2 Motivation and orientation of research

2.1 Motivation and scope

Some six years ago the author shared many of the beliefs which have been described as those of the English-speaking world. New theories, comparable to those under development elsewhere, could only emerge from a confrontation between these preconceptions and data emerging from the consideration of a possible cadastre in Britain.[25] A particularly important result was the discovery of apparently planned oblique relationships between the main road and the hypothetical cadastral grid.

In this earliest investigation it was noted that two segments of main Roman road oblique to the South Norfolk 'A' cadastre have a common orientation; they are parallel and are both at about 30° to the cadastral grid. So it was natural to wonder if this had occurred purely by chance.

Given that multiples of 30° play a major part in Ulrix's (1963) theory, it was initially supposed that further study of this case would reveal the same angle between both road segments and the grid. However, careful measurements were made of the angles between the road segments and the north of the Ordnance Survey grid using a vernier protractor. This was added to the orientation of the cadastre with respect to the same north, and it was clear that the angles between these segments and the cadastre were likely to be closer to 31°, rather than 30°.

Since the discrepancy was so large, this was a disappointing result. Nevertheless, the angles of the two road segments are the same and the idea persisted that they could have both been planned in the same way, possibly in relation to the cadastre. Furthermore it was recognised that a numerical specification of this relationship, in

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[25] See below *(5.1)* for a general presentation of research on the South Norfolk cadastres.

Roman mathematics, would not involve real numbers, but must be in integers or possibly ratios of integers[26].

Since a theory based on the use of rational sines was unsatisfactory, attention then turned to rational tangents. This produced a much better result. $Tan^{-1}(3/5)$ is 30.96°, more nearly in agreement with the measured angles. Furthermore, one of the Roman road passes through a point halfway along the side of a century. This is clearly a point of special significance in the layout of the century's internal divisions (Favory 1983), which is likely to have been marked by a **terminus*. This road segment would thus fit a model in which, in principle, oblique features could have been surveyed by joining the *termini* of the cadastre. The oblique feature is then the diagonal of rectangles with integral sides, formed by the cadastral axes; and its angle is determined by their ratio. This can be expressed as 5:3, using the convention that the length along the axis nearer to north is given first.

Now, this theory seemed to fit the hypothetical South Norfolk A cadastre, but it was unlikely to be believed in that context. It was therefore necessary to discover if it could be applied generally, thus demonstrating that it is not constructed - *ad hoc* - solely to explain the features of this small area of an apparently peripheral part of the Empire.

This whole investigation was thus initially stimulated by an interest in this particular form of surveying technology and by a desire to study it over a wider area.

Roman technology is admirably suited to this purpose because in many fields, such as military equipment, architecture, transport, water supply etc., virtually identical artifacts and structures can be recognised throughout the whole Roman world. The technical aspects of Roman culture are to a certain extent predictable.[27]

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[26] This was why 30° had been attractive, because its sine is 1/2.

[27] Collingwood in 1928 demonstrated the value of a predictive model of Roman fort siting on the Cumbrian coast (van der Dussen 1981: 239-241).

There was thus reason to believe, in the absence of convincing evidence to the contrary, that techniques of land surveying would be no different[28] and that lessons learnt in one area could be usefully applied in another. Therefore one aim underlying the research was to study these ancient land information systems in as broad a context as possible.

Another aim was to avoid the restrictions of a single approach to such a study[29]. From the start the author felt the need for several different approaches. This feeling was initially personal and intuitive,[30] but it also had an institutional basis. The University of East Anglia has always been organised into multi-disciplinary schools of study, and to some extent the ethos of the organisation encourages the use of several approaches to a problem.

Nevertheless the author, because of his own background, felt that mathematics and computing would be the areas in which he could make the greatest contribution to the investigation of ancient cadastres. With this in mind some of the main research questions can be stated. Can we find methods which will allow for the measurement of cadastral systems and of their relationship with other features of the landscape? Can we develop and test a theory of oblique planning in a wider context? As a result of the development of these methods, what can we say about the cadastral systems themselves?

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[28] Note also that the work of the *agrimensores* was closely linked to the legal system. This would also encourage uniformity.

[29] Compare the remarks of Myres (1986: 218), quoting Symmachus, "It is impossible to solve so great a puzzle by using one route only".

[30] However, it may be justifiable within the context of realist philosophies of science; and such a justification is attempted below *(7.2.3)*.

2.2 A computational approach

The aim, then, was to explore these land information systems via the landscapes which they may have influenced, to further investigate the idea that they might have been implemented in Britain, and (for these purposes) to develop computational methods which would be capable of being used in an ancient cadastre in any geographical context.

Such a project faces some difficulty, particularly if it is to be attempted in Britain itself. It is generally thought that a search for Roman centuriated cadastres in this province cannot succeed. In Martin Jones' opinion this must be so, because:

> "The major epoch of physical land division in Britain would appear to be the second millenium B.C., but such landscapes continue to be reworked in subsequent millenia. Attempts either to compress all prehistoric land enclosure into the second millenium B.C., or to isolate subsequent periods of extensive enclosure, have not stood the test of time. We must envisage a continuous reworking of an ancient structured landscape, some of which is to be located in the late prehistoric and Roman periods. On the question of centuriation, despite some ambitious speculation no patterns have been discerned within the contemporary British landscape that approach anywhere near the pronounced rectilinearity of centuriated landscapes found elsewhere in the Empire; nothing resembling the ordered patterns recovered from more southerly parts of the Empire survives in the British landscape." (Jones 1989: 129)

This authoritative statement (note the "we must") relates the landscapes of Roman Britain principally to those of earlier periods and, in the last sentence, effectively dismisses the idea of centuriation in Britain.

This rejection is based upon the fact that there is no correspondence between the actual landscape and the image of "centuriation" which many British scholars, including Jones, convey to their audience, and (presumably) to themselves. Jones does not make it absolutely clear which southerly parts of the Empire he has in mind, but

it seems safe to assume that he is referring to well-known examples in Italy, Dalmatia, Africa and possibly Gallia Narbonensis.[31] Since nothing in Britain resembles these relatively obvious systems, his conclusion is inevitable.

For the possible reasons proposed above*(1.2)*, the British conventional view exists, and we can see that, once established, it tends to prevent the acceptance of facts which do not conform to its image, as Jones' views show. He and his fellow scholars would almost certainly dispute the existence of systems in eastern France, in the Saône plain[32], outside the Mediterranean sphere, since these cadastres certainly do not meet their criterion of obviousness. Nevertheless, as a later description of the use of a simple computational technique will show *(3.1.4)*, one of these systems is almost certainly real. The apparent accuracy of its surveying give good reason to regard it as a fact, despite its almost total lack of physical presence in some places.

These systems in "long haired" Gaul are not obvious; and there is yet another way in which they convey an image which is different from that of the conventional British view.

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[31] These four areas appeared in (Bradford 1957). Cadastre A of Béziers was eventually mentioned in an English book (Greene 1986), but 16 years after the original publication. Rivet (1988) also includes some reference to the Narbonensian systems, but again the information tends to be out of date.

[32] Descriptions of these were first made generally available by Chouquer and Favory (1980).

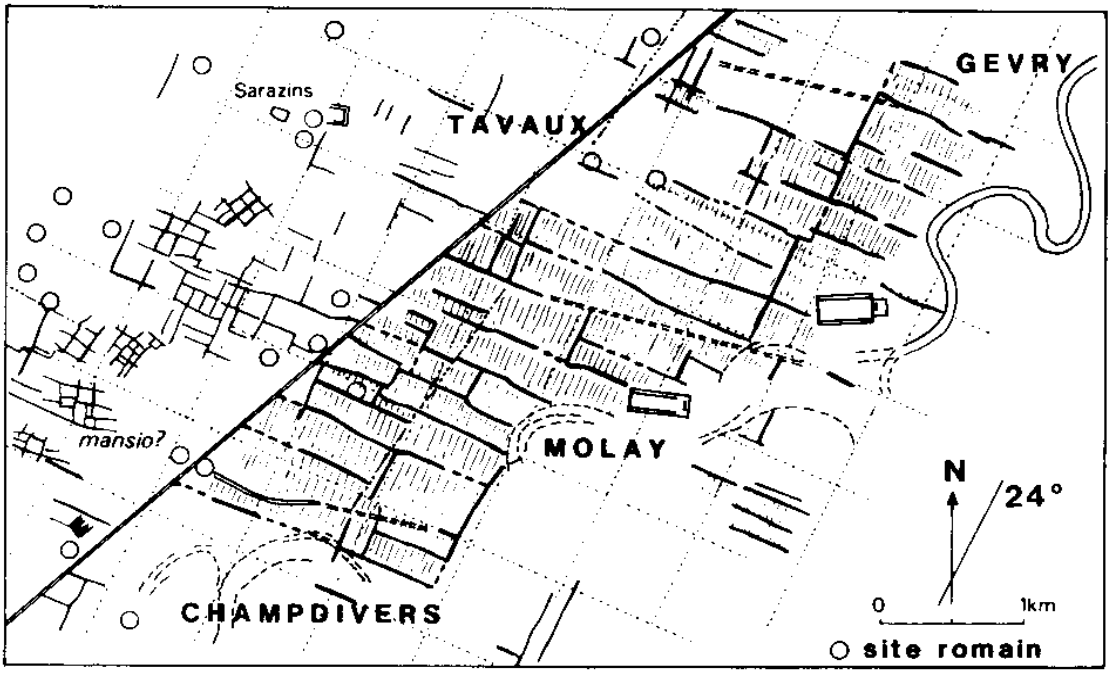

Figure 2.1 *Reconstruction of the domain of the Molay* villae, *showing fields in 'native' style within the centuriated cadastre of the Saône plain, eastern France; after Chouquer and DeKlijn (1989: Fig. 13).*

Superimposition of cadastres is evident; and in the Finage (Jura), it is theoretically possible that 'Celtic' fields survive as discordant 'islands' within the scope of a Roman centuriation *(figure 2.1)*. According to Chouquer and de Klijn (1989: 282), some may have been newly created in the Roman period, discordant to the cadastre In general, Roman cadastres need not necessarily totally erase the traces of earlier systems of land management and they may also co-exist with fragments of an earlier Roman cadastre at a different orientation.

There is nothing new in this claim. Dilke gave us, more than 30 years ago, some documentary evidence (1961: 418, and see also 1985: 93) in a passage from the *Constitutio* ascribed to Hyginus Gromaticus:

> "Augustus also re-founded a number of cities previously founded as colonies but depopulated in the civil wars, by sending out new colonists and sometimes increasing their territory. The result is that in many

areas new centuriation cuts into the old at a different angle, the stones at the old points of intersection still being visible".[33]

And the evidence for partial superimposition is not just textual. Aerial photography long ago revealed superimposed systems in Algeria (Chevallier and Soyer 1962: 45), and more recently excavation has shown that the three differently oriented systems of Béziers are not a figment of the researcher's imagination. Boundaries of land division of all three systems have appeared, following excavation (Bonifas, Poupet and Vidal 1990).

The image held and conveyed by significant groups of British and French workers - and by this is meant their mental picture of what they think they are talking about - is clearly not the same. For this reason a group of French workers are prepared to consider the existence of centuriated cadastres in the north-western part of the Empire, whereas, in general, British scholars are not.

This difference in viewpoint leads to a lack of agreement on the appropriateness of methods of investigation. Optical filtering is an example.

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[33] You might expect this practice to lead to confusion; and it did. Siculus Flaccus explained for the benefit of the trainee surveyor the problems that arose in the *ager nolanus*, an area which had been surveyed with two independent sets of *limites*. Chouquer, Clavel-Lévêque, Favory and Vallat (1987: 206, note 375) draw our attention to the following (Blume, Lachmann and Rudorff 1848: 162, 3-8): *Evenit aliquando, ut in Nolano comperimus, idem, quom diviso non ab uno puncto concessit, sed ex diversis limitibus, qui oblique inter se concurrunt*. For Chouquer et al. this is clearly a case of superposition. They say "Dans le cas évoqué pas notre arpenteur, il s'agit sans doute de la difficulté à localiser sur la forma et sur le terrain un fonds décrit de manière trop sommaire dans une *tabula aeris,* c'est-à-dire que les coordonées qui y furent portées ne se référaient qu'à une seule limitatio, alors que la situation s'est compliquée ultérieurement, avec la superposition d'un autre cadastre, producteur de nouvelles coordonées spécifiques."

Anthony King expresses strong reservations on the use of the technique:

> "As far as centuriation is concerned, aerial photographs have formed the basis for some scholars to suggest that many hitherto unsuspected areas of Gaul were regularly laid out. The Gaulish land allotments were apparently swept away in favour of a new, regulated Roman system. However, . . . , many of the proposed centuriations seem to owe more to faith than reality. This applies especially to those suggested areas to the north of Gallia Narbonensis and the Lyon centuriation system. It is the technique of optical filtration with its emphasis on right angles and rectilinear boundaries visible in an aerial photograph that is largely responsible for optimistic proposals of centuriation systems. . . . Another problem arising from the use of this technique is that land allotments apparently overlying one another at different angles have been inferred; at Béziers, for example, no fewer than three such grids have been proposed. This seems to fly in the face of evidence of continuity from most areas through long periods of time once a system was established. Was it necessary to impose a new centuriation system at a different alignment if the existing allotments followed Roman practice and were available to be reallocated? It would seem most unlikely." (King 1989: 99).

This is radically at odds with some French views and, as an almost "official" British view (it appears under the imprint of the British museum), it merits criticism.

First, nobody claimed that in order to implement Roman cadastres "the old Gaulish land allotments were swept away", and as we have seen above in the case of one of the Saône plain systems it may not be true. However, it is a widely accepted ideology, even in France. As Chouquer says (1989: 96),

> "Pires que les légions de César ou les colons d'Auguste, nous écraserions la réalité indigène et son paysage au profit de la norme cadastrale nouvelle."

In our own minds, when we consider the events accompanying the implementation of a cadastre, we are inclined to wipe out the pre-Roman landscape to a much greater extent than the Romans did. We find it difficult to escape from the twin notions, firstly, of the

cadastre as a necessarily physical structure in the landscape and, secondly, of the Roman conqueror as a dispossessor, or at the least a rearranger, of those existing land holdings which fell within its scope[34].

Second, King's assessment of optical filtering seems ill-founded. He feels the need to question the method, apparently because it leads to the production of evidence for the superimposition of cadastres (a concept which he does not accept), but he appears to misunderstand the way optical filtering is used. It is an objective aid which, like any filter on reality, reduces and simplifies the data in a consistent fashion in different geographical and social contexts. The images are processed at many angles and the results are not the sole basis for the advancement of a particular hypothesis. The method may reveal genuine cadastres, some of which on further examination turn out to be probably Roman, but the genuineness still needs to be established by other methods.

There thus appear to be some strong differences of opinion between experts. Even a scientific method such as optical filtering can be mistrusted when its implications go against ingrained beliefs. In this difficult situation a computational approach has arguments both for and against.

The advantage of a computational approach derives from the nature of the systems under consideration. Their remains may now be degraded, but, as we shall see, their original surveyors must, in certain cases, have gone to the limits of their ability to make the survey accurate. Hence computational models can be applied in the expectation that they will often be a good fit to reality.

This very unusual situation allows us to establish numerical parameters for individual grids, to test predictions about the statistics of selected groups of features (in order to estimate the plausi-

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[34] Disposession does not seem to have been mandatory. Large areas of land in the Orange B cadastre (Piganiol 1962) were "TRIC RED", i. e. given or given back to the Tricastini, although perhaps not immediately.

bility of hypotheses), or to suggest relative chronology by measuring their degree of association with particular grids

Some work has already been done on these lines. That by Dodinet, Leblanc and Vallat (1987) was devoted to estimating orientation and module for the two cadastres Béziers A and B by calculating the best fit to possible *limites* in a small area to the south-east of Béziers.[35] Rita Compatangelo (1989) used several computational methods. She used a χ^2 test to estimate a confidence for the degree of association of menhirs with a centuriated grid at the south east tip of Italy; another of her computational approaches will be the subject of a later critique *(5.1.3)*.

The disadvantages of a computational approach are at least twofold. One is that the methods employed may be of little ultimate use, because they are incomprehensible to most archaeologists. A second is due to the inevitable association that is made between computation and the "new archaeology". Those who react against the ideas of this school of thought may be unreceptive to arguments based on the use of even the simplest computational models.

The first problem is not, strictly speaking, scientific. Nevertheless the fact remains that if the research methods are not understood then they are hardly likely to be trusted.

The difficulties seem to lie in communication and education, and for that reason some attempt will be made here to present the computational material in as straightforward a way as possible, often from first principles. This may be tedious for the mathematically experienced reader, but the approach recognises that the end users of the techniques may have had no such training.

The second problem is potentially more substantial.

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[35] They also created a small database for information on villas in the same area, and made some remarks on their likely relationships to the two cadastres, but this part of the work was qualitative.

Quantitative approaches are inextricably linked with the New Archaeology and this movement is, in its turn, often linked with a positivist view of the world. This is clearly expressed by Lewis Binford (who is often regarded as one of the founders of New Archaeology), speaking about Thomas Kuhn's (1977) widely known paradigm theory of the development of science:

> "Science grows as a consequence of the development of means for objectively monitoring experience in its myriad forms. As our skill at objective evaluation of ideas grows, there is a growth with continuity, or pattern of accumulative development of knowledge. Kuhn's view of change by paradigm replacement could only be true in the absence of objective means of evaluating experience. It may be the normal pattern for prescientific intellectual change, but within science orderly growth and accumulative development of knowledge are the patterns to which the scientific method is dedicated. Paradigm change may give the appearance of revolutionary change when poorly developed areas of science become increasingly developed and there is a shift from the general cultural paradigm to a more objective, scientific one. Such realities of life are in no way valid justifications for abandoning scientific goals and returning to prescientific forms of debate. Similarly, the argument against the logical positivist's position, questioning the role of theory testing, is misguided." (Binford 1982: 136).

In saying that Science develops by "growth with continuity" Binford seems to be mistaken[36], but the more interesting part of his argument is the true statement that "Kuhn's view of change by paradigm replacement could only be true in the absence of objective means of evaluating experience." In other words, *if* there were no objective means of evaluating experience *then* Kuhn could be right.

Of course it is an article of faith to positivists that such objective means exist, if only we look hard enough for them. But there are

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[36] For contrary evidence see Chalmers (1990), Feyerabend (1978), Hallam (1973), LeGrand (1988). Most of the discussion centres around the Galileian or the Plate Tectonics revolutions.

others whose epistemological theory is different, for whom there are ultimately no such means of obtaining the truth. They would see Kuhn's theory as perfectly reasonable.

Binford asserts in this particular article his commitment to Logical Positivism, and because of his belief he is bound to deny the validity of theories like Kuhn's. He treats any outdated search for knowledge (under what a Kuhnian would call an earlier paradigm) as pre-scientific, thus giving a special place to science as we know it, and also a special place to theory testing as the only scientific method.

Now, theory testing almost always involves quantification, so it is tempting to assume (wrongly) that an investigation which involves quantification must be based on theory testing. Furthermore, since most theory testing is conducted within a positivist framework, following Popper's (1972) method of falsification, it is also easy to assume that theory testing and positivism are always associated. This chain of associations can lead one to think that a worker's quantitative approach necessarily implies that he or she has a positivist outlook.

So quantification may not aid the acceptance of a piece of work. Rather, it can be a barrier to those who feel, perhaps without articulating their feelings, that their own personal archaeological world is a place which is too complex to be quantified or subjected to falsificationist testing.

To sum up this section, there are several obstacles to the quantitative study of Roman cadastres, particularly if we are attempting to study those that may exist in Britain. The salient problem is that, in the eyes of those who see Roman cadastres according to the British image, there are no available sense data which fit the conventional oversimplified model. Thus, for them, no British examples exist. The evidence of real systems which leave tenuous surface traces, and of superimpositions attested by aerial photography, excavation and ancient documents, is ignored. Optical filtering, a method which is intended to introduce greater objectivity, is discounted when it gives the "wrong" answer. There is thus no guarantee that results

produced by computational methods, including statistical tests, will be taken to be valid evidence, even if their basis is understood. There is also the danger that the very use of such methods will create an impression that the research is being conducted within the framework of positivism, an approach which many now discredit.

However, we must proceed. There may be obstacles which hinder the acceptance of the results of the research, but it is still clear that the quantitative study of antique cadastres, in a wide geographic context and in conjunction with other methods, offers both opportunities and benefits.