Drones as a support tool for seismic acquisition.

Jason Stephenson
Velseis Pty Ltd
83 Jijaws St, Sumner Park, Qld
jstephenson@velseis.com

Shaun Strong
Velseis Pty Ltd
83 Jijaws St, Sumner Park, Qld
sstrong@velseis.com

SUMMARY

The availability of relatively inexpensive UAVs in the form of drones provides many opportunities to seismic exploration.

While government regulations still provide many restrictions in this space, this trial has demonstrated that significant advantage can be achieved by using these tools. These have the potential to improve the safety of personnel and reduce the QC costs of seismic acquisition.

Key words: UAV, seismic acquisition, drone, quad-copter

INTRODUCTION

In last decade aerial drones (UAVs) have gone from just being expensive toys to useful machines for a variety of commercial sectors. This includes, photography, real estate, agriculture and the mining industry. Geophysics has not been blind to these developments.

In fact, the advantages of using UAVs were outlined by Macnae (1995). He suggested that UAV would provide the potential to acquire airborne magnetics surveys at higher densities with reduced costs and greater safety. This have been demonstrated in the potential fields side of the geophysics industry (e.g. Stoll, 2011) to various extents since the late 90's.

For the seismic industry the applications have of UAVs have only recently been recognised. While some groups are looking at using the technology in directly integrated it with seismic systems (e.g. Stewart et. al., 2016) there is also the many options for using UAVs in a supporting roll for seismic surveys.

Some of these include:

- Site photography and planning (e.g. Changqing et. al.,2018).
- Use of Images and video footage to indicate hazards or direction to acquisition crews.
- Node deployment.
- QC of seismic deployment.
- Equipment scouting and recovery.
- Delivery of object to a remote position.

The aim of this investigation was to examine the feasibility of some of these.

The Drone used for this testing was a DJI Mavic Air (Figure 1). DJI are world leaders in the drone industry and have a great emphasis on safety. The Mavic Air is a foldable drone that is about the same size as a large smartphone when it is folded. It has a stated flight time of 21 minutes and can fly about 4000 meters although in reality, actual the flight time is more like 17 minutes for the type of flights used in this testing.

The Mavic Air is a relatively cheap drone at $1100 and is packed with features including all round obstacle avoidance. It is easy to fly and could be classed as a beginner drone.

Figure 1. DJI Mavic Air with protective case.

SAFETY AND REGULATIONS

In Australia the greatest limiting factors to the use of UAVs are are associated with regularity restrictions. Initially it was unclear as to the extent that standard aviation regulations applied to the commercial use of small drones. However, in recent times specific ruling and procedures have been implemented to make it clearer how these can legally be used. While these are quite restrictive they do allow more opportunities.

The following standard operating conditions apply to small drones like the one used in this trial (Civil Aviation Safety Authority, 2018):

- Used during daylight.
- Must remain within visual line-of-sight. This means being able to see the aircraft with your own eyes rather than through a device.
- Flight must not exceed 120 metres (400ft) above the ground.
- Must be greater than 30m from another person. And not fly over anybody.
- Drone must not be flown over or near an area affecting public safety or where emergency operations are underway (without prior approval).

This could include situations such as a car crash, police operations, a fire and associated firefighting efforts, and search and rescue.

- Operator may only fly one drone at a time.
- If the drone weighs more than 100g, it can not fly within 5.5km of a controlled aerodrome.
- It is illegal to fly for money or economic reward unless the operator has completed a drone operators certificate, or you are flying an excluded drone in the sub-2kg or private landholder category.
- Do not operate in a way that creates a hazard.
- Notification of flight paths with CASA is required for commercial activities.

Velseis had two experienced and licensed operators on staff who ran this trial. It was also decided that some extra controls should be implemented to ensure safety to persons, livestock and company reputations:

- Fly at 30m to avoid trees, powerlines and spooking cattle
- No flying near landholders dwellings
- Maximum of 100 nodes checked per flight when scouting.
- Prior to all operations aerospace restrictions were examined using the CASA online tools (https://casa.dronecomplier.com).

FIELD PROCEDURES

For this trial the UAV was mostly used to QC the deployment of Nodal seismic equipment and assist with the retrieval of the same equipment.

Node Deployment QC

The initial idea was to fly missions over a chosen property then head back to the site office for video analysis.

The first step was to pre-build flight paths using a combination of node deployment files, Google Earth, in-house software and a third party DJI support application.

Deployment-file node information was imported into Google Earth, then using Google Earth's polygon tool, flight paths areas were created (Figure 2). With the aid of in-house software and a third party application the flight paths were quickly generated. These consisted of 1 waypoint for each node location.

Once the flight paths were created it was just a matter of heading to the property and flying the pre-planned missions. Careful consideration was given to finding elevated positions to pilot from, ensuring best possible line of sight. The red crosses on Figure 2 indicate the two positions used for the four missions (blue polygons) shown.

After returning back to the Site Office the drone videos and flight logs were used to extract frames corresponding to the time the drone was over each known node position. Figure 4 compares the typical white square of a node in the correct position/upright with those knocked out of the ground. Any nodes out of the ground were recorded to file for spread checkers.

A process was also trialled where one person flew the missions, one person analysed the video and a third person fixed any node issues, with all three in the field together thus dealing with any out of ground nodes sooner. The process, while a bit more complicated showed some promise although to cover large areas it would require setting up a vehicle to in order to recharge computers, batteries and remote controllers.

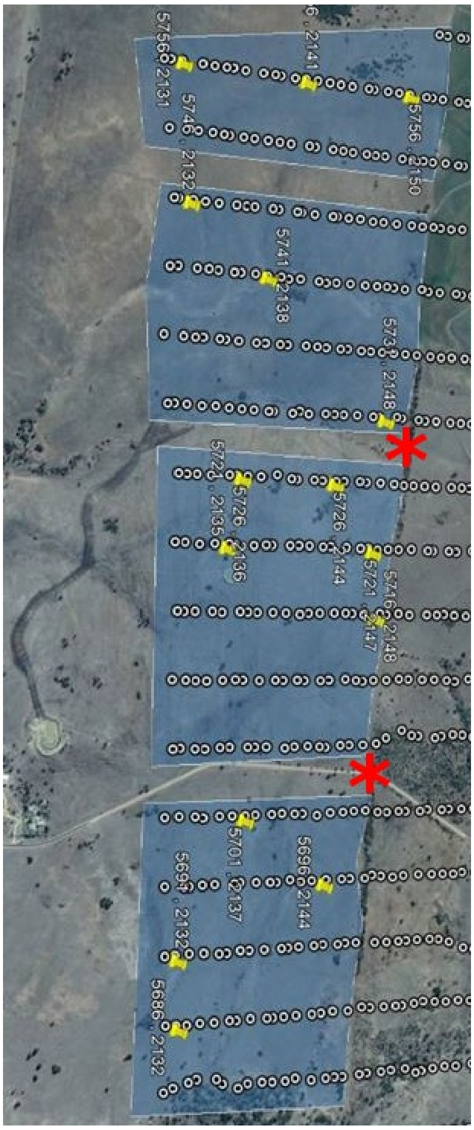

Figure 2. Deployment-file node Information with polygons of selected flight-path areas. Red crosses show drone launch sites. Locations where disturbed nodes were identified are indicated by the yellow pins.

For the area indicated in Figure 2 and increase in productivity of a factor of 5 was seen the introduction of the drone to the operation. What previously took about 5hr by driving every line was reduced to a little over an hour with drone support.

Lost Node Recovery

Another handy use of the drone was to search for hard to find nodes. On more than one occasion the evidence had suggested that some type of wild animal had pulled the node out and walk away with it. In one particular case a node was over 50m away from it's original position in a rough blade plough area. After a couple of failed attempts to find it on foot, consisting of about 6 man-hour, the drone managed to film it while flying a search pattern around its last known location. This took less than half an hour.

Other nodes where found by the drone in similar situations.

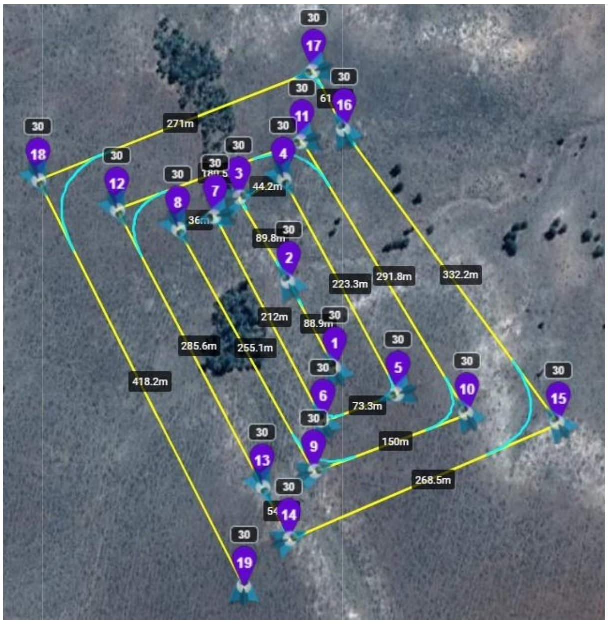

Figure 3. Flight path used to find a lost node in rough ploughed terrain.

DISCUSSION AND CONCLUSIONS

The use of drones to support seismic acquisition showed a number of benefits these included:

- Reduce line crew exposure to all usual hazards
- Reduce footprint on properties
- Reduce fuel, vehicle wear and tear etc.
- Increase the efficiency of spread checkers, more so in the case of blade plough or creek riddled properties.
- Assist Project Managers with decision making
- Reduced noise on spread

However, there were some limitation that restricted their use especially within the guidelines of the currently regulation. These were mostly related to line-of-sight, i.e. hills and vegetation restricting the ability of the operator to see the drone.

It was also expected that land holders may be hesitant to allow the use of drones. However, in most cases it was found that they were quite supportive of the idea.

This trial has demonstrated that while drones may not be able to be used in all occasions, their advantages when they can be used suggest that they should be available for use when required.

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Figure 4. A sample of images from drone node QC. The image on the left show the square shape of a node that is correctly planted in the ground. The images on the right show the blue-white casing of nodes that have been kicked out of the ground by cattle.