

SURVEYING +

June 2017
Issue 90

SPATIAL

**Living Lab –
Making Wellington
a Safer City**

**Property Rights
and Housing –
Ownership, or
simply Access?**

**Single-base RTK,
network RTK
– What's the
Difference?**



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COVER IMAGE

Cuba Mall, Wellington.
Chosen as an ideal location
to develop a "Living Lab" as a
proof of concept.
See Page 6 for details.



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EDITOR

Diane Moriarty

survey.editor@yahoo.co.nz

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The Chief Executive
New Zealand Institute of Surveyors
PO Box 5304
Lambton Quay
Wellington 6145
New Zealand
Phone: 04 471 1774
Fax: 04 471 1907
Web address: www.surveyors.org.nz
Email: nzis@surveyors.org.nz

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• EDITORIAL



Going going... gone

Diane Moriarty

This is to be my last edition of *Surveying+Spatial*. It has come to that time, the children have grown (well they are now both at school), the husband has spoken and I have returned to the 'workforce'.

The four years I have spent as editor have been a pleasure and some of the most rewarding working years of my life. Four times a year I get to produce and edit a magazine of which I am very proud and in the process have met and worked with some very talented and interesting people.

There are a number of people I need to thank. Firstly, and most importantly, Jan Lawrence and Hadyn Smith, who gave me this opportunity in the first instance and have continued to support me throughout my time in the role. My trusty publisher, Chris Benge of KPMDesign, has been an absolute treasure, producing a fine looking magazine every quarter whilst putting up with my fussy nature. My regular contributors: Mick Strack, Stephanie Harris, Christina Hulbe and Mark Dyer the Surveyor-General for their continued support, and of course everybody else that has contributed to the magazine. Last but not least, thanks must be made to my husband Craig, by whom a copy of my editorial was read (and edited) before it ever left the building!

Although I reluctantly hand over the reins to our new editor, I also look forward to reading future editions of the magazine and seeing it grow and change with a fresh mind at the helm.

This edition features the Supreme Award winner from the 2016 New Zealand Spatial Excellence Awards. Jenny Rains of Wellington City Council provides an account of their 'Safe City Living Lab' project. This project was community driven, using smart technology to develop solutions to assist with improving community safety. It allowed for the collection, analysis, sharing, and integration of location based data, providing a mechanism for future urban planning and to aid in real time response to local incidences. It is a powerful tool which could be used by cities worldwide to combat anti-social behaviour and plan for future development.

The topic of a coordinated cadastre is always a contentious issue and one which promotes lively debate. In this edition we have two articles which explore this concept. The first comes from abroad, a recent survey graduate now working in South Africa has been corresponding with David Goodwin from our National School of Surveying. David provides us with an excerpt of these communications to allow us to see another side of the coin. The second article comes from Trent Gulliver of the Cadastral Professional Stream with an article entitled "A coordinate cadastre for New Zealand? Yeah, nah!" Take a read and see if you agree.

I hope you enjoy my last edition.

The Bigger Picture

Mark G. Dyer

Kia ora,

Did you read 'Smart Cities – Intelligent Buildings' by Tony Mulhall in the last issue of *Surveying+Spatial* (Issue 89 March 2017)? It challenged us to think about the inter-relationships between individual buildings and the cities they are in, especially in relation to integrating their management using building information models (BIM) and smart city technologies. This integrated approach paves the way for city information modelling (CIM), according to Tony's article.

This BIM-to-CIM continuum is becoming more prevalent and prompts me to consider other areas where obvious interrelationships exist, but where we tend to focus on individual elements of a system rather than the bigger picture. Surveyors are taught to work from the whole to the part, and usually, bring this approach to all aspects of their work. But is the 'whole' we are thinking about big enough?

For instance, when a surveyor is subdividing a property, the focus is on the site that is being developed. However, this site is part of a complex natural, social, cultural and economic environment. It should, of course, be surveyed and mapped to provide the necessary information to facilitate the development and meet the client's goals, but what thought do we give to how that same information could be used especially when integrated with other data? The survey data could be incorporated into an environmental model that's used by diverse parties to make better decisions for the benefit of all.

Similarly, a cadastral survey dataset contains survey and legal information relating to a specific property and is created to meet a particular client's needs. That information is integrated into the cadastre, contributing to a national model of property rights that serves the greater good by enabling efficient management, thorough analysis and better decision making.

We need to see ourselves and our individual projects as part of a bigger ecosystem. And that means that we must see our role and our respective datasets as part of a greater collaborative exercise – for design, for construction, for management, for decision-making.

This way of thinking has the potential to open up many opportunities for surveying and spatial experts, as we consider the role we can play in creating and managing models of the 'bigger picture'. It also brings challenges – from standardising data to intellectual property to open data policies, as well as integration with other processes and functions such as e-planning, building management, etc. And, most importantly, ensuring we have the people with the right capability in the right places, now and into the future.

Our profession needs to be part of these conversations and contribute, if not lead some of the thinking. Now is not the time to sit back!

Nga mihi.



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Cadastral

The Cadastral Survey Act working group are progressing and hope to have a report for Council later this year as to their findings.

The Landonline refresher seminars enjoyed good attendance in the three centres in which they were run. We hope that those attending were able to take the tips and tricks learned back to their office and also that LINZ is able to use the feedback given to allow new features to be designed into the existing Landonline platform or ASaTS.

Speaking of ASaTS, you will have seen that NZIS are advertising for a surveyors' Stakeholder Representative for the ASaTS project. If you are interested in this full time position or know of someone who is, see the Jobs Board on the NZIS website: https://www.surveyors.org.nz/Category?Action=View&Category_id=1050

The Surveyor-General has informed all cadastral surveyors that the Interpretation Guidelines for the Rules for Cadastral Survey 2010 have been updated and are now available on the KnowledgeBase on the LINZ website. To quote the email received from the Surveyor-General, Mark Dyer, "these articles are the authoritative version of the Surveyor-General's guidelines issued under section 7(1)(ga) Cadastral Survey Act 2002."

As always, if you wish to contact the Cadastral Stream, this can be done through the National Office.

Matt Ryder, Cadastral Stream Chair

Engineering Surveying

The Engineering Surveying and Positioning and Measurement Stream Seminar was held on the 26 May at the Novotel, Auckland Airport. It comprised several presentations and workshops where the tools and techniques of engineering positioning in the New Zealand context were investigated and discussed along with other matters affecting the profession. A full report will follow in the September edition of *Surveying+Spatial*.

The National Conference is also looking in great shape to support engineering surveyors. If you haven't yet registered you can do so at www.nzisconference.org.nz.

The engineering surveying industry is still going strong, particularly in the Auckland region. Some of the large infrastructure projects on the horizon for engineering surveyors in Auckland include:

- Central Interceptor pipeline
- Onehunga to Mt Wellington (east-west) Link
- City Rail Link (CRL) tunnels and stations
- Northern Corridor.

Michael Cutfield, Engineering Surveying Stream Chair

Hydrography

NZIS/SSSI Hydrography Seminar

A very successful inaugural NZIS/SSSI Hydrography Seminar was held in Wellington 17 March 2017 with 31 hydrographic surveyors from NZ and Australia attending. Papers from Land Information New Zealand (LINZ) – *Transforming height and depth datasets between datums, High density ENC's & Digital First, Data Centric*, NIWA – *Integration of Geoswath Plus information with EM2040 backscatter for habitat mapping*, Eliot Sinclair (representing the private sector) – *Fit for purpose surveys-Kaikoura Earthquake Response* and the University of Otago's School of Surveying – *Who's in Charge? Hydrographic Surveyor Education and Certification* provoked a considerable amount of audience interest, discussion and feedback. A lively open session forum addressed a number of issues facing the profession and a working group of members was formed to assist with the response to industry initiatives. The Hydrography Professional Stream in conjunction with the SSSI Hydrography Commission is planning to make this an annual event.

NZR AHS Seminar

The NZ Region (NZR) of the Australasian Hydrographic Society (AHS) will be holding their annual seminar and AGM at Te Kura Kāirui/The School of Surveying, University of Otago, Dunedin on 6 July 2017. Thanks to generous sponsorship from the AHS, Discover Marine Ltd (DML), Eliot Sinclair, IX Survey, LINZ, NIWA and Trimble, we are pleased to announce that applications are now being received for **student sponsorship** to this event. Students can claim **up to \$400NZD** to help them to attend and present their research. For more information please email Emily Tidey: emily.tidey@otago.ac.nz. The theme this year is "Mapping our seas, oceans and waterways – more important than ever."

AHS Education Award

The Australasian Hydrographic Society Education Award is currently open. The **\$3,500AUD** award is provided to a student whose study – in the opinion of the Award Panel – best promotes hydrography and related sciences, best recognises the efforts of the student involved in the study of hydrography and related sciences and promotes visibility of hydrography and related sciences. Further details are on the AHS website: <http://www.ahs.asn.au> or by emailing Emily Tidey: emily.tidey@otago.ac.nz.

Emily Tidey, Hydrography Stream Representative

Land Development and Urban Design

The word from the cities and regions-in-general is that workloads are still buoyant and in particular urban growth is still steady. The question is whether the pace of development is meeting the Country's housing needs and this is likely to become a high-profile issue in election year. On that note, the Ministry for Business, Innovation and Employment has released a discussion document on the forming of Urban Development Authorities and the frameworks required to implement these, with the specific purpose of accelerating growth in identified areas to accommodate housing solutions to satisfy current demand.

These authorities will be set-up with Central and Local Government representation with wide-ranging powers. This is a detailed document and the committee, in conjunction with National Office, is currently contributing to the formulation of a submission document on behalf of NZIS.

With the upcoming NZIS conference in Napier being the first of a new three-day format excluding the AGM, I urge all members of the stream to attend if possible as this will be a worthwhile event with some focus on issues relevant to our stream. There will be several speakers of interest and it is likely there will be some additional panel discussions around current topics of interest from the land development and urban design perspective for the benefit of members.

As always I look forward to any feedback or suggestions from stream members on any relevant issues and our future direction as a stream of NZIS.

*Phil Cogswell,
Land Development and Urban Design Stream Chair
phil@cogswellsurveys.co.nz*

Positioning and Measurement

SNAP Webinar Series

The Positioning and Measurement Stream and LINZ are pleased to present a two-part webinar series on SNAP

(Survey Network Adjustment Package; a suite of programmes for adjusting the coordinates of stations in a survey network using least squares).

The series will be made up of two 90 minute sessions, each including worked examples and test datasets. The first session held in early July will include an overview of SNAP, including SNAPLOT, CSV inputs and output files. The second session will occur in late July and will cover advanced applications of SNAP, such as the adjustment of levelling data.

These interactive sessions will be recorded and offered for future reference in the Training on Demand section of the NZIS website.

For more information regarding this webinar series please contact Chris Pearson chris.pearson@otago.ac.nz or Nic Donnelly ndonnelly@linz.govt.nz

*Rachelle Winefield,
Positioning and Measurement Stream Chair*

Spatial

The 2017 New Zealand Spatial Excellence Awards entries will be opening soon and we would encourage all Spatial Stream members to put their entries forward to be considered for this increasingly prestigious event. Year on year this event has been a success and it is now New Zealand spatial industry's premier annual event. The website for this event has not yet been updated, so get busy

NZSEA

Recognising Spatial Excellence

with your entries and keep an eye out for the opening date on the website <http://www.nzspatialawards.org.nz/>

NZIS have signed a Memorandum of Understanding with SIBA, the Spatial Industries Business Association, so we can work more closely together. This will allow the two organisations to define the experience and qualifications necessary for a career in the spatial sciences, and enable NZIS to offer career pathways with real value for employers.

Greg Byrom, Spatial Stream Representative



Jenny Rains, Community Services Manager, Wellington City Council

IN MAY 2014, WELLINGTON CITY COUNCIL (WCC) AND NEC SIGNED A COLLABORATION AGREEMENT TO EXPLORE HOW TECHNOLOGY COULD IMPROVE CITY SERVICES, CREATE ECONOMIC GROWTH, REDUCE ENVIRONMENTAL IMPACT AND ENHANCE COMMUNITY WELLBEING.

This project came from the Wellington City Council’s Community Services team working with NEC to explore how to use technology to solve those hard urban problems and improve safety outcomes for the city and its residents. Early discussions were about progressing ideas on how technology could assist with an interagency collaborative approach to developing solutions tailored to local issues and opportunities. Of particular interest was developing a platform enabling agencies to share, collect and analyse data and improve the situational awareness in Wellington.

Safe city workshop – November 2014

We recognised that a locally delivered project must be developed in collaboration with partners and key stakeholders and the Council and NEC facilitated a Safe City Workshop to progress a co-design approach. The workshop was attended by over 100 stakeholders from local and central government agencies such as NZ Police, NZ Fire Service, Capital and Coast DHB and Regional Public Health. Participants also included Wellington free ambulance, health and social service providers, residents, retailers and agencies working with the city’s vulnerable – homeless and street people.

The workshop identified there was a common interest in developing a mechanism for evidence based future planning and a more informed situational tactical response to local incidences and wider issues affecting Wellington.

At the time there was a growing concern with inner city

alcohol and psychoactive substance abuse and subsequent antisocial behaviour and overt begging.

A key element in addressing these challenges was identified as improved data and information sharing, including mapping and the integration of numerous data sources. This integration of data and mapping (geocoding information) would add significant value to situational awareness and the ability to respond and plan. It was also identified that new technology, such as video and acoustic analytics, could assist with data collection and provide new insight into day-to-day street level trends, patterns and hot spots, all while being tested in a low-risk, cost-effective manner.

From these discussions there was agreement that Cuba Mall (*Figure 1*) was an ideal location in which to develop a “Living Lab” as a proof of concept;

- Cuba Mall is a clearly defined geographic location with layers of complexity both in design and street environment
- There is a diverse range of people and retail and residential activity and there were common issues to be addressed.

Living lab approach

Through the NEC and Wellington City Council partnership, there was an agreement to implement a Living Lab Proof of Concept (POC) in Cuba Mall to test and understand the new technology and use of the situational awareness and the collaboration platform.



Figure 1 – Cuba Mall

The Safe City Living Lab is a collaborative initiative way to explore benefits to business and community of using technology in a low-risk way. This model provides the opportunity to test ideas and change quickly – an iterative and agile approach to the development of the project.

Most importantly it provides a platform that leverages off the collective impact of this collaboration to ensure the whole of the city can benefit. Crucial to the project was the acknowledgement of the need to complement existing as well as informing future planning and delivery of programmes and services for the city. This project provides the opportunity to use existing assets and sources of data and information in a streamlined and integrated way coupled with new sensory and analytical methods and technologies.

The POC also gave us a chance to test a number of use cases for analytical sensors and these include glass breaking, detection of beggars/rough sleepers and behavioural changes. It also provided a situational view in the form of a GIS Map overlaid with real-time alerts/detections and shared data from external partners.

We have worked with the Privacy Commission to ensure the way information we collect, use and share complies with the principles of the Privacy Act. The flexibility of the

co-design approach has enabled customisable solutions including air-gapped security and individual user account settings, to ensure the principles are upheld whilst maximising the effectiveness of the system.

A platform for inter-agency collaboration

The resulting inter-agency platform allows for the collection and analysis of data, sharing of data between agencies, and integration of third party data sources. The Smart Board also provides a situational awareness platform which assists understanding of incident patterns in certain locations over time through tools such as heat-mapping and incident reports. Not only does this provide the Council and its partners with the ability to respond in real-time, it also allows evidence-based planning for deployment of resources and future urban design. The platform also provides ability for insight into day-to-day street level trends, patterns and hotspots such as the incidents of rough sleeping and presence of begging in the city over time.

A real-time situational awareness is provided through data from an acoustic sensor, local hosts reporting and the CCTV camera observations – allowing cross-agencies to develop a targeted response to issues as they occur.

It is important that when we do identify social issues we are able to ensure appropriate support is in place. For example, we currently work closely with a number of social organisations in the city that provide support through an outreach team for people who beg and/or are homeless. The use of sensor analytics for begging gives us the ability to provide a multi-agency response to those in need in real-time once an alert is received.

Once an alert is received we can then email the support outreach team asking them to visit the person ensuring they are connected to appropriate support services.

While the platform supports a real-time response it



Figure 2 Alert of incidence of begging and subsequent email to the outreach team

also provides for improved tactical and planned responses through situational awareness. We are able to overlay multiple and shared datasets to assist with identifying trends and patterns and providing a framework for evidence based decision making and future planning.

It also allows us to visualise incidents in a defined geographic area and/or within a defined buffer zone from a centralised point. The example below shows incidences of begging obtained through numerous data sources which are further defined within a geographic location (purple hexagon) and within 500 meters of a landmark.

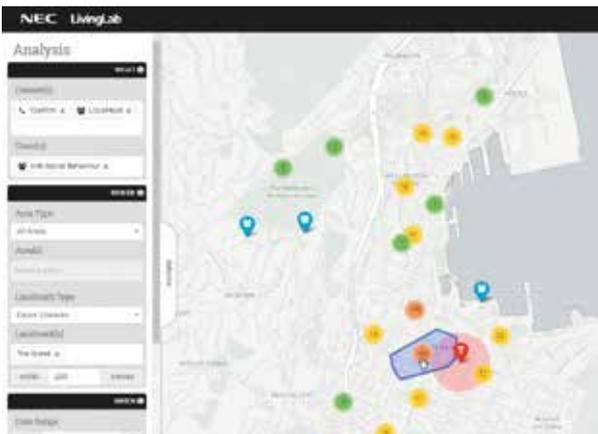


Figure 3

The Living Lab Platform also allows the integration of third-party data sources to provide further insight into patterns and trends associated with other social issues. For example, the national data base 'Stop Tags' is used by the council to record and monitor the graffiti in the city. Integrating this data provides insight into exactly where

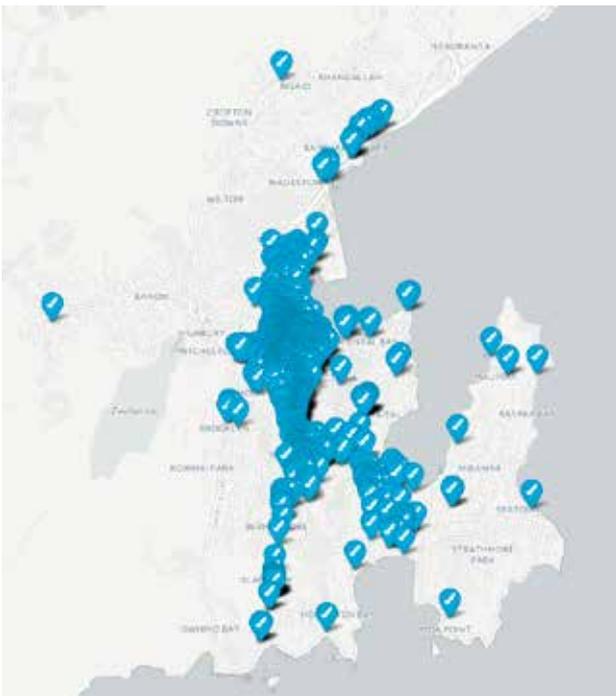


Figure 4

new graffiti emerges and analyses trends and patterns over time. This can then be correlated to other events – such as school holidays, determining if graffiti appears along particular routes at particular times, and if it is related to the weather and/or time of year. This overlay of other factors assists the council and its partners (including the police) in all aspects of graffiti management.

The NEC Living Lab system is scalable and can show patterns in small datasets across short timeframes or large datasets across long timeframes. Figure 4 shows how a large dataset of the instance of graffiti over a year is not really useful when visualised this way. However, a cluster map of the same information is more readable and can be interpreted for spatially enabled decision making.

Clustering the data does not lose the fine-grained aspects of the visualisation. Hovering over clusters shows the zone they cover and clicking on them reveals the associated attribute data of the points. Further information about each incident can be visualised through the third party database. The example on the next page shows a geocoded record of the graffiti incident – this allows searching on the tag, location and type of asset. It also shows the type of graffiti, for example paint, felt pen or glass etchings. The 'Stop Tags' database also provides us with a record of the tag being removed. The geotagged photos and accompanying information is captured and loaded via a phone app and is mandatory for all our contractors.

While the visualisation of discrete data sets is essential for quantitative analysis, the platform provides a facility for the same data to be visualised; heat maps are also

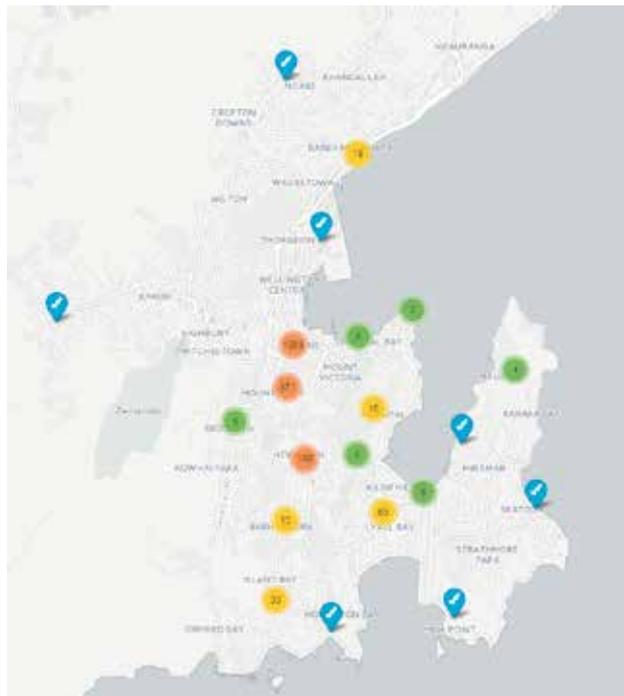




Figure 5

a useful tool for looking at trends over time. Figure 6a shows incidences of rough sleepers over a year (from a number of data sources); Figure 6b is a heat map for winter, and Figure 6c shows the distribution of rough sleepers during the summer months.

While the overall numbers remain relatively stable over the year the locations show differences over summer and winter. This allows us to allocate resources appropriately to assist and support the homeless. It also provides insights into where we need to relook at the urban form and look at doing a safety audit using Crime Prevention Through Environmental Design (CPTED) principles.

Ongoing development of the project

As a 'living' lab the project is constantly developing and integrating new components to enhance its use and benefits. The current next steps include developing a business intelligent function which will enable more in-depth analysis of the data and trends highlighted through the smart board. This platform will also enable other smart city projects to be connected together providing shared benefits.

The existing visualisation function will be developed to include three-dimensional mapping as well as a virtual reality component where the user will be able to 'walk' through the streets of Wellington as well as having a bird's eye view of the landscape. These enhancements not only increase user experience but also expand the potential uses of the system such as behaviour prediction tools for looking at how people would interact with new spaces to inform proposed urban design changes.

An award-winning partnership

The living lab project is an award winner: late last year this

project won the New Zealand Supreme Spatial Excellence Award and Community and Engagement Spatial Excellence Award. In April this year the project gained further accolades, receiving the JK Barrie Spatial Excellence Award and the Community Engagement Award at the Asia Pacific Spatial Excellence Awards in Sydney.

Aside from the unique combination of technology that brings the solution together, we believe the success of the Safe City Living Lab comes down to the strength of WCC and NEC's community's partnership approach – which is one of true open collaboration and co-design to achieve positive community outcomes. WCC gains a vendor and technology-agnostic partner who is willing to de-risk the technology choices on the city's behalf, while NEC gains a city partner who is prepared to act as a proving ground and incubator for global solutions.

An opportunity for further collaborative innovation

The wave of modern technology that can be applied to make our cities safer and smarter holds great promise. With partnerships like those between WCC and NEC there is a fantastic opportunity to practically apply and field test these technologies so that other cities can benefit from these experiences. We see the Safe City Living Lab as a medium for ongoing innovation and are keen to extend an invitation for other cities to engage and share their learnings.



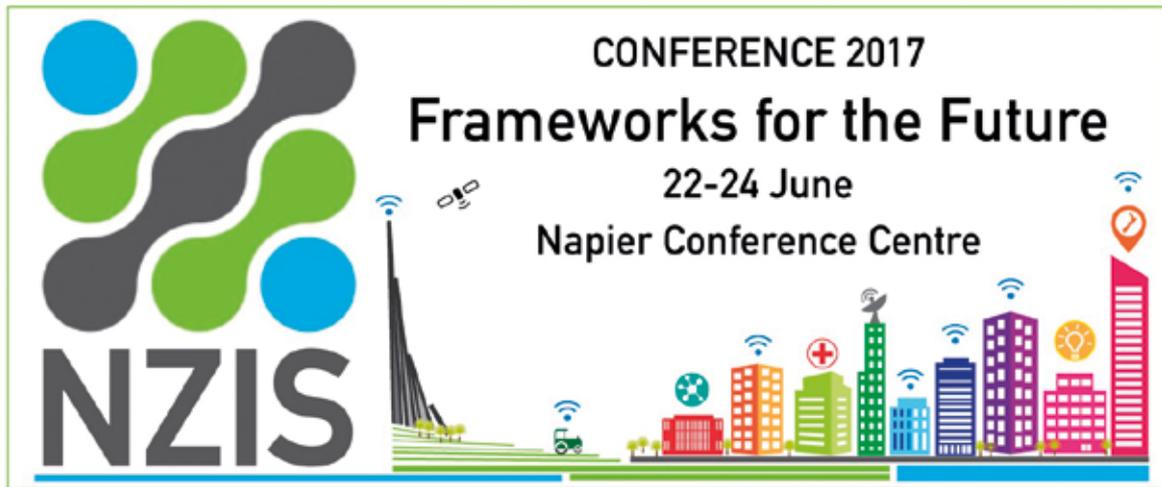
Figure 6a



Figure 6b



Figure 6c



CONFERENCE IS COMING

by NZIS National Office

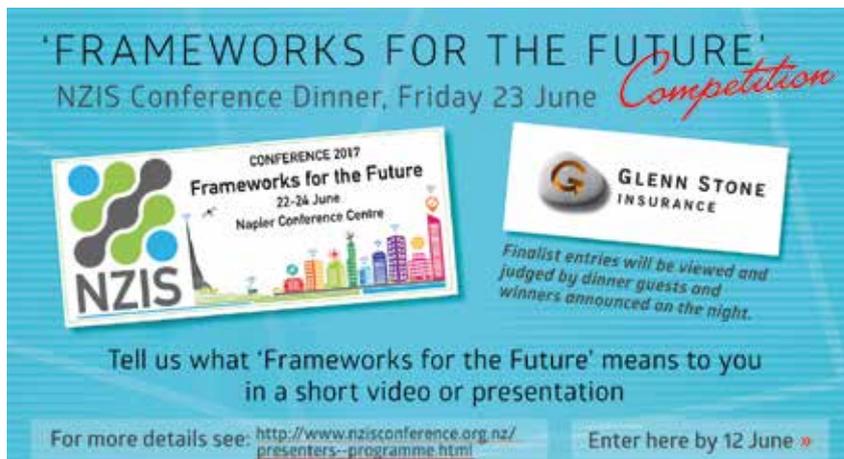
Not only is this year's conference earlier than previous years, but it also follows a new format over part of a weekend. Following a member feedback during a 2016 workshop, a review and refresh of the existing conference and awards model were needed. This conference is part of that review.

Being held over three days, Thursday to Saturday, the new day format is to help minimise disruption to work. With the carefully chosen theme of *Frameworks for the Future*, the topic threads have been developed to reflect the changes happening within the industry and profession and to look at the fundamental things that need to be in place to support these changes.

There are some exciting future-focussed threads including earthquake recovery, particularly the recent Kaikoura events, disruptive technologies – the impact of these and resulting applications, how big data is captured and managed by spatial professionals.

Hadyn Smith, NZIS CEO, says he's excited about the new format and the potential of the topic themes. "We already have some excellent technical, motivational and business leader speakers lined up who will be covering topics from big data management, spatial engineering, game changing disruptive thinking strategies, innovative and motivational practices to how to get the best from recruitment practices."

"With the annual awards model undergoing a review, we are using the opportunity to do something totally different in the interim," says Hadyn. "We have a competition for conference delegates to tell us what the theme means to them in a short video or presentation. These will be shown, judged by dinner guests and awarded on the conference dinner night, providing added interest to the conference pinnacle dinner and making it a really fun night!"



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NZIS YOUNG PROFESSIONALS



NZIS Young Professionals Executive at FIG Working Week 2016 (Robert Mears, Jono Renwick, Melissa O'Brien, Claire Buxton and Taryn Martin)

Giving Back and Making Connections

*Melissa O'Brien, Chair NZIS Young Professionals & Vice Chair FIG Young Surveyors
Taryn Martin, NZIS Young Professionals Executive Member*

*"We make a living by what we do. We make a life by what we give."
(Winston Churchill)*

THE FIRST PART OF THIS QUOTE NEEDS NO EXPLANATION. WE WORK, WE MAKE MONEY, AND WE USE THAT FOR OUR EVERYDAY LIFE. HOWEVER, OUR IDENTITY IS IN THE VALUES AND MORALS THAT WE STAND FOR AND THE ACTIONS THAT WE TAKE.

Volunteers are key to the success of many professional bodies within New Zealand and around the world, and NZIS is no exception. Local branch-

es, Streams, Divisions, Council and Board are all made up of volunteers, taking their own time to give back to the industry. It is admirable how

much time and effort these volunteers give and if you ever ask any of them “why?” you will get a similar answer: “You give a little to gain a lot”.

Melissa O’Brien, Chair of the NZIS Young Professionals and Vice Chair of FIG Young Surveyors Group, and Taryn Martin, NZIS Young Professionals Executive Member, share their thoughts on volunteering for NZIS and the associated benefits.

Benefits of Volunteering

1. Helping Others

NZIS promotes growth, innovation and excellence in all facets of surveying and spatial in New Zealand. Volunteering your time and energy to NZIS is about helping the industry and the people they serve. Volunteering exposes you to the work of an organisation in a deeper way than becoming a member. You develop a new appreciation for those who give their time to help others, not only within NZIS but also in employment and everyday life.

“Teamwork makes the dream work. You are part of a team helping and encouraging each other and the resulting outcome serves the industry and more.” – Taryn

2. Learn new and transferable skills

Volunteering helps you develop new skills as well as apply current skills in different ways. New skills are developed by being exposed to others working in the industry at different stages of their career. You can learn from and be energised by anyone and everyone. Teamwork, goal setting, group dynamics, planning and implementation are all key skills that can be transferred to other areas of life.

“Being the NZIS Young Professionals Representative to Council has helped me develop my leadership skills. The Council consists of well-respected leaders from each Stream and Division of NZIS. By watching those people, you can identify qualities of leadership that you admire and develop those qualities yourself.” – Melissa

3. Expand Personal and Professional Networks

Volunteering gives you visibility. It exposes you to a wide range of people and provides you with the opportunity to network. It is a quick and easy way to meet new people, and be introduced to others who have similar backgrounds or that have taken similar (or completely different) career paths. It also exposes you to trends and best practices within your profession. It offers you the world regarding learning and professional development.

“Being involved with NZIS has seen my personal and professional network expand. It’s an amazing thing to say that I have colleagues from every region of the world.” – Taryn

(continued p.14)

Personal Experiences



Melissa O'Brien

*Chair of the NZIS Young Professionals
and Vice Chair of FIG Young Surveyors Group.*

I am passionate about the surveying industry, the people within it, and the people we help. My involvement with NZIS has seen this passion and energy grow and flow on to my career and life.

Volunteering for the profession has allowed me to travel the world, develop networks, learn new skills and help others. Highlights have included my first NZIS Conference in Invercargill, a SSSI Conference in Melbourne, FIG Congress 2014 in Kuala Lumpur, and FIG Working Week in Helsinki, Finland. All of which have involved a large amount of my own time preparing presentations, and organising events and conference programmes. I have no regrets, all the effort you put in is worth it. The people you meet, the cultures you experience, and the knowledge you gain is invaluable.

Following my involvement with NZIS as Chair of the Young Professionals Group and my involvement with FIG Working Week 2016, I have taken the opportunity to represent Young Professionals at an international level as Vice Chair of the FIG Young Surveyors Group. I am looking forward to learning more about FIG, expanding the Young Surveyors Network and inspiring others to be part of something bigger.

Volunteering for my profession has also opened up doors for my career that I never thought possible and provided me with a world of opportunity. Overall, it has been a very rewarding experience and I am excited about what the future will bring.



Taryn Martin

*NZIS Young Professionals Executive Member,
NZIS Conference Committee
and previously Secretary of NZIS Taranaki Branch.*

Contributing my time to NZIS and the industry has resulted in my career climbing at a faster rate than expected. It has taught me valuable skills to better myself for the profession and opened up windows I did not know existed.

Involvement at national and international surveying events has allowed me to understand the dynamic changes to the industry on national and global scales and how to embrace these changes moving forward, something the company I work for appreciates immensely.

Networking has been a large reward for my time involved with NZIS. What initially started out being additional contacts and mentors locally grew into having a mentor outside my province and opportunities globally.

During recent overseas adventures I re-connected with delegates I met at the FIG Working Week 2016. I saw myself eating 'Dal Bhat' in Nepal with Ganesh Bhatta from the Survey Department, Government of Nepal, and his family. He showed me around the streets of Nepal and shared how the Nepalese cadastre works and their optimum direction forward for Land Titles. I got to share a drink on the edge of the Danube in Vienna, Austria with Eva-Maria Unger (Chair of the FIG Young Surveyors Network) and attended a local event with Eva-Maria and her friends. This opportunity also allowed me to get tips about the best places to explore within their country and what to see 'off the beaten track'.

I also connected a fellow NZ surveying friend with other delegates from the FIG event. My friend was in Italy on a 'work-away' holiday, and the landowner requested some assistance in understanding the boundaries of his property. Using my connections through the Young Surveyors network, I was able to connect my friend with local surveyors where he assisted with a boundary definition. The above experiences would not have been possible without having an interest in the industry, growing my network and giving my time at these events.

4. Career exploration

Volunteering allows you to try different roles and be exposed to different issues and perspectives, without changing jobs. It can help you discover new skills or interests that you were unaware of and is also great for professional experience on your CV. Volunteering gives you visibility and opens the door to a number of career opportunities.

"My involvement in NZIS has seen me exposed to opportunities and role models that have helped shaped my professional career."

– Melissa

5. Be part of something bigger

When you volunteer your time, you are giving back and making a difference. NZIS is involved locally, nationally, and internationally advocating for the industry and helping others. When you volunteer and become involved you can make an impact and become part of something rewarding.

"If you have strong opinions and want to see action, get involved and be the driving force. A little can go a long way." – Taryn

"My involvement with FIG has highlighted that we are often so caught up in our day to day lives we forget about the bigger global issues. Surveyors have a unique skill set and everyone has something different to offer – by working together at all scales we can change the world." – Melissa

NZIS Young Professionals

The NZIS Young Professionals Group aims to inspire the future of the surveying and spatial industry within New Zealand, providing opportunities for networking and professional development in accordance with the vision and values of NZIS. The Group has a large, active and visible membership base throughout New Zealand, networking with other young professional groups such as Young Planners, Engineers and Architects, as well as volunteering for initiatives such as Future in Tech.

If you would like to find out more, please contact yp@surveyors.org.nz or check out our Facebook Page [@NZISYP](#)

Topcon Delta Solutions

Simplifying structural deformation monitoring

In partnership with deformation monitoring and tunneling specialists, VMT GmbH, surveying technology developer, Topcon, has released a new scalable suite of geosensor hardware and software solutions for structural deformation monitoring.

Made up of several components and designed to be completely scalable depending on end-user requirements, the system offering is collectively known as Topcon Delta Solutions.

Topcon Delta Solutions provides hardware support for the autonomous collection and processing of total station and environmental sensor data, where the end-user needs to monitor for structural or environmental deformation in order to protect assets.

Topcon Delta Solutions uses a number of hardware and software components in order to simplify geosensor networking. The system comprises four components in one technology suite; Delta Log, Delta Link, Delta Watch and a corresponding Topcon MS AXII total station.

How does each component interact in order to create a complete monitoring and reporting system?

Through Delta Log, parameters for total station and environmental data are set. Accessed via a secure web portal, Delta Log is designed to provide an intuitive interface to manage observations, target types, and measurement scheduling. Delta Log provides a simple platform, with unique Topcon features such as matrix detection controlled through the software.

Delta Link then records and processes captured data. Delta Link is also a secure web-based interface through which monitoring, measurement scheduling and target management can be prioritised. This component of the Delta Solutions package features extensive flexibility, with a number of options available for data delivery communication, including Ethernet and Wi-Fi, along with an integrated cellular modem offering SIM card compatibility.

Battery back-up and an external solar panel provide end users with added reassurance that captured data can be transmitted from the field



whenever required, regardless of connectivity.

Data from robotic total stations, GNSS receivers, levelling devices and other geotechnical systems in the field is captured and disseminated via Topcon Delta Watch for detailed, real-time evaluation. Once processed, Delta Watch provides the ability to manage and evaluate data captured from monitored structures, giving project personnel the ability to monitor and manage captured deformation data.

Additionally, the Topcon Delta Solutions system uses a Topcon MS AXII total station combined with the Topcon Delta Watch software.

Data from the total station, GNSS receivers, levelling devices and sensors can be processed and analysed individually or as a network-adjusted solution.

The system allows for the distribution of scheduled reports and gives the observer the ability to trigger alarms and send notifications via email or SMS messaging if a pre-prescribed deformation threshold has been reached.

Topcon states that together the reporting system can provide field staff with data confidence, as regardless of whether the Delta Watch database is connected, Delta Log always remains linked to the total station. Even if interrupted; once restored, all captured data is salvaged and synchronised, providing for a continuous flow of up-to-date information.

Topcon Delta Solutions is sold and supported in New Zealand by established Topcon distributor Synergy Positioning Systems.



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- Kevin Birch, Director of Birch Surveyors



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Property Rights and Housing

Ownership, or simply access?

Kirsten Brown, National School of Surveying
broki086@student.otago.ac.nz

Introduction

The right to property and security of tenure have always been regarded as important. Early nomadic cultures recognised the right to travel over, inhabit, and use resources on land. Conflicts would occasionally arise if one group felt that their rights were being impinged upon by another. In feudal Britain, land was a measure of status, to the extent that the right to have one's voice heard in politics depended on holding land. While the right to vote is no longer tied to land ownership, there are still numerous benefits associated with having access to property, and these are so significant that the right to own property is recognised by the United Nations as a basic human right. In major economic centres of developed countries, however, entry into the property market can be very difficult, if not impossible, for many first-time buyers, and those who lack sufficient funds for a down payment are immediately disadvantaged.

In New Zealand, the national mindset around property ownership involves obtaining a piece of land and a house to call one's own. In recent years, this has become increasingly difficult for buyers in major centres, such as Auckland. The National Government has received much criticism for not actively addressing this issue; New Zealanders believe that the ability to purchase quality, affordable housing is their right. Before passing judgement, however, it is worth examining whether New Zealand's current situation is simply a shift away from the dominantly egalitarian structure that has characterised the country up until the last couple decades, or whether it is actually resulting in a violation of basic human rights.

Property ownership and secure tenure benefits

The United Nations recognises that secure land and property rights for all are essential to reducing poverty since



these rights underpin economic development and social cohesion. Security of tenure and property ownership have many benefits, for both the individual and the state.

Personal Benefits

The benefits to owning property for the individual have been clearly recognised throughout history; possession of property puts the landowner in a better position, both in terms of personal comfort and financially. Property ownership comes with a "bundle of rights", which may include the right to occupy, use, enjoy, derive income from, develop, mortgage, or sell. While not all of these are included within every landholding, there is always a certain bundle of rights that the landowner may take advantage of.

Landowners may also derive additional benefits which fall outside the traditional bundle of rights, and beyond the definition of a basic human right. Perhaps the most obvious of these is the financial security that owning a piece of land or property provides. Disregarding the potential for capital gains, most landowners hold the majority of their wealth securely in their land and their land holding acts as a financial safety net. Of course, the likelihood that capital gains will be achieved is also a very attractive reason for investing in property, and this can be further augmented by any credit gained through mortgaging one's property, enabling the land owner to make investments that will result in further accumulation of land or wealth.

More abstract benefits to holding land are associated with the status it may give the landowner. Owning and occupying land entitles the occupier to claim and access public resources, be they natural resources or community resources. Owning land also awards a sense of place, a sense of community, and a sense of belonging, which are all fundamental to personal well-being and the functioning of a healthy society. It is easier for a person to be a successful member of society (e.g., retain employment, contribute to the community) if they have secure housing.

The challenge, however, lies in amassing enough capital to break into the property market.

Benefits for the State

Access to housing and security of tenure also provides societal benefits. The sense of belonging associated with land ownership helps build healthy and safe communities. People who feel connected with, are proud of, and have a relationship with their land are more likely to care for their property, invest in it, and contribute to sustainable development. This further increases land value, which benefits the entire community. When some people in a given area have secure access to property and others do not, for whatever reason, divided communities result with notable gaps in wealth distribution and this trend has a tendency to discriminate against minority groups, in particular.

Safe communities and quality housing are key factors in supporting the physical health of community members, so equitable land ownership across society raises the overall standard of living. In countries with publicly funded medical systems, such as New Zealand, citizen access to warm, dry housing reduces the overall burden on the system. As well, given how closely land and economics are related, a healthy property market is essential for a strong economy; the global recession induced by the 2008 property market failure in the United States illustrates this dependence.

Society divided

The transition towards neoliberal economics in the 1980s resulted in a higher emphasis on private property interests compared to public ones, and increasing globalisation supported the statutory tenure systems more centred around the rights of individuals. Those with property are able to amass more of it and, in New Zealand, the absence of a capital gains tax means that the wealth gained by select individuals through their property is not redistributed, and so the wealth gap in society begins to grow. Once this gap has been established, a positive feedback mechanism is activated: the best education opportunities for children are located in the best communities, and parents assist these children later in life to purchase their first home. As communities become gentrified, people who cannot afford to live locally have no choice but to move to more remote suburbs, further from their jobs and the enhanced opportunities that living in the economic centre affords. In this way, a trend towards rapidly increasing property prices is established in major economic centres; suddenly only the very wealthy can afford to own property in these areas and reap the associated benefits. Extra pressures may also be put on the housing market by overseas buyers.

New Zealand has traditionally prided itself on being an egalitarian society with relatively small wealth and standard of living gaps. This may have been achieved in part through the state housing scheme. This programme took hold in 1935, as the Labour government attempted to boost the economy by providing housing, work, and stability for those who were left without following the Depression, and this trend continued through the post-war years. The houses were well-built and situated in well-planned communities that people could connect with and be proud of.

Although there is agreement amongst the political parties in New Zealand that housing should be provided for the most destitute, the degree to which government should intervene is debated. The Labour Party's view is that private enterprise does not deliver an adequate standard of housing for people in need and the responsibility rests with government to house those who cannot house themselves, so a supply of state housing stock is required. The National Party mindset, on the other hand, is that too much government intervention limits private investment in housing and discourages self-reliance of citizens. It is little surprise then that, in the 1950s, the National government subsidised the building industry and encouraged New Zealanders to purchase their state homes as their own by offering very good deals. In 1991, in an attempt to make the rental market more equitable and revoke the apparent privilege being given to state tenants, the National government went further and announced that rental rates on state houses would no longer be subsidised based on renter income, but rise to match market rates. This had detrimental effects on the system; many families in need were unable to keep living in their homes and had to revert to accommodation often characterised by overcrowded, unsuitable, or unhealthy conditions.

Discussion

By introducing market-rate rents into New Zealand's state housing scheme in the 1990s, the National government was limiting the availability of adequate housing, forcing many people into substandard living conditions, and thereby not acting in support of this human right. It has been observed that "access to secure and affordable land is a pre-condition for social and economic development and for human dignity", and insecure tenure undermines social security, political security, and quality of rights, in general. Clearly, to ensure the healthy functioning of safe communities, it is in a government's best interest to provide some basic level of property security for its people. The trick, however, lies in finding a good balance between providing the right amount of intervention to ensure hu-

According to the Universal Declaration of Human Rights, everyone has the right to own property and not be arbitrarily deprived of it.



man rights are upheld while still supporting the growth of a healthy economy.

Article 17 of the United Nations Universal Declaration of Human Rights states that “1) Everyone has the right to own property alone as well as in association with others.”, and, “2) No one shall be arbitrarily deprived of his property.”. It can be assumed that the UN’s rationale in making these statements is to ensure that people are not subjected to unhealthy, substandard living conditions, or deprived of resources or a community environment which would result in adverse effects to their health or significantly degrade their quality of life; however, the Declaration does not elaborate on the reasons why. People in developed countries may therefore extend the concept of the right to own property to include not only the basic rights, but also the additional benefits, such as capital gains income or financial security, that home ownership awards.

The International Covenant on Economic, Social, and Cultural Rights, Article 11, perhaps offers more clarity on the topic, recognising the, “...right of everyone to an adequate standard of living for himself and his family, including adequate food, clothing, and housing, and to the continuous improvement of living conditions.”. This statement contrasts with the Universal Declaration which describes *owning* property as a basic human right, while the Covenant refers simply to *access* to property of a suitable standard.

Access to property that will keep the occupier safe, secure, healthy, and allow them to contribute to their community should be available to all. Under the current economic structure in New Zealand (and elsewhere), however, this does not extend to each property having the same value or amenities as all the others. Some properties are going to be more valuable than others, some people are going to have the means to obtain these properties, and many others are not. The government’s responsibility is to ensure basic property rights for its citizens, and sometimes this is still not being achieved. Although tenancies, even under contract, are not as secure as freehold ownership it has been demonstrated in the past that state rental arrangements were successful in providing suitable

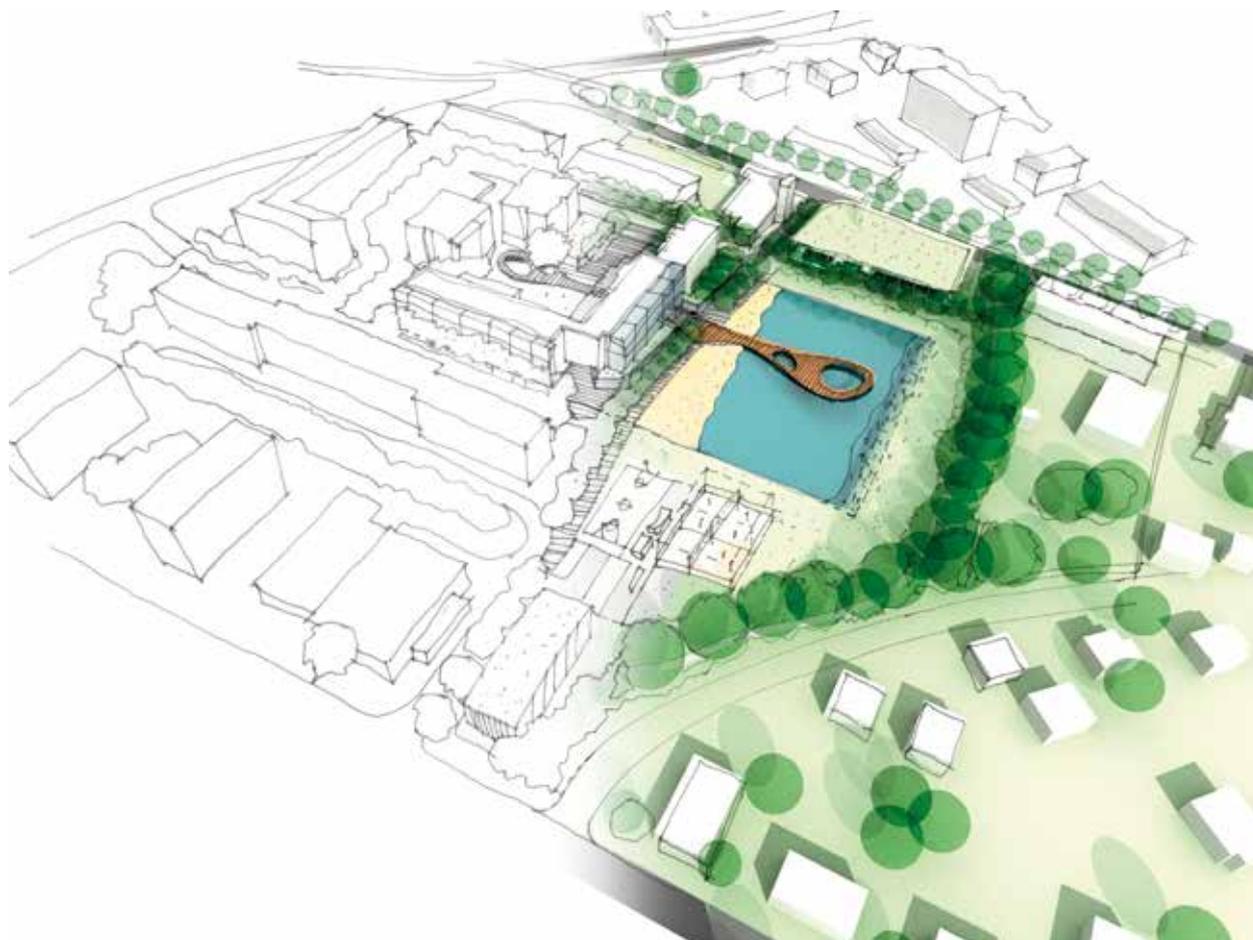
housing, building communities, and raising the standard of living for thousands of New Zealanders. Achieving a more even distribution of wealth is a larger issue that will not be solved simply by one government providing more housing for purchase, or subsidising the housing market. Even if this were to happen, prime land is likely to be already owned, or at least bought up by private developers, so this wealth will remain in the private domain. If the government were interested in assisting with wealth redistribution, taxing capital gains would be one approach.

Conclusion

According to the Universal Declaration of Human Rights, everyone has the right to own property and not be arbitrarily deprived of it. In major economic centres of developed nations, however, housing bubbles have grown to the point where the majority of first time buyers are not financially able to enter the housing market without outside assistance. By not acting to remedy this situation and make home ownership accessible to all, some may be of the opinion that the government seems to be disregarding this human right.

The issue of wealth disparity, which has contributed to the housing shortage in developed nations, stems from years of political and economic systems that prioritise private interests over public ones, and this issue will not be solved simply by making more land and housing available. With an ever-increasing population, as the supply of any common resource, including property, decreases, an attitude shift will be required where the population learns to relinquish some of the rights to which they have become accustomed. Until then, government intervention is likely better placed in providing additional safe and secure housing, under rental agreements, to people who still do not even have access to that, thereby ensuring that basic human rights are enjoyed by a greater proportion of the population truly in need, rather than those simply interested in investing in the housing market.

Note: A list of references is available on request to the author. broki086@student.otago.ac.nz



The Future of Place-making and Urban Design

IN MAY 2016 *LOCAL GOVERNMENT MAGAZINE* PUBLISHED AN ARTICLE ON PLACE-MAKING AND URBAN DESIGN: [HTTP://LOCALGOVERNMENTMAG.CO.NZ/SPECIAL-FEATURE-LG/FUTURE-PLACEMAKING-URBAN-DESIGN/](http://localgovernmentmag.co.nz/special-feature-lg/future-placemaking-urban-design/) LAND DEVELOPMENT AND URBAN DESIGN STREAM COMMITTEE MEMBER BRETT GAWN CONTRIBUTED TO THE ARTICLE BY ANSWERING THE FOLLOWING QUESTIONS POSED BY MARY SEARLE BELL.

1. When it comes to place-making and urban design how will the role of local authorities change over the next 10 years? What can local authorities do to make the most of these changes?

Good urban design and the creation of great places within existing urban areas often requires larger sites than generally exist within one lot or contiguous ownership. To achieve a good urban design outcome requires the aggregation of a number of lots to provide scale. The private sector has difficulty in doing this. Councils and or Government may need to consider assisting with this by facilitating the aggregation of land into larger holdings

and vehicles for development of those areas. (An example of this is the Tamaki Redevelopment Company.)

Another change I believe to be necessary is for Local Authorities to be able to form teams of people from their various departments to work together both within Council and with the developer's design team to create master-plans for these larger development sites. This ensures that when formal planning applications are lodged there are no surprises for the local authority or the community. Some of the learnings from dealing with Special Housing Areas need to become the norm for Councils.

Another change that I would like to see is a more macro

and risk management approach to responding to development proposals – a bit less of inefficient sweating over minor matters. This would mean that an assessment of a proposal might start with the question “is this proposal on balance a good thing for the community?” If so – can the Council staff take a facilitative approach to working with the applicant to make it happen?

Councils are likely to face more standardisation over planning codes and guidelines through amendments to the Resource Management Act (RMA) and National Policy Statements that will likely include urban design criteria.

2. In terms of place-making and urban design, what are the three big issues that local authorities will need to consider in the next 10 years?

- **What challenges will local authorities face in achieving this?**
- **How can they overcome these challenges?**

Different areas are facing different issues.

Auckland and some of our other cities have serious growth issues that require intensification of the existing urban areas. Higher density requires a lot of thinking about improved streetscape, pedestrian and public space amenity, successful public transport and significant “brownfield” redevelopment of existing areas.

Other local authorities are facing zero or negative growth and need to work out how to cope with that without losing their vitality and their urban amenity. Urban design for them will be about using scarce resources to maintain and enhance key public spaces and areas of their towns and cities to strengthen the existing community.

3. What criteria will be critical for good place-making and urban design in the next 10 years?

Well written Council Planning documents (District Plans, Design Guidelines and Codes of Practice – perhaps more use of NZS 4404:2010)

Recognition that good urban design is important in place-making and requires a multi-discipline approach from both skilled and experienced professional design teams working for developers and within Councils

A balance between a whole of life asset management approach to assets and good urban amenity – the recognition that great towns and cities need to be people orientated and this may cost a little more in operations and maintenance. On the other hand, urban designers need to ensure that we create assets that are easy to maintain and operate.

4. Should local authorities even be looking at getting involved in place-making and urban design?

Yes- I think they need to be aware that it is important for the success of their towns and cities.

• Is that their role?

Their role is to encourage it politically and through their planning and other regulatory documents and to be as facilitative as possible with developers who are attempting to create great places.

• If not, whose role is it?

It is the development community – encouraged by the public sector – that needs to lead in good place-making. Land development professionals need to be encouraging our developer clients to provide the best urban amenity the circumstances allow in the places we are designing and building.

5. Urbanist Jeb Brugmann will be a keynote speaker at the LGNZ (Local Government NZ) conference later this year. In his book ‘Welcome to the urban revolution’ he argued that the 21st century’s greatest challenges can, and must, be met through improved approaches to city building.

• To what extent do you agree with this view?

Improved city building is only one of the important responses needed to combat things like climate change, food security and distribution, and availability of water and energy. To say all these issues can be met by improved city building is overstating its importance to some extent.

6. Which NZ cities, towns or places best ‘get’ the idea of good place-making and urban design right now?

- **What are they doing well?**
- **What can local authorities in other places learn from them?**

I’m a bit biased but I love the Wellington CBD. I think the Hobsonville Land Company is doing a fantastic job with the redevelopment of the Hobsonville Air Base. And I think that Oamaru is an example of a small town with low or no growth that is doing very well.

I think they have all understood the environmental, cultural and heritage attributes of their place and have worked hard to build on those. Walkability is encouraged, the buildings and public spaces work together to create human and sometimes inspiring urban spaces and the infrastructure supports this feeling; there is good storytelling around the natural, cultural, historical and built attributes of the place. They have formed partnerships between public and private sector and created an environment where the whole community has pride and a willingness to contribute.



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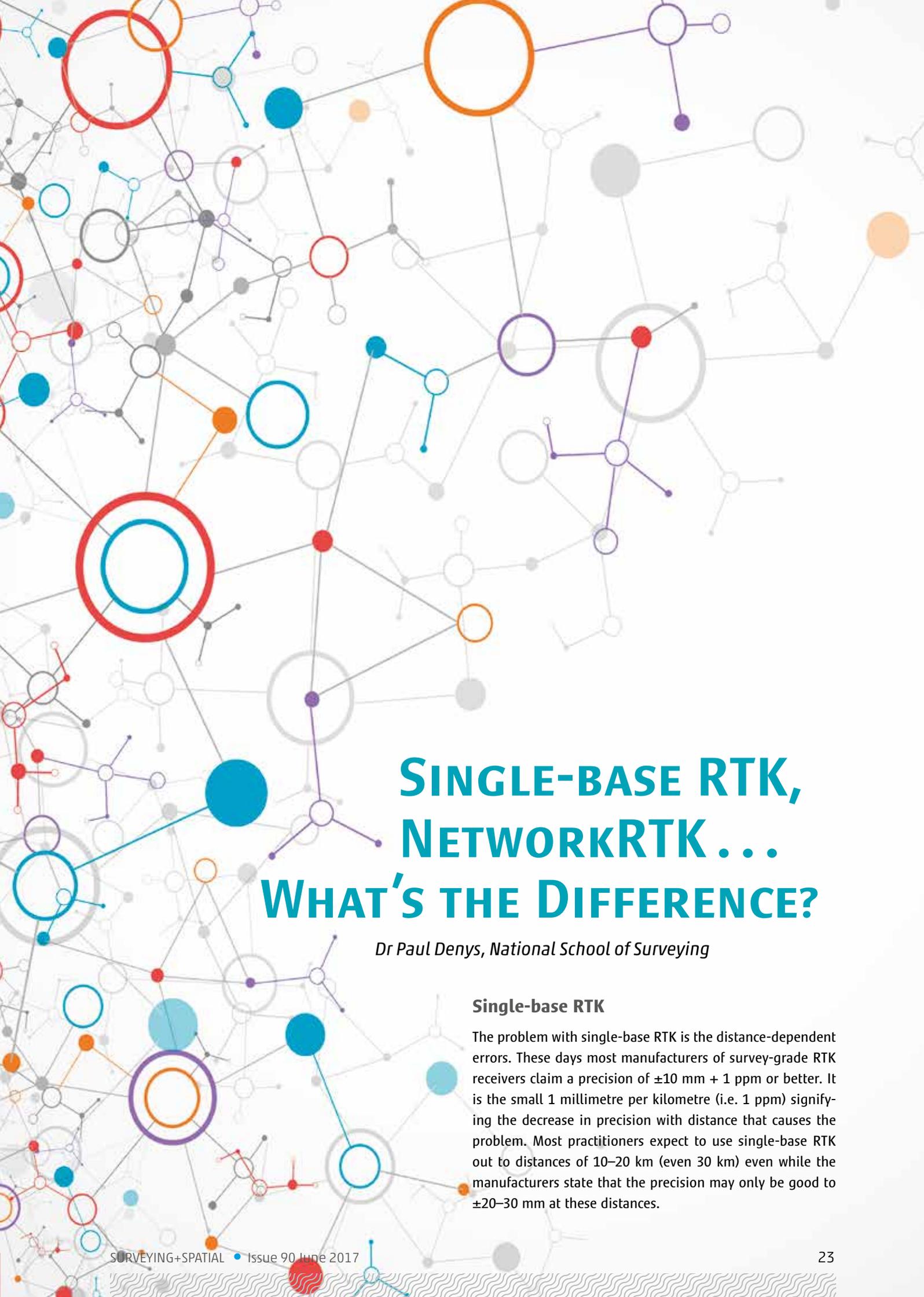
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SINGLE-BASE RTK, NETWORK RTK... WHAT'S THE DIFFERENCE?

Dr Paul Denys, National School of Surveying

Single-base RTK

The problem with single-base RTK is the distance-dependent errors. These days most manufacturers of survey-grade RTK receivers claim a precision of $\pm 10 \text{ mm} + 1 \text{ ppm}$ or better. It is the small 1 millimetre per kilometre (i.e. 1 ppm) signifying the decrease in precision with distance that causes the problem. Most practitioners expect to use single-base RTK out to distances of 10–20 km (even 30 km) even while the manufacturers state that the precision may only be good to $\pm 20\text{--}30 \text{ mm}$ at these distances.

The biases that contribute to the 1 ppm distance dependent errors are largely the atmosphere (troposphere, ionosphere) and orbits. The carrier phase double differencing algorithms used to compute the base to rover vector (baseline) assume that the atmosphere and orbit errors are the same at both the rover and base receivers. While the orbit error at the base and rover is strongly correlated, the atmospheric errors become increasing less correlated with distance. If the atmospheric conditions are generally consistent, the correlation will be high, but if the weather conditions are significantly different between the two sites (which is more likely as the base to rover distance increases), then the assumption that the atmospheric errors are the same is no longer valid. Baseline errors are likely to occur; hence the rover's position will be in error.

It is difficult to set up an experiment to test the effect of atmospheric changes on position, but I have observed a significant height change over a 30 minute period that was caused by a sudden and sharp squall passing through. We happened to be measuring kinematic data on a static platform over an 11 km long baseline. The southerly came through hitting first the rover followed by the base station a short time later. The pressure dropped some 20 millibars and the temperature dropped by 10 °C. The height changed by 15 cm and there were small but clear changes in the horizontal position of a few centimetres.

Another twist to RTK positioning is that many GNSS receivers have two frequencies (carrier phases L1, L2). The purpose of two frequencies is to mitigate the effect of the ionosphere bias, and is mandatory when observing long baselines (>10-20 km) e.g. for control or large scale survey applications. While many GNSS RTK receivers have dual frequency, the second frequency is only used for carrier phase ambiguity resolution. Once the ambiguities are resolved, the second frequency is not used in the baseline solution. The reason for this is while the ionosphere bias is reduced for long baselines, the observation noise increases by a factor of three and hence the observed baseline/position becomes less precise. This is not desirable over short distances, say less than 10 km, and so the RTK system defaults to single frequency.

NetworkRTK

Clearly if the atmospheric and orbit errors are contributing to the RTK distance dependent error, a method to control these errors should improve the error budget of RTK. The approach taken 20 years ago was to spatially model the biases by processing three or more nearby base or reference stations in near real time. The initial Flächen-Korrektur-Parameter (FKP) method models the biases as a flat plane. This approach is similar to geometrically modelling the geoid where the geoid ellipsoid sep-

aration is determined at benchmarks and the East-West and North-South slopes of the plane are determined. For FKP, the biases are determined at the network reference (base) stations, modelled as a plane and the slopes (tilts) transmitted to the rover position. The correction at the rover is determined based on the location of the rover.

The main approaches used today have developed from the FKP concept and include the Master Auxiliary Concept (MAC, -MAX, -iMax; Leica) and the Virtual Reference Station (VRS; Trimble). In addition to modelling atmosphere and orbit errors, other attributes include resolution of the reference station ambiguities, 1-way or 2-way reference network to rover communications and data formats. Much attention has been paid to data formats that are efficient e.g. RTCM 3 (developed by the Radio Technical Commission for Maritime Services Committee, Leica), CMR/CMR+/CMRx (Trimble), Ntrip (BKG and Dortmund University). (For additional technical details, see the networkRTK paper, Positioning and Measurement stream, NZIS website).

While high quality, survey-grade, multi-constellation GNSS receivers are desirable, the real nexus of running a networkRTK system is data communications. This occurs at two levels: 1) the transmission of the network reference station GNSS data to a network processing server (NPS) and, 2) the transmission of GNSS carrier phase and error modelling data to the rover. As the NPS must receive the reference station data in near-real time, there must be a reliable data link between each reference station and NPS. Standard options include Fibre/ADSL/VDSL, radio or satellite links. Similarly, the rover must be able to send and/or receive data in a timely manner. Cellular network links are the most common, but other methods, e.g. radio or satellite links can be used.

Issues

There are several operational networkRTK systems available in New Zealand. LINZ makes the GNSS data from many of their PositionNZ sites available (through GeoNet) for use of both single-base RTK and networkRTK systems (commercial or private). Most networkRTK systems have grown organically around population centres or clients in the regions where this is commercially viable. Commercial operators also offer single-base RTK solutions where the user (rover) connects to a single reference station. The main advantage is that the user does not need to operate or even purchase their own base station; instead they make use of the GNSS data from a single reference station and the cellular network (typical). The latter option is no different to setting up their own base station and therefore has all the disadvantages of a distance dependant single-base solution.

Even with all of this technology available, we still hear of unsatisfactory performances. Users experience jumps in position, data communication issues or simply inability to determine a reliable (or precise) position. For data communication the user is usually at the mercy of their internet service provider. Changing providers may not improve the quality of service although there is evidence that services are generally becoming more reliable.

Assuming that all satellites are available all of the time is not a good strategy. Working in environments with poor sky visibility or an urban canyon will always be a challenge. A quick check of an online satellite planning software will resolve any time of day issues. Taking advantage of the availability of multi-constellation will also mitigate this in time.

While networkRTK software is operational around the world and can be considered mature, there are a number of issues, some specific to New Zealand, that contribute to less than robust and unreliable networkRTK.

1. Data Latency

Where NetworkRTK providers piggyback off the LINZ PositionNZ network, data latency can be an issue at some sites. To be fair, the PositionNZ network was not established to support networkRTK operations; rather, its primary function is to monitor the broad scale deformation of the Australian-Pacific plate boundary. Many sites were established in remote locations where it can be difficult to achieve fast and reliable communications. Many sites use radio telemetry or satellite communications that add small delays in the data reaching the NPS. Once the data latency from a site is too great, the site is dropped from the networkRTK solution, which weakens the network reliability and affects the modelling. For the LINZ sites, the expected data latency is < 2 seconds (95% of the time). Figure 1 shows an example of the data latency and data gaps for a recent 20 hour period for the Wellington (WGTN) GNSS site.

2. Reference Station Coordinates

It is often asked (or assumed) that the reference station coordinates are in terms of NZGD2000. Hence we would expect the rover position to be in terms of NZGD2000, (which would be ideal). If New Zealand was located on the interior of a tectonic plate that is stable (e.g. Australia), then that might be possible. However, straddling a plate boundary means that the distances between reference stations in many parts of the country has changed (deformed) since 1st January 2000. Hence, if incorrect reference station coordinates are used, it may not be possible to resolve the carrier phase ambiguities at the reference stations, which in turn results in positioning errors at the rover. As a rule of thumb, if you expect the rover's position to be accurate to ± 10 mm, then the reference station co-

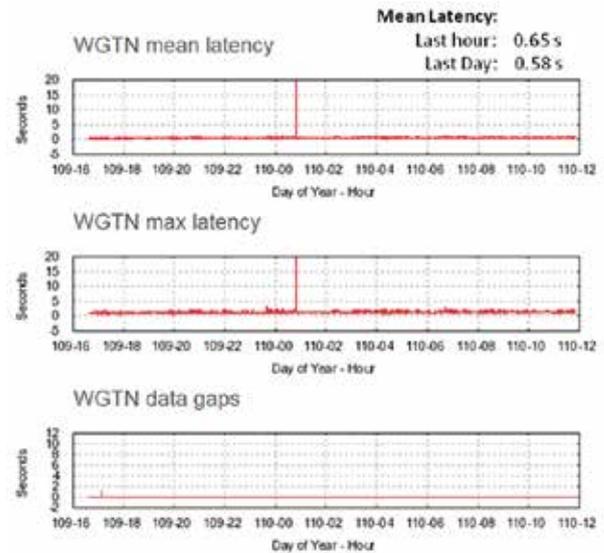


Figure 1: GNSS data latency and data gaps at the Wellington (WGTN) site. The period shows the last 20 hours (DOY 110, 19th April 2017), where the mean latency is better than 0.6 s (last 24 hours) and the maximum latency is typically 2-3 seconds, although there is one peak >20 s. There is one small data gap during the same time period.

ordinates should be an order of magnitude more accurate i.e. within a few millimetres.

To account for relative motions (deformation) between reference sites, the site coordinates need to be current day (or observation) coordinates that are in terms of the reference frame of the satellites i.e. ITRF2014. The problem here is that the coordinates computed by commercial software can only assume linear velocities. Hence non-linear motion such as caused by slow slip events (SSE) or post-seismic deformation (PSD) cannot easily be accounted for. For example, the effect of the 2013 Kapiti Coast SSE created positional errors in some sites of 50 mm over the space of one year compared to the linear motion.

The coseismic deformation caused by the M_w 7.8 2016 Kaikoura event displaced sites by up to several metres. In fact all of New Zealand was shunted including ~ 1 mm in Northland, ~ 2 mm in Southland and ~ 4 mm in the Chatham Islands. So what did not move? The coseismic displacement (Figure 2) is relatively easy to deal with; collect a few days of GNSS data and re-compute the site's coordinate. If the earthquake is not too large, it is possible to assume the (linear) velocity used prior to the earthquake, at least in the short term. However, if the PSD is significant, then the site velocity will be significantly different compared to before the earthquake. This is the case for Kaikoura 2016, where the velocities for KAIK and CMBL cGNSS are E @ 25 and NE @ 45 mm/month respectively (Figure 2). (The normal trajectory of these sites are approximately NW @ 45 mm/yr.) Consequently it will take years for the normal trajectory to resume.

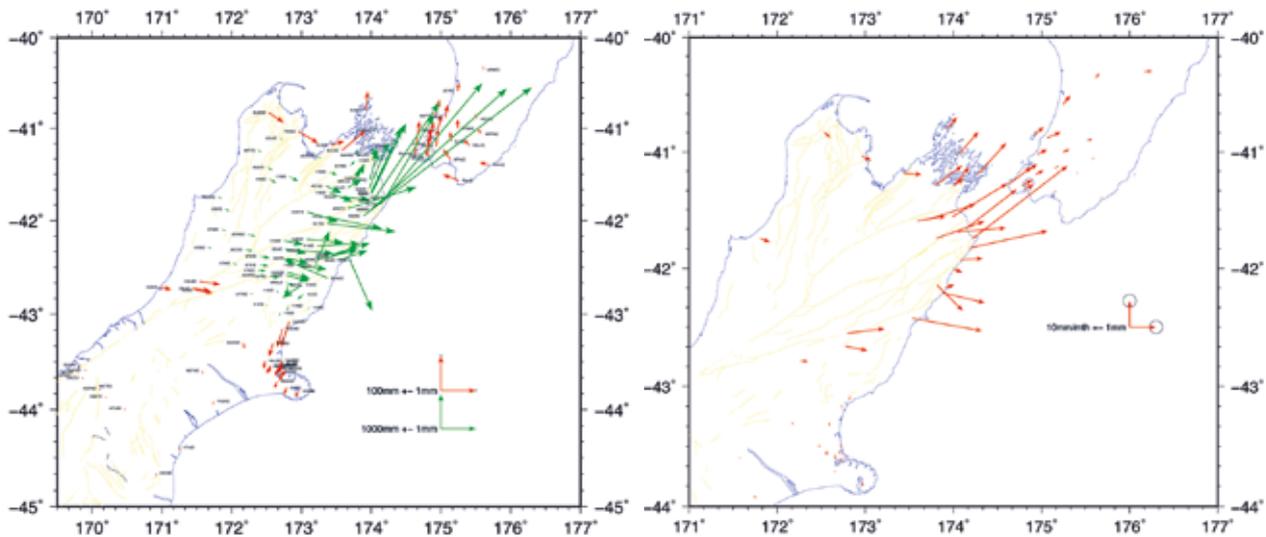


Figure 2: Coseismic (left) and post-seismic (right) deformation following the 2016 M_w 7.8 Kaikoura earthquake. Note the coseismic deformation is shown as two scales: green arrows are 10x larger than the red arrows. The post-seismic deformation is shown as millimetres per month.

3. Network Configuration

The strength of networkRTK is its ability to model atmospheric errors and resolve carrier phase ambiguities. The purpose of the network reference stations is to spatially sample the atmosphere. Hence, the location of reference sites should be geometrically evenly spaced over the region of interest. Similar to a topo survey, you would not want all your spot heights grouped too close together. The maxim “Work from the Whole to the Part” comes to mind. While it might be expedient to have reference sites close to the action e.g. the CBD of an urban area, to accurately model the atmospheric biases you require sites away from the CBD, but also uniformly distributed. Given that many networkRTK systems have grown organically with new sites located where there are (commercial) requirements, site configuration is not optimally designed to measure the atmospheric conditions.

4. Rover position

Similar to reference site coordinates, the final consideration is how to determine NZGD2000 coordinates. The rover coordinates are implicit in terms of the ITRF coordinate system. The three options include 1) a rigorous 14 parameter Helmert plus NDM transformation, 2) a local transformation, or 3) baseline vectors.

The rigorous 14 parameter Helmert transformation accounts for the difference between coordinate frames (e.g. ITRF2014 and ITRF96/NZGD2000), while the NDM accounts for the linear and non-linear motion across New Zealand. This is the approach taken by LINZ’s PositionZ PP.

A local transformation requires the user to tie to three or more reliable survey marks to determine the horizontal translation and rotation. This approach works well for

small regions such that any local deformation is not significant e.g. less than 10×10 km.

The final approach is to compute the baseline vectors between sites, observed in such a manner that the systematic biases are removed. The computed vectors (distance, bearing, height difference) are then used as the survey measurements. This approach may be suitable for cadastral surveys.

The best method will depend upon the type of application (fit for purpose) and the resources available.

Summary

NetworkRTK was developed to overcome the distance dependent limitations of single-base RTK due to unmodelled atmospheric and orbit biases. To provide optimum performance, NetworkRTK needs to be designed and operated carefully. To improve the reliability of networkRTK in New Zealand, consideration needs to be made of GNSS data latency, the maintenance of accurate reference station positions due to non-linear motion (e.g. SSE, PSD), optimum network configuration to model atmospheric biases and the determination of NZGD2000 coordinates.

RETROLENS

New online tool provides historical lens on New Zealand

Iain Campion, Environment Canterbury
Team Leader Data & GIS



What is *retrolens*?

An online system providing councils with access to historical bird's eye view imagery of areas right across the country was launched in December last year.

Environment Canterbury has led, with key partners Waikato Regional Council, Bay of Plenty Regional Council and Hawkes Bay Regional Council, the creation of the *retrolens* website (<http://retrolens.nz>) – which provides free access to hundreds of thousands of historic digitised images of New Zealand from the 1930s to the 1990s.

The website, which showcases historic aerial imagery, highlights how much the country's landscape has changed during the past several decades.

Why was *retrolens* developed?

The historic aerial imagery project was developed as a collaborative initiative between a number of councils and central government to preserve and digitise New Zealand's treasure trove of more than 600,000 historical aerial images – some which date back to the 1930s.

New Zealand's only copies of these precious images, which had been stored in aluminium canisters, were deteriorating rapidly and on the verge of being lost forever.

In response to this, a mass scanning project, led by Land Information New Zealand (LINZ), with support from local government, started. Alongside this, local councils came together to develop *retrolens* – a first of its kind shared



Comparison of the change in land use from 1940 to the present. Location: Wigram Airport in Christchurch Check out www.retrolens.nz

... the key purpose behind the project was to provide a shared resource for councils to aid in future planning as well as economic and environmental decision making.



online resource for councils – this took the scanning project one step further by providing quick and easy access to the images for councils and our communities across the country.

Regional councils and local government recognised the need for people, outside of councils, to access these images so it made sense for a website to be developed nationally.

The *retrolens* project was developed by the Local Government Geospatial Alliance (LGGa), a group represented by the geospatial section of New Zealand's local authorities, with images provided by LINZ. With local governments focus on innovation, open data and creative commons, the *retrolens* project lines up with the Government's current ICT Strategy.

The total cost of the national digitisation project, managed by LINZ and due for completion in 2021, is estimated at \$5 million.

The funding partners for the national digitisation project with LINZ are: Auckland Council, Bay of Plenty Regional Council, Environment Canterbury, Gisborne Regional Council, Hawkes Bay Regional Council, Environment Southland, Tasman District Council, Otago Regional Council, Northland Regional Council, Wellington Regional Council and Waikato Local Authority Shared Services.

The images are freely accessible to the public, however the key purpose of the project was to provide a shared resource for councils to aid in future planning as well as economic and environmental decision making.

Why is *retrolens* so important?

By studying historical images, we can see changes in coastal areas and land use, identify where hazardous substances have once been used or stored and identify special features, including geothermal vegetation and archaeological sites. On top of this, the system can be used as a resource for cultural research.

In particular, at Environment Canterbury, understanding environmental changes informs the work we do. The site is a great resource for future planning and making sound economic and environmental decisions.

These images were particularly important for identifying past land use in the Christchurch Hazardous Activities

and Industries List project and is being used in the earthquake response to Kaikōura.

For those not involved in planning, it's also interesting to check out what your property looked like decades ago and you can download a copy of the image for your own purpose.

Liz Tupuhi, Waikato Regional Council's land and soil scientist, sees all sorts of opportunities from a science point of view.

"Through the images, we can see stream channels and understand whether today's drain is yesterday's meandering stream, we can see erosion scars and trace these through the years, we can see forest fragments and perhaps even work backwards to establish what they might have been and we can also see former land uses and historic activities which may influence future development. It's very exciting."

Continuous improvement

The project is ongoing, with 150,000 images currently available on the system. By the end of the project in 2021, that number is expected to increase to 500,000.

We are also taking steps to add further value to *retrolens* by taking the raw data that's already available in the system and post-processing the images to create ortho-rectified mosaic versions of the images.

This will mean that images can be viewed seamlessly with a panning functionality (similar to that of Google Earth). The key benefit of this is that it will allow others, such as scientists, planners, engineers, to find out more specific information land changes over time by having the ability to measure these changes.

Currently, initial stages of this work is being undertaken between Waikato Regional Council, Environment Canterbury and Bay of Plenty Regional Council with a focus on images across these regions. However, eventually this is something that could be transferable across other local authorities and potentially other stakeholders interested in using the images, such as iwi, engineering companies and resource consent businesses. Environment Canterbury already has large collections available to the public through its website <http://canterburymaps.govt.nz> in this format.

MORE ON LANDSCAPES

Man O'War Station v Auckland Council [2017] NZCA 24

Mick Strack, National School of Surveying

The Supreme Court case of 2014, *EDS v NZ King Salmon*, continues to impact on protections of Outstanding Natural Landscapes (ONLs) as required in s6(a) RMA. My review and commentary of that case in *Surveying+Spatial* (Issue 79) and the discussion about ONLs in the March issue (Strack & Holyoake *Surveying+Spatial* Issue 89) provide some background to the questions about landscape protection. The recent Court of Appeal case; *Man O'War Station v Auckland Council* (February 2017) is worth additional clarifying comment.

Man O'War Station brought a case against the Auckland Council objecting to the designation of a considerable part of their Waiheke farm as outstanding natural landscape. The case was heard at the Environment Court, appealed to the High Court and further appealed to the Court of Appeal on a selection of well prescribed legal questions. The appeal was largely centred on how the *King Salmon* case had changed the law about regional councils' identifications of ONLs. It was Man O'War's contention that ONLs should now be: 1) assessed and dependent on the protections afforded to that landscape; 2) assessed at an elevated level because of the more restrictive interpretation provided in *King Salmon*; 3) reassessed because the previous permissive interpretation (the overall judgement approach) contemplated that ONLs could be adversely affected if there was some greater benefit, while the *King Salmon* case clarified that there was an environmental

bottom line which required avoidance of all adverse effects; 4) recognised as allowing for continuing operations of a working farm; and 5) assessed by comparison with other landscapes nationally.

In brief, the Court of Appeal dismissed all these assertions, the result being that the ONLs defined by the Auckland Regional Plan were accepted. However, the case provided another opportunity for more legal discussion about landscapes. Of particular interest was that the identification of ONLs was a factual one, which was quite separate from the establishment of policies which deal with landscape protection in regional plans.

It was also established that landscapes should be viewed and assessed regionally. The point was made that if ONLs were assessed nationally and in comparison with the more pristine areas of Fiordland, the Southern Alps and the high country lakes, for example, then few other landscapes would qualify as outstanding.

While the *King Salmon* case clarified the interpretation of documents (like the priority of the NZCPS) and the consideration of a policy clause (like the need to avoid adverse effects) having the effect of a rule under the regional plan, and therefore provides for more assertive protection of ONLs, it hasn't changed either the assessment criteria for ONLs, nor the policy framework implemented in regional plans to protect landscapes from inappropriate subdivision, use and development.



Native bush, Waiheke Island



Photo courtesy of Simon Construction.



New Christchurch Showroom and Industry Training Centre

Accurate Instruments are excited to announce that development is well underway of the new Christchurch office complex in Avenger Crescent, Wigram.

Situated just a stone's throw from the current showroom and service centre in Hayton Road, the new office complex will feature a larger expanded showroom and hire facility, house all of our technical sales and advisory team, have a state of the art service and calibration centre and will also be the head office of the Industry Training and Education department for the company.

This new location will enable Accurate Instruments to further develop and expand its support network for the South Island, with the larger premises allowing further expansion of our Training and Education department – which delivers industry training, advisory, seminars and demonstrations throughout the country.

Accurate, with its wide array of instrumentation for the surveying, engineering and construction markets, is also one of the leaders in the market offering technical and industry support, best practice theory and usage training and instrument calibration, testing and certification.

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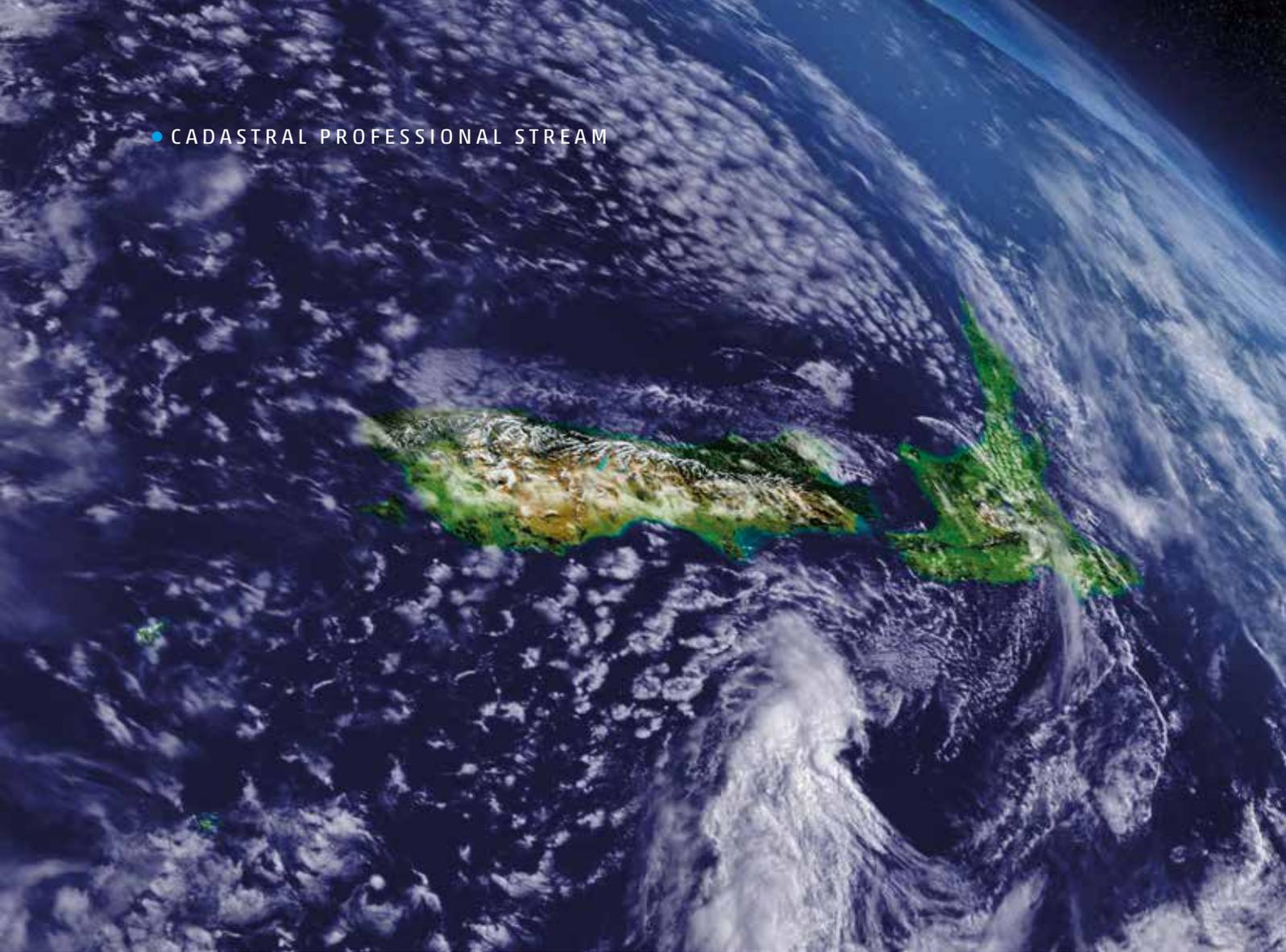
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A Coordinate Cadastre for New Zealand? Yeah, nah!

Trent Gulliver, NZIS Cadastral Professional Stream Leadership and Senior Survey Advisor, Office of the Surveyor-General, LINZ

I CAN RECALL SOME PRETTY LIVELY DEBATES AMONG SURVEYORS OVER THE YEARS RELATING TO NEW ZEALAND'S CADASTRE AND WHETHER IT IS ON TRACK TO TRANSITION FROM ONE THAT IS FOUNDED ON MONUMENTS (MARKS) IN THE GROUND, TO ONE BASED ON COORDINATES.

My first recollection of such a discussion was around the time Landonline was being introduced, and then again in the lead-up to the introduction of the Rules for Cadastral Survey 2010. With the imminent review of the Rules and the Advanced Survey and Title Services (ASaTS) project currently underway to replace Landonline, the topic could once again be of interest to surveyors.

In this article, which is reasonably brief and high-level, the role of New Zealand's cadastre is discussed in the context of the property rights system and the cadastral

survey system that supports it. Through this discussion, the nature of the cadastre is explored along with the roles of marks and coordinates, both now and into the future.

Property Rights and the Cadastral Survey System

New Zealand benefits from a property rights system that promotes efficiency and confidence in the transaction of property rights. The cadastral survey system is a core component of the property rights system with a prime pur-

pose to define the location and spatial extents of land and other real property (e.g., a unit under the Unit Titles Act 2010). This information is used by managers of tenure systems to enable the registration of rights, restrictions and responsibilities ('rights') and provides interested parties with confidence in the location of boundaries.

The Cadastre

Closely associated with the cadastral survey system is the cadastre. The Cadastral Survey Act 2002 defines 'cadastre' to mean "all the cadastral survey data held by or for the Crown and Crown agencies". In practice, this describes the repository of cadastral survey datasets lodged with LINZ and integrated into its database (currently Landonline). These integrated data are referred to in the Surveyor-General's strategic document, Cadastre 2034, as being fundamental to the cadastral survey system. In addition to the 'fundamental cadastre' Cadastre 2034 refers to a 'broader cadastre' to describe other rights in land which are created and managed in terms of other legislation and which are not explicitly part of the fundamental cadastre. Generally, the broader cadastre is not currently reflected in the Cadastral Survey Act 2002 and Landonline.

The Cadastre and Marks

The spatial definition of the New Zealand cadastral survey and property rights systems, and hence cadastre, is based on physical marks in the ground. The legal position of boundaries is defined by original and undisturbed boundary marks. These boundary marks are connected by survey observations to nearby witness marks, which are in-turn connected to other survey marks. These connections help surveyors to confirm the reliability of old boundary marks and also to relocate boundary positions if the original mark is determined to be disturbed or no longer there.

The Cadastre and Coordinates

The connection of the cadastral network to the geodetic network allows coordinates to be assigned to all survey and boundary marks that are integrated into Landonline. It is through these coordinates that the cadastre can be managed digitally, including for positional accuracy. Coordinates have also enabled the highly-automated capture, validation, recording and supply of cadastral survey data.

While coordinates enable surveyors to readily relocate survey and boundary marks, they do not provide a legal definition of boundary location. The legal definition of boundaries continues to be provided by original and undisturbed boundary marks established by the surveyor and supported through observations connecting those marks, as documented in the certified cadastral survey dataset.

The Cadastre and the Parcel Fabric

A valuable output of the cadastral survey system is the parcel fabric, being a continuous surface of connected parcels that covers the whole of New Zealand. The parcel fabric is a substantive layer of information that is being used extensively in a myriad of spatial applications, well beyond cadastral surveying. In some jurisdictions around the world, and even within New Zealand, the parcel fabric is considered to equal the cadastre (and vice versa). Although the parcel fabric is derived from information provided through cadastral survey datasets, it should not be confused as being the legal cadastre. The parcel fabric is a digital, non-legal representation of boundaries with a positional accuracy that may not coincide with original and undisturbed boundary marks in the ground and their relative positions as documented in the legal cadastre.

The Cadastre and the Effects of Ground Movement

New Zealand's geographical location astride the collision zone between the Australian and Pacific tectonic plates adds to the complexity of cadastral surveying in this country. Survey observations between local marks accommodate 'general' ground movements across the country because the distortions over small areas are normally insignificant (i.e., the relativity between boundary and witness marks is preserved). In the case of significant movements, such as those resulting from a powerful earthquake (especially around fault lines), the differences might be too great to ignore. In these situations resurvey work is required, based on old marks in conjunction with other information available to the surveyor.

The Canterbury earthquakes have, through the Canterbury Property Boundaries and Related Matters Act 2016, confirmed the principle that it is the original, undisturbed boundary mark that provides the primary definition of legal boundary position. While bearing and distance observations to other boundary and survey marks are useful, this information is subordinate. Under the Act, where boundaries within greater Christchurch are deemed to have moved with the land, the original, undisturbed boundary mark (i.e., as placed by survey and that has moved in harmony with the land) must be respected. In some instances this could mean significant discrepancies with original title dimensions.

The effects of ground movement also impact on the accuracy of coordinates used for the digital management of the cadastre. As New Zealand moves discrepancies occur between the in-the-ground position of marks and their coordinated representation. While a move to a dynamic

(continued p33)

Liability and dealing with complaints

Stephanie Harris, Glaistor Ennor Solicitors

It is always valuable for surveyors, like engineers, lawyers and other professionals, to step back and consider the legal and professional conduct framework we are operating under. Professional service providers are not only subject to law suits when things go wrong, but also complaints and disciplinary action by industry regulators when such bodies consider there has been a breach of certain ethical standards.

In a surveyor's line of work, what appears to be a simple mistake which could easily have been prevented by having proper systems in place, can have huge implications because boundary issues often impact on not just the client's property but the neighbouring properties. An example under the old system is a case on point. When a plan was being deposited for a high rise building, a surveyor made a mistake in transposing the value of unit entitlements obtained from a valuer on to the unit plan. Unit entitlements were organised into columns, and where there are over 100 units, if you miss one unit when copying down the values, you can imagine how this simple mistake would impact the rest of the units down the column. Years after the plan was registered with the incorrect entitlements, the mistake came to light and the surveyor and its insurer were faced with a claim by numerous unit owners who have overpaid body corporate levies for many years.

If you are a licensed cadastral surveyor, your conduct is regulated by the Cadastral Surveyors Licensing Board of New Zealand ("**Board**"), which is established under the Cadastral Survey Act 2002 ("**Act**"). If you are a member of the New Zealand Institute of Surveyors, you are subject to the Institute's rules and disciplinary body.

You cannot control another person's decision to lodge a complaint against you. However, there are things that you can do in your day to day work to ensure that a) the risk of a mistake arising is minimised and b) you have the best possible supporting evidence and documentation to back up your submission should the need ever arise. I will summarise some of the rules that are enforced by each of the regulatory bodies before making recommendations.

The Board can investigate complaints alleging that a licensed cadastral surveyor is guilty of professional misconduct and take appropriate disciplinary action. Professional misconduct is set out in the Act and includes negligence in the conduct of cadastral survey. Negligence is complex legal concept, but generally speaking, one may be considered to be negligent in carrying out a professional service if they fail to exercise their skills at a standard which would be expected in the industry resulting in harm or loss to another.

The Act also sets out that if you have not personally carried out or directed the cadastral survey but have certified to the accuracy of the cadastral survey or cadastral survey dataset, this is also deemed to be a professional misconduct. You must also carry out sufficient checks to ensure the accuracy of the entries in any field book and other cadastral survey records that may have been made by any employee.

This means that there is a limit to what you can delegate when you are the certifier and in particular you cannot delegate the responsibility of directing the cadastral survey to another.

A system you could implement is a detailed checklist with a description of tasks and checks to undertake to en-

(continued from p32)

ment and output of cadastral survey data. A coordinated representation of the cadastre already exists but it does not provide the authoritative location of boundaries. The fact that New Zealand is too geologically dynamic and volatile is one reason for this. Equally important is that the original, undisturbed boundary mark continues to be the prime evidence of legal boundary position, a concept that is entrenched in practice and in law. Ultimately, it is clear that boundary marks (supported by local witness marks and observations), not coordinates, are the appropriate long-term approach to ensure continuity of New Zealand's robust property rights and cadastral survey systems.

Is a Coordinate Cadastre right for New Zealand?

datum would help to keep the differences between actual and calculated positions to a minimum at a national level, significant ground movement at the local level could continue to prove difficult to model to cadastral accuracies.

It can be established from the above discussion that there are two answers to this question (the title of this article may have given that away also!). Firstly, yeah, a coordinated representation of the cadastre is required to realise efficiencies of digital input, checking, storage, manage-

ment and output of cadastral survey data. A coordinated representation of the cadastre already exists but it does not provide the authoritative location of boundaries. The fact that New Zealand is too geologically dynamic and volatile is one reason for this. Equally important is that the original, undisturbed boundary mark continues to be the prime evidence of legal boundary position, a concept that is entrenched in practice and in law. Ultimately, it is clear that boundary marks (supported by local witness marks and observations), not coordinates, are the appropriate long-term approach to ensure continuity of New Zealand's robust property rights and cadastral survey systems.

So, is a legal coordinate cadastre right for New Zealand? Nah!

sure that all necessary steps have been taken by the person conducting the cadastral survey before certification. The checklist should require dates to be completed and signed off. This not only helps to ensure accuracy but also acts as a record to show that you have carried out your duties under the Act which you may be able to produce as supporting evidence. You can also institute a regular audit system by another independent professional who can give competent advice on compliance with the checklists.

More generally, you should always record key discussions and verbal agreements in a file note, or email the other party confirming the verbal agreement, and leave a paper trail showing your compliance with the Act. It goes without saying that your files should be in order and up to date.

If the Board decides to accept a complaint, it must notify you of the reasons why and the date set down for hearing. You or your representative may appear before the Board at the hearing. The Board must observe the rules of natural justice and may receive evidence that may not be admissible in a court of law. In a nutshell, natural justice is a legal concept which requires the decision maker to follow a transparent and fair procedure and be free from bias. As part of this requirement, you must be given a fair opportunity to present your case. You have the right to appeal against the decision to the District Court but the decision of the District Court on the appeal is final.

The Board may cancel your licence, suspend your licence for up to three years or require you to practise subject to certain conditions as to employment for a period of up to three years. You may also be required to pay for costs of the hearing and any investigations conducted to test the accuracy of any cadastral survey and any incidental costs associated with these.

Given the relatively serious nature of the penalties and the impact it would have on your livelihood, I recommend you seek professional advice about how to present your case most persuasively. Having a robust system in place including keeping good records will assist greatly in your defence.

Members of the New Zealand Institute of Surveyors must follow a Code of Ethics which sets out certain standards of professional behaviour. Complaints against a member are heard by a sub-committee of the Ethics Committee of the NZIS Council. The current Code of Ethics covers the following broad topics: professional conduct, conditions of engagement, communication, conflict of interest, fees and completion of unfinished work. If a member is found guilty of unethical or unprofessional conduct, the Council may take enforcement measures such as expelling the member from the Institute or imposing a fine not exceeding \$25,000.

If a complaint is made against you, you have 20 working days in which to lodge in writing any explanation in relation to the complaint made.

As property lawyers we work closely with and alongside surveyors on development projects. What we notice is that some surveyors tend to take an alarmingly relaxed attitude towards client confidentiality and conflict of interest. For example, we often see surveyors approaching their client's neighbour without their client's prior consent to inform the neighbour of the survey work on the boundary. While we understand the good intentions and other justifiable reasons for this approach, unbeknownst to the surveyor, the client and the neighbour might be in the middle of a dispute about boundary or other issues and the surveyor's action could escalate matters. Sometimes we see surveyors acting for owners of both sides of a boundary but without realising that the two parties' interests are not necessarily aligned for example if there is a dispute about where the proper boundary lies. As lawyers one of the most important obligations which we always come back to is who our client is and what their best interests are; and this may be something that surveyors would also benefit from adopting at the forefront of their client considerations.

Just a few points of advice in drafting your written submission: keep to the point and avoid emotive language. Seek help from a colleague or another professional to review your draft written response. Respond to each and every allegation with supporting documentation where available. Again, a robust checking system and good record keeping will prove to be invaluable in these kinds of situations.

Lastly, remember to promptly notify your insurer of any complaints made or legal action taken against you and cooperate with all their information requests promptly. Note that most professional indemnity policies require that you notify your insurer as soon as you become aware of a possible issue and further require that you do not admit any liability without first consulting with your insurer. Failure to do so can invalidate your insurance.

Stephanie Harris is the joint managing partner of Glaister Ennor Solicitors. She has extensive experience in property and commercial law. She acts for SMEs, larger corporates, investors and developers on many large and complex property transactions and developments, ownership structures, leases, security interests and general structuring and finance.

Contact Details:

DDI: (09) 356 8232

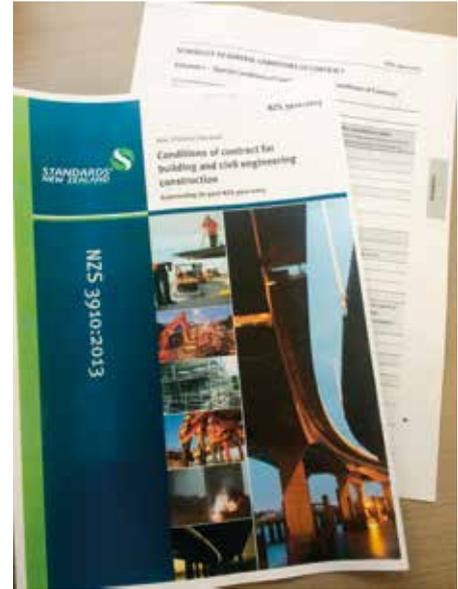
Fax: (09) 356 8244

Email: stephanie.harris@glaister.co.nz

Construction Contract and RMA Update

Paul Turner & Ben Addington, Landlink Limited

THE CONSTRUCTION SECTOR HAS BEEN BOOMING IN NEW ZEALAND FOR SOME TIME NOW. STRONG POPULATION GROWTH CONTINUES TO DRIVE DEMAND AND CAPACITY PRESSURES ARE BUILDING UP WITH CONSTRUCTION COSTS RISING. RECENT LEGISLATION CHANGES HAVE BEEN INTRODUCED TO PROTECT CONTRACTORS (THE CONSTRUCTION CONTRACTS ACT (CCA)), AND THE RESOURCE MANAGEMENT ACT (RMA) IS FACING CHANGE AFTER NEARLY THREE DECADES OF EVOLUTION.



Construction Contracts Act Trust Regime – Are you, your Principals and Contractors ready?

The retention money provisions of the Construction Contracts Amendment Act 2015 came into force on 31 March 2017. This aspect of the changes to the CCA is the final and most important change introduced in the 2015 Amendment.

The provisions are designed to better protect retention money owed to contractors and subcontractors in the event of a business failure, and ensure retention money withheld under construction contracts is responsibly managed.

The Regulatory Systems (Commercial Matters) Amendment Act came into force on 31 March 2017 and clarifies the amendments made in the Construction Contracts Amendment Act 2015 that:

- retention money provisions only apply to contracts entered into, or renewed, on or after 31 March 2017.
- developers or head contractors (Party A) who choose to withhold retention money from a contractor (Party B), have two options:
 - ♦ hold retention money on trust in the form of cash or other liquid assets readily converted into cash – the default option
 - ♦ obtain a financial instrument, such as insurance or a payment bond, to provide third-party protection to ensure payment of retention money.

Trust funds receive a special place in the hierarchy of

how funds are dealt with in a receivership, liquidation or bankruptcy as they are not the property of the party who holds them. This means that Party B will have a claim to retention money ahead of other creditors, including the banks and the Inland Revenue Department (IRD).

Construction contract managers, including surveyors and engineers (Engineers to Contracts under 3910), should be providing advice to their clients about how the funds should be managed in order to comply with the CCA. As set out above, the monies must be held as cash, or another liquid asset. Party A could invest the retention money so long as they uphold their obligations under the Trustee Act 1956 (that the funds are readily convertible to cash).

Party A could also 'co-mingle' the funds into their current accounts (working capital) but it could be difficult to demonstrate that this offers sufficient protection for the funds and that record keeping is robust (the record keeping requirements are the same as those in the Companies Act). Party B could request copies of the records to ensure that Party A is upholding their obligations.

There remains uncertainty about some aspects of the process – there are no regulations which define the minimum amount or retentions to which the Act applies (assume that all retentions are covered by the Act).

CCA: Should Surveyors use the CCA to increase protection ?

The CCA, since September 2016, covers design, engineering and QS professionals, and they can benefit from the

protection which the CCA provides, but they will also be subject to the adjudication process either as claimants or respondents. The practical reality is that claims against the CCA appear to have been limited to fee disputes, not professional negligence issues, as is the purpose of the Act.

The CCA provides protection for consultants who undertake work 'related to construction'. It could be argued that setting out a fence, preparing a resource consent for earthworks, setting out a building and completing a land transfer survey are all related to construction and are therefore construction contracts falling under the CCA. Given that you can't contract out of the Act, it may be best practice to assume that all your contracts are CCA contracts. If it is subsequently determined, through proceedings or through case law, that this is not the case, then nothing is lost.

Our business has defined our work as being subject to the CCA by voluntarily entering into contracts under the CCA) and we have had only one case where this stance was queried (determining the level of a house subject to flood risk prior to construction works, therefore 'related' to construction, in our opinion).

What is unclear to us, in the case of a dispute, is whether we, and our insurers, could comply with the tight timeframes required by the CCA in the event of a dispute.

RMA AMENDMENT UPDATE

National Direction – the Big Picture

The scope and powers of National Policy Statements and National Environmental Standards have been broadened and extended to provide greater direction. This includes the development of National Planning Standards, which are required to be in place by 2019. Regulations to standardise council charging and monitoring practices have also been enabled and further work on these from Government is expected.

Decision-Making Functions – reducing compliance costs

Procedural principles have been added to minimise council process costs including a customer focus, reduced regulatory duplication and the use of concise wording. Monitoring of these processes is now also required. Significant natural hazards are now a matter of national importance with amendments to sections 106 and 220 introducing a risk-based approach.

Perhaps the most significant change to surveyors is that subdivision is to become a permitted activity which aligns with land use. Alongside this council are now required to ensure that there is "sufficient residential and business development capacity" within District Plans.

Resource Consents – the Coal Face

"Boundary Activities" have been created to increase time and cost efficiencies, and improve the proportionality of the consenting system. In addition, councils will be able to exempt "marginal or temporary" rule breaches from requiring a resource consent. This is intended to address the issue that resource consents are sometimes required for activities that have effects comparable to the permitted baseline. A fast-track process for processing controlled activities in 10 working days has also been created. Although it is now relatively common practice, off-setting and compensating adverse environmental effects are now explicitly provided for. The scope of resource consent conditions has also been tightened to those directly connected to adverse effects arising, the applicable rules and implementation administration.

This is a brief overview of some of the key changes that will affect surveyors in their everyday practice but there are also changes to plan making, electronic communication and other legislation as well as Environment Court and Board of Inquiry processes.

Will the reforms save time and costs?

Like all changes, the reforms are likely to generate complexity and uncertainty in the short term, but there should be reductions in the costs and timeframes.

The inclusion into the Bill, at the last minute, of *Mana Whakahono a Rohe* clauses will involve iwi appointees in plan making, consenting, appointing committees, monitoring and enforcing bylaws could put at risk the intention to streamline resource management processes.

The consensus is that the Bill does not address the need for better integration between the RMA, the Local Government Act and the Land Transport Management Act. Given the large investment in infrastructure that has been proposed by the Government over the next few years, along with the continued pressure caused by immigration and growth, this disconnect should be addressed.

The recently released Productivity Commission report 'Better Urban Planning' (which is fascinating reading) has raised the prospect that the Government could rethink the RMA, and with an election on the horizon, the eyes of landowners, investors, developers and environmentalists will be on the RMA.

The Commission's proposals for a future planning system are designed to provide a greater responsiveness, adaptability and dynamism in a number of ways, including:

- less prescriptive land use rules, creating more space for development within clear environmental limits and for local innovation and adaptation;

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SURVEYING IN SOUTH AFRICA

Coordinate vs monument cadastre

Compiled by David Goodwin, Senior Lecturer, National School of Surveying

THE FOLLOWING ARTICLE IS AN EXTRACT FROM CORRESPONDENCE WITH AN OTAGO SURVEYING GRADUATE WHO WORKED IN CHRISTCHURCH, NEW ZEALAND (NZ), AND THEN IN SOUTH AFRICA (SA). THE OTAGO PROGRAMME PROVED TO BE EXCELLENT

PREPARATION EVEN FOR A DIFFERENT LEGAL SYSTEM (ROMAN-DUTCH CIVIL LAW IN SA, AS OPPOSED TO ENGLISH COMMON LAW IN NZ), BUT NOTHING COULD HAVE PREPARED THE GRADUATE FOR WORK IN GAME RESERVES, WHERE HE IS USUALLY ACCOMPANIED BY AN ARMED GAME SCOUT IN CASE OF ELEPHANTS AND LIONS. HE HAS GOOD THINGS TO SAY ABOUT THE NZ SYSTEM, BUT HAS ALSO ENJOYED SOME FEATURES OF THE SA SYSTEM.

David Goodwin (DG): *Hi, I'm glad you have finished your law exams. How are you finding the South African system relative to New Zealand?*

Otago Graduate (OG): Sorry for my delayed reply! I received some good news this week, I passed my Professional Land Surveyor exams!

In response to your query, it's frustrating not having an online database like Landonline (e.g. surrounding data/parcel description text), but otherwise I have found the SA system a lot more simple than in NZ. I like the fact that the corner beacons hold as great an accuracy weight as working points/survey points. We don't record or look at directions and distances in the field anymore. You upload coordinates to a GPS controller, find a mark, find a control mark, Town Survey Mark or trig, perform a site calibration, check onto another few marks and place your control



where necessary. Then if you need to use a total station, the same controller is used with the coordinates you have just determined by GPS measurement. Enabling you to setup on that point, back sight and look at residuals in coordinate format, check on another mark then complete the job and export points to a CSV file, download into software, fiddle around, prepare your final coordinate list and submit. Your surveyed coordinates then become the new published digital coordinates.

I was initially frustrated at the limitations of the software used here for computing traverse and vector information as I was accustomed to using the 12d traverse tool. However I rarely use it now because I don't have to recreate the traverse around a site. Occasionally I use this function for old diagrams with only angles and distances. Obviously Landonline does allow the extract of digital

coordinates in xml format but this is still unnecessarily cluttered by the vector data.

The diagrams and working plans are a lot less cluttered here as the vectors are not shown. But SA regulations still require you to submit a vector comparison sketch showing the original vectors of the boundaries being re-established, and your surveyed and final adopted distance and directions. *[DG: these vectors are calculated by calculating joins from original coordinates and from surveyed coordinates.]* I guess coordinates and vectors both have their place; sometimes it is easier to analyse data by looking at a coordinate shift, and other times distance and directions tell the story from a different angle.

We should be submitting digital coordinates, but at the moment SA is still submitting hard copies or PDFs, and the Surveyor General then captures the coordinates and checks closures. The survey data is then input into a GIS data base, but there is no direct integration or sharing of the coordinate information for survey purposes, which is frustrating. The old survey records are slowly getting scanned to an online database. What I miss about NZ is the generally higher standard of work ethic, professionalism and obviously the more technologically advanced cadastral system. I think the development of the system here is restricted by financing and government recognition and the scale and spectrum of land tenure issues is much bigger here.

DG: *Heartiest congratulations on passing your exams! You have given some good insights. I was interested to read about the vector comparison sketch. Yes, a coordinate transformation usually shows what is happening, but occasionally a comparison between joins from the previous and present survey can better show what movement there has been, and then a comparison sketch is helpful.*

I like what you say about SA not requiring vectors to be shown on a working plan/survey plan, although sometimes, even where one is not obliged by law to show measurements, surveyors find it helpful to do a printout of a layout and to hand-draw in measurements in red pen to prove (to themselves just as much as the Surveyor General, and also for the benefit of future surveyors) that every surveyed point has been checked.

OG: I do wonder where things will be in a few years time, as I hear the accuracy of phone GPS may get much better. I imagine with the integration of augmented reality, and a secure dig-

ital cadastre there could be a time when we do away with the placing of physical corner beacons. Home owners may be able to put on a head set and walk to the corner of their properties. The stakeout application could be via a phone app available to anyone, e.g. both adjacent property owners (allowing transparency, less conflict if both can get the same answer at any time). Surveyors will then become more like managers of the digital cadastre, ensuring its correctness, security and maintaining and updating the coordinates. I know it's a lot more complex than this because of the history of land ownership, records and mathematics involved etc., but the physical monument will always be vulnerable to disrespectful land owners and obviously to certain forces of nature.

DG: *Yes, the question of whether to go to the ultimate abstraction of coordinates only, and dispense with corner marks, is an old one. For countries with appreciable tectonic movement, a coordinate-based cadastre would have special difficulties, and you will have more experience of these than most, having surveyed in Christchurch. Let's say an entire land parcel, walled and with a house on it, moves relative to the country's active control reference stations. What is the land owner going to take as the extent of her/his property? Obviously the new position of the house and walls after the quake. However, if coordinates rather than physical boundary evidence ever become legal, then the occupation will be at variance with the legal coordinates. It will take some fairly heavy-duty mathematics to transform the legal coordinates to be in sympathy with the new occupation, and that mathematical transformation will need survey input of the post-quake positions of walls, houses etc. Transformations would also benefit from before-and-after positions of better-defined survey marks, but ironically, in a legal-coordinate cadastre these marks may be few and far between.*

If monuments continue to be the basis of the cadastre, a number of difficulties are avoided. If a corner mark is





missing and needs replacing, the usual way to do this is to find the closest survey marks that still occupy the same relationship with one another (checked by a coordinate transformation, or else by comparing joins from the previous and new surveys), then to infer a relative position from the closest accepted mark to the missing mark (in order to minimise bearing swing and scale errors), and so replace it. This requires no high-level mathematics, and it ticks the ethical box because it re-establishes the relative positions of occupation to which right holders have agreed.

If countries do go with this kind of “monument based cadastre” there are two obvious corollaries: first, that the more ground marks you have, the easier and more accurate it will be to replace missing or moved marks in future. This underlines the need to place boundary marks with well-defined centres that are as robust as possible, and to require these to be fixed by an independent determination. There is no reason why such marks should not have the same status as the survey control, thereby densifying the control network. The denser the control the better, for a whole lot of reasons, and well-defined boundary marks should be included in this control. Second, to record surveys in the form of coordinates rather than vectors because, while being exactly the same data, observation coordinates are much easier to upload into data controllers and CAD software e.g. for use in coordinate transformations. Coordinate files should be stipulated as a routine part of survey records. [OG: The excel file is a direct output from the survey software in the form of an ASCII, CSV, it takes one click of the button. In other words you build up your survey database on the screen as you would see it in plan view (with the option of opening a dataset that lists your point details).]

Even where a country does not experience major tectonic movement, monument based cadastral are probably a good idea, because “what you see is what you get” again ticks the ethical box. The necessity to possess suitable technology to stakeout corners (as you say, headsets to

“see” coordinates on the ground) arguably discriminates against lower income right holders and less-developed countries. Phone chips will also probably continue to need better antennas to achieve really good accuracies. Perhaps a workable and ethical solution that is also in line with technology advances could be for monuments still to be the legal bottom-line, but for real estate agents and right holders for many practical purposes able to visualise approximate boundaries with phone apps (with a legal disclaimer that results are indicative only). The surveyor’s role here would be managing the data, readjusting coordinates in line with tectonic movement and datum shifts, setting out boundary marks for new developments, and also arbitrating in cases where the phone app solution proved inadequate. The latter might include high-value land, contentious right holders, and high disturbance environments. For these cases, a suitably qualified quasi-legal practitioner (i.e. a land surveyor) would still need to confirm the closest unmoved control marks (hopefully these will be quite dense if well-defined and checked boundary marks have comparable status) and to re-establish missing or disputed points where necessary.

Postscript: The correspondence ranged more widely, from the idea of electronic chips being planted in boundary and survey marks, right through to “western” notions of land rights being at variance with deeply rooted ideas about communal tenure in African and Pacific cultures. From a cadastral perspective, perhaps the biggest paradigm shift for a New Zealand surveyor working in Southern Africa was accepting that observation coordinates are just another way of representing vector information, and not to be confused with “legal coordinates.” Ultimately monument-based cadastral the world over are about surveyors doing whatever it takes to establish and re-establish the relative positions of marks, and although the new generation of digital tools available today has changed the most convenient way of expressing survey data, it has in no way changed the underlying issues.

(continued from p36)

- higher-quality and more cohesive plans better linked to infrastructure supply that permit and prompt the supply of development capacity to keep up with demand;
- more use of market-based tools and infrastructure pricing, which signal to individuals and firms the efficient locations to develop, or times to use, infrastructure; and
- longer-term infrastructure and land-use planning

based on adaptive management and real-options analysis, which explicitly factor uncertainty into the development and analysis of options and incorporate flexibility in the investment decision-making process.

Paul Turner is a Director of Landlink Ltd, a Kapiti and Wellington based land development consultancy specialising in new neighbourhoods, strategic planning for land development and technical construction related work. Ben Addington is the Principal Planner at Landlink.





Christina Hulbe, Dean, National School of Surveying

Just about a month ago, while on holiday with my family in the US, I met a former university colleague for lunch. When I asked how things are going in her department she replied that their building is like a ghost town. Everybody is teaching and learning online these days. Now, that's surely an exaggeration but it does reveal how my friend feels about her work. She said that in the online versions of her papers, students spend more time writing than in the past and their skills in that area are improving. But because she doesn't see her students or talk with them directly, she does not know how or if their soft skills (social skills, communication, emotional awareness) are developing and because she can't read their expressions or body language, she doesn't know until long after a chat room discussion is over if anybody was really picking up what she was trying to lay down. The spontaneous human interaction is different now that it's digital. I don't know if her students miss the live interaction but they may not even recognise that a tradeoff has been made on their behalf.

I thought about this conversation when I finally started to read the recent Productivity Commission report, *New Models of Tertiary Education*. The Commission does not conclude that new models and "disruptive innovation" are needed, which was the premise upon which the report was requested by government (Chapter 1, page 11). Before writing more, I should note that the Commission would argue that as a beneficiary of the status quo, my view of their work is clouded by confirmation bias: "People in established, successful organisations tend to internalise their established ways of doing things as defining quality in their field." (Chapter 11, page 318). That's a reasonable concern but I have a good prophylactic; the academic literature on innovation in education.

The key proposals for disruption have to do with markets. The report offers a neoliberal view of education in which a diploma or degree is a commodity and the student is the consumer. The Humboltian model is out and market forces are in, though provision is made for government intervention in the market via a performance component in pricing (Chapter 13). Circumstances in which education consumers' choices are misaligned with industry needs

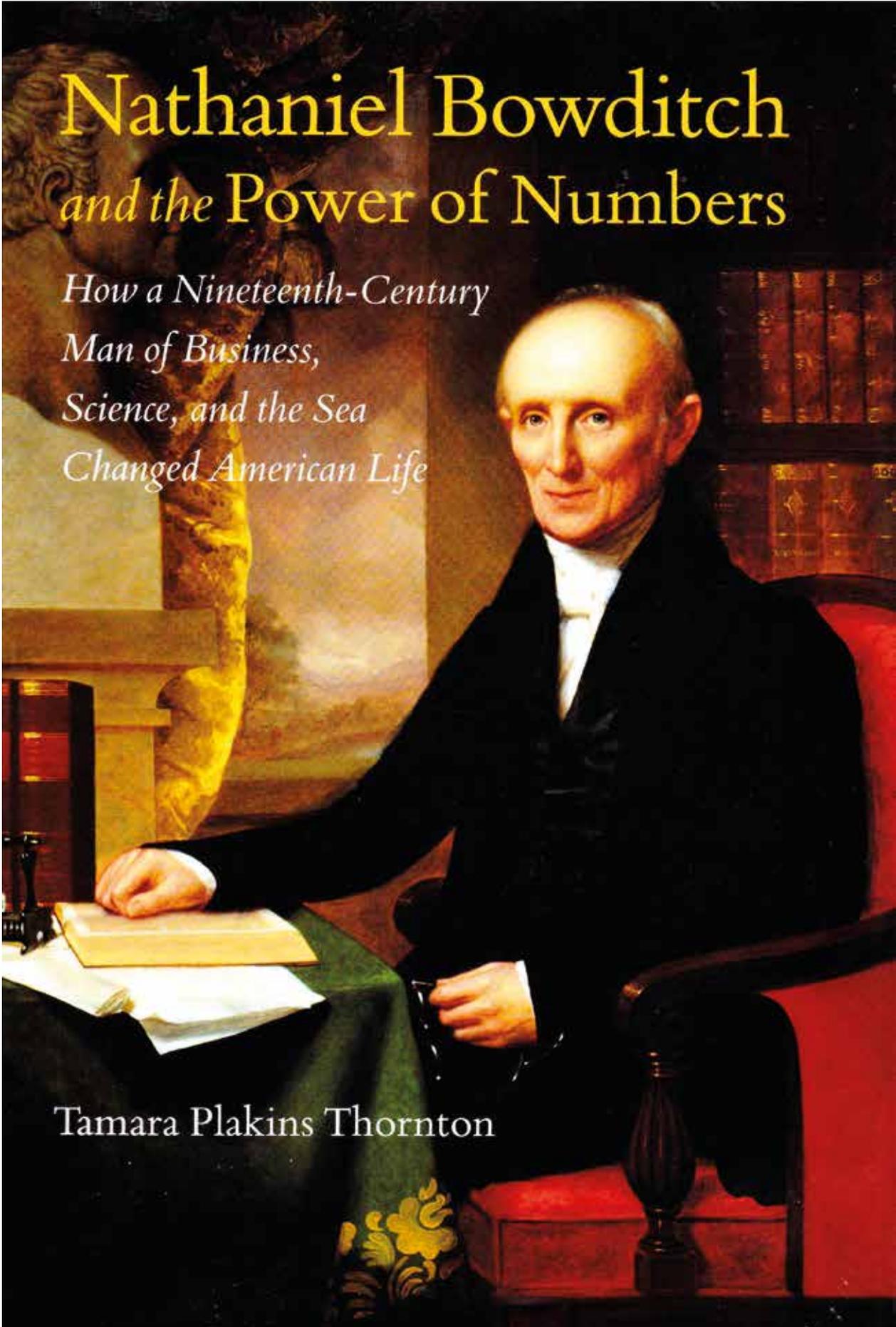
are also referred to (Chapter 15). Readers might want to think back to how they felt about lecture attendance in their first year at university before agreeing that the consumer is always right (unless I am wrong in my assumption that the student is the consumer in this model).

Online content delivery is the only teaching-focused disruptive agent given attention in the Commission's report. This should resonate with our community—distance to a brick and mortar campus or the need to balance work with study are sometimes raised as a challenge for developing new cohorts of surveying and geospatial graduates. However, the report notes that completion rates for "extramural" courses are lower than for intramural ones. Students aged over 40 and those who are retired have the highest completion rates (Chapter 11, page 342). The Commission's interest is market-based, that is, the interest is in access, not pedagogy. If you are interested in the latter, you might do an online search for one of the many distance programmes already available in New Zealand. A recent editorial in the journal *Distance Education* (Naidu, 2017) provides a good overview of the tradeoffs in this approach.

Even better, ask Hamish McKenzie and Debbie Hallam about the land surveying diploma programme at Bay of Plenty Polytechnic. Debbie developed their hybrid course, which blends together online, classroom, and workplace environments. Hamish is now delivering the content and recently, Paul Denys, Mick Strack and I have been talking with him about how to support each other and improve the pathway for students who complete a diploma and want to move on to university, carrying on from a conversation started with Debbie. You might also ask them about the significant effort involved in developing and delivering the programme. It's not easy to establish new programmes, and perhaps that's why the Commission report looks to offshore providers to offer alternatives (Chapter 11, 14).

I have not yet absorbed all 441 pages of the report but it certainly is interesting and I expect to find more aspects worth discussing. However, from the vantage point of a discipline founded in part on sound understanding of what

(continued p44)

A portrait of Nathaniel Bowditch, an elderly man with a receding hairline, wearing a dark suit and a white cravat. He is seated in a red upholstered chair at a desk covered with a green cloth. On the desk are several books and papers. The background features a bookshelf and a bust of a man's head.

Nathaniel Bowditch *and the Power of Numbers*

*How a Nineteenth-Century
Man of Business,
Science, and the Sea
Changed American Life*

Tamara Plakins Thornton

Nathaniel Bowditch

David Stewart FNZIS

A long time ago in a galaxy far, far away, when I started work as a survey cadet in 1962, I began computing traverse closures. I soon learned about the Bowditch rule as the means of eliminating closing errors; it was enshrined in the 1959 Survey Regulations, where Section 22 read;

Elimination of close – *In new traverses forming a complete surround or traverses connecting two standard blocks or two triangulation stations, where these have been adjusted to conform with the “geodetic triangulation”, the closing error is to be eliminated by the Bowditch rule, by distributing the closing error according to the following:*

- ♦ *As the total length of the traverse is to the length of each line, so is the whole error in latitude or departure to the correction of the corresponding latitude or departure, each correction being so applied as to diminish the whole error in latitude or departure.*

Heady stuff for a young cadet, I think I was just taught what to do, rather than trying to decipher that clause in the Survey Regulations. The firm I was working for was engaged in large scale land development projects, where there would be a number of adjoining traverse circuits within the property, so as to be able to peg each point on the subdivision.

A more senior cadet in the firm, Ron Goodwin, told me that on that type of job, you should first look at the traverse leg that was common to two adjoining circuits, and if a correction in that line would improve the close in both circuits, then that correction should be applied first before applying the Bowditch rule to the balance of the circuit. I don't think the plan checkers ever noticed this minor but sensible departure from rule.

There was an almost identical provision in the 1972 rewrite of the Survey Regulations at Clause 22, but by the time of the 1998 rewrite, with the advent of computers capable of more sophisticated adjustment techniques, the corresponding provision at Clause 28 read;

Misclosures – *Misclosures must be distributed by a systematic adjustment acceptable to the Chief Surveyor.*

At the time I first learnt of the Bowditch rule – with so much to learn as a cadet in so many subjects – I never had the time or inclination to ponder where the Bowditch rule had come from. Fast forward forty years or so, having become a keen golfer, I often watch the television coverage of the US PGA Tour tournaments. I noted the

emergence of a young Australian professional on the Tour, Steven Bowditch. That was the first time I had seen the name again, and I did wonder if he might be a descendent of the originator of the Bowditch rule, but never had the opportunity to enquire further.

Then in the latter part of last year, I read a news report that an underwater drone operated by a US Navy survey ship in the South China Sea, had been abducted by the Chinese. I believe that the drone was returned without incident, but was interested to read that that ship that had been operating the drone was the USNS Bowditch. This aroused my curiosity and some investigation soon led me to Nathaniel Bowditch.

What a man. He was born in Salem, Massachusetts in 1773, and was based there until 1823, when he moved to Boston. He then lived in Boston until his death in 1838. His father came from a family of several generations of seafarers. His father had originally learned a trade as a cooper, but then also became a sea captain. However in 1775, at the start of the American Revolution, his father's ship was captured at sea by the British. He was held prisoner in Halifax until he escaped in 1777. His father never went back to sea, and on his return to Salem worked in his cooperage business.

Nathaniel started in what was then called a Dame school at the age of three. A Dame school was generally a small school run by a woman, often in her home. The teacher is reported as saying he was the best scholar she ever had. At age seven he started at a more conventional primary school. He asked the teacher to let him try to solve a complex mathematical problem and when he solved it, the teacher accused him of cheating and getting help to solve it. But he soon demonstrated that he could solve the problems on his own, and in today's term would be called a child prodigy.

But at age ten, his father made him leave school to work in his cooperage business. That started a long period of self-teaching. At age twelve his father indentured him for nine years as a bookkeeping apprentice to a ship chandlery business near the Salem harbour. The job also provided board and lodgings, and the owners of the business encouraged him to continue his studies at the end of the working day. There were also a number of men of learning and science in Salem who mentored him and gave him access to their libraries.

At age fourteen he began to study algebra and two years later taught himself calculus. He found many texts

on mathematics by the likes of Isaac Newton which were in Latin, so at seventeen he taught himself Latin, and two years later taught himself French. He also developed an interest in navigation under a former Royal Navy survey master. On completion of his indenture in 1794 he worked with a sea captain on a survey of the Salem foreshore. It was reported that he had been paid twenty-seven pounds, a considerable sum in those days, for his work, so the survey would have been extensive.

In 1795 at the age of 22, he went to sea on the first of four voyages as the vessel's clerk and captain's writer. These were long voyages, to Spain, Portugal, the Philippines, Indonesia and Reunion Island. During this time at sea he became intensely interested in the mathematics of celestial navigation and very soon became de facto navigator on the voyages. In those days navigators used the English almanac, "Moore's New Practical Navigator", prepared with assistance from the British Astronomer Royal, Nevil Maskelyne.

Moore's work was known to contain errors, and Bowditch set about trying to recompute all Moore's tables and rearrange the work. However the task became so extensive, he decided to write his own book, and to put down in the book "nothing I can't teach the crew". In 1802 his Bowditch's Practical American Navigator was published, and it soon became known as "the sailors bible". An important element of his publication was an improved method of observing 'lunars' to determine longitude. Bowditch's method allowed a mariner to determine his longitude by measuring the angle between the moon and specified stars. His publication include tables with precalculated corrections for parallax and atmospheric refraction.

Whilst John Harrison's marine chronometer appeared in the mid-1700s, they were extremely expensive and not in common use on vessels until the 1830s. Bowditch's fifth and last voyage was as master and part owner of the ship. On that voyage it is reported that every man of the crew of twelve, including the ship's cook, became competent to take and calculate lunar observations and to plot the position of the ship.

He returned from that last voyage in 1804, having married in 1798 and eventually fathering eight children, fur-

(continued from p41)

it means to make and use a measurement, I am surprised and disappointed at the lack of statistical context for any of the large number of charts and graphs presented by the Commission. Of the many trends reported and discussed, for example, none are accompanied by a statistical test to show at what level they have significance. This is a little bit ironic. In some places the report criticises (rightly, in my view) testimony to the commission that was not itself

ther risky sea voyages were not considered. He resumed his mathematical studies and entered the marine insurance business, becoming what is regarded as America's first insurance actuary. In 1799 Bowditch had been elected to the American Academy of Arts and Science and in 1802, following publication of his almanac, Harvard University awarded Bowditch an honorary Master of Arts degree.

He published numerous articles on lunar observations, naval charts of several harbours, and papers on the orbits of comets. Bowditch's translation of Pierre-Simon de Laplace's 'Traite de Mecanique Celeste', an advanced mathematical treatment of the working of the solar system, was completed in 1818. By 1819 his international reputation had grown to the extent that he was elected as a member of the Royal Societies of Edinburgh and London, and the Royal Irish Academy.

By 1823 Boston had grown to a much larger commercial centre, and following his move there that year, he became increasingly involved in insurance, trusts and investment management. He is said to have applied the rigorous logic of mathematics to the operation of the businesses he was involved with, rather than the *laisse faire* approach that prevailed in a lot of businesses at that time. Following his death in 1838 a memorial statue of him was erected through public subscription in the Mount Auburn Cemetery where he was buried.

Coming back to the Bowditch rule, it is reported that it was devised by Bowditch as a proposed solution to the problem of compass traverse adjustment, which was posed in the American journal "The Analyst" in 1807. That publication described him as a surveyor, navigator and mathematician.

The following books on Nathaniel Bowditch have been the source of most of the material in this article;

Memoir of Nathaniel Bowditch, by Nathaniel Ingersoll Bowditch (his eldest son), 1840.

Carry on, Mr Bowditch, by Jean Lee Latham, 1955. This is a fictionalised account of Bowditch's life up to the time of his first sea voyage, aimed primarily at younger readers.

Nathaniel Bowditch and the Power of Numbers: How a Nineteenth Century Man of Business, Science, and the Sea Changed American Life, by Tamara Plakins Thornton, 2016. Thornton is professor of history at the State University of New York, Buffalo.

contextualised. Perhaps they should enrol in an online statistics paper. There is one on at Massey right now.

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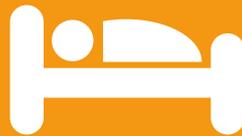
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