
Urban morphology and computers

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Abstract. *The use of image processing and GIS in urban morphology research in the Department of Art and Architectural History in Groningen University is described. Attention is focused on a research project on the development of the town plan of the city of Groningen since the early seventeenth century. The potential of the computer is demonstrated, not only for the comparison of historical plans but also for visualization and analysis.*

Key Words: urban morphology, computers, historical plans, GIS, Groningen

In the last decade in particular, a number of disciplines have developed, or adapted, computer programs to process and analyse spatial information. Within the fields of planning, geography, biology and archaeology, for example, such programs now have an important role in research. Within urban morphology too they have become a significant research tool. However, within historical urban morphology in particular, computer programs for analysing spatial information present a number of problems; they are not a panacea.

New technology in research

The main advantage of the new technology is that it makes time-consuming operations easier, quicker and, sometimes, more accurate. In addition the visual aspect of this technology has advantages, and by using Geographical Information Systems (GIS) it is

possible to analyse data that themselves contain no direct spatial references.

This article is based on research on the reconstruction of the town plan and planning ideas in the city of Groningen since the early seventeenth century. In this research, 'traditional' methods have been combined with the use of the computer.

This is not the first historical research on the town plan in which a computer has been used to analyse spatial transformation processes. In the early 1980s, for example, research was started at the University of Pisa on the reconstruction of the fifteenth-century town plan of the city of Carpi.¹ This project used a CAD program based on cadastral data of 1472. The resulting plan was compared with the oldest reliable cadastral plan, which was prepared in 1893. Aerial photographs were used to establish more precisely the relationship between the fifteenth-century boundaries and the morphological character-

istics of the buildings. The research was carried out using a register that provided the location and measurements of all of the plots.

Groningen's townscape, 1620-1830

For the research on Groningen there was no such register. Only a few plans were available and the relevant archival records had not been explored in detail. Information enabling precise locations to be determined was not available until the first cadastre of 1830-2. However, by comparison of plans from different periods, changes in the town plan could be recognized and described.

When historical plans are compared with other cartographic materials several problems need to be resolved. First, there are differences of scale. By the use of the computer all material can be brought to the same scale. Secondly, there are differences of orientation. These too can be reconciled by the use of the computer. The twin processes of bringing plans to the same scale and orientation are now found in almost every GIS package. For this registration process to work, it is necessary to have a minimum of four corresponding points, although to avoid distortion and other problems more points are advisable.

After registration, the plans can be overlaid and merged on the computer and used for analysis. Complex procedures can be undertaken, as has been demonstrated by Hunter and Williamson.² They were able to study the evolution of land parcellation and development in conjunction with other social, economic and environmental data. Examples of procedures that they could undertake in their system are the listing of all parcels in chronological order and the finding of all parcels created between two dates.

Levels of analysis

In the Groningen research, the town plan is studied at a number of levels. The first level is that of the location and topography of the entire city (Figure 1). The second is the streets, squares, canals and building blocks,

and the influence of the fortifications on the layout. The third is the plots and plot pattern.

With regard to location and topography, soil and pre-urban structures are important considerations. Plans exist of the seventeenth-century extension (begun in 1608 and completed in 1621) and for earlier dates. The drawing of a map of soils and relief allowed a digital terrain model to be constructed. This provided a basis for overlays. A digital system was thus created that was similar to those prepared for the historic towns atlas projects that have existed in a number of European countries since the 1960s.³

Street systems and building blocks have received considerable attention in urban morphological research. The work of M.R.G. Conzen and the geographers of the Urban Morphology Research Group at the University of Birmingham led to the development of new methods and techniques of town-plan analysis. Research has also been done by Keyser⁴ and Muratori,⁵ and in the Netherlands by Visser on the small town of Schoonhoven,⁶ and by Van Oerle on Leiden.⁷ In all these studies the town plan forms the basis, usually derived from the first cadastral plan, since this is usually the earliest accurate representation of plot boundaries.

Once the street pattern and building blocks had been established, plot patterns and land use can be studied. Previous examples of such work include that by Muratori and Caniggia⁸ and the study by Boudon and Chastel of Les Halles in Paris.⁹ These studies viewed the plot as the smallest and most fundamental unit for research purposes. By using new technology, data from different sources can be almost endlessly combined at this level of resolution, although, because of the heterogeneity of the data, care is needed in analysing the results. In addition to typological and socio-topographical analysis, the computer can also be used to perform time-consuming statistical analyses. For example, it can be used to undertake such metrological analyses as the determination of

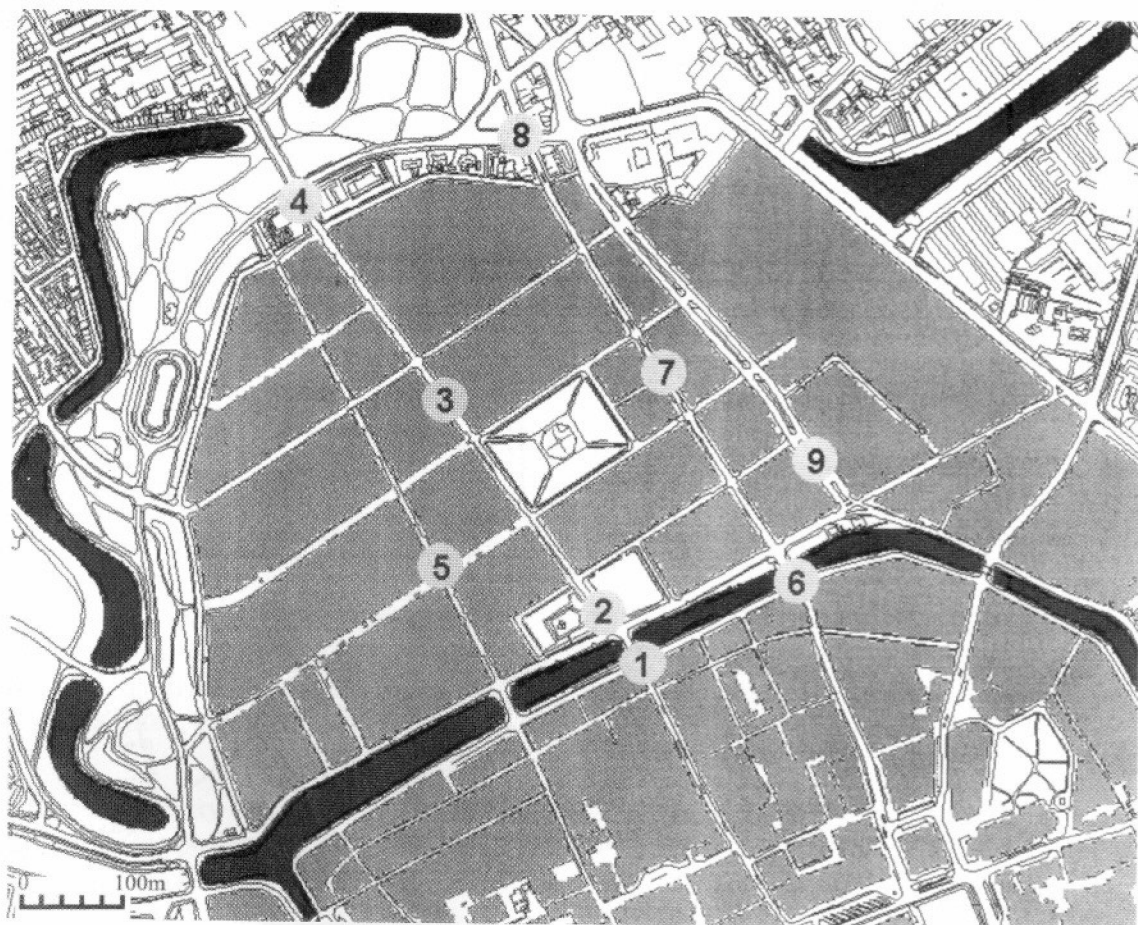


Figure 1. The research area, showing important streets and city gates mentioned in the text (designed by E. Koster, using Grass 4.1). 1 - Oude Boteringeport; 2 - Ossenmarkt; 3 - Nieuwe Boteringestraat; 4 - Nieuwe Boteringeport; 5 - Nieuwe Kijk int Jatstraat; 6 - Oude Ebbingeport; 7 - Nieuwe Ebbingestraat; 8 - Nieuwe Ebbingeport; 9 - Boterdiep.

recurrent plot dimensions.¹⁰

By using image-processing technology and GIS, two plans that were initially difficult to compare could be merged in one new plan. The resulting plan was used to study, for example, the question that had been raised by historians concerning the location of the newmarket in the seventeenth-century extension of Groningen.

During the 80 years' war, which was a rebellion against Spanish rule in Holland, many Dutch cities changed their defence system. Groningen was one of a number of cities that, at this time, extended its area to provide more building plots. The first and

most attractive plots, facing the old city, were built before the old fortifications were demolished. A decision was then taken to utilize as a market place part of the area formerly occupied by the fortifications (Figure 2).¹¹ Probably this decision was influenced by the owners of the plots to the east of the market, mostly leading citizens who had not yet built their houses. Houses on the west side of the new market place had no façades facing the market (Figure 3). Also, houses built along Boteringestraat lacked a prominent façade on the market place. The plots in the north-west corner contrast with those on the other side of the

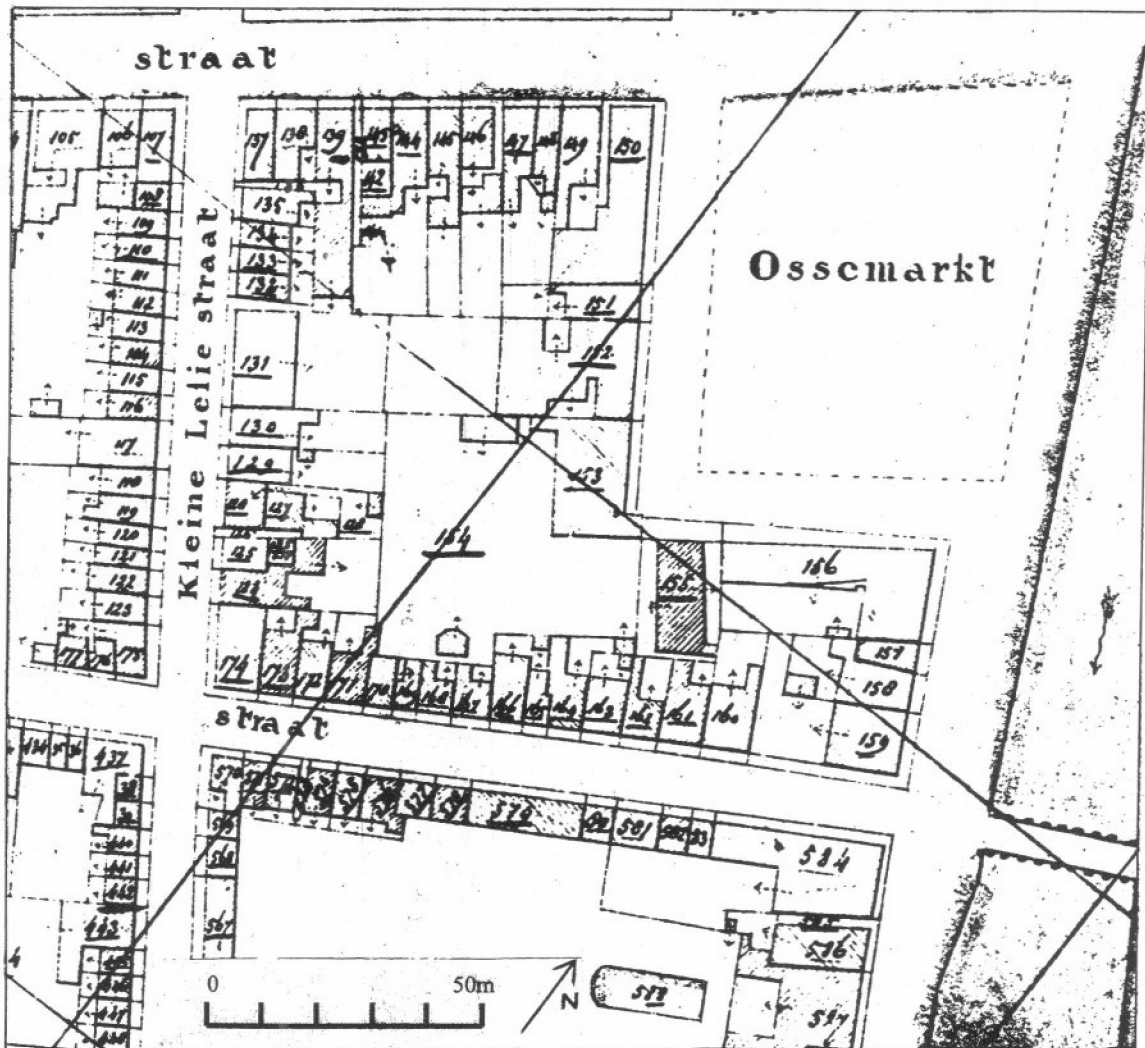


Figure 2. Detail of the earliest cadastral plan of 1830-2 (Gemeentearchief Groningen, Kadastraal Minuutplan Sectie E, 1832).

main road. The former are small and have their heads on Boteringestraat. The plots on the other side of the market place are long and nearly all extend to a back street.

Based on a register of the original sale of plots, which provides the dimensions of each plot, a reconstruction has been made of the initial plot pattern. Using the metrological method, the computer was used to calculate and visualize possible plot boundaries. Without the need to measure all plots by hand, the computer can identify plots that have the same width and produce a map accordingly. In Groningen a resolution of the

city government determined a standard plot size that should have been adhered to for the entire extension to the city. That it was not fully put into effect is evident from the cadastral plan. Which plots comply to this standard, and what the town would have been like if the city's ruling had been followed, are revealed by the computer.

A further computer application is the analysis of the influence of the fortifications on urban form. In Dutch towns, as in most European towns, city fortifications had a constraining role. Most of the constraints stemmed from the regularity that is sought

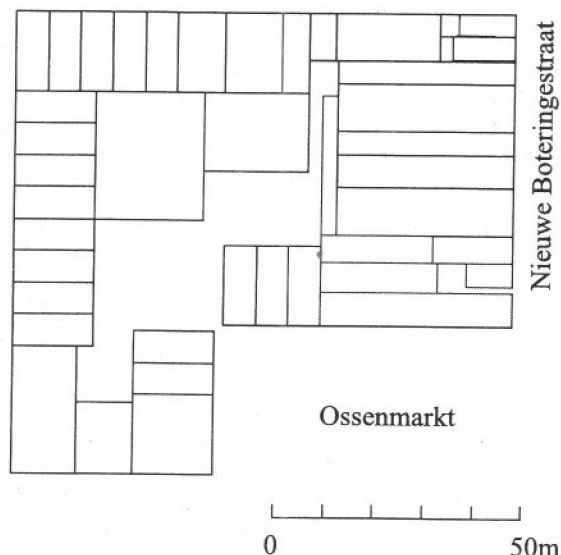


Figure 3. Reconstruction of the Ossenmarkt block, based on the register of lease contracts of 1625 (designed by E. Koster, using AutoCad v. 13).

after in military architecture. A critical feature is the positioning of town gates. The city walls of Groningen were demolished at the end of the nineteenth century, but a computer reconstruction has been made which allows, for example, studies to be undertaken of the town gates and the pre-urban cadastre and the influence of the positioning of the town gates on the street system.

Conclusion

New technology is not always an advance. Analysis by hand is sometimes preferable. In other cases, new technology offers advantages as a tool for morphological analysis. The technique of overlaying plans facilitates their direct comparison, and, by incorporating other data into these plans, for example from written documents, analyses that would otherwise be prohibitively time consuming can be undertaken. Because information technology is still new in this field, software and techniques are sometimes lacking. Nevertheless, research on the

transformation of the seventeenth-century town plan of Groningen has demonstrated the potential of the computer, not only for the comparison of historical plans but also for visualization and analysis.

Notes

1. Bocchi, F. and Lugli, F. (1988) 'Computer methods used to analyse and reconstruct the cadastral map of the town of Carpi (1472)', in Denley, P. and Hopkin, D. (eds) *History and computing* (Manchester University Press, Manchester) 222-7.
2. Hunter, G.J. and Williamson, I.P. (1990) 'The development of a historical digital cadastral database', *International Journal of GIS* 4, 169-79.
3. See, for example, Stoob, H. (ed.) (1973) *Deutscher Städteatlas* vol 1 (Größchen, Dortmund).
4. Keyser, E. (1958) *Städtegründungen und Städtebau in Nordwestdeutschland im Mittelalter* (Selbstverlag der Bundesanstalt für Landeskunde, Remagen).
5. Muratori, S. (1959) 'Studi per una operante storia urbana di Venezia', *Palladio* 9, 97-209.
6. Visser, J.C. (1964) *Schoonhoven* (Van Gorcum, Assen).
7. Oerle, H.A. van (1975) *Leiden binnen en buiten de stadsvesten* (Brill, Leiden).
8. Caniggia, G. and Maffei, G.L. (1979) *Composizione Architettonica e Tipologia Edilizia: 1. Lettura dell'Edilizia di Base* (Marsilio, Venezia).
9. Boudon, F. and Chastel, A. (1977) *Système de l'architecture urbaine: le quartier des Halles à Paris* (Editions du Centre National de la Recherche Scientifique, Paris).
10. Lafrenz, J. (1982) 'Die Metrologische Analyse als Instrumentarium zur Morphogenetischen Interpretation Frühneuezeitlicher Stadtgrundrisse', *Trierer Geographische Studien, Sonderheft 4/5*, 275-308; Slater, T.R. (1981) 'The analysis of burgage plots in medieval towns', *Area* 13, 211-16.
11. In the summer of 1996, archaeological excavations were begun, using the plan reconstructed in this research, to find the remains of the fortifications.