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ELECTRONIC RECORDING SYSTEMS USED DURING THE EXCAVATION OF S11/20, PONUI ISLAND, HAURAKI GULF.

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Archaeological research questions require that ever-increasing amounts of data are recorded during excavation. Considerations of site formation processes and intra-site spatial organization increasingly require that the three-dimensional position of artefacts, ecofacts and features be recorded. For a number of years archaeologists have used small computers to manage such data, however, commonly this has involved considerable manual data entry after returning from the field. More developed and cheaper electronic surveying instruments which directly interface with small computers mean that provenance information can now be recorded directly at the point of excavation with minimal manual entry. This paper describes a system using such an instrument to record the position of material excavated at the site of S11/20, located on the south coast of Ponui Island.

THE PONUI ISLAND EXCAVATIONS

The site of S11/20 is adjacent to a creek mouth at the western end of Motunau Bay and covers quite an extensive flat area behind the beach. It was excavated in the years 1956, 1957, 1959 and 1962 under the direction of Mr V. F. Fisher of the Auckland Institute and Museum. Evidence found suggested the former presence of surface structures and a range of activities including cooking, tool manufacture and use (Nicholls 1964). A substantial collection of artefacts and faunal remains from the excavation was lodged in the Auckland Museum. Many were thought to date from an early time in the Auckland sequence although European artefacts were recovered as well.

In 1989 and 1992 during the University of Auckland archaeological field schools, further investigations were undertaken. In 1989 S. Best and G. Irwin carried out initial test excavations to determine the composition and extent of the site. In 1992 surface surveying was done by P. Sheppard and N. Champion and more extensive excavation was carried out by students supervised variously by S. Holdaway, G. Irwin, R. Wallace and M. Taylor. An important research objective was to establish some spatial context for the wealth of artefactual material recovered by Fisher. Briefly, we hoped that the spatial distribution of artefacts, structural features, and midden would suggest some of the behavioural processes that lead to the formation of the site. For this reason it was decided to use electronic recording based on an electronic theodolite with an inbuilt distance meter.

THE THEODOLITE AND DATA LOGGER

At the Ponui excavations, a Sokkisha total station electronic theodolite was used. It measures the cartesian coordinates (x, y, and z) of any point in a site relative to a fixed datum (normally marked at a convenient spot by the archaeologist). A reflecting prism is placed next to an object in the site, and the theodolite is focused at the centre of the prism (see Plate 1). The theodolite then measures two angles, a vertical angle measured from the true horizontal, and an angle of direction in the horizontal plane normally measured with reference to magnetic north (although any other reference point may be used). The electronic distance meter then emits an infra red laser beam that is reflected by the prism. The phase relationship between the transmitted and reflected beams of light is used by the theodolite to calculate the distance from the instrument to the prism. These three measurements, two angles and a distance, are used to calculate the three dimensional coordinates for the object.

The Sokkisha theodolite was interfaced with a Sokkisha SDR Electronic Fieldbook data-logger, both instruments owned by the Auckland University, Anthropology Department. The SDR electronic data-logger is a hand-held computer produced in New Zealand that is directly interfacable with the theodolite and comes with a number of built-in programs useful for surveying. One of these programs, TOPOGRAPHY, converts the angle and distance measurements taken by the theodolite to coordinates relative to arbitrary values given to a fixed datum. These coordinates are then stored in the notebook as northing, easting and height equivalent to y, x and z in a cartesian plane. Because the data-logger is connected directly to the theodolite, no manual keying of coordinates is necessary. The data-logger automatically numbers each set of coordinates, and provides a note field at the end of the record where the operator can store comments concerning the objects recorded. The data-logger comes bundled with software that allows transferral of the data to a PC through a serial port.

RECORDING SYSTEMS AT PONUI

At S11/20 a fixed datum point was selected near the stream so the theodolite had an unobstructed view of all areas to be excavated. A fixed datum was established by driving a stake into the ground and giving this point an arbitrary value of 1000,1000,0, corresponding to 1000m in the northing, 1000m in the easting and a height of 0 meters. These values ensured that x and y coordinates would always be positive no matter which areas were excavated, and height (the z coordinate) would be negative. The theodolite was set up directly over this datum, aligned to north and the coordinates of the datum entered into the data-logger (see Plate 2). When set up in this way, an electronic grid is effectively thrown over the entire site (and the neighbouring region) meaning that any area selected for excavation can be related spatially to any other.

Plate 1. Excavation in area Test 20. The student in the centre of the picture is holding a reflecting prism attached to a one-metre pole.

Initially readings were taken for a topographic map of the site and immediate environs. Since actually recording the three dimensional coordinates of a point takes under five seconds, many points can be shot in a short space of time, the only limiting factor being the speed with which an operator can focus the instrument on the prism.

Next, boundary points for the areas to be excavated were recorded. If these are aligned parallel to the electronic grid, the theodolite can be used to quickly set out regular squares or rectangles on the ground. This removes the need to use 3-4-5 triangles to establish parallel-sided excavation units. Each of the regions to be excavated at Ponui was identified with an area number beginning with one as an organizational aid in the field. Excavation areas were of variable size, many being small test pits, while others were larger rectangles.

As excavation commenced, the theodolite recorded spatial information for a number of different types of material. Firstly, as artefacts were uncovered they were left in the ground and a measurement taken of their position.

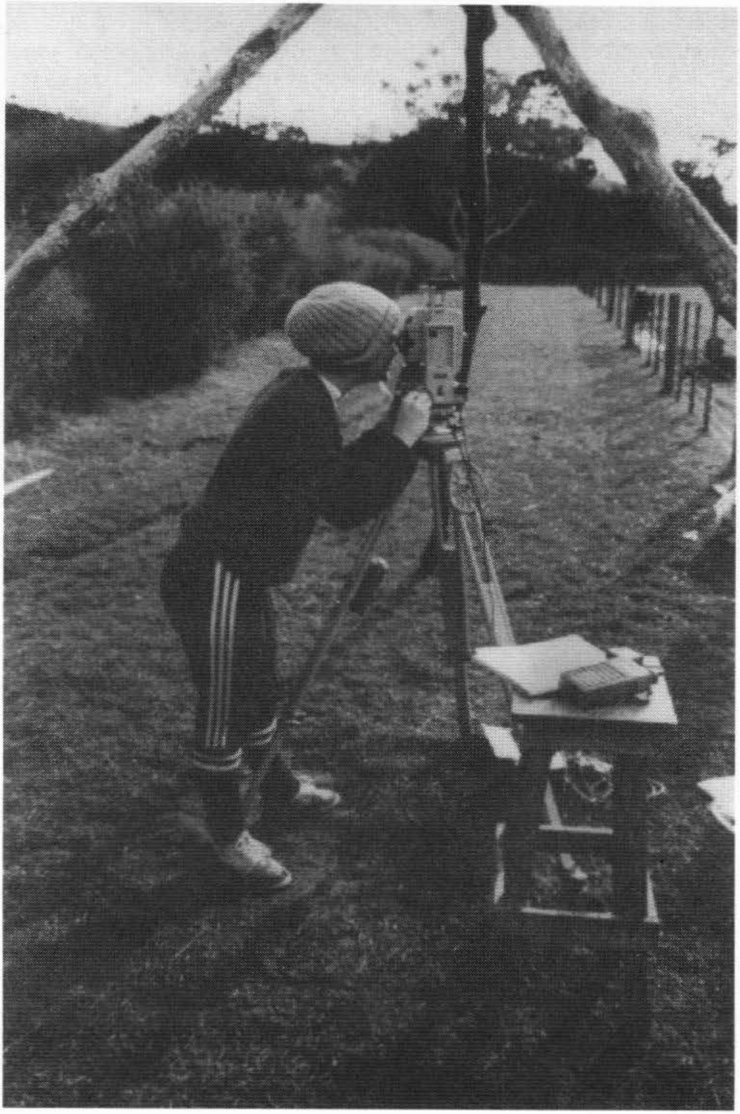

Plate 2. The theodolite set up over the site datum during the excavation of S11/20. One of the students is focusing the theodolite while the data logger rests on the stool.

then bagged separately. Secondly, one shot was taken with the theodolite for each bucket of material removed. It was decided for artefacts too small to be easily identified during trowelling, provenance to the quarter metre square would be sufficient. Hence, material from 50x50cm squares was bucketed separately. Before excavation commenced, a shot was taken in the centre of the 50x50cm square and then a bucket (20litre) of material was excavated. The sediment in each bucket was then sieved and cultural material bagged as the contents of the bucket shot. Excavation followed the stratigraphic layers, with a new bucket begun when a layer interface was crossed, however in thick layers repeated bucket shots effectively meant that excavation was conducted in spits, since each bucket represented excavation to a depth of about 5cm. A variant of the bucket shot was termed a sample shot. In this case all the material (both cultural and non-cultural) that did not pass through the sieve was retained for further analysis in the laboratory.

The third type of measurements recorded with the theodolite were the spatial position of layer interfaces (i.e. the surface between two stratified layers - see Harris 1989). After a layer interface was defined a series of shots were taken to record the topography of the layer before continuing excavation.

The fourth type of record concerned features, defined as layer interfaces that cut across underlying layers in a localized region. At Ponui these were commonly post-holes and fire-scoops. Initially the spatial position of a feature was recorded on the surface from which it was defined and then the topography of each layer that filled the feature was recorded separately. Artefacts and buckets removed during excavation of the feature were recorded as belonging to that feature. Finally, topographic shots were taken to define the interface of the fully excavated feature.

Shots of all types were recorded in the data-logger in a separate file for each day and transferred to a PC each evening.

CODES

As mentioned above, the data-logger includes space for a note field at the end of each record. At Ponui this field was used to store important additional information for each shot. Three pieces of information were entered, each separated by a blank space. The first was the excavation area number where the shot was being taken. Next a letter code was entered designating the type of shot, A referring to artefact shot, B to bucket shot, S to sample shot, and T to topographic shot. As the excavation progressed an additional code was added - O for fauna. This code was used for the location of large pieces of bone or shell rather than humanly modified artefacts. These codes serve to differentiate the precision with which three dimensional position was recorded, and whether a shot was taken to define a layer interface (topographic) or to locate material in three-dimensional space (artefact, fauna, bucket and sample shots). Obviously these codes could be expanded to include more specific identification of materials excavated. However, field identifications are often inaccurate, so further sorting is probably best left to the laboratory. Codes used at Ponui allowed individual artefacts, items of fauna, and bags of specific material to be distinguished from buckets in need of further sorting in the laboratory.

The third piece of information recorded in the note field referred to the layer number. This was a simple numeral for the majority of shots, but became somewhat more complex for features. Within each area features were labelled serially with the letter F followed by a number. Layers within a feature were designated by the feature number followed by a fullstop and the layer number. Thus, F2.3 referred to Layer 3 of Feature 2. At the base of any feature a final set of topographic shots was taken to define the shape of the excavated feature, and labelled simply by the feature number.

Table 1 illustrates some typical records for artefacts and buckets recorded in the data-logger. First, is the unique identification number for the shot, then the northing, easting and height coordinates, and finally the code divided into area, shot code, and layer. All fields of data are space delimited (have a blank space between each value) allowing the data to be easily transferred to other PC based programs. The same code information as entered into the data logger was written on the bags containing artefact and bucket material. Thus, bags were labelled with a circled number representing the excavation area, the layer number, shot code (A, B, or S) and, finally, the unique identification number automatically allocated for each shot by the data logger.

THE DATABASE

The inbuilt data transfer programme in the SDR Electronic Field Book data-logger outputs the records as an ASCII file, a generic form of computer file that can be read by a wide variety of PC-based programs. At Ponui the ASCII file was read into a relational database manager, running on a portable PC XT, each night at the excavation camp. Separating each of the data fields by a blank space means that the database manager can recognize that the identification number, coordinates, and code fields represent separate types of information. The data was visually checked to ensure that area, code, and layer information had been entered correctly, and that the number and type of shots tallied.

Using a relational database manager means that a number of specialist databases can be created at the same time for the simultaneous analysis of different types of materials. Each of these databases will then be used to access the spatial information held in the central database. This is achieved by using a common field (the unique ID number) in both the central and daughter databases. Thus, one researcher may be interested in analyzing obsidian while another may be concerned with fishbone. Quite different types of observations will be required in each instance but both researchers will be able to access the provenance information from artefact, faunal and bucket shots using the ID number of each record.

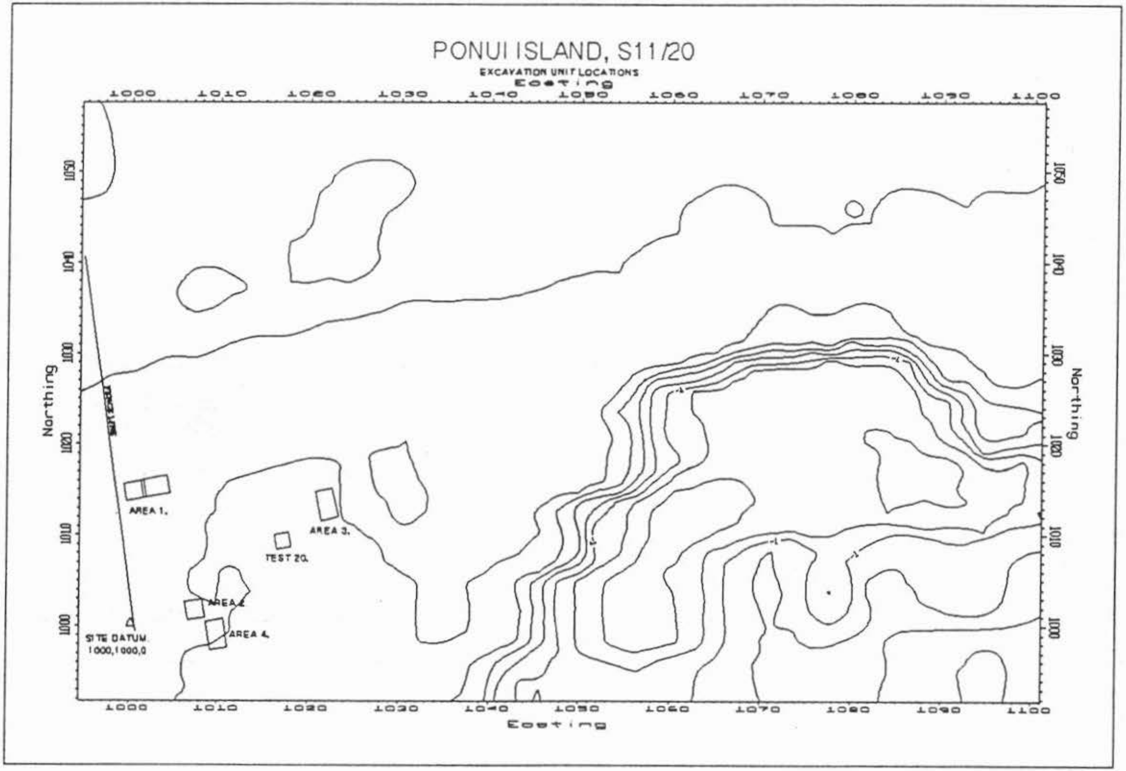

Figure 1. A topographic plan of S11/20 showing the location of the major excavation areas and the site datum. This plan was generated in the field using data obtained with the theodolite.

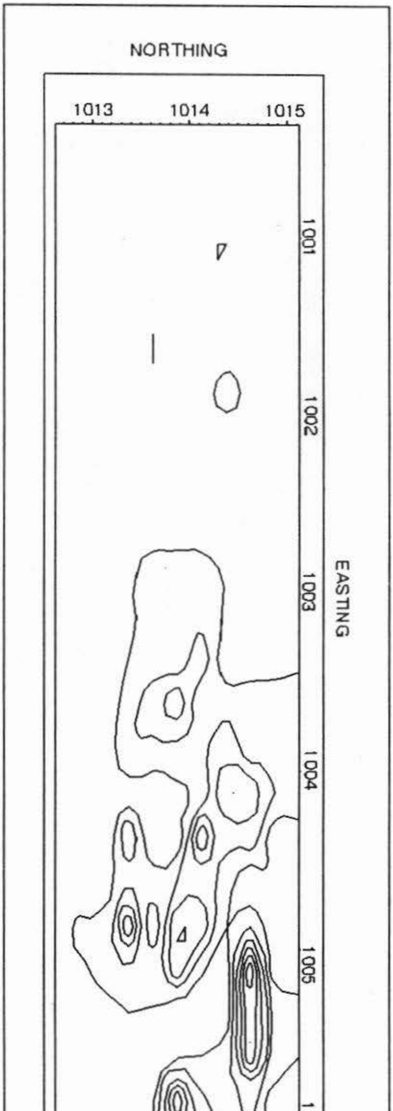

Figure 2. A density contour map of stone artefacts for excavation area 1. of S11/20 using data obtained with the theodolite.

BENEFITS AND LIMITATIONS

Some archaeologists consider that three-dimensional plotting of artefact positions is a useful exercise when the archaeological material is in situ, but that it may be rather superfluous when the material has been disturbed by post-depositional processes. Recent work has, for instance, emphasized the importance of three-dimensional placement for understanding artefact distributions in relation to house floors (Sutton 1984, Marshall and Fulton 1987), but in general such recording practices have not been followed in New Zealand until recently.

While the three-dimensional recording of artefacts and features has an important role to play in understanding intra-site spatial patterns, this type of information can also be used to help gain an understanding of the taphanomic processes that have affected a site. The refitting of artefacts whose position is accurately known can, for instance, be used to demonstrate the degree to which material has become dispersed since deposition. Similarly, accurate mapping of the dispersal of material can often reveal the existence of features. Oven stones might be expected to be displaced by ploughing, but studies overseas suggest that the spatial clustering suggestive of an oven scoop will be retained despite such seemingly destructive post-depositional processes (see Wildesen 1982). Three dimensional plotting also ensures that artefacts derived from areas of disturbance in a site can be considered separately during the analysis phase of an excavation.

Reluctance to use three-dimensional recording can often be put down to the large amount of time needed to manually plot the position of artefacts in three dimensions during excavations. This is compounded by the potential for error in manual methods. Problems with the accuracy and speed of recording are solved by the use of an electronic theodolite but new problems of cost and technical skills to operate the equipment have been added. Electronic theodolites are not cheap (currently around $25,000 each, with an additional $2000 for the data-logger), but like all electronics, prices are continuing to drop. Even at present levels they are not outside the purchasing power of University Departments and government agencies. The skills needed to operate the equipment are a combination of traditional surveying techniques and familiarity with small computers. The former has long been an aspect of archaeological training, while the latter is increasingly common among practising archaeologists in the wider academic world. The trend overseas is for electronic theodolites to become regular equipment on archaeological excavations and it seems likely that this trend will continue in New Zealand.

A regular power supply is a final consideration that is seen by some as a limitation. At Ponui, we were fortunate to have an average of five hours electric power per night provided by a generator. This was more than sufficient to charge batteries for both the theodolite and the portable computers. For more remote locations, solar panels have been used successfully overseas to charge all the batteries required for operation.

APPLICATIONS

Having three dimensional spatial information read directly into the computer at the point of excavation means graphical displays of artefact spatial patterning can be generated very rapidly. Figure 1, for instance, shows a site topographic map of S11/20 that was produced in the field using a mapping program and the data acquired with the electronic theodolite. Figure 2 represents a contour map showing stone artefact densities in Area 1 also generated in the field. Plans such as these, have the potential to be important aids in determining excavation strategy. Overseas, during the excavation of deep Paleolithic sites, computer generated plots of artefact distributions are regularly used to help with complex stratigraphy (Dibble and McPherron 1988). Given the rapid improvement in the portability and power of small computers, future excavations may have a computer on site capable of displaying three dimensional images of features, artefact positions and density, as they are excavated.

The ability to rapidly locate any point in three dimensional space means that there is no reason why excavations should be marked out as regular squares or rectangles. Because the position of any point can be measured relative to one fixed datum, virtually any shaped excavation unit can be mapped by the theodolite. The choice of unit shape can relate to the nature of the site and excavation strategy. The effective range of the theodolite artefacts is measured in hundreds of metres, so the instrument would be ideally suited for spatial control during large, area excavations. In situations where the datum point is set at a considerable distance from some excavation areas, two-way radios can provide an effective means for communication between the excavators and the theodolite operator.

CONCLUSION

The recent excavations on Ponui Island was a learning experience for some staff as well as students. They persuaded even some sceptics (except S.B.!) that electronic theodolites are an important tool for the archaeologist. The equipment can function under typical New Zealand field conditions. Although the equipment is initially expensive, the benefits of having accurate data for spatial analysis and taphanomic studies make the investment well worthwhile.

ACKNOWLEDGEMENTS

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TABLE 1.
Example of SDR Notebook output from excavations at S11/20, Ponui Island. ID refers to the unique identification number for each shot, North, East and Z are cartesian coordinates relative to the site datum, Area gives the excavation area number (Test12 refers to test pit number 12), Code gives the type of shot (artefact A, fauna O, and bucket B), while Layer gives the layer number. The first four fields are created automatically in the SDR Notebook while the last three fields are entered by the theodolite operator.

ID	NORTH	EAST	Z	AREA	CODE	LAYER
1115	1001.07	1007.36	-0.07	2.00	O	2.00
1116	1001.04	1008.49	-0.07	2.00	A	2.00
1117	1019.56	1002.72	0.07	TEST12	A	2.00
1118	1000.89	1008.53	-0.07	2.00	A	2.00
1119	1013.55	1003.588	-0.02	1.00	B	2.00