

Mapping and analysing medieval built form using GPS and GIS

Keith Lilley, Chris Lloyd, Steven Trick and Conor Graham
School of Geography, Queen's University, Belfast, BT7 1NN, UK.
E-mail: k.lilley@qub.ac.uk

Revised manuscript received 27 August 2004

Abstract. *Drawing upon recent research experiences of using a Global Positioning System (GPS) and Geographical Information Systems (GIS), this paper sets out how spatial technologies can be used in the study of medieval built form. The paper focuses particularly on the use of differential GPS and ArcGIS™ in mapping and analysing the plan of Winchelsea, an English medieval 'new town' established in the 1280s. The approach used to conduct this research is outlined here, with comments on the practicalities of using GPS and GIS in historical urban morphology. Although the research on which this paper is based is at a preliminary stage, the paper offers a working method for those interested in using spatial technologies to build upon existing methods of morphological study, namely town-plan analysis and metrological analysis. Some preliminary research findings relating to the planning of medieval Winchelsea are also presented.*

Key Words: spatial technology, GPS, GIS, historical urban morphology, medieval town planning

In Europe, the Middle Ages is a period for which relatively little is known about the agents and decision-making that produced urban landscapes, largely because the decision-making process often went unrecorded, or was recorded only tangentially (Lilley, 2001). However, inherited patterns of streets and plots are, as Beresford (1967, p.147) put it, 'dumb witness' to the activities of those individuals who created them, and in this regard built forms constitute the primary evidence for the history of a town's medieval spatial development (Conzen, 1968). Two particular approaches to analysing medieval built form have become dominant in UK and Irish studies, these being town-plan analysis and metrological analysis (see Slater, 1990; Whitehand and Larkham, 1992).

Town-plan analysis lends itself to both trying to reconstruct what the built form of a town or city was like in the Middle Ages and showing its historical and spatial evolution

(Conzen, 1960). Two principles are used for this: first, simplifying nineteenth-century source mapping so that it shows only those morphological features most likely to be of medieval date, namely streets, plots and buildings ('plan elements'); and secondly, using the variations in built form shown by patterns of streets and plots to identify plan units, each of which nominally represents a stage in the evolution of a town's plan (Baker and Slater, 1992; Lilley, 2000). From the smallest medieval towns to some of the largest, plan analysis makes possible an interpretation of the temporal sequence of urban formation, as well as providing a means by which to assimilate and integrate other information about a town's past derived from archaeological and historical sources (Lilley, 1994, 2000).

Metrological analysis of town plans also aids understanding of how urban landscapes were created in the Middle Ages. Using

careful field survey and taking measurements of plot and street patterns can yield evidence for the units of measure used to plan medieval towns, as Slater (1981, 1987) has shown for the twelfth-century episcopal 'new towns' of Lichfield and Stratford-upon-Avon in the English midlands. The twelfth century, in England at least, saw many such new towns being created but unfortunately little is known from conventional historical accounts of the individuals who had the responsibility for such acts of 'town planning' (Lilley, 2001). Instead, it is not until a century later, especially with the reign of Edward I (1272-1307), that specific documentation on matters of founding and planning towns begins to be more forthcoming thanks to the diligent statecraft of the king and his household (Tout, 1920, 1934).

Building upon the plan-analysis and metrological-analysis techniques currently favoured by historical urban morphologists, a project was initiated in 2003 to develop ways of applying spatial technologies to map and analyse medieval built forms.¹ The empirical focus of this research is on the new towns founded by Edward I in England and Wales, through which the project seeks to understand more about the agents and decision-making involved in forming urban landscapes in the Middle Ages. This paper derives from this current research and has two main aims: first, to show how field survey can be undertaken with a Global Positioning System (GPS) to map street and plot patterns, as well as other features of the medieval townscape, with a high degree of spatial accuracy; secondly, to show how these spatial data can be processed using a Geographical Information System (GIS) to facilitate 3D analysis of its morphological features and characteristics. It is suggested that these two spatial technologies can help not only enhance existing morphological techniques of analysing medieval built form but also yield interesting results about the process of town planning in the Middle Ages.

Spatial technologies and historical urban morphology

The use of spatial technologies to map and

analyse historical built forms is by no means new (see Holdsworth, 1992; Koster, 1998, 2003). What is new, however, is using GPS to survey morphological features of a medieval town, and then incorporating these data into GIS to map and analyse built form. Such GPS work has been done successfully for sites in open, rural locales (Chapman, 2003; Chapman and Fenwick, 2002), but built-up urban contexts pose particular difficulties and challenges, not least because of the limited sky-view (and thus limited contact with satellites for positional measurement) resulting from buildings fronting the streets, causing a 'shadow effect'. Also posing difficulties and challenges is how then to make sense of the GPS field-survey data, and in particular how to use these data to create new maps of the urban landscape that can then be used as a basis for analysing aspects of built form. GIS as an analytical tool provides the capacity to undertake such analysis, but its use in helping to reveal from the layout of streets and plots the histories of their formation is yet to be explored. These were the main methodological issues that were to be confronted by conducting a pilot study of one of Edward I's 'new towns', actually an old town refounded on a new site in the 1280s when the townsfolk of Winchelsea in East Sussex, on the south coast of England, lost their established port and town due to flooding (Homan, 1949).

The new town of Winchelsea provided a good case for a pilot study to test the use of GPS and GIS to analyse medieval built form. The town today is quiet, having lost much of its population during the later Middle Ages and not regained it. The layout of the town is well-preserved, both as existing streets and also, in the abandoned areas of the town, as earthworks (see Beresford and St Joseph, 1958). By medieval standards the town is also comparatively well-documented from its inception, and has a detailed written rental survey of 1292, made just a year or two after the town had been created (Beresford, 1967). The plan of the new town has received attention before and an attempt to reconstruct Winchelsea's layout based on the 1292 survey was undertaken by Homan (1949) and was

recently revised by Martin and Martin (2002). As one of twelve Edwardian towns to be studied by the project, Winchelsea emerged as a good starting point, and so field work was carried out there in September 2003 following access agreements obtained with landowners of those fields containing earthworks, and preliminary study of Ordnance Survey (OS) mapping of the town, both the first edition (1872) 1:2500-scale plan, the main cartographic source favoured by Conzenian historical geographers, and the most recent (2003) MasterMap[®] digital mapping produced by the OS. The remainder of the paper is divided into two sections, the first dealing with how to acquire field data in a town using GPS, and the second how then these data are mapped and analysed through GIS software. Both sections are chiefly methodological, although some preliminary results from this work are also discussed.

GPS and field-survey work in Winchelsea

Differential GPS was used in preference to a total station for the field survey of Winchelsea. While a total station can obtain high accuracy measurement of distances and angles (Bannister *et al.*, 1998), compared with using GPS it is slower and more cumbersome, and necessitates the establishment of a local grid system or linking to an existing co-ordinate system. GPS is also to be preferred to measuring tapes, often used in metrological work in urban morphology (Slater, 1981; Friedman, 1988; Randolph 1995), but which can be subject to inaccuracies, which are difficult to quantify, and provide no elevation data. As it provides both independent and verifiable spatial data, GPS offers a superior method of conducting urban field survey than either of these two traditional techniques. Since using GPS equipment for surveying relict urban features – such as medieval street and plot patterns – is a novel application, its reliability and suitability required testing in the field and, for the purposes of morphological mapping and analysis, the usefulness of its output (that is, spatial data) needed to be

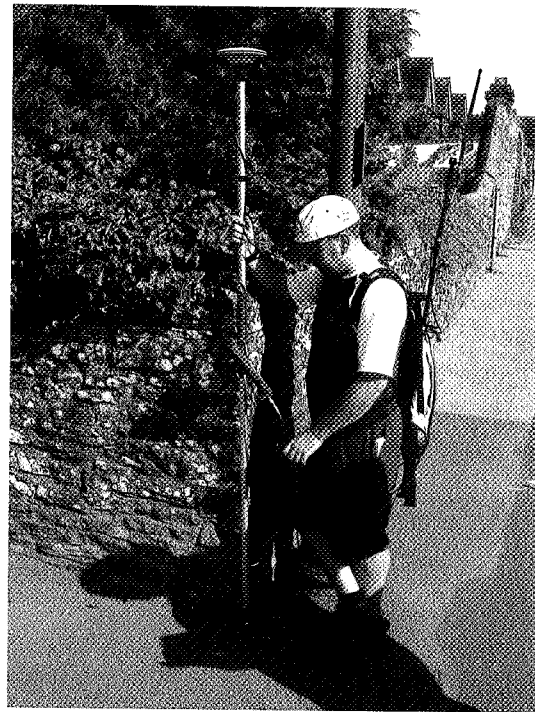


Figure 1. Differential GPS in use at Winchelsea: the mobile unit.

examined.

In the field, two Leica GPS500 receivers were used in tandem enabling high precision 'differential' modes of survey. The 'real-time-kinematic' (RTK) technique was the primary survey method, allowing a high degree of mobility for the surveyor. It can be used to report positions in 'real-time', to an accuracy of ± 2 cm. The approach adopted for surveying Winchelsea is as follows. First, a local benchmark is set up in the town to serve as a reference point for the survey. This is achieved using a 'static' form of GPS measurement, involving setting one GPS receiver over a nearby Ordnance Survey Benchmark (OS BM) of known co-ordinates and then setting up the other at the designated local station in the town. The two receivers are left to record observations over a period of at least two hours. The position of the local station is determined by post-processing the observations collected at both stations, using the GPS software.² This static form of surveying ultimately offers extremely high accuracy over long distances but can be time-consuming (Leick, 1995).

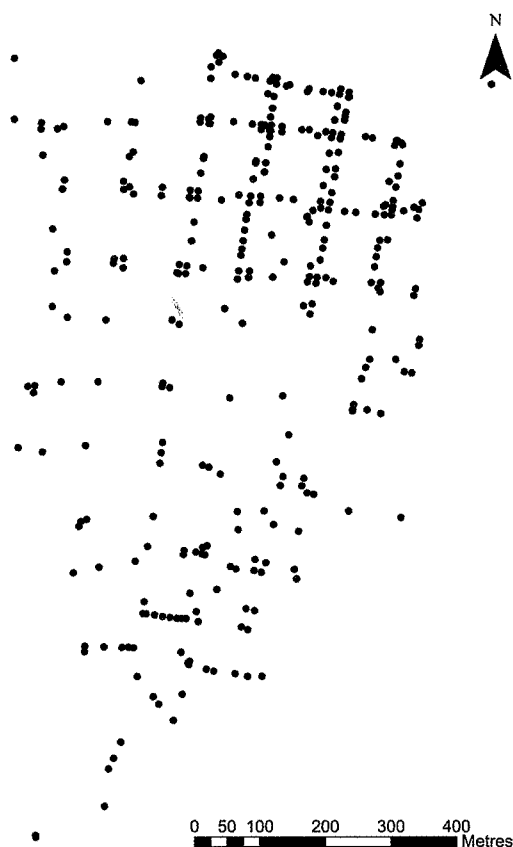


Figure 2. Winchelsea: plot showing GPS survey points collected for the whole town.

With the local station in place, surveying can begin using a mobile GPS receiver in the RTK mode of operation (Figure 1). One receiver remains positioned over the local BM, the 'base-station', while the other is carried around by the surveyor, with the main unit in a backpack, and the antenna mounted on a pole. Since the base station has a predetermined location, it can calculate inaccuracies in positional fix, and transmit differential corrections via a radio link to the mobile receiver, resulting in real-time, high accuracy survey. In built-up, urban environments, where high buildings and trees are present, it is advisable to place the base station in an elevated position, preferably on top of the tallest building locally. This ensures good satellite contact for the RTK base station, and also improves the range of the radio transmissions. For the operator of the mobile GPS sensor, the local configuration of streets and buildings determines the mode of data

collection. In parts of the town where the sky-view is clear, observations can be made using the pole alone, but where there is a satellite 'shadow', caused by either buildings or trees, then an additional piece of equipment is used (Leica DISTO) which enables an offset to be measured from a location with good positional fix to the 'hidden' target feature. The DISTO determines the distance of the offset by laser beam fired at the target feature.

Using the pole or offset, 346 field observations were made in Winchelsea over a period of six days. These observations were taken at selected street intersections, plot boundaries, buildings, and earthworks, all recorded in terms of their position (X, Y co-ordinates and elevation (Z)). To ensure a systematic approach, all locations at which ground points were surveyed were photographed with a digital camera and an accompanying field sketch made. Each observation was also given a unique identification code. Throughout the survey it was invaluable to have a copy of the first edition OS 1:2500 plan superimposed on to the 2003 MasterMap[®] plan of the town. This helped in identifying morphological features in the field (such as surviving (pre-1872) plot boundaries), while having a hachure survey of earthworks (carried out by the Royal Commission for Historic Monuments (England) (RCHME)) also helped. Following field survey, the GPS points, stored as geographic (WGS84) co-ordinates, were translated into British National Grid format (OSGB36) using GridInquest software (Quest Geodetic Software Solutions Ltd, 2002), and then imported into the GIS package, ArcGIS. Once within the GIS the points are displayed as an array of discrete points, each with its position and attribute label (Figure 2). These field-survey data then form the basis for morphometric analysis and for creating 3D models of the town's plan.

Mapping and analysing medieval Winchelsea using GIS

The main strengths of GIS lie in the ease with which it can be used to store, manipulate and

Figure 3. Winchelsea digitized polygon (quarter 8) derived from GPS survey points overlaid on OS First Edition 1:2500.

show the morphological features of Winchelsea: its streets, plots and buildings (those 'plan elements' selected in a conventional plan analysis – see Lilley, 2000). ArcMap™ (a module of the ArcGIS software) was used to construct, through on-screen digitization, street blocks from the GPS point data. Through this process, street blocks were represented as *polygons* and the plot frontages as *polylines* (Figure 3). The GPS points also provided the source data for creating a simple model of the topography of the hill-top on which the town is situated. In order to create a continuous surface model of the town, the elevations of the GPS points were interpolated using a natural neighbour algorithm (see Sibson, 1981). Using the 3D Analyst feature of ArcScene™ the digitized urban features were draped on the surface model to derive 3D versions of these vector datasets. (This part of the procedure could be enhanced through the use of photogrammetry, or some other means of measuring elevation based on remote sensing, to represent more accurately the elevations between the locations at which

The exploration of Winchelsea's medieval town plan entailed collation of several data sources. The OS first edition 1:2500 plan (1872) and the RCHME earthwork survey were georectified in ArcGIS to the GPS field-survey points,³ and an up-to-date colour OS Master-map® Imagery Layer (aerial photograph) was added. These three layers each

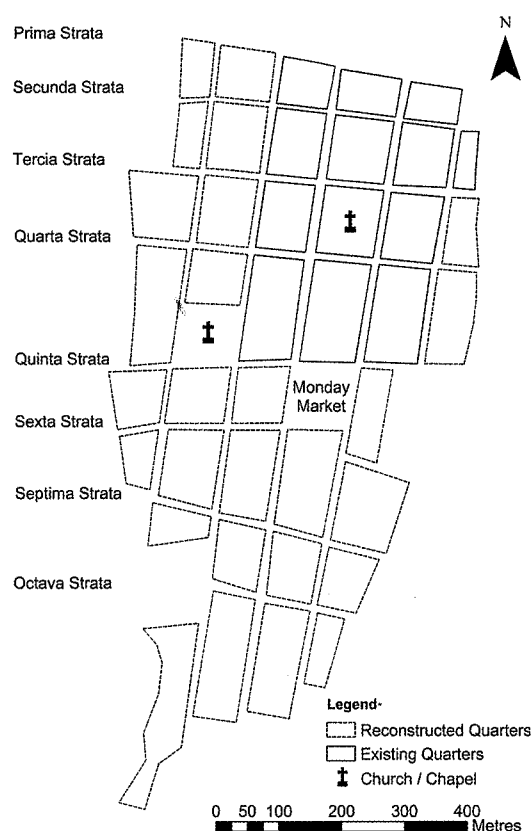


Figure 4: Winchelsea street blocks c.1290, showing reconstructed and existing ‘quarters’ based on combining GPS field measurement and areal values recorded in the 1292 rental.

measurements were made using GPS).

While it is comparatively straightforward to digitize street blocks (polygons) between GPS points for those parts of Winchelsea that still exist as a built-up area, this is not the case for the areas, particularly to the south and west of the town, that were abandoned during the later Middle Ages and which are now empty fields. For these it was necessary to reconstruct their layout using the GPS survey in combination with information derived from a property survey of the town made in 1292 – undertaken very soon after ‘new’ Winchelsea was founded – and the RCHME earthwork survey, showing the outlines of relict streets and street blocks. The 1292 rental survey is a list of individual properties, recording them quarter by quarter (that is, street block by street block – 39 in all) and including information on their area (measured in *virgae*) as well as their occupier

and the rent they were paid (National Archives (NA): SC 11/673 and 674). Both Homan (1949) and Martin and Martin (2002) have used information from the 1292 survey before to reconstruct the town plan of Winchelsea, albeit with slightly different outcomes. The GPS data make possible a further interpretation, as well as giving some indication of the accuracy of the 1292 surveyors’ work.

The first task in reconstructing the layout of ‘lost’ Winchelsea was to combine the 1292 rental survey with the GPS data. A problem was that property sizes in the rental are recorded in *virgae*, an *areal* unit of measure (rather than the *linear* measure of the statute perch, cf. Slater, 1981) of uncertain size (see Maitland, 1898). Winchelsea’s medieval surveyors were, of course, measuring the properties as a 3D surface with rods, cords or chains. To find what size their *virga* was on the ground required several steps. First, GPS-derived measurements of individual street blocks (the digitized polygons) were obtained. Secondly, the areas (from the rental) of all the recorded properties for each ‘quarter’ in the northern part of Winchelsea (where townscape continuity is strongest, and some surviving buildings and certainly the outline of streets date back to the thirteenth century: see Martin and Martin, 2002) were identified. Finally, the two sets of values were compared. The area of each of these known street-block polygons (‘quarters’), nine in total, was thus calculated in square metres and compared with the total *virgae* that the medieval surveyors had measured for the quarters and recorded in their rental list. From them a mean square-metres per *virga* was calculated, this being 25.13 m². Having derived this for the surviving quarters in the northern part of the town it was then possible to work out (using the quarter totals in the 1292 survey) the area in square metres for each of the ‘lost’ quarters, and so reconstruct the outline of the ‘missing’ street blocks in the south and west of the town (Figure 4). This was helped by the overall regularity of Winchelsea’s plan, particularly the north-south longitudinal streets, and also the survival of streets and street blocks as earthworks (shown by the RCHME plan).

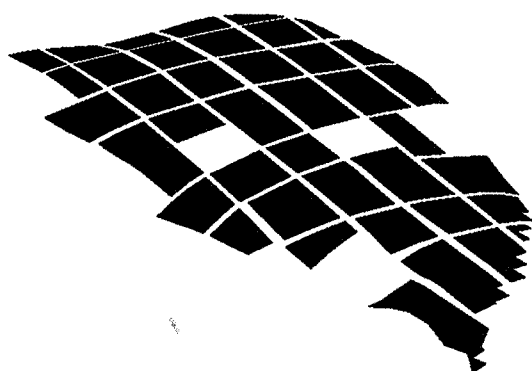


Figure 5. Winchelsea: quarters of the medieval new town visualized in 3D, as seen from the south-west (vertical exaggeration is x2).

The plan of Winchelsea reconstructed from GPS data, the 1292 survey and cartographic sources do not come together as neatly as one might hope. Some of the street blocks apparent as earthworks or field boundaries, when measured on the ground, do not equate very precisely with the area of the quarter given by the 1292 rental. For example, the area of Quarter 19 is measured (from the GPS data) as 14,123.34 m² while the 1292 rental suggests that it should be 14,267.56 m² (using the mean *virga* of 25.13 m²). Such differences could be accounted for by inconsistencies or errors in the medieval surveyors' measurement or calculation of measurement in the rental. Or it could be that the mean *virga* calculated from the GPS survey in the northern part of the town is too different from the actual (but unknown) area of the *virga* used in the 1292 survey. Homan (1949) suggests the *virga* equates to a measure of 16.25 feet, and this does in fact compare well to the GPS-derived calculation (16.25 x 16.25 feet = 24.53 m²). Or, of course, it may be that the reconstructed street blocks identified on the ground are not identical to the quarters listed in the survey, so that perhaps the sequence of quarters recorded by the 1292 survey has to be looked into more closely, and the plans of Homan (1949) and Martin and Martin (2002) revised. The process of reconstructing Winchelsea's plan using GIS to marry together data sources is, while inherently uncertain, nevertheless enlightening, for it reveals something of the accuracy of surveying land in the later Middle

Ages as well as the difficulties of matching together historical and archaeological data. Notwithstanding these difficulties, the plan of Winchelsea that results from this mapping process provides us with what we believe to be a fairly accurate representation of the layout of the whole town as it was at around 1290.

The reconstructed plan of *c.* 1290 can be visualized in 3D by draping it on the surface model for the hill derived from the GPS point data (Figure 5). This then begins to reveal the way the town as a whole was fitted to the local terrain, showing how the northern part of the town dips away quite steeply, as do the south and west areas, with the flattest parts reserved for the town's two principal longitudinal streets, running on either side of the two street blocks that contain the parish church of St Thomas and the site of the Monday market (see Martin and Martin, 2002).

3D morphometric analyses of Winchelsea's plots

Plot frontages measured in the GPS field survey may in some cases date back to the time the town was laid out in the 1280s. This raises the possibility that their widths could yield information about the unit of measurement used to create the layout of Winchelsea. One of the questions that arises from the 1292 rental is whether the *virga* was the unit used to lay out the town, or whether a linear measure was used, such as the perch. If a perch was used in creating the plan of Winchelsea, which one was it? From metrological analysis of plots widths in the Midlands, Slater (1981, 1987) found that the statute perch of 16½ feet was used in the twelfth century in setting out plots in the cases of Stratford-upon-Avon and Lichfield. However the perch, though standardized in the late-twelfth century, actually varied widely in length across the regions of medieval England, from 12 to 24 feet in length (Grierson, 1972). In East Sussex, that is around Winchelsea, the presence of a 22-foot perch is recorded (Homan, 1949), though here the difficulty is knowing which foot measure was actually used, for as Grierson (1972, p. 23) notes, feet

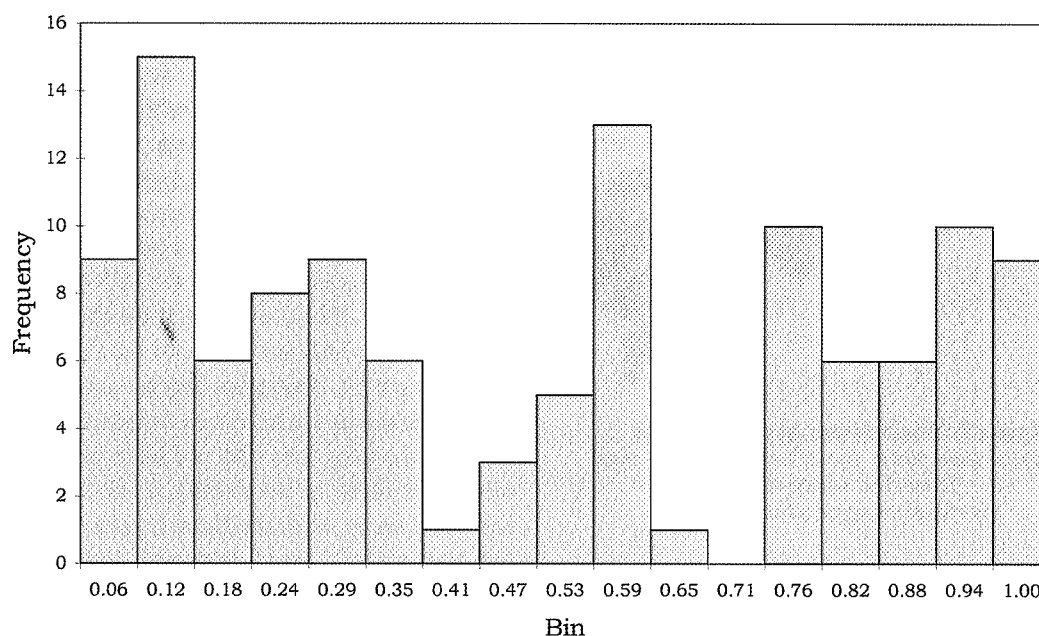


Figure 6. Analysis of plot widths revealing possible 20-foot measure: If a given perch measure (and its fractions) were used a peak of values near 0, 0.25, 0.5 and 0.75 would be expected and this is most clearly the case for the histogram referring to a 20-foot measure (see text).

were variously measured in the Middle Ages and not always equivalent to an imperial foot.

For Winchelsea, the GPS-measured plot frontages (the distances between plot boundaries at the point at which they front on to the street) were tabulated in metres for each surviving street block (quarter). Using a specially-written routine (created in Fortran programming language by one of the authors) these data were analysed to see whether a particular perch-length (or multiple or fraction of a perch-length) was present in the measured plot fronts, there being 117 frontage measurements in all. The programme assessed the width of each individual plot front to see how well it related to various perch measures (statute, eighteen-foot, twenty-foot, and twenty-two and twenty-four foot perches). Winchelsea's surviving plot frontages were divided by each of these perch measures. The procedure worked as follows:

- (i) A plot frontage measurement is divided by a given perch unit (for example 16½ feet).
- (ii) A calculation is made of how many times a perch unit fits into a plot frontage, and the remainder is noted.

- (iii) This is repeated for all plot frontage measurements and the remainders are plotted in a histogram which indicates how closely each of the plot frontage measurements is fitted by a given perch measure.

If a given perch unit was used then the differences (obtained in step (ii) above), depicted in the histogram, will cluster around 0 (plot frontage measure is close to one or more perch units), 0.25 (close to some multiple of quarters of the perch unit), 0.5 (close to some multiple of halves of the perch unit), 0.75 (as for 0.25) or 1.0 (as for 0). A twenty-foot perch and its fractions (that is, 5 feet, 10 feet and 15 feet) fitted into the plot-frontage measurements more closely than any of the other perch measures assessed. This raises the possibility that a twenty-foot perch was used and that the town's plots and street blocks were laid out using a linear measure, rather than the areal, *virga* measurement used to survey the town's properties listed in the 1292 rental (Figure 6). Further metrological analysis of Winchelsea's plot widths may confirm or refute these results, while documentary evidence also provides some

help. For example, a royal mandate issued in 1286 indicates that Stephen de Penecestre, warden of the Cinque Ports (of which Winchelsea was one), had responsibility for carrying out the 1292 rental survey, whereas 3 years earlier he, along with two eminent London administrators, mayors Henry le Waleys and Gregory de Rokesley, were appointed by Edward I 'to give directions for streets and lanes necessary for the new town' (Calendar of Patent Rolls, 1281-92, 81-82, 225). Two different units of measure – one used for planning plots and another for assessing them – may therefore reflect this division of labour and also the protracted process of 'founding' new Winchelsea. There is a caveat to this, of course, for not all surveyed plot widths are necessarily medieval survivals – a problem germane to metrological analysis (see Slater, 1987).

Using GIS is beginning to reveal a little more of the processes and agents involved in medieval surveying and town planning, at least in the case of Winchelsea. While there may be different ways of interpreting the metrological data for Winchelsea, what is clear is that the GPS field survey coupled with GIS-based analysis has the potential for helping to reveal the processes that formed its urban landscape in the 1280s.

Conclusions

The purpose of this paper was to report on some recent experiences of using spatial technologies in mapping and analysing medieval built forms. This research is in its preliminary stages and what is offered here is simply intended as a working document to help urban morphologists think about using GPS and GIS in their work. The following conclusions can be drawn which may help in this regard.

The advantages of using GPS lie in the ability to gather *independent* urban field-survey data with a high degree of locational accuracy, providing that satellite coverage is unimpeded. Where buildings do block satellite coverage, an offset can be used. For both cases, differential GPS, as outlined above, is to

be recommended (in preference to using, for example, either a total station or tape measures). The advantages of GIS include the ability to bring diverse spatial datasets together (cartography, aerial photography etc) and relate them in the same co-ordinate space using the GPS data as ground control points. One of the results of doing this is that it has revealed positional inaccuracies of urban features (such as plot boundaries and street lines) shown by the current OS Master-Map® data (although OS data are due to undergo reassessment as part of the OS Positional Accuracy Improvement programme (PAI) over the coming year – see the OS website, www.ordsvy.gov.uk).

In the course of our morphometric analyses certain specific limitations to the software (ArcGIS) became apparent. First, ArcGIS does not as standard measure 3D polygon areas or the lengths of 3D polylines. This can, however, be achieved using free 'add on' tools obtainable online via ESRI (www.esri.com) but which are not straightforward to implement. Secondly, ArcGIS itself has no tool for measuring angles or bearings. This again can be circumvented using additional modules posted to the ESRI website discussion forums. (Alternatively the data could be imported to and analysed in a CAD). ArcGIS readily reports on the quantitative aspects of spatial data, but like other GIS it lacks tools for statistical analysis (Fisher, 1999). It can, however, generate outputs in a form that can be readily input into spreadsheet or specialist statistical packages for further analysis. Therefore, for the urban morphologist interested in using GIS to do historical work (beyond simply integrating spatial data sets), it may be necessary to find GIS extensions from the web (via ESRI), or even compose entirely new routines.

A variety of applications of GIS in mapping and analysing medieval built form have been demonstrated in this paper, including combining different data sources, and digitizing on-screen to provide a 3D visual representation of urban landscape features. Quite apart from providing a useful method of visualizing townscapes this also provides a basis for

conducting analyses of features that make up a town's plan. The ease of exporting data from GIS (here, ArcGIS) to spreadsheet software, as well as dedicated statistical packages, opens up the potential for a wide variety of statistical analyses of the morphology of a town, which is particularly valuable in the case of medieval urban landscapes for it can help to disclose patterns of measurements used by medieval surveyors. To this end, GPS and GIS are two spatial technologies that help to build upon existing morphological techniques of plan analysis and metrological analysis, providing yet further scope for mapping and analysing medieval built forms.

Acknowledgement

The authors acknowledge here the financial support of the Arts and Humanities Research Board, the residents of Winchelsea, who have showed so much interest in the project and enabled us to undertake successfully the field survey, and the National Trust who allowed access to their open land for the earthwork survey. Richard Comotto and Ivy White helped with establishing the local GPS station. David Martin very kindly gave us access to his work on Winchelsea.

Notes

1. 'Mapping the medieval urban landscape: Edward I and his new towns'. AHRB-funded project B/RG/AN3206/APN14501, directed by Dr Keith Lilley and Dr Chris Lloyd, Queen's University Belfast (UK). For more information see http://www.qub.ac.uk/urban_mapping/
2. Observations are collected by both receivers and the position of the local station is determined afterwards using specialist software.
3. Using a first-order polynomial transform.

References

- Baker, N.J. and Slater, T.R. (1992) 'Morphological regions in English medieval towns', in Whitehand, J.W.R. and Larkham, P.J. (eds) *Urban landscapes: international perspectives* (Routledge, London) 43-68.
- Bannister, A., Raymond, S. and Baker, R. (1998) *Surveying* 7th edn (Pearson Education, Harlow).
- Beresford, M.W. (1967) *New towns of the middle ages* (Lutterworth, London).
- Beresford, M.W. and St Joseph, J.K.S. (1958) *Medieval England: an aerial survey* (Cambridge University Press, Cambridge).
- Calendar of Patent Rolls, 1281-92: *Calendar of the patent rolls preserved in the Public Record Office [Great Britain] prepared under the superintendence of the deputy keeper of the records* (HMSO, London).
- Chapman, H.P. (2003) 'The recognition, interpretation and management of archaeological sites and landscapes using GPS and three-dimensional computer modelling', in Robson-Brown, K.A. (ed.) *Archaeological Sciences 1999*. Proceedings of the Archaeological Sciences Conferences, University of Bristol (BAR International Series 1111, Oxford) 31-5.
- Chapman, H.P. and Fenwick, H. (2002) 'Contextualising previous excavation - the implications of applying GPS survey and GIS modelling to Watton Priory, East Yorkshire', *Medieval Archaeology* 46, 81-9.
- Conzen, M.R.G. (1960) *Alnwick, Northumberland: a study in town-plan analysis* Institute of British Geographers Publication 27 (George Philip, London).
- Conzen, M.R.G. (1968) 'The use of town plans in the study of urban history', in Dyos, H.J. (ed.) *The study of urban history* (Edward Arnold, London) 113-30.
- Fisher, P.F. (1999) 'Geographical information systems: today and tomorrow?', in Gillings, M., Mattingly, D. and van Dalen, J. (eds) *Geographical information systems and landscape archaeology* The Archaeology of Mediterranean Landscapes 3 (Oxbow, Oxford) 5-12.
- Friedman, D. (1988) *Florentine new towns: urban design in the later Middle Ages* (MIT Press, Cambridge, MA).
- Grierson, P. (1972) *English linear measures: an essay in origins* (Reading University, Reading).
- Holdsworth, D. (1992) 'Morphological change in lower Manhattan, New York, 1893-1920', in Whitehand, J.W.R. and Larkham, P.J. (eds) *Urban landscapes: international perspectives* (Routledge, London) 114-29.
- Homan, W.M. (1949) 'The founding of New Winchelsea', *Sussex Archaeological Collections* 88, 22-41.
- Koster, E. (1998) 'Urban morphology and computers', *Urban Morphology* 2, 3-10.
- Koster, E. (2003) 'Multi-scale cartographic systems and morphology', *Urban Morphology* 7, 38-9.
- Leick, A. (1995) *GPS Satellite Surveying* 2nd edn (John Wiley, New York).

- Lilley, K.D. (1994) 'A Warwickshire medieval borough: Brinklow and the contribution of town-plan analysis', *Transactions of the Birmingham and Warwickshire Archaeological Society* 98, 51-60.
- Lilley, K.D. (2000) 'Mapping the medieval city: plan analysis and urban history', *Urban History* 27, 5-30.
- Lilley, K.D. (2001) 'Urban planning and the design of towns in the middle ages: the earls of Devon and their 'new towns'', *Planning Perspectives* 16, 1-24.
- Maitland, F.W. (1921) *Domesday book and beyond: three essays in the early history of England* (Cambridge University Press, Cambridge).
- Martin, D. and Martin, B. (2002) *A quarter-by-quarter analysis of Winchelsea, East Sussex* (Archaeology South-East, London).
- Quest Geodetic Software Solutions Ltd (2002) *Grid inquest user manual version no 6* (Newcastle upon Tyne).
- Randolph, A. (1995) 'The bastides of south-west France', *Art Bulletin* 77, 290-307.
- Sibson, R. (1981) 'A brief description of natural neighbour interpolation', in Barnett, V. (ed.) *Interpreting multivariate data* (Wiley, Chichester), 21-36.
- Slater, T.R. (1981) 'The analysis of burgrave patterns in medieval towns', *Area* 13, 211-16.
- Slater, T.R. (1987) 'Ideal and reality in English episcopal medieval town planning', *Transactions of the Institute of British Geographers*, New Series 12, 191-203.
- Slater, T.R. (ed.) (1990) *The built form of Western cities* (Leicester University Press, Leicester).
- Tout, T.F. (1920) *Chapters in the administrative history of mediaeval England*, vol. 1 (Longman, London).
- Tout, T.F. (1934) *Mediaeval town planning: a lecture* (Manchester University Press, Manchester).
- Whitehand, J.W.R. and Larkham, P.J. (eds) (1992) *Urban landscapes: international perspectives* (Routledge, London).

ISUF Symposium 2005

ISUF's programme of meetings has evolved in recent years on the principle of holding large conferences every other year (Birmingham 1997, Florence 1999, Cincinnati 2001, Trani 2003), in alternation with smaller symposia in the intervening years (Versailles 1998, Groningen 2000, Como 2002). This pattern was interrupted in 2004 with a large conference held in Glasgow and Newcastle celebrating ISUF's tenth anniversary, organized in conjunction with the Thirtieth International Geographical Congress in Glasgow. As a result, ISUF's Council decided to follow this with a smaller symposium in 2005, with the intention of holding a large conference in 2006.

ISUF will hold an international symposium in London at The Prince's Foundation 25-27 August 2005, hosted by the International Network for Traditional Building, Architecture & Urbanism (INTBAU) and The Prince's Foundation. The broad theme for the symposium will be 'Tradition and modernity in urban form'. Besides the latest work in urban morphology, it is hoped on this occasion to explore fruitful intersections between the interests, ideas and expertise of members of ISUF and INTBAU. In addition to academic sessions and panels, a special morphological excursion through a portion of near-central London will be offered.

Urban morphologists wishing to present a paper at the symposium should contact Dr Matthew Hardy, Secretary of INTBAU, The Prince's Foundation Building, 19-22 Charlotte Road, London EC2A 3SG, UK (E-mail Matthew.Hardy@Princes-Foundation.org). Proposals should have the following format: name of author(s), affiliation, postal address, e-mail address, telephone number, fax number, title of paper, and an abstract of about 250 words. The deadline for the receipt of proposals is 10 May 2005.

The number of places at the symposium will be limited and acceptance for attendance will be on a first come, first served basis. Placement on the programme will be communicated to applicants by 1 June 2005, and will be contingent upon advance registration. Details are available on ISUF's website (www.urbanform.org), as well as that of INTBAU (www.intbau.org).

The next meetings of the Council and Editorial Board will take place during the Symposium. Any matters that members wish to bring to the attention of the Secretary-General, Professor Michael P. Conzen, should be communicated to him via e-mail: m-conzen@uchicago.edu (postal address: Committee on Geographical Studies, University of Chicago, 5828 S. University Avenue, Chicago, IL 60637-1583, USA).