A comparison of three survey methods: baseline offset, trilateration, and triangulation (tape and compass).

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Aim:

The aim of this report is:

(1) to compare three methods of two-dimensional archaeological pre-disturbance survey techniques: baseline offset, trilateration, and triangulation (tape and compass);

(2) to contrast their levels of accuracy; and

(3) to discuss the most effective in ease and accuracy of the three techniques.

Introduction:

Baseline offset, trilateration and triangulation are two-dimensional survey techniques that utilise distances and/or angles to fix an unknown point from one or more known points. This aids in the formation of an accurate site plan.

Background:

The aim of survey is to record the position of a point, or target in relation to known fixed points (Dean, M., Ferrari, B., 1995). The technique by which a site may be surveyed can be determined by establishing the extent and nature of the site. This aids in the development of a survey strategy.

(a) Establish a perimeter.

This needs to be done to define the site which is to be surveyed and may be done in various ways by either:
(1) Using cardinal points and then measurements can be made of the perimeter of the site from a random central point;

(2) A distance and bearing may be measured by a swim around the perimeter;

(3) If the site is small and there is good visibility, measurements can be made across and down the site.

(b) Establish primary datum's.

A datum point is a reference point from which survey measurements are taken (Dean, M, Ferrari, B., 1995) and in order to be useful it must:

(i) not move;

(ii) be precise, a specific point;

(iii) it must be conveniently placed for intended measurements; and

(iv) its position relative to every other datum point on the site must be known (Dean, M, Ferrari, B., 1995)

These need to be established and the site baseline may be attached to these datum points so they should be uniquely identifiable.

(c) Establish the baseline.

The baseline should be a measured steel line or tape and attached securely to the datum points.
There are also important things that must be considered irrespective of the survey used to ensure accuracy of the data recorded:

(1) Divers need to be trained and briefed;
(2) Quality tape measures that are fibreglass and resistant to stretch need to be used;
(3) There must be standard recording forms used, i.e. the same units of measurement; and
(4) The tape measure must be less than 15m long, etc.

Methods:

Baseline Offset:

This involves fixing the position of an unknown point by measuring its distance from an established baseline and the distance it lies up the baseline.

First, a baseline needs to be established which runs parallel to the site, either along one side of the wreck, or down the middle. Also, the bearing of the baseline should be recorded.

Two measurements are taken:

(1) the distance the object lies up the baseline (Figure 1), and
(2) the distance it lies from the baseline - this distance must be measured such that the tape extending from the baseline is perpendicular to the baseline (Figure 1).
Trilateration:

This involves two fixed datum points from which measurements are taken. Two tapes are used to measure the two distances from the datum's, and the distance is recorded where they intersect at the location of the object (Figure 2). More than one point may be read on the object for further accuracy and to ensure the lie of the object is correct.
Triangulation: tape and compass

A datum or fixed point is established, approximately in the centre of the wreck site. Then using a tape:

(1) the distance from the datum to the object is recorded; and then

(2) a compass bearing is read from the object towards the datum (Figure 3).

Figure 3: Triangulation (tape and compass)

Discussion:

Throughout the surveying we completed on the wreck Victor, Eclipse, and under the jetty
we used all three survey techniques discussed in this report. We used different techniques at all three sites because each site was unique in it’s topography, weather conditions, tidal conditions, water depth and visibility, vegetation and how it is affected by humans. Thus, the site determined the survey method.

At the Victor site we used baseline offset to survey the site. This was able to be done because the seabed was relatively flat, which meant that the baseline that was laid was approximately horizontal, as well as the tape coming off the baseline. This method was favourable because the longest baseline extended approximately 20m, and baseline offset is a simple and quick survey method. Although this site was subject to moderate surge, relative to the other sites it was not as strong.

At the Eclipse site the surge was very strong, and it move us a few metres either way; but based on the distribution of the site, tape and compass was used. The site is spread into three sections which lie approximately in a triangle shape around a reef, and each section is at least 20-30m apart. The distribution of the wreck determined the survey method used, despite this being an unfavourable method. This is due to it’s inaccuracy, because of:

(1) the small design of the compass with large degree intervals;

(2) the compass is affected by iron objects; and

(3) it is only accurate if the object is close to the datum.

Also, the site was subject to such strong surge, that when we were taking the compass reading we were constantly being moved side to side. This would have potentially produced inaccurate results. Baseline offset wasn’t used because the wreck didn’t roughly lie in a line, it was spread such that if that method were used, three baselines
would had to’ve been constructed. Tape and compass was the simplest method to use based on the conditions.

Under the jetty, the survey area was 10mx20m, there was almost no surge and the visibility was up to 10m. This meant that sometimes the entire area could be seen at once. Due to the calm conditions, the good visibility and the flat site, trilateration was used.

This method is most accurate of the three because two points are used to determine the position of the point, but it is most accurate if more than two points are used, since they all must intersect to give an artefact’s location. Plotting the intersection gives precise precision of the artefact location. It can be inaccurate though, when the object is too close to the baseline, or when angles are too acute or obtuse. This method was easier to be used at this site rather than at the Victor site or the Eclipse site. This is because:

(1) At the Victor site the baseline used was at least 20m long, so the site was relatively spread out. This meant if trilateration were used the baseline would had to’ve had numerous datum’s, at least two per area of debris. This would have meant more time setting up the datum’s and also carrying out the trilateration.

(2) At the Eclipse site, the wreck was very spread out, almost in three separate ‘circles’ of debris, so the best type of survey would’ve been one which takes measurements radially out from one point. Again, as at the Victor site, trilateration would’ve meant that numerous datum’s would have been needed and taken more time- which was a constraint in these surveys.

Alternatively, for a high level of accuracy more than one method of surveying could’ve been used. This combines the strengths and weaknesses of different methods to compliment each other and produce a more reliable result. For example; when using
offsets, diagonal checks could be incorporated to verify correct data points, or could be combined with trilateration.

Other factors that affect the method chosen for site surveying are:

- How much time is permitted;
- The equipment available;
- The expertise and skills available; and
- The size of the site.

**Conclusion:**

In conclusion, it was found that the most accurate method of surveying was by trilateration, because two data points were measured. This meant that the location of the artefact was defined by the intersection of two points, creating a higher accuracy that the other methods which do not incorporate this. The jetty site was most suitable for this method because the site areas were only 5m square, there was good visibility, and the site was relatively flat. Triangulation was the most inaccurate because of the use of the compass, as previously discussed, but was useful for the Eclipse site because it was a radial type of measurement, which correlated to the distribution of the site. Baseline offset was intermediate in accuracy compared to the other two methods, however, it was the easiest to draw onto the site plan from the raw data in comparison to trilateration. This may be because the data collected was more accurate when the baseline offset measurements were conducted.

Thus, it is evident that the survey techniques used at a site are heavily dependant upon the characteristics of the site, and this determines the appropriate survey method.