SURVEYING + SPATIAL

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Issue 93

Earthquakes, dolphins and big data – challenges in hydrographic surveying

Conservation on the Antipodes Islands – GIS in action

Volunteer surveying in post-earthquake Nepal

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A Year of Change

Rachel Harris

2018 is well under way and already shaping up to be a year of significant climatic events. As I write, ex-tropical Cyclone Gita is looming large over central New Zealand and many of us are bracing for gale force winds, torrential rain, coastal flooding and widespread damage across the region.

The issues surrounding climate change have certainly sparked debate around the world, but the surveying community is taking note of this immensely important global issue, considering some of the challenges related to climate change within the industry this year.

This year's NZIS conference in Nelson will feature a timely discussion on rising sea levels and what it means for the surveying and spatial sectors. Professor Matt King, from the University of Tasmania, and Professor John Hannah, Emeritus Professor at the University of Otago, will pose some interesting questions for the surveying community.

The Australasian Hydrographic Society will also be addressing this theme at Hydro18 in Sydney this year, focusing on 'The Climate for Change-Hydrography in the 21st Century' and how best to utilise the science of hydrography to adapt to climate change, resource sustainability and renewable energy requirements.

Our first edition for 2018 features a range of specialised topics, from the legalities surrounding the vesting and dedication of public roads, to real-time monitoring on the Britomart Station project and an overview of Trimble's Catalyst technology, winner of the 2017 NZSEA Supreme Excellence Award.

The challenges of hydrographic surveying in Queen Charlotte Sound/Tōtaranui and the Tory Channel/Kura Te Au area are examined by LINZ Senior Hydrographic Surveyor Stuart Caie and Bruce Wallen, Quality and Projects Manager at Discovery Marine Ltd, who discuss the geographical, environmental and technical encounters faced during the hydrographic survey programme.

Department of Conservation geospatial analyst Ann De Schutter gives her personal account of GIS use on the 'Million Dollar Mouse Project' on the remote Antipodes Islands. The rodent eradication project, a collaboration between DOC and the Morgan Foundation, aims to protect the islands' biodiversity and aid recovery of native species from the effects of predation.

From the young professionals, Jordan Friis gives an insight into volunteering in Nepal's post-earthquake recovery as part of the International Federation of Surveyors new volunteer programme for young surveyors.

This edition will also revisit the complex issue of cross leases in Mick Strack's Case Law Commentary, with a recent case study of a cross lease shared arrangement that descended into legal action.

Finally, on a lighter note, Duane Wilkins takes a look at his top 10 free geospatial datasets to browse this autumn.

Happy new year everyone.

Integrating land and sea data

Mark Dyer

Kia ora koutou.

There is no doubt that collectively we are driving better decisions by creating, analysing, and presenting geographic information to those who need it, when they need it. This presents fantastic opportunities for new approaches and innovation. We are also experiencing, along with decision makers, increased client demands to respond with accurate and authoritative information, often complemented with other information of unknown provenance or trust.

Good information can inform good decisions. Often the information required only needs to be fit for purpose – 'approximately right rather than horribly wrong' – and provided at the right time to lead to those good decisions. But information gathered and analysed for one purpose and then applied to other decisions can lead to trouble.

There is also the efficiency argument: if information is being commissioned for one purpose, what else can it be used for? In many cases these future or alternative uses can't be anticipated, and so the metadata about that information is critical.

Some fundamental elements of geospatial information need to be captured and understood. Datums and projections, as well as time, are essential. We also need to understand the adjustments and error analysis to inform that future use – can it be relied on in its current form, or do we need to revisit the processing of raw data?

Once we understand these elements, we gain confidence when we relate one dataset to another, and then we have increased confidence in what analysis of the integrated data tells us.

One of New Zealand's big challenges is understanding the relationship between the land and sea. With increasingly sophisticated models of sea level rise, tidal models, and modelling of land and seafloor surfaces and deformation, it is important that our geographic information is able to integrate and support decisions.

LINZ recently commenced its Joining Land and Sea (JLAS) project, a programme of work to integrate land and sea-based data. Height and depth datasets are currently captured, reduced and disseminated in relation to a range of reference surfaces or datums.

Historically, terrestrial measurements were referenced to one of the 13 local MSL vertical datums based on a local tide gauge. Marine boundaries and depths were also defined in terms of marine tidal levels or datums such as Mean High Water Springs (MHWS) or Lowest Astronomic Tide (LAT). However, these marine surfaces were often identified from a temporary tide gauge established for the duration of a survey or interpolating tidal levels between the nearest ports, rather than referencing the same tide gauges as they do on land.

Increasingly, height information has been determined using GNSS, and consequently the GRS80 ellipsoid of New Zealand Geodetic Datum 2000 (NZGD2000) is being used for vertical positioning on land as well as at sea. Recently, LINZ implemented the new geoid-based (rather than tide-based) vertical datum, New Zealand Vertical Datum 2016 (NZVD2016). NZVD2016 provides a standardised national datum and enables transformations between the land-based vertical datums.

LINZ's JLAS project aims to develop a transformation tool, to use between the land and marine datums. The JLAS project uses NZVD2016 as a common reference surface, thereby enabling the integration of land and sea spatial datasets. At a future stage of the project, we are looking to include the integration of an improved New Zealand tidal model to enable the determination of a marine datum. This will allow us to use our GNSS measurements and the transformation tool to determine surfaces such as MSL or LAT from ellipsoidal heights at any given location along the coast.

Ngā mihi.

Cadastral

The stream has been busy over the last couple of months working towards finalising the registered professional certification requirements for Cadastral. This has been a very time-consuming process and one that we feel must be right prior to its release.

We have also been working with LINZ on both the ASaTS project and the early stages of the rules review process. We urge all members to get involved with both of these projects where appropriate, as we are going to be the end users. It is a great opportunity for the profession to work with LINZ to ensure that we all achieve an ASaTS platform and a set of rules we are proud of.

Earlier this year a call was put out, on behalf of LINZ, for cadastral surveyors wanting to be involved in a working group to review the rules, to forward their details to LINZ. By the time this is published, the deadline for expression of interest will have passed. I am sure LINZ will have received applications from some very capable and respected surveyors. Last year we organised, with assistance from National Office, the GNSS for Cadastral Surveys seminar. If there is a topic that members believe would be a good seminar topic, please let the group know and we will look to organise an event for later in the year. If you have a suggestion for a seminar topic, please email us via National Office.

Matt Ryder, Cadastral Stream Chair

Engineering

Nightworks – installation of the water main on Royal Road Bridge

The Auckland engineering surveying space in the construction industry is booming. Large infrastructure projects are dominating the workloads, whereas the infrastructure maintenance side has been in decline, highlighting the priority of local and national government.

The SH16 Lincoln to Westgate Project is on track to be delivered by November 2018. Construction includes three new bridges, a new Royal Road off-ramp, bus shoulders, a designated shared cycleway/pedestrian path, 30-plus retaining walls, stormwater lines, a wetland area, water mains and numerous service relocations.

A key aspect of the works on site is the ability of the survey team to geometrically model the site, to ensure works are constructible and/or designed cost effectively. Working in conjunction with other contractors, our team had to be experienced with Leica - Trimble - Topcon machine control systems, deformation monitoring, directional drilling, pipejacking, 3D bridge modelling and pavement construction.

Engineering stream contributors:
Daniel Wiederkehr Daniel.Wiederkehr@downer.co.nz
and Les Whalley les@landsandsurvey.co.nz

Hydrography

The Hydrography Professional Stream is looking forward to a dedicated stream day on Thursday, May 17, at the NZIS Conference in Nelson. We have planned a tour of Port Nelson followed by a range of hydrography related presentations in the afternoon – from Hydro101: 'How to do a hydrographic survey', to reports on the latest charting work undertaken around New Zealand, updates from LINZ and Otago, and a discussion of RPSurv certification for hydrographers. All are welcome (not just our stream members). We will wrap up our day with a HPS meeting and open forum. Look forward to seeing you there.

The Australasian Hydrographic Society will be calling for nominations for its annual Award Scheme in April and applications for its Education Award in April/May. Remember to pencil in October 30 –to November 2 for the HYDRO18 '*The Climate for Change. Hydrography in the 21st Century*' conference in Sydney.

Go to: *http://www.ahs.asn.au/* for more information on awards and the conference.

Emily Tidey,
Hydrography Stream Chair

Land Development and Urban Design

I recently took over the role of stream chair in November, at the AGM in Wellington. I would like to thank Phil Cogswell for his valuable contribution as stream chair since the early days of the revised NZIS structure.

After graduating from Otago in 2010, I became licensed in 2014. Land development is a core aspect of my role at Beyond Ltd in Tauranga. I have worked on a range of projects and have a particular interest in urban design.

Phil will stay on as a member of the Land Development and Urban Design Stream Committee and continue to represent the stream on the National Technical Committee for the upcoming Nelson conference in May. Organisation of the conference is well under way, and we aim to provide site visits and speakers that stream members will find valuable.

For the Land Development and Urban Design Stream, moving forward into 2018, there will be a strong focus on continuing professional development opportunities. I would like to encourage members to suggest topics of particular interest. I look forward to hearing from you at: Julia@beyondnz.co.nz.

Julia Glass, LDUD Stream Chair

Positioning and Measurement

A7RT: Clifford SD, visited in Summer 2018 GNSS Campaign

This summer has seen some interesting developments with regards to 'Projections and Datums', the stream theme for 2018.

On Sunday, January 14, a new version of NZGD2000 (v 20171201) was released. This update included deformation model 'patches' for the movement due to the Kaikōura earthquake of November 14, 2016 and subsequent post-seismic deformation. More information about this update can be found on the LINZ website.

Following on from the Kaikōura 2016 earthquake and the NZGD2000 update, many members of the P&M committee have been out in the field collecting campaign GNSS data. The goals of this collaborative project between GNS Science, Otago University and LINZ is to investigate post-seismic deformation and continue to enhance the NZG2000 deformation model.

Rachelle Winefield,
Positioning and Measurement Stream Chair

Spatial Stream

A key focus area for the Spatial Stream over the past year has been the ongoing discussions around the introduction of spatial professional certification. These discussions are ongoing, with the intent to provide a framework that will prove both valuable and sustainable for the spatial industry and our spatial members.

There has also been a focus on planning for the NZIS conference in May, with the stream reps contributing to the spatial content within the conference programme. As always, we see this as an opportunity to better connect across the streams and understand the diversity of perspectives that contribute to the NZIS membership as a whole.

As well as the NZIS conference, there are also some other conferences of interest to members coming up in the early part of 2018. Of particular note is the GeoSmart Asia2018/Locate2018 joint conference being held from April 9-11 in Adelaide, which will be a significant geospatial event for the Asia-Pacific region.

The ALGIM Autumn conference, which includes the GIS symposium, will be held on 14-15 May in Wellington and brings together practitioners and experts from across New Zealand's councils.

There have been a few new degree initiatives from tertiary providers in the geospatial area which we have provided feedback on, and look forward to their progression and implementation.

Kat Salm, Spatial Stream Representative

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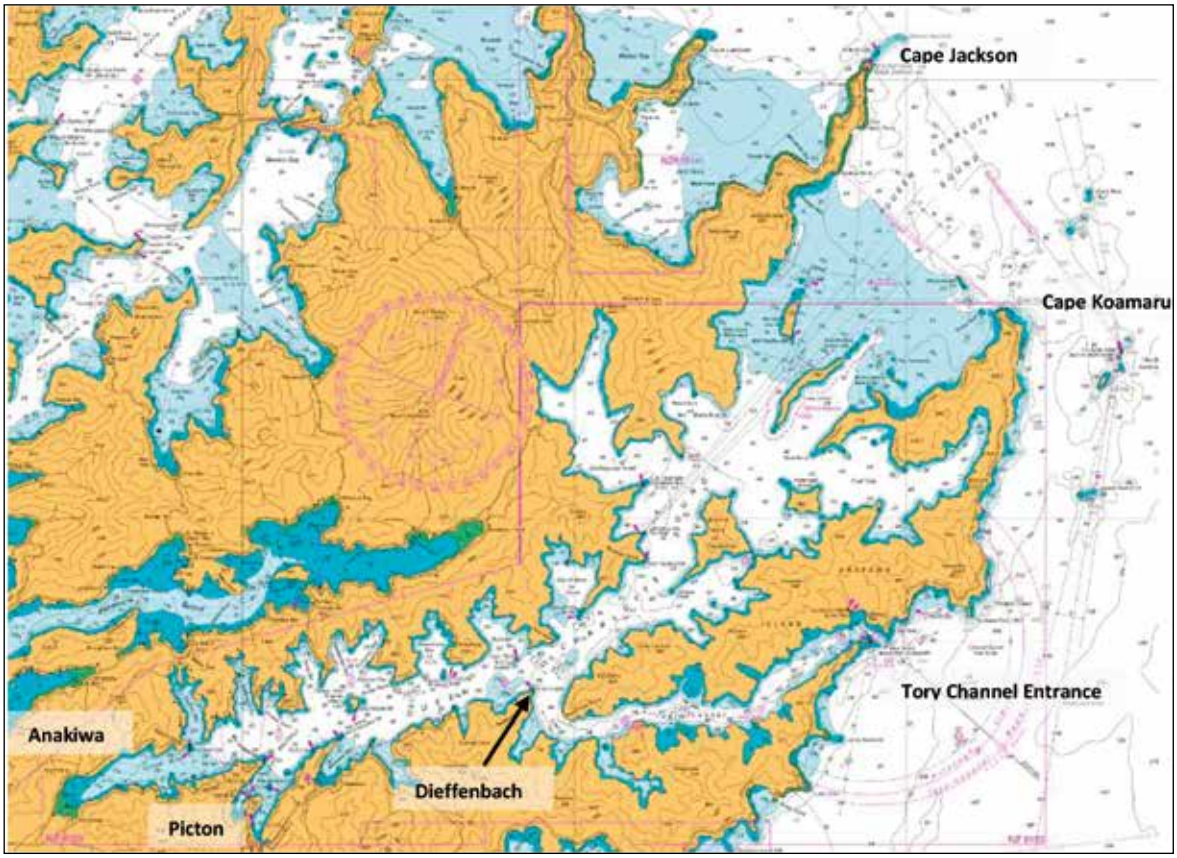


Portion of LINZ Chart NZ615 showing Queen Charlotte Sound/Tōtaranui and Approaches

EARTHQUAKE, DOLPHINS AND BIG DATA

The challenges in hydrographic surveying

Stuart Caie, Senior Hydrographic Surveyor, Land Information New Zealand (LINZ) and Bruce Wallen, BSc, MNZIS, Quality and Projects Manager, Discovery Marine Ltd (DML)

Introduction

In 2016, Land Information New Zealand (LINZ) completed an evidence-based, risk-led assessment[1] of the accuracy and adequacy of nautical charting in New Zealand. The results identified Queen Charlotte Sound/Tōtaranui and Tory Channel/Kura Te Au as areas of heightened risk. LINZ, in partnership with Marlborough District Council (MDC), developed a programme of work to carry out hydrographic surveys for safety-of-navigation and scientific purposes. This collaboration was a first for both organisations.

The survey requirements called for a variety of deliverables in a number of areas on a variety of dates. Given the size of the survey area (440km^2), the number of water users, time constraints, inquisitive dolphins and large volumes of data, the project posed some known challenges. Throw in an earthquake and the challenges increase.

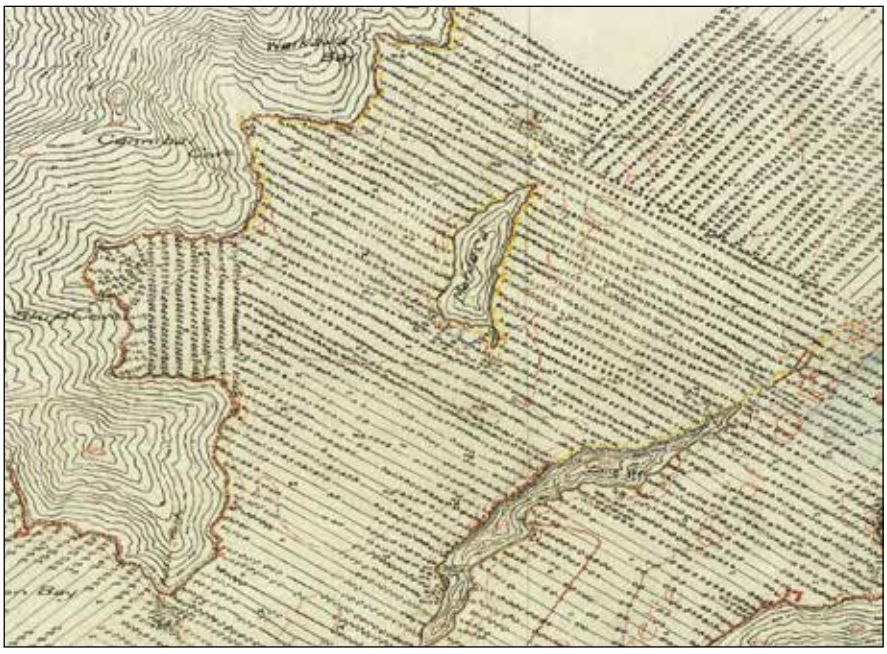
Managed overall by LINZ, the prime contractor was the National Institute of Water and Atmospheric Research (NIWA), which will deliver all the science components. Discovery Marine Ltd (DML) was subcontracted to provide the hydrographic survey components, which included the provision of the surveyor-in-charge and the delivery of safety-of-navigation components. At the time of writing, the safety-of-navigation draft deliverables have been received by LINZ, which is now wading through the vast dataset, validating the deliverables. Once this process is complete, the data will be used to update the charts. This

article describes the rationale behind the survey and discusses the challenges encountered during the project.

Background

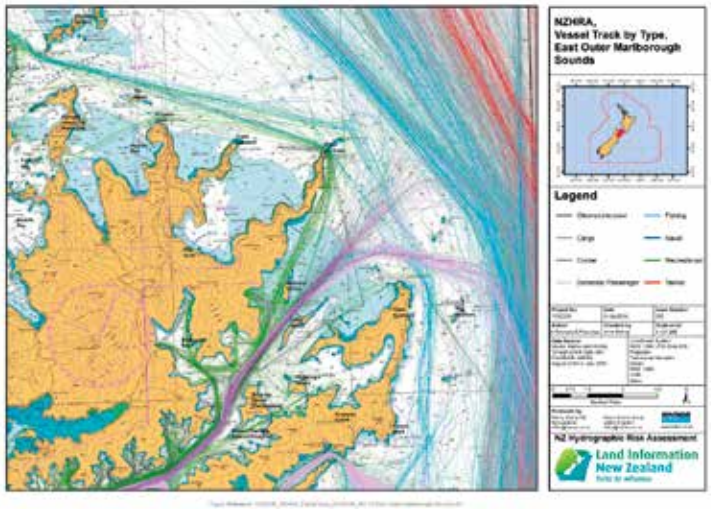
Queen Charlotte Sound/Tōtaranui comprises 320km of deeply indented coastline, formed by a drowned valley system with generally steep sides and a relatively flat seafloor. The northern entrance lies between Cape Jackson and Cape Koamaru, an area that shoals from 380m depths to 20m. It contains shallow banks and rock ridges, giving rise to extremely turbulent waters with strong currents, eddies and upwellings. The eastern entrance is through Tory Channel/Kura Te Au where very strong tidal streams enter and exit the Sounds through a narrow passage. The two approaches merge at Dieffenbach Point, from where the Sound leads inland to Picton and Anakiwa.

The last full survey of the area was undertaken in 1942-43 by HMS *Elaine*. Additional areas in Tory Channel/Kura Te Au and the northern approaches to Queen Charlotte Sound/Tōtaranui were surveyed by the RNZN in 1978 and 1984. An area adjacent to Long Island was surveyed by MDC in 2005. All these surveys were undertaken with single beam echo sounding (SBES) systems operating either wet paper recorders or electronic stylus digital depth recorders. Positioning was by sextant resection or two range trisponder microwave positioning. Only the 2005 MDC survey was carried out using DGPS.



Portion of 1942-43 HMS *Elaine* survey sheet showing Ship Cove and Long Island

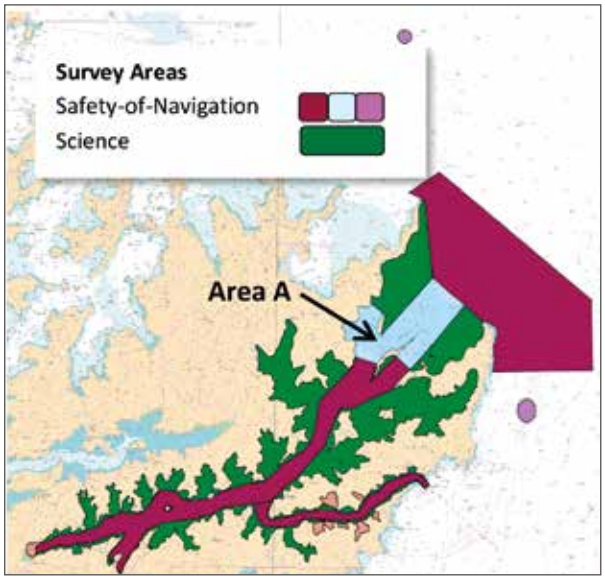
Using the results of the New Zealand Hydrographic Risk Assessment, LINZ identified Queen Charlotte Sound/Tōtaranui and Tory Channel/Kura Te Au as a priority to undertake a modern hydrographic survey. LINZ was also investigating opportunities to collaborate with stakeholders to maximise efficiencies by utilising the survey assets for other activities closely aligned to LINZ objectives. Following discussions with MDC, LINZ discovered they had scientific-focused survey needs in the Sounds, and through a memorandum of understanding, both parties worked together to redefine the survey requirements.



Vessel track by type, east outer Marlborough Sounds (August 2014 to July 2015)

As the New Zealand Hydrographic Authority, LINZ requires data and information to improve the accuracy and adequacy of the nautical charts for the area. The LINZ requirements and specifications[2] are well known, have been in use for decades and are based on the International Hydrographic Organization (IHO) Standards for Hydrographic Surveys, S-44.[3]

As the agency responsible for maritime safety within their area of jurisdiction, MDC has similar requirements for safety-of-navigation. Of priority was the delivery of data by January 2017 to enable the MDC harbour master to make a decision on the location of a pilot boarding station close to Long Island (Area A on map following); and preferred routes for larger vessels entering the Sound from the northeast. In addition, in late 2019, large-scale celebrations in Ship Cove and other locations around New Zealand will commemorate the 250th anniversary of



Lieutenant James Cook's arrival in New Zealand. As there is expected to be a large number of vessels attending, and the chart uses data from 1942-43, there was a need to ensure the chart was updated with new data well in advance.

MDC also requires information to support its monitoring, management and decision-making processes in relation to the natural environment. In particular, the characterisation and mapping of seabed habitats; benthic terrain modelling to classify habitats and ecosystems; and the identification of biogenic (or living) habitats important for biodiversity throughout the entire Sounds area. Specifications for the science component took some time and effort to finalise, to ensure the requirements were well understood and explained.

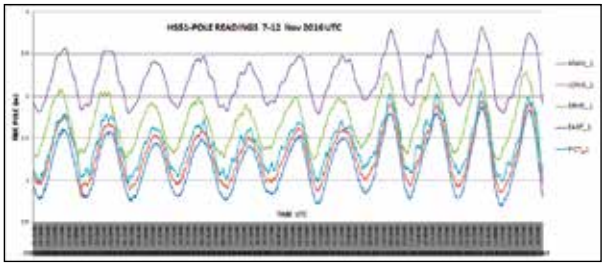
Survey fieldwork

Two vessels were used for the survey, RV *Ikatere*, operating a Simrad EM2040 multibeam echo sounder (MBES) and RV *Rukuwai* operating a Simrad Geoswath to provide Side Scan Sonar (SSS) coverage and an ODOM CV100 single beam echo sounder (SBES) system. NIWA and DML personnel operated from local accommodation established in Waikawa for two periods of fieldwork, from 12 October to 16 December 2016 and from 7 February to 22 June 2017. There were between three and five DML personnel and a similar number of NIWA personnel on site at all times. The survey involved 195 days on the survey ground during which both vessels were operating. The MBES sounding took 136 days and the Geoswath and SBES work took 44 days each. Collecting ancillary data such as positioning of lights and beacons, measuring light sectors, seabed sampling and checking the coastline took a further 24 days. Installing seven tide stations, levelling the associated benchmarks and monitoring tides throughout the survey took 43 days. Weather downtime was only six days, whilst 16 days were lost to MBES component failures/replacement/recalibrations. During some of the MBES downtime the survey vessel was used for other survey tasks.

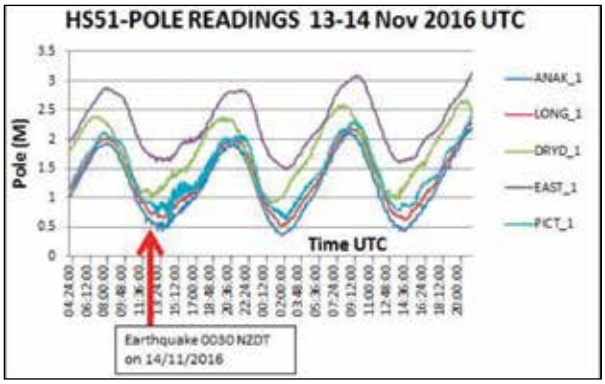
Challenges

Tides

A total of seven tide stations were installed for the survey to provide vertical control and connect to Chart Datum throughout the survey area. It was anticipated that these gauges could all be linked together, and a linear interpolation tidal correction model be developed to provide a seamless surface representing Chart Datum. However, after logging water level data for several weeks, it became apparent that the tidal regime was non-linear and uniquely different in various parts of the Sound. Time lags, seiching, varying range and the effects of weather in Cook Strait were seen in the tidal data. The following image shows overlapping tide curves for five gauges.



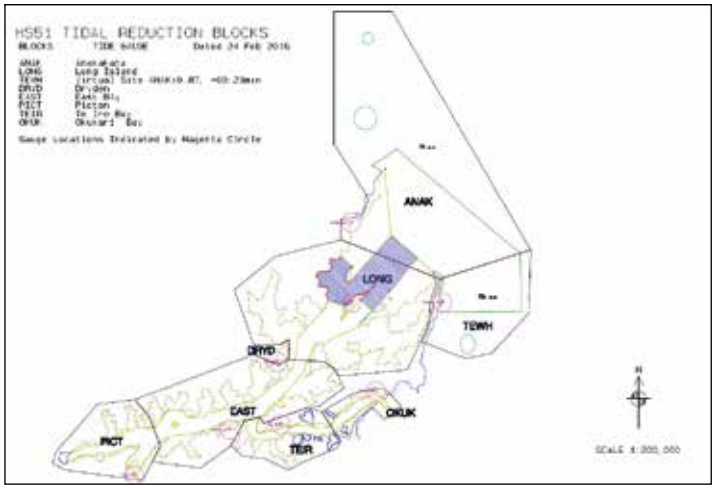
The application of standard datum transfer methodologies to derive datum was replaced by undertaking a series of harmonic analysis using at least 30 days' data for each tide station. The first complete 30-day dataset was expected late November/early December 2016, allowing datum to be defined and depths for the priority area reduced and validated in time for rendering to MDC by January 2017.



This first 30-day set of data for tidal observations was disrupted by the Kaikōura earthquake on 14 November 2016. The tidal data was corrupted for several days and required additional checks and levelling between benchmarks to verify that relationships between gauges, tide poles and benchmarks had not changed. Only minor shifts

(<3cm) were observed at all stations. This disruption to data caused by the earthquake meant the determination of datum was not possible until February 2017 at the earliest.

In view of the challenges with the tidal regime and the delay in defining effective sounding datum for each site, the tidal correction methodology was changed from linear interpolation to applying simple block corrections based on a defined geographic area around each tidal station. This approach allows tidal corrections to be re-applied at a later date, post-survey, should a better tidal model be developed. The boundaries for the area within which each tidal station was applied were set to ensure there was minimal step in tide between adjacent tide reduction blocks. Using a survey line that crossed each boundary, a comparison was able to be made on each side to verify that the tidal step was within the allowable total vertical uncertainty of the specifications. The steps across boundaries were quite small and varied between 0.01m to 0.17m, with one boundary step at 0.25m which was in an area of water depth greater than 40m depth.



Tidal reduction blocks

The challenge of defining datum at each station also meant that field processing and checking of survey data for coverage and gaps were undertaken using provisional sounding datums for each tide station. Whilst the best value at the time, using provisional datums, meant that all data needed to be reprocessed for final tides post-survey.

Deliverables and deadlines

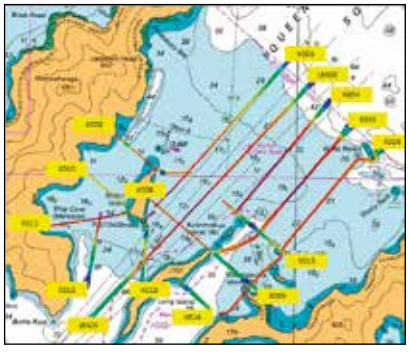
For most hydrographic survey work, clients receive results at the end of the job, when all data has been checked and validated to ensure specifications have been met.

For this survey, three sets of deliverables were required at different times during the survey; MDC required bathymetry and coastline for Area A by January 2017, LINZ required complete deliverables of the same area by May 2017, and LINZ draft deliverables for the entire survey area were required by January 2018.

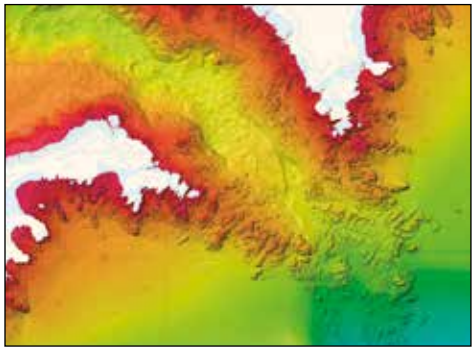
The challenge of these various deliverable requirements and dates was in the planning, co-ordinating, monitoring and directing personnel involved in processing and survey fieldwork at the same time. As data capture continued specific activities, such as checking aids to navigation and the coastline, were undertaken in addition to processing, checking and rendering portions of the survey data. Having a robust process for recording which data had been processed and what had happened to it was essential to avoid any loss or duplication. Essentially the work involved running two smaller surveys inside a larger survey.

Achieving the MDC requirements meant completing all fieldwork for Area A before departing the survey ground in December 2016. Sounding of Area A was top priority and was proceeding on schedule until the Kaikōura earthquake occurred on 14 November 2016. A possibility existed that the earthquake had altered the already surveyed seafloor and that work may need to be repeated. To determine if this had occurred, a series of close spaced MBES check lines were run through the area already sounded to identify whether there had been any changes to the seafloor that exceeded survey depth accuracy specifications. The range of mean differences was -0.03m to +0.04m. These checks confirmed depths were within the required accuracy standards and there had been no significant change to the seabed as a result of the earthquake. However, the earthquake also disrupted the time series to be used for the determination of datum for Area A. This resulted in depth data rendered to MDC being classed as provisional.

In addition to these checks, MDC requested checks were carried out around the wharves in Picton to understand what, if any, changes had occurred before permitting vessels alongside.



Location and names of Area A cross lines



Area A MBES final coverage

Data for Area A delivered to MDC in January 2017 included a dense XYZ depth dataset of 32 megabytes, 2 megabytes of plotted XYZ depths, 4x 1:10,000 plots and a survey report. It was adequate for MDC planning purposes and has enabled decisions about pilotage routes and aids to navigation to be progressed. The difference in density of data points used for charting between the 1942-43 survey of Ship Cove and the 2017 survey can be seen in the following images of Ship Cove (images at approx. same scale).

Portion of Cook's 1770 chart of Cook Strait and Queen Charlottes Sound, image from *Early Charts of New Zealand, 1542-1851, P.B. Maling, AH&AW Reed, 1969.*

Ship Cove survey 1942-43 (depths in fathoms). Depths represented at a scale 1:25,000.

Ship Cove survey 2017 (depths in m). Depths represented at a scale 1:10,000.

Compilation of LINZ May 2017 deliverables for Area A required full reprocessing of the dataset using the approved tidal datums, thorough checking of the combined final surface and compilation of LINZ specified reports and datasets. Draft LINZ deliverables for the entire survey were compiled and rendered in late December 2017.

Due to the large data volumes, processing computers were not available for other work at times. The time required to load daily project files and make a surface ranged from 12 to 48 hours per block. When edits made to the block surface were unloaded back to raw files or data was exported, the time required could be as long as 48 to 96 hours. Making a backup copy of a block project could take anywhere between 12 and 18 hours.

Area	Bathymetry	
	Raw	Processed
Area A	1.1 Tb	284 Gb
Entire area	13.0 Tb	914 Gb

Volume of data delivered to LINZ

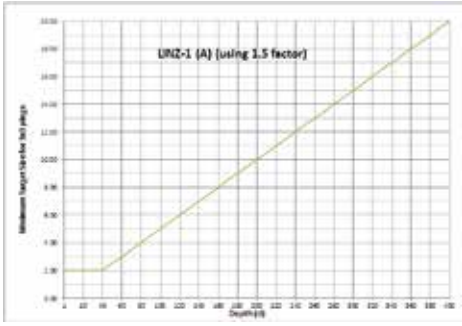
Achieving the processing task took a total of 6700-man hours expended by a dedicated team of four personnel working in shifts of two each day from 8 July to 5 December 2017. Apart from the tedium of data cleaning for 6 hours, personnel were challenged with managing and tracking the volume of data as they worked across different data blocks containing 14,084 MBES and 964 SBES data files.

Data collection to achieve specifications in outer QCS and approaches

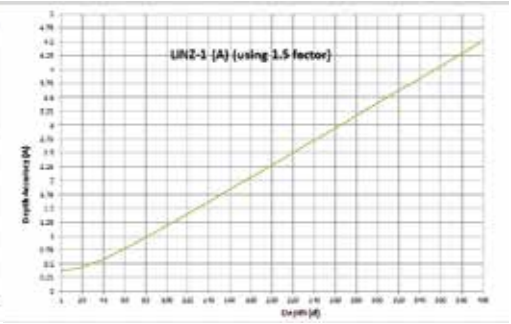
When planning an MBES survey, the estimated time to be spent collecting data is derived by assessing the expected depth of water, the anticipated swath coverage (in degrees), the ping rate of the MBES (number of times the sounder will transmit/receive per second) and the required survey depth accuracy specifications. For this survey, the specifications were LINZ-1 depth accuracy in depths greater than 5m. LINZ-1 requires that the total allowable depth uncertainty (TVU) in metres at 95 per cent confidence level, is obtained from the following formula.[4]

$$TVU = \pm M\sqrt{0.25^2 + (0.0075d)^2}$$

(Where M is the LINZ order multiplier, in this case M=1.5, d=depth, and 0.25 and 0.0075 are the maximum allowable TVU values at 95 per cent confidence level for IHO Special Order surveys (from the Minimum Standards for Hydrographic Surveys table in S-44)). The resulting graph of depth accuracy (below) shows that at a depth of 5m the accuracy required is ±0.38m, at depth 20m ±0.44m, at depth 50m ±0.67m, at depth 100m ±1.18m, and at depth 200m ±2.28m. LINZ 1 specification includes a criterion for the minimum horizontal size of a target that must be detected. For depths less than 40m a target size of 2m or more must be de-



Depth accuracy for LINZ-1



Target detection criteria for LINZ-1

tected by three pings along-track and three pings across-track. In water depths greater than 40m the minimum target size is 5 per cent of the depth. The graph of target size for depth is included below and shows that at 50m deep a target 2.5m in size must be detected, likewise at 100m a target 5m, and at 200m a target 10m.

There are a number of factors to be considered when operating MBES in changing water depths.

As depths increase, the ping rate decreases due to additional time required for the MBES to receive seabed detections between individual pings. To maintain high ping rates, the swath width can be reduced e.g. from 120° to 110° or less, but this sacrifices seafloor coverage. As ping rates reduce in deeper water, the vessel speed must be reduced to ensure target detection criteria are maintained. Additionally, the vessel track needs to be straight to ensure horizontal ping spacing is consistent and not cartwheeling or swinging around making gaps in the data. When depths exceed 75-100m, then the MBES transmit frequency may need to change to enable seafloor tracking and detection to continue. To ensure survey specifications were achieved, the online hydrographic surveyor constantly monitored the relationship between MBES swath coverage, ping rates, frequency, target detection and depth.

Several challenges were encountered during the survey when collecting MBES data in the outer areas of this survey. One was the impact the seafloor topography and tides had at the sea surface. The strong currents, eddies, upwellings, overfalls and turbulence caused by the ridges and valleys across the Entrance and by the Brothers Islands meant that the vessel survey line orientation, vessel speed and at times heading and motion were affected. To ensure the target detection criteria was met there were times when the vessel would only survey in one direction; heading into the tidal stream. Sounding in the same direction as the stream would mean the vessel was travelling too fast to meet the criteria. Also, at times the vessel heading could be thrown 30° off course by turbulence, causing gaps in MBES data necessitating reruns.

A second challenge was how quickly depths fluctuated in the area, requiring operators to monitor swath widths to ensure satisfactory ping rates for target detection. This challenge was overcome by limiting operations for that period to particular depth bands and covering the deeper areas another day. Guidelines were developed for operators to use to ensure specifications were met.

Depths	Swath Max	MAX Speed over Ground	Frequency / Ping Rates	
Coastlining	+/-75-45 deg Generally +/-65 deg.	As required	300 /set to 15 max	May swing swath shoreward on inshore line (coastline). Overlap into 5m (green) colour band from Rukuwai work
< 25m	+/-65 deg.	6.5 knots	300 /15 max	
Increasing beyond 25-30m	+/-60 deg.	6.5 knots	300 />12	Where depth is continuing to increase then reduce the swath width
25-65	+/-60deg	6-6.5	300 />10	
60-110	+/-55	5.5	300 />8	
110 -150	+/-50	5-5.5	200 />6	Use freq to 200kHz over 100m and deeper
150-220	+/-45	5	200 />4	
200-300	+/-40	5	Change to FM Mode at 200 m	Change mode once deeper than 200m
300-400	+/-40	4-5	FM Mode	

Operator guidelines to ensure specifications were met

The third challenge was managing the best use of weather conditions, as this outer area was at least a one-hour vessel transit time each way from the operating base. Unfortunately, weather forecasts were not always reliable, which meant a vessel was sent to survey in this area only if at least four hours' work on site could be achieved within the forecast conditions.

The greatest challenge of this outer area was in exceeding the time planned for sounding, and the potential for this time overrun to impact on other survey tasks. Estimates of the effort before the job were that it would take 80 hours (10 days) to survey. In reality, due to the challenges listed above; the need to infill gaps; and re-survey areas where data did not meet specification, it took a total of 230 hours of sounding spread over 35 days to complete.

Kelp and dolphins

One of the more entertaining challenges of the survey involved the SBES work in Tory Channel/Kura Te Au where survey lines were 150m apart. There are extensive areas of fast growing kelp *(Macrocystis pyrifera)* that rise from depths of approximately 8m to the surface along both sides of the Channel and then flow along the surface, changing direction with the tidal stream. To sound through these areas meant dragging and collecting clumps of kelp on the echo sounder frame, necessitating frequent pauses in work to cut the kelp free and clear the sounder.

Clump of kelp on SBES Echo Sounder

Vessels inevitably attract the attention of dolphins which want to investigate what the interesting sound is and play in the vessel wake. From the outset, MDC recognised the need to ensure dolphins were not harmed or impacted by survey operations and commissioned an independent review to determine what, if any, risk existed. The report provided operational guidelines to ensure interactions with dolphins were kept to a minimum. When dolphins were sighted close to the survey vessels, work was halted until they had moved on. MDC also set up a Marine Mammal Liaison Group to help manage public concern about the MBES interactions with dolphins. The group involved iwi, an environmental non-governmental organisation, and members of the community, and was a useful mechanism for keeping people informed through regular reports from NIWA. The outcome was that public expressions of concern quickly evaporated. A record of all sightings and interactions with dolphins was maintained and supplied to MDC.

Conclusion

The survey of Queen Charlotte Sound/Tōtaranui and Tory Channel/Kura Te Au presented all involved with a number of challenges, some a first. During the project development stage, LINZ and MDC worked closely together to understand each other's requirements and how they should be translated into a specification and tender documentation. As mentioned, specifications for a hydrographic survey are well known and understood by LINZ and survey contractors. However, clearly describing the requirements and specification for the science component posed challenges as no standard set of specifications exist. International best practice for the collection of seafloor backscatter was followed, although this only forms part of the specifications.

Subsequent to this survey, LINZ is collaborating with the Ministry of Primary Industries (MPI) on a survey between Kaikōura Peninsula and Cape Campbell. Learnings from the Queen Charlotte Sound/Tōtaranui survey were applied to the science specifications for this survey, which are generally the same.

NIWA and DML experienced challenges due to the location's geography, natural environment, technical difficulties and, of course, an earthquake. The results will provide a new dataset for LINZ to update the charts in areas last surveyed in 1942-43. It will also provide MDC with a significant baseline dataset to monitor environmental changes in the Sounds. Of note, it is estimated that over 5.5 billion depth points were collected during the survey by the MBES, a significant dataset that will be freely available to the public.

Benefits of the survey go far beyond the chart updates and baseline environment data. There is a need for standardised national specifications for the collection, processing and representation of science data and information. It is recognised that scientific aims may vary in different regions, so a standard specification may be difficult to develop. However, it would be reasonable to have a common approach, such as the guidelines produced by the GeoHab Backscatter Working Group,[5] as well as the production of benthic terrain modelling and seafloor classification.

NOTES

1. New Zealand Hydrographic Risk Assessment *https://www.linz.govt.nz/sea/charts/annual-work-programme/new-zealand-hydrographic-risk-assessment*

2. *https://www.linz.govt.nz/sea/charts/standards-and-technical-specifications-for-our-chart-and-hydrographic-work*

3. *http://iho.int/iho_pubs/standard/S-44_5E.pdf*

4. Contract Specifications for Hydrographic Surveys, Version 1.3, 1 June 2016

5. Backscatter measurements by seafloor-mapping sonars: Guidelines and Recommendations. Publication by GeoHab Backscatter Working Group. May 2015.

Accurate wingtra

ACCURATE AND WINGTRA AG ANNOUNCE PARTNERSHIP FOR NEW ZEALAND

In Feburary 2018, Accurate Instruments (NZ) Ltd and Wingtra AG Switzerland forged a partnership for the sales distribution, support and industry advisory on the WingtraOne UAV drone for precision surveying and aerial photogrammetry.

This followed a successful product technical demonstration seminar in November 2017, undertaken by Wingtra in Christchurch, which some NZIS members attended.

Antonio Zivolic, Sales Manager for Wingtra Ag who was present at the product showcase, has shared his enthusiasm and support of the partnership stating "I'm excited that we're kicking off our new partnership and looking forward to working together in 2018"

ABOUT THE WINGTRAONE

The WingtraOne is a tail-sitting VTOL unmanned aerial vehicle developed and commissioned in Switzerland by Wingtra AG.

It is powered by two electric motors, designed primarily for use in precision agriculture and surveying roles, and collects high resolution aerial data using precision world class digital SLR technology, which is used to generate ortho photos, 3D reconstructions , point cloud and NDVI maps.

Wingtra have also had their product and design globally recognised, with the WingtraOne being awarded the Swiss Excellence Product Award in 2016.

The first of the WingtraOne UAV's will be arriving into NZ in March 2018 and technical seminar showcases will be kicking off in Canterbury in April.

The WingtraOne seminars will also be popping up in other locations through 2018.

To learn more or register your interest, contact us today.

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Volunteer Community Surveyor Programme

Nepal, October–November 2017

by Jordan Friis

Surveying can look very different depending on where you are in the world. My interest in global land tenure issues was sparked with an international land tenure course in my final year at university. This course highlighted the disparities that exist in our land administration systems globally.

In July last year, the International Federation of Surveyors (FIG) launched a pilot for their brand-new volunteer programme for young surveyors and called for expressions of interest. The programme is a joint initiative between the International Federation of Surveyors, Young Surveyors Network (FIG YSN) and the Global Land Tool Network (GLTN). The goal of the programme is to enable young surveyors to volunteer their time and skills to assist in international land administration type projects.

In 2016, I attended the FIG Working Week in Christchurch which was themed 'Recovery from Disaster'. There, I participated in a joint GLTN/UN-Habitat awareness event on the Social Tenure Domain Model (STDM). I learnt that STDM is one of GLTN's land tools used to assist in pro-poor, gender responsive and fit-for-purpose land administration. More specifically, STDM is a plugin for QGIS, which is open source software meaning it is free and available to the public. During this workshop we were shown how the software works and what it can achieve.

Having done the training, I was prepared for basic use of the tool in the field. I applied for the VCSP programme and, in September, was notified that I had been selected.

The project I was selected for was a pilot for STDM in Nepal. The context of the project was post-disaster recovery with a focus on security of tenure and 'building back better' after the heavily destructive earthquakes of April and May 2015.

The project was less focused on upgrading the legal cadastre and more focused on influencing land policy for more effective recovery in the wake of the earthquake. Three major areas of concern were identified as being problematic for the recovery effort, and these informed which sites were chosen for the project.

The first concern was, in order to receive the government grant for reconstruction, a household needed a title to their land. In the case of Phulapa, a rural area with around 700 households, almost all of the residents are 'sharecroppers'. This means they farm the land and share the produce with the owners of their land who live elsewhere. Most of these people have no title documents for the land they occupy.

The other two concerns related to the safe relocation of existing settlements to new sites, and the need for integrated settlements with infrastructure planning in the future. Most of the housing in the rural areas is scattered

without any planning, and many of the areas around the villages are prone to landslides and in need of geotechnical assessment. Also, obtaining a building permit without title documents poses difficulties. With support from local authorities, the village of Jilu is receiving two small settlements with an integrated planning approach through a land pooling and readjustment project which was under way during my visit.

A Local NGO called the Human Rights Awareness and Development Centre (HURADEC) was engaged to undertake and manage the field work and data collection for this project. When I arrived, this was well under way. The data was collected using household questionnaires and handheld GPS devices. Once this was completed, field surveyors organised a time to meet the community. Using a participatory process of 'visual boundary marking', the location and ownership of the land parcels were marked on A0 satellite images. This was deemed 'fit for purpose' as it was practical, relatively fast and achieved the intended purpose.

My role as a volunteer in this project was primarily validation of the collected data, geo-referencing the satellite images and digitisation of the farm boundaries. Data validation involved using queries in QGIS to interrogate the data and check its validity. Geo-referencing involved taking high-resolution photographs of the satellite images and aligning them with the underlying satellite imagery in the GIS. Digitisation was then easily carried out by drawing polygons over the geo-referenced images and assigning unique identifiers to the parcels. A relationship could then be defined between the household data collected and the land.

As a volunteer on this project, I learnt good problem solving and project management skills in a foreign environment where resources were limited, and communication could be difficult! I worked independently for a lot of the project and used this time to learn the GIS software. There were other opportunities too. For example, I took part in research on automatic feature extraction using remote sensing for cadastral mapping.

As well as the professional development I gained, this programme was an exceptional experience of another culture and work environment. I would highly recommend this experience to other young surveyors interested in volunteering their time and skills in overseas projects. Volunteers assist in project tasks but also gain fantastic professional and cultural experiences while working abroad.

Do you have experience in working overseas in similar work to Jordan? We need you! The Young Professionals Group are looking to run a workshop for our members to equip themselves with the right tools to enter into any similar voluntary initiatives. We would like one or two people with your experience to share their lessons learned alongside a couple other experts in land administration/land tenure.
Please contact: yp@surveyors.org.nz or Facebook Page @NZISYP.

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Real-Time Monitoring when your reference network is moving

E Audigé and C Fagan, SIXENSE Oceania, Auckland

Application to Britomart Station on the City Rail Link project in Auckland

Introduction

The City Rail Link (CRL) project in Auckland consists of 3.4 kilometre-long twin tunnels to create an underground rail line linking Britomart and the city centre with the existing western line near Mt Eden.

Around Britomart, the excavation under the historic building involves the underpinning and jacking of the entire structure via 32 interior columns, without causing damage to sensitive heritage ceramics within the building.

The construction of this tunnel underneath Auckland's city centre is a major challenge requiring a robust and innovative approach to construction monitoring. A comprehensive real-time monitoring system has been deployed and represents a first of its kind in New Zealand.

The monitoring of the Britomart station was a specific challenge for monitoring in real time, both the facades and interior columns of the building were without fixed non-moving reference points within the building. The solution that has been deployed is an innovative and unique technology developed by Sixense – Cyclops Evolution™.

Context

The entire project, led by Auckland Transport, has been divided into nine work packages to be awarded separately, C1 through C9 as shown in Figure 1. The main tunnel construction packages, or contracts, are C1 to C3, and to date (February 2018) only contracts C1, C2 and C6 have been awarded.

Figure 1 – Overall alignment of the City Rail Link project and work packages contracts C1 to C9

The C1 contract consists of the CRL connection under the Chief Post Office (CPO) to the existing line on the east side and Downtown Shopping Centre on the west.

The C2 contract consists of two separable portions as illustrated in Figure 2.

- A 500m long pipe-jack under upper Albert Street to create a two-metre diameter stormwater pipe parallel to the existing one allowing for the construction of the tunnel. This portion involves the digging of four access shafts up to 18m deep at the intersection of Albert Street and Victoria Street, at Wellesley Street in the south, and Swanson Street in the north.
- A twin running tunnel on the lower part of Albert Street using a method of cut and cover involving excavation up to 20m deep and 350m long at the foot of heritage and/or high value buildings, hotels and properties.

Figure 2 – Localisation and identification of work packages contracts C1 and C2

With deep excavations in close proximity to sensitive structures in a high value urban environment, both packages (C1 & C2) have critical and costly consequences in terms of construction failure. Accordingly, a comprehensive real-time monitoring programme has been developed and deployed to mitigate those risks and provide a common situational awareness to the stakeholders.

Monitoring solutions

Overall approach

Despite separate contracts for C1 and C2, after some consultation, risk analysis and consideration of best practices, the approach adopted by Auckland Transport, now City Rail Link Ltd, was:

1. to award the monitoring of both packages to a single provider to minimise any negative boundary effects, have consistent data and reports and rationalise cost
2. to deploy state-of–the-art technological solutions that have been proven effective in similar projects in urban environments overseas.

The outcome was the global award of monitoring services to the Sixense Group, subsequent to a tendering process, and the implementation of a global wireless and real-time monitoring network with a cloud-based central database and web-based analysis and reporting software Geoscope.

Scope of instrumentation

The monitoring instrumentation that has been deployed consists of:

- 37 x multi-level ground water piezometers with wireless data transfer
- 12 x in-place inclinometers with wireless data transfer
- 19 x inclinometers read by manual probe
- 32 x biaxial tilt meters with wireless data transfer
- 234 x strain gauges with wireless data transfer mounted to various structural elements
- 15 x Cyclops™ (advanced Total Station further described)
- 790 x building and structure 3D monitoring prisms, automatically monitored
- 270 x ground 3D monitoring prisms, automatically monitored.

All sensors that are monitored by data-loggers are autonomously powered and connected to a proprietary wireless data communication network. This long-range radio communication network allows for connecting sensors up to a few kilometres away to a central gateway in a very flexible way, with a concept of 'connected objects' or 'Internet of Things' (IoT).

Cyclops™ and Centaur™ systems

The Cyclops™ systems are the core of the instrumentation programs for both the C1 and C2 contracts. Cyclops is based on commercially available total station hardware that is operated by proprietary Sixense software drivers and data processing modules.

The components and operating principle of a total station is well known. It involves:

1. A set of references reflective prisms installed outside of the zone of influence
2. A set of monitoring reflective prisms installed on the structure to be monitored, often known as targets
3. The total station itself, best installed outside the zone of influence. This laser-based system is robotically controlled and measures the angles and distances to the reflective prisms
4. A computer and software to drive the total station and process the data into Cartesian coordinates and displacements.

After scanning the different reference prisms to check that the instrument has not moved – or to record its new position – the system scans the monitoring prisms to record the angles and distances to each and sends the information to the computer to transform the raw measurements to Cartesian coordinates and 3D displacements.

The scan of the reference prisms, to confirm the position of the instrument, is critical to the derived positions of the monitoring prisms. Without this check, it would be difficult to ascertain which elements of the monitoring network were stable, and which were moving.

When a total station with reflectorless measurement technology is used, an extension of the Cyclops system, called Centaur™, can be deployed. Centaur reflectorless measurements on a surface such as a roadway or footpath

yield displacement measurements in an orthogonal direction to that surface. An algorithm has been developed to project those displacements in a same plane to assess the heave or settlement of the surface. Figure 3 illustrates the concept and operating principle of both Cyclops and Centaur using the same hardware.

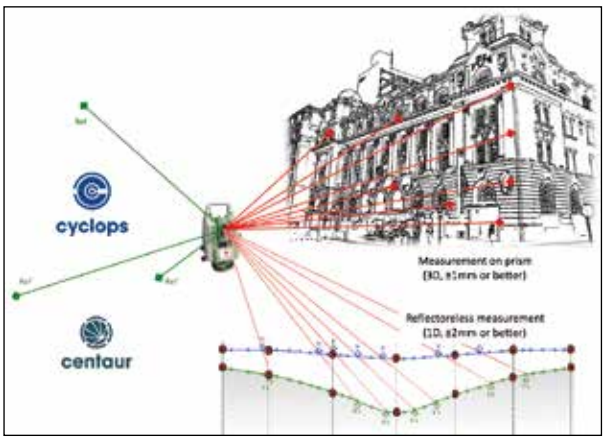

Figure 3 – Concept of prism and reflectorless measurements with Cyclops and Centaur

Cyclops performs 3D measurement on prisms with typical accuracy of ± 1mm, and Centaur achieves reflectorless measurements on one direction with a typical accuracy of ± 2mm but is more prone to weather interferences.

Eight Cyclops/Centaur are used for the C2 to simultaneously monitor the movements of the buildings and settlement of the road along Albert Street.

Monitoring the CPO building

The problem of no, or moving, references

The critical aspect of the construction work required for the C1 contract, (excavation under the CPO building), is the jacking of the 32 columns and load transfer. This operation must be achieved within strict tolerances of movement on the columns and surrounding structures, so a real-time monitoring system is necessary. Cyclops is a good technology for this application, but there are two major impediments.

1. There is no possibility for the Cyclops to have a line of sight to reference prisms installed on fixed unmoving structures outside of the building.
2. The entire building is subject to movement while in the middle of the zone of influence.

With no stable and unmoving 'reference' prisms within the CPO building, it appears impossible to monitor in real time the movements of the columns using traditional technologies.

The Evolution™ technology

To overcome this problem, the solution that has been deployed consists of virtually linking multiple Cyclops via a complex mathematical process, allowing the group of Cyclops to share the same reference prisms. The process, fully detailed in a patent assigned to Soldata[1] and known as Evolution™, is illustrated in Figure 4.

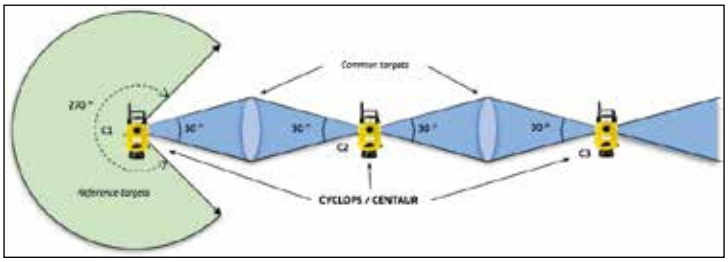

Figure 4 – Principle of Evolution™ technology allowing for sharing reference targets with multiple total stations

The components of this networking or grouping technology are as follow:

- A set of reference prisms covering a large solid angle for stability
- Multiple Cyclops *sharing* at least two prisms – with 30° solid angle separation – with its neighbours.

In practice, it is often difficult to physically share a prism with two or more Cyclops. Therefore, the process has been enhanced to allow the use of 'dual prisms'. A dual prism is an assembly of two different prisms, relatively close to each other and linked via a rigid structure, thus with a known vector of separation, as illustrated in Figure 5. Using the same principle, triple prisms can be used in a similar way.

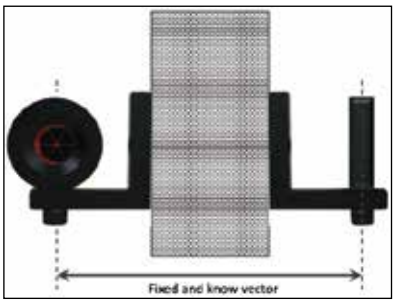

Figure 5 – Concept of 'dual prisms' to be shared by different Cyclops

Once all prisms have been installed and their positions learnt for all Cyclops, the operating principle is as follows:

- Each Cyclops included in the Evolution group performs its measurement cycles and records the angles and distances of all prisms linked to it
- Once all measurement cycles are completed, data is processed globally using a least square adjustment process. The process is described briefly below, extracted from the patent document.

The calculation is iterative: a first calculation makes it possible to establish a tailored set of solutions on a basis of external elements. The tailored set of solutions is then

used as an approximate set of values and so on and so forth until the convergence factor converges according to an accuracy fixed in advance. The set of solutions that are adopted is that which minimises the sum of the squares of the residuals corresponding to each coordinate.

It is thus possible to automatically identify the targets corresponding to bigger residuals via a mathematical processing of these residuals. These targets are then de-activated, and the mathematical processing is resumed, ignoring the measurements involving these targets. Thus, it is understood that the configuration of the network of stations can be managed dynamically.

In this process, the reference target can be managed in two different ways.

1. Fixed position: as the name suggests, the coordinates of the reference prisms are constrained to their initial values. The outcome of the least square data processing is a set of coordinates and residuals for each prism
2. Free floating: the reference targets are considered as normal measurement prisms. The outcome of least square data processing here is a new set of coordinates and residuals for each prism.

The comparison of the coordinates of two 'fixed position' and 'free floating' processes makes it possible to assess if any reference prism has moved – and shouldn't be considered any more as a reference – or not. If the fixed and free coordinates are diverging, we know that the reference is moving and should be removed from the group of reference prisms. The 'fixed minus free' coordinates of the reference prisms in a group are processed and checked for each measurement cycle and represents a strong quality control of the measurements.

The least square process also yields a global residual or σ_0. This σ_0 value gives an indication of the overall quality of the group process and is one of the main parameters used to decide if a group process passes or is rejected.

It is important to note here that the Cyclops themselves are considered as targets in the global data processing. This is one very interesting benefit of this method allowing for installation of the Cyclops in the zone of influence, or in other words, unstable and moving areas.

Application to the CPO building and surroundings

Overview

Seven Cyclops have been deployed to monitor the CPO and surrounding buildings and roads; four devices at the exterior (ATS-E1 to E4) and three units inside (ATS-I1 to I3) the building, as illustrated on Figure 6.

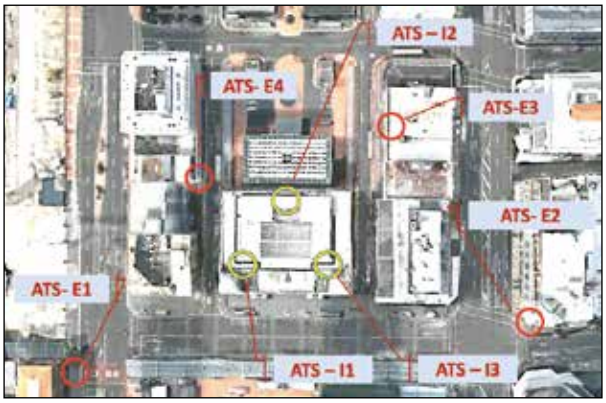

Figure 6 – Locations of the seven Cyclops for monitoring the CPO

This installation forms a complex measurement system as shown on Figure 7:

- Reference prisms (in yellow)
- Monitoring prisms (in red) for buildings and CPO columns
- Reflectorless settlement points (in blue).

One option was to use the seven Cyclops to create a single group and perform the measurements globally. However, a downside of this approach would be that if one Cyclops fails, the measurement process for all prisms will be rejected, as the least square processing is a global approach. By experience, this risk can be considered as low. Nonetheless, we've decided to mitigate this risk and create two different – and independent – groups.

Monitoring the interior columns of the CPO

For monitoring the interior columns, the group that has been established includes:

- No 2 Exterior Cyclops
- No 3 Interior Cyclops
- No 16 Reference prisms

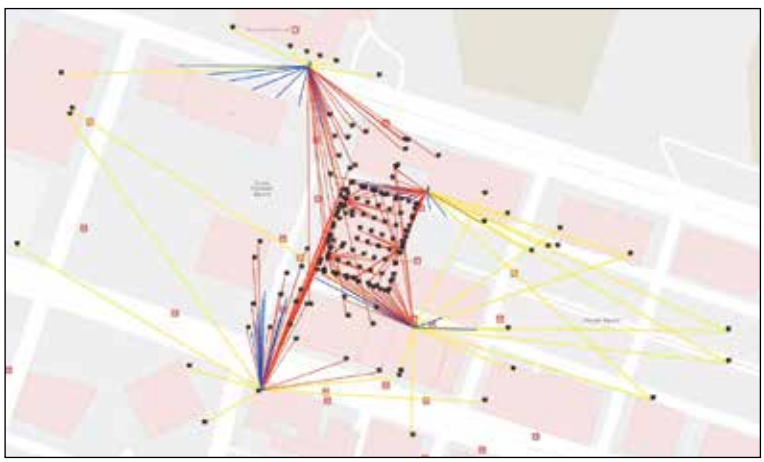

Figure 7 – Measurement structure of CPO and surroundings with reference prism (yellow), monitoring prisms (red) and reflectorless settlement points (blue)

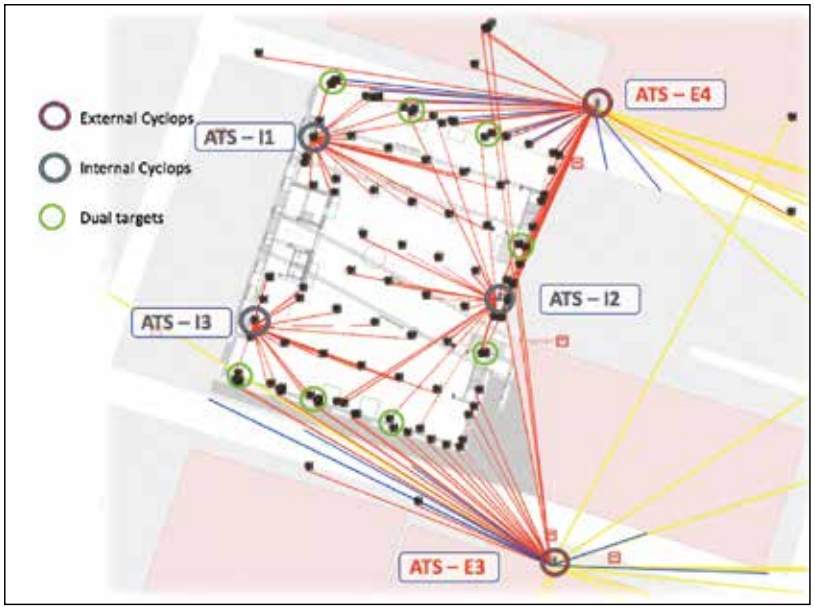

Figure 8 – Layout of the group of Cyclops and prisms for monitoring the interior columns

- No 76 Measurement prisms (expanding to over 200 with future works)
- No 8 Dual prisms.

The dual prisms are set on each side of the walls of the building and the vector linking the two prisms is recorded in the configuration database.

Figure 8 shows the arrangement of the CPO group.

Once processed, the Cartesian coordinates of all prisms are transformed to displacements in x, y, z directions from a reference date. All data is represented graphically in Geoscope, a web based geographical information system (GIS) and alarms are automatically triggered when movement exceeds set thresholds.

Results

The system has been running continuously and automatically for a few months, without issues on the global solution. As stated, the quality parameters to watch closely are:

1. the fixed-free coordinates of the reference prisms
2. the overall group process residual σ_0.

Figure 9 shows the fixed-free coordinates for some of the reference prisms.

For clarity, we are just showing three prisms and only the Z (vertical) axis. The following can be inferred from the data shown in Figure 9:

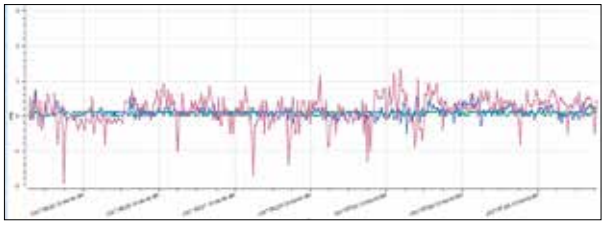

Figure 9 – Evolution of the fixed-free coordinates of reference prisms

1. All 3 prisms should be considered as stable references, as the trend lines of each are not diverging from horizontal.
2. The red prism is on a structure that is responding to some sort of cyclical event, most likely temperature/direct sun. Even though this data is noisier than the other prisms, the variations are small and acceptable as a reference.
3. The green prism is extremely stable and unaffected by temperature/sun effects.
4. The blue reference is somewhere between the two previous ones in terms of stability.

Figure 10 shows data from the global group process residual σ_0. From this data, the following can be inferred:

1. Daily rise and fall in quality is due to daily temperature effects on the global prism network.

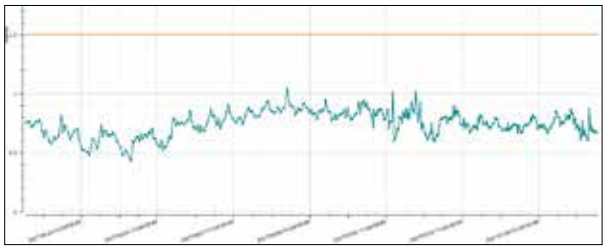

Figure 10 – Evolution of the global residual σ_0 of the Least Square processing

2. Multi day rise/fall in quality is due to longer seasonal/periodic temperature changes, atmospheric pressure, foggy/rainy periods, etc. The important thing to observe is that over time the σ_0 value is not increasing. If it were, this would indicate a deteriorating quality of the Least Square group process. In this instance, an alarm has been set at 1.5 – a figure based on previous experience – and the stability of the group is acceptable.

The final result of the process is the x, y, z displacement values of the columns that is represented in Geoscope as illustrated in Figure 11 (next page). Iso displacement lines are also drawn. Of course, there is no physical meaning of these iso-lines while the material has been excavated between the columns, but it provides a quick understanding of the situation without having to look into details at the values. The Cyclops are set to record data on 20 minutes cycles, and each hour the group process is run and the x, y, z displacements shown below are updated.

Conclusions

Due to the risks involved, the construction of the City Rail Link under the Chief Post Office requires real-time monitoring of the building facades and interior columns.

Total stations (Cyclops) located inside and outside the building are the correct instruments for this task, but the lack of stable references for the systems inside the structure makes it necessary to use an innovative and different approach to data processing than usual.

The global data transformation approach – Evolution – based on a least squares algorithm is the solution that has been successfully adopted allowing for

- The confirmation of the stability of the reference prisms via double processing using Free Floating or Fixed Position parameters and analyzing the difference of the outputs
- A global and precise assessment of the movements of the monitoring prisms in three dimensions
- A strict quality assurance and quality control procedures assessing the global residual of the processing.

Figure 11 – Final result of the displacement of the columns and iso-lines representation for quick understanding

Acknowledgment

This work was conducted in collaboration with the Soletanche Bachy, Downer – Joint Venture in charge of the construction of the CRL-C1 and City Rail Link Ltd for managing the CRL project.

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or Chris Fagan: chris.fagan@sixense-group.com

NOTES

1. United States Patent – US 7,023,537 B2. SYSTEM FOR MONITORING THE MOVEMENTS OF CONSTRUCTION WORK PARTS. Apr 4, 2006.

PRESIDENT'S MESSAGE

The Biggest Challenge

I was asked recently what it is that I believe is the biggest challenge for NZIS. After some thought, I responded that it is probably remaining relevant to both our current and future members. While this has been and will always be the case for any professional body, in this day and age where a lot of information can be sourced online and people are supposedly time poor, it seems particularly hard to keep our members interested and engaged.

You will hear a lot over the next year from our leaders, at every level of this organisation, about the importance of our more experienced members staying connected with our branches. We need to remain visible and show leadership at branch meetings, technical seminars and social events.

As a generalisation, our young professionals are seeing fewer of us attending branch meetings and the message to them is that professional networking is not valuable or important. I'm sure I speak for many of us when I say that it can be really difficult to make the time to attend, particularly if a significant amount of travel is involved. However, I know from personal experience that the real value of our organisation is in the connections we build at branch level. It is hugely rewarding for our young professionals to see their colleagues and those from other firms interacting through informal discussions and serious debates at branch meetings and events. For those in smaller companies or teams, I would think it is essential to have the opportunity to hear other opinions, technical or professional.

I don't think it's an exaggeration to say that everyone I have ever spoken to about their own involvement in branch activities has echoed these sentiments. I am going to commit to make more of an effort to show up at my local branch meetings – will you do the same?

Finally, thank you to those individuals who have been in touch to welcome me in as President and to provide some feedback on current items we are seeking feedback on. Keep the communications coming, we always appreciate people having an opinion. I look forward to seeing many of you at this year's conference, it is shaping up to be another great one. Don't forget to involve the deserving members of your staff!!

Rebecca Strang, NZIS President

Photo: James Doube.
Looking at our base setup with
the helicopter hangar in the background.

Antipodes Islands' Million Dollar Mouse eradication

Ann De Schutter, Department of Conservation

The Million Dollar Mouse Project

The Antipodes Islands are part of New Zealand's subantarctic region, protected as a nature reserve and a world heritage site. House mice *(Mus musculus)* are the only mammalian pest species on the Antipodes, first recorded in 1907 but possibly arriving much earlier, and they have had a significant impact on the species endemic to the island.

The project started in 2012 when the Department of Conservation (DOC) partnered with the Morgan Foundation to eradicate mice off the islands. The campaign was called 'Million Dollar Mouse' with Gareth Morgan from the Morgan Foundation matching public donations dollar for dollar.

The main goal was to protect the islands' biodiversity and enhance the recovery of native invertebrates and endemic land birds from the effects of predation. There are many native, endemic, rare and threatened species currently impacted by mice on the Antipodes Islands, to name a few:

- There are 3700 pairs of the endemic Antipodean albatross that breed on the Antipodes Islands. The Antipodean albatross was nesting while we were there for the eradication, and we often witnessed a feeding ritual between parent and chick.
- Both the number and size of erect-crested and eastern rockhopper penguin colonies have been in decline since the 1950s. There are currently 42,500 nests. The erect-crested and eastern rockhopper penguins return to the

Photo: Finlay Cox

island in September-October and were absent during the eradication.

All of the birds on the Antipodes are incredible and so unaccustomed to people that they hop about between your feet or fly straight over you. Both the Antipodean penguins are examples of rare and endemic species on the Antipodes.

Project planning started in 2012 and led to a team of 13 people being deployed to the island for 10 weeks from May to August 2016. At the time, this was the largest (2000 ha) mouse eradication attempt where mice were the sole mammalian pest species. The mice population was estimated to be 200,000 or up to 150 per hectare.

This was the most challenging project logistically that the Department of Conservation had undertaken. The Antipodes are located 760 km southeast from Dunedin and can only be reached via boat transport. There is limited anchorage and no harbour. Helicopters had to be flown on and off the cargo vessel during suitable winds and sea swell. All other gear was flown off the cargo vessel by helicopter. The weather is typically poor, with predominately strong westerlies hindering operations.

The opportunity of a lifetime

I had been working as a geospatial analyst at the Department of Conservation and, as part of that role, I had been involved in aerial pest control operations across New Zealand.

Jumping at the opportunity, I was involved in the final planning stages of the project from January 2016. Due to the remote location, we needed contingencies in place for everything. As we couldn't just hop over to double check, everything had to be mapped out. Steep slopes and coastal areas are higher risk for eradications.

To ensure that we got the last remaining individuals, achieving full coverage, we needed to do a slope analysis to identify where those steep slopes were. The coastal zone needed to be mapped out as well for this area to be treated additionally by helicopter.

It was also important to calculate flight paths for the helicopters, so we would know how much fuel to take, and safety zones for walking were also important.

The island is uninhabited and there are no established walking tracks. There are three-metre high ferns and tussock areas where you are either walking in between the roots, on top of the tussocks, or somewhere in between if you are not careful.

We had one cargo vessel going with most of our gear. I went on the *Evohe*, a 25m passenger expedition sailing vessel along with most of the team. I hadn't spent much time out on the open ocean. According to more experienced travellers, the ocean was quite calm, however, I was very surprised about the movement of the ship in all directions.

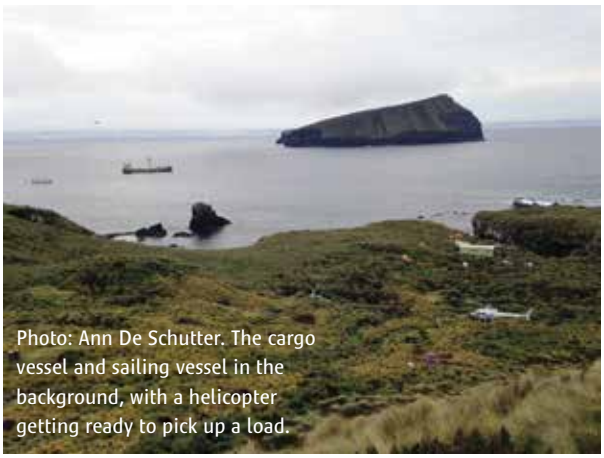


Photo: Ann De Schutter. The cargo vessel and sailing vessel in the background, with a helicopter getting ready to pick up a load.

Once we arrived at the Antipodes Islands, we had to wait two days to be able to land on the island. This was probably the part of the whole trip where I had absolutely no idea what to expect, waiting for the swell to calm down so waves wouldn't be crashing down on to the beach that we would be loading on to. After two days we got transported in a small zodiac and carefully taken to the beach, where timing was of the essence to get out without getting too wet.

I quickly realised what incredible islands the Antipodes were, the beach we had landed on had numerous elephant seals just lazing around us!

Over the next few weeks, we focused on setting up our infrastructure. The research hut on the island has six bunks, so many people were camping outside for the duration of the project. We also needed protection from the elements for the helicopters, so we brought a portable helicopter hangar from New Zealand, which we set up with help from an experienced building team in the first few weeks.

After the setup phase was completed, we made sure we were ready to start helicopter operations at the first good-weather window. Unfortunately, the weather was either very windy on the island, or low cloud for days, weather windows were few and far in between, so we had to be ready to make the most of every single opportunity.

In between the weather windows, we monitored birds when the weather allowed. During other days we became experts in playing cards, Settlers of Catan and darts.

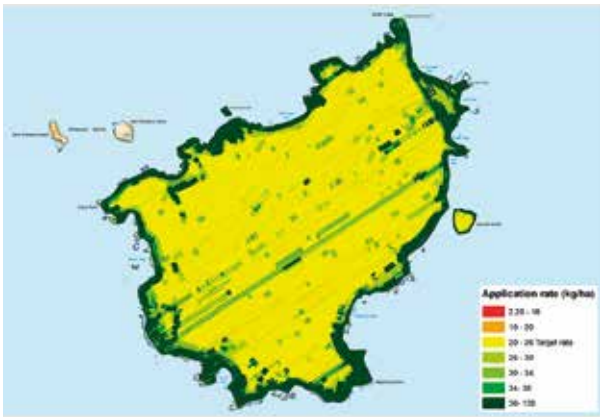
GIS crucial in eradications

GIS has become essential in eradication projects, as it enables an accurate representation of bait on the ground to ensure full coverage. The outcome of an eradication is binary, successful, or not.

My tasks consisted of downloading GPS tracks from the helicopters every time they refuelled. The helicopter GPS records a centreline of where they fly. I converted these

lines into polygons based on the known swath width, and followed progress of the operation. My most important task though was to check for gaps. Whenever gaps were detected, this was relayed back to the helicopter pilot for them to go back and fill it in. In between I was also checking bait usage and flight safety.

There were some new innovative techniques used in this eradication. Prior to this, bait density would be calculated based on the area covered and bait used. This gives an indication of bait density per run, but there are many other factors that contribute to bait density (i.e. wind, speed of helicopter, terrain, etc). For this project the speed flown per line was used, as recorded by the helicopters GPS. This meant a bait density per line could be calculated instead of per run. This is a big improvement in bait density calculations and would vary 2-4 kg/ha compared with not taking the speed into account. A model to quickly import the data made it possible for the GIS analyst to keep track



Map: Ann De Schutter. Bait density after both treatments showing 100 per cent coverage, and the additional bait on coastal areas and steep cliffs.

of bait use and flight safety on top of the normal job of checking coverage. Each night I would create bait density maps which would be used for planning operations for the next day.

In total we had two helicopters spreading 65.5 tonnes of Pestoff 20R Rodent Bait (20 ppm of brodifacoum) over two treatments. The total treatment area was 2045 ha in which we reached 100 per cent coverage.

Life on a subantarctic island

But what was it like to live on an uninhabited subantarctic island for 10 weeks during winter? Even though we were a team of only 13, there was still a lot going on. Friday night was pizza night. We also had a 'hairdresser' with us, however after witnessing his first haircut I decided to stick it out for the duration of the project without one. We had a few darts tournaments, and at mid-winter we organised a mid-winter festival where we all dressed up, played basketball and other games, followed by a quiz. At the end of the night, the winning team received the Solstice Cup.

There was a curious incident where 35 packages of chorizo were ordered for the duration of the trip, but instead we had received 382 packages of chorizo. Each package contained two sausages, which meant we had 764 chorizo sausages in total, and 390 litres of yoghurt.

What now?

Working in a high-pressure remote environment in GIS is challenging but exciting at the same time. I gained building skills, although I'm still not great at darts. I have learnt you're not that excited anymore about chorizo after you've had it every single day for 10 weeks. But most of all I have learnt how the right team of people can make or break a job/trip!

Anecdotal evidence has suggested moths and flies were in much greater abundance the past two summers and no signs of mice have been detected.

However, a final outcome cannot be announced until after the end of February, when a team went back to the Antipodes Islands with rodent detection dogs and tracking tunnels. Fingers crossed! To follow their trip, go to: *www.milliondollarmouse.org.nz*

This project played a part in the New Zealand government announcing its goal of a Predator Free New Zealand 2050, with the intermediate goal of all offshore islands and nature reserves to be pest free by 2025.

The knowledge gained on the Antipodes Islands will be used in future offshore island eradications and contributes towards a strategy for a Predator Free New Zealand. If you'd like to be involved in similar projects or to see what you can do for conservation have a look at: *https://predatorfreenz.org*

Thanks to our project partners: the Morgan Foundation, WWF New Zealand, Island Conservation and public donors for making this project a reality. I would especially like to thank the team for making this into a trip of a lifetime.

Photo: Finlay Cox

NZIS Conference 2018

Ambitious Diverse Connected

17-19 May, Rutherford Hotel, Nelson

NZIS

The NZIS Annual Conference has definitely changed its structure and the value to the sector.

The buzz last year from those attending was hard to characterise, but all liked the new technical focus and relevancy of topics. Perhaps it's the National Technical Committee (NTC) seeking out quality subjects and speakers? Could it be the moving of the AGM out of the event, stream input or even the themed focus. All have had an effect but NZIS President - Rebecca Strang, believes currency and relevancy to members, especially Young Professionals, is gaining the most rewards for the surveying and spatial sector.

"We have worked hard on bringing into the conference many key issues and topics – such as climate change, the evolving workforce, new technology and the future of geospatial data. Our focus for the conference has been on ensuring that this is the biggest training event of the year. We need business owners to recognise that this is the real deal. Its where they need to send staff and especially Young Professionals, so they connect and remain in tune with the sector and the changes that are part of our daily life," said Rebecca.

NZIS CEO – Hadyn Smith, is also impressed with the programme and the effort being put in by the NTC, our Diamond Commercial partners and the Local Organising Committee.

"I don't think I've seen a high school programme (afternoon) before and to see our partners assisting with speakers and focus topics has been impressive. Even the methodology behind many of the LINZ presentations has focused on the national use of various systems and case studies. The chalk and talk type thinking has gone. We have also added an interactive "App" that will allow the better use of instant audience interactions with panel topics through the website. Overall, last year was great, but this year is looking even better with topics and focus areas across all of our sector. I can't think of any gaps and our speakers focus on climate change learnings as it relates to surveying and spatial should be compelling," said Hadyn.

NZIS has also added a new conference website that will be updated daily and will produce focus items and overviews as they are developed right through to the start. Check it out.

The full programme that includes four international speakers and a Thursday Hydrographic Seminar can be found at the conference website along with all the booking and registration detail. Early bird bookings close on Monday 9 April with full registrations open through until the event start on Thursday 17 May in Nelson.

www.nziconference.org.nz

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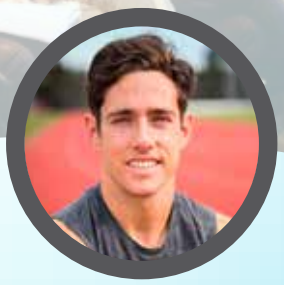

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Anne Harper
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Rebecca Strang
Good survey practice

Bruce Robinson
Leveraging off the four GNSS networks

Thomas Gibbons
Land Titles

Nick Stillwell
ASaTS

Johann Bernhardt
Passive Solar Design for surveyors.

Sea Level Rising:
What does it mean for the Surveying and Spatial Sector?

Professor Matt King
University of Tasmania

Professor John Hannah
Emeritus Professor- University of Otago

NZSEA Supreme winner- Catalyst (Trimble)
Outstanding kiwi ingenuity bringing high accuracy to smartphone users

Advanced Survey and Titles Services (ASaTS):
Where are we heading? What is possible? Replacement for Landonline

Case Studies

The Surveying and Spatial Vision - the journey from Young Professional to key practitioner (Panel)

Major Nelson Projects

Vesting and dedication of public roads

Stephanie Harris, Glaistor Ennor Solicitors

We all understand that Council rightly needs to minimise any prejudice to itself or the burden of costly ongoing obligations in the transfer of land to Council for roading purposes in new subdivisions.

Accordingly, vesting of roads is the commonly accepted process. Vesting occurs under section 238 of the Resource Management Act 1991 (RMA). The process requires the removal of all encumbrances and other interests affecting the land to be created as road so that the land vests in Council free of any interests on the titles.

This occurs pursuant to section 224(b)(i) of the RMA and requires the consent of every registered proprietor who has an interest in the roading land, along with any charge holders. This excludes land covenant interests, in that case, charge holders consent is not required where the registered proprietor of the land having the benefit of the land covenant, and immediately affected by the vesting, has provided the consent.

In any event, the end result is that all interests are extinguished on vesting. The relevant title for the road is issued and then immediately cancelled with the status of the road considered to be clearly evident from the spatial view in Landonline. The rationale and history for the above policy was discussed in a helpful article written by then Registrar General of Lands, Brian Hayes, published in the Butterworth Conveyancing Bulletin (1986) 4 BCB 36.

However, the concept of vesting can be problematic where there are numerous land owners as dominant tenements of numerous covenants on the relevant proposed roading title. We have recently faced this issue in respect of a number of subdivisions. The accepted work around is to dedicate the land rather than vest it where utilisation of the vesting process is not possible because compliance with section 224(b) of the RMA is not achievable.

Dedication occurs pursuant to section 17 of the Public Works Act. The Public Works Act allows Council to obtain the land for the purposes of public work and the dedication is implemented by way of memorandum of transfer of the land to the Council.

The transfer records the affected land that is to be dedicated as road. This means that as part of the documentation is prepared for the subdivision, a transfer is included to transfer the affected land by dedication to Council. The survey plan deposited with the RGL records the land to be dedicated and a certificate of title is created for that road lot (and as a matter of Land Information New Zealand (LINZ) policy also immediately cancelled as with vesting).

The process of dedication is easy for LINZ and the subdividing owner as it is simply a matter of creating that transfer for the dedicated road. However, Council must agree to

take the road by way of dedication and is often reluctant to do this, as (unlike the process of vesting) Council will be inheriting the burden of all existing easements and encumbrances. In addition, there is a procedure under section 18 of the Public Works Act which requires Council to serve notice on every person with a registered interest in the land prior to the registration of the transfer of the dedicated road.

My experience is that this is not generally undertaken, and that LINZ registration occurs in any event.

Further, the process of dedicating land as road is treated in much the same way as vesting and although the easements and encumbrances affecting the land are not actually surrendered, it has become practice for LINZ to cancel the certificate of title in exactly the same way as they do for vesting for the dedicated road, as soon as it is created. The effect being that Council does not end up having a registered interest in the road and the easements and encumbrances affecting the road are extinguished – at least in the registered sense.

The question remains, has an indefeasible title right in respect of the benefit of interests on the title been extinguished by the use of the dedication process in this manner? The answer should be no, and Council remains obligated by them, but the cancelled title certainly raises question marks around this. I suspect that this is not often considered in practice, as Councils are reluctant (as you would expect) to take land pursuant to the dedication process and where there are obvious impediments, the cautious approach is to say no.

Increasingly, the issue is now commonly arising in a slightly difference context as well. That context is other infrastructure that is appropriately located in the roading space, but it is to be and to remain privately owned. For example, a recent issue arising in our office is around a private sewerage treatment plant (with more and more of these being required in Auckland) and the consequential private sewerage pipes from various residential lots back to the private sewerage facility. Those sewerage lines are intended to be private and intended to be owned by an incorporated society which owns the treatment plant together with all the infrastructure and installations. However, in the usual course, Council requires roads in which that infrastructure is appropriately located, to be vested but they do not want ownership of the sewer lines or any of the other infrastructure within the vested roads created.

This then raises the question about how roads can be treated, obviously vesting is not possible, leaving only transfer by way of dedication if the roads are to be public roads. This further raises the question of how private infrastructure is to be treated under the roads if the title is cancelled in accordance with the usual LINZ policy on the issue.

The issue is really the disconnect between Council's desire to own roads and have them vested without other interests (which unfettered fee simple has a strong public policy rationale), verses its unwillingness to take responsibility (understandably) for private infrastructure works which are rightly located within the road. In this regard, it is important to reference Part 21 of the Local Government Act, 1974, which gives Council the power to grant rights in roads for such private infrastructure (see section 338 and section 341 particularly in that regard).

However, in our experience these sections are not commonly utilised or indeed easily accepted by Council or the developer as, of course, it requires a financial commitment for the payment of rent for the right to locate infrastructure in the road and other conditions as to the construction, repair and maintenance of such infrastructure works, and repair of the road as the Council sees fit.

The approach to ownership and control of utilities and infrastructure is evolving quickly in the Auckland land development market, and presumably in other towns and cities in New Zealand. The issues stem from the status of the land as public road and who rightly should have the long-term responsibility for the management of key infrastructure (but often privately owned) servicing new subdivisions and laid within our roading network.

As an aside, I note the availability of section 317 of the Property Law Act, which provides a mechanism via the High Court to remove redundant easements where it is simply not possible to gain consent of the relevant dominant tenements. It is particularly relevant where there are large numbers of dominant tenements and it is just not feasible to approach them individually, but the easement or encumbrance is entirely redundant. Essentially, the Court can make orders to modify or extinguish, wholly or in part, easements or land covenants if they are now irrelevant. It is a relatively simple High Court application, the issue of course being the time and cost of any High Court process.

There is also a second avenue pursuant to section 70 of the Land Transfer Act via the Registrar General of Land, again relating to removing redundant easements. However, LINZ has little discretion in the application of this provision and it can be difficult to have it applied.

In any event, these are issues which should be addressed early on in the master planning phase of any development, so that consideration can be given to the most appropriate method of creation of public roads and ownership responsibilities of infrastructure therein, while balancing affected land owners rights to the benefit of covenants or encumbrances running with their land.

TRIMBLE CATALYST: The high-accuracy data collection tool in everyone's pocket

By Stacey Hartmann

When Trimble Catalyst hit the global market in July 2017, it made high accuracy spatial information accessible to a much broader segment of users, enabling them to operate at levels of precision and data confidence previously attained only by highly skilled, well-equipped geospatial professionals.

It is still early days for Catalyst, a software-defined Global Navigation Satellite System (GNSS) receiver for mobile devices, but reviews of the technology with innovation roots in New Zealand describe a new era of democratized GNSS that is 'the way it is supposed to be', in the words of one industry analyst.

The geospatial profession in New Zealand has taken note, recently honouring Catalyst with the 2017 Supreme Excellence Award for 'Outstanding Kiwi ingenuity for bringing high accuracy to smartphone users anywhere in the world.'

"Out of all the entries, this promises to have the most impact," judges for the New Zealand Spatial Excellence Awards commented on Catalyst. "It stood out for its immense potential for delivering survey accurate measurement solutions using widely available mobile means – its professional and public reach, therefore, cannot be underestimated."

Smartphone evolution

Trimble Catalyst owes its genesis to the increasing processing power, high resolution graphics and connectivity of smartphones and tablets. These increased capabilities have made it possible to turn smartphones into professional-quality data collection devices and sparked a broad range of mobile apps.

Although GPS first appeared on mobile phones in the mid-1990s, the concept of location-based services using a device's built-in GPS didn't take hold until Apple's iPhone 3G. Today, accuracy and reliability of GPS positions on smartphones and tablets remains limited, even in good conditions, to one or two metres.

Geospatial professionals, dedicated as they are to measurement, have fully embraced high accuracy GNSS tools. But for casual users, who might want to use high accuracy GNSS positioning only occasionally, the cost/benefit ratio has been a barrier to broader use.

Innovation backstory

Development of Trimble Catalyst began in 2013 when several engineers came to Mark Nichols, General Manager for Trimble, to discuss an important convergence point in which smartphones would have enough processing power to run a software GNSS receiver.

"I've always been a believer that there are windows of opportunity, and points in time where it's the right time to bring a technology to market," he said.

That time was upon them but the company's engineers needed to figure out how to supplant the processing power required from dedicated chips with software running on the smartphone's main processor.

"At that point, we really didn't know what the computing power would be," said Greg Wallace, Engineering Director for Trimble, "There were a number of unanswered questions."

They also needed to simplify the technology, get rid of the need for a GNSS base station, and make a solution that was smaller, lighter, affordable and easy to use so more people who want access to geospatial positions and measurements could benefit.

Market opportunity

In 2016, Trimble Catalyst made its debut at the Dimensions User Conference, introducing the geospatial industry to a revolutionary technology that opens more businesses, processes and people to these questions:

- How can accuracy help you?

- What will you do with it?
- Can capturing centimetres now save you from needing to do something else later?

With Catalyst, users can access Positioning-as-a-Service to collect geo-location data with Trimble or third-party apps on Android smartphones, tablets and mobile handhelds.

They do so with only a few components:

- Any location-enabled mobile app
- A Catalyst subscription, with accuracy options ranging from one-metre to centimetre level
- Trimble's small, lightweight DA1 antenna that plugs directly into Android smartphones and tablets

Photo: Colin MacDiarmid. NZSEA 2017 Trimble Catalyst Supreme Excellence Award.

Catalyst's Positioning-as-a-Service business model enables users to access different levels of accuracy on demand, which is ideal for project workflows that require accurate positioning for short-term use as an operating expense rather than a capital expense. Monthly Catalyst subscriptions are based on accuracy, so users only pay for the accuracy they need, when they need it.

Bring Your Own App

Higher accuracy can increase the performance – and value – of location-aware applications, but the costs and complexity of high-accuracy GNSS solutions previously presented barriers to entry for many potential developers and their customers.

To encourage support for Catalyst, Trimble opened the system to third-party solution providers and developers so they could add precise positioning to their applications using the free Trimble Precision Software Development Kit (SDK).

In addition to managing the GNSS solution, the SDK enables applications to use positioning metadata such as satellite status information and quality data. Because the SDK can link to any application running on the smartphone or tablet, developers can add accurate positioning to their existing apps.

Applications for Catalyst run the gamut from traditional GIS data collection to higher accuracy work such as utility locations and facility/asset management. Trimble also has implemented Catalyst support in its TerraFlex software and is integrated with Esri's Collector for ArcGIS.

New Users

As part of an early adopter program, John Londo, Senior Geographic Information Systems (GIS) Specialist with CH2M, took Catalyst combined with Collector, for a test drive at the Central Park for the City of Centennial in Colorado. He used Catalyst on an Android tablet connected to the plug-and-play Catalyst DA1 antenna on a pole to collect about 50 data points for streetlights, hardscaping, electric junction boxes, and other public works assets across the 11-acre park.

By integrating with a wide range of applications and providing a dual-frequency, multi-constellation receiver picking up signals from the DA1, Catalyst made it possible for Londo to collect data points that were then added to Collector field software, a collaborative solution for the creation of maps, scenes, layers, analytics and data.

"If it was just Catalyst by itself, I'd say it's a definite cost saving and it's easy to use, but as a bonus, it also works flawlessly with the Collector app. The interaction of the two together is the biggest selling point," Londo said.

Augview, an augmented reality software development company in Auckland is using Catalyst to address the 'drift' of 3D models when viewed on the displays of smartphones, which generally have low-cost GPS hardware, tiny GPS antennas, and employ heavy smoothing techniques that limit their usability for augmented reality mapping workflows.

When using a low accuracy GPS data stream, even if it is filtered to smooth out data spikes, the 3D model itself will appear to wander on the screen, making it impossible to confidently show where the virtual representation of the asset should truly appear in the display's field of view.

By blending precise positioning through Catalyst with its 3D modelling software, Augview is producing stable, accurate views of underground utilities that enable technicians in the field to "see" the location of buried pipes and conduits in real time to avoid damage or safety issues, according to Mike Bundock, founder and CEO.

"We all need to build on each other's shoulders to get at totally viable, good solution," Bundock said.

Stacey Hartmann is a freelance writer who covers the geospatial industry.

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"After exhaustive attempts without success to recruit suitable staff for our land surveying consultancy, I met with Mark to discuss recruitment services. We have now employed 8 additional staff in the last 2 years, all of whom were carefully interviewed and screened by Mark and his team. Although recruitment costs are not cheap, the cost of not employing staff is even more expensive!"

- Kevin Birch, Director of Birch Surveyors

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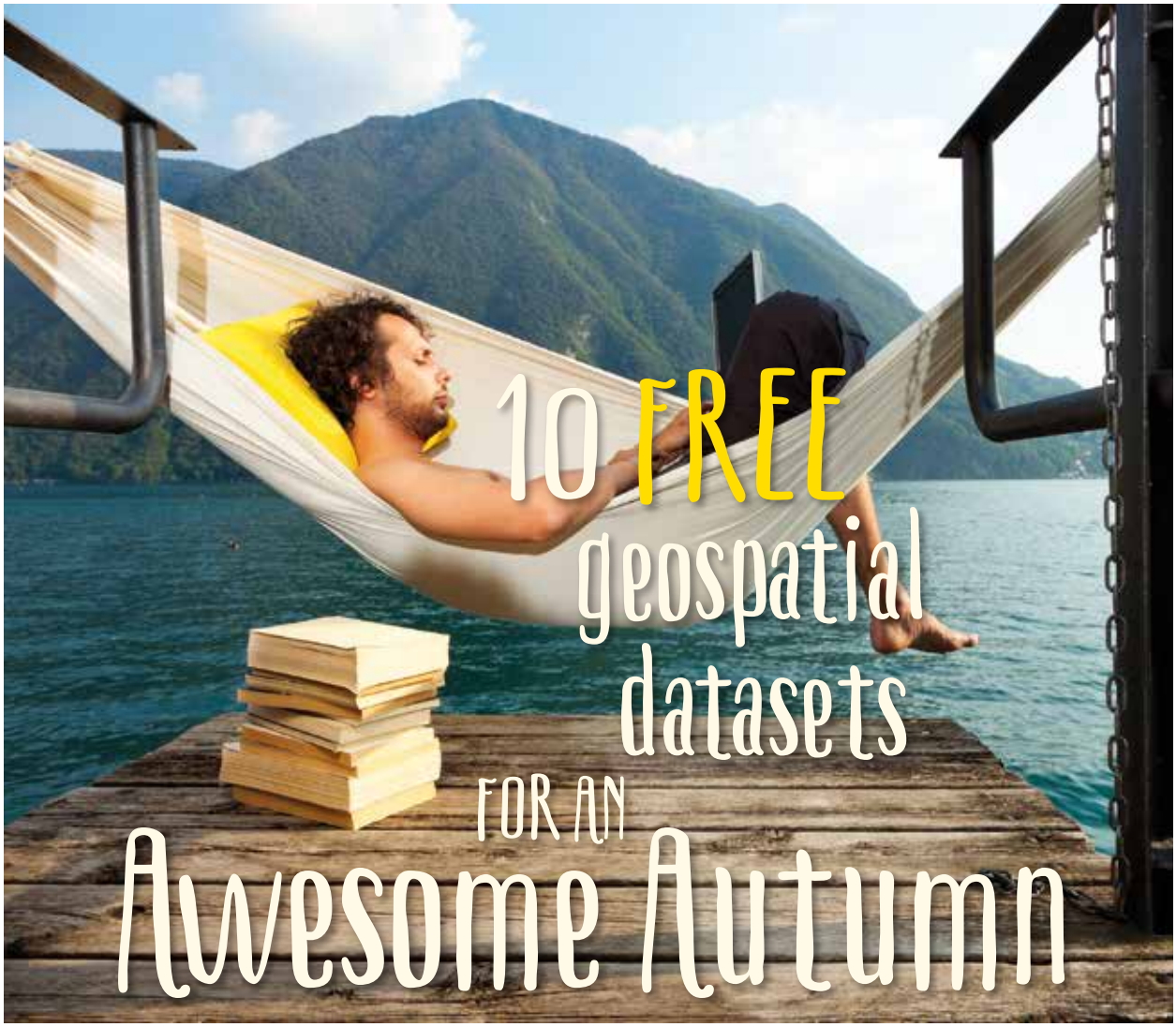


10 FREE geospatial datasets FOR AN Awesome Autumn

Duane Wilkins, Geospatial Advocate, Capability and Outreach. Location Information, Land Information NZ

In an ideal world, we'd be able to download or stream all the data we need from a single location and easy to access and use. It would be free and authoritative, but anyone who says geospatial was going to be easy must have been in sales! There are a bunch of us working towards this, but it's a big job.

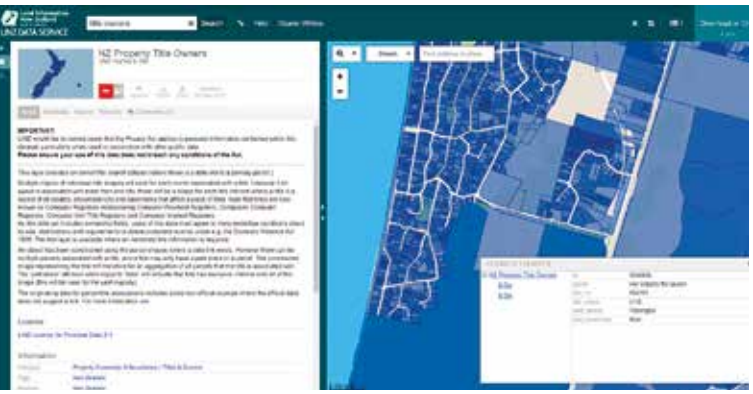
There's heaps of geospatial datasets that can be found on directories like *data.govt.nz* or Esri's open data portal which is now called *hub.arcgis.com*, or on *Koordinates.com*, but it helps to know what to look for sometimes.

Put your feet up, relax in your late summer hammock and browse through these sites and datasets we thought you may not be aware of, are useful or just good fun. That said, once you start down this geodata rabbit hole, you may not come out for several hours, you've been warned!

Most of this data is freely available for you to download in a variety of formats, access in your own software and reuse for commercial purposes.

View this ecological disaster in the new Google Earth on the East Coast at: *goo.gl/UgLaFA* – We've used a keyword-based URL redirect service from Google – type the links into the web browser address bar (not a search box) and the associated website will redirect you and open. Be sure to type in the address exactly as shown.

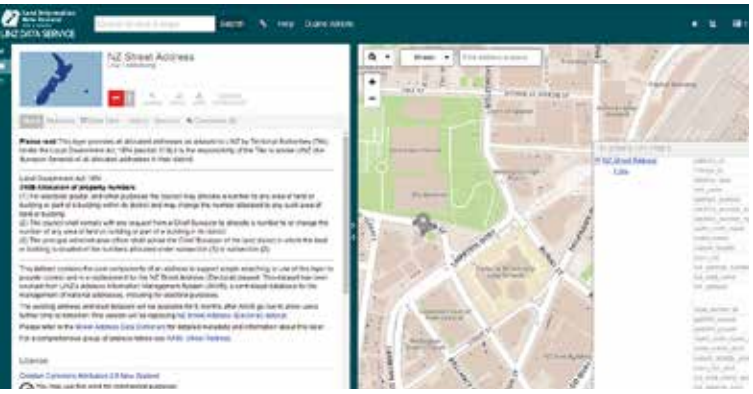
NZ Property Title Owners | *goo.gl/gUiVz7*



This describes the property title and represents it as a polygon, along with the title number, and the owner details. Multiple copies of an individual polygon will exist for each owner associated with each different title, so one polygon for each named owner of that parcel all overlapping.

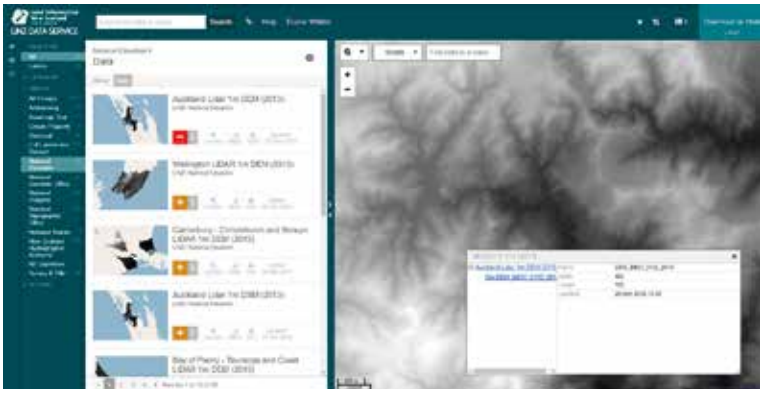
The link above will not work until you've applied for access. Because this dataset includes the ownership fields, you will need to agree to the more restrictive conditions about its use, distribution and requirements to delete protected records. Read and agree to the terms found at on the LINZ Data Service (LDS) and once approved you'll be able to access the data when logged into the LDS.

NZ Street Address | *goo.gl/ysX6gY*



This dataset contains all allocated addresses provided to LINZ by the Territorial Local Authorities allocated for their district. It contains all the essential address components as well as a Decimal Degrees Lat Long coordinate pair for each address location.

1m LiDAR DEMS | *goo.gl/3D7r8E*



Everyone loves filling up a drive or seven with LiDAR point clouds and there are hundreds of gigabytes worth now available to burn out your router and fill up your hard drives several times over. For best results, look for the Index Tiles for each area of interest and only download what you need. If you're not sure what LiDAR is, here's a short video that may help fill in the gaps: *goo.gl/cQDweA*

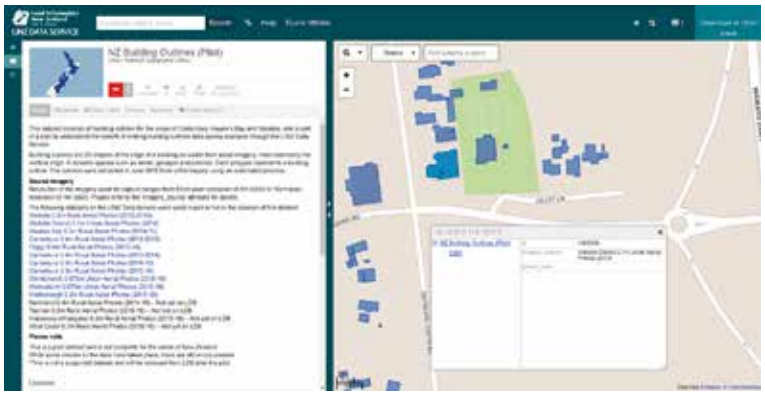
NZTA State Highways 15cm Aerial Photos | *goo.gl/UxAQAo*

This imagery is a half terabyte national treasure you sometimes need to know is there before you can find it. Like most good image sources, the data is available in web map tile services format (WMTS) which allows you to add the imagery directly into your mapping software without having to download 248,000 megabytes before you can use it. If you log in to the koordinates.com site and add each layer to your 'collection' you can also view and zoom into all of the imagery in the browser directly.

Urban and Rural Aerial Photos | *goo.gl/3oFk2q*

Thanks to the National Imagery Coordination Programme there is an abundance of free to access aerial photography. Orthophotography is the process where an image is geometrically corrected so that the distortion on hillsides for example is significantly reduced. Most imagery is stored in NZ Transverse Mercator metric grid projection, sliced and diced based on the NZ Topo50 map sheet index to help us figure out where each tile goes. Each pixel represents between 10cm to 75cm, generally the data has more detail in urban areas, and more than 85 per cent of New Zealand has coverage available. If the software you use for mapping can consume a streaming webservice, WMTS is available.

NZ Building Outlines | *goo.gl/NHGf1U*



This is a set of building outlines for parts of the country that generally shows a roofline polygon of a building from an aerial image. It can be used for planning and seeing where structures are, and for serious geeks you can add a height attribute and create 3D blocks to represent buildings.

EXTREME PROCRASTINATION WARNING!

While reviewing the following items, periods of significant time loss and time travel to a point some hours after beginning may be experienced by some viewers.

Retrolens.nz

1936 was quite a year. England celebrated its first ever win over the All Blacks, Peter and the Wolf debuts, Alan Turing submitted a paper 'On Computable Numbers', Adolf made his infamous summer Olympics opening speech in Berlin, Italy annexed Ethiopia, Donald and Pluto was first released, (not *the* Donald, the other one) the last Tasmanian Tiger died, and the BBC began broadcasting TV.

Meanwhile here in New Zealand Henry Drury Piet van Asch founded NZ Aerial Mapping Ltd, and 81 years later, we can now access the treasure trove of over half a million aerial photographs. The value of these images is in showing change across New Zealand. The photos were taken for a range of reasons such as land management and mapping as well as to develop intelligence to counter the impending threat of invasion from Germany and later by the Japanese.

Auckland Airport at exactly 12:54pm on the 19 August 1960. The International Terminal currently sits near the horse racing oval on the foreshore.

If you've not burnt out your router yet and would like a copy of the mother of all aerial datasets, here is a link that enables you to identify coverage for all aerial photography taken on behalf of the government between 1936 and 2005: *goo.gl/j4ArQg*

Google Earth and Earth Engine Historical Imagery | *google.com/earth/desktop*

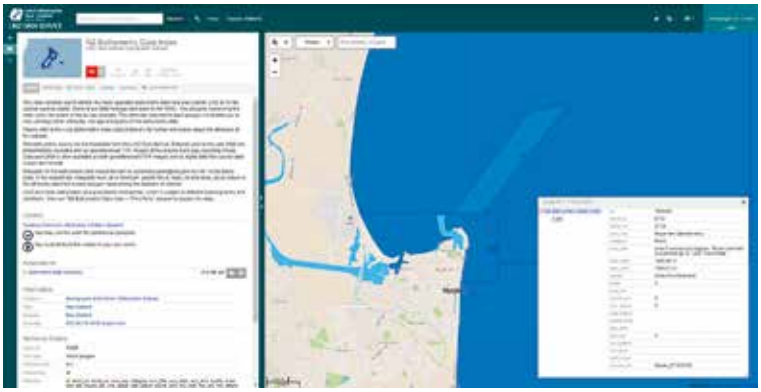
"GIS is a form of digital mapping technology. Kind of like Google Earth, but better" ~ Arnold Schwarzenegger at the Government Technology Conference's 2008 Conference on California's Future.

When you combine a bunch of geogeeks with *literally all of* the world's public satellite imagery with *literally* unlimited disk storage and *literally* unlimited processing power, interesting things happen.

So, long story short, trillions of pixels, millions of hours processing and then a day and a half later, Google Timelapse was finished!

In addition to the time lapse sequences, it's possible to view this and a wide range of other historical imagery in Google Earth Desktop at more localised areas using the wee tool left of the Sunrise icon on the main toolbar. Download and install Google Earth Pro for Mac or PC from *google.com/earth/desktop*

NZ Bathymetric Data Index | *goo.gl/XieQH2*



This index enables you to identify the freely available bathymetric data held and used by LINZ on its New Zealand coastal nautical charts, and some date back to the 1930s.

You can use the attributes from this index to help find the marine charts you might be interested in using for a variety of work related, and non-work related purposes such as identifying underwater reefs and other features that make the best fishing spots, enjoy!

Streetview 3D – Highlights of the Great Walks | *goo.gl/KA4fTi*

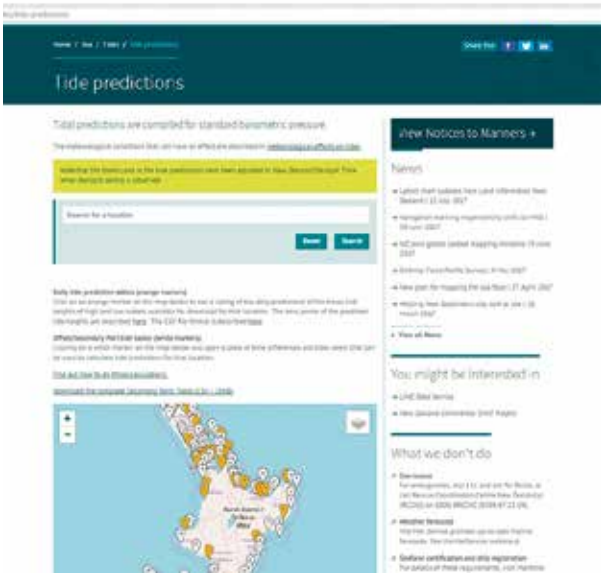
This last one is not explicitly a geodata set but is the ultimate couch potato conservation warrior enabler. This map was prepared to highlight the most picturesque Google Trekker imagery from seven of New Zealand's Great Walks. Zoom into a track that you're interested in, click through the photo icons and when you find one that you like, on the left panel click the 3D view to open the immersive 360-degree image. You can also download the map as a KML for viewing in Google Earth desktop. Be warned, you

may lose a few days virtually walking, and if you purchase a $5 Cardboard viewer from Trade Me you'll be able to explore the Great Walks in Virtual Reality using your phone.

Tides | *goo.gl/YyjgY5*

Ok, so back to our fishing theme for the summer season and our final 'dataset' for this month, which you'll no longer need to wait for it to come out in the *New Zealand Herald* Summer edition. Here, ladies and gentlemen, LINZ presents you with tide tables for almost every place in New Zealand – enjoy (don't forget your marine charts).

*Land Information New Zealand takes no responsibility for any increased leave resulting from increased fishing activities by *Surveying+Spatial* magazine readers.



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Cross lease boundaries

- Boyer v McCracken [2017] NZHC 755, (2017) 17 BCB 424

Mick Strack, mick.strack@otago.ac.nz

Cross lease problems

Since the Law Commission's report on Shared Ownership in 1999, which strongly recommended that legislation be prepared to ban further cross lease developments and require existing cross leases to convert to unit titles or subdivisions, little has changed; cross leases are not consistently being converted, and because there are at least still some residual benefits of a cross lease development over a subdivision, cross leases are still being done.

One of the advantages of cross lease developments since their inception is that the survey costs are significantly cheaper. The survey plans are usually only low-accuracy scale plans illustrating the general layout of buildings (showing the extent of a lease), use areas (covenanted for exclusive occupation) and common areas (whatever is left of the shared title).

When considering the hierarchy of evidence (natural boundaries, pegs in the ground, longstanding occupation, words on a deed and numbers and lines on a plan) the lines on the plan hardly prove anything. Depending on whether the external boundaries need to be confirmed by survey, there may be some quick observations from witness marks, to observe to building corners and internal spaces (e.g. fences, driveways and garages), but more normally, the fix is a plastic tape survey of offsets from existing occupation boundaries. These internal division lines and corners are not 'surveyed' in the sense of a cadastral boundary survey – and even if they have been observed to, they have not been marked on the ground by monuments and usually there have been no independent survey checks. The surveyor's declaration confirms that all buildings are within the allotment boundaries, but makes no mention of the internal divisions of the exclusive covenant areas.

The outline of the dwelling spaces and the areas set aside for exclusive occupation are then plotted onto plans with pen lines at say 1:200 so cannot readily be reproduced except by scaling. They may later be fenced in positions determined by nonchalant builders or occupiers. Therefore, it is my view that it is an occupation boundary which purchasers buy and accept (until they don't!), not a reproducible boundary that can be legally defended.

The Law Commission recognised the uncertainty about these non-surveyed boundaries, and an early consideration in their report was whether, in the conversion of the cross lease area to a fee simple title subdivision, the title could be issued as 'Limited as to Parcels' where the boundary is defined by possession and a full survey would later be required to remove such limitation. This recognised that the lines drawn on the plan were not surveyed. This option was dismissed as the purpose of the recommendation was to upgrade the title – the creation of a limited as to parcels title would retain the uncertainty about 'boundaries' that currently exists.

Shared ownership models continue to cause conflict. There are numerous case examples of conflicts about Unit Titles (although mostly caused by the roles and responsibilities of the Body Corporate) but not many examples of Cross Lease conflicts, in spite of the Law Commission warnings. But it seems that there are many more disputes about these than go to court – as one Auckland City report just reported: "There is no public visibility or counting of these disputes".

It is therefore significant that a recent case; *Boyer v McCracken* and an earlier similar case *Duncan v Taylor* (2010) are particularly focused on a dispute about these internal division lines.

The case Boyer v McCracken

The cross lease titles affected here were developed in a commonly occurring fashion. An existing dwelling with a developable front yard was created as Flat 1 (Boyer) and a survey was prepared which showed the front area ready for an additional dwelling. The area around the existing house was considerably bigger than the area set aside for an additional house. An old house was moved onto the front land (Flat 2 – McCracken) and the flats plan was completed showing the whole parcel, two lease areas defined by the two houses, and two exclusive possession areas surrounding each house. The houses and the covenant division line were fixed by hanging line observations from road traverse marks.

Both houses were sold several times and each new owner was either assured or assumed that the dividing fence was the legal and physical boundary between the two. Both lessees wanted to expand the footprint of their houses which would invalidate the lease, so needed the permission of their lessors (themselves). The front site was rather limited in the area allowed for development, so a

closer examination of the dividing fence and the Flat Plan line showed that they did not match. The line on the plan indicated that the division abutted the existing entrance porch of the original house, but in fact the fence was about 1m away to accommodate a path to the front door.

The path had always been occupied by Flat 1, but the plan had shown it by implication as being within Flat 2 exclusive occupation area. As neighbourly relations deteriorated, Flat 2 removed the fence. It seems that both parties came to court agreeing that the 'boundary' was against the porch of Flat 1. The path then, was claimed by Flat 1 as a misplaced structure. The application to the court relied on the Property Law Act 2007 sections concerning 'misplaced structures'. A rather tortuous argument was brought before the court to describe the path, which existed before the cross lease survey was done and before the fence was erected, as a misplaced structure. It may have seemed more obvious to describe the fence as a misplaced structure. The judge accepted jurisdiction under the Property Law Act and by balancing the costs, benefits and convenience to both parties, granted the 11m^2 strip of land of the path to Flat 1 (the occupier) with payment to Flat 2 of $85,000. Flat 1 was valued around $1.4m so perhaps the cost of the added 11m^2 was reasonable.

Some additional observations

In defending her rights to the strip of land, Ms McCracken claimed that she had purchased 251m^2 of land with her flat, and that is what she expected she would obtain. The judge appeared to accept this claim as valid. However, and with respect, there is no basis for such a claim. Ms McCracken held an undivided share of the whole parcel as tenant in common, and within the cross lease there is no property separation (dimensionally or otherwise), just a poorly defined exclusive occupation area. At most Ms McCracken acquired exclusive rights to the house (as built) and the area (as occupied) with some expectation, but no guarantee, that they corresponded with how they were illustrated on the plan. Furthermore, the court accepted that she had been paying rates on the strip that was occupied by Boyer. I believe she bought what she was shown by the land agent, and paid for exactly what was occupied. The rates, being based on valuation, which essentially boils down to what people will pay for property, cover exactly what she bought.

I suggest that there may have been many different arguments considered in this case. Some revolve around the nature of a cross lease title and the definition of covenant spaces.

Could a claim for possession have resolved this dispute?

A claim for **adverse possession** can be maintained when the boundaries of property are known and there is open, manifest, exclusive and continuous occupation by someone other than the registered owner with an intent to possess.

A claim for **possession** can be maintained when boundaries are unknown or undefined and one party is in undisputed possession for a period of time, usually 20 years. "Everyone who is in possession, though he has no rights, has a greater right than one who is out of possession and has no right."

This issue raises some interesting questions. Under a cross lease title, holders share the whole fee simple title in equal shares as tenants in common. In other words, they all own all the land. Since this cross lease was established in 1992, and since having some ownership changes, all new purchasers were under the assumption that they were buying the flat as stated and the exclusive occupation of the surrounding land as indicated by the fences, as if "the fence represented the boundary line". This fact was undisputed. Possession is sometimes the best evidence of title, and fencing is the best evidence of possession.

Secondly is the line dividing the exclusive use areas a 'boundary'? As we all know, a cadastral boundary is very carefully established. It normally must be measured to, marked on the ground (survey pegs), documented by dimensions and plans, approved by the chief surveyor (so recorded in LINZ database), be reproducible and then, usually, occupied (although this latter condition is just to further validate the boundary – or to provide some physical evidence on the ground of the invisible boundary line). The exclusive use area has none of these characteristics. The line on the plan remains merely, a line on a plan. Attempts to re-establish that line may rely on scaling off a plan, so may have no survey quality. The fence has similar characteristics as a general boundary in the UK, in other words the ground evidence proves the position. This situation is analogous to a limited title boundary.

This case seems to be another example of neighbours getting into conflict and the boundary dispute is merely a symptom of personal disagreements and resentments. Both parties wanted a new lease title anyway to develop the houses beyond the existing defined lease footprint. They could not both get their own way. The court recognised that both parties had acted in a hostile and intimidatory manner and both exacerbated the situation. Cross lease shared arrangements are likely to continue to cause conflict as exclusive use ambiguities undermine the strength of this form of tenure. Surveyors should be cautious when dealing with spaces which have no defensible definition.

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INVESTING IN EDUCATION

Christina Hulbe, Dean, National School of Surveying

It's common to hear education described as an investment. Individuals and the communities in which they live, commit resources to education from kindy through to postgraduate study, and they both expect dividends.

Here in Aotearoa New Zealand, the investment in tertiary education has, in recent years, been made about equally by those two interest groups.[1] Advanced education is associated with greater earning power, so we assume that the investment is worthwhile. But is it? And if it is, why is that so?

The relationship between education investment and economic return is not necessarily linear. If it was, we'd never have any new occupations and the rate of innovation in existing fields would be achingly slow. So, education should also be seen as setting expectations for the future, not *what* we want it to be but *how* we want it to unfold. Put another way, New Zealanders are not purchasing a surveyor when they underwrite a BSurv degree, they are investing in individuals who are prepared to be active participants in shaping our future towns and cities, reimagining land and resource management, and developing applications we can't yet imagine.

Education for the future seems unlikely to be about excessive specialisation or narrowly defined skill sets. Global surveys of skills demand in different industries consistently emphasise complex problem-solving and social skills over technical skills and specific content knowledge.[2] Cognitive abilities like flexibility, creativity, logical reasoning, mathematical reasoning and visualisation are all growing in importance. Technical skills, many of which can be reproduced by machines, are declining.

In his 2013 book *Mass Flourishing,* Nobel prize-winning economist Edmund Phelps argues that innovation is not the special domain of either the academy or the private sector. Instead, progress is most rapid, and economies are the strongest when there is a robust exchange between the two. The successful economy, in his view, is a creator, rather than a consumer of innovation. But hold on before you conclude that Professor Phelps is thinking just about science when he makes this case. Emotional intelligence, negotiation and persuasion—all key social skills—are the traditional domain of the humanities, not the sciences. Phelps' work is also notable for placing people in the centre of the economic picture and when you do this, you find that the more inclusive and diverse the economy, the more access it has to creativity and the more successful it is.

Given all of this, even if it is associated with relatively high employment rates, STEM education (science, technology, engineering and mathematics) alone is no guarantee of future success. Courses of study that support students to develop both disciplinary expertise and a much wider suite of cognitive and social skills are required to truly prepare our graduates for a future characterised by adaptation and ongoing change.

How do we ensure this happens? From the point of view of the university, I would argue that research-informed teaching, seminar-style papers in which students are required to think critically about what they read and what they 'know', and the opportunity to pursue self-directed projects are all essential. Following Phelps' view of innovation, learning how to develop a new research project connects directly with modern professional practice. Maintaining the social networks developed at university, both with faculty and with peers, is also essential to ensure the exchange of ideas continues.

Investing in education is as much an expression of what we value in our society as it is a calculated financial decision. Innovative, inclusive, and prosperous economies require strong connections between academic research and the private sector. And this, I would argue, requires academics to value the private sector and businesses in which workers understand the world of research. While they may not be for everybody, at least not straight out of school, degrees in which broad skill sets (including social and critical thinking skills) are developed and in which students experience research hands-on are best suited to meet this ambition.

NOTES

1. OECD *Education at a Glance 2017* report: *https://data.oecd.org/eduresource/spending-on-tertiary-education.htm*
2. The World Economic Forum *Future of Jobs Report* 2016: *http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf*

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