

An Integrated Approach to Archaeological Survey Design, Methodology and Data Management

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Abstract. A 'Common Archaeological Grid System' is proposed as a survey design template for large-scale multidisciplinary projects. This system includes a number of novel procedures to streamline the collection, processing and management of survey data. The procedure requires that all archaeological surveys be aligned to Ordnance Survey National Grid to ensure the exact correlation of all datasets and enable data-values to be more easily assigned positional co-ordinates. Data in this 'xyz' format is compatible with most graphical applications and Geographical Information Systems (GIS). The strength of the common archaeological grid system lies in its data management potential, enabling individual filenames to contain both descriptive and location information. This in turn can facilitate the archiving of survey data and enable the integration of survey data from diverse, unrelated projects in a GIS environment. The common archaeological grid system, therefore, has potential implications for the establishment of a 'National Archaeological Data Archive'.

Keywords: survey, template, grid, integrate, geophysics, filename, archive, Rathra, Ireland.

1 Introduction

Up until the recent past, excavation was widely regarded as the principal investigative technique in field research. Though of primary importance, excavation is now more commonly regarded as a single strand in a more wide-ranging multidisciplinary research strategy. As a consequence archaeological investigation is becoming increasingly reliant on the application of a variety of specialised scientific techniques from geochemical analysis and fieldwalking to topographical and geophysical surveys. A preliminary non-invasive survey strategy can often provide a more cost-effective and less destructive means of evaluating an archaeological site and can identify specific targets for a more efficient programme of strategically placed excavation cuttings. In some instances, a judicious choice of complementary survey techniques may prove to be an effective alternative to excavation.

A research strategy that facilitates the integration and analysis of all these various strands of archaeological investigation is of particular importance, especially in large-scale multidisciplinary projects. This paper proposes a novel survey design strategy as a template for an integrated approach to archaeological field research. It presents simple procedures to streamline the collection, management and processing of field data. These procedures were successfully implemented in the detailed survey of Rathra multivallate enclosure (Fenwick 1997) and will serve here as an illustrative case study. This methodology builds on the experience of large-scale multidisciplinary research projects such as the Tara Survey, Discovery Programme, and the ArchaeoGeophysical Imaging Project, NUI, Galway (Goucher 1997: 244-52; Fenwick *et al.* 1997; Waddell *et al.* forthcoming). The common archaeological grid system has subsequently been implemented in a number of other archaeological research projects, most notably

on the Hill of Tara, Co. Meath (Fenwick and Newman 2002) and at Aughris Head, Co. Sligo (Fenwick 2001: 94-9).

2 Rathra Multivallate Enclosure

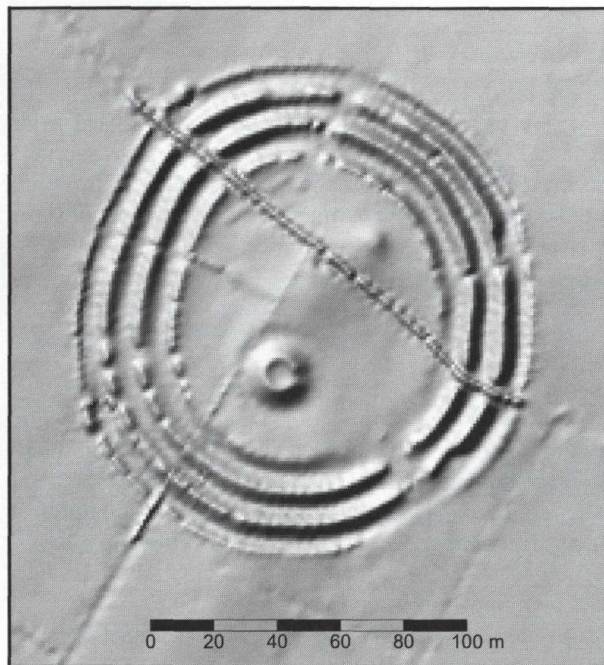


Fig. 1. Shaded relief topographical model (Surfer software) of Rathra multivallate enclosure, Co. Roscommon

Rathra, one of the largest and most spectacular archaeological earthworks in the province of Connaught, is also one of the most unusual and enigmatic (Fig. 1). Prior to this study, the monument had received only cursory archaeological attention (Knox 1911: 218-20; Timoney 1990: 13-6; Herity 1991: 40, pl.8). It is situated ap-

proximately 5km east of the town of Castlerea in the barony of Castlerea, Co. Roscommon, lying on the southwestern slopes of Mewlaghadooey Hill, straddling the Southpark Demesne/Rathbarna townland boundary.

The monument is sub-circular in plan with maximum external dimensions of 147m east-west by 161m north-south. It slopes east to west from the 120m to the 111m contours reflecting the natural incline of the hillside. The multiple rampart, averaging 32m in width, is composed of three massive banks and fosses circumscribed by a smaller counter-scarp bank. The original entrance is a simple causewayed gap through the rampart in the southeastern quadrant. The internal space contains a number of topographical features including two large earthen mounds and field subdivisions.

The archaeological field survey strategy implemented at Rathra was based on a threefold hierarchical division of research.

1. A detailed survey of the monument.
2. A study of the monument in its local context.
3. An examination of the monument in its wider regional context (10km diameter).

This case study outlined below confines itself to just a sample of the detailed survey of the monument but the procedures illustrated here can be applied to any systematic survey technique and is equally applicable to large-scale regional archaeological surveys.

3 Survey Grid Systems

The role of a site grid has long been recognised as an essential component of archaeological field research. A site grid, for example, is the simplest way to provide a location reference for features and artifacts discovered during the course of an excavation.

3.1 Alphanumeric Grid

In some instances, before the common use of computers for archaeological applications, an alphanumeric grid was adopted as a site or excavation grid, with numbers assigned to one axis and letters of the alphabet to the other (Fig. 2). This system, however, has limitations as the position of a feature or artifact could only be assigned to a certain square on the grid rather than defined with pin-point accuracy.

Numeric co-ordinates, however, are necessary to define a specific point with greater precision. Cartesian co-ordinates, containing numeric x, y and z axis values, are necessary to define a precise point in three-dimensional space and are essential for mapping and graphical computer applications. From the outset, therefore, it is strongly advised that a simple numeric survey grid be adopted for all archaeological surveys, including excavation.

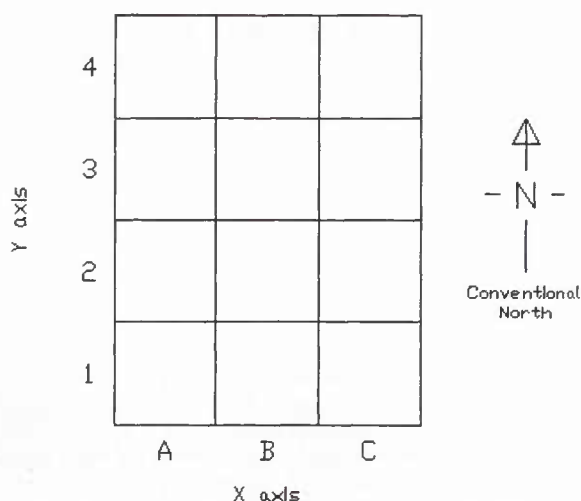


Fig. 2. Alphanumeric Grid

3.2 Arbitrary or 'Floating' Grid

An arbitrary grid co-ordinate system may be considered adequate in the context of a small-scale survey or excavation. These grids are often referred to as 'floating' as the co-ordinates are not tied to a recognised mapping co-ordinate system such as Ordnance Survey National Grid. In this instance it is wise to choose a conventional North (based, for instance, on a compass bearing of Magnetic North) and a numerically positive co-ordinate system in metres (Fig. 3). Assigning one of the survey pegs arbitrary Cartesian co-ordinates of say (1000, 2000, 100) will ensure that even if the survey area should extend west or south for several hundred meters, the site co-ordinate values will always remain positive. It is also a useful policy to assign the co-ordinate marking the position of this 'primary' peg with different numeric values for each of its x, y and z axes (as a measure to avoid accidentally confusing axes during fieldwork or data processing).

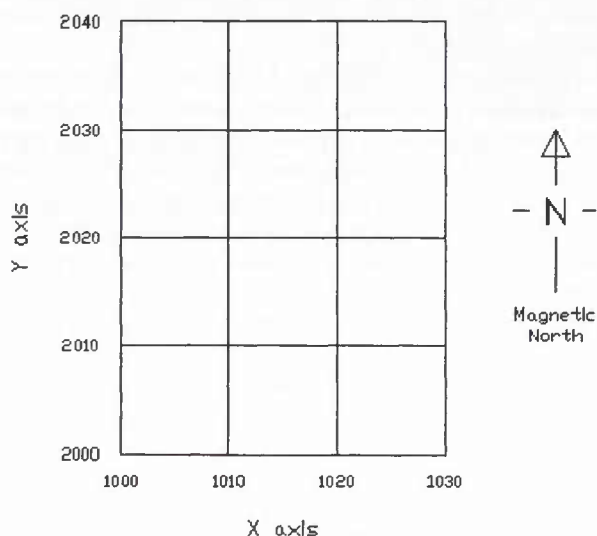


Fig. 3. Arbitrary or 'floating' grid

It is preferable, indeed common sense, to use the same grid as the basis for all archaeological field research (topographical survey, geophysical survey, excavation, etc.) rather than attempt to establish different, independent, grids for each subsequent survey. This simple procedure greatly facilitates the correlation of various 'layers' of spatially related survey data.

3.3 Adoption of a Pre-existing Grid

In the case of archaeological fieldwork in advance of, for example road or pipeline construction, it may be prudent to adopt the engineer's survey grid in order to facilitate the correlation of engineering and archaeological datasets. This will ensure that any data, maps or plans supplied by the engineer to the archaeologist, or *vice versa*, can be integrated into the overall survey without requiring the translation and rotating of survey data to its correct position and orientation.

3.4 Ordnance Survey National Grid

On large-scale multidisciplinary archaeological projects – where individual sites or monuments may be dispersed over a wide area or where research will be ongoing over a number of years – the adoption of Ordnance Survey National Grid as the archaeological grid has clear advantages. Though there is nothing new in using National Grid for the purpose of integrating and correlating various disparate archaeological datasets over a large area, the notion of a 'common archaeological grid system' is based on a simple variation of this concept.

4 Common Archaeological Grid System

In the case of Rathra, a strategy that integrated the topographical and various geophysical surveys as a single unit was considered at an early stage of the project design. It was decided, therefore, to use Irish National Grid as the basis for the site grid and the entire study area – a 10km diameter circle centred on Rathra. A Global Positioning System (GPS) in differential mode (in this case a Magellan Model CPZ) proved to be the most cost-effective and rapid method of establishing National Grid on site. The topographical survey of Rathra (using a Sokkia Set5E total station and SDR33 electronic field notebook) could therefore be tied to the Irish National Grid and height above Ordnance Datum with an acceptable degree of precision.

The geophysical survey grid was also set out, with the aid of a total station. A feature of geophysical area-surveying is its use of a grid of squares or 'panels' as a framework for data collection. These panels are typically 10m x 10m, 20m x 20m or 10m x 20m in area. Within each panel measurements are taken at regularly spaced station intervals, typically between 0.25m and 1m apart along a series of parallel transects, usually running north-south and typically 0.5m, 1m or 2m apart (Clark 1990: 158-63; David 1995: 4).

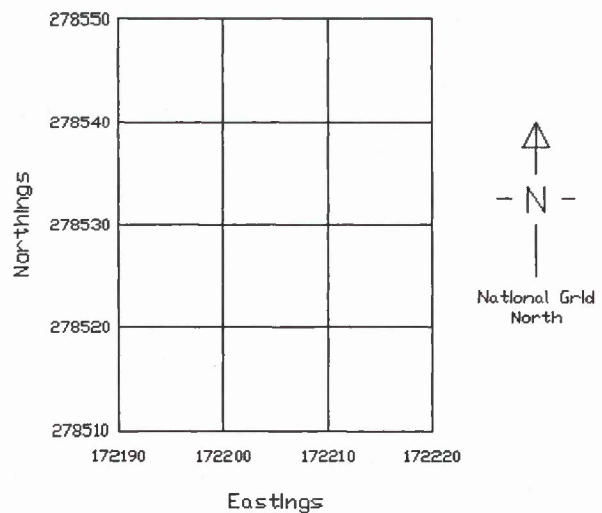


Fig. 4. A 'common archaeological grid system'

In the case of Rathra, these survey panels were deliberately aligned to the Irish National Grid axes with the corner co-ordinates of each panel synchronizing precisely with 10m multiples of Irish National Grid (Figs 4 and 5). This methodology greatly simplifies the collection and correlation of the various survey datasets and, in turn, simplifies data processing, editing and management procedures. It is the basis of the 'Common Archaeological Grid System' and can be easily implemented for any number of independent systematic survey techniques.

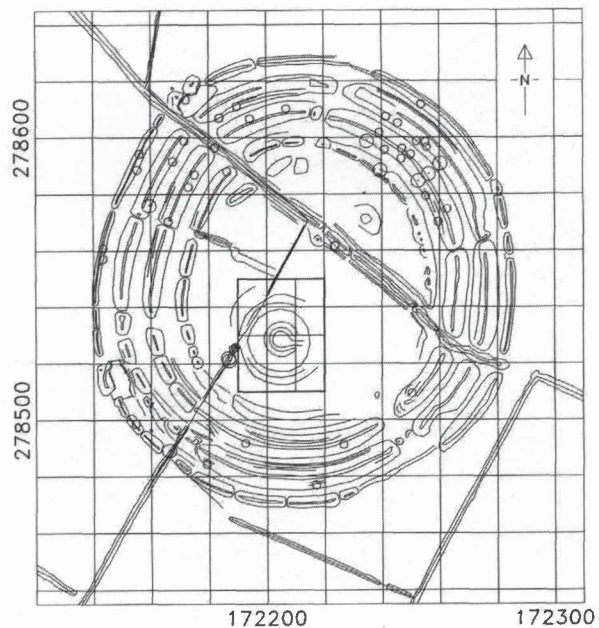


Fig. 5. AutoCAD line map of Rathra with a grid of 20m x 20m panels aligned to Irish National Grid superimposed over the monument and a grid of 10m x 10m over the larger internal mound (case study)

As the site grid is already aligned to Irish National Grid, only minimal editing procedures are required in order to

assign Irish National Grid co-ordinates to each individual survey value. The resulting datasets can, therefore, be readily converted to xyz format, compatible with, and easily imported into, many computer-based mapping and graphical packages including GIS.

4.1 Topographical Survey

Unlike geophysical data, topographical survey data are generally composed of multiple spot-heights, randomly distributed over the ground surface. The topographical survey of the larger internal mound at Rathra, was conducted using a total station from a series of strategically placed survey stations, whose positional co-ordinates were already tied to Irish National Grid (Fig. 6). There was no need in this instance, therefore, to convert the resulting survey data to National Grid. The resulting xyz survey data is similar to that displayed in Table 1.

Table 1. A typical example of topographical survey data in xyz, tab-delimited, format (O.D. = Ordnance Datum)

Easting (x)	Northing (y)	Height O.D. (z)
172198.221	278524.397	115.124
172212.862	278529.108	116.194
172203.101	278540.872	118.772
172193.887	278533.119	117.551
172197.561	278534.261	116.223

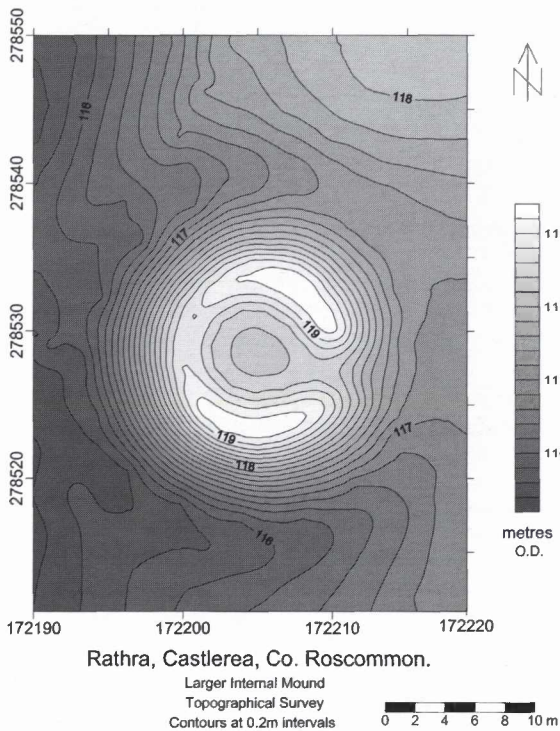


Fig. 6. A topographical contour map (0.2m contours) of the larger internal mound at Rathra (Surfer software)

4.2 Magnetic Susceptibility Survey

Measurements of magnetic susceptibility (Using a Bartington MS2 and MS2D fieldloop) were taken at 1m intervals along parallel transects set 1m apart within survey panels measuring 20m x 20m (Fig. 7). In this instance, data was collected in zigzag format (proceeding northwards up one traverse line and southwards down the next) as a string of values without positional co-ordinates. As the corner co-ordinates of each panel are a 10m multiple of Irish National Grid this becomes a much-simplified procedure. The x values for every measurement along each traverse line will remain the same while those of the y axis will increase, or decrease, incrementally as one ascends, or descends, the survey panel (Table 2). This procedure was initially done manually, using a spreadsheet, but a simple program was later written (by Mr Kevin Barton) to do this task automatically.

Table 2. A typical example of magnetic susceptibility survey data (employing the common archaeological grid system) in xyz, tab delimited, format

Easting (x)	Northing (y)	SI units (z)
172190	278510	1
172190	278511	0
172190	278512	4
172190	278513	2
172190	278514	9

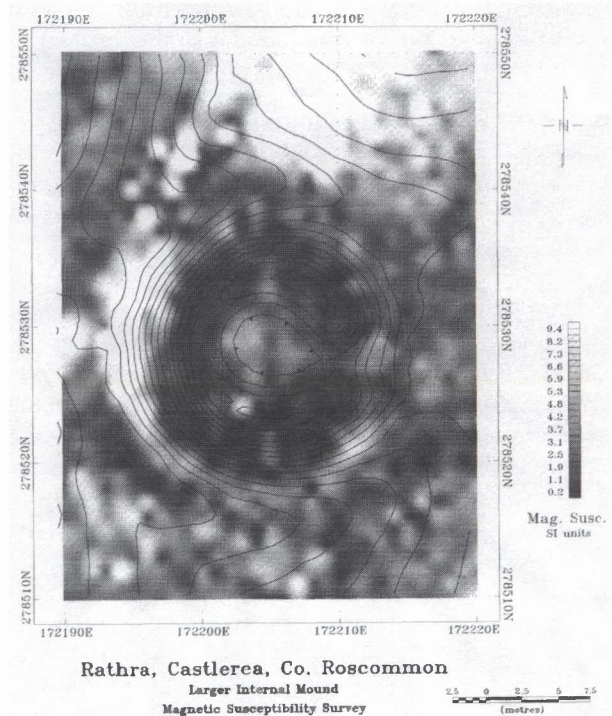


Fig. 7. A grey-scale magnetic susceptibility image of the larger mound within Rathra with an overlay of topographical contours at 0.25m intervals (Geosoft software)

4.3 Fluxgate Gradiometry Survey

Measurements of magnetic gradient (using a Geoscan FM36 fluxgate gradiometer) were taken at 0.5m intervals along north-south parallel transects set 0.5m apart within survey panels measuring 10m x 10m. Data were collected in parallel format (starting, in each case, at the southern end of the traverse line and proceeding northwards). Again, data were collected as a string of values independent of positional co-ordinates. Like that of the magnetic susceptibility data, these can be easily converted to Irish National Grid once the corner co-ordinates of the grid panel are known (Fig. 9). The resulting data in Irish National Grid xyz format is similar to that illustrated in Table 3.

Table 3. A typical example of fluxgate gradiometry survey data (employing the common archaeological grid system) in xyz, tab delimited, format

Easting (x)	Northing (y)	nT/0.5m (z)
172190	278510	3.1
172190	278510.5	5.5
172190	278511	1.3
172190	278511.5	-3.9
172190	278512	-0.4

4.4 Electrical Resistance Survey

Measurements of electrical resistance were taken at 0.5m intervals along north-south parallel transects set 0.5m apart within survey panels measuring 10m x 10m (Fig. 9). Data were collected in zigzag format progressing along transect lines from west to east. The survey was conducted using a Campus Geopulse resistivity meter and prototype Square-4 array. Data were captured on a laptop computer in the field and the proprietary software enabled the south-western corner co-ordinates of each panel, along with the panel dimensions, station interval, traverse separation interval, and mode of data collection (zigzag or parallel) to be input prior to commencing the survey. It was possible, therefore, to assign National Grid co-ordinates automatically to each individual value of electrical resistance as the survey progressed. The resulting survey data is similar to that illustrated in Table 4.

Table 4. A typical example of electrical resistance survey data (employing the common archaeological grid system) in xyz, tab delimited, format

Easting (x)	Northing (y)	Ohms (z)
172190	278510	37
172190	278510.5	44
172190	278511	61
172190	278511.5	128
172190	278512	49

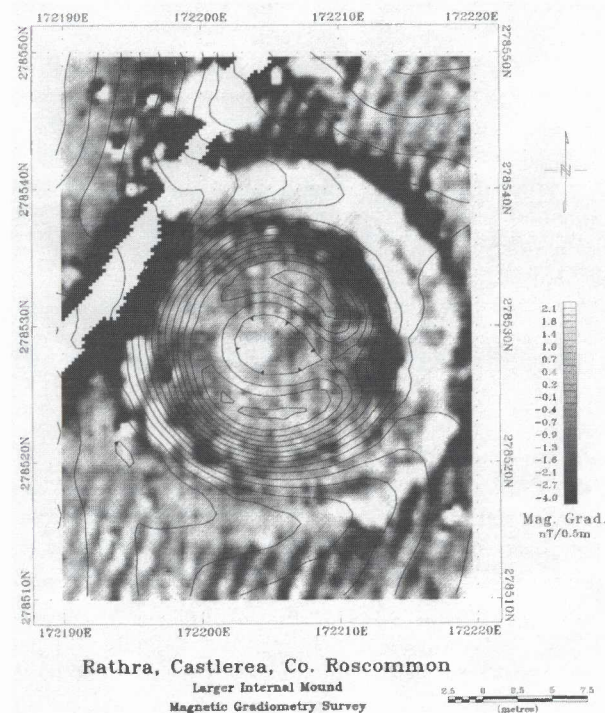


Fig. 8. A grey-scale magnetic gradiometry image of the larger internal mound at Rathra with an overlay of topographical contours at 0.25m intervals (Geosoft software)

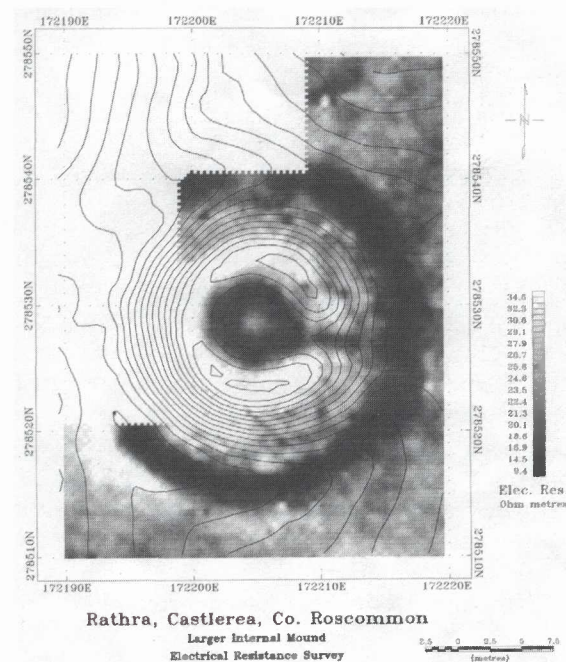


Fig. 9. A grey-scale electrical resistance image of the larger internal mound at Rathra with an overlay of topographical contours at 0.25m intervals (Geosoft Software)

5 Computer File Naming Conventions

The adoption of a systematic and logical computer file naming convention is essential for efficient data management, particularly as a large volume of data can be generated even in relatively small multidisciplinary archaeological surveys. The use of a common archaeological grid system can facilitate data management by providing a means to label individual computer files with a more meaningful filename that contains both descriptive and location information. A number of simple filename conventions were used for the collection and management of the Rathra survey data.

At the time, the various survey data for Rathra were processed on a PC using the, now redundant, DOS operating system. All filenames were limited to a maximum of eight characters followed by a filename extension of three characters. The filename extension usually describes the format in which the data is stored. The filename extension '.raw', for example, was assigned to unprocessed or unedited data-files. Similarly, a filename extension '.xyz' refers to data that contains co-ordinate information (often processed or edited '.raw' files).

As the filename was limited to just eight characters it was important that it contained as much descriptive information as possible, in a condensed form, in order to allow the archaeological monument and the survey type to be identified at a glance. Additionally, it should contain information to enable the data to be located in its correct position in the overall survey. The shorthand file naming convention devised for the Rathra survey fulfils all of these criteria.

The first two characters were assigned to identify the archaeological monument or survey area and the third used to identify the survey technique employed. The shorthand codes used in the case of Rathra are as follows.

The first two characters used in the filename.

- rr** Rathra multivallate enclosure (SMR No. 27:12)
- rf** A ringfort located 60m to the northwest of Rathra (SMR No. 27:11).

The third characters used in the filename.

- t** Topography (Total Station)
- s** Magnetic Susceptibility
- g** Magnetic Gradiometry
- r** Electrical Resistance (Square-4 array)

The next four characters of the filename are assigned to locate the data in the overall survey without necessarily requiring the file to be opened to examine the data itself. The intermediary step of a location plan to identify the position of individual geophysical area-survey panels is also unnecessary if a common archaeological grid system is adopted.

As the corners of individual geophysical panels are aligned precisely to 10m multiples of Irish National Grid, the position of each individual panel can be as-

signed 'shorthand' co-ordinates for its southwestern corner. In this instance the third and second last digits of the Irish National Grid Easting (x) and Northing (y) co-ordinates (representing hundreds and tens of metres respectively) suffice for locational purposes. The Irish National Grid co-ordinate 172190E, 278510N, for example, can be condensed to 1951. This procedure, in effect, identifies the unique Easting and Northing co-ordinates of the southwestern corner of any 10m x 10m panel lying in an area measuring 990m x 990m. Provided the limits of the geophysical survey area (for any individual monument or survey area) do not exceed 1km on either of the two axes (Eastings and Northings), the possibility of duplicate filenames will not arise.

By following the system of conventions outlined above it is possible, for example, to distil all the necessary survey details of a panel of magnetic gradiometry (mg) undertaken at Rathra (rr), with National Grid south-western corner co-ordinates of 172190E, 278510N (1951) in edited xyz format (.xyz), to the simple filename 'rrg1951.xyz'.

The eight and final letter of the filename can be used for sundry purposes – for example to identify data files that have been edited (e) or rotated (r). If, for instance, the data in the file above were subsequently edited the filename would become 'rrg1951e.xyz'.

Current computer operating systems make provision for longer filenames that effectively overcome the file naming restrictions of DOS. This allows a greater flexibility when devising filename conventions and, of course, enables more scope for descriptive detail to be contained within it. Using a filename convention like that outlined above, it is possible for software to be written that will 'read' individual filenames and automatically assign National Grid co-ordinates to the data contained within (pers. com. Steve Bullas). Perhaps this process may be taken into account in the design of geophysical software packages in the future.

6 National Archaeological Data Archive

The adoption of 'Common Archaeological Grid System' as a universal standard provides the scope for pooling all digital data from various independent archaeological projects, on a national scale, into a single, centralised 'National Archaeological Data Archive'. A GIS is the ideal environment for such an archive and would provide a platform from which to access, update and augment information. It is infinitely more flexible than traditional 'hard-copy' archives and would have enormous research and interpretational potential for archaeological research. Furthermore, this archive could actively encourage and facilitate future re-examination of 'stored' survey data through the application of more sophisticated data-processing procedures that have yet to be developed or, indeed, imagined.

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I would like to dedicate this article to the memory of Péigi Dooley, an enthusiastic archaeologist with a zest for life, which was all too short.

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