SURVEYING + SPATIAL

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Issue 97

Dogs, trekking and theodolites: mapping the Antarctic in the '60s

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The role of the surveyor in BIM design

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Our vulnerable environment

Rachel Harris

Survey and Spatial New Zealand and the New Zealand Antarctic Society recently celebrated 50 years of New Zealand Antarctic surveying, a milestone that serves as a timely reminder of how important supporting ongoing research and protecting Antarctica's fragile environment will be in the future.

Every summer, more than 100 New Zealand scientists and researchers travel to Antarctica and the Southern Ocean to undertake research projects. Their studies increasingly are being undertaken further afield on the continent to study where change is occurring at an accelerated rate, such as the floating ice shelves, ice sheets and oceanic systems.

Antarctica New Zealand states that within a generation there will be substantial differences to a part of the world that encompasses more than 10 per cent of the Earth's surface and is surrounded by the Southern Ocean, which drives the climate and ocean circulation of the planet. If Antarctica's 26.5 million cubic kilometres of ice melted, global sea levels would rise by more than 60 metres.

Working in collaboration with the international scientific community, our research is integral in assisting with data, monitoring and gaining greater insight into protecting the Antarctic environment as changes occur.

This first edition for 2019 features a diverse range of topics from industry research across the survey and spatial sectors to technological developments and an examination of climate change and coastal hazard challenges for the industry.

The unparalleled challenges of Antarctic fieldwork surveying and mapping is presented by Peter Otway, who has recounted his unique experiences of surveying the Transantarctic Mountains with dog sled teams in the early 1960s.

Mel Gurdon, of New Zealand transportation and spatial specialists Abley, presents an analysis on its new innovations for safer vehicle overtaking, undertaken by its road safety team. The 3D spatial design, which has been developed by transport engineers and spatial analysts, aims to provide safer overtaking opportunities on undivided roads.

From the hydrographic stream, University of Otago Hydrographic Surveying lecturer Emily Tidey and hydrographic surveyor Rian Mayhead present a report on legal and regulatory considerations for unmanned surface vessels (USVs). With technological advancements developing at a rapid pace, the authors encourage operators and businesses to participate in law reform processes to implement safe and secure procedures and practice.

And from the Young Professionals, Sam Wells takes a look at the developing role surveyors play in BIM design (building information modelling).

Celebrating Surveyors of the Antarctic

Fred Davey, Jan Lawrence and Peter Barrett

Dog sledging, tobogganing, surveying and geology, skills with dogs, machines and mountain craft were all featured in a special Antarctic celebratory evening in November 2018.

Some of the 'true pioneers' of surveying and mapping in the toughest of conditions got together along with many other guests to celebrate and acknowledge their work and achievements at a dinner jointly hosted by Survey and Spatial NZ and the New Zealand Antarctic Society at the Wellington Club.

The dinner was preceded by the Society's annual Sir Holmes Miller Memorial Lecture, delivered by veteran surveyor and Antarctic surveying pioneer Peter Otway.

The lecture's namesake, Sir Holmes, or Bob to his friends, was the architect and driving force behind New Zealand's Antarctic mapping programme from 1957 to 1964.

Peter delivered an informative and very entertaining presentation titled *Mapping with dogs and theodolite in Transantarctic Mountains*, based on his experiences as a surveyor for 16 months in the Antarctic.

Included was a three-month summer sledge journey with three companions, mapping from the Polar Plateau and down the Axel Heiberg Glacier to the Ross Ice Shelf on the 50th anniversary of Amundsen's epic polar journey. Other activities involved feeding and caring for more than 50 ever-hungry dogs and being nursemaid to about 20 overeager pups during the winter!

The society's patron, Emeritus Professor Peter Barrett, MC for the evening was also an Antarctic geological pioneer. He spent two months in late 1963 with Vic McGregor, the geologist on Peter Otway's epic journey down the Axel Heiberg Glacier, and surveyor Alan Gough, completing geological mapping along the coastal mountains to the north, using motor toboggans for the first time in the NZ Antarctic Programme. One memorable discovery was a huge fault along the front of the Transantarctic Mountains.

Dr Fred Davey, a marine geophysicist and an Antarctic marine surveying pioneer, led a Toast to Treaty Nations and spoke of the Antarctic Treaty "arguably one of the most successful international treaties of our time". After ratification in 1961 by 12 nations, the treaty now has 53 parties. It has shown remarkable success in preserving Antarctica as a place for peace and science.

The treaty grew out of the strong international collaboration shown, particularly in the Antarctic, during the International Geophysical Year (IGY) – an international global collaborative scientific study of the physical properties and processes of the Earth and its environment, involving nearly all UN countries.

Fred noted that one IGY study of interest to surveyors was the measurement of the detailed astronomical position of a global network of observatories that led to the finding that the Earth is not round, but pear-shaped!

During the evening, Bill Robertson and Survey and Spatial NZ were thanked for their efforts in making the evening happen. There was also poignant recognition for and remembrance of the efforts of people who have worked in this harsh environment. These included colleagues and friends who have passed away, the Erebus crash victims – by Colin Fink, the Antarctic and Erebus crash surveyor – and toasts to mountaineering assistants, all Antarctic surveyors and Antarctic mapping. The support of Scott Base staff and families at home was also acknowledged.

(Peter Otway's address is on p33)

"That's it, sir . . . we've eaten the last of the geologists!"

Cadastral Professional Stream

The Cadastral Stream are working on a number of work items at present, including the Rules Review (thank you to those members who provided feedback), STEP, ASaTS, otherwise known as the Land Online replacement and have one of our executive members on the National Technical Committee assisting with the conference. We are also looking to run another seminar later this year, the topic of this is yet to be determined and we ask that members forward ideas or topics which they would like to be considered for a seminar topic to *cadastral@surveyspatialnz.org*.

As always, if you would like to contact the group, please do so via the email address above.

Matt Ryder, Cadastral Stream

Engineering Surveying Stream

Most of us in the Engineering Surveying space – if we were lucky enough to get a break over Christmas, have been working non-stop on the many construction projects around the country. This coming year sees the planned start of two major horizontal infrastructure projects in Auckland, namely Contract #3 of the City Rail Link, and Watercare's Central Interceptor project. Each of these projects will be around the $1bn mark and will be on the hunt for talented construction professionals. The Manawatu Gorge my also begin later this year and looks also to be a very significant project. Not to mention all the vertical construction that is happening not just in Auckland.

All this activity will put pressure on the current projects underway that still have some years to complete, so if you are considering putting down the peg bar and picking up the Gyroscope or the BIM software, now's the time.

Michael Cutfield, Engineering Surveying Stream

Hydrographic Professional Stream

The HPS is looking forward to the S+SNZ conference in Auckland in May. We have some interesting hydrography-related presentations scheduled on Friday 10 May ranging from marine geospatial information to autonomous surface vessel use in Tonga, marine science and hydrography, to investigations linked with national Tuia 250 Encounters commemorations (250 years of Māori and European interaction since James Cook visited on the Endeavour in 1769).

We also look forward to networking with our stream in Auckland, and will host a short stream meeting there.

Hydrography around New Zealand

DML has completed the fieldwork phase of the LINZ-contracted Eastern Bay of Plenty survey around East Cape, Whakaari/White Island and Moutohora Island.

iXblue and DML are mobilising for a LINZ survey in Fiordland, including Dusky Sound, Doubtful Sound, Bradshaw Sound and Deep Cove.

A programme of satellite-derived bathymetry, airborne laser bathymetry and multi-beam echo sounder surveys (including the use of an unmanned surface vessel) has been completed in Tonga as part of the NZ Aid programme, Pacific Regional Navigation Initiative.

LINZ has launched an online chart catalogue spatial view (*https://www.linz.govt.nz/sea/charts/nz-chart-spatial-view*). Also at LINZ a project to join land and sea datasets together is under way – datasets include topographic and bathymetric LiDAR, multi-beam echo sounder and terrestrial laser scanner.

At the University of Otago, summer students have been working hard on the aforementioned Tuia 250 Encounters project, currently titled Tuia: 250 years of navigation, map making and belonging.

Eliot Sinclair has been busy along the Kaikoura coast profiling the rocky inshore zone with their drone 'dipping' system, West Coast profiling, Clutha and Heathcote river surveys and Nelson, Gisborne and Greymouth dredging support.

LINZ is working with stakeholders across a range of New Zealand organisations to unlock value from marine geospatial information to contribute to a thriving Blue Economy.

In February the first meeting of the National Marine Geospatial Information Working Group was held in Wellington. This is a national body of representatives from government agencies, CRIs, regional councils, universities, and other entities that have an interest in co-ordinating and improving access to marine geospatial information.

We would love to profile other HPS members' hydro work in our quarterly S+S news – please get in touch!

Emily Tidey, Stuart Caie and Maurice Perwick – HPS leadership team

Land Development and Urban Design Professional Stream

The LDUD Stream Committee has had a busy start to 2019.

After numerous years of valuable work on the Examinations Panel, Ross Thurlow and Mark Dyer have resigned from their roles on the panel. Many thanks for all their hard work over the years.

Expressions of interest to fill the planning, design and resource management examiner and land development engineering examiner roles were sought in January, with many quality applications received. The new examiners will be announced shortly and all ready to go for the April examinations.

Otago University is also well under way with preparations for its 150-year celebrations. As part of these celebrations, there will be a CPD workshop on 1 June at the Survey School. The focus of the workshop will be Beyond Subdivisions: Why Urban Design Matters.

This workshop will explore design ideas and solutions to common urban design problems, and best practices through discussion and analysis of New Zealand projects and the Global Street Design Guide. This will be an event not to miss!

Julia Glass, LDUD Stream

Positioning and Measurement Professional Stream

The Positioning and Measurement Stream (P&MS) has a goal to identify and develop the vision and functionality that is required to ensure that the needs and wants of the stream are both recognised, and wherever possible, understood and supported by the parent body and the sector.

In order to help to identify and develop a vision, we want to encourage an understanding of technology trends (not just in the spatial sector, but in general) that are taking place. Knowledge and improved understanding of these trends will enable us to move to being proactive in managing change, and create the functionality required.

The stream has been using LinkedIn as a medium to post articles, and as a resource, that will help develop an understanding of change and hopefully create discussion and questions. I would encourage you all to follow, comment and post in the LinkedIn group: *https://www.linkedin.com/groups/6922254/*

In recent weeks we have posted on:

1. SmartCities
2. Kaikoura rebuild
3. The surveyor and artificial intelligence
4. Blockchain mapping

These articles will hopefully lift all our knowledge, and turn us to facing the future with a greater level of knowledge and confidence, question our current thoughts, and enable us to take a lead role in change.

Bruce Robinson, Positioning & Measurement Stream

Spatial Professional Stream

For 2019, the Spatial Professional Stream will be focusing on our SPS strategy – working to develop and expand the offerings and inclusiveness for existing and new spatial stream members. If anyone is keen to be involved, please let us know (*spatial@surveyspatialnz.org*).

Our first focus for the year will be the running of the value proposition workshop, the planning for which is under way. Another key focus will be to finalise our position on RPSpatial and report back on that to members.

We are also looking at a couple of exciting new initiatives so watch the mailouts (and the next *Survey + Spatial* edition!).

The S+SNZ conference in Auckland this year will have a day (Friday, 10 May) with a specific spatial thread running through it, so even if you aren't planning to go to the whole conference, it's worth considering coming in for the day.

This includes a keynote presentation from Ed Parsons (Google), a spatial panel session and spatial lightning talks, as well as session presentations from some exciting spatial speakers. Check out the conference website for more information.

Also worth considering is the Locate conference in Melbourne from 8-10 April (locateconference.com). S+SNZ members can register for the conference and pay SSSI member rates, so keep that in mind if you are planning to attend.

There are a number of Women in Spatial events planned for 2019, including a WIS lunch at the conference on 10 May. If you would like to know more, please email *spatialwomen@gmail.com* or join the LinkedIn group: Women in Spatial (NZ).

As always, we welcome any suggestions or feedback, at *spatial@surveyspatial.org*.

Kat Salm, Spatial Stream

TO ALL OUR MEMBERS AND ASSOCIATES:

S+SNZ would like to acknowledge the careers and contributions of all members past and present upon their passing and would like to actively encourage all branches to prepare obituaries for publication in *Surveying + Spatial* as the occasion arises.

If you would like to publish an obituary for the next edition, please email the editor, Rachel Harris at: *surveyingspatial@gmail.com*

ATELLITES TO AVE LIVES

Ryan McNie, National School of Surveying

1. Introduction

Transportation is an essential part of everyday life. Cars are used to go to jobs, hobbies and visit family. Even when biking or walking, traffic is still an issue. This increase in mobilisation has made travelling easy and opened up opportunities that were just a dream 100 years ago. However, with increased mobility, there have come some issues.

The cost of cars, fuel and mobile infrastructure cannot be ignored in any decision made. Alongside these costs are the future economic, social and ecological costs such as noise, resource consumption, exhaust pollution, and loss of productive time due to traffic. However, none of these compares with the impact of harmful or fatal accidents.

Traffic-related accidents are the leading cause of death for people aged 15 to 29, with more than 1.2 million people around the world dying in road crashes each year, with an additional 20 million to 50 million left injured or disabled. For this reason, a future in which no one is killed or seriously injured is envisioned, the idea of 'Vision Zero'.

To achieve this, automotive companies have invested in accident avoidance and damage mitigation. Driver assistance systems (DAS) offer a means to enhance active and integrated safety. These have evolved from internal dynamics such as anti-lock braking systems (ABS) and information such as radar and lane departure warnings and are being used in automated and cooperative driving such as autonomous cars and traffic sensor networks.

As surveyors and spatial specialists, our knowledge can contribute to the future of accident avoidance. The knowledge of how global navigational satellite systems (GNSS) works, and how precision, accuracy and error contribute to these systems is imperative, and will pave the way for other advances.

This contribution will focus on car-to-car accident avoidance systems, looking initially at direct measurement collision warning systems (CWS) and indirect CWSs, followed by how cars use sensors to warn of collisions. The advantages and limitations of the current state of CWSs are also examined.

2. Direct collision warning systems

The term 'direct CWS' does not refer to the nature of the collision, but how the measurements are made. A direct CWS makes use of measurements undertaken directly by the subject car. This is a simple form of CWSs as it does not require cars to communicate with one another. The forms of direct CWSs currently in use are vision-based, radar and light detection and ranging (LIDAR), with supplementary on-board sensor information. Many cars adopt an integrated approach using vision-based as well as radar or LIDAR to get the most a robust CWS.

2.1 Vision-based systems

As humans use vision as one of the main sources of information, it is understandable that vision-based systems also became a source of information for cars. Vision-based systems use colour cameras or stereo cameras to determine the distance of an object from the subject car, as well as determining what the object is.

One difficulty with using vision-based systems is determining what each object seen by the camera is. To do this, the generic obstacle and lane detection (GOLD) method is widely adopted. The GOLD method outlines, as suggested by the name, how lanes and obstacles are determined by using a combination of patterns, supplemented by features such as texture, symmetry, shape, or using an approximate contour.

Once the lanes and obstacles have been determined, this information is combined with the on-board sensors to determine whether a collision may happen.

2.2 Radar systems

Radar sensors emit and receive electromagnetic waves that determine the range to objects, as well as range rates. In other words, radar can determine whether the distance between the subject car and an object ahead is reducing

at such a rate that may cause a collision. Radar originally helped adaptive cruise control (ACC) by measuring the distance and relative speed to the car ahead to maintain a minimum distance. This has since been use in CWSs to determine the distance and whether a collision may occur.

2.3 LIDAR systems

LIDAR sensors are the most popular active sensor that sends and receives data to localise the subject car in relation to its surroundings. LIDAR and radar work in a similar manner but operate at different wavelengths. LIDAR uses the ultra-violet, infrared and visible light wavelengths, whereas radar uses the longer radio wavelengths.

The shorter wavelengths of LIDAR means it has better resolution but poorer penetration properties; radar is better than LIDAR at penetrating dust, rain, and snow. When it is raining or snowing, however, a greater reliance is made of sensors being able to 'see' obstacles that humans are unable to see. Therefore, the trade-off between more valuable sensors and cost must be evaluated, as LIDAR is less expensive than radar.

3. Indirect collision warning systems

Indirect CWSs relate to the collision information being obtained from direct measurements made by sensors on the car, such as cameras or radar sensors. They instead receive relevant information from other cars and uses it to determine the collision information. A prime example of indirect CWSs is using GNSS. The GNSS information from surrounding cars is combined with the GNSS information measured by the subject car to calculate the distance between the two. This is called cooperative collision warning (CCW). In addition, the technology does not have to be limited to cars, as GNSS receivers located on infrastructure, such as building or bridges can also provide GNSS data to the subject car.

Previously, the internet has not played a large role in cars, with data links being used only for navigational support and 'infotainment'. With the potential for use with DASs being recognised, GNSS observations and direct measurements can be communicated with surrounding cars using dedicated short-range communications (DSRC).

To determine the distance between the cars using this method, basic safety messages send raw observation data from which the relative distance between two cars can be calculated. As precision is imperative, real-time kinematic observation data from continuously operating reference stations (CORS) is received by radio transmission or NTRIP protocol, and cellular communications.

Unlike direct measurements, indirect measurements are able to be used when a direct line of sight is unable to be achieved. This can be useful when a vehicle is around a corner that may cause a problem for the subject car. Indirect and direct measurements are most powerful, however, when they are combined, supplementing one another. By using the CWSs together, the measurements have higher redundancy, higher reliability and higher integrity, which is of utmost importance in safety of life applications.

Direct and indirect CWSs have the ability to provide efficient driving conditions through platooning.16 Platooning is the idea of all the cars working together, sending relevant information to all surrounding cars, such as speed, stopping ability (condition of brakes), acceleration ability (throttle condition), and route. This creates an efficient method of movement.16 It has been suggested that "a single automated lane could carry as much traffic as three or four ordinary lanes". This improves safety by taking away the human factor of driving.

4. Advantages of collision warning systems

The main advantage of CWSs is obvious – reduced loss of life. Road traffic injuries are one of the leading causes of preventable deaths. One of the recommendations to improve driving safety provided by the World Health Organisation is to reduce driver distractions, as it reduces driver reaction time and therefore driver braking times. CWSs alongside autonomous collision prevention measures, such as automatic braking, would reduce this time to lower than what a human could achieve, even if not distracted.

CWSs also would increase the efficiency in terms of energy, time and resources. Braking patterns would become less erratic and would therefore reduce congestion and reduce the amount of fuel used. As mentioned previously, when platooning becomes available, multiple cars would be able to travel faster, safer, and more comfortably.

5. Limitations of collision warning systems

Although offering many advantages, CWSs are a safety technology that has not been widely adopted. In addition, CWSs only offer safety advantages for the vehicles equipped with the technology. More market penetration is required for full utilisation of CWSs, especially regarding platooning. Platooning has been tested and the results have been successful, however, it requires all cars to be equipped with the appropriate technology before the benefits of the technology is available to car users.

Increased awareness for DASs and their benefits would increase market penetration, as would regulation through law. An example of the law increasing the market penetration are electronic stability control systems (ESC) now mandatory in all new vehicles in Europe.

Another limitation of CWSs is that although they are able to collect detailed data of the subject car's surroundings, traits prevalent in humans such as machine cognition and situational awareness are still in their infancy. One reason for this infancy is the lack of symbolic scene classification. Acquiring information from a greater number of sources than currently available will make this classification easier and increase the machine cognition.6

Finally, the introduction of other road users, such as motorcyclists, cyclists, and pedestrians, creates additional challenges. This group makes up half of the total traffic-related fatalities and pedestrians make up 22 per cent of the total.

Pedestrian detection is difficult from a machine vision perspective. The lack of available models leads to the need for machine learning techniques. Especially with pedestrians, this technique breaks down due to the variety of poses, lighting, clothing, and backgrounds associated with pedestrians.

For example, a father holding their child would appear vastly different to a couple holding hands, which would again look different to an elderly person with a walker. Such limitations are well known and therefore are a focus of many research groups. For pedestrian detection to no longer be a risk, future movement predictions and behaviour modelling are required to be developed.

6. Conclusion

This contribution looked at the current car-to-car collision warning systems – firstly, by explaining current direct and indirect CWSs, then looking at their advantages and limitations.

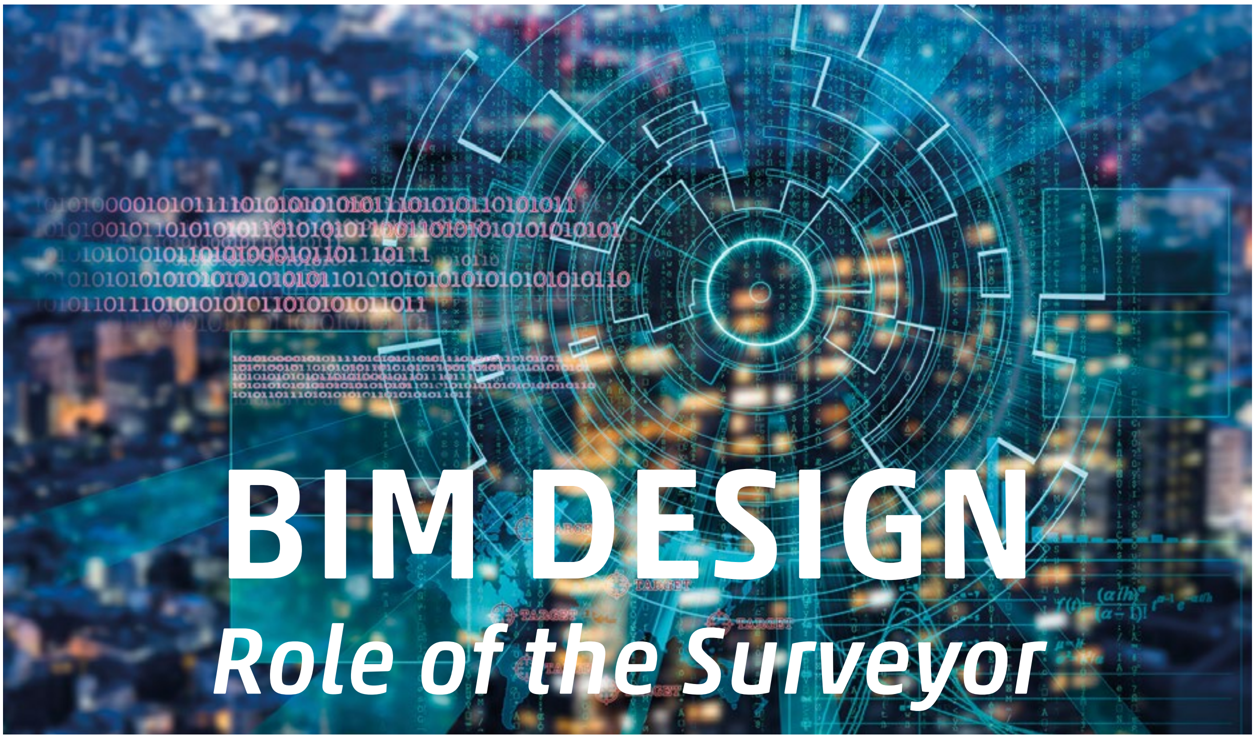
Direct CWSs make use of measurements and information obtained directly from the subject car. These include vision-based systems, radar and LIDAR.

Indirect CWSs use data obtained from other cars or infrastructure. This is mainly in the form of raw GNSS measurements. By using direct and indirect CWSs together, it is possible to create redundancy, complement strengths and improve reliability needed for safety of life applications.

This is an important topic as traffic-related accidents account for more than 1.2 million deaths per year and are the leading cause of death for people aged 15 to 29 (WHO, 2015). Reducing this number to zero would reduce the monetary cost, ecological cost and the trauma that is caused by loss of a loved one. Surveyors know space, precision, accuracy, and errors well, and these are the areas that must be certain before these systems are included in cars.

REFERENCES

For a full list of references for this article, please contact the author: *ryan.mcnie@hotmail.com*



BIM DESIGN
Role of the Surveyor

Sam Wells

Surveying has evolved considerably over time. From vintage chain and plumb-bob stories through to digital modelling and automation, technological change and innovation have had a huge impact on how we collate information and connect with our clients.

The adoption of laser scanning into day-to-day workflows is an excellent example of innovation in action. Laser scanning enables surveyors to produce incredibly accurate 3D models of site environments, and align these with BIM (building information modelling) tools to align project design across different engineering disciplines.

The surveyor's role in BIM further ensures core principles of control and verification are maintained, and contributes to ongoing career development and enrichment through increased proficiency in a host of modelling software.

Building services will frequently deal with complex site environments including plant rooms and high-rise structures. The ability to scan these environments enables key site features and information to be collated into highly detailed 3D models, as shown in *Figure 1*, of a modelling plant on a factory tower. The 3D model can be freely incorporated into design models, creating opportunities for survey as a primary data source for BIM. The survey process however, still requires adherence to core principles to ensure accuracy.

Surveying in the workplace

At Beca, surveying has long been closely associated with transport and infrastructure, providing topographical models, cadastral legalisation and road design. The evolution of laser scanning has expanded our relationship beyond infrastructure to include building services, architecture and structural engineering. These disciplines, through technological advances, have become more competent at working with large 'point cloud' datasets, once a key scanning data limitation.

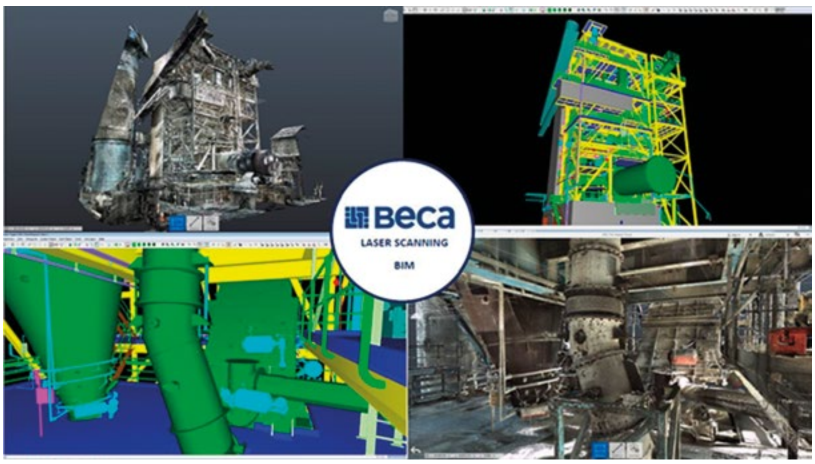


Figure 1: BIM deliverables from 3D laser scanning.

Not forgetting the fundamentals

To ensure scanning accuracy, a control network is always installed and connected to the local geodetic datum through the traversing and levelling of the project environment. The scanning dataset is then related to the control on-site through fixed targets or post processing. The accuracy of the dataset is therefore determined by the accuracy of the control.

Methods to capture point cloud data may change, however the fundamentals of ground control cannot be overshadowed. The same applies to verification, a process staged through control, point cloud processing and deliverables, to ensure potential errors do not carry throughout.

Survey fundamentals also apply to point cloud capture and processing. Point cloud data can be captured by various methods, including engineering-grade laser scanners, UAV, LiDAR and small scanners with generic point cloud functionality.

Basic workflow means anyone can truly capture a raw point cloud, however, the importance of using appropriate tools and understanding their limitations cannot be emphasised enough. This domain is where surveyors will always be valued, for our ability to question the methodology and provide certainty in the delivered model.

It is essential the correct tools and software are applied relative to the output requirements. Software such as Leica Cyclone or Autodesk Recap all have their place in delivery (see *Figures 2* and *3*). It is up to the surveyor to determine how each are applied in the reduction process to achieve the best output.

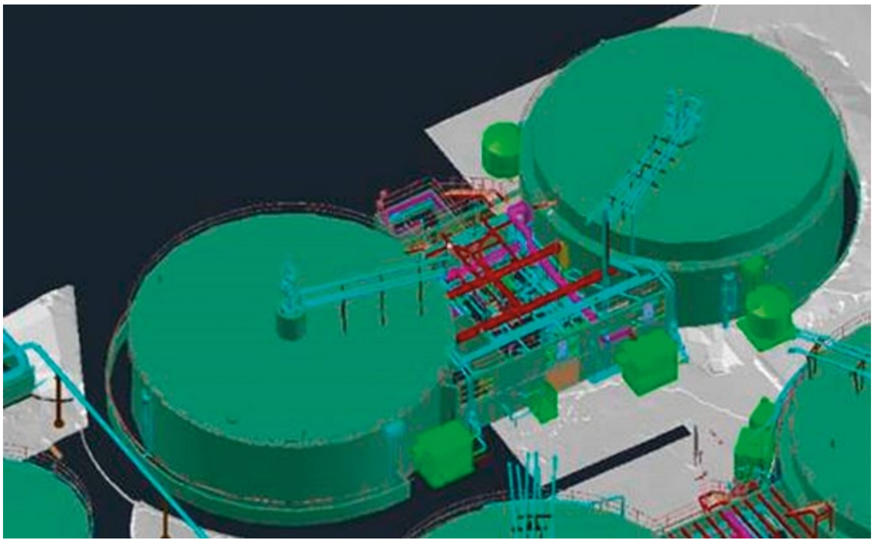


Figure 3: AutoCAD solid 3D model of the same plant room – external perspective.

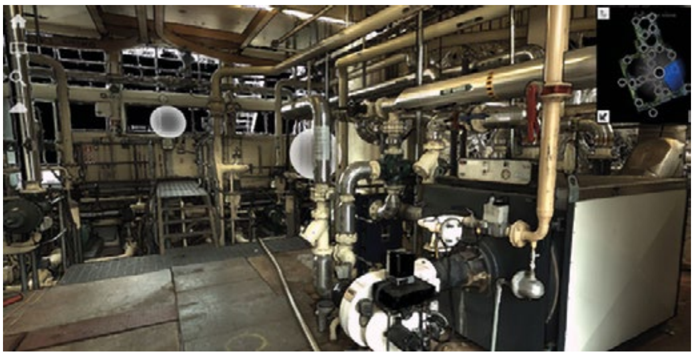


Figure 2: Autodesk recap model of a plant room – internal perspective.

Areas for future growth

How we as surveyors are involved in BIM is an ongoing development. More common is the management of data between sub-consultants, project management and the client, including the distribution of large datasets and providing advice or feedback on the deliverable.

An area of growth we must embrace is model verification. It is our responsibility to ensure the model reflects both the captured point cloud and the specified level of design for delivery.

We are starting to use the functionality of packages such as Autodesk Revit, Navisworks and 3D Reshaper in order to:

- understand feature modelling and shared coordinate systems
- verify the accuracy of the geometrical model against the point cloud
- improve client interaction on the received dataset.

Increasing our knowledge of modelling software will not only improve the control that we as surveyors have over the BIM output, but also enhance our connections with the engineering designers.

BIM as a modern workflow in design has created opportunities for surveyors to develop in the 3D spatial world. The door has opened to grow our profession through digital modelling and align more closely with building and structural designers.

As technology continues to improve, data capture such as laser scanning and UAV will change alongside, however the survey principles of control and verification will always remain. The imperative is to ensure control of the model and have processes in place to maintain confidence in what we deliver.

Legal challenges facing unmanned surface vessels

An example of an USV, the Z-Boat 1800RP. Source: www.teledynemarine.com/z-boat-1800rp

Rian Mayhead and Emily Tidey –
Te Kura Kairūri/National School of Surveying, University of Otago

Many people find pleasure in building and playing with model airplanes and boats, and there now exist commercial applications for these remote devices. The hydrographic sector is no exception, following technological advancements in unmanned[1] systems.

Large unmanned surface vessels (USV) can be used alongside a mothership to decrease time and costs for offshore projects, and small USVs can be helicoptered to remote locations, shipped overseas, or placed in a company vehicle and driven to a survey area.

However, a major issue with USVs is the lack of any regulations specific to unmanned systems. Currently, the relatively new technology poses an unknown risk to maritime safety, but as USVs grow in popularity, it is anticipated that appropriate standards will be put in place controlling their use.

This article explores some of the considerations that should be made when determining these regulations. It is a part of a professional project undertaken by University of Otago School of Surveying student Rian Mayhead during his final year of studies in 2018.

Legal issues

Firstly, there is some confusion regarding the term USV. Some hydrographers agree that it means unmanned surface *vessel*, while others prefer the term unmanned surface *vehicle*. A quick Google search indicates that nine out of 10 websites list the term as vehicle. While there does not appear to be a significant importance in the wording at face value, maritime law suggests otherwise.

The International Regulations for Preventing Collisions at Sea 1972 (COLREGS) are the rules that all *vessels* must follow to prevent collisions at sea. However, these rules do not apply to *vehicles* (Detweiler & LeBouvier, 2015). The most significant requirement for a vessel is that it be equipped with a means of propulsion.

In the case *Lozman v City of Riviera Beach* [2013], a ruling was made that a houseboat without any form of propulsion was classified as a vehicle not a vessel primarily because it could not be used as a means of transportation on water.

In a practical sense, a small USV may be no more than an obstruction when operating on the surface, but because it has propulsive capability, it must follow COLREGS.

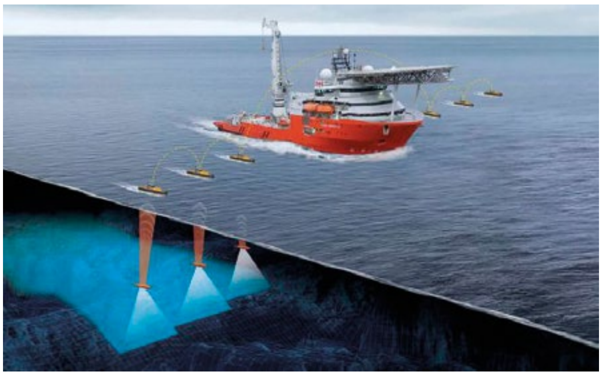
New Zealand legislation does not define either vessel or vehicle, but specifies that a ship means "every description of a boat used for navigation, regardless of whether or not it has a propulsion system" (Maritime Transport Act 1994 s2). This suggests that navigational rules may be imprecise, requiring clarification of the legal liability that new technology presents.

All registered vessels must have an owner, that is, the person responsible for the vessel management. This includes setting up a safety system to ensure the vessel is fit for purpose and appointing a qualified master (skipper) who has total command of a vessel during its voyage (Maritime Transport Act 1994 s19(1)).

This is straightforward if the USV is the only vessel involved in a survey, but an issue arises when two or more vessels are being used in unison. From the owner's perspective, it would be expensive to have a separate master for each vessel, so they may consider that the master of the mothership is in charge of auxiliary vessels. This presents legal challenges.

While the master is highly trained and should be able to deal with several simultaneous emergencies on their vessel, the challenge is amplified when they must also consider dangers on vessel other than the one they are on. Therefore, the master in this case will likely have difficulty in undertaking their duties correctly (Turner, 2018).

One solution may be based on that used by Swire Seabed. During its Ocean Infinity project (which undertook the most recent search for the missing aeroplane of Flight MH370), it had eight online surveyors in the control room monitoring the performance of the eight deployed USVs



The Ocean Infinity project using multiple USVs.
Source: *mh370.radiantphysics.com*.

An example of an RPAS, a DJI Phantom 4 Drone.
Source: *www.cdt.ch/ticino/locarno/194061/collisione-tra-elicottero-e-drone-denunciato-il-pilota*

in addition to eight autonomous underwater vehicles collecting data (Rumson, 2018).

However, for these surveyors to truly be considered the master of each vessel, they would need the appropriate maritime qualifications in order to be able to legally carry out their duties (Turner, 2018). This would come at a cost to the employer for the upskilling of employees.

New Zealand health and safety legislation applies to all New Zealand ships wherever they may be (Health and Safety at Work Act 2015 s10). Employers are directly responsible for the health and safety of workers, customers and members of the public. Health and safety policy is largely drawn up from recommendations from manufacturers, with input from sales teams and experienced operators and government advisors.

With emerging technologies such as USVs, a whole range of new recommendations will need to be developed to enable safe operation of each of the different types and applications of vessels available now and into the future. Businesses can then use these recommendations and develop company policies to match their own operations and site-specific requirements.

Maritime UK published a code of practice in November 2018 that aims to provide practical guidance for the design, construction and safe operation of autonomous vessels (Maritime UK, 2018). It is hoped that these types of documents will pave the way for an updated set of maritime rules that are specific to unmanned technology.

Autonomous challenges

The introduction of remotely piloted air systems (RPAS) into the surveying profession has changed the way many projects are approached.

The Civil Aviation Authority (CAA) requires people to gain authorisation from air traffic control when flying near an airport to avoid interfering with other flights (Civil Aviation Authority, 2015).

However, the public do not always adhere to these rules and there have been recent reports of unauthorised RPAS flying within controlled airspace. At Gatwick Airport, drone sightings cancelled flights over a two-day period in 2018, leaving 110,000 passengers stranded (*The New Zealand Herald*, 2018).

Further regulations on the use of RPAS include maximum altitude restrictions and privacy considerations. One major rule is that the RPAS must remain within line of sight of the operator at all times. The only exception is with permission from the CAA, but a strong safety case must be presented. An observer must also be present at all times to look for obstacles or other traffic entering the area (Civil Aviation Authority, 2015).

These rules could be similar to what may be expected of USVs. It is important to remain in line of sight of a vessel not only for communication purposes, but also to ensure that it does not enter into any hazardous situation, regardless of whether or not it is operating autonomously.

Similar to the RPAS regulations, maritime law requires all vessels to have a lookout on board who is aware of any potential collisions and can inform the master if a risk arises (Maritime New Zealand, 2018).

This raises an interesting challenge as USVs have no personnel onboard. When working further away from the operator, keeping a USV within line of sight of a lookout may not be possible and it is not clear if a video stream from on board would be enough.

Self-driving cars are another emerging technology gaining in popularity. The extent of autonomy depends on the capabilities of the car as well as the environment encountered along the route travelled. The degree of autonomy ranges from level 0, with no automation, to level 5, which is fully autonomous.

In most cases, a car will still require a driver to be attentive and able to take control if the vehicle finds itself in a situation exceeding its limits (Dormehl & Edelstein, 2018). This reinforces the importance of having a lookout to monitor a USV at all times in case human intervention is required.

USVs also have differing levels of autonomy and it is evident that using USVs in different scenarios would pose different threats to maritime safety. For example, a USV deployed in deep coastal or offshore waters would be in a low risk zone where potential collisions would be dealt with individually.

Further technological advancements such as automatic identification systems, which use LiDAR on board USVs to determine if the vessel is on a collision course may be used here. The operator may use these aids to decide what the best course of action is, whether it is to stay on course, alter course or stop and wait.

In contrast, in hazardous areas such as shallow water or port surveys, where there are many obstacles or high volumes of vessel traffic, the operator may choose to retain remote control of the vessel in case several obstacles need to be avoided in quick succession.

Of particular note when working within harbour limits, the harbourmaster has the authority to override what may be permitted under normal circumstances (Maritime New Zealand, 2016).

Even if laws and regulations allowed for fully autonomous vessels, the harbourmaster might limit the use of USVs to certain levels of control, specified areas or certain times of the day, details of which may have to be widely published in Notices to Mariners and local news outlets (Turner, 2018).

External challenges

Another difficulty that the industry can expect to face is the risk of cyber-attacks on all remotely operated and autonomous instruments. With onboard internet connections, a hacker only need know an internet protocol address to work out how to break into the control systems. In 2015, a car travelling along a highway in the UK was hacked and the brakes were cut causing the vehicle to slide into a ditch with the occupant still inside (Curtis, 2015).

Similarly, a woman in Blenheim, New Zealand, had her work van remotely disabled by her boss while driving through a roundabout, almost causing her to crash (Hatton, 2018).

It is necessary for cyber laws to be updated to keep up with changes in technology and how these systems are to be managed. Presently, the maritime industry is at the beginning of a transition into fully autonomous vessels (including cargo ships) (Schuler, 2018). The sooner clear laws and regulations are put in place, the easier it will be to plan for the development and safe utilisation of all of these systems.

Case law will be required to set precedents and test the law. Those cases involving RPAS and autonomous cars may also affect the safety precautions that the hydrographic industry will have to follow.

Clear direction on USVs in maritime law is important as companies may be reluctant to invest in systems and use them for hydrographic surveying purposes if there is any uncertainty regarding liability issues.

Alternatively, the first companies proactively involved will likely benefit the most, as they could make submissions from a hydrographic perspective on what the law(s) and regulations should consider.

Conclusions

Technological advancements constantly transform the maritime industry. Laws and regulations must be updated to keep up with these developments.

USVs are entering mainstream survey use, but still lack specific regulations for the safety of owners, masters and other mariners. In addition to current maritime law, similar systems such as RPAS and autonomous cars can be used to gauge what some of these rules will look like.

There is also the threat of cyber-hacking and misuse of the technology becoming an increased challenge for all industries.

By participating in law reform processes, proactive businesses will be able to benefit from the regulations put in place and will be more confident in their understanding of an autonomous future.

USV Trials with iXblue in Tauranga. Source: Rian Mayhead.

Rian's full professional project also covered the considerations of planning, practical capabilities and processing when using USVs for hydrography. He was supervised by Emily Tidey. Rian now works as a hydrographic surveyor for Discovery Marine Ltd (DML): www.dmlsurveys.co.nz.

For a full bibliography of references for this article, please contact the authors: mayhead.rian@outlook.co.nz, emily.tidey@otago.ac.nz.

NOTE 1. The use of the word 'unmanned' is the common term used by manufacturers.

DRONES, THEN AND NOW

Rodney Pilbrow of Pilbrow Surveying Limited,
Jonathan Kubiak of DJI Ferntech and
Michael Cutfield of Fletcher Construction

I (MICHAEL) STARTED MY DRONE JOURNEY IN 2014 WHEN I SAW THE FIRST MULTI-ROTOR DRONES FOR SURVEY FROM ALTUS ON DISPLAY AT THE NZIS CONFERENCE.

There was a buzz about their presence, and since then the drone market became rather saturated with what seemed like more than 50 per cent of the stalls at following conferences having a drone on display. The first drones commonly used for survey were mostly fixed-wing models that cost more than $100,000.

Today, we are using the newly released Quad rotor drone with numerous sensors including GNSS RTK positioning. For more information, see https://www.linkedin.com/pulse/first-look-phantom-4-rtk-michael-cutfield/.

With the help of Rodney and Jonathan, we will attempt to highlight what has changed over the years in regard to purchasing a drone and address some of the common questions.

Rodney is one of the pioneers in surveying with drones in New Zealand when he purchased the Gatewing X100 September 2011. As a result, he learnt a lot and he put together the following information to help surveyors in their purchase:

Rodney checks out the Gatewing X100 soon after its purchase.

Things to consider when buying a Gatewing X100 in 2012

We were looking for a number of specific things when we bought the X100:

- A safer method of surveying stockpiles, quarry faces and earthworks sites
- Another option when deciding the most cost-effective survey method to use on such sites
- A way to enhance current outputs by supplying an aerial image
- The capability to handle NZ weather conditions
- Robust enough to work in a real-world environment
- The ability to survey the top of stockpiles which ground-based scanners can't do
- Able to work as just another piece of survey equipment
- Return data within our clients' demanding time frames.

What we were not looking to do:

- Survey very large areas (>300ha)
- Be fully trained pilots
- Have to have had years of experience to use the equipment
- Need a degree in electronics to keep the system working
- Spend weeks processing data.

The X100 has fulfilled these requirements and now a year after buying it we have all our systems in place to efficiently carry out a site survey and get data back to clients within a few days. However, there are some things which we have had to work through to get to this point.

The new Phantom 4 RTK is bringing down the cost and increasing the accuracy of drone surveys.

1. Photogrammetric processing – the processing of the images from the X100 is very demanding on computer power. To ensure that data can be processed within a reasonable time, we have had to buy a new desktop computer.

A typical flight can produce 500 images at 10MB each so a minimum of 16GB of RAM is needed. As the datasets get bigger, the RAM requirement increases.

So, if you are considering doing the processing yourself, then make sure to allow for the cost of a decent computer.

2. Data processing – the data that can be extracted from an X100 survey is very dense. We have had to upgrade to a different software package to allow for the increased size of the data.

As the resolution of the DTMs produced is so good even small bushes and construction vehicles are incorporated and need to be cleaned out to produce a ground model.

We are now using 12d to clean up DTMs and import the orthophotos for plan preparation. So, if you don't already have a suitable software package allow for that as well.

3. Clearances – when setting up to carry out a flight it is essential that you know the elevations of the high points surrounding the area. Launching the X100 is easy but on a calm day you must allow for a much longer take-off path than on a windy day.

The X100 has a very wide turning circle and at the end of each pass it will travel another 250 metres to allow to turn and return on a straight line for the next run.

This means that not only the area to be flown but the area where the turns will be needs to be checked for clearance.

Rodney switched from fixed wing to multi-rotors.

The X100 drops about 10m during the turn so allow for that as well. The landing circuit of the X100 has a 600m final run when it comes in. In many of our sites it is this requirement which gives the biggest restriction.

4. Ground control markers – to ensure terrain models are in real-world terms and for maximum accuracy, it is necessary to place a number of ground control markers around the site to be surveyed. After a bit of experimentation, we have found that disposable paper plates are ideal markers.

Their 250mm to 300mm diameter is ideal for our usual flying height of 100m to 125m AGL. We place 20 GCPs for 500 images as most of the sites we survey have abrupt changes in elevation and we have found that having plenty of markers gives a better final model.

5. Camera settings – Gatewing has gone with a Ricoh camera in its system. This has a relatively small sensor compared with other small cameras. At our usual flying height of 100m, this camera gives a ground sample distance of 3.3cm and an image footprint of 125 x 92m.

I felt that more could have been covered during the training on the camera settings. The relationship between the ISO settings and shutter speeds with regard to the light and wind conditions during a flight is very important.

The importance of image overlap and how this changes with regard to differing elevations of the area to be surveyed was also not covered very well.

The current flight planning software does not allow to

Rodney's impressive single rotor ORC from Altus can take a large payload easily, such as the LiDAR unit, and has a flight time of up to 45 minutes on a single battery.

change the X100 height during a scan so the overlap you choose to ensure the area is covered within a single flight may not allow sufficient overlap on high points for the images to be aligned correctly.

Today, nothing much has changed from Rodney's recommendations. The computing power has increased, and the processing software has become more efficient, making an off-the-shelf gaming computer ideal for processing at a reasonable cost. Remember to read the software manufacturer's recommendation on computer specs.

Rodney later changed to multi-rotor aircraft following the law change in 2015. The main reasons for the switch included the new requirement to obtain permission from landowners to fly over property, and the development of LiDAR sensors small enough to be fitted to only multi-rotor aircraft.

an inexperienced, untrained operator shouldn't be using a piece of equipment that they have no knowledge of. As a result, we are increasingly finding that most operators are getting their 101 or 102 as a means to show competency, even if it isn't a requirement.

"How does it handle the weather – is it waterproof?"

Most drones are not waterproof – they are air-cooled and lightweight so rainproofing is difficult. Matrice aircraft are more rugged and can handle the rain but once you have water on the lens, you'll be getting useless data anyway. Photogrammetry will remain a good-weather pursuit for some time. In terms of wind, it's surprising just how much wind they can handle. As a rule, it is half the top speed of the aircraft, which puts most of the fleet in the 33kmh range. Again, the Matrice can push this out to 43kmh.

Jonathan demonstrates the versatility of a multi-rotor, together with the stability of a camera with a gimbal attachment.

Jonathan, who sells drones for DJI (which holds the majority of the market share of drone sales) gives some insight to the common questions asked by potential customers:

When purchasing a drone, the most common questions from 2018 are:

"Do I need a licence?"

In most circumstances, licensing is not required. Surveyors will need at least a 101 operator certificate to operate within 4km of an airfield however. The Health and Safety at Work Act is another matter though. There is no specific guidance on drones, but the general ethos is that

"How long does it take?"

In terms of time/area calculations, this varies by two fundamentals – ground sampling distance and overlaps. There is no hard and fast answer. You can generally do around 15ha per battery.

"Why should I get a multi-rotor instead of a fixed wing?"

Multi-rotors are far more flexible to use, in terms of area, even though they can fly for longer. With a fixed wing, you need a large turnaround area at the end of each line and a large landing area. This limits the operating environment. A multi-rotor offers far more precise positioning and can be operated within very tight margins. This

The base station from DJI for the Phantom 4 RTK drone is inexpensive and very effective.

is especially helpful where the law prevents overflight of neighbouring properties.

"Can I use it with my base station?"
Conventional base stations cannot be directly connected to drones. The drones operate using dedicated high bandwidth, low latency radio systems. Networked bases can be used however and bases that log data can be used for PPK processing.

"How accurate is it?"

Accuracy has three parts – ground sample distance (Not accuracy, but you need to know it to see how good you can get), internal accuracy and global accuracy. Many clients have no idea what they actually need or the differences between the three. Broadly speaking, to the mass market, 3cm x, y, z is achievable globally and 1cm internally. There isn't a one-size-fits-all, yet, and different systems still have different advantages.

Common misconceptions:

"I heard of this app called DroneDeploy – now I can do survey work. What should I charge?"

As with any industry, as technology becomes more usable, reliable, cost-effective and available, Joe Public will believe that they can do the job and offer their services. Surveying is no exception, sadly. It's important to remind clients of the need to hire professionals when carrying out important work. I've seen stunning models produced with cheap, consumer drones – the reason that the models were good was the diligence and expertise of the operator.

"My survey isn't accurate – this must be faulty."

Any survey is only as good as the information presented. Photogrammetry requires a methodical, step-by-step process to ensure good, consistent results. Like any survey, it is important to have checks in place so that accuracy can be verified. One of my favourite examples is where an accuracy of 1cm was expected yet the ground control points used could only be visually centred to within 10cm. Apparently the drone was at fault...

"If I fly lower, my accuracy will improve."

Flying lower increases resolution alone and therefore ground sample distance. Ground sample distance isn't the same as accuracy. The photo centre is still just as accurate as it was before. What most users fail to realise is that once you are flying too low, the post-processing software is searching a much smaller geographical area for tie points and is at risk of erroneously tying the wrong points together or failing to find ties altogether.

If you want higher resolution, ask whether you actually need it. Often you don't. If you do, you need a higher resolution camera.

"Capturing too much data."

A 10 per cent change in overlap can change flight time by a third. It almost doubles the quantity of captured photos. This equates to twice the processing time, which, on a large project can be a day. PPK and RTK allow us to reduce overlaps as the photo centres are far more precisely calibrated. Remember this and your post-processing hardware will thank you for it.

In terms of sales statistics, the tech moves so fast that looking at growth in a product is hard. Surveying took up one day a week when I started. It now takes up more than 80 per cent of my time. That's in 18 months and I sort of know what I'm doing now.

I asked Jonathan if he could elaborate on the licensing needs, as the information out there can be conflicting:

Part 101 – the regular rules

Anyone can fly, recreational or commercial (New Zealand makes no distinction), so long as they follow the 12-part 101 rules, all of which can be found with a quick Google search. The training organisations (Part 141 organisations) can provide part 101 certificates. The benefits of being certificated under part 101 are as follows.

1. You demonstrate competency – clients who don't know drones like to see that you're a professional.
2. You gain a comprehensive knowledge of safe practice and aerospace.
3. You can fly unshielded within 4km of an aerodrome, so long as you have an observer with you and the consent of the aerodrome operator.

Part 102 – when the rules don't suit

To do something that is ordinarily not permitted under part 101, you need to demonstrate a need, a lack of alternative and a procedure that will allow you to do it safely.

A part 102 has two parts – the operator's certificate and the organisation's exposition.

The operator certificate is essentially the same as a part 101. There is some small increases to curriculum and the addition of a flight test (conducted with the aircraft in manual 'Atti' mode). This shows that the operator knows what they are doing.

The next part is the organisation's exposition – this is a complete manual of the operating procedures. Everything from maintenance to how many cones you need in your take-off area, to the paperwork you need if you crash is listed in here. Essentially, this replaces that law and must be followed. The CAA then read over and approve your exposition.

The beauty of 102 is that there is nothing that is theoretically impossible. If you want to build a 40kg, fire-breathing drone that looks like a dragon, you can, and someone has.

With a 102, you have as much right to airspace as everyone else. As a result, when operating within 4km of an aerodrome, you must notify them and have a spotter. It is notification though, not permission. They can only refuse if they have a valid safety reason to.

Other common waivers under a 102 that are relevant to surveying:

Private property: The right to fly wherever you want is rarely granted. The private property requirements are relieved though when flying over, say, large subdivisions, and a 102 exposition may allow you to notify properties by leaflet drop rather than seeking the consent of each and every owner/occupier.

Height: A 102 allows you to get issue NOTAMS (notice to airmen) and such a NOTAM may be able to operate in excess of 400ft.

Night flight: Not so common with most surveying but thermal surveys will often require it.

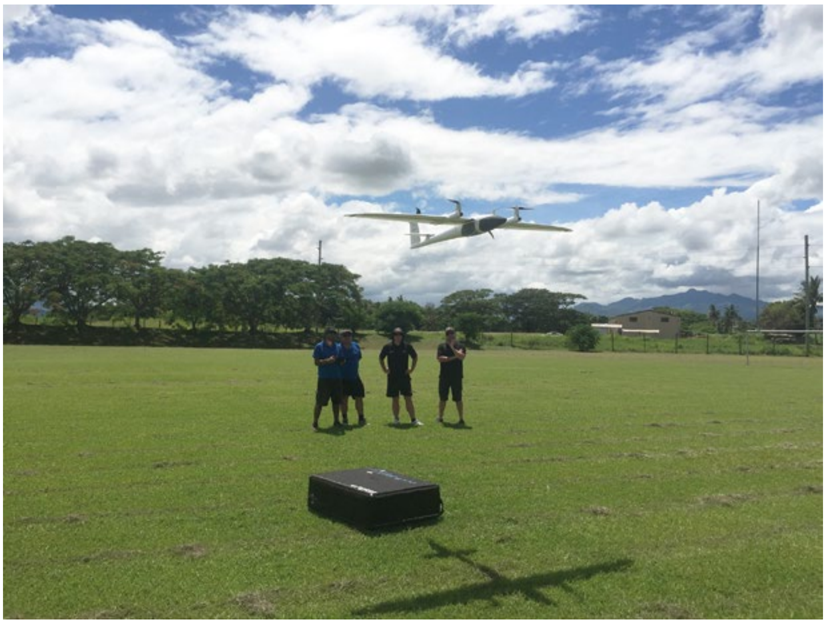
Craft over 15kg: If flying over 15kg, you must be under the authority of a 102. This is relevant for large drones flying heavy LiDAR.

Flying over people: Craft redundancy will usually be required; however, CAA can approve flying over people without their consent. This is perfect for large construction projects. Note, without this, the CAA take the view that consent to overfly must be explicit. Merely walking past a sign that says "drones overhead" doesn't comply. Everyone must know about the drone as part of a hazard briefing (or similar) if it is going to be directly overhead.

Part 102 is a double-edged sword though – it holds you to its higher standard and your exposition must be adhered to, even if the flight could be completed under 101.

If your exposition specifies hi-vis jacket, fire extinguisher, first aid kit, signs and a coned take-off area, you need these even if taking a quick photo of the team Christmas party with a 200g selfie drone.

It also takes a while to get – the CAA is somewhat under-resourced and 102 expositions take several months to obtain.



The new Trinity F9 Vtol fixed-wing system gives the best of both worlds with the turning circle of a multi-rotor and the long flight times of a fixed wing.

MORE THAN MEETS THE EYE

A new modelling approach to enable safer overtaking

Mel Gurden, Abley

Introduction

Do you remember the last time you overtook another car on a state highway? How did you decide it was safe to do so?

As any driver knows, the decision to overtake is not one to be taken lightly. It is an inherently dangerous manoeuvre that puts not only you and your passengers at great risk, but also the driver and passengers of any vehicles coming towards you.

Making roads safer for the people who use them every day is a high priority for transport agencies, roading authorities and system designers. New Zealand, along with many other countries, has adopted the "Safe System" approach to road safety. This is based on creating a forgiving road system, whereby it's acknowledged that people make mistakes and have limited ability to withstand crash forces.

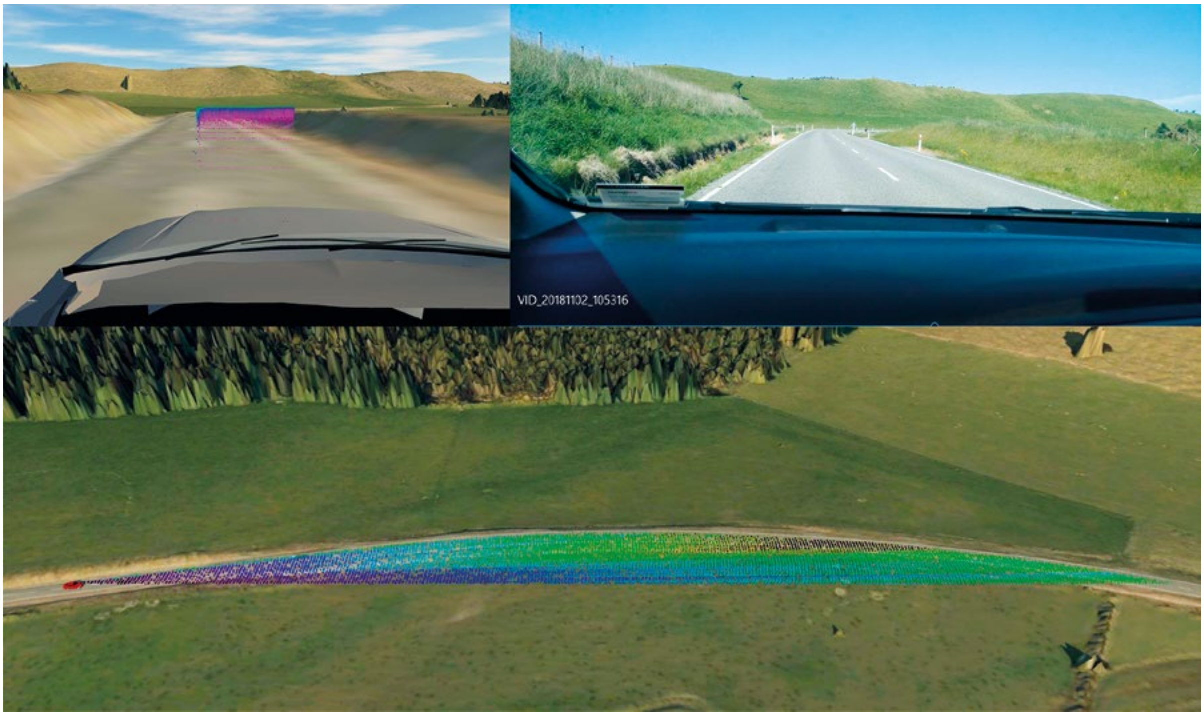
Using the Safe System approach, Abley's road safety team which includes both transportation engineers and spatial analysts, have been working together on an innovative solution for safer overtaking. Utilising a range of tools and technical expertise, they have recently developed a 3D spatial process to assess safe overtaking opportunities on undivided roads.

The statistical story

As in many countries around the world, the vast majority of New Zealand's high-volume roads are undivided carriageways. Two-lane state highways typically run through rural and peripheral urban land-use areas.

They make up about 90 per cent of our state highway network and carry about 30 per cent of the country's annual road travel (as measured in vehicle kilometres travelled).

Driver error during overtaking manoeuvres can result in head-on collisions at high speeds, involving forces the human body simply cannot withstand. The social impact of these collisions are far greater than the physics at play, and the resulting serious injuries or fatalities leave a lasting effect on families and friends.



View comparison and associated viewshed

Field testing clearly revealed the model's accuracy in depicting the terrain from driver's eye level. Associated viewsheds add a further dimension to the information.

In the past 10 years, 863 people have died in head-on or overtaking-related crashes on high-speed New Zealand roads. As the volume on our rural highways increases, so too does the risk of deaths or serious injuries.

A question of alignment and road marking

In theory, the act of passing another vehicle is rather straightforward; simply go faster than the vehicle you wish to pass. However, with overtaking you are not only looking to 'leapfrog' the other vehicle, but also navigate a period of travel in the opposing lane, used by oncoming vehicles.

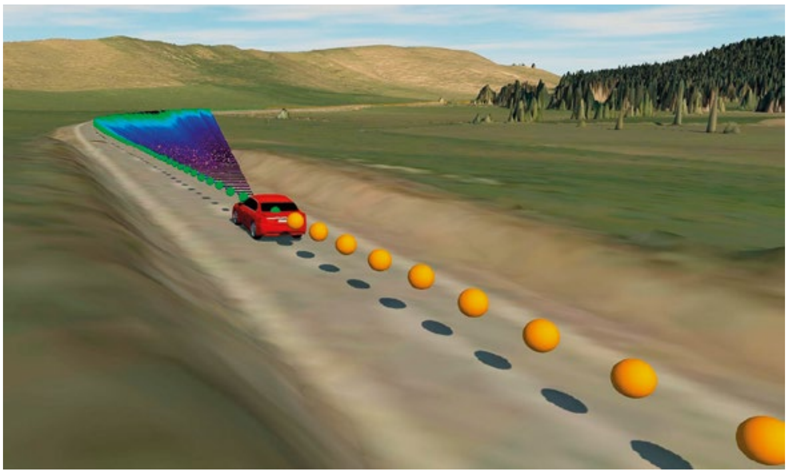
This exposes the overtaking vehicle to the dangers posed by oncoming traffic during the overtaking, which increases the complexity of this manoeuvre significantly.

The alignment of the road ahead is the key influencer when it comes to a driver's decision to overtake another vehicle. Unfortunately, some drivers make poor judgments with respect to the amount of time and space required to perform an overtaking manoeuvre.

There are many ways to encourage drivers to not overtake at locations where the road alignment is unsuitable, including systems such as no-overtaking yellow road marking, special median treatments and driver education.

Like many countries, the road marking on New Zealand's dual carriageways is often at odds with the overtaking risk associated with the alignment of the section in question.

Naturally, road controlling authorities attempt to mitigate overtaking risk wherever possible. However, the tools they have at their disposal to audit their vast networks and identify safety deficiencies related to road alignment are often rather limited and may require intensive manual assessment of sightlines and visibility.



Categorisation of summary points

The dots in this example represent two-metre-spaced summary points. The point at which they change from orange to green shows where 330 metres of visibility is achieved from the centreline.

This experimental model was named 'CFVM': Continuous Forward Visibility Model.

It became apparent that this model's accuracy would only be as accurate at the data we input, so high-precision surface elevation and road geometry data were required.

Conveniently, LINZ (Land Information New Zealand) had recently begun publishing LiDAR data captured by aircraft over large areas of the country. Combined with a good quality road centreline and some high-resolution aerial photography, we had all the data required to build an accurate test model.

Exploring a new approach to modelling safe overtaking

After attending a national user conference for Safe Software's FME (Feature Manipulation Engine), a designer at Abley was interested in testing the limits of the software's capability.

Sightline analysis is a design check used by designers and safety auditors to establish whether a road alignment requires certain measures to improve safety outcomes.

Historically, this is a largely manual process which relies on generating two dimensional long sections of a given road, and then visually interpreting the available sightlines.

Based on the high level of risk associated with overtaking and the existing manual methods for assessing whether adequate forward visibility is provided, the team at Abley explored whether FME could be used to mathematically determine if adequate forward visibility is available from any point along a road. Was it also possible to locate the source of visual impediment?

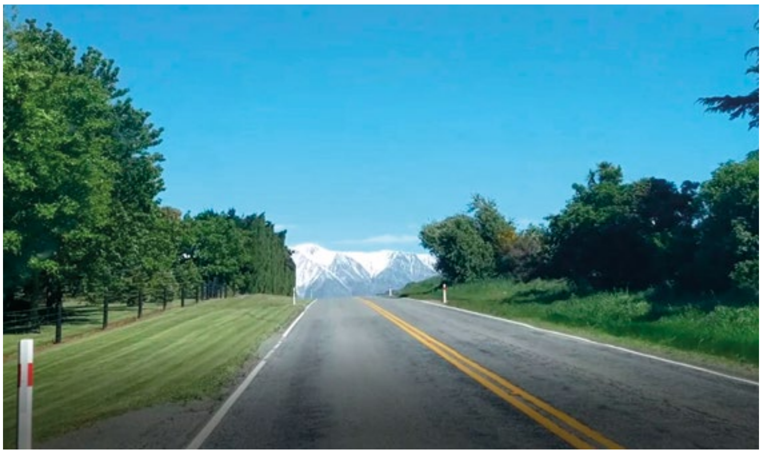
If this were possible, could we then identify and classify the obstruction, for example a hump/crest in the road, or an external factor such as surrounding vegetation, buildings or earthworks?

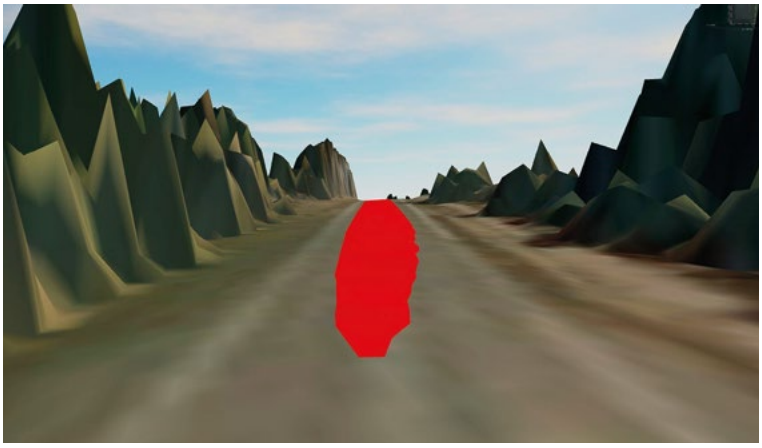
Achieving this would give an indication of the risk profile for overtaking vehicles, and whether the current road markings are correct. It would also reveal where adjustments in road markings or minor road alignment adjustments were desirable.

Testing the model

Our test location was a 30 kilometre section of rural state highway, which we selected due to its undulating terrain and the horizontal curvature of the road.

We calibrated our model to evaluate the available forward sightline for a driver every two metres along





Road grading

Red areas in the model view indicate where the grade of the road itself is compromising visibility – something not easily ascertained by the naked eye.

the road. This allowed us to evaluate if it were possible for a driver attempting an overtaking manoeuvre to achieve the required clear sight distance ahead (330 metres) as required by the design standard.

Given the iterative nature of this process, this test model was going to be computationally demanding. For each of the 15,000 evaluation points along the road, the model needed to check both the horizontal and vertical components of the road simultaneously see if the driver's view would be obstructed.

With some careful planning and data management, the power of FME allowed us to create a precise and scalable automated workflow.

The outputs were viewable in 3D, so it was possible to visually validate whether the analysis was accurate and represented the existing built environment.

To accomplish this, source data and analysis outputs were loaded into Autodesk's Infraworks. This allowed our team to really 'see' what our model was doing, and to experience our test location from a driver's perspective – all from our desk.

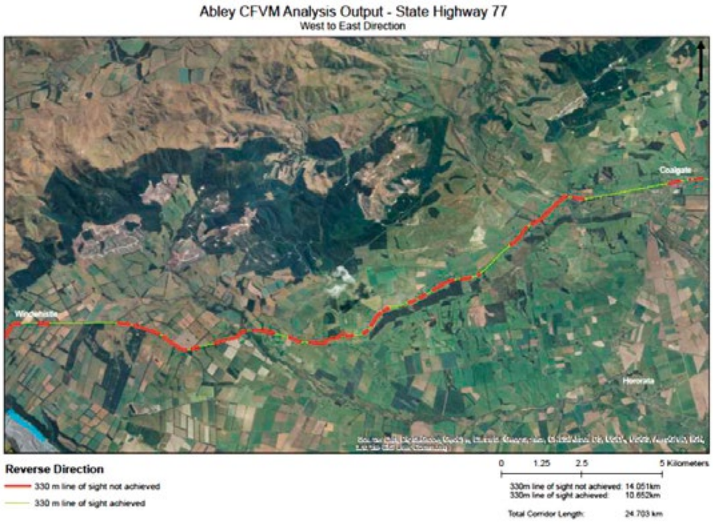
Field validation

But did our digital twin and FME analysis really mirror reality? Only field validation could answer this question so we headed out to site to put it to the test.

Equipped with measuring equipment, some hi-vis configurable props and a map of the CFVM analysis, the test corridor was inspected at every location where existing road markings were deemed to have insufficient visibility, and then at every location where the CFVM analysis showed visibility loss.

The results speak for themselves. We were able to successfully identify each point along the road where a driver's visibility was less than the required 330 metres. We were even able to identify what type of obstruction blocked the driver's sightline.

The 3D Infraworks model also enabled us to detect the exact locations of correct and incorrect road markings, identify the locations where alignment could be optimised to create safe overtaking opportunities, and identify areas for vegetation management on the roadside or within neighbouring properties.



Mapping visibility

The model provides mapped sightlines for 'big picture' understanding of the corridor as a whole.

RED = 330m line of sight not achieved due to surroundings

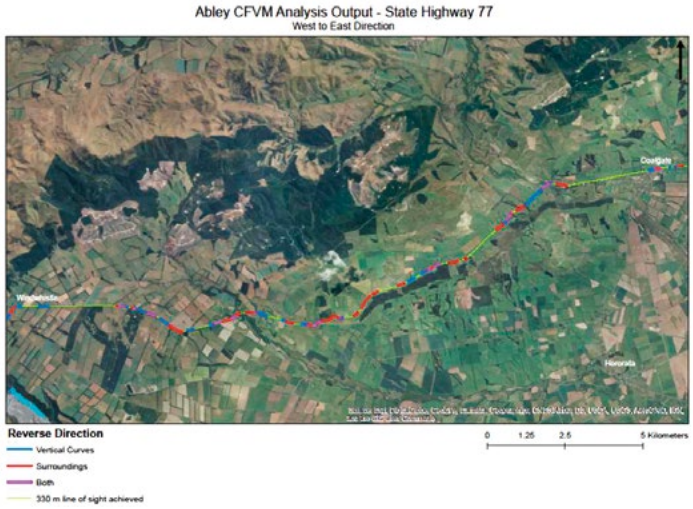
GREEN = 330m line of sight achieved

The most impressive part of CFVM was that within our FME workbench, we averaged an analysis rate of about 30 million calculations per minute, equivalent to 500 thousand sightlines per second.

FME loaded and processed the complete data set in about 20 minutes. Better yet, the analysis variables such as required observation distance, observation eye height, speed limit and target object height can all be dynamically adjusted to simulate a realistic overtaking scenario.

Leveraging the model

First and foremost, the CFVM model is an approach that can save lives. By using Abley's CFVM overtaking analysis tool, our team hopes to help reduce the frequency of overtaking-related head-on crashes on New Zealand's road network.



Intervention assessment

Reasons for sight obstructions are plotted by the model; providing a useful tool to help guide where interventions could be considered.

BLUE = Unacceptable visibility due to vertical curves; candidate for regrading

RED = Unacceptable visibility due to surroundings; candidate for vegetation management

PURPLE = Unacceptable visibility; unlikely to be able to be improved

GREEN = 330m line of sight achieved

Initially, we can confirm whether road markings are correctly implemented across the road network as per the national regulatory framework. With the addition of other traffic and GIS data sources, we can then pinpoint stretches of road across the network that feature too few overtaking opportunities per kilometre.

This information can help evaluate the impact of constructing a passing lane or undertaking minor realignment works to the road to provide a greater number of safe overtaking opportunities.

The CFVM model can even be used to investigate the impact of a national policy change with respect to road marking regulations, and how it would increase or decrease the available overtaking opportunities relative to the volume of traffic along a road.

Conclusion

By creating an automated process that uses high quality data inputs, the CFVM promises to make a big impact in the safety of overtaking. By providing road controlling authorities with a 'big picture' view of overtaking on their networks, as well as the ability to pinpoint down to the metre where overtaking challenges and opportunities exist, road safety with respect to overtaking can be improved.

Furthermore, the question of 'is it safe to overtake?' can ideally move from a decision fraught with risk, to a manoeuvre of relative safety.

Mapping with Dogs and Theodolite in the Transantarctic Mountains in the Early 1960s

A summary of the Sir Holmes Miller presentation by Peter Otway in celebration of 60 years of Antarctic surveying by New Zealand teams.

Sir Holmes Miller – or Bob Miller to all who knew him – was, in effect, the architect and driving force behind New Zealand's seven-year long reconnaissance mapping programme which commenced in conjunction with the Trans Antarctic Expedition (TAE) in the summer of 1957-58. He was certainly a great inspiration to me when I successfully applied to join the NZ Antarctic Research Programme as a surveyor in the spring of 1960 shortly after qualifying.

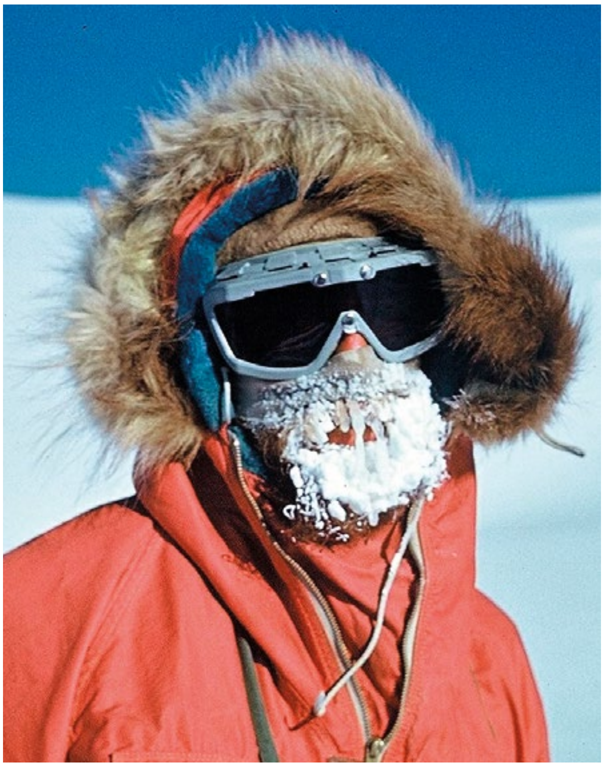
The great experience I enjoyed during the following 16 months at Scott Base, including two three-month-long field seasons, was typical of the surveyor's role during that period. In fact we were more than mere surveyors – we were exalted dog handlers! Our mode of transport for our small teams was by husky-drawn sledges as we and our geological colleagues explored and mapped the Ross Dependency section of the 4,000km-long Transantarctic Mountains. The scenery of this virgin territory was striking, as suggested by the numerous images in my presentation, but the feeling of actually being there could not be captured in pictures.

The aim of our field work in those far-off days pre-EDM/GPS/satellite imagery/electronic computer (and pre-skidoo) was to establish a framework of ground control over our assigned region for the detailed mapping (to be plotted from the US Navy aerial Trimetrogon photography) while also carrying out a systematic geological reconnaissance.

Each survey party of four men and two teams of nine dogs comprised at least one surveyor and one geologist, working on selected nunataks and mountains with commanding views and good rock exposures. The 1960-61 Northern and Southern Parties were assigned to map the region between the Byrd and Nimrod Glaciers. The Northern Party was led by surveyor Garth Matterson with Don Goldschmidt and me as assistant surveyors and David Skinner as the geologist.

We were flown into the field by VX-6 Squadron (of the US Navy), landing in undulating country at the foot of the mountains 350km south of Scott Base in early November while the Southern Party, led by Peter Hunt, was landed 150km further south to work independently. Garth's plan, based on the available Trimetrogon photography, was to spend at least a day camping and working at each location before sledging on to the next camp site, for instance at the foot of a selected nunatak 25km to 40km away.

Our camp consisted of two two-man Scott polar tents with each nine-dog team chained to wire spans anchored nearby. The privilege of camping in pristine country never explored before was surely the experience of a lifetime,



perhaps made even more special when the dogs began their evening wolf-like "howlo" chorus. The occasional blizzard roaring in from the south, threatening to tear the tents apart, was a different experience again!

In a typical travelling day, the sledges would be loaded by about 9am as all 18 dogs howled and danced around wildly, then it was time to pull up the pickets and be off, bouncing over the wind-hardened undulations, or in cloud of loose snow, at first more under the control of the excited dogs than the two men on skis towed beside the sledge. The dogs soon settled into a steady pace with the lead dog supposedly obeying the commands – more or less anyway – to bear left or right, or stop for a regular short spell, or longer for the lunch break.

It wasn't long before we knew them all intimately, with all their quirks, as individual characters. Needless to say, the journey did not always run like clockwork: there were dog fights along the way, crevasses – sometimes only narrowly avoided – and often a skier on a rope out front leading the dogs. There were a few steep hills, sometimes requiring all hands to heave up each sledge in turn, and rope brakes to apply to slow the descent. Slippery bare ice clear of any snow, or snow so soft we bogged down, further helped break the monotony.

If we lost our landmarks in low cloud we could continue, crevasses permitting and provided at least the glow of the sun was visible, steering the sledge by sun compass and adjusting the pointer regularly as the sun moved around the horizon. Sledging straight into a strong wind at -15 degrees C for eight hours was another challenge, making the mere thought of a warm sleeping bag and hot meat-bar stew particularly attractive.

The following morning, the four of us would trudge up our nunatak, or perhaps a more serious mountain, to set up the theodolite on the summit while the geologist went off with an assistant to collect rock samples and make the first-ever record of the region's geology. Survey observations consisted of horizontal and vertical angles to 20 to 30 peaks and landmarks around the compass while the booker quickly sketched the panorama, assigning a code name to each observed point.

The theodolite (a Watts No 2) was then transformed into a photo-theodolite by mounting a camera on top for a complete panorama, to enable additional minor detail to be later intersected using the office photo alidade. Astronomical sunshots were also taken at set times for latitude, longitude and azimuth, and observations to two or three of the brightest stars later introduced (for the first time by NZ teams) to improve accuracy by minimising refraction.

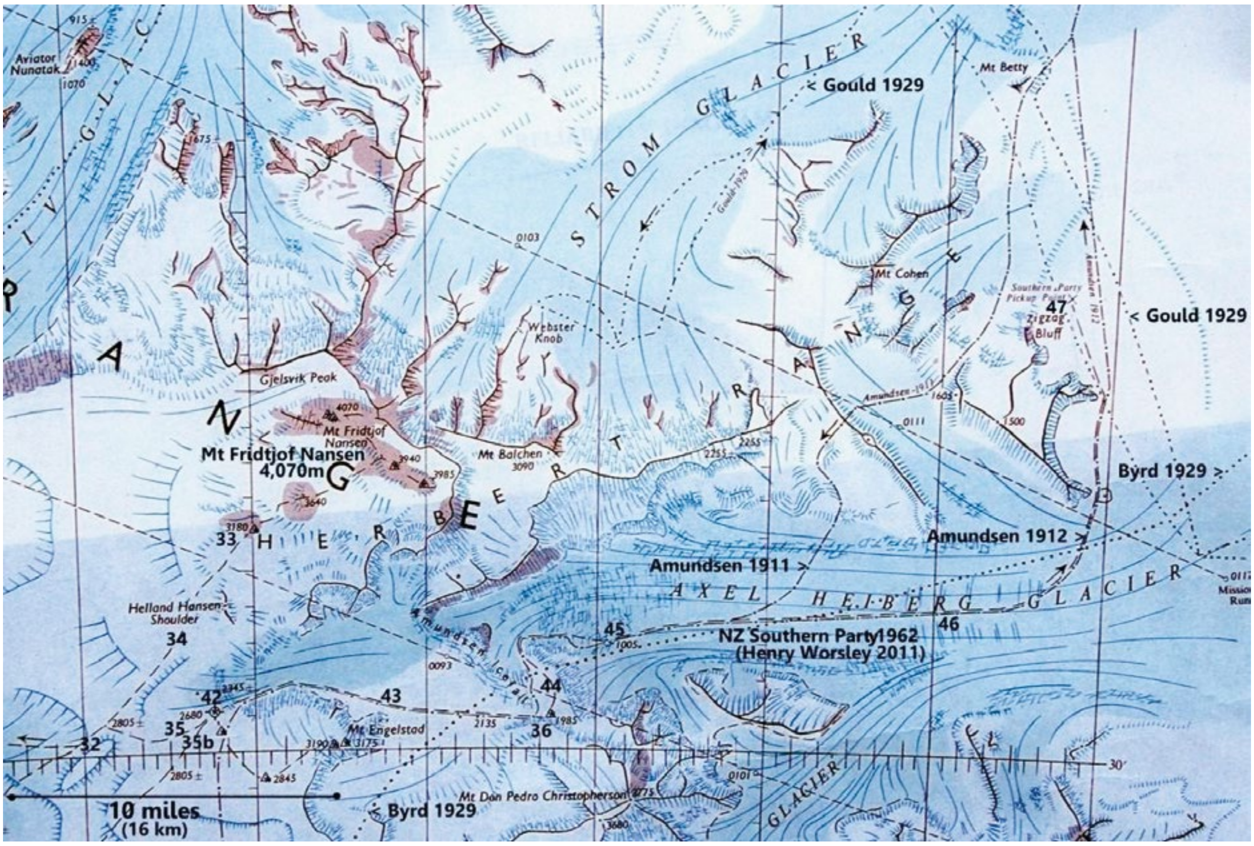
Surveying for five to seven hours from exposed mountaintops 1000 to 2000 metres above sea level ranged from being slightly uncomfortable to a personal challenge for observer and booker alike in the fresh breeze and -5 to -20 degrees C, especially when the instrument repeatedly went off level in the frigid air and hot sun, or the brittle film broke repeatedly.

On a cold day we would have to break off and clap hands while stomping around to restore circulation. The day's work would be capped off by building a rock cairn over the mark, sometimes assisted by the geologist if he had run out of interesting rock exposures by then. To provide scale for the whole survey, two baselines were laid out and observed in separate localities during the season, double-chaining lines of up to 2.5km across a flat snow surface and marking the end stations with snow cairns.

On completion of our survey in early February, we were flown back to Scott Base where we sorted out our gear and rock samples before all but two surveyors (Wally Herbert from the Southern Party and me) returned home. Wally, a surveyor and already a seasoned polar explorer, and I then became part of the 13-man wintering-over team to run the base and continue the scientific observations begun during the International Geophysical Year (IGY) four years earlier.

Our specific responsibility was to look after the 65 dogs and their pups to make sure that four well-trained teams were put into the field the following summer while keeping two less experienced teams back for work at base.

Sawing up 17 tons of mutton and the quota of 50 freshly killed seals to feed 65 ever-hungry dogs, being nursemaid to about 20 overeager pups, preparing the field gear, packing endless ration boxes and doing a multitude of



daily tasks around base kept the two of us well occupied throughout the autumn and cold sunless winter.

Computing and plotting our survey observations was almost spare time relaxation. Nevertheless, wintering over with a great crew turned out to be the experience of a lifetime but the eagerly awaited return of the sun in late August was also a reminder the new field teams would soon be with us and eager to spring into action.

After several more months of training the dogs and introducing the new field men to sledging and all that goes with it, we were ready to leave for the field by early November. This time I was to be the principal surveyor for the 1961-62 Southern Party, with Wally our experienced leader, and mountaineers Vic McGregor the geologist, and Kevin Pain our field assistant.

We were to map as much as possible of the historic but virtually unknown region between Shackleton and Scott's notorious Beardmore Glacier, and Amundsen's much steeper Axel Heiberg Glacier lying 800km south of Scott Base and just 500km from the South Pole. The Northern Party was to work on the opposite, western side of the Beardmore. Our overall plan was to sledge eastward around the edge of the Polar Plateau, surveying the rugged mountains and glaciers lying below us towards the Ross Ice Shelf.

We landed in VX-6's DC3 on the plateau near the head of the Beardmore at 2,800m, and with -32 degrees C and a steady wind, it suggested that last season had only been a picnic – but a very useful learning experience for me.

Our first survey station on a deceptively high and distant summit was an exhausting, cold and miserable experience, proving we had not yet acclimatised, but within a few days, we had settled into the new environment, as had the dogs who were as keen as ever – and again entertained us most evenings with their wolf-like howlos.

For the next three months we carried out the familiar routine of sledging, climbing and surveying, following my scheme to establish a coherent triangulation pattern with about 24 major stations by using a mixture intersection and resection techniques. This network was to be again fixed for latitude and longitude by both sun and star shots. Our station locations also provided Vic with interesting outcrops, in fact leading to his major discovery of the first Triassic age fossils in Antarctica. To systematically cover the area we followed Wally's meticulously planned route, endeavouring to bypass the worst of the crevassed neves of four major glaciers as we worked steadily eastwards. Due to our heavy loads, hauling eight weeks of supplies to last us safely beyond the only planned resupply airdrop, we were forced to establish food and fuel depots which had to be relayed forward regularly, thereby increasing our total sledging distance to 1200km by the end of the season.

Thanks to the elevation of our stations – ranging from 3000 to 4000m – we had great views and long rays, commonly up to 100km long across the Beardmore and down

to the ice shelf, enabling us to establish ground control over – and later map – 55,000sq km. Many stations also gave us a full panorama of the crevasse-ridden routes up which the great explorers had hauled their sledges to the plateau in their race to the Pole half a century earlier.

Our exposure to the constant wind ranging from -33 to -13 degrees C made both sledging and surveying a real test of patience and endurance, with frostbite an ever-present threat. Frustration was added to discomfort by being stranded, thanks to ever more blizzards and white-outs lasting three to five days, in the second half of the season. For further unwelcome tests, long stretches of sastrugi (wind-polished ridges of iron hard snow) caused two major sledge breakages, and the exertion at high altitude eventually caused our two oldest dogs to have fatal heart attacks.

The final test was almost farcical. Over our final six weeks, I spent endless evenings tapping out Wally's long arguments by Morse code between radio blackouts, trying to obtain permission to sledge down the Axel Heiberg Glacier – coincidentally, the first to do so since Amundsen, who had described it only briefly, exactly 50 years earlier. From one of our stations on top of 4,070m Mt Fridtjof Nansen (the highest Antarctic mountain climbed at the time), there appeared to be only one feasible route down for our sea level pickup at the end of the season – necessary because the DC3 was not capable of lifting us and all our gear off the plateau.

The debate with Antarctic Division, Scott Base, McMurdo and VX-6, Admiral Tyree and other notables (some for, some against) was due to their perception that the main icefalls were far too dangerous – even *after* Wally and Vic had skied right down through them flagging a safe sledging route! Permission finally came through the day we finished our survey!

After 90 days on the bleak Polar Plateau, the sheltered and scenic Axel Heiberg was a real treat, albeit requiring a great effort to drag our sledges through unexpectedly deep snow, even downhill. By leading our dogs down the flagged track winding its way through the icefalls – the only feasible route and almost certainly the one Amundsen had found – we managed to avoid the disaster of losing an entire team down a crevasse. After six days on the glacier, on 8 February 1962, we were picked up by the old DC3 and flown back to base for our first shower and square meal in 95 days.

For all four of us, the descent of this virtually unknown, dangerous and awe-inspiring glacier was "the icing on the cake" for an ultimately highly successful season. All the same, the real reward for our endeavours was, as Bob Miller agreed, the act of Wally and me completing our draft map in Lands and Survey's Draughting Section in mid-1962, and then seeing it published in five 1:250,000 sheets a year later.

It was not just New Zealand's southernmost map but the first accurate one of the region, revealing many "new" mountains and large glaciers, and "rearranging" features only sketched in before. The meandering routes of Shackleton, Scott and Amundsen were carefully plotted for the first time, as was Admiral Byrd's flight to the South Pole 17 years later. For a young surveyor it had been a personal challenge and a unique privilege – and the fulfilment of a boyhood dream.

Responding to Climate Change and Coastal Hazards

Mick Strack mick.strack@otago.ac.nz

Surveyors are at the forefront of land development, land-use change decisions and the creation of the cadastral pattern over our land that determines boundaries between public and private uses.

As warned by the Parliamentary Commissioner for the Environment, many of our coastal areas are subject to a significant hazard from the effects of climate change – erosion, inundation and storm damage. At the Survey and Spatial New Zealand conference last year in Nelson, there was a well-supported session on climate change and sea level rise that provoked plenty of interest and feedback. There are issues we should be dealing with.

Can the momentum from the Nelson conference be harnessed? Are surveyors and the institute prepared to take leadership on climate change responses?

Given the serious impact that climate change is having on South Dunedin and other Otago coastal areas (like Kakanui), the Coastal Otago branch has been discussing how the profession might respond. Some other professional bodies have produced position papers on this evolving hazard. The purpose of this article is to encourage our institute and members to be proactive in our responses to the challenges of climate change. The following draft of a position statement is intended to be a discussion opportunity from which a formal position paper promoted by S+SNZ may arise.

Preface

This position paper has been prepared to provide some guidance to surveying professionals about responding to climate change and coastal hazards particularly with respect to considerations about coastal development, and to demonstrate to the public that S+SNZ is prepared to take the lead and act proactively to consider climate change (especially on sea level rise) in all coastal management planning and development decisions.

Coastal zone

New Zealanders have a longstanding and important relationship with the coast. We value the stunning coastal landscapes and the natural character of the coastal and marine area. The coastal zone is, variously, workspace, playground, living space, place of retreat and seclusion and place of active and passive recreation. Access to the coast is considered a governing principle in legislation, policy and social expectation. The coast is highly desired and valued for casual, holiday and permanent occupation, all of which drive development demands and property values. Coastal property is in big demand in spite of continuing and increasing threats to the land: tsunami, erosion and sea-level rise hazards, in other words: the future prospect of erosion, inundation and loss of property is high.

Surveyors/kairūri

Surveyors are at the forefront of development and planning. They are also key to engaging with the multi-disciplinary teams involved with the economic, social, cultural, and ecological environment of the coast. Engagement with other professionals, local authorities, local communities, tangata whenua, and scientists is crucial to integrated and adaptive management of the coastal environment. Surveyors have a responsibility to demonstrate well-informed, ethical, professional leadership with respect to coastal development based on a set of guiding principles.

Cadastral boundaries

Fixed property boundaries imposed on the land by the cadastral system are at odds with natural ecosystem boundaries, and they inhibit integrated management. Surveyors should be wary of establishing permanent boundaries over inherently impermanent and changing landscapes.

Principles underlying decision making and action

Environmental literacy

Ecological, social, economic, and cultural conditions are complex and interrelated. The RMA requires all these environmental components to be incorporated into decision making, and a full assessment of the effects on all these components should be focused on avoidance of adverse effects (as per the NZCPS).

Sustainability and resilience

If we can foresee that we can continue to do what we do now into the far future without producing adverse effects and without unreasonable outside inputs (of energy or resources), then we can claim we are close to sustainability.

The essence of sustainability is about working with natural systems rather against them. The RMA may be about balancing ecological, social and economic, but because the economy is all that is easily measured, the economy has always been favoured in that balancing act. Strong sustainability is not about balancing, but about recognising that all economic and social activity occurs within the biosphere – everything else (human existence) is dependent on a healthy biosphere.

Surveyors must ensure that ecosystems (biosphere) are preserved so that social and cultural conditions (sociosphere) can flourish, and can contribute productively to the economy (econosphere).

Precautionary principle

The Rio Declaration on Environment and Development (1992) is regularly cited as the clearest statement of the precautionary principle: *Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation* (Principle 15).

The precautionary principle is usually applied to human activities having uncertain impacts on the environment. In the coastal development realm, it is about environmental changes having uncertain impacts on human activities. The precautionary principle recognises that delaying action until there is compelling evidence of harm will often mean that averting the threat is too costly. Invoking the principle promotes action to avert risks of serious or irreversible harm to the environment or to any development. The principle therefore provides a fundamental policy basis to anticipate, avoid and mitigate threats.

Engagement and interdisciplinarity

Surveyors are ideally placed to bring together multi-disciplinary teams. They are often the first point of contact for both monitoring environmental changes (sea level, MHWS) and development proposals. Surveyors should therefore initiate consultation with other professionals, scientists and experts, planners and administrators, and local communities. Surveyors must encourage information sharing, and demonstrate innovative responses.

Integrated and adaptive management

Integrated management involves consideration of legal principles, ecological systems, social and cultural expectations and financial responsibility. Surveyors must use their skills and knowledge confidently to manage and respond to environmental change.

Adaptive management recognises that actions taken now on the basis of current knowledge should not close the door on future action required for new situations and circumstances.

Surveyors should investigate responses and solutions that provide flexibility and adaptability.

Secondary principles

Cost-benefit/cost-effective

Surveyors must seek out new models of development that provide benefits for developers while avoiding adverse effects. The cost-benefit assessment must look to future costs.

Prevention and timeliness

Prevention now is cheaper than remedial work later. Investment now will save future costs. We are now dealing with decisions made 100 years ago. We don't want to leave a mess for future generations to fix.

Uncertainty

Climate change and sea level rise will not have uniform effects.

Is there a tipping point? Will it be gradual and steady or will there be some point where there is catastrophic collapse of the ice shelves? What will be the rate and amount of sea level rise? How will the cumulative impacts propagate?

Climate change will affect ground water, soil saturation, liquefaction, land stability, and earthquakes in many different ways.

Ethics and professional responsibility

Surveyors must act from a level of expert understanding, with integrity and a sense of responsibility for coastal management and development.

Proposals for Survey and Spatial action

Advocate for the protection of natural landscapes and character as per the guidance from the New Zealand Coastal Policy Statement 2010.

Encourage clients and developers to respond with appropriate development proposals that will avoid future adverse coastal change effects.

Educate the profession and the public more widely about climate change, sea level rise, land use changes, the impacts on property, and appropriate responses.

Consult widely with all interested and affected parties and communities to avoid the adverse effects of development in the coastal zone.

The Invading Sea: Coastal hazards and climate change in Aotearoa New Zealand

By Neville Peat

The Cuba Press. RRP $38.

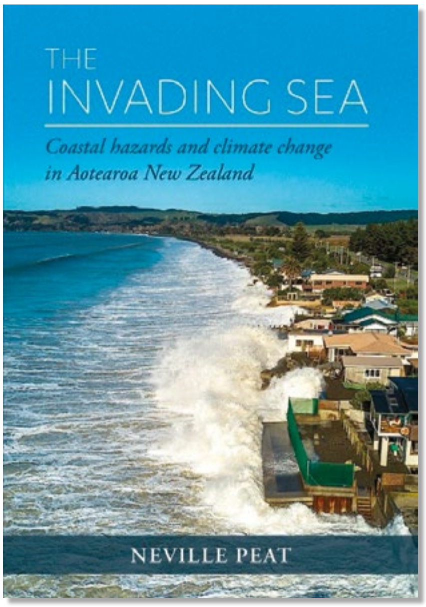
Reviewed by Mick Strack

The pressing need to bring the issues of climate change and sea level rise to people's attention so responses can be implemented sooner rather than later is the purpose of Neville Peat's latest book – *The Invading Sea*.

While this book includes plenty of science, it is written in accessible language and a pleasing format for a wide public audience. It follows and adds to a growing library of calls to action on sea level rise alongside a similar book by journalist Jeff Goodell (*The Water Will Come. Rising seas, sinking cities, and the remaking of the civilized world*, 2017) which focuses primarily on US examples, and another by Bronwyn Hayward (*Sea Change. Climate Politics and New Zealand*, 2017).

This book is organised in two parts: first, commentaries about what is happening to our coastal land and communities, and second, how we respond. The first part describes some of the science behind climate change and a selection of coastal communities around New Zealand that are facing the threats of erosion and/or inundation from rising sea levels and more severe storm events. The second part includes the roles of local authorities in planning decisions, central government in establishing policies and legislation, and responses to international obligations including commitments made at the 2015 Paris Agreement to reduce carbon emissions.

Throughout the book there are several personal stories of people affected by coastal processes and brief biographies of leading scientists at the forefront of climate concerns. Much is drawn from the work of experts such as Dr Rob Bell, Dr Judy Lawrence, and the past parliamentary commissioner for the environment, Dr Jan Wright.



The emphasis is primarily on adaptation to coastal change (avoid, accommodate, retreat, defend) rather than mitigation (how we might achieve carbon emissions targets), and while a general conclusion seems to be that, even though eventually, retreat is the fallback position, in the short term, people and communities have other choices to defend and adapt.

Peat, as an experienced local government politician, a widely respected environmentalist and a strong advocate for community engagement, wishes to ensure people and communities are treated fairly. He repeats recommendations for more central government support, including the setting up of a national hazard fund to provide compensation for property lost to the sea, and/or to facilitate managed retreat for existing coastal communities. But he also recognises that territorial authorities should have more power to regulate new and proposed coastal development.

As Peat observes: "… private property is a powerful, entrenched ethos in New Zealand and retreat is usually the last resort". Property owners will need special incentives to retreat from the coast, and it is unfortunate that a significant planning incentive – transferable development rights – is not investigated here.

Among other suggestions about information and data gathering required for decision-making, Peat suggests that more extensive lidar data is required. It is here that I have a slight criticism of the discussion in this book. Coastal land mapping and coun-

Housing perilously close to the mean high water springs at Cook's Beach, Coromandel. Photo: Mick Strack.

Aspects of body corporate operation and management

Stephanie Harris and Vicki Toan

Unit titles are an increasingly common form of development as our housing density increases and is, in the writer's experience, the most widely used form of multi-unit property ownership. It is regulated by the *Unit Titles Act 2010* and every unit title development has a body corporate. The key question is whether or not the body corporate is functional.

The body corporate is responsible for a range of management, financial and administrative functions relating to the common property and to the owners in the development as a whole. Thus it is critical that its functions are understood in terms of the things that all unit owners have a shared interest in and it is critical that it functions for the benefit of all owners.

Below is an overview commentary on three aspects of body corporates that seem to be common questions and raise increasing frequent issues.

Appointment of administrator

Got a dysfunctional body corporate? Do you need an administrator?

An administrator is an independent third party appointed by the High Court under section 141 of the Unit Titles Act 2010 (UTA) to assume the powers and duties of the body corporate (and the body corporate committee).

An application for the appointment of an administrator may be made by the body corporate, any person having a registered interest in a unit (i.e. a mortgagee as well as a unit owner), or a creditor of the body corporate. The application must show 'cause' for the appointment of an administrator, but section 141 does not set out what grounds would justify the appointment of an administrator.

The court therefore has a wide discretion. In the past, the court has appointed an administrator where it considered that it was appropriate to do so – where the court found actual or alleged dysfunction of the body corporate, i.e. the body corporate is unable to govern itself. Examples of the types of behaviour that amount to dysfunction include:

- undemocratic or ultra vires (unlawful) decisions
- deadlock
- decisions made through undue influence or which unnecessarily harmed the interests of the minority (see *TBS Remcon Ltd v Body Corporate 354994* [2016] NZHC 1689, *Low v Body Corporate* (2011) 12 NZCPR 142 and *Melview Viaduct Harbour Ltd (in rec) v Body Corporate 348911* [2012] 1 NZLR 84).

The court has however been reluctant to use section 141 as a device to ensure that the body corporate pays its outstanding debts, i.e. by circumventing other debt collection processes.

More recently in *Maiden v Body Corporate 46112* [2018] NZHC 448, the court considered the issue in respect of a nine-unit apartment building. The five applicants in the proceedings owned five of the units in the development. The second respondent owned the other four units.

In the lead-up to the proceedings, the body corporate held an annual general meeting in 2010. There were no AGMs in 2011, 2012 or 2013. In 2014, an AGM was held but abandoned before the body corporate could pass any

(continued from p40)

cil-defined hazard lines (which have come under serious scrutiny in the courts – in the Kapiti area notably) are based on land surface levels, which suggest that the threat of sea level rise is predominantly about inundation over low-lying land. In fact, coastal erosion is just as much a threat on land often well elevated above sea level and is a function of subsoil structure – it is cliff faces that often cause the most unexpected hazard.

There is a chapter on the threats to Pacific atolls, and once again I would suggest that it is not just the concern of creeping encroachment of a rising sea over low-lying land, but the fact that any significant combination of storm surge, atmospheric pressure, spring tides, and even tsunamis could completely wash through the atolls.

Climate change and sea level rise are happening now, and at some time in the future, "there will be a tipping point in coastal management when 'adapt' turns into 'retreat'." The final warning is that reining in greenhouse gas emissions (mitigation) and adapting to coastal hazards "requires decisions and actions right now". This is, of course, a timely book and an important call to action, and surveyors have an important role to play in encouraging responsible and safe development around the coast.

resolutions, and subsequent attempts to hold meetings failed. The body corporate had no effective governance structure.

As well as the failure to hold AGMs, the applicants also claimed that the body corporate had failed to fulfil its duties to repair and maintain the common property and building elements under section 138 of the UTA. At the time of the application, critical maintenance included exterior painting, roof replacement and joinery replacement. The second defendant accepted that the body corporate was dysfunctional and that repair work was required urgently.

The court found that:

- the body corporate was dysfunctional because there had been no AGMs and no operative governance structure
- in the absence of an elected chairperson, an interim measure was necessary
- the lack of agreement between unit owners was preventing the building being maintained
- the buildings required repairs.

The court ordered the appointment of an interim administrator to undertake an urgent and objective inquiry into the governance and maintenance issues and provide an independent report to the court in four weeks before a further hearing.

Leases and licences of common property

A body corporate can lease or license all or part(s) of the common property to an owner, occupier or third party for their personal use under section 56 of the Unit Titles Act 2010 (UTA). The lease or licence of common property may be granted for any number of purposes, the most common being car parking, storage, signage, or outdoor seating.

The legal process for granting a lease or licence over the common property is set out in section 56 of the UTA. The same process applies whether the body corporate is granting a lease or a licence (or, in fact, selling all or part of the common property).

To grant a lease or licence over common property, the body corporate must first pass a special resolution (requiring a 75 per cent majority). The body corporate must then complete the designated resolution process in sections 212-216 of the UTA.

The designated resolution process requires the body corporate to serve written notice of the resolution to grant a lease or licence on all owners and their registered interest holders (such as mortgagees and caveators). Every person served with a notice of designated resolution may then object to the resolution within 28 days. Once the objection period has lapsed and any objections have been resolved, the body corporate may enter into the lease or licence.

The body corporate must distribute any licence fee, rental or other proceeds from the lease or licence of common property to unit owners in shares equivalent to their ownership interests, unless the body corporate resolves otherwise. An owner may elect to have their share of the proceeds credited to their unit to offset any current or future levies associated with that owner's unit.

Before passing a resolution under section 56, the body corporate should be clear whether the common property is to be leased or licensed, and the differences between the two. The body corporate should also be aware that the Property Law Act 2007 applies to leases and licences and imposes obligations on both parties, especially in respect of cancellation.

As a reminder, a lease is a legal interest in land and transfers to successors in title. Assignments or subletting may also be possible depending on the terms of the lease. A lessee has a legal right to exclusive possession and may sue for nuisance or trespass.

And, a licence is a lesser right than a lease. A licence creates a personal right to occupy a property for a particular purpose. It does not give any right of exclusive possession. A licence typically does not automatically transfer to successors, but is between the named licensor and named licensee only.

From an administrative point of view, we recommend that leases and licences are recorded in writing and signed by the parties, and that copies held by the body corporate together with the original resolution and designated resolution certificate. Where the lease or licence relates to a specific part of the common property, we recommend that the area be shown on a plan attached to the lease or licence document to avoid confusion or future uncertainty about the extent of the leased or licensed area.

Residential tenants and body corporate rules

Under section 105(4)(c) of the Unit Titles Act 2010, body corporate operational rules are binding on any person who occupies a principal unit. But, where a unit occupier is a residential tenant under the Residential Tenancies Act 1987 (RTA), the RTA affects the enforceability of the operational rules against the residential tenant.

A recent decision of the Tenancy Tribunal highlights the need for unit owners to take care when establishing a tenancy to ensure that the body corporate operational rules are enforceable by the unit owner/landlord against the unit occupier/residential tenant.

In *El Amor Ltd t/a Quinovic Property Management v Johnstone* (application no. 4016089, 26 April 2016), Ms

Johnstone occupied a residential apartment in a unit title development under a residential tenancy.

The landlord sought an order terminating Ms Johnstone's tenancy on grounds that Ms Johnstone had breached the terms of her tenancy agreement and the body corporate operational rules for the unit title development by operating a business from the apartment. Ms Johnstone was running a small owner-operated brothel from one of the bedrooms in the apartment. The landlord claimed that Ms Johnstone was in breach of the following operational rule:

"All units shall be used for residential or home office purposes and no owner or occupier of any unit shall use or permit the use of his unit for any purpose which may be illegal or injurious to the reputation of the building or of the owners or occupiers of units or which may interfere with the peaceful enjoyment [and] use of another unit by the owner or occupier thereof or which may interfere with the general management of the building."

Ms Johnstone opposed the claim on the basis that:

- she had the landlord's prior consent to operate a lingerie business from the apartment (this was not disputed)
- she was occupying the apartment principally for residential purposes
- the use of the apartment is not illegal, did not harm the reputation of the building, did not interfere with the peaceful enjoyment of any neighbours in the building, and did not interfere with the management of the building.

The tenancy agreement included a clause requiring the tenant to comply with the operational rules. This is consistent with section 16B(2) of the RTA, which provides that body corporate operational rules are taken to be terms of the tenancy agreement.

The tenancy agreement did not however include a statement of the applicable operational rules, as is required by section 16B(3) of the RTA. Nor was Ms Johnstone provided with a copy of the operational rules until after a 'breach notice' was issued.

The adjudicator held that:

- the apartment was used principally for residential purposes, and the landlord failed to prove that the apartment was not being occupied principally for residential purposes
- the landlord failed to provide a statement in the tenancy agreement of the operational rules that affected the tenant, and failed to provide a copy of the operational rules to Ms Johnstone before the breach notice was issued
- it would be unfair for Ms Johnstone to be held liable for a breach of the operational rules where the landlord had itself breached section 16B(3) of the RTA
- the landlord did not prove that Ms Johnstone had breached any of the operational rules.

Points to note from this decision are that the applicant has to prove his or her case on the balance of probabilities i.e. the evidence has to show that the applicant's version of events is more probable than not. And, that a landlord must comply with its obligations under the RTA to be able to enforce body corporate operational rules against a tenant pursuant to a tenancy agreement – notwithstanding section 105(3) of the UTA.

It is possible that this second point may be decided differently if the claim was brought by the body corporate, but also serves as a reminder for a body corporate to require unit owners to provide copies of the operational rules to all unit occupiers. The body corporate did not participate in the case.

We also note that rules referring to not injuring the reputation of a building may not be sufficient to prevent adult entertainment activities including brothels, escort agencies, retail shops etc from lawfully establishing in the building. Alternative or additional rules may be required to control the use of unit property to prevent such activities.

MILESTONES

Christina Hulbe

Since our first two finalists in 1964, the University of Otago has educated almost 2000 surveying graduates. (By my count, it's 1986 including diplomas and degrees up to 1997 and BSurv graduates from there.) I don't know if that number is large or small, but it seems like a milestone to me.

The surveying class of 1968 was on campus last spring, celebrating their own milestone year. We enjoyed reminiscing with them about their student days and giving them some insight into research and teaching in the school today.

The class was kind enough to send along a copy of their reunion yearbook and the short biographies are great reading, though tamer than graduating class magazines tend to be. We think a lot about our culture in the school and visiting with the class of '68 reinforced for us just how important friendships developed here can be.

Thanks to Rod Keucke, who organised the reunion, and to the whole class for their generous scholarship donation.

2019 marks an even bigger milestone, 150 years of the University of Otago. A wide variety of events are planned for the year, with a focus of activity on Queen's Birthday Weekend at the end of May. It's worth browsing the activities (*www.otago.ac.nz/150*).

In particular I'd call your attention to CPD workshop organised by Crystal Filep, our new lecturer in urban design, and Mick Strack (whose class is organising their own reunion that weekend).

Titled, *Beyond Subdivisions: Why Urban Design Matters*, the workshop will be a chance to discuss the Global Street Design Guide and several New Zealand projects.

2019 also marks 250 years since the first encounter between Māori and Europeans, when James Cook and his crew arrived on the Endeavour. That's a milestone for Western navigation and surveying, so you will not be surprised to learn that folks in the school have a few projects under way, in alignment with the national *Tuia – Encounters 250*.

A group led by Emily Tidey, Mick Strack and Tony Moore are considering how map-making and human interaction around that activity have changed over time. If Emily or a student working with her contacts you to talk about the history of hydrographic surveying in Aotearoa New Zealand, for example, please do get involved.

A few weeks ago, I had the privilege of introducing Pascal Sirguey at the annual Otago staff Excellence Awards. The university gives three awards, one for overall excellence among the non-academic staff, and two new awards for team and individual excellence in health and safety practice.

We nominated Pascal for his leadership with the school's two remotely piloted aircraft systems (RPAS). The operations manual that Pascal developed was adopted by the university to govern RPAS operations campus-wide but what stands out to me is the way Pascal integrates safe and compliant operations into every aspect of his RPAS-based teaching.

The inherent complications of mission planning, logistics, hazard mitigation, and other details are an essential part of the learning process. Everybody in the school takes health and safety planning seriously and it's great to see Pascal's comprehensive approach recognised at the university level as the inaugural recipient of the individual award.

It might not be the same kind of milestone, but 2019 also marks time for the school to be reviewed in Otago's internal Quality Advancement process. The review is an opportunity to reflect on how we have progressed over the past 10 years and to think strategically about the future.

We are looking forward to working with as many of you as we can to amplify the message we deliver to schools about the BSurv, our BSc options, and BAppSc GS degrees and to working with S+SNZ on the Diversity Agenda.

Last year we assessed our curriculum in the context of the evolving model for professional registration and that work continues today. There is a good chance your firm has already been contacted to make a submission but if not, and if you have something to say, send an email to *surveying@otago.ac.nz* and we'll put you in contact with the review secretary.