I. INTRODUCTION

This thesis deals with intrasite spatial analysis: the analysis of spatial patterns on site level. My main concern has been to develop a simple method for analysing Stone Age sites of a special type: those characterised by the presence of a hearth closely associated in space with an artefact scatter. Though this type of site is quite common, especially in the Upper Palaeolithic, other types do exist. The method introduced in this thesis, the ring and sector method, will generally be inappropriate in cases where the global "spatial organisation" of a site is not defined by a central hearth (however, see Ch. V for an application to another situation). Being feature-oriented, the ring and sector method is restricted in its range of applications.

My interest in this type of research developed as a result of the excavation (1980, 1981) of a Hamburgian site at Oldeholtwolde in the Northern Netherlands (Stapert, 1982; 1986A; Stapert et al., 1986; see also Moss, 1988; Stapert & Krist, 1990).

The artefacts were embedded in Lateglacial coversand. On the site the Usselo Horizon is present, separating Younger Coversands I and II. The Younger Coversand II is only a few decimetres thick, relatively coarse-grained and not distinctly layered; it was deposited during the Late Dryas Stadial (Dryas 3). The Younger Coversand I is finer and contains "loamy bands". This deposit is about 2 m thick and clearly horizontally laminated; it rests upon Upper Pleniglacial brook deposits. The find level was about 30 cm below the top of the Younger Coversand I, and can thus be dated stratigraphically to just before the beginning of the Allerød Interstadial, in the last part of the Dryas 2 Stadial. The find level was not located in a soil or erosion level. Therefore we can be fairly sure that the site represents only one (relatively short) occupation. Because of this a spatial analysis of the site seemed to be meaningful undertaking.

The artefact concentration had a roughly circular shape with a diameter of about 6 m. In the middle was a large hearth consisting of a heart-shaped configuration of flat stones (average thickness about 2 cm) in a shallow depression. In the centre a pit (about 35 x 50 cm, depth about 10 cm) had been scooped out, its floor and sides lined with closely set, flat stones, mostly sandstones. The hearth contained charcoal from burnt brushwood (Salix: Dr W.A. Casparie, pers. comm.), especially under the stones in the central pit. Four or five C14-dates are available (see the Note on the radiocarbon dates, appended to this introduction). The hearth is similar to Late Magdalenian ones in France, but differs somewhat in the sense that the Hamburgian people took great care in selecting thin slabs for use in the central pit. Since there was charcoal beneath, these were obviously heated, perhaps to roast meat or fish on top.

The hearth of Oldeholtwolde is in a broad sense comparable to the foyers à cuvette et bordure at Pincevent (see e.g. Leroi-Gourhan & Brézillon, 1966; 1972). French colleagues generally call them foyers domestiques, since they are located in the centre of dense scatters of artefacts and bones, which are interpreted as habitation units occupied by small groups such as families. In the periphery of these habitation units smaller hearths may be encountered, which are called foyers satellites. These were used for specialized activities (Julien, 1984).

The global spatial organisation of the site at Oldeholtwolde is similar to that of the habitation units at Pincevent: a large hearth in the centre of a dense artefact scatter (at Oldeholtwolde no satellite hearths were found).

It is for this type of site that the ring and sector method was developed. My intention was to use simple ways of describing global spatial patterns, relating to the hearths, in the distributions of flint artefacts. A major goal was to summarise these patterns in simple diagrams or indexes, allowing the comparison of different sites.

The idea behind the ring and sector method is that the "domestic hearth" was a focal point in the daily life of a small group of people. The hearth attracted many activities, including some
that did not require the direct use of fire or heat. In other words: the domestic hearth should not be seen in functional terms only; it also played an important role in social life (e.g. Binford, 1983; Olive & Taborin, 1989; Yellen, 1977). As Simek (1984: p. 406) has put it, features such as hearths may have acted as "centres of gravity" (see also Carr, 1984; and Ch. IV).

Using rings and sectors around the hearth centre seems to be a "natural" way of charting spatial patterns in such situations. These two related ways of partitioning space are derived from the structure of such sites, and therefore seem eminently suited to reveal patterns relating to the hearth.

Stone Age archaeologists mostly excavate according to a grid system; an early example is the work of W. Pengelly at Kent's Cavern, 1865-1880. As a result, many approaches to intrasite spatial analysis are also based on grid systems (see e.g. Blankholm, 1991). However, grid systems rarely bear any immediate relation to the spatial structure of the sites, and this applies especially where a central hearth is the dominant feature. Grid systems may be useful for purposes of description. For example, global density patterns can be illustrated satisfactorily (see Cziesla, 1990). However, if one wishes to develop hypotheses on the interpretative level, grid systems present severe difficulties. Many different site-formation processes have played a role in shaping the archaeological residues to be interpreted (e.g. Schiffer, 1976). Computerised methods using grid-cell frequencies have to operate on the assumption that all artefact locations have the same relevance mathematically. This will make interpretation of their results very difficult, because we do not have straightforward models for unravelling the various kinds of formation processes that may have operated.

Because of this problem it seems useful to develop methods that are feature-oriented. The interpretation of the results can then proceed in a structured way. In a feature-oriented approach we are looking for spatial patterns in relation to a certain feature, and interpretation of any such patterns, if they can be demonstrated unambiguously, will be guided by our knowledge concerning that feature. This approach may seem more restricted than most current methods for spatial analysis, which are often "general" in nature. In my opinion, however, this very restriction constitutes the strength of feature-oriented methods: they allow us to penetrate deeper into the data jungle, because the pattern recognition process is now structured and specific. Simek (1984) was one of the first investigators to stress the importance of feature-oriented spatial analysis.

In principle, several types of feature could be employed as "anchors" for a spatial analysis. In this thesis the "domestic hearth" is selected as the feature on which to centre the spatial analysis. This choice leads to the use of rings and sectors. Another type of feature on which a method for spatial analysis could be based is the dwelling structure (tents, huts, etc.). However, this would present us with severe difficulties in many cases. Establishing the presence of a Palaeolithic dwelling structure and its layout may be difficult, and is often impossible. Sites where unmistakable remains of dwelling structures have been excavated are quite rare. In many cases the evidence presented for dwellings postulated at Palaeolithic sites is inconclusive. In my opinion, therefore, establishing the presence or absence of a dwelling structure should be an important goal of spatial analysis, instead of an assumption on which to base the analysis.

Hearthrs, especially if characterised by stone constructions, are relatively easy to identify archaeologically. Even in cases where the hearth was neither stone-lined nor located in a pit, and where the charcoal was removed secondarily, the location of the hearth can often be inferred from the clustered distribution of burnt flints. Moreover, it seems reasonable to suppose that many more types of activity bore at least some spatial relation to a hearth than were related to a dwelling structure - if indeed there was a dwelling. Thus, if one adopts a feature-oriented approach for spatial analysis, the hearth is obviously the best choice.

Another decision made in the early stages of my research was to restrict the analysis to the distributions of flint artefacts. The reason for this is poor preservation of bone on the sandy plains of northern Europe.
An attractive aspect of the ring and sector method is the circumstance that it is closely related to Binford's "hearth model" (1983), based on ethnoarchaeological research. Binford described a characteristic pattern of "drop and toss zones" around outdoor hearths. In retrospect, this model (see Ch. II: fig. 8) already suggests the use of rings and sectors. This correspondence between an ethnoarchaeologically derived model and an analytical tool is, I believe, one of the main reasons why the ring and sector method seems to perform well. After playing with the ring and sector approach for some time (using the data of Oldeholtwolde and Pincevent T112), I began to see various patterns, some of which I could interpret on the basis of Binford's observations. It was only after I discovered that the method made it possible to establish the presence or absence of dwelling structures, that I started to take this game seriously (Stapert, 1990). In fact, Binford's model has proved to be of much value ever since, precisely because it allowed me to attach meaningful interpretations to the patterns brought out by the ring and sector method. I do not hesitate to admit that the route I followed was from game to theory, not the reverse.

In the above, I sketched a brief history of my involvement with the ring and sector method. This thesis is not a structured monograph, but a collection of four articles which evolved in the course of some five years. They are reproduced here in the chronological order in which they were written. This structure has certain disadvantages, one of which is some unavoidable overlap between the various papers. In the course of time my thoughts evolved, which is clearly reflected in the texts. On the other hand, the basic ideas never changed; I did not in the meantime come across serious objections to the method, though I had many colleagues comment on earlier drafts of the four papers. This gave me the confidence to combine them into a thesis. In other words, I do not regard this thesis as a polished end product. Rather, it is a methodological progress report, showing that the ring and sector method is a useful addition to our analytical repertoire.

In retrospect, I found that, alongside Binford's model, several approaches bearing some similarity to the ring and sector method had already been explored by other researchers. In a paper by Dekin (1976) the "elliptical analysis" was introduced. This method is directed at analysing postulated dwelling structures. The assumed interior of the dwelling is divided into eight equally large cells, by a system of two ellipses and four quadrants. In principle, this method could be adapted for analysing artefact scatters around hearths, but using rings and sectors seems more natural in such cases.

"Tipi rings" are sometimes excavated by American archaeologists using a system of rings and sectors. Hull (1987) applied such a system to the spatial distribution of chips smaller than 1 mm.

In both these cases, feature-oriented methods were employed, albeit not centred on hearths; yet they could be so adapted. There are also hints of a feature-oriented approach in the work of Löhr (1979), though he did not attempt to quantify spatial patterns. Simek (1984) explicitly stressed the potential of feature-oriented spatial analysis, and used the mean distance to hearths of artefact classes as an analytical instrument.

In a more general sense, the ring and sector method is also reminiscent of the "quadrant method" for excavating burial mounds, devised by Professor A.E. van Giffen, the founder of the Biological-Archaeological Institute.

The work reported in the four papers of this thesis may be characterised as a methodological exercise in feature-oriented intrasite spatial analysis, using the hearth as the main feature. The first paper (Ch. II) concentrates on the wonderful site of Pincevent, exploring especially the analogy with Binford's model. The demonstration of the presence or absence of "drop and toss zones" with the help of the ring and sector method is a central theme. It was found that at some sites toss zones cannot be demonstrated - at least not on the basis of the distributions of flint artefacts. These may be sites where the occupants anticipated only a short stay, for example hunting camps of small groups of men.

A second important topic is the application of the method with regard to the dwelling question; for this the work on Gönnersdorf was essential (see below). Several other issues are
also touched upon, including an attempt to identify gender patterns in the space around hearths which were probably located in the open air.

The second paper was a joint venture with Thomas Terberger (Mainz). We had worked together already at an earlier stage, on Concentration IV of Gönnersdorf (Stapert, 1990; Terberger, 1988). At this Concentration a clear tent ring was excavated by Bosinski, and the analysis by the ring and sector method produced the first indications of its usefulness in establishing the presence of a dwelling, independently of what Leroi-Gourhan (e.g. 1972) calls structures évidentes. This idea was then tested using the data of Concentration I at Gönnersdorf, and it was found that the ring and sector method allowed an independent reconstruction of the outline of a tent. This reconstruction turned out very similar to the one by Bosinski (1979), based on the constellation of postholes. These results are summarily reported in the first paper of this thesis (Ch. II), but I intend to write a more extensive report on Gönnersdorf in the coming years. The ring-diagrams of Gönnersdorf I which formed the basis of my reconstruction are illustrated in the Appendix to Ch. II. At most of the investigated sites the hearths seem to have been located in the open air. This applies for example to all concentrations at Pincevent.

In the second paper (Ch. III) Terberger and I investigate the possibility of multiple occupations in the case of Concentration III at Gönnersdorf. Multiple occupation seemed likely because at this Concentration six different raw materials were exploited. Separate application of the ring and sector method on each of these raw materials showed that at least two occupations must have taken place, the first of which occurred inside a tent.

The third and fourth papers (Chs. IV, V) again concentrate mainly on the dwelling question, with regard to a Maglemosian site in Denmark, and to three Middle Palaeolithic sites in northwestern Europe, respectively. My main concern was to explore the potential of the ring and sector method for sites dating from periods other than the Upper Palaeolithic. A general conclusion from this work is that the method can be fruitfully applied to settlement traces from these periods as well. This must be because the processes underlying the patterns brought out by the ring and sector method are very basic, and therefore do not vary much between different cultural contexts in northwestern Europe. In other climatic regions, for example the tropics, different site-formation processes may be anticipated.

Though the ring and sector method is simple, it is rather time-consuming. During the work reported in this thesis, I had to measure the ring and sector distributions of many thousands of artefacts. This was done by hand, and for much of the subsequent data processing a mere pocket calculator was employed. Most of the statistical calculations were done with the help of STATPAK, and many diagrams were produced with SLIDEWRITE PLUS. It is, of course, possible to develop a computer programme to do the job. As during the initial years I considered this work largely as an interesting game, I did not bother much about automating it. However, I now think that developing dedicated software would be very worthwhile. One of the main reasons is the fact that one could then explore several alternative possibilities in applying the method. For example, one could vary the width of the rings, the number and position of the sectors, and even the location of the "centre". In doing this, one would be able to find the "optimal" parameters of the method for any given site, and this would enhance its level of resolution. At present, G.R. Boekschoten (Groningen) is engaged in developing a programme in TURBO PASCAL. The data used by this programme are Cartesian coordinates of the locations of flint artefacts, divided into several categories. As a test file the data from Oldeholtwolde are used. The programme will also be able to deal with stones of other kinds than flint, bones, and other types of material. It is expected that this programme, named RINGS&SECTORS, will become available within a year.

Despite the tiresome processing of the many data, I have enjoyed this work. Stone Age studies once more became a lively and interesting discipline to me, which was satisfactory after the disagreeable experience of my involvement with the "Vermaning affair" (e.g. Stapert,
1986B). One of the most pleasant aspects was my contact with so many colleagues; their interest in my work and the stimulating discussions we had were a true source of inspiration. It was encouraging to find that even "zooming in" on such a detailed and seemingly small world as intrasite spatial analysis need not isolate the scientist from other fields. Indeed, the more deeply I got involved in this work, the more interested I became in other ways of looking at the Palaeolithic world, such as use-wear studies, refitting analysis, and ethnoarchaeology. It increasingly transpired that "everything tied up with everything", and this made the game a fascinating one.