

Clonehenge: an experiment with gridded and non-gridded survey data

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This is a report of further work investigating methods of survey and of presentation of topographical data from archaeological sites. It continues on the theme of two papers given at the 1987 *Computer and Quantitative Methods in Archaeology* conference which were concerned with graphical methods of data presentation (Spicer 1988) and a series of experiments to quantify the 'quality' of surveys done on grids (Fletcher & Spicer 1988b).

The main purpose of this paper is to introduce a versatile simulated archaeological site on which the work mentioned above may be tested. It can also be the subject of many other experiments concerned with the manipulation of topographical data. Although we describe some very preliminary experiments performed on this model these are not to be considered as complete, merely a starting point for considerably more detailed work, both by us, and, we hope, by others.

A computer generated 'site' is by no means a new idea: Scollar simulated a double-ditched Roman fort as a rectangular magnetic anomaly (Scollar 1969) which was generated along with the noise and degeneration normally met with during geophysical surveying.

Our simulation is more immediately recognisable by the archaeologist, for it consists of a collection of earthworks visible (so far!) only as surface features. The site, known as 'Clonehenge', may be 'surveyed' by any means and at any resolution, since the data is produced from a function, written in C, with all the mathematics needed for the heights of an infinite number of points on the model's surface. A listing is to be published elsewhere (Fletcher & Spicer 1988a) so as to permit others to compare results using the same reference standard.

The archaeological simulation is based very broadly (and with apologies to it) on Arbor Low, in Derbyshire. Clonehenge is a class II henge, with perfectly circular ditch and bank, separated by a narrow berm. The entrances are not exactly opposing; they are

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circular in shape, allowing the banks and ditches on each side to have sloping profiles and both acute and oblique terminations (see the vertical 'pseudo aerial photograph', Fig. 20.1). Within the henge are eight 'stone holes' of differing depths, but of equal diameters, spaced in an irregular circle. Just as at the real site, a mound overlaps the bank at one place, and it too has a depression on top (signifying an early barrow-digger's work). On the other side of the site, a vertically-sided low bank approaches, but just stops short of the henge bank. Elsewhere the site reveals a vertically sided ditch, with a right-angled curved corner, and a small square 'enclosure', with raised sides of a curved cross-section. All these features lie on a gently sloping saddle-shaped surface.

The features have been chosen to emulate some of those normally known of in advance of investigation, and also those which may not be immediately perceptible on the ground, but which might be found by a careful gridded contour survey; their shapes, sizes, and angles have been carefully chosen to give variety, whilst retaining at the same time both a simplicity and an archaeological credibility to assist in subjective comparisons. It is appreciated that the palimpsest represented in the model is not altogether tenable archaeologically: the chronology of each feature is not secure (the stone-holes being as 'fresh' as the barrow-digger's depression; the 'Roman ditch' being steep-sided), but if the model is 'eroded' by means of a simple local-averaging filter (Fig. 20.3) it can quite convincingly emulate an ancient site at its present state of decay.

For the present purpose, however, we shall consider Clonehenge in its pristine condition. The smooth lit surfaces (Spicer 1988) of Figs. 20.1 and Figs. 20.2 were produced from the results of a 400×400 gridded 'survey', and Figs. 20.4 and 20.5 show the site surveyed on regular grids of 200 and 100 points square. (We normally think of the Clonehenge site as being 100 metres square, though this is, of course, a matter of subjective interpretation). One can see from these figures how certain features are modelled better with a higher survey resolution (notably the berm and the rectangular enclosure). One can note, too, how the grid itself reacts with features—in particular the edges of the main circle—producing the distorting toothed effect known as aliasing; the solution to this graphics problem is more the province of image processing, and will not be dealt with here.

To survey such a site as this in reality using 100×100 points on a carefully laid-out grid would be time-consuming, but worth the effort if certain features were revealed which could not be seen on the ground at the time of the survey. In our case, all the features of Clonehenge are shown clearly enough at one-metre grid resolution and are readily identifiable, though the berm is beginning to diminish, being visible only as an occasional interruption of the bank/ditch slope. We have chosen this particular scale and sampling density as the control for the following experiments.

With the increasing availability of EDM equipment, it no longer seems appropriate to use a regular grid, since x and y positions can be located for any point on the surface of the site. We shall therefore use Clonehenge to simulate this sort of survey method and examine ways of converting a series of 'randomly' positioned co-ordinates into the gridded data required by the graphics programs.

Clearly we would not want to survey in a truly random fashion in the mathematical sense, since clumping might be present: we would subjectively choose our data so as to come from a *uniform* distribution around the site. For the first simulation, a regular grid of the same size as before was randomly perturbed by plus or minus half a grid

<i>Feature name</i>	<i>Number of surveyed points</i>
Henge bank/ditch	1600
Stoneholes	234
Barrow	410
Square enclosure	141
'Roman' corner	200
Small radial bank	113
Straight diagonal ditch	214
TOTAL	2912

Table 20.1: Points used for each feature

unit in both x and y directions. This meant that each grid square still contained an average of one reading. It is the equivalent of a very drunken walk along a grid. Figure 6 shows the result of 10000 measurements after conversion into a regular grid using a very crude, but fast, interpolation algorithm. A much better shape is produced by a slower program which uses more data points for interpolation (Fig. 20.7), and this has been adopted for the remaining figures.

If we were to survey in a genuinely random manner across the whole area, just for comparison, using the same number of sample points as before, we would expect the results to be similar. This has been found to be the case, and it produces a final picture (not shown) almost identical to Fig. 20.7.

So far we have simply shown that we can obtain a fair approximation to our site from an irregular sampling method using the same number of points as a regular grid. A comparison of Figs. 20.7 and 20.5 reveals that all features are still visible and identifiable. The next step is to find out how our surveying effort may be reduced by taking fewer but more carefully chosen measurements.

If the uniform sampling rate is reduced, then it is evident that the smaller features would suffer first, whilst the larger features would remain clearer: this is demonstrated in Figs. 20.8 and 20.9, where the survey is performed on a perturbed grid of 50 and 30 units, representing 2500 and 900 readings respectively. Intuitively, a human surveyor on the ground, however, would want to increase the sampling rate where the rate of change of slope is greater. To simulate this, a vertical 'aerial photograph' of Clonehenge similar to Fig. 20.1 was placed on a digitising tablet and the stylus used to choose coordinates at which to survey the site. For this experiment, each individual feature of Clonehenge was given separate treatment, the output going to separate files. The features were surveyed subjectively, with emphasis given to those parts which contained sharply altering gradients. Table 20.1 shows the numbers of points used for each of the features. Figs. 20.10 and 20.11 show the intermediate results of creating surfaces from just two of these files, and Fig. 20.12 is the shape obtained from all individual files. The surface fitting algorithm used for these pictures was given a search limit of ten metres, which resulted in their ragged shape and the occasional 'hole'. When an overall 'background' survey file, of a mere 20×20 perturbed points, is added to this data, the result (Fig. 20.13) is, we think, a convincing representation of the original, standing up well to comparison with Fig. 20.5, and being almost indistinguishable from the reconstruction from 10,000 points of Fig. 20.7.

When the 400 points of the 'background' (taken at rough '5-metre intervals') are added to the total for the features, the 3312 points are only about a third of those taken with our control grid. Such clear savings on surveyor hours may well compensate for the greater expense of EDM equipment.

We must stress that the experiment shown here is by no means conclusive; so many factors are involved in deciding how much information can be gleaned from different methods of survey that this singular 'pass' cannot be regarded in isolation from a series of tests. The authors intend to continue to evaluate techniques and surveying methods and hope to report when conclusions are reached. What Clonehenge can do is to offer a comparative method of testing surface-fitting algorithms, and contribute to a global perception of sampling strategy. It is up to those who are interested in improving or optimising their surveying method to conduct their own experiments (and publish their findings), thereby contributing to a collective experimental data set. We hope we have convinced readers of the necessity of experiment and the combination of archaeologically credible subjectivity and mathematically repeatable objectivity which Clonehenge provides.

Acknowledgements

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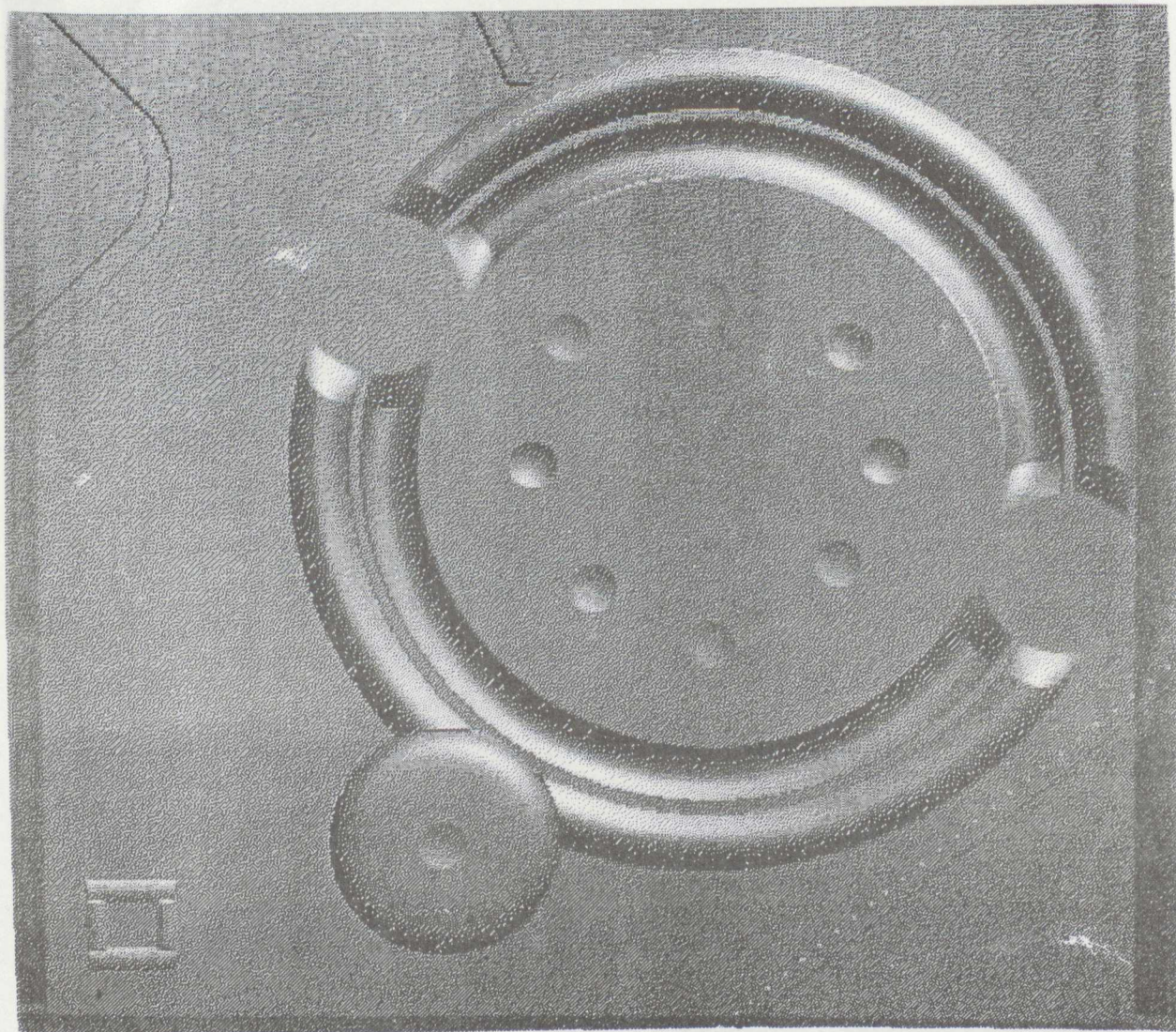


Figure 20.1: Clonehenge, vertical lit-surface view, from a grid of 400×400 readings

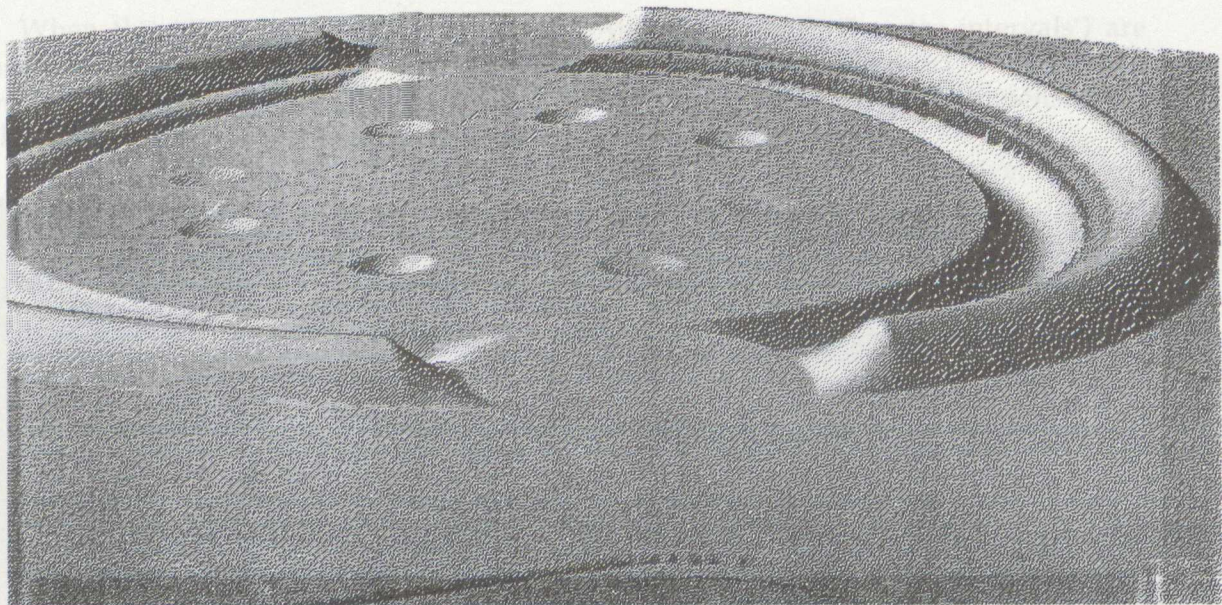


Figure 20.2: Bank and ditch profiles and terminations at one of the entrances

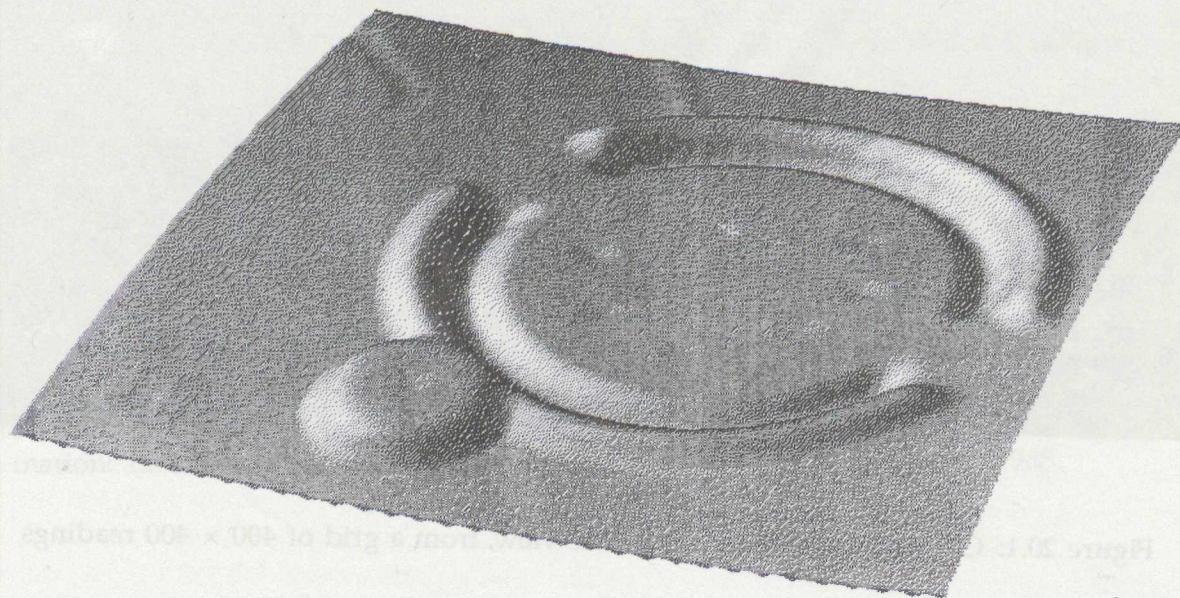


Figure 20.3: Clonehenge 'eroded' by local averaging filter: grid 100×100

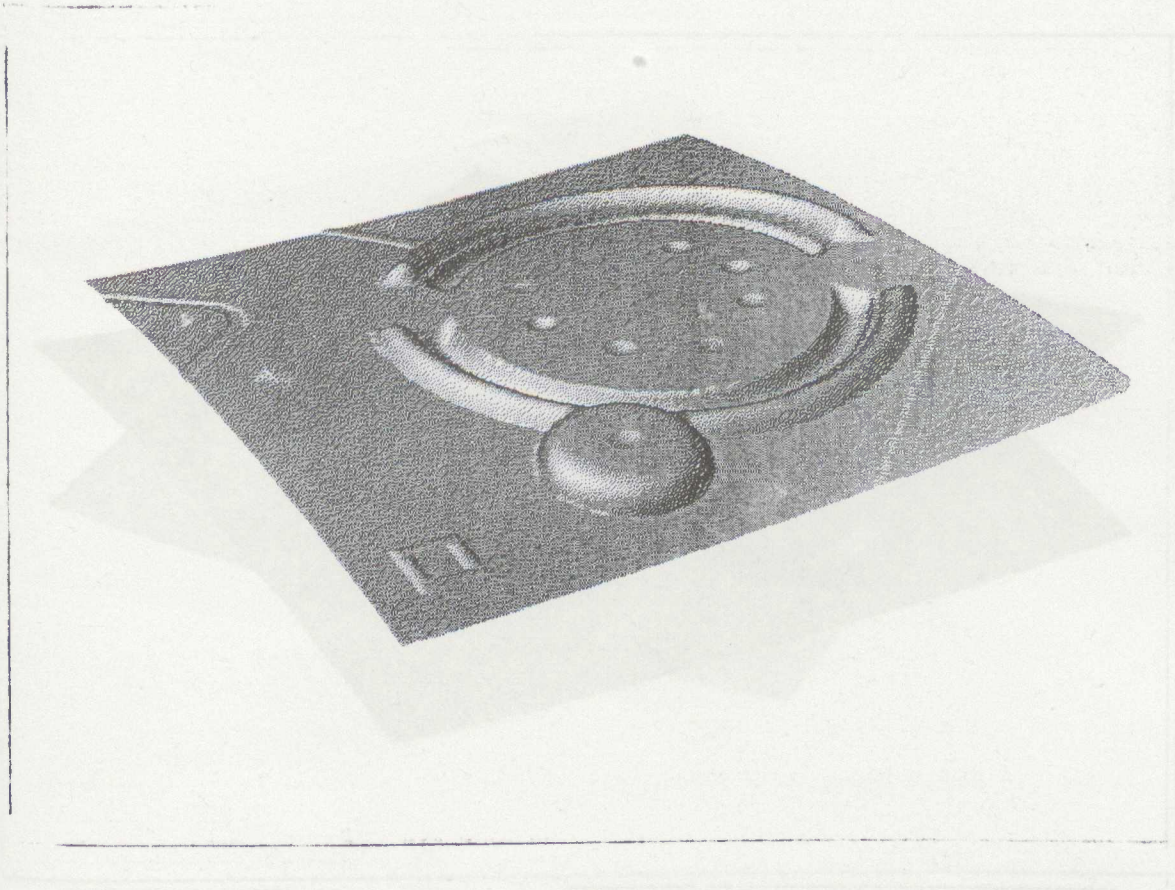


Figure 20.4: Overall view of unaltered Clonehenge, 200×200 grid

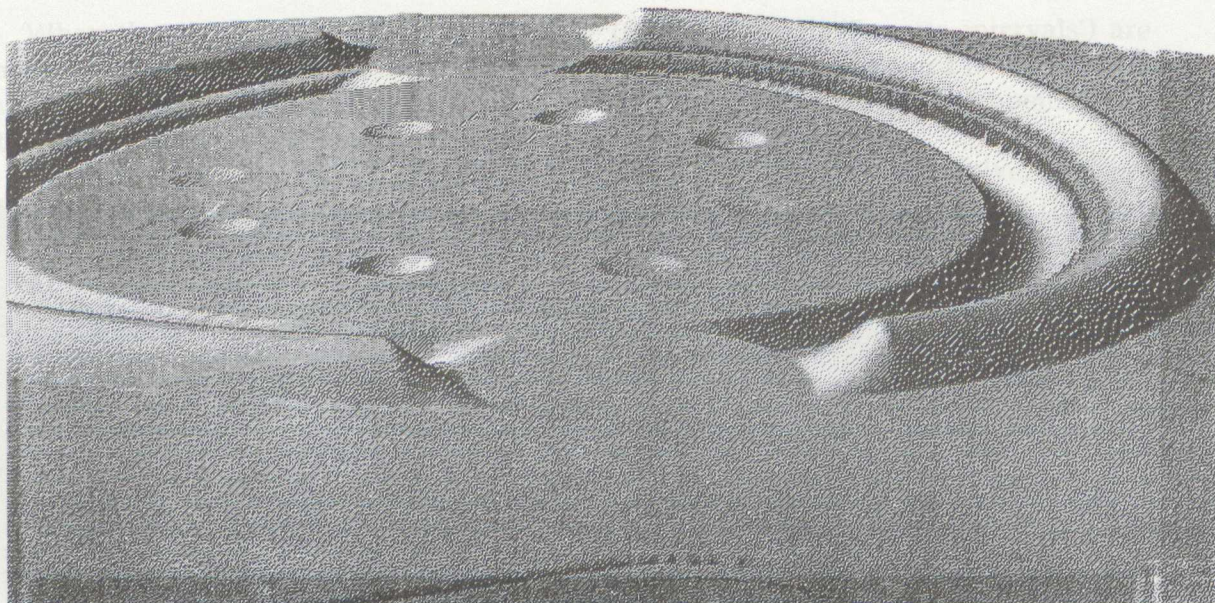


Figure 20.2: Bank and ditch profiles and terminations at one of the entrances

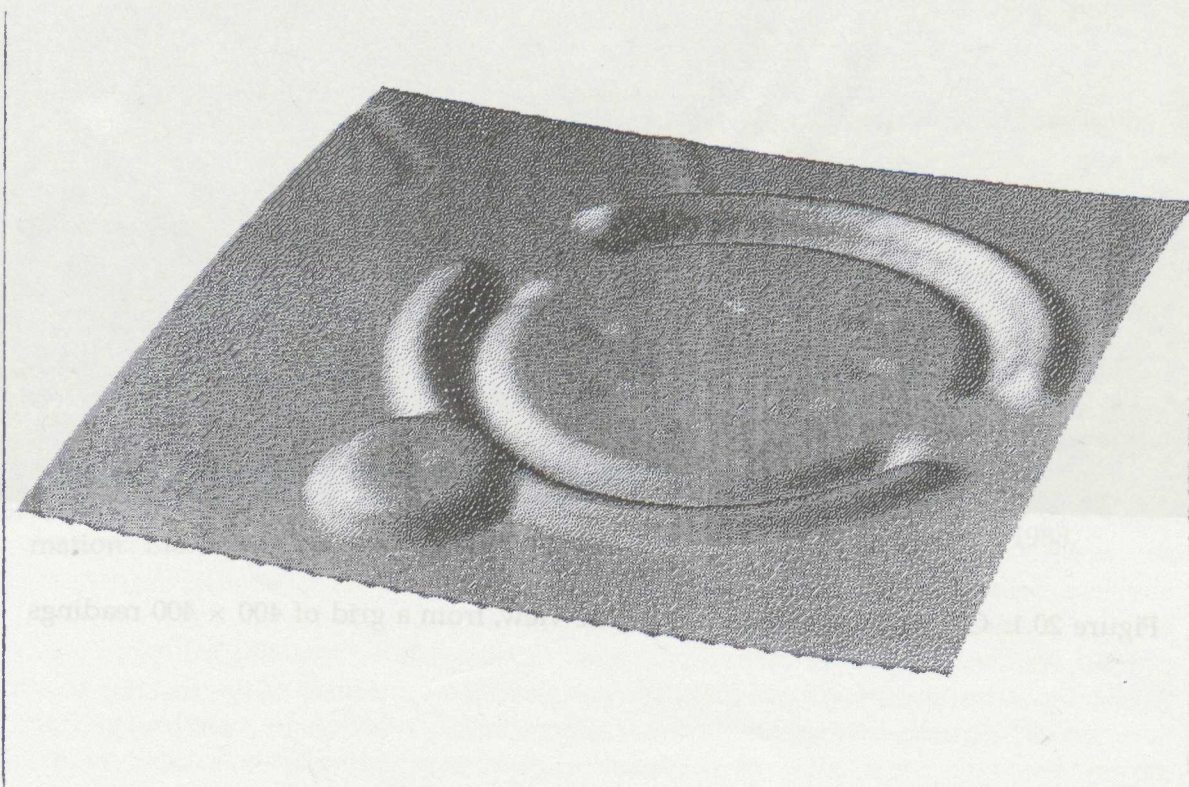


Figure 20.3: Clonehenge 'eroded' by local averaging filter: grid 100×100

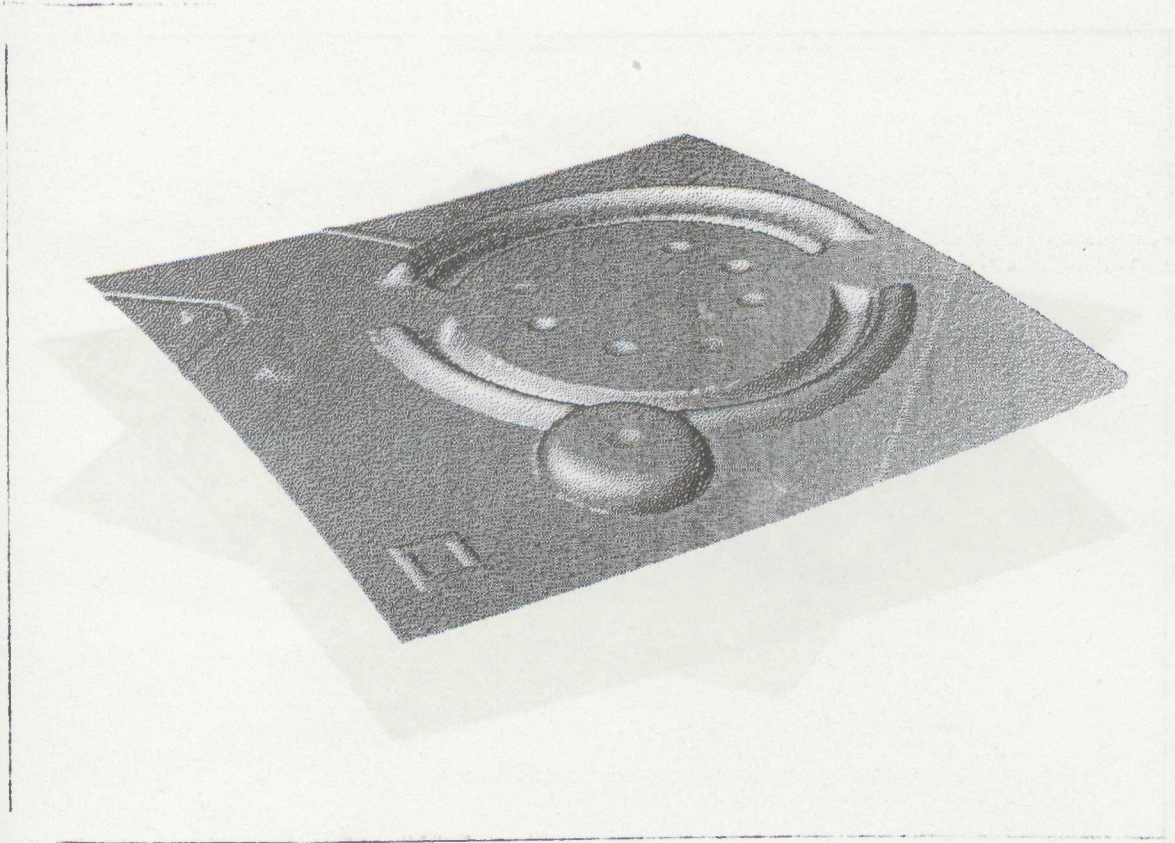


Figure 20.4: Overall view of unaltered Clonehenge, 200 × 200 grid

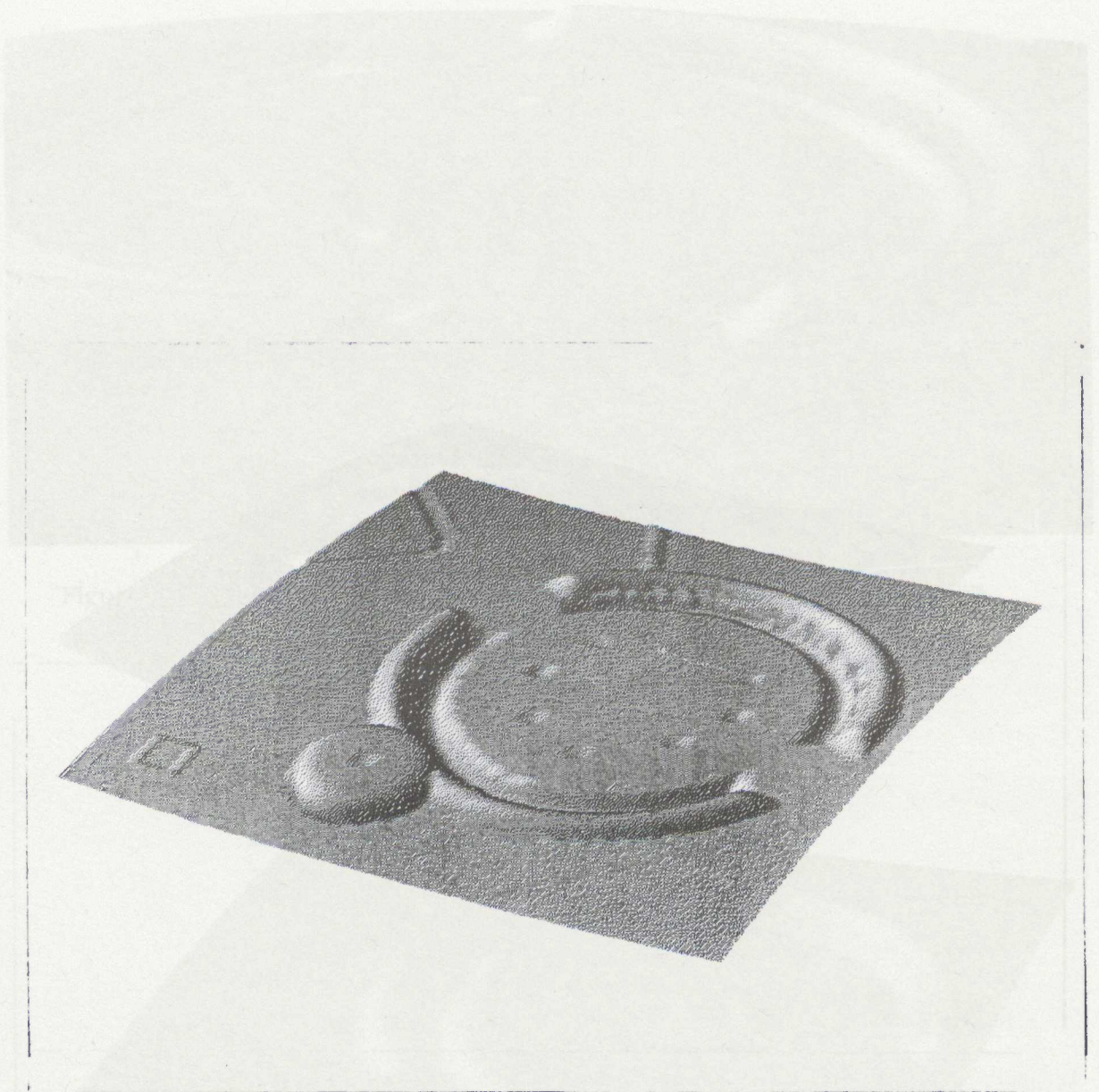


Figure 20.5: As above, 100×100 grid



Figure 20.6: 100×100 perturbed points, restored using fast interpolation.



Figure 20.7: As 6, with improved interpolation. This data (10 000 regular points) is used as the control for comparison purposes

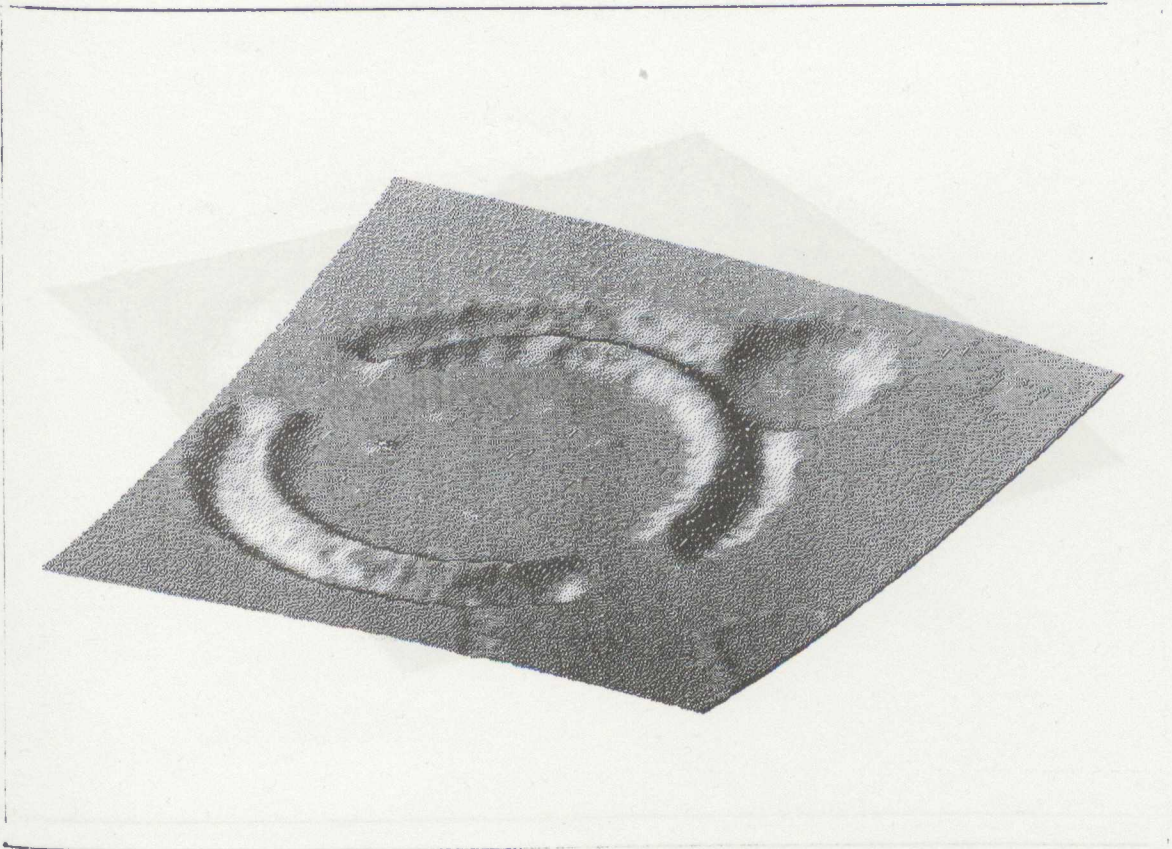


Figure 20.8: 50×50 perturbed grid (2500 points)

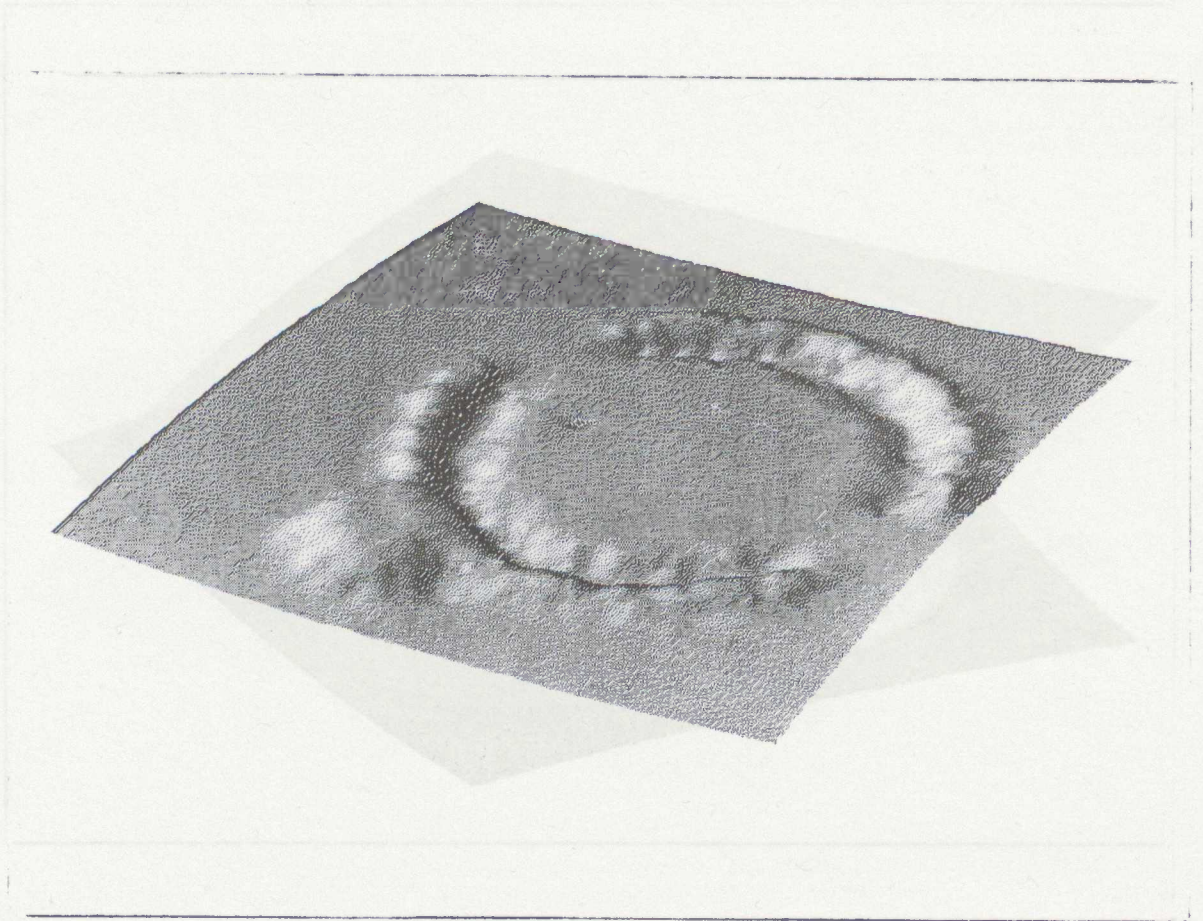


Figure 20.7: As 6, with improved interpolation. This data (10 000 regular points) is used as the control. Figure 20.9: 30×30 perturbed grid (900 points)

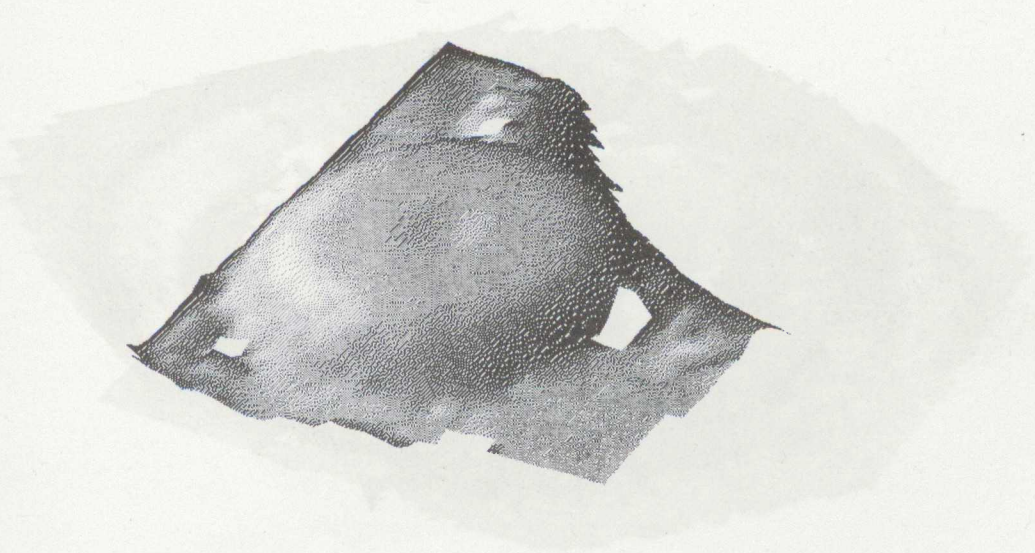


Figure 20.10: 'Barrow' alone surveyed subjectively with 410 points

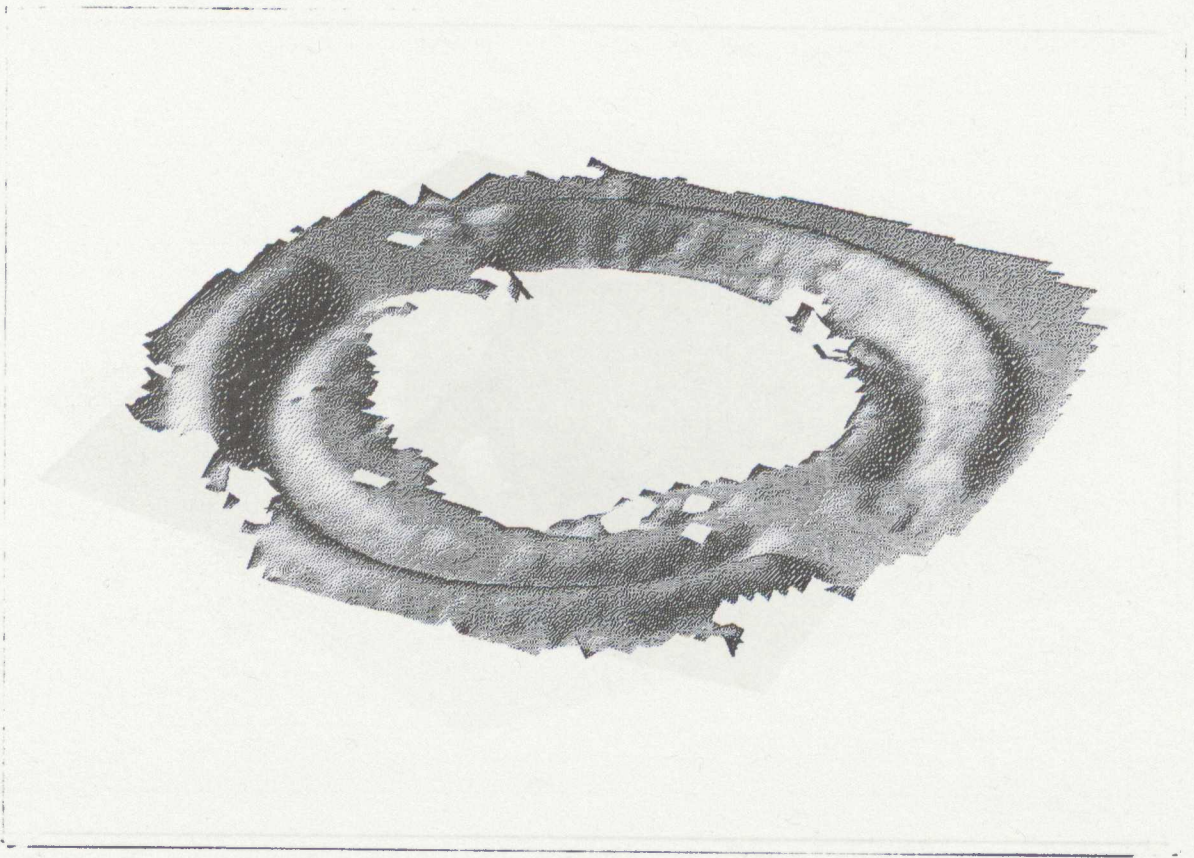


Figure 20.11: Henge 'bank and ditch' alone surveyed subjectively, 1600 points

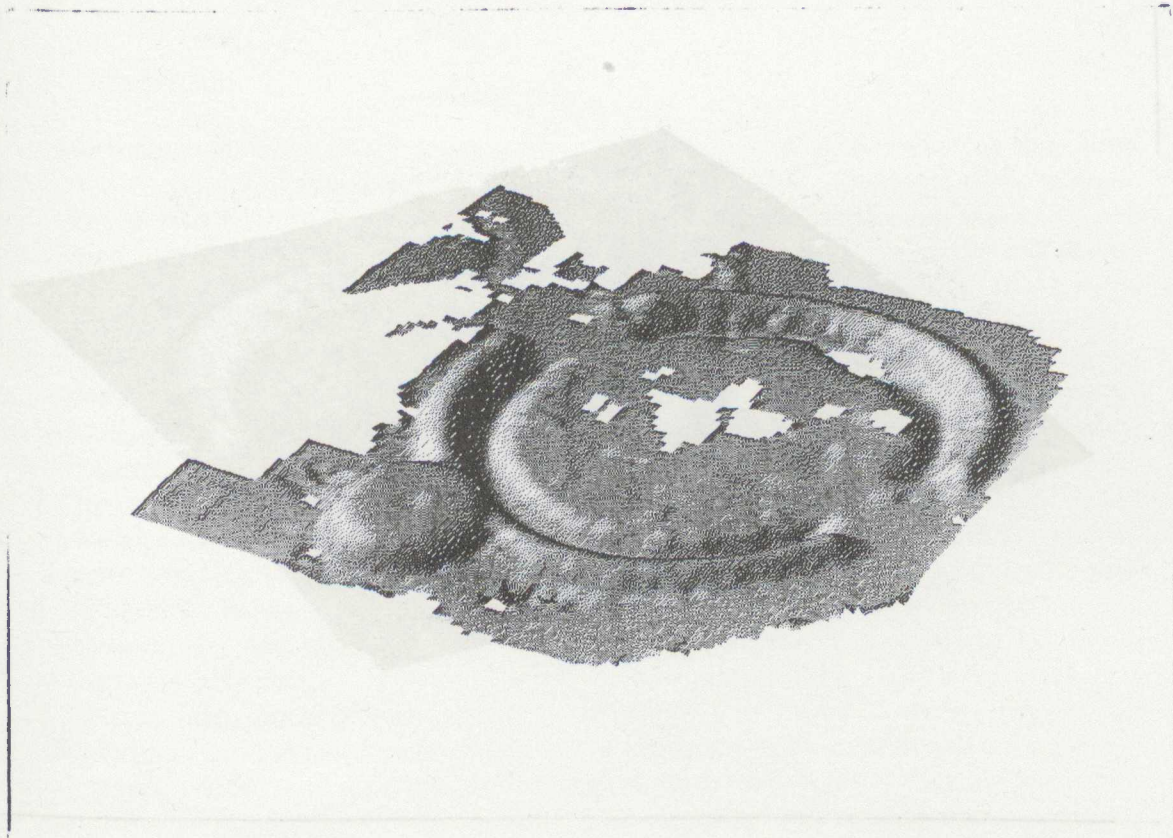


Figure 20.12: Whole site surveyed subjectively, 2912 points

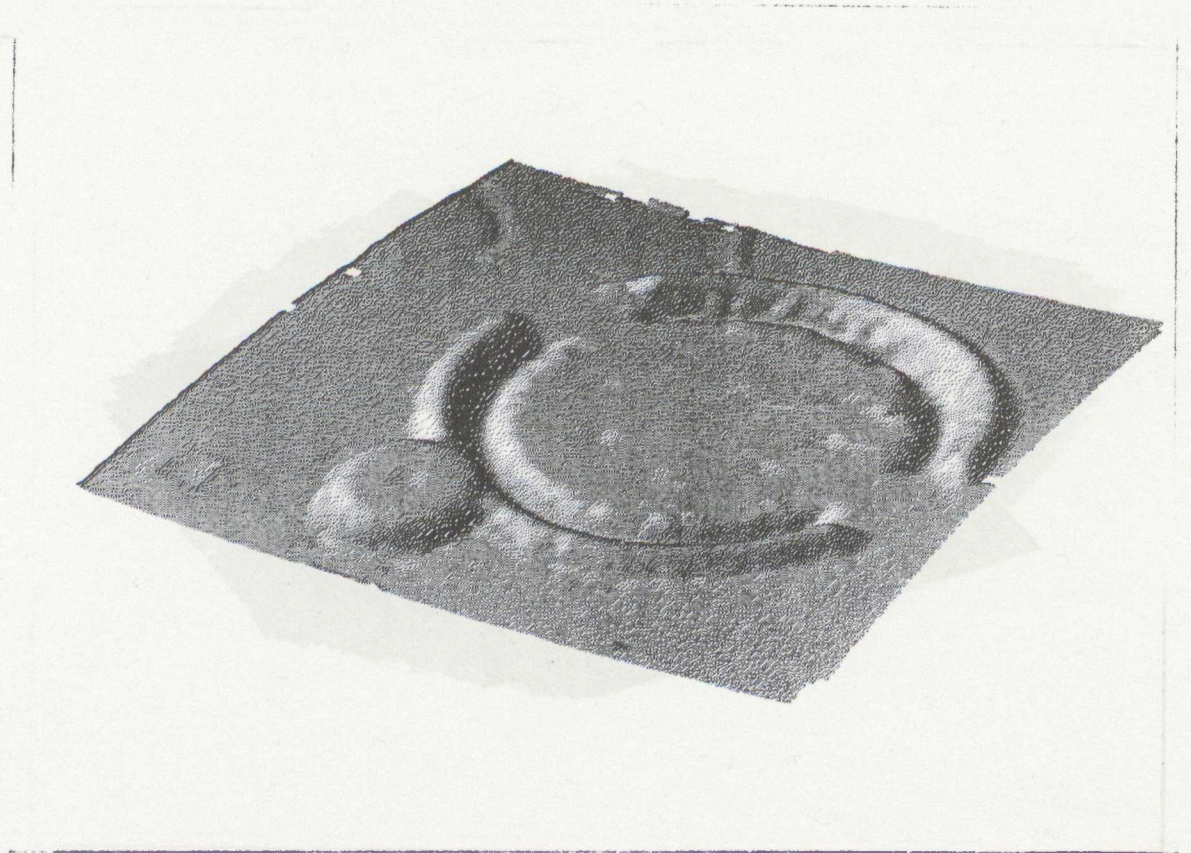


Figure 20.13: As 12, with added 'background' of 20×20 perturbed grid, total of 3312 points

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Browsing through the stratigraphic record

N. S. Ryan

21.1 Introduction

The production and use of a computerized stratigraphic record is an important element of current archaeological and pre-historic research. Although there is some doubt as to whether it is the recording and presentation of data that is important, the computerized record does have several advantages. The approach developed by (Harris et al. 1971) during the 1970s (Harris 1979). The system is usually based upon a stratigraphic list of units. The units are arranged in a sequence of units based upon the relative positions of the units in the stratigraphic record. The units are arranged in a sequence of units based upon the relative positions of the units in the stratigraphic record. The units are arranged in a sequence of units based upon the relative positions of the units in the stratigraphic record. The units are arranged in a sequence of units based upon the relative positions of the units in the stratigraphic record.

21.2 Automated computer displays

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