proceeded, the problems of recording at various stages, etc. As a hint or *aide-mémoire*, and one which produces moving images and thus gives a more rounded picture of the three-dimensional context in which work took place, video clearly has a potential role. However, if it is to be more than just a useful adjunct to the traditional excavation record, its application has to take place in a more structured way. To become part of the basic record of individual stratigraphic units which allows comparison between features in later analysis, the timing of shots, direction of view, etc. need careful consideration and consistent implementation. None the less, the wider availability of increasingly cheap equipment, and increasingly sophisticated computer storage of visual information, suggest that photography will have a continuing, and probably growing, importance in the site record.

8

THE SPATIAL RECORD

Introduction

All stratigraphic units have a spatial dimension, which can only be recorded in its entirety after a unit has become completely visible, and before any of it has been removed. Recording its position must therefore await its being defined as the uppermost element of the sequence but precede the start of excavation. Such spatial information can, of course, be gathered by purely informal methods, for example by the use of textual description ('The pit is about 2m across and lies 5m north of the building'). This approach may be adequate for initial survey work but greater accuracy is normally required in formal excavation and so a drawn element usually accompanies any written record.

In creating the drawn record, the usual practice is to start by setting up a grid system covering the site to which all drawings can be related. It is also necessary to decide at this initial stage on the techniques and equipment required, the latter being chosen with an eye to the future storage in archive (both issues discussed previously). The conventions to be adopted in the drawn record must then be decided (see **8.1** below). Next there must be an agreed policy on which elements to record in plan and which in section, and to what degree(s) of accuracy. Various types of approaches to planning can be suggested ('single context', 'phase' and 'daily' plans – **8.2**), and a variety of methods for producing such drawings can be used (triangulation, offsets or drawing frames – **8.3**), each with advantages and disadvantages in terms of speed and accuracy. Similarly, there are various types of sections and elevations (the recording of baulks at the limit of excavation, cumulative/running sections, and those laid out to solve particular stratigraphic problems or across intrusive or standing features to elucidate their character – **8.4**) and a variety of techniques can be used to prepare such surfaces for section drawing (**8.5**). Finally, as well as drawing complete stratigraphic units, particular circumstances may require recording the spatial position of individual finds within such units (**8.6**). Only when all these issues have been thought through will it be possible for the site worker, with the right equipment to hand and sufficient expertise in the hand, to complete any drawing.

Apart from knowing the conventions and having the right pencil and paper, there is another prerequisite for successful drawing on site – namely to have decided beforehand the limits of what you want to record. Only then can one ensure proper differentiation within, and between, drawings (Ford 1993). Some time ago a child, when asked how she approached her drawings, is reported as replying 'First I have a think, then I draw a line around my think.' This, to me, grasps the essence of producing technical drawings on site – they should be representations of decisions already made, not part of an evolving, individual thought process. Hence spatial aspects of the stratigraphy must be conveyed accurately, and in a way which is consistent with the activities of the other workers on site. The illustrator is concerned with graphics skills, not artistic inspiration.

8.1 Techniques, equipment and drawing conventions

In the near future, technical advances will reduce the amount of time taken up by planning. Spending many hours bent double over a drawing frame, plumb bob in one frozen hand and crayons in the other, will be a thing of the past. It will be replaced by the digitising of the periphery of a unit using a giant electronic pencil which transfers information directly to a computer in the site hut, storing only those points needed to produce an edge of unit to the requisite degree of accuracy dictated by the research design. Photographic techniques, most obviously digital cameras, will then be used to record the surface of the deposit without losing any nuances of detail (Stančič 1989) and the resulting image will be translated into pixels and draped by computer over the digitised periphery of the unit on screen when required by the archaeologist. Similarly, the position of each find will be recorded electronically and downloaded automatically (Plate 24). For the present, however, it's back to the drawing board.

It is not intended to discuss here the specific techniques required for archaeological illustration. Fortunately, it is easy to turn to far more accomplished illustrators in the field for advice. For example, the experience of Hope-Taylor (1966) is still relevant three decades later, even if the materials, especially the soft pencils which he recommends, have become outmoded (the use of plastic film – 'permatrace' – is *de rigueur* on most sites today). Barker's discussion (1977: 150ff) of the manual techniques involved is also very useful, together with his comments on the different proprietary brands of crayons which are available. Finally, Adkins and Adkins (1989: chapter 3) provide the most convenient, general discussion of the expertise required.

Similarly, the types of equipment, especially in relation to the long-term preservation of the record, are discussed in detail elsewhere. Adkins and Adkins (1989: chapter 2) look at mundane materials such as pencils and paper, plus some more technical equipment, and provide lists of suppliers. Arnold and Gersbach (1995) note the existence of a new machine for field drawing, the Kartomat, which has the advantage of not needing a power source. Finally, Kenworthy *et al.* (1985) give good general background on the horror stories that have arisen when archiving of the drawings which result is not properly

Plate 24 The use of an EDM to record the co-ordinates of individual finds, with data then downloaded directly onto computer. Here communication with the pole holder in the distance requires the use of walkie-talkie radio, held by an assistant to the right of the surveyor.

planned, and provide appropriate solutions. Other aspects such as the machine readable archive will no doubt be superseded as computer hardware and software are developed, though the principles which underpin their use will stay the same.

There remains the issue of the conventions to be used in drawing. Whether one employs a specialist architect for all site drawing (Dinsmoor 1977) or, as I would prefer, uses most site staff for producing the basic record but greater expertise for reconstruction and publication work, every site plan will have to incorporate a certain amount of standard information. Thus each should carry the appropriate site code; a plan number which either is allocated according to a running sequence or, for single-context plans, is the same as that of the stratigraphic unit drawn on it; a north sign and reference to the site grid which allows the plan to be related accurately to all other drawings; a place for the drawer to sign and the checker to counter-sign; and a space to add any relevant notes giving extra information, such as colour codes peculiar to that drawing. The use of pre-printed permatrace sheets is now widespread, ensuring that the appropriately sized boxes exist on each drawing to promote the completion of all this information. Such sheets also guarantee drawings of a consistent size, thus easing storage at a later stage. Finally, all drawings will have to be done to an appropriate scale, designated beforehand on the basis of the degree of accuracy demanded by the research design, with that chosen scale recorded on the illustration.

In addition to these common requirements, every site planner will have to adopt conventions for the edges of each unit and its surface details. When using plans to compare the extent of successive stratigraphic units in post-excavation analysis, two types of information concerning their edges are essential. First, the drawing must clearly show which edges represent the extent of a unit as it would have been when it was laid down, and which are arbitrary, constituting a limit where it was cut away by an intrusion or continued beyond the excavation: only edges of the first sort make statements about the 'real' boundaries of the unit, the others being evidence for what happened to it later. Hence if two adjacent floor make-ups have a common, real northern limit, this may be an indication that they abutted a wall line on that side. However, if their surviving edges coincide simply because both were truncated at this point by a later, linear intrusion, their corresponding edges need have no such implication.

Second, as mentioned previously, not all edges of a unit can be established with complete certainty and it is essential to record the *degree* of indeterminacy, as well as the fact of indeterminacy, on the drawing to aid the analyst using the spatial information later on. These uncertain limits should not be simply left open on the drawing. Even where they cannot be exactly determined, the edges may not vary wildly. Conventions to illustrate this degree of uncertainty are fairly straightforward. The most useful has proved to be a zig-zag symbol, whose width varies according to how uncertain the edge is.

Many excavations also record the distribution and type of inclusions incorporated into a unit, whether in its surface when drawing a plan, or in elevation in section. The level of detail required (i.e. the minimum size of inclusion to be drawn) will have to be designated in advance, bearing in mind the research objectives. Thus, if the distribution and size of cobbles in a road metalling is seen as essential to understanding the development of street topography, all such surface detail will have to be plotted accurately during the planning process. Equally, it will be important to relate any decisions on the size of inclusion to be included to the scale being used on the plan – remember that a sherd 2cm across at a scale of 1:20 is represented by a 1mm diameter dot. If surface inclusions down to this size are to be recorded usefully, more accurate, larger-scale drawings will be required.

A key to inclusion types will also have to be determined. Written abbreviations, noted adjacent to the detail on the plan, might be used when few inclusions are to be represented ('ch = charcoal, st = stone'). However, this method can become cumbersome on complex drawings and colour codes are now more common. By selecting a crayon close to the colour of the inclusion in the real world (black for charcoal, red or orange for ceramic tile, etc.), one can commit the conventions more easily to memory, removing the need to refer continuously to a correlation chart. However, when buying new crayons to colour in surface inclusions, always remember to reorder the same make: each company seems to produce slightly different shades and, if one is not careful, the orange convention for brick adopted at the start of the project begins to merge gradually with the red convention for tile over time, as office staff obey orders from their bosses to buy materials from whoever is the cheapest or most convenient supplier of the moment.

8.2 Types of plan

Drawings produced by hand are still the most common way to record the horizontal dimensions of a stratigraphic unit and here three types of plan can be distinguished – multi-context single-level plans, multi-context phase plans and single-context plans (Figure 9). Each has its advantages and drawbacks, the choice depending in particular on the depth and complexity of the stratigraphic sequence being recorded and its degree of integrity.

A **single-level ('top') plan** is a drawing of the extant stratigraphy, done at a designated point in the excavation process. Such drawings are the only form of planning recommended by some, a particular form being the 'daily trench plan'. Thus Joukowsky stipulates that 'all architectural features and objects must be plotted and recorded intelligibly on the daily plan' (1980: 214). Even if drawings are not produced on a daily basis, the method is still the norm on many excavations, and not just on sites with limited stratigraphy (Hammer 1992).

However, when dealing with complex sites, the problems of such a system become manifest. It is seen to be unsound in theory, and likely to produce incomplete records in practice. Concerning the former issue, any excavation aims to distinguish entities which relate to events which really happened in the past. Thus we record an area of clay as a distinct stratigraphic unit because it is believed to have once been a floor, a line of stones because it seems to have been a wall foundation, etc. However, the various units shown on a single-level plan, though they are viewed by the excavator on the site together at one time, do not purport to refer to a real, existing point in the historical development of the site. Indeed, they may be known to be of very different periods, even at the point at which the plan is being drawn.

For example, in the illustrated case (Figure 9), it is fairly clear, even at this stage, that the walls and floors at the base of the drawing are later than the two lines of post holes towards its centre. Equally the layer which overlies the corner of the wall on the bottom right, together with the pit which cuts into the metallings flanking it at the top right, obviously belongs to a later period(s). In sum, the only thing which the various units recorded on this top plan have in common, whether it was drawn at the end of a day, a week or an excavation

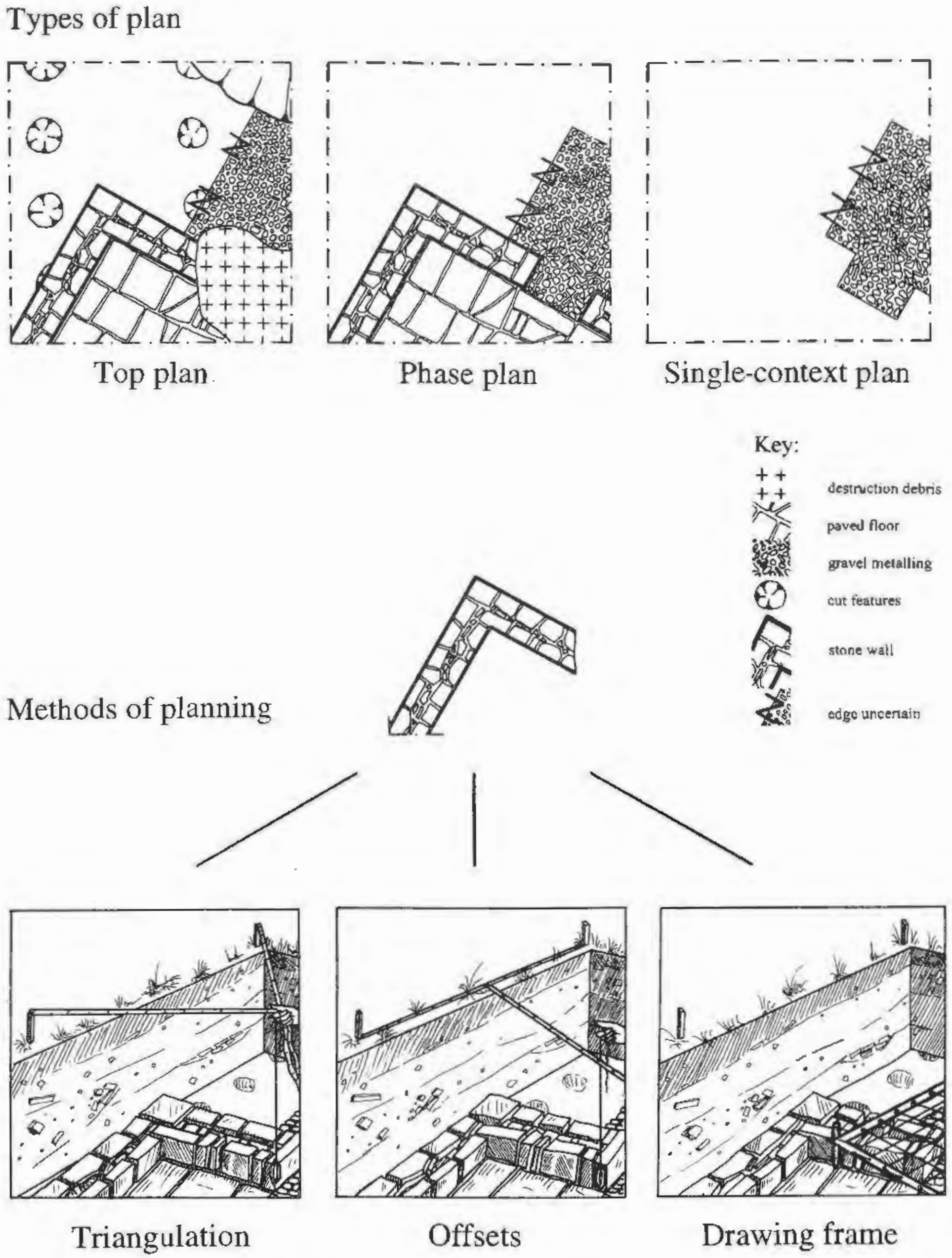


Figure 9 Examples of different plan types and planning methods.

season, is that archaeologists happen to have exposed them at a single time. Thus the top plan method essentially records the process of excavation, the progress of the work, rather than the past reality which we, as field-workers, are trying to approach. This makes its production philosophically unsound.

Furthermore, there are practical problems. If the site includes superimposed stratigraphic units, then it is impossible for the full extent of each unit to be recorded on such multi-context plans. In the illustration, the probable doorway in the wall line is covered by a later layer. As a partial solution, the excavator might use dotted lines to show such sealed edges. However, doing so already represents a move away from the concept of drawing a single level and, because of the superimposition of units, such a plan is unlikely to record all of the surface detail of every unit: *lacunae* are likely to be embodied in the spatial record (Alvey and Moffett 1986).

A second approach, which gets round at least some of these problems, is to use **phase plans**, i.e. multi-context drawings of extant stratigraphy, created at a stage where the horizon exposed across the whole site is considered to belong to a single point in time in its development. Planning by phase is believed in some quarters to have 'long gone out of fashion' (Adkins and Adkins 1989: 77) but such plans are, in fact, still in widespread use within the field profession, at least in Britain (Hammer 1992). This is partly due to the influence of particular projects utilising the method, for example work in the 1970s in Winchester which trained a whole generation of field-workers and had a formative influence on stratigraphic practices in particular. Unlike the arbitrary 'top plan', this procedure at least has the merit of being based on a decision about an archaeological entity, the phase, which is purported to have actually existed in the past.

However, there are problems with the method and it has to be used with caution. For one thing, it suffers from some of the problems concerning incompleteness which were noted with the top plan: sealed, or partially sealed, units may be not recorded in their entirety, or may even be missed out altogether. A more fundamental difficulty concerns the status of the decision on phasing which forms the basis of the drawing. In one sense, of course, any decision taken on site to do a drawing is an interpretative act, as discussed above (the young girl's 'line around the think' mentioned previously). Thus the statement during an excavation that 'This is a single deposit of clay, and therefore will be treated as a single stratigraphic unit, rather than part of a larger clay unit or subdivided into several different sorts of clay' clearly embodies an element of interpretation. Yet the *level* and *type* of interpretation involved in this case are qualitatively different from those needed to justify the drawing of a phase plan: 'This clay layer, and those three underlying but partially exposed layers, fit with these two walls and the seven parallel post holes to form a building, flanked by those gravel metallings and their associated occupation layers and ditches.' The phase plan, then, embodies a different order of interpretation (though not necessarily a more risky one) than a basic decision on the extent of individual units. If this higher interpretation turns out to be wrong, then so is the plan. The latter is not, therefore, a record of primary data from the site.

Furthermore, the underlying stratigraphy which gives rise to that surface configuration is not fully visible at the point in time at which one decides to draw a phase plan. Still less is the stratigraphy fully understood, not least because firm information from finds on dating and site function will not be known for some time. Yet knowledge of sealed deposits and other specialist information are both required before phasing can be securely established. So, if this planning policy is applied across the board, the basic spatial record produced in the field, in the form of a multi-layer drawing, will represent what can only be *preliminary suggestions* on site phasing. Its content may, and on a site of any complexity will, change as a result of later analysis post-excavation.

These problems with planning multiple layers on a single drawing have led to a third approach, the use of **single-context plans.** These are particularly prevalent on deeply stratified sites containing stratigraphy truncated to different levels, where the identification of phases across the whole excavation area at one time can be impossible. The *rationale* for the single-context plan is straightforward. The process of excavation involves splitting a site into its component parts and recording each unit in its own right. The record of the physical attributes of each unit defined in this way can be stored by writing on a single, preprinted sheet. So, in the same way, its spatial attributes should be given their individual sheet – the single-context plan.

Unlike the single-level, multi-context 'daily' plan, this system ensures that the surface of every unit is recorded in its entirety and, unlike the phase plan, it does not require that decisions on correlations between stratigraphic units become embodied in the basic record. It also lends itself more easily to efficient work organisation, with each recorder responsible for all aspects of the recording process as applied to a particular unit. This avoids the hold-ups which occur when one excavator defines the extent of a deposit, then waits for the specialist planner to produce a plan of the area, before returning to describe and dig the layer in question. Finally, single-context plans can be stored more easily, whether as hard copy or as digitised points in a computer.

However, there is a price to pay for these advantages. Some maintain that, with single-context drawings, 'planning errors are likely to occur' (Adkins and Adkins 1989: 76). I see no evidence of this, especially when a system of overlays is then used to calculate stratigraphic relationships (see Chapter 9). More convincing, perhaps, is the claim that the standard of drawing falls when the site is split into these unconnected units. It is true that some of the most accomplished site drawings in Britain, particularly coloured plans with a highly detailed record of surface inclusions, have come from sites recorded using phase plans, not individual-context plans: the archives from the Roman town

at Wroxeter and the Lower Brooks Street sites in Winchester contain some of the most impressive examples. However, even these archives have their 'failures', in terms of graphics standards, so planning by phase is no guarantee of success. Also single-context planning has meant that a lot more plan information is being recorded than previously. Any fall in standards is more likely to be due to the increased workload and to its being spread around to less experienced, and thus less accomplished, planners. This is an argument for more training, not against the single-context method *per se*.

One thing that cannot be denied is that recording a site in this way makes each unit seem to float free of any of its associates and the main result of this is to place much greater emphasis on deciding phasing at the post-excavation, analysis stage, rather than on site. This has important implications for the procedures used at this later stage, one of the issues taken up in the final chapter. Whether the analytical work is made more difficult, easier, or simply different, is open to discussion.

8.3 Techniques of measurement

Various drawing methods can be employed to produce a plan, of which the mechanical methods of triangulation, offsets and using drawing frames are the most common (Figure 9). **Triangulation** uses tapes attached to two grid points (or three if one requires extra accuracy) to measure successive points around the periphery of the unit. The mechanics of taking the measurements involve holding the two tapes between thumb and forefinger and hanging a plumb bob in the angle between them. Then, standing to one side, it is possible to let one or other tape slide gradually through the grip while keeping both tapes taut and moving slowly backwards until the plumb bob lies vertically above the point to be measured, then reading off each distance. For accuracy, it is important to maintain an approximate right-angle between the tapes. If this becomes too sharp or too shallow, it will be necessary to move the zero point of one of the tapes to a new, known base point.

The points on the periphery of the layer are thus recorded as being a certain distance from each triangulation point and their exact position can then be plotted with a beam compass or, if necessary, a scale rule. Plotting can be done either at the end of a measuring session or by a second party as the person reading off the actual measurements moves to the next point. The latter is preferable, as points plotted off-site at a later stage tend to produce plans which look like 'join-the-dots' drawings, whereas someone plotting on site can look directly at the edge being represented and reproduce accurately the intricacies of its twists and turns between each measured point, either by eye or with occasional use of a hand tape.

A second method is to measure by **offsets** from a base line, each point therefore being recorded as so far along, and so far out from, that line. Once again this technique is best used with one person drawing and another measuring. The former individual is positioned beside the base line opposite the point to be measured, the latter directly above that point holding the zero end of a hand tape. When the hand tape lies perpendicular to the base line, the distances along and out from that line can be recorded. However, if necessary, the same result can be achieved by a single person, using a plum bob and a hand tape set at right-angles to a base tape as illustrated, noting the two measurements and then plotting the point out. Accuracy can only be ensured if the hand tape is exactly perpendicular to the base line. Fortunately the human eye can be extremely exact in judging right-angles but, if there is uncertainty, you can check by using the hand tape to describe an arc above the base line. When this reaches a minimum reading, the two tapes are perpendicular to one another. However, given the potential inaccuracies in the method, it is best not to offset over a greater distance than 2m. Setting out a series of parallel base lines at 4m intervals solves any problems.

Both of the above methods are effective for measuring the periphery of a unit, but can be cumbersome for recording surface detail. As this has become an increasingly important requirement of the drawn record, fieldwork has involved the greater use of **drawing frames.** These are relatively easy to make (Adkins and Adkins 1982) and comprise a wooden or, preferable since lighter, a metal frame which is strung with twine at set intervals. The interval chosen should match the scale adopted for planning. Thus, if drawing at 1:20, it is best to place the string at 0.20m intervals, each grid square formed by the string in the frame then corresponding to a 10mm square on the paper. By standing vertically above the frame, using a plumb bob if it has to be set far from the surface being drawn, the planner can then record the edge of the unit and most of its surface detail by eye. The size of frame used depends on the irregularity of the ground, greater irregularity requiring smaller frames. However, frames 1m by 1m cover most situations. Whatever its size, positioning the frame can be problematical. For accuracy, it has to be level and positioned as near to the ground as possible. A spirit level can be used to check the former, but the undulating character of many sites means that one corner may be much higher than another, and so the frame has to be supported precariously on bricks, pins, etc. Adjustable legs are an inexpensive way to ensure accuracy and stability.

Whichever method is used to create a plan, the drawing will have to record inclusions and undulations which form the surface details of any unit. The former may involve not only colour-coded different types of find, as discussed above, but also the delineation of areas of wear or increased compaction, some of which may be patterned and thus reveal important information about former occupation. The vertical dimension of the spatial record can be represented either by a combination of spot heights and hachures, which record breaks in slope on the surface, or by contours. Contour lines can be very

effective but are time consuming to produce, although this will change if the data are held in computer, when the survey might be produced at the push of a button. For the present, spot heights remain the commonest method to record the vertical dimension on a plan. Their number and position depends on the degree of irregularity of the surface being recorded. Thus an exactly level unit covering the whole site (admittedly an unlikely event) requires a single spot height, whilst a small deposit with many peaks and troughs will need many readings, carefully positioned on its maxima and minima. Setting a rule requiring the taking of measurements every 0.20m, in the guise of being 'more scientific', is therefore misguided.

The taking of levels on site at these designated points used to be the reserve of the specialist site surveyor, using a separate 'levels book' with its own numbering system. This brought few advantages, merely cluttering up the plan with a mass of large, inconvenient numbers and the need to search for the elusive book, which was always being used by someone else on another part of the site when you most required it to hand. In fact reading and reducing levels is easily done by all site staff, requiring neither the special surveyor nor his special book. The best method is for the planner to mark spot height positions on the drawing and number them in a running sequence specific to that unit. When the set up of the levelling instrument has been checked, and a backsight and its associated bench mark recorded, the staff is then placed on the appropriate points whilst a colleague reads off the level and records the result on the unit description sheet. These readings can then be reduced to give the absolute level and the result transferred to the plan, the place where they will be needed in future analysis. The advantage of reducing the readings immediately is that any 'impossible' levels, usually the result of either reading the staff inaccurately or sloppy mathematics, can be corrected before any evidence is removed from the ground. This becomes particularly important if using a calculator to reduce readings, when it is also becomes even more vital to make a lasting record of the backsight and its bench mark. When employing manual methods, leave the calculation visible on the recording sheet, so that a rogue level appearing at a later stage can be investigated and, perhaps, corrected.

8.4 Types of section

Sections and elevations have long been employed to record the vertical dimension of stratigraphic units in various situations. They may provide an all-embracing record in controlled conditions, as with the trench edge drawn with great care and accuracy at the end of a long open-area project. Alternatively, the record may be rather more fragmented, though no less accurate, as with a detailed drawing of the thin, 0.25m wide strips of strata made visible by omitting some boards from the shuttering which supports the trench edge. At the other extreme, section drawings may be much less accurate, the result of work undertaken on the top lip of a hole which it is too dangerous to enter in a salvage operation, where sketches of the sides of the hole and a tape hung down to get approximate depths may be all that is possible. Even an outline idea of the level of natural strata and the character and the depth of stratigraphic accumulation on top can be a vital part of deposit mapping at the site evaluation stage. So the archaeological section has a role to play in a great variety of recording situations.

Whatever the mechanics of its production in the field, the use of sections in the controlled conditions of full-blown excavation can be rationalised into three broad areas. They can be used to record the stratigraphic sequence, along the lines promoted by Wheeler and taken up by many others since his time. Second, they can give information on the internal configuration of a particular deposit, for example to throw light on formation and transformation processes within the silting in a ditch, or on the relationship between units, for instance by recording the character of the interface between successive layers. Finally, sections can be used to solve specific stratigraphic problems on the site, for example the relationship between two inter-cutting pits, or between a trench-built wall and adjacent strata. Different types of section are necessary for these different roles. None the less, as I will argue below, better methods than the section exist today to record the stratigraphic sequence. Thus, I believe, sections are best employed in the last two cases, to elucidate deposit formation and for problem-solving.

The types of section which are available to the field-worker can be divided between that drawn from the trench sides or baulks at a specific time, usually the end of the excavation; that produced cumulatively along a predetermined line across the site in which the whole sequence is recorded eventually but never seen in its entirety at any one time; and that imposed on the site to resolve specific issues and removed once these have been sorted out.

The **section drawing of the baulks** exposed at the edge of a trench was seen by Wheeler and his followers as the fundamental record of the stratigraphic development of the site. Just as plans drawn in each box gave information on spatial configuration within it, section drawings of the sides recorded sequential development. When the intervening baulks between boxes were removed at the end of the excavation, the spatial record could be completed. Thus it was possible to reconcile two different aspects of the record. This system is still followed on many sites, at least to the extent of drawing the strata exposed at the limit of excavation when the site has been fully excavated within this. Where sheet piling obscures these standing sections, drawing can be done piecemeal as excavation proceeds, before the metal sheets are lowered (Plate 25).

Such a system may work well when the plan form of the buildings being investigated is fairly regular, as they were with Wheeler's excavations of Roman sites. However, when sites leaving more ephemeral, less symmetrical remains had to be recorded, recognising the plan form became more problematical.

Plate 25 Section of stratigraphy showing below the sheet piling of an excavation. The strata can be drawn on a cumulative section before the sheets are driven down to the extant horizontal stratigraphy and excavation continues to lower levels.

Here larger excavation areas were required, and stretching the distances between baulks exacerbated what had always been the problem with the box excavation – that not all of the units visible in plan appeared in the section at the trench edge.

One solution to this problem is to create intermediate **cumulative sections** across the excavation area using temporary, narrow baulks. These are not left in place to be drawn top to bottom at the end of the excavation, but are drawn in part then removed, to be reinstated when underlying stratigraphy needs to be added to the drawing. Thus a section through the entire sequence is created, though the latter is never seen in its entirety on the ground at a single point in time. The definition of the stage at which the successive elements of the section should be drawn varies. On some excavations it is done when one reaches the base of a major phase, recalling the philosophy (and problems) behind the use of the phase plan described above. On others, recording occurs when one reaches a distinctive stratigraphic unit which is easily recognisable on either side of the temporary baulk, guaranteeing success in connecting up the two sides. In others still, it is drawn simply when a deep or extensive horizon is reached on both sides.

Often, these three criteria are used interchangeably, though it should be

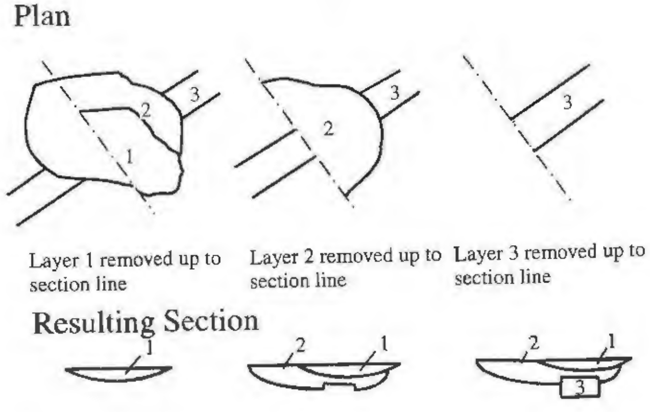


Figure 10 Creating a cumulative section.

noted that there is no guarantee that the top of a phase will be comprised of distinctive or large horizons, so there is a certain amount of confusion here. Given this, many excavators have taken the logical way out: the section to be drawn cumulatively is set up on a predetermined line and, whenever it crosses the position of any single unit which is about to be excavated, the line is strung out and one part of the unit is excavated up to that line. Its profile in elevation is then added to the section drawing and the section string is taken down. After this, the remaining portion of the layer on the other side of the line can be removed (Figure 10).

A major disadvantage of this solution is that one can never see successive units together in section. Thus investigating the nature of the interface between deposits, so useful in illuminating site formation processes, is automatically precluded. Furthermore, both section drawings of trench baulks and those created cumulatively within the excavation area have the important drawback that their line must be decided on, and imposed, in advance. Thus, in both cases, the section can cut into particular parts of the stratigraphic sequence only by chance, rather than by intent. On a site composed of small stratigraphic units, the likelihood of every unit crossing a predetermined line is slight. Hence such sections are unlikely to be able to portray the full sequence. Finally, their ability to elucidate the internal character of any deposit or the nature of the interfaces between contiguous deposits may be limited. For example, an arbitrarily imposed section line which happens to cross that of a linear feature such as a ditch or wall at a very oblique angle is unlikely to throw light on the nature of the feature itself, and may even create problems in understanding the relationship between it and adjacent stratigraphy.

These difficulties have produced a move away from using sections in set positions to record full sequence and promoted the idea of individually positioned

sections which cater for particular problems. Thus, when two apparently intercutting pits are visible on the surface of the site, yet the relationship between them cannot be determined by the trowel in plan, a suitably aligned section might be used to help throw light on the problem (Figure 11). Similarly, carefully aligned sections can be vital in elucidating matters when dealing with strata which have a vertical element in their mode of deposition. Tip lines within the fills of a pit, or the exact configuration of stones in a wall core, can be seen to best effect in elevation, using a standing section set carefully across the full width of the pit or perpendicular to the line of the wall. The increased use of open-area excavation has often been criticised for making insufficient use of the section as a recording tool. What is being argued here is that, with proper problem orientation, area excavations can make much fuller use of sections by focussing them on those aspects which they are best qualified to tackle, as opposed to just hoping that they hit the right spot by luck rather than judgement.

8.5 Preparation techniques

The techniques of preparing a section for drawing are fairly straightforward. The excavator should ensure that it is as vertical as is possible, using a plumb bob, then clean the surface **from top to bottom,** concentrating on difficult areas at each level before going on to those beneath, and working around any inclusions which protrude if they are too solid to be sliced through, as with stones, or too important, as with skeletons. Remember that, as with stratigraphy seen in plan, differences in texture and compaction can be more vital than colour for stratigraphic distinctions, so concentrate on deposit definition during the cleaning. Indeed, if one leaves all such definition to the end, there is a danger of having a perfectly clean elevation but still not knowing where all the lines are to be drawn. Going back to reclean a problem area near the top then means that every other division below becomes dirty and thus obscured. When the surface has been cleaned as thoroughly as possible, it may be useful to spray with water to bring out slight colour differences. Differential drying, and even weathering if the section can be left for a while, can also indicate layer boundaries.

The mechanics of actually drawing the section are well known (Adkins and Adkins 1989: 81). It starts with the setting up of string to form a horizontal line at a known level across the whole section, the end points of the string being tied in to the site grid. The information on the datum level of string and its position at either end of the section should then be marked on the section drawing, together with the scale of the drawing. The best way to avoid errors in section drawing is to begin with the top and bottom of the section and the limits of excavation at the sides, then in-fill this frame with the main strata, followed by

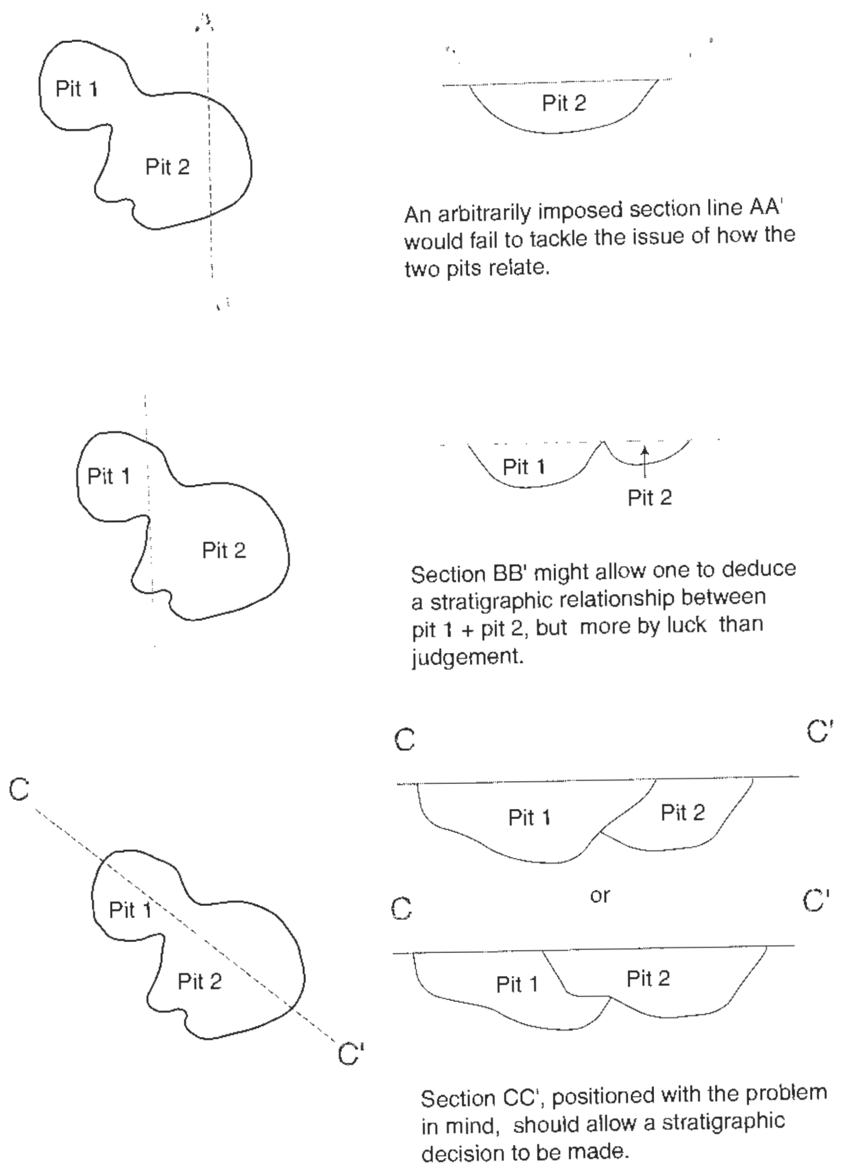


Figure 11 Positioning a section line for problem-solving. A section imposed at the start of excavation along the line AA′ might provide a convenient cross-section of Pit 2 but would say nothing about its relationship with Pit 1. That running from B to B′ *might* give some indication of the order in which the two pits were cut but lies at such an oblique angle to the likely line of intersection that this information would be obtained more by luck than judgement. In contrast, a section deliberately positioned along the line CC′ stands the best chance of allowing an informed decision.

the more complex areas. If some strata are particularly tightly packed, or detailed inclusions must be recorded, for example of the stones of a wall core, then a drawing frame hung vertically against the section aids speed and accuracy. When the drawing is complete, critical finds can be dug out of the baulk to give a rough idea of the dating of successive strata. If excavation in plan is precluded, and section recording is all that is going to be possible, it may even be useful to dig back behind its line at this stage to try to ascertain the alignment of any walls, etc. seen only end-on in the drawing.

Two issues which often arise in section recording are whether one should use continuous lines to delineate the boundaries of strata, and whether colour-coding of layers should be used. By matching drawing crayons with the real colouration, colours can then be blended together to reflect more accurately the merging of deposits when appropriate. The approach advocated by Pyddoke (1961: 120) is worth repeating here. The intention behind recording stratification is to provide information on events, the section providing either an intelligent interpretation of these or the information for such in the future. Hence it is important to show both the cases where layers clearly exist, and also areas of blending. For this a conventionalised section, with full use of the symbols indicating indeterminate edges where necessary, may be preferable to a naturalistic, coloured one.

A final point concerns the relationship between the section and the plan record. Every excavator is aware that they do not always match exactly. This can lead either to attempts to reconcile the two, which is not always possible, or to a battle over which element of the record should be accorded priority. Both solutions rather miss the point. The two drawings record the stratigraphic sequence in totally different circumstances. There is never a complete correlation, not because one is right and the other wrong but because they are trying to do different sorts of things. It is interesting, indeed it may be vital, to view the sequence in these two different ways. When the two correlate, this is important; when they do not, it is equally important and perhaps more interesting. But neither should be considered as inherently superior to the other and thus more likely to be believed.

The practical implication of this argument is that, because they represent two different views of the site, they should be created independently of each other. Thus each unit shown on either plan or section drawing should be given its own number and description, with a separate and individual statement of its stratigraphic relationships. It is important to construct the sequence as indicated by the section in a separate sequence diagram immediately the drawing is done, so that the illustrator can focus in on particularly vital relationships while the physical strata are still in view. Then, when a particular relationship is being used in a vital argument at the post-excavation stage, the analyst can be reassured by the knowledge that it was recognised as important at the time of recording and a decision reached which was as reasonable as was then possible.

Producing a full set of new descriptions for the strata seen in section, when one has only just excavated the adjacent, and broadly equivalent, material in plan, might seem like unnecessary repetition. However, it is not that time-consuming (and one need never run out of numbers for new units if they are allocated from a running sequence!). In addition, where correlations between plan and section are inexact, it will be necessary to have separate numbers anyway. Indeed, even when there is a one-to-one correlation, the case can be made much more succinctly if the two units have been recorded separately and shown to match after due consideration of all the evidence, rather than assumed to be a single entity from the start and appearing as such in the primary record. In the latter case, one cannot even begin the have the argument in analysis.

8.6 Measuring-in or piece-plotting finds

On most excavations, the stratigraphic unit is defined in terms of its physical composition and spatial and stratigraphic attributes. When these components have been recorded, the numbered unit is excavated and any finds from it are kept under its number. Thus the position of any find is known to the extent that it must come from that part of the site indicated by the plan or section of its associated unit. For small units this may be sufficient to tie finds down to a very small area, but for deposits which are either deeper or more extensive in plan, individual finds will obviously be tied rather less accurately. Then it may become desirable to divide a large horizon into arbitrarily defined sub-units (spits). A special case of this situation occurs when it is important to know the position of a particular find type with even greater accuracy: Hietala (1984) gives a variety of studies in which the analysis presupposes that the exact position of each artefact has been recorded in the process of excavation, for example.

In other cases, the measuring-in of individual finds may provide a way of reconstructing stratigraphic groups. For example, the 'blurring' of boundaries in alluvial deposits on a Bronze Age site at Runnymede (Needham and Stig-Sorensen 1988) required each sherd to be numbered and its exact position recorded. Consideration of the position and condition of individual sherds and of their interrelationships allowed the identification of the original surface of the settlement and elucidated post-depositional changes. Computer techniques such as 3DPLOT (Nelson *et al.* 1987) can speed up the processing of these spatial data in order to assess whether occupation levels can be recognised in deep sites lacking visible stratification, whilst other software packages can utilise evidence from joining sherds to elucidate both formation processes and post-depositional factors (Bollong 1994).

On sites with very few artefacts, it may be possible to measure-in all finds as a matter of course. However, on most excavations, a selection policy will be needed. Projects often decide to give such priority to the 'most important' finds, importance being defined for them in terms of the rarity of the find or its potential to provide accurate dates. Coins, for example, are often measured-in this way. However, these criteria can be difficult to justify. When a coin provides a vital date within a stratigraphic sequence, what really needs to be known is not its position to the nearest millimetre, but that the find was well stratified.

In general, the most important factor to be born in mind when deciding which finds to measure-in should not be the nature of the find itself, but the status of the relationship between it and the stratigraphy on site. In particular, we need to know more accurately the position of those finds which have not been redeposited, and which may relate to primary activities in the area. This requires establishing criteria for recognising the right kind of deposits and the right type of find in advance. Also, if distribution maps are to be created, the designated find must occur in sufficient numbers for statistical viability, but be sufficiently spread for meaningful patterns to emerge. Generally it is not eminently datable coins or prestigious gold jewellery which needs measuring in (though each of these may need separate treatment and numbering at a later stage for other reasons, for example to distribute to specialists or comply with a museum accessioning system). In terms of site activity, it is specified artefacts that occur in some numbers and from known primary contexts which deserve the extra accuracy which measuring-in provides.

Grave goods are an obvious case in which a primary context can be defined in advance. More mundane, but equally valid, are artefacts with a known structural function (door fittings, window glass) lying within, or at the base of, *in situ* destruction debris, thus providing vital structural information when plotted individually. Nor need it be only primary contexts which are important in this respect. For example, at the Billingsgate excavation in London, certain worked stones set within the core of a post-medieval foundation were clearly recycled from an earlier structure. Although in a secondary context, each stone was measured-in and, when analysed later as single artefacts, it proved possible to understand their architectural role in the original building. By comparing this with their position as found, one could understand the process by which one building (in fact a church burnt down in the Great Fire of London) was dismantled and a second (the merchant's house which replaced it) rose from its ashes. Obviously, if the number of finds involved is large, measuring-in every one can be time-consuming and thus prohibitively expensive. So, before embarking on such a policy, it is necessary to be very clear on how the information which may accrue fits into one's research strategy.

Some short cuts can be used when measuring-in finds. For example, rather than measure the position of each designated find straight away, a modern nail can be used to mark the point during excavation (different artefact types can be plotted by using differently painted modern equivalents if necessary). If there are too few nails to allow significant patterns to emerge when the layer is completed, they can simply be removed. If there are a large number, and their configuration seems significant, they can be planned or photographed, otherwise not. Of course, this does not avoid the difficult problem of deciding which patterns are significant. It must always be remembered that such patterns can be a positive indication with structural significance (e.g. lines of nails indicating planks of a timber floor), but can never be used as negative evidence. At the very least, marking positions in this way, then measuring several at a single time, is more efficient than dodging back and forth continuously between trowel and hand tape throughout the excavation of the layer in question.

Finally, when measuring-in large numbers of finds, the practical implications of this for their later processing must be considered. An EDM, for example, can enhance the speed with which individual co-ordinate points can be obtained (Plate 24) (Dibble 1987), perhaps linked via a computer to a numbering system related to the unit from which they came (2570/1 for the first object from unit 2570 and so forth). Thus it becomes possible to store the co-ordinates for hundreds, if not thousands, of finds quickly and efficiently, even printing out automatically a bar-coded label to accompany the measured find. But such recording may then play havoc with the finds data-base in the computer constructed on the basis of a different numbering system. It also requires that all finds processing and cataloguing at a later stage be similarly individualised. Knowing the exact position of every sherd may provide an exciting way of using the site's new piece of surveying wizardry, and be excellent news for the manufacturer of small plastic bags, but can be most unwelcome in the finds shed where each sherd must be individually marked with its unique number and stored separately – be sure that it is really worthwhile before committing the resources involved. None the less, when applied consistently and for good reason, there is no doubt that recording exact finds positions in this way can release vitally important contextual and structural information.

9

THE STRATIGRAPHIC RECORD

Introduction

Perhaps the most common justification for putting resources into excavations is that, in contrast to random digging for treasure, the work of the field archaeologist must take place in controlled conditions, allowing full recording of the physical character and spatial disposition of the stratigraphic units on a site. Such conditions do not merely allow better descriptions of site features and yield larger numbers of finds: they also let the excavator understand the latter's context of deposition and position in a sequence of development of the site. This allows excavated data to be interrogated in ways which are qualitatively different from that which would be possible using unprovenanced assemblages. If the expenditure on modern excavations is to be justified in such terms, then the drawn and descriptive elements of each unit must be set beside a third component – the stratigraphic relationships between units. Without these, deposits remain dissociated entities and every finds group floats with respect to all the others. Recording stratigraphic relationships is therefore a fundamental aspect of almost every excavation.

The types of relationships which might be encountered on any site come in two broad types. First there are general ones relating units which touch each other or are superimposed, i.e. essentially physical relationships. In addition there are the true stratigraphic relationships (both are discussed in **9.1**). Having decided on the type of relationships being recorded, the issues of how they are to be stored and represented graphically come to the fore, and here three broad approaches might be distinguished (**9.2**). Lastly the methods used to calculate how each unit relates to all others (which has been, surprisingly, little discussed in the literature) will be considered (**9.3**). The conclusion of this final section is that plan overlays are the most secure method of producing accurate stratigraphic information. This can only be done after a unit has been drawn and is best done on site before it is described and actually excavated: hence the discussion of stratigraphic relationships comes at this point in the manual.

9.1 Types of stratigraphic relationship

The relationships between units of stratigraphy can be classified into two broad types – physical relationships and, a sub-set of these, purely stratigraphic relationships. The physical relationships take a variety of forms, often recorded in terms of pairs of opposites – a particular unit overlies/underlies, cuts/is cut by, abuts/is abutted by another unit. They can also include more ubiquitous relationships, such as when one unit is recorded as touching/being touched by another.

There are several reasons why excavators might need to record such connections. For example, in order to identify the very existence of a truncation horizon within a sequence, it may be helpful to know all physical relationships of every unit (Yule 1992: 22). Alternatively, they may have a role when integrating finds information. For example, to understand cross-joins between residual pottery sherds in the fill from a pit and from adjacent horizontal stratigraphy, it will be important to consider those deposits which the intrusion actually cut. Knowing already that 'A is cut by B' will speed up analysis. Similarly, when analysing the structural development of the site after excavation, it can be very useful to be aware that a particular floor was laid against a wall. This implies that the latter continued in use, rather than the floor sealing its line and thus marking its demise as a structural division: knowing 'A abuts B' will be helpful. Finally, recognising that one unit actually touched another may help in understanding such matters as how an environmental sample from one deposit may have been contaminated by the percolation of a chemical compound from an overlying, contiguous deposit: a note of 'A touches B' is required. In such situations, therefore, a record of the physical relationships between units on the site can be vital.

However, in creating a system to register such relationships, two points should be remembered. First, deducing some of these physical relationships can be a very time-consuming business. A modern pit intruding from the top to the bottom of a complex sequence may truncate many thousands of other units. So its position and cut number will have to be labelled at all future stages of the excavation in order to make a complete record of the 'cuts/is cut by' variety, unless the recorder is content to have recourse to the chancy mechanism of individual memory. Similarly, when dealing with a horizontal layer, one might ask the apparently simple question 'Which other units were in direct contact with Unit X?' Yet if Unit X was extensive and only seen in plan, then it may prove exceedingly difficult to provide a completely accurate answer to the question. Of course, the fact that a relationship may take a long time to calculate is not a reason for failing to record it. But it is a reason for making certain that the question being asked is important enough to justify such an investment of time.

It is equally important to decide whether such relationships are needed for all units, and thus require systematic recording on site as a matter of course, or are merely important in particular circumstances, as in the examples given above. In reality, in my experience, there are very few occasions when the former is the case, raising the issue of whether they need to be part of the basic

site record. If they are required for particular aspects of specialist work post-excavation, then proper use of the plan record should enable them to be deduced retrospectively one-by-one as required. Usually it is only after some analysis following the excavation, rather than at the data capture stage, that the reasons for wanting to know physical relationships can be assessed more accurately and fully justified in terms of the project's research objectives.

Second, it is important to realise this type of relationship is different from a *stratigraphic* relationship in the strict sense of the word. The latter is concerned not with the physical disposition of the units (which unit touched another), but with the chronological construction of the sequence, a record of the order in which the deposition of successive units took place. It is usually only relationships of this second type which must be recorded as a matter of course in excavation.

Even if one accepts that it is stratigraphic, not physical, relationships which should be recorded, there is a further confusion to be dealt with. Harris, in what was a seminal work, rightly made much of the above distinction between physical and stratigraphic relationships. However, when discussing purely stratigraphic connections, he suggests (1989: 36) that these can take three forms. Any two units might:

(A) 'have no direct stratigraphic connection'
(B) be 'in superposition'
(C) be 'correlated as parts of a once-whole deposit or feature interface'.

The first two types present no problems. If two layers have no proven link, as in (A), then they can be seen as 'potentially contemporary', or 'floating with respect to each other'. To call this lack of a stratigraphic connection a true relationship may seem a little strange, but the meaning is clear. Though not recorded directly on site, its existence can be recognised implicitly by the absence of any relationship of types (B) or (C). Equally clear is the meaning of type (B), commonly translated on the recording sheet as one layer being '(stratigraphically) earlier than' another and, correspondingly, of the second being 'later than' the first.

However, the implication of Harris' third category, (C), is less obvious. What does it mean for one layer to 'correlate' with another? Such correlations are usually translated as one unit being the 'same as' another but this phrase is open to a variety of interpretations. It could denote that two numbers were allocated in the field to what turned out, on fuller investigation, to survive as a single, continuous unit. But this does not mean that a new type of relationship has been conjured into existence, merely that an error has been made. It is better not to make the mistake in the first place than to invent a technique for representing it in a sequence diagram.

Yet it seems unlikely that this is what Harris has in mind. The figure which illustrates his case is a section drawing in which two units of similar character and level are shown to be cut by an intervening intrusion. Presumably, therefore, the implication is that two physically distinct units on either side of the intrusion are thought to have joined up. It is *interpreted*, then, that one unit was once the 'same as' the other. However, correlating stratigraphy on either side of a later intrusion is a chancy business. Two layers might be linked on the basis of their physical characteristics, their surface level, their position in plan, the date of the finds which they contain, or any combination of these, and other, criteria. Whatever the basis used, it clearly involves a higher level of interpretation than is needed to deduce the existence of an (A) or (B) type of relationship. Thus Harris' Type C should be acknowledged as being different in kind from the more fundamental relationships.

This discussion suggests that the true stratigraphic relationships which must be recorded for every unit as a matter of course can be reduced to the 'earlier than/later than' category, the second element being, of course, simply the converse of the first. Hence what is required of a system is that it can decide, for each unit, which other unit(s), excavated previously, are immediately later than it. Everything else then follows on. Some ways of doing this will be described in the final section but first the graphical representation of stratigraphic relationships must be considered.

9.2 Representing stratigraphic relationships

There are a variety of ways in which stratigraphic relationships recorded on site might be stored and represented. The information on an individual unit, of course, can be held in words on its associated description sheet – 'unit 2 underlies 1, and overlies 3 and 4'. However, the objective of stratigraphic recording is to see all such relationships interrelated, not just written on each recording sheet, so a diagram combining them is required for analytical work. The ways put forward by Carver (1979b) and Harris (1989) will be considered here.

The Carver approach is essentially a development of the sequence diagrams derived from the Wheeler system (see, for example, Kenyon 1964: figs. 13 and 14). In this 'Carver diagram', stratigraphic units are represented in boxes, either individually or collected together in a feature. Their position on the diagram reflects the position on the site, and the size of the box, especially its upper and lower limits, corresponds to the length of time during which each entity is thought to have continued in use: a building with a complex internal structure and a long life will occupy a wide and long box; a simple ditch which remains in use for an extended period of time will be contained in a tall, narrow box; and a pit dug, filled and quickly sealed will be drawn as a box of limited dimensions in both planes. Thus, although the diagram obviously contains stratigraphic information, it is essentially concerned with presenting interpretations of the sequence, of how basic units form higher-order groups (see discussion

under 13.7) and of how long they were structured into the activities on the site, rather than recording basic stratigraphic fact. Such interpretations are vitally important but, it will be argued below, can be made with certainty only at the post-excavation stage. This suggests that, *as a method of storing fundamental stratigraphic relationships*, the Carver approach may be of limited use (its ability to present interpretative suggestions after analysis is another matter – see further in Chapter 13).

In contrast with Carver's approach, the Harris-Winchester matrix can be used from the start of excavation to record basic stratigraphic relationships and should not change its configuration as a result of analysis afterwards. The method is well known, having been clearly set out on several occasions by Edward Harris himself (Harris 1989 provides the most recent statement; Orton (1980: 66–73) also gives a particularly concise definition of the matrix, although he maintains that, strictly speaking, it is a lattice, not a matrix). The Harris matrix is, in my experience, the best, in fact the only, way of representing the stratigraphic sequence on a site of any complexity, presenting a complete statement of the stratigraphic sequence which shows all relationships, rather than just those which happen to reach the baulk, as with section drawings.

The essential basis of the diagram is very simple. The number representing each unit is inserted in a consistent rectangular box. Unlike the 'Carver diagram', the size of this box does not vary as a function of how long-lived the unit is thought to be (though, as discussed in the final chapter, its shape may be changed after post-excavation work to indicate the different types of interpretative units – occupation layers, pits, walls, etc.). Figure 12 demonstrates the principle: if unit 2 can be shown to be earlier than unit 1, then a line is drawn between the base of box 1 to the top of box 2. If 3 is earlier than 2 a line is drawn from 2 down to 3 and so forth. Hence if 3 is earlier than 2, which is earlier than 1, then 3 is also earlier than 1. This is demonstrated diagrammatically by the fact that one can travel up the strands from 3 to reach 2 and then 1. Similarly, 4 is earlier than 2, and by implication earlier than 1. However, it has no relationship with 3, and they are placed on different strands of the diagram.

This diagram shows that Unit 1 is later than Unit 2, and that Unit 2 is later than Units 3 and 4. These are both Type B relationships - that of being '*in superposition*'. Units 3 and 4 will have one of two relationships: either '*no direct stratigraphic connection*' (Type A); or '*correlated as parts of a once-whole deposit*' (Type C). Which of these types applies depends on higher-order interpretations based on the physical and spatial characteristics of both these deposits, and of others around them.

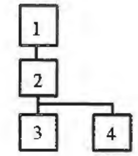


Figure 12 A simple Harris matrix.

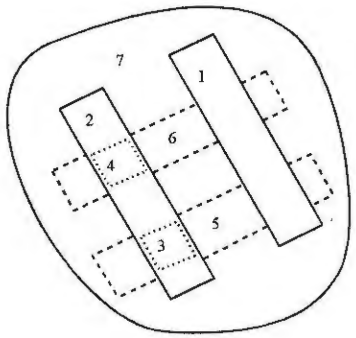
In this way the stratigraphic relationships between any one unit and all the others on the site can be illustrated, however complex the sequence:

> if one travels from a particular unit via the strands running up from it, all units through which one passes are provably later than that unit;
> if one travels down, every unit *en route* is provably earlier;
> any unit which cannot be reached in one of these two ways has no proven relationship with the unit in question (i.e. the two units are potentially contemporary, an example of the Type A relationship discussed above).

For sites of all sizes it makes sense to put all of this information onto a single, site-wide diagram since every unit is part of a single sequence. However, on an extensive, complex site with many such units, this diagram can get very large. In practice, the only limitation is the size of the wall of the site hut (perhaps an argument for more palatial accommodation on excavation!). However, when thousands of units are incorporated onto a single diagram, it can be very difficult to find a particular number amongst a mass of boxes in order to insert a newly numbered unit below it. In this case, it is useful to divide the diagram into areas labelled by letter running across and numbers down it, like a street map. The square in which any unit lies is then written on its recording sheet and those wishing to add further boxes below it then know roughly where to look on the diagram.

Three further practical points might be mentioned. First, matrices are often drawn in which one line 'jumps' another. They can make a diagram appear overcomplicated and it is best to iron out as many as possible (indeed, computer software has been created to do this automatically – see Herzog 1993: 209ff). However, because a matrix represents three-dimensional stratigraphy in two dimensions, some jumps cannot be avoided. (Figure 13).

The stratigraphic situation represented below comprises a rubble foundation ⑦, overlain by timber sills ⑤ and ⑥, with each sill capped at one end with a levelling tile, ③ and ④ respectively, before these tiles were themselves overlain by another timber ②. These relationships are shown below diagrammatically using continuous lines. However if a second timber ① also overlay sills ⑤ and ⑥, its position in the matrix cannot be represented accurately without implying a false relationship with either ③ or ④. Here it is necessary to use a drawing convention to show one line 'jumping' another (seen in the dashed lines below).



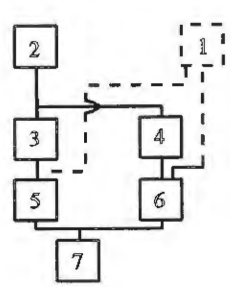


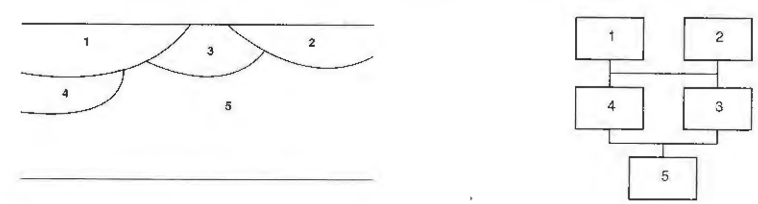
Figure 13 Dealing with 'jumps' in a Harris matrix.

Given that not all loops can be removed from a diagram, it is far more important to ensure that the diagram is clear and that the statements it makes are correct than agonising for hours on whether a loop can be removed by redrawing. A rough and ready, but essentially correct, record is much to be preferred at the end of the excavation, as opposed to a copied matrix which has minimal loops but embodies inaccuracies.

Second, a common source of error when constructing such diagrams is the creation of misleading 'H-shaped' relationships (Bibby 1993: fig. 7.2). These creep in when the lines drawn to the base of an overlying unit are not split but enter as single lines. Thus, in Figure 14, if 3 underlies 1 and 2, but 4 only underlies 2 and has no proven relationship with 1 or 3, then it is simply incorrect to have a diagram which shows 1 and 2 as both over 3 and 4.

Finally, it is important to finish off the matrix diagram clearly. At the end of the project, there will be some strands on the matrix whose lowest members hang in mid-air, lacking underlying strata. These should all be units which were the earliest encountered during the work. Such boxes should be drawn as overlying the limit of excavation (LOE) or above a point when no further excavation (NFE) took place. If there are then any remaining boxes hanging in mid-air, they represent mistakes, stratigraphic units which should have been linked back into the main sequence but have not been. The use of LOE/NFE elsewhere allows the ready identification of this, hopefully small, residue. The incomplete relationships must then be revisited and tied in before the matrix can be considered a finished record.

The stratigraphic situation shown in section below is often represented, inaccurately as:



As there is no proven relationship between 2 and 4, the correct diagram is:

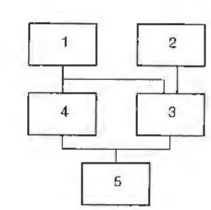


Figure 14 Avoiding a common error in Harris matrix construction.

9.3 Calculating stratigraphic relationships

Although there has been a certain amount of discussion in publications on the best way to represent stratigraphic information, very little has been written on how the individual relationships are to be calculated and when this should be done. For example, Bibby (1993), in a chapter entitled 'Building stratigraphic sequences on excavations', argues strongly and eloquently for the need to record stratigraphy accurately and consistently, but then gives no insight into methods. Similarly, Pearson and Williams (1993), though recommending the super-positioning of plans to calculate relationships, then do not expand on how this is to be achieved in practice.

Of course, if the drawn section is used as the basic record of the site sequence, as was once common with the 'Wheeler method', then the relationships which it embodies can be abstracted in diagrammatic form at any stage. As was argued above, such stratigraphic decisions are best taken on site when the section is being drawn so that any inconsistencies or vital areas where relationships are not entirely clear can be recognised straight away and perhaps subjected to more cleaning and closer inspection to sort matters out. However, as also discussed earlier, recording sequence only in section has its problems. With large numbers of 'open-area' excavations, it is often the case that not all layers are visible in section, and alternative ways of calculating relationships are needed.

In many quarters, it is still assumed that the excavator will simply know, or can easily remember, what unit(s) overlay the one being dealt with at a particular time and can fill in the boxes on the recording sheet accordingly. Sometimes, especially on relatively shallow sites with limited horizontal stratigraphy and extensive layers, this will be a valid assumption. The excavator has very few units to deal with and it is usually a matter of knowing that B is below A when you have just finished the latter and are starting to record the former. However, in other situations, reliance on recent recollections can also be a recipe for disaster.

An area may not have been touched for some time and the memory fades, if only because the excavator may remember the character and rough position of any overlying deposit, but not its number. Alternatively, personnel in the area may have changed, and the new excavator simply has no memory of the overlying sequence to rely on. Third, excavators working in adjacent areas will be dealing with sequences which sometimes interdigitate with one another, so the memory of more than one person has to be called on. Finally, on sites of any complexity, especially when individual layers are small and discontinuous because they have been cut away by later intrusions, it is rare for one unit to be sealed completely by an overlying deposit and completely cover the next one down. Overlaps between deposits are much more common, and these may be

only small but vital. Thus to remember that 'a deposit excavated two weeks before did, in fact, continue far enough south to overlap by 80mm the layer now visible in plan' is a chancy business. All of these difficulties increase as the workforce is enlarged and the professional field-worker, working in a large team on a complex site, requires formal mechanisms of stratigraphic calculation, rather than relying on informal guesses and individual memory. Methods which are impersonal and checkable (i.e. repeatable), yet simple, are the order of the day.

In the light of these problems, some have advocated the use of the computer programmes to monitor stratigraphic information. Thus the excavator writes down the relationships, presumably from memory, and feeds the result into a data-base. The programme then checks the information for internal consistency, and may even remove the loops in the sequence, flag up duplicated numbers, eliminate true but redundant relationships, and print out the resulting diagram in various colours. So, such programmes are clearly useful in terms of producing a tidy illustration, and in telling you that no data have been entered which imply the existence of the impossible relationship such as A is later than B, which is later than A. However, proving that a relationship is not impossible is not the same as showing it to be correct. After all, the information input from the site may create a diagram showing all units as being below topsoil and above the limit of excavation, but having no relationships with each other. Such a record is internally consistent (i.e. though unlikely, and certainly the product of a very boring site, it is not a stratigraphic impossibility). However, checking programmes cannot tell you whether there really were *no* relationships between *any* of the excavated units. The essential issue – the quality and accuracy of the original information – remains and here there are only two ways of creating a fool-proof system: labelling a stratigraphic unit in relation to all others as soon as any part of it appears during the excavation; or using the plan of a newly drawn unit to calculate relationships immediately before its excavation.

In the former system, underlying units are allocated a number and marked on the ground as soon as they are exposed following the removal of the overlying unit. These numbers are then entered onto the latter's recording sheet straight away. Thus the excavators remove topsoil, numbered 1, and twenty layers are distinguished below it. All are labelled on the ground, and 1 is recorded as being later than 2–21 inclusive on its recording sheet. As outlined in the initial discussion of this chapter, when these underlying units themselves interrelate stratigraphically, what is being recorded here is essentially the *physical* relationships between 1 and the other units – what the base of the topsoil actually touched – rather than its *purely stratigraphic* properties.

Certain practical problems arise with this approach. A complex site, on which each layer is labelled in the ground immediately any part of it appears, can quickly look as if it has been scattered with confetti as the tags proliferate.

Plate 26 Excavations at Winchester in the late 1960s, in which each deposit was numbered and labelled on-site as it was first exposed in the side of later intrusions. This had the big advantage of avoiding overreliance on the excavator's memory when calculating stratigraphic relationships. However, it meant that what was, in reality, a single deposit might be allocated many different numbers initially, all of which had to be correlated retrospectively. The excavation could also take on a confetti-like appearance in the course of the work.

Also the excavation of a major intrusion such as a pit may expose hundreds of other units, some of which may not be seen completely in plan, and thus will not be ready for excavation, for many months. In the meantime, nails can become dislodged, labels obscured or lost, etc. However, the solutions here – long nails, proper marking pens and careful excavation staff – are clear enough and present no barrier in themselves (Plate 26).

More difficult to solve are the problems derived from the need, in this system, to decide on underlying stratigraphic configurations immediately they are exposed. Consider the hypothetical example in Figure 15. On removing a layer of topsoil (1), several other deposits become visible and thus must be labelled. The dark silt layer (2) exposed in its entirety directly below the topsoil, which will be tackled next, presents no problems – 2 is stratigraphically below 1, and recorded as such on each sheet. But the clay layer seen in a 0.20m wide strip at

the silt's west edge, and the superficially similar clay just appearing from below it at its east edge, will, presumably, each be given a new number, 3 and 4. If, on removal of the dark silt 2, the clays 3 and 4 are found to connect up, there will be two numbers for a single unit. This difficulty may reach enormous proportions. An extensive layer might appear in the sides of a hundred pit cuts and become visible beneath countless discrete and overlying deposits in the horizontal areas between the pits (Plate 26). The same stratigraphic unit will thus be given a different number many times. Of course, this is not an insurmountable problem. The numbers can be equated in post-excavation analysis, or even when the extensive deposit becomes fully exposed and is about to be excavated: the good thing about labelling units in a numerical sequence is that you can never run out of numbers.

Yet there is a third problem which cannot be overcome so easily. A particular unit numbered previously as a single entity, rather than being amalgamated with another layer, may on closer inspection in fact divide into two. This is particularly likely to occur when only a small portion of a deposit could be seen when it was first numbered and its relationship with an overlying unit recorded, as with the clay layer 4 mentioned above. Only when it is seen fully in plan does it become clear that a differently textured area at its eastern end is not a surface detail, as originally assumed, but really an additional, new unit which thus has no number. If this element is now allocated another number, 4a, and the remaining unit is called 4b, one cannot be sure that both 4a and 4b were covered by the original deposit 2. The only way to establish the relationship between 4a and 2 is to compare the extent of each in plan. This solution thus gives a clue to the other general method of calculating stratigraphic relationships. If it is necessary to refer to plans at this point to calculate the stratigraphic relationship, why not use that method from the start, in the process avoiding confetti on site and the making of long-winded correlations, and removing redundant, equated numbers, after the site has been dug?

If every unit is to be planned then the resulting drawings can be used to create a site-wide matrix during the excavation. The case for single-context plans was outlined in Chapter 8. Their usefulness for calculating stratigraphic relationships on complex sites provides, if anything, a stronger justification for their employment. The mechanics of calculating stratigraphic relationships using plan overlays are fairly obvious. The extent of the unit on the newly drawn plan is compared to that of another unit as represented on its plan, using the site grid to position the two exactly. If there is an overlap between them, the new unit must be earlier than the previously excavated one. By repeating this process for all the plans drawn thus far, one can establish the unique stratigraphic relationships of the new unit before any of it is removed from the ground.

Of course, the process of overlaying plans to calculate relationships can be

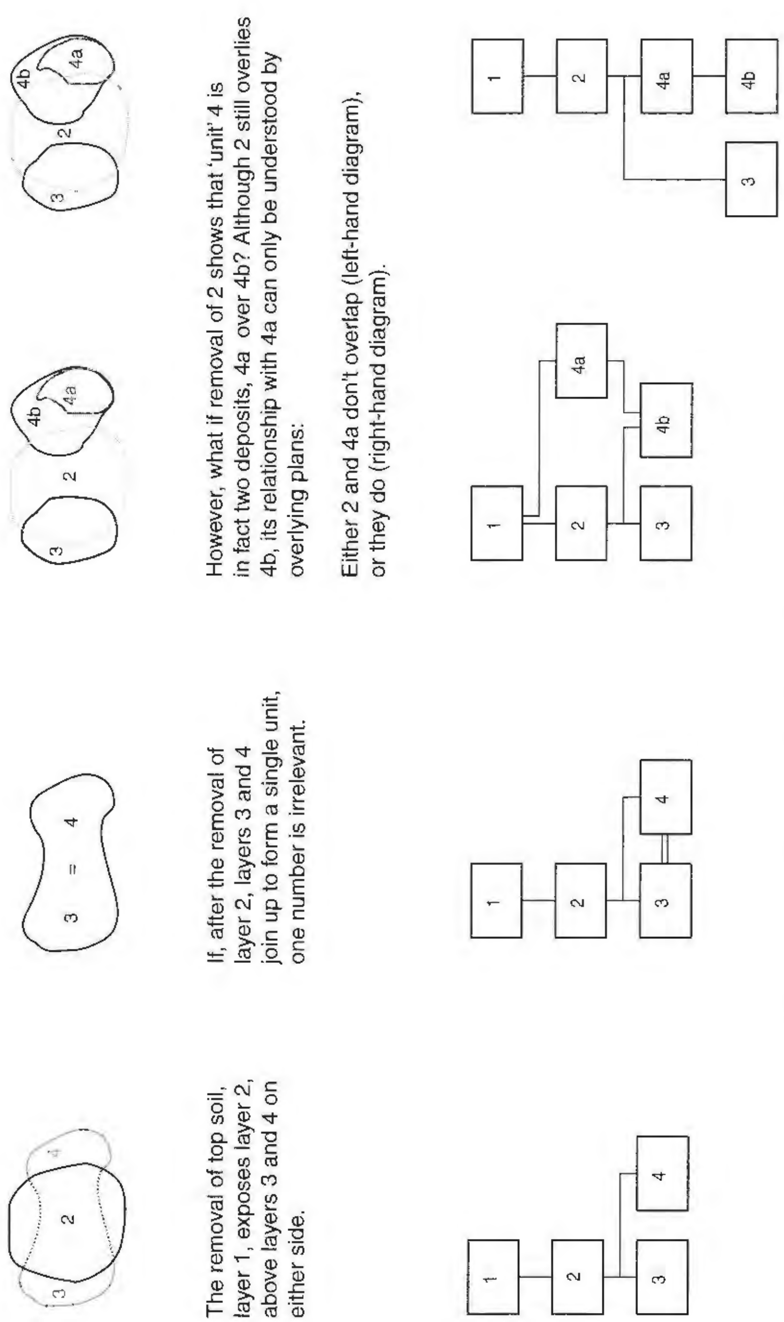


Figure 15 Problems in labelling stratigraphy ahead of its excavation.

done only after a unit is completely exposed and its full extent known and drawn up. Strictly speaking, this operation could occur at any stage thereafter, even when the excavation has ended (and sometimes this may be the only feasible time, most obviously with 'backlog' sites dug before matrices were in common use, or even thought of: Clark 1993). Yet there are some pressing reasons to carry out this overlaying process, where possible, at the earliest opportunity. First, any mistakes, either in planning or in overlaying, can be recognised straight away. Thus inaccurate plans – those drawn 0.20m too far west because the drawing frame was wrongly positioned; those rotated through 90 degrees due to the inexperience of the site worker – will usually be recognised straight away as being problematical because they do not match the positions of diagnostic features of overlying units (the edge of a later intrusion, the limit of excavation). These drawings can then be amended before the mistake formally enters the site record (incidentally, this mechanism constitutes one answer to the criticism of single-context planning, that it is likely to produce inaccuracies). Overlaying at this early stage also means that any small shifting of the site grid, which often occurs when large areas are being excavated over extended periods of time, can be recognised and taken into account. The process, then, is best done when the plan has just been drawn but before any of the unit which it represents has been removed from the ground.

There are still some problems with the overlay system to be considered. Calculating stratigraphic relationships on a large site can be a long-drawn-out process when it involves comparing the extent of a newly drawn plan with that of many thousands of previously excavated strata. Inevitably, for a site with complex stratification, the vital task of recording those relationships is bound to be time-consuming whatever system is employed (and even more so if only informal methods are used or if the work is left until after the excavation is finished). Fortunately, there are also practical measures which can be taken to make this workload more manageable.

First, with a new plan in hand, one should not simply check it against existing drawings in a random fashion. Because the site matrix is being created as the excavation proceeds, the relationships between all previously excavated strata will be recorded already on an evolving diagram. One can therefore start the overlaying process with the plan of a unit hanging at the base of one of its strands. Thus, on Figure 16, if the newly drawn unit 10 proves to underlie 9 when their plans are overlaid, and 9 itself has already been shown to be earlier than 6 and 4, there is no need to check for overlap between 10 and 6 or 4: whether or not 10 overlaps either in plan, it is provably stratigraphically earlier by virtue of the intervening relationship with 9. Of course, if no such overlap exists between 10 and 9, the plan of 10 must then be compared to that of units further up the sequence – 6, followed by 4, followed by 1 if necessary, until an overlap is established. If none can be found, 10 can float to the top of the sequence, alongside 1, and must await the excavation of underlying units to be pulled more fully into it. On a complex site, where many strands are in existence at any one time, tying a unit into one of these will not mean that all the others can be ignored. Each will have to be checked in turn before the relationships of the newly drawn unit can be uniquely established. None the less, starting with 'hanging units' can reduce the workload considerably.

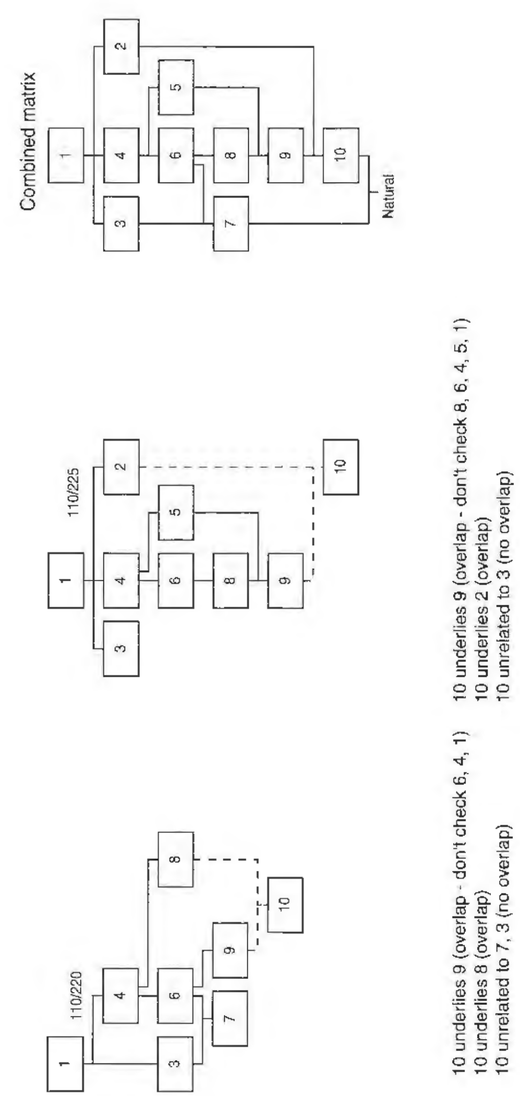
There is a second way in which the process can be speeded up. While a newly drawn unit may *potentially* overlap *any* previously excavated unit, those units in other parts of the site entirely will never in fact do so. If this can be known in advance, the chore of overlaying is much reduced. One way of doing this is to draw plans within pre-ordained grid squares and file them by such squares. When a newly planned layer is contained entirely within a particular square, it can only relate to other units also in that square. Thus one can produce small-scale matrices interrelating the plans in each grid square, and only these have to be checked (using, of course, the 'bottom up' approach described previously). The new plan can then be added to the diagram when its relationships have been identified.

Obviously, if a unit falls within more than one grid square, it will have to be drawn on a second plan and this will have to be checked in its own grid square. The relationships deduced here can then be added to the first. Some of these will simply confirm the decision of the first square; others will be additional, the total relationships of the new unit being an amalgamation of all such calculations; others still will be shown to be true, but irrelevant since superseded by more critical relationships in the other square. When all plan matrices have been filled in, the relationships from adjacent squares amalgamated, and the true-but-irrelevant ones removed, the result can be entered on individual recording sheets and on the site-wide matrix. Computer technology now coming on stream will reduce such basic work of amalgamation to a minimum though, for reasons given above, will not remove the need to overlay plans to deduce individual relationships in the first place – only computer storage of the digitised periphery of each unit could allow this to take place automatically.

Thus, in Figure 16, if one deduced that unit 10 was earlier than 9 and 8 in one square and earlier than 2 and 9 in another, the repetition of 9 would mean a redundancy, the overall relationships being 10 earlier than 2, 9 and 8. But what if the relationship with 8 deduced from the first square was known from the second square not directly, but by virtue of 8 already being provably later than 9 there? Then the fact that 10 was earlier than 8, though true, would be irrelevant overall. Only the critically important relationships – that 10 was earlier than 9 and 2 – would be entered on each unit recording sheet and on the site-wide matrix. The relationship between 10 and 8 in the first plan matrix, though shown to be irrelevant overall, would be retained in that matrix because it might still be important in subsequent calculations of relationships for units confined to that square alone.

Clearly, when calculating the optimum size of grid square within which to

The plan of a newly drawn unit in a particular 5m square is checked for overlap against all previously drawn plans in that square, starting with the earliest units. In this case, in 110/220, 10 is found to underlie 9 (therefore it is not necessary to check 6 , 4, and 1) and 8. It has no overlap with 7 or 3.



By repeating this process for all plan squares (here 110/225), one can then amalgamate the results. Some relationships will be reproduced in each square (e.g. 10 is under 9 in both); some are additional (the relationship between 10 and 2 in 110/225 was not evident in 110/220); and others, though true of one square, are redundant overall because a more complicated route exists elsewhere (e.g. as 10 directly underlies 8 in 110/220 but 9 underlies 8 in 110/225, then the relationship between 10 and 8, though true, is not critical). A combined matrix represents the context relationships from all grid squares.

Figure 16 Using plan overlays to produce a Harris matrix.

construct these 'mini-matrices', there will be a trade off between the size of the squares on site and the number of plan matrices. If one chooses small squares, each plan matrix will be simpler and thus more quickly checked against each new unit. However, the chance of a unit occupying more than one such square is increased and the excavator is more likely to have to repeat the overlaying process for successive squares. Conversely, the larger the square, the more likely that a unit will fall completely within it, but also the greater the complexity of the individual plan matrices. The size of the grid square thus depends on the 'average' size of the stratigraphic units. On an urban site with truncated stratigraphy surviving only in discrete islands and comprised of small units often less than 2m across, grid squares of 5m may be appropriate. On an extensive rural site, where stratigraphic distinctions are difficult and the majority of units which can be defined cover much of the site, no subdivisions may be needed: the plan matrix is thus redundant, as it would be nothing more than an exact copy of the overall site matrix. Pre-excavation evaluation will help in making these decisions, also ensuring the most beneficial siting of grid squares, by positioning them along the lines of breaks in the stratigraphic sequence, for example where later intrusions cut it into discrete islands.

A final point about the method outlined above is that some commentators have seen this use of plan matrices as a move away from open-area excavation and back to Wheeler's methods of working within small squares or boxes (above, 1.1). In reply, it should be emphasised that using plan grid squares in this way has no implications for the excavation of the unit itself, which must still be described, numbered and removed as an individual entity. The plan matrices simply facilitate the process of overlaying plans, easing the complex task of calculating stratigraphic relationships by breaking it up into more manageable elements. Such a system ensures that a consistent, checkable method of calculating stratigraphic relationships can be implemented, with no need to be reliant on individual memory, or chancy estimations, in creating what should be a fundamental part of the excavation record of any site.

10

DEPOSIT DESCRIPTIONS

Introduction

The objectives of describing the physical characteristics of any stratigraphic unit are twofold. First there is the need to elucidate the formation processes which created the unit and any transformations which it has undergone in the ground subsequently: this requires a *detailed* description of its character and contents. Second, this record has to be created in such a way that every stratum is comparable with all others: this necessitates a *systematic* approach to recording. A great variety of types of stratigraphic unit may be encountered on site and an almost limitless number of aspects of each might be noted, so any record must select which are important on the basis of the research objectives of the project and site evaluation before full-scale excavation. The resulting recording system will then require the creation of field test procedures and the training of personnel in their use. Of course, even with such planning, any site can throw up the unexpected – a type of organic survival not anticipated, a method of construction not predicted – so the recording system will always be a development of the initial blueprint. However, the unexpected is best catered for by working away from an agreed method, rather than simply drifting towards a new approach because of gradually evolving circumstances. Certain broad but common categories of unit can be predicted and are discussed below.

Before any aspect of the written record can be produced, it is necessary to decide which personnel are to be involved in its creation and the stage of the excavation process at which they will do the work (see **10.1** below). Nowadays it is further necessary to design appropriate computer storage mechanisms for the data produced (**10.2**). Nearly every site will encounter different sorts of deposits, mostly sediment in horizontal layers. In recording these, archaeologists have drawn extensively on the methods of the soil scientist, though it is worth remembering that strata created by human agency are not the simple equivalent of those produced in nature (**10.3**). In general, field-workers will need to record the colour (**10.4**), particle size (**10.5**), compaction (**10.6**), inclusions (**10.7**) and the thickness and surface details (**10.8**) of each deposit. Stratigraphic units other than deposits – masonry and brick features, timber, human skeletons, intrusions and finds groups – will be dealt with in Chapter 11.