerial camera and software of LH Systems, has made it possible for Australian company, PSN Survey, to capture 1.2 million points and to create from this data a 3D model of North Sydney.

What if a city developer wanted to build a 50-storey skyscraper in the middle of a Central Business District? In the past this proposal would have been a painful undertaking – plans would need to be drawn manually, shadow and wind tunnel analysis calculated and large textual reports produced for administrators to consider and assess.

Luckily, the future of urban planning is upon us. 3-D computer models of entire city areas with details down to the cracks in the pavements are now a reality. Town planners, architects, engineers, and designers now have a wealth of information at their fingertips – able to visualise conceptual and engineering projects and locate physical structures throughout the entire municipality down to a couple of centimetres.

North Sydney Council's newly-completed digital Urban Information Model,

developed by Sydney-based PSN Survey, has defined a new benchmark in local government development control and asset management it is one of the largest accurate and detailed information databases of its type in the world.

The model, which involved accuracies between 1:250 and 1:500, was honoured at a recent international

conference, when it was selected from entries from forty countries to be awarded for its engineering and technological excellence.

PSN exclusively employed Leica Geosystems' equipment for a combination of detailed ground survey techniques, aerial survey, and photogrammetry. Analysis and processing of photogrammetric work

High resolution ortho-photographs show every detail of the area.



Peter Noble, Partner and Chief Surveyor, PSN Survey: "In essence, North Sydney Council have a dynamic, online and immediately accessible computer model of their entire region with a complete three dimensional model and detailed photo mapping of every single physical structure in their area."

was carried out using LH Systems' SOCET SET™ digital photogrammetry software.

One of the most detailed models in the world

The Urban Information Model provides North Sydney Council with a complete three-dimensional model and data link of every physical structure including buildings, complex roof structures, roads, sign posts, parking bays and kerb crossings.

“Customers are always into seeing a real picture rather than lines.”
Stephen Gaynor

More than 20,000 buildings made up of an array of contemporary high rise office blocks, residential dwellings and historic terrace villages have been measured, 100 kilometres of roads have been accurately mapped and every utility located to within two or three centimetres over the entire municipality. Every manhole, gas valve, telecom pit and hydrant has been precisely mapped and linked to North Sydney Council's Geographic Information System and land visualisation systems supported by high resolution photography.

Several cities around the world are now developing advanced models of their cities, but North Sydney's model is so detailed and accurate that even cracks in the pavement have been measured and pram crossings can be modelled and visualised in three-dimensions to better than a few centimetres.

New model allows for detailed accuracy checking

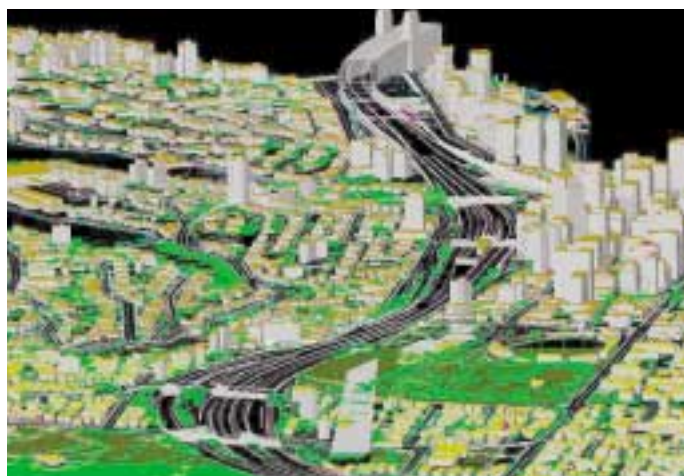
Until now North Sydney Council had been reliant upon a series of hard copy plans to manage their spatially-based management and information systems. “We decided that the Council needed a detailed and accurate large-scale database and three-dimensional model defining the topography, buildings and utilities,” Mayor of North Sydney Council, Genia McCaffery said. “Prior to this, the systems we used did not allow us to check for accuracy.”

This spatial database required transfer into the Council's existing Geographic Information System (GIS) and modelling systems with full verification of all layer components to enable access and three-dimensional visualisation throughout the modelled city and suburbs.

PSN has been able to provide a model which not only defines the physical structure to great accuracy but also locates all the utilities, road structures and provides asset maintenance monitors such as pavement deterioration and vegetation growth.

High accuracy terrain model and contour formation were carried out in conjunction with equally high accuracy orthophoto production to support the Council's GIS. Whilst normal orthophotos are corrected for terrain, plane and camera parameters, the entire area was corrected for building lean of over twenty thousand buildings as well as over 100 kilometres of roads and 250 kilometres of pathways.

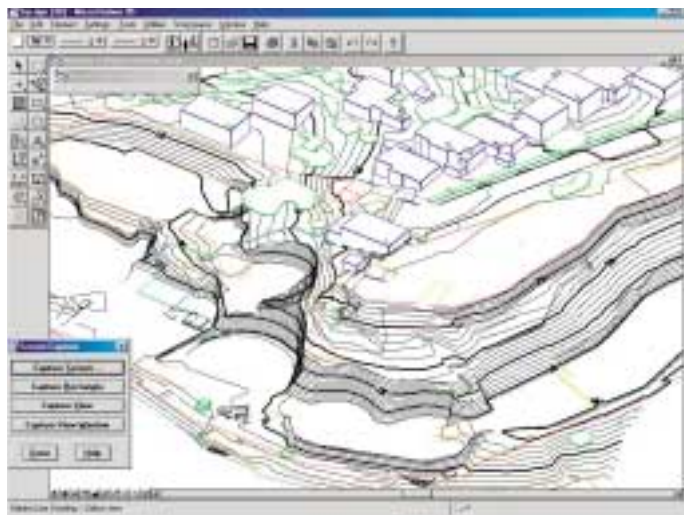
“In essence, North Sydney Council has a dynamic,



North Sydney is the first big city to be documented in a GIS in such detail.



The height profile of the whole of North Sydney has been defined with equipment from Leica Geosystems.



The North Sydney GIS includes the following survey elements

2nd order control – traverse and GPS
1st order control – GPS
Detailed ground survey
Metrology
Digital photogrammetry
Topographic modelling
Control Adjustment
Digital Cadastre adjustment
Photographic mosaicing
Orthorectification (including building lean)
GIS creation
GIS polygon verification
Project design and implementation
Digital information management
Engineering analysis
Regional slope analysis
Solar analysis – full Keplerian mathematical analysis



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Stephen Fisher, Information Services Manager North Sydney Council: *“This is going to give everybody the most accurate data available.”*



online and immediately accessible computer model of their entire region with a complete three dimensional model and detailed photo mapping of every single physical structure in their area,” Peter Noble, Chief Surveyor of PSN said. “Council staff can manage, view, take cross sections of, or visualise all of their roads, sign posts, parking bays, drainage, trees, assets and facilities within a matter of minutes without going out the door.”

Wide-ranging benefits to all involved

Direct benefits of the model are diverse. The Council can now undertake very detailed asset management, the time of the development application process is greatly reduced, and the conceptual and engineering design considerations can be rapidly resolved. The effects of developments as major as under city tunnels or as localised as awnings and sign posting can be analysed accurately and immediately. Environmental, shadow, aesthetics or engineering considerations via computer or photography and complex three-dimensional image draping over the buildings is also possible.

“This is going to give everybody the most accurate data available – something the Council hasn’t had before,” Stephen Fisher, Information Systems Manager of North Sydney Council said. “The internal staff require this product as part of their business. It will reduce manual methods, reduce errors and provide the whole solution in one place, in a complete corporate database.”

Several projects are already underway. Council assets

are being accurately registered, the effect of individual trees adjoining footpaths is being investigated and a structure is in place for a full drainage analysis using high accuracy contours. ‘What if’ scenarios for development, road realignment and shadow effects can be reliably evaluated for shadow or view corridors as well as visual amenity and context in a tenth of the time normally required.

Whilst in-house benefits to Council are evident, a wealth of information is also available to residents and potential developers who can seek access to the information for their development proposals regarding utilities, adjoining property information, large scale photography or survey information. This has resulted in a dramatically improved customer relationship due to the ability to communicate with customers to evaluate proposals, resolve conflicts and discuss broader planning issues using either models or photographs.

“*That’s the beauty about the model – it can always be updated.*”
Joshua Crowley

Marc Forestieri, Managing Director of Architects’ Quantum Leap, views the Urban Information Model as a huge benefit to his work. “This is a great management tool. We can tie our demographic information with the model, and present our clients with graphic information about the terrain and the buildings that would have normally been presented in a report format,” he said.

“This is the key of what we want to do – putting this kind of information into the hands of people who need to make decisions, people



who often aren't mapping or database experts."

Technologies from entire surveying spectrum

The North Sydney Project took eighteen months to complete and employed a broad array of measurement, computing and presentation technologies spanning the entire surveying spectrum. The project relied upon three significant stages: data collection, model and map formation and image visualisation. All three stages relied almost exclusively upon Leica state-of-the-art surveying, measurement, photogrammetric technology, and software and data transfer to analyse services.

The data collection phase encompassed control measurement using electronic theodolites, first- and second-order GPS positioning and adjustments. Several hundred second-order control stations were placed through the area tied into the State network for ground and air control and over a million points were measured to structure the model. Continual development and implementation of methodologies for high-speed data collection by ground and air

was necessary with careful and consistent monitoring of the individual positional accuracys.

Due to the diversity of features collected and measurement systems used, over fifteen major software packages were extensively required for development of the computer model. Once completed the models required verification and transferral to North Sydney Council's software. To satisfy inter-linking of the software, it was often necessary to develop proprietary software in-house as a means of smoothing the transitions. Information was structured to tie in directly with Council's existing GenaMap and MapInfo (with full polygon verification), and layers were established for their future three-dimensional modelling software.

Leica Geosystems' equipment is stable, predictable and reliable

"PSN has always found Leica equipment to be stable, predictable and reliable," Peter Noble said. "It provided an ease of use and a continuous line of technical support and technical credibility that was fundamental



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Stephen Gaynor, from LH Systems and Joshua Crowley from PSN Survey view stereo images on the screen. The analysis and processing of photogrammetric work carried out using LH Systems' SOCET SET digital photogrammetry software.



to the integrity of the Urban Information Model."

"What made the collection of the data so effective was that we could go from the camera system and the scanning to the film measurements and the industrial measurements, link them all together and have a continuous level of accuracy right throughout the model. In fact we are able to confidently report that there was not a single error found in the verification process of the Urban Information Model."



Marc Forestieri, Managing Director of Architects' Quantum Leap: "This is the key of what we want to do – putting this kind of information into the hands of people who need to make decisions, people who often aren't mapping or database experts."

Up-to-date data is critical, and as such a rigorous maintenance program is being developed to support the initial information. "As a dynamic model, the Urban Information Model is always going to require updating and maintenance," Peter Noble said. "This can be done using a variety of methods – Leica has a facility within the SOCET SET™ system to provide regional updating and measurement of change. Ground survey, aerial survey and industrial measurement techniques will still be used to not only maintain the level of integrity that is placed in the model right now, but also to extend that level of information."

Innovation is the key

As technology improves, the model will also be developed for rapid photographic visualisation and more detailed analysis programs such as vegetation and environmental alteration.

Whilst the project was initially seen as a traditional aerial survey project, it was PSN's innovative approach to North Sydney Council's requirements that won them the contract. "PSN actually won the project through tender by virtue of introducing

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Peter Noble

what is called a new economy technology," Peter Noble said. "Traditionally, photogrammetric surveys have been carried out using aerial photogrammetric systems only – PSN offered a complete solution whereby all the information traditionally covered by trees and building shadow were also included in the project."

"The main challenge of the North Sydney Project was that it hadn't been done before. No one has collected information to the level of

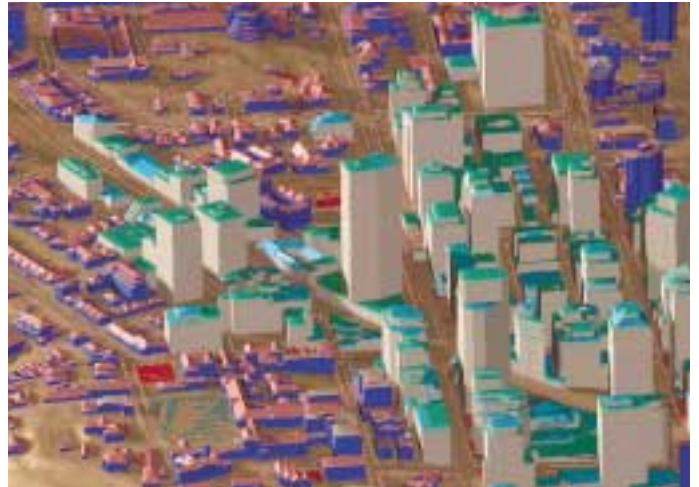
detail that we have and many new technologies were employed in the development of the project," said Stephen Fisher.

North Sydney's management area comprises several major foreshore parklands and heritage listed parks and significant structures. Minimal environmental impact occurred during the project, in fact most people were unaware that work had been undertaken. Actual effect was limited to establishment of new and more precise control marks for future surveys.

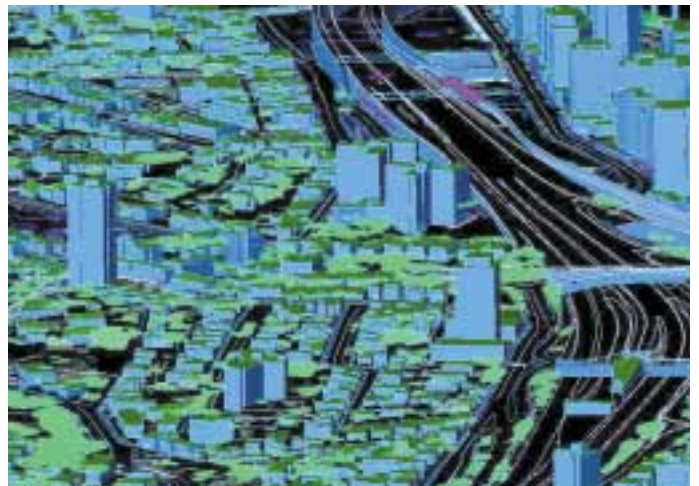
As a result of the project, North Sydney Council has been projected to the forefront of modern local government management. The project has been on exhibition at international exhibitions including the US Surveying and Remote Sensing Congress and the Bentley User Conference, and received international focus when the digital photography was displayed alongside NASA projects.

"The application of the Urban Information Model of North Sydney is repeatable around the entire globe," Peter Noble said. "Any city that has a sizeable population, that has physical structures, requires a detailed understanding of its assets and its elements within for effective management."

With the new capacity of Leica Geosystems, this task has become easier. PSN has done an excellent job demonstrating the capabilities of modern GIS data collection to every user. A video of this project is available from Leica Geosystems representatives upon request to show how the future can be transformed into reality today. **Bt**



North Sydney is the first big city to be documented in a GIS in such detail, allowing also shadow analysis.



Below: Survey technology has recently undertaken quantum leaps. Cyrax is able to measure complex structures in very little time as a test on the Sydney Harbour Bridge shows.

The system delivers accurate, "as built" 3D models to scale that can be viewed from any perspective.

