

A multi-disciplinary perspective on the built environment

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Space Syntax and Cartography – the communication challenge

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Abstract

Despite the rhetoric, truly multi-disciplinary projects in which conventional worldviews are pushed to their limits are still rare in academe. Research into the built environment has suffered in particular through a lack of collaboration and the use of incompatible analytical toolsets by built environment specialists and human geographers. The increasing acceptance of Geographical Information Systems (GIS) across a wide range of subject areas presents new opportunities for multi-disciplinary research. The challenge is to make GIS technology genuinely useful in negotiating the competing claims of varied philosophical perspectives. Space syntax theory and methodology, for example, provides a powerful means of exploring and representing the structure of the built environment through the use of axial and segment maps. However, its traditional emphasis on spatial structure tends to marginalise the socio-economic and demographic processes that are the human geographer's primary concern. At the same time, geographical research has tended to prioritise the social construction of space at the cost of considering how this relates to the built environment in which social activity is situated.

Integrating space syntax into a GIS environment goes beyond simply acknowledging contrasting methodological approaches; it also suggests a critique of the theoretical models from which they arise. Space syntax maps (or graphs) have been successful in engaging architects and urban designers in a highly visual knowledge discovery process in which the colouring of the axial lines and segments anticipates a more detailed phase of statistical analysis. For human geographers working in GIS, by contrast, mapped visualisations usually represents the culmination of a lengthy data exploration process.

This paper draws upon issues encountered during the implementation of a multi-disciplinary project at UCL concerned with the socio-spatial characteristics of successful suburban town centres in Greater London. The project aims to integrate space syntax and GIS approaches within a single theoretical-methodological model. Our work shows how a GIS can help conceptually to "demystify"

the use of space syntax methodology for researchers from other disciplines while also bringing a greater sensitivity to the intuitive and exploratory aspects of research into built form into the GIS environment. We conclude by discussing our work in the wider context of traditional Conzenian town-plan analysis and ask how far this approach could inform the further integration in GIS of space syntax's concern with the structure of built form, and the geographer's emphases on socio-economic processes and more particular notions of "place".

1. Introduction

Despite the rhetoric, truly multi-disciplinary projects in which conventional worldviews are pushed to their limits are still rare in academe. In the past, working practices within universities have been notorious for developing competitive research groups which work in isolation to develop their own subject areas. Now the pressure is on to create multi-disciplinary projects which share ideas across disciplines in order to develop new theories and provide new answers to complex research questions. The EPSRC funded research project Towards Successful Suburban Town Centres (SSTC) is just such a multi, inter-disciplinary project. Seeking to question simplistic cultural representations the project approaches London's suburbs as potentially complex and adaptable built environments, capable of sustaining a diversity of activities over time. The research draws on space syntax methods developed in the fields of applied architectural research to produce quantitative descriptions of built form and street networks, and on the expertise with analysing geographical distributions of socio-economic data associated with human geography.

2. The multi-disciplinary challenge

One of the project's aims was to integrate space syntax data generated in Depthmap (Turner 2004) and Ordnance Survey address point data in a GIS (Geographical Information System) platform for the purposes of analysis and visualisation. At first, this aspect of the research seemed principally a technical challenge. However, it soon became apparent as the dialogue between researchers from geographical and space syntax backgrounds developed, that far from 'analysis and visualisation' being neutral terms, they in fact meant different things in each of these methodological perspectives. Following an initial phase characterised by mutual misunderstanding, the dialogue evolved into a mutual exchange of reflective practice in which previously unquestioned methodological assumptions were systematically critiqued. The result was a collaborative dynamic which provided the basis for a genuine cross-disciplinary understanding to emerge. This paper provides a record of GIS–space syntax collaboration on the SSTC research project. It draws attention to a particular problem of space syntax visualisation as an example of how engagement between researchers in GIS–human geography and space syntax functioned not only to enhance mutual comprehension but also as an exercise in articulating and subjecting to critical examination the unspoken assumptions of contrasting methodological perspectives. By drawing on a number of project outputs, the paper seeks to demonstrate that research clearly benefits where the legitimacy of such perspectives is not taken as a given.

2.1 The challenge of space syntax for geographers

Research into the built environment has suffered in particular through a lack of collaboration and the use of incompatible analytical toolsets by built environment specialists and human geographers. Space syntax theory and methodology, for example, provide a powerful means of exploring the spatial configuration of the built environment through the use of quantitative analysis derived from graph theory and represented on axial and segment maps (Hillier and Hanson 1984; Hillier and Iida 2005). However, this emphasis on spatial structure can seem to marginalise the socio-economic and demographic processes that are the human geographer's primary concern (Soja 2001) This is because it seems to imply a geometrical determinism that is all too easily associated with the discredited positivism of geography's 'quantitative revolution' of the post-war period (Johnston and Sidaway 2004). The geographers' critique is represented in figure 1(a) in which an over-determined built environment is seen to render human activity as anonymous and mechanistic. By contrast, research in the field of space syntax argues that human geography tends to prioritise the social construction of space at the cost of considering how this relates to the built environment in which social activity is situated (Hillier 2008). The world view of the human geographer, from the space syntax perspective, is illustrated in figure 1 (b) in which the human

activity is clearly represented against an undifferentiated background. Clearly there is a need to be sensitive to both perspectives if we are to understand the relation of the structure of the built environment to human activity, illustrated in figure 1 (c).

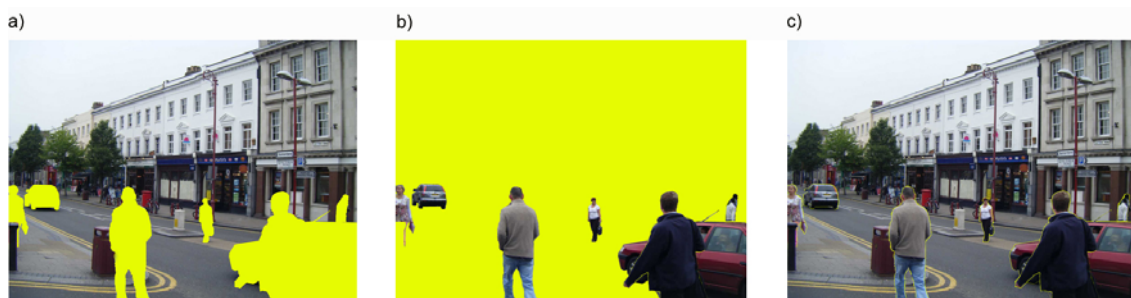


Figure 1

Schematic illustration of contrasting approaches to society and space, from left to right: (a) built environment focused (b) human activity focused and (c) integrated

2.2 The use of GIS as a platform for collaboration between geographers and space syntax experts

Geographical information science (GISc) is the study of methods and theories associated with geographical information systems (GIS), the systems for input, storage, manipulation, and output of geographic information. GIS are useful because "almost everything that happens, happens somewhere" (Longley et al., 2005 p.2). By knowing where something happens we are better placed to improve our understanding of that phenomenon. So much so that over the last 15 years there has been an incredible growth in the application and use of GIS to the point that in 2005 there probably were more than 2 million users of GIS around the world (ibid.). This common acceptance of exploration and understanding of the spatial elements of phenomena (as human geographers would understand this) has great potential for new multi-disciplinary research opportunities.

Multi-disciplinary collaboration is particularly relevant to GIS since the power of being able to accurately map the geographical distribution of phenomena has clear implications for research in many subject domains, from epidemiology to archaeology. However, at a recent conference addressing the use of GIS in historical research, it was notable that virtually all of the delegates were geographers.¹ This is symptomatic of the difficulty of allowing research methods to become independent of their discipline – especially when, like GIS, the complexity of the software means their use generally requires a high level of expertise (Traynor and Williams, 1995; Jones, Haklay et al., forthcoming). It is, therefore, necessary to address the challenge of how to make GIS technology genuinely useful in a wide range of academic and non academic contexts.

It makes sense to approach the dialogue between researchers in human geography and space syntax on the Towards Suburban Town Centres Project in terms of the challenge GIS faces in fulfilling its potential as an accessible facilitator of interdisciplinary research. However, for space syntax practitioners there is an additional concern of the relative inaccessibility of its body of work developed within the growing field of applied architectural research that still struggles to exert influence on more established disciplines where human activity rather than built form per se is the central concern. The collaborative approach to using GIS technology therefore serves not only to highlight the competing philosophical approaches and methods of human geography and space syntax but also creates the possibility of a broad cross-disciplinary domain where these can be resolved.

As truly collaborative research becomes more important in the academy, a requirement for synergy between contrasting methodologies becomes more desirable. The advantages afforded by representing and manipulating space syntax graphs within a GIS aim to improve visualization, cognition and knowledge construction for experts and non-experts alike. The adoption of GIS and its methodologies for complementary or 'value-added' graph analysis has the potential for:

- Improving understanding of graphs by non-experts through the use of landmarks and situational geographic information;
- Classifying the graphs using standard cartographic practice;
- Enabling systematic comparison of multiple case studies;
- Integrating socio-economic elements into studies of the built environment.

Whilst the benefits of methodological synergy are clear, there are issues that arise from developing space syntax representations in GIS which require recognition and consideration prior to implementation. These derive from the particular disciplinary differences in approaches to data analysis and representation relating to the practices of *standardising by colour and standardising by numbers*.

3. Standardising by colour and number: the representation of space syntax graphs in a GIS

Space syntax is a visually driven form of quantitative analysis. It provides architects and designers with a technique for articulating their intuition of how spaces work by assigning them statistical descriptions. Space syntax software, designed especially for this analysis, calculates a vast array of measures which are then represented graphically by colouring the lines using a continuous colour scheme, typically on a completely black background. These maps are manipulated by the expert researcher with the intention of 'picking out' patterns that are meaningful in terms of the particular problem being addressed. In other words the colours of the graph are used to standardise the representations according to intuition.

For non-experts conventional representations of space syntax graphs are problematic. Segment maps can be difficult to interpret - especially when presented without a background map that gives context such as roads and buildings. The absence of such information in the visualisation makes it difficult for people to locate the graph lines or segments in geographical space and increases the cognitive load during the interpretation of the configurational patterns on display.

While current space syntax software such as Depthmap (Turner 2001-2008) does allow cartographic data to be imported. It does not, at this stage in its development, have functionality comparable with a GIS and does not provide a viable platform for multi-disciplinary collaboration that requires integration of geographically related social data. Similarly, while a specialist product such as Confeego, designed as a plug-in for MapInfo, provides one possible solution for using space syntax in a GIS environment, it requires considerable expertise in both fields to handle confidently (Gil, Stutz, and Chiaradia 2007). Our concern is with the problem of facilitating collaborative work between GIS and space syntax researchers where the kind of shared conceptual understanding of methodology, the premise for effectively deploying a platform such as Confeego which has not yet been developed for a wider audience.²

For a non-specialist using a syntax graph in a GIS the inclusion of contextual information means that an abstract representation of the built environment characterised by a coloured network of lines becomes a comprehensible component of analysis for studies of geography and place. Although, in doing this we need to be aware of other sources of potential conflict between disciplines which are related to how the axial segments are coloured. The process of colouring the segment raises two issues; firstly the complex choice of colours and secondly the choice of classification used.

The colouring of segments in space syntax is carried out within software such as Depthmap. The measures are applied to a street network, differentiated according to a spectrum of colours from warm red through green and yellow to cold blue. In cartography the colour scheme used in a space syntax graph is known as a 'complex full spectral colour scheme'. This scheme is intuitive because it draws upon common perceptions of red representing heat and blue associated with cold, a notion reinforced by the daily exposure to this colour scheme. Whilst the choice of this colour palette is useful and creates powerful visualisations, for geographers it can be problematic. This is because it can be confused with a 'diverging colour scheme'. Diverging schemes place the emphasis of a quantitative data display as progressions outward from a critical midpoint (the

lightest colour) of the data range (Brewer, 2005). Thus a geographer may interpret the map differently when they should be seeing it as a continuous distribution of a network.

The actual data classification for which the colour scheme is applied by the space syntax researcher is the result of an exploratory process, in which prior to statistical analysis, the researcher explores a range of coloured visualisations to identify those that intuitively seem to represent the 'real world' being studied. For this reason, cartographers see space syntax methodology as an example of standardising by colour. Only at the stage when a range of representations have been found that appear to be meaningful, does the researcher proceed to more detailed statistical description and analysis.

The space syntax approach is considerably different to a geographer trained in the use and application of GIS. Human geographers are specialists in the preparation of complex datasets which often require extensive organisation according to strict criteria – ensuring data are consistently in the same format. For data to be useful within the GIS they require a corresponding geographical reference, which is assigned to a point, line or polygon (area) according to its place on the earth's surface, using a predefined coordinate system such as a national grid or latitude/longitude. Following the period of data preparation and georeferencing a number of different analyses are applied. This means that the cartographic visualisation represents the end, rather than the beginning, of the data analysis process ensuring that properly sorted data is represented according to established cartographic rules. The types of cartographic representations are chosen carefully according to the numbers in the dataset and rigid rules conforming to data classification for mapping (Jenks and Coulson 1963; Jenks and Caspall 1971; Evans 1977; Monmonier 1996). Thus the colouring of phenomena using numerical classification in a GIS can be regarded as standardising by numbers.

Clearly, neither the space syntax approach of standardising by colour, nor the GIS approach of standardising by numbers should be regarded as 'wrong'; on the contrary both are indicative of the contrasting methodological approaches of the disciplines from which they arise. This might seem self-evident but in the context of a research project discussed here, it led to problems of communication as, initially, researchers from both backgrounds assumed their perspective was the only one that counted. The focus for this frustration were the difficulties experienced in standardising the space syntax graphs by colour in a GIS, such that the researchers' intuition of the spatial structure could be represented, while at the same time standardising by numbers such that that systematic approach to processing complex datasets required by a large GIS based comparative study could be satisfied. This meant that, in the early stages of the project, segments were never differentiated enough to satisfy the intuitive understanding of the built environment researchers. Moreover, the procedure of automating the production of visualisations in the GIS meant that the easy exploration of visual outputs available to space syntax researchers in software such as Depthmap was no longer possible once the process had been run.

3.1 The cartographic classification of syntax graphs in a GIS

For many years now cartographic representations in geography have been used to encode geographic relationships to assist geographic reasoning and understanding (MacEachren 1994). It is natural that combining techniques builds greater understanding and knowledge of observed phenomena. Consistent with this thinking it is argued that the "interpretation of phenomena geographically depends upon visualisation by means of maps" (Philbrick 1953, p. 11). A cartographic form or map is not, therefore, just a means of communication but if used appropriately can be an effective tool for acquiring spatial (as geographers understand this term) understanding and knowledge. The use of GIS and geovisualisation technologies, for developing space syntax analysis can assist researchers to contextualise their analysis of configurational structure through an improved consideration of the other, socio-economic, components of place. However, this raises the question of the statistical basis on which to classify (i.e. 'colour-up') a space syntax map within a GIS environment so that the representation of the spatial phenomena being measured corresponds with the intuition of the researcher. The intention is not for GIS to 'colonise' space syntax methodology but rather to become responsive to the demands of this methodology for understanding the built environment.

In the SSTC project the challenge was to marry the more intuitive approach of classification used with syntax graphs with modern day cartographic classifications. In essence, a well chosen classification in geography is the primary method for abstracting the complexity of reality into a simplified map. Since the 1960s, and more recently with the rise in utilisation of GIS, there has been a shift towards a numerical approach to map classification; the notion of colouring by numbers came to the fore as the science of cartographic classification (Jenks and Coulson, 1963).

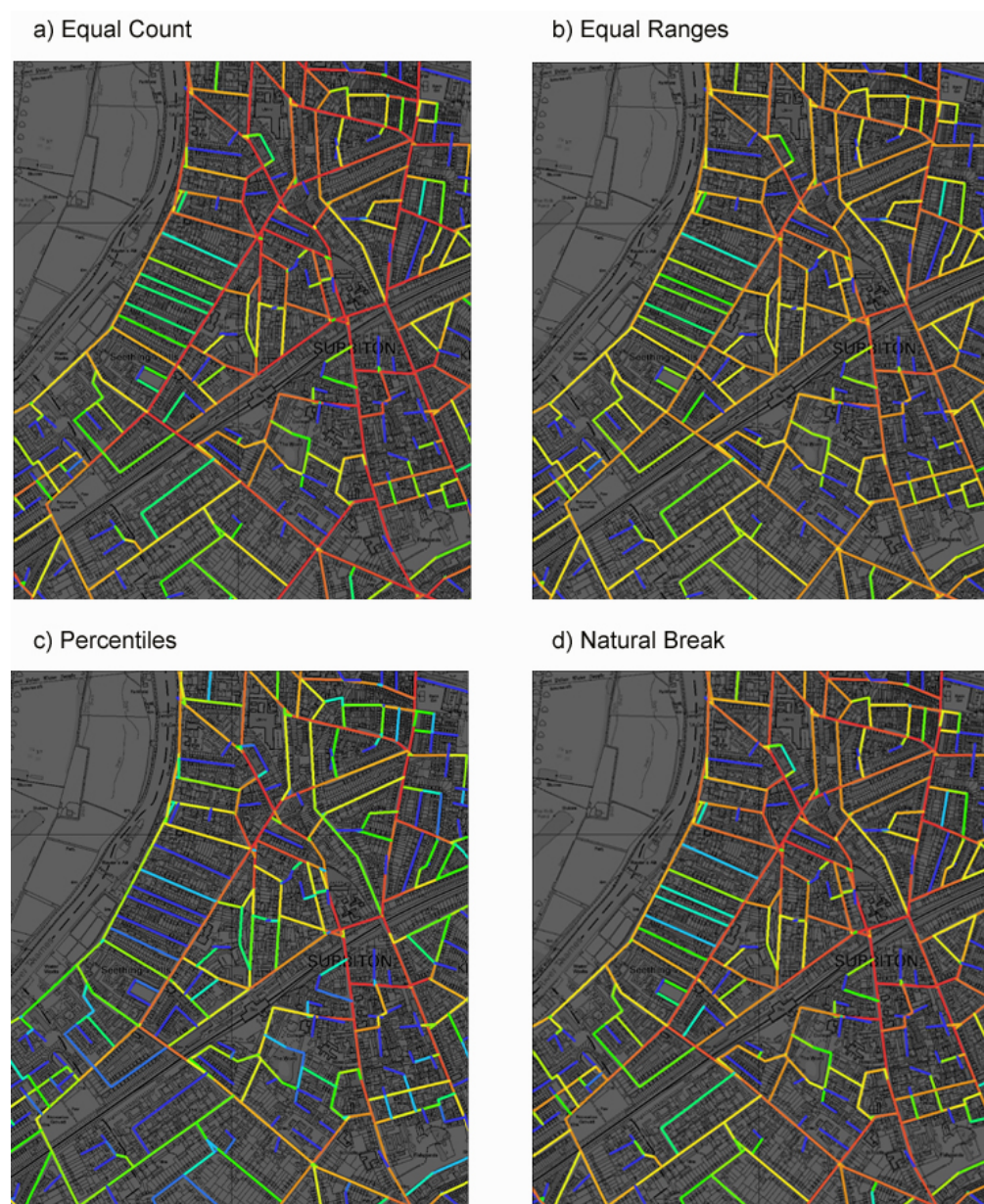


Figure 2

Four cartographic classifications for representation choice radius 800m: Surbiton, London, UK. (With underlying 10K raster base map © Ordnance Survey 2009)

A cartographical classification aggregates data, in this instance the values of different syntax segment measures, by grouping all segment lines with a particular range of values into a single category. One group of values is represented by the colour of the line (Monmonier, 1996). Classifications are used because the datasets are too large to colour individually, and the aim is to identify a meaningful pattern differentiated by the perceptual dimensions of the chosen colours. For a cartographer this process is not without its limitations. The method of classification is critical to the look of the map. Using an inappropriate classification will impair an understanding of the map due to the distorting influence the classification will have on the geographical pattern and

how it is interpreted. Incorrect generalising and simplification of data will hide subtle changes in the distribution –particularly important in space syntax analysis where the required differentiation may occur within a fairly restricted range of values. Therefore, the aim is to find the most appropriate classification to match the distribution of the underlying data.

There are various types of classification applied to data distributions in GIS. Figure 2(a-d) highlights the outputs of four different types of syntax classification which can be applied using a GIS: equal count, equal interval, natural break and quantiles (percentiles). How these different methods categorise the data is described in the following paragraph. The question is: which of these is the most appropriate? The input data for the graphs are the segment values of choice radius-800 metres for the twenty-six town centres in London's suburbs that comprise the project's sample. Figures 2 (a-d) are zoomed in on the London suburb of Surbiton. The challenge was to produce a single classification to highlight differentiation across the centres: easing their comparison for space syntax researchers while satisfying GIS procedures of statistical robustness.

Figure 2(a) illustrates the equal count range which assigns interval values so each has an equal number of segments. This distribution produces a map which appears to have a balance of warm and cold coloured segments. In contrast, the segment map coloured by the equal ranges classification (Figure 2b) assigns interval values so each interval contains the same range of values. Equal ranges is an easy distribution to understand but it often fails to represent the underlying distribution of space syntax data. The segment map has fewer values at the top and bottom of the range so it is not balanced. A percentiles or quantiles map (Figure 2c) is useful for exploration, but again it does not consider the distribution of the data. Instead it merely ranks the data and then divides them so that all intervals contain approximately the same number of segment lines. This classification produces a visually balanced map as shown by the number of red and blue lines but it forces some values into the same interval when it may not be appropriate, as there is no inherent consideration for the data being classified. The final classification in figure 2 (d) uses the natural breaks method. Natural breaks is a statistical technique to identify clusters of values that are inherent in the data distribution. Each cluster is then put into a different interval or group for the purpose of classification. Natural breaks seems like the most relevant classification for representing the structure of the underlying data in space syntax analysis. This is because it is the least likely to miss potentially significant data groupings (Monmonier, 1996). Nevertheless, this method still failed to produce a coloured graph that satisfies the intuition of a space syntax researcher.

4. The collaborative development of a methodology

Maps tend to look better if the number of elements in each interval class is balanced, but here we must go beyond the aesthetics and consider how a given classification will be used to understand the nature of the data being mapped. Although the natural break classification was agreed to be the most promising, none of the representations in figure 2 were felt to be sufficiently differentiated for the space syntax researchers. This proved a source of difficulty on the project as the unique colouration the team's space syntax practitioners were accustomed to creating in Depthmap was not immediately replicated in the GIS.

Figure 3 (a) shows the graph output as produced in Depthmap and figure 3 (b) illustrates the equal ranges map produced in a GIS. An equal range classification was used because it seemed to be the conventional practice of space syntax researchers to do so when producing representations of syntax graphs in a GIS. In Depthmap the colour slider (top-left in figure 3a) changes the colour distribution of the map until it returns a representation that makes sense to the space syntax researcher in terms of their understanding of the spatial configuration and is frequently done in order to visualise the spatial core of a system.³ The human geographers on the team had difficulty understanding this approach since the statistical basis of the preferred Depthmap visualisations appeared to be rather 'mysterious' to someone trained in standard rules of cartography. We now recognise this confusion to be the result of the methodological differences between disciplines.

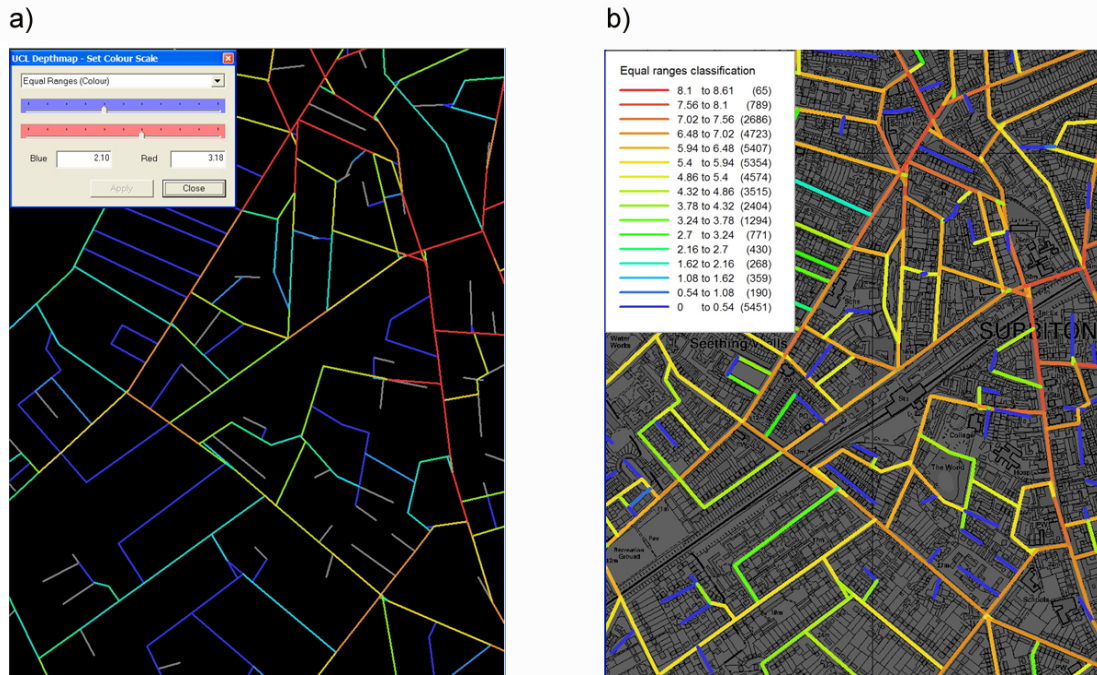


Figure 3

Space syntax visualisations: (a) created in Depthmap and (b) created using GIS (with underlying 10K raster base map © Ordnance Survey 2009)

This dialogue between the researchers showed how the differences between space syntax and GIS methodologies were not superficial (technical) but more fundamental (methodological). There was a clear meeting of disciplines with different perspectives which needed to be resolved. Space syntax analysis is visually exploratory – it moves through a rapid series of investigatory hypotheses whereby the visuals are manipulated to characterise intuition. It was this rapid visualisation of data, standardising by colours, that was problematic for the human geographers. On the other-hand doing syntax in a GIS environment led to the feeling with space syntax researchers that visualisations failed to bear any relationship to the configuration of built form, but just conformed to an abstract GIS method of colouring by numbers.

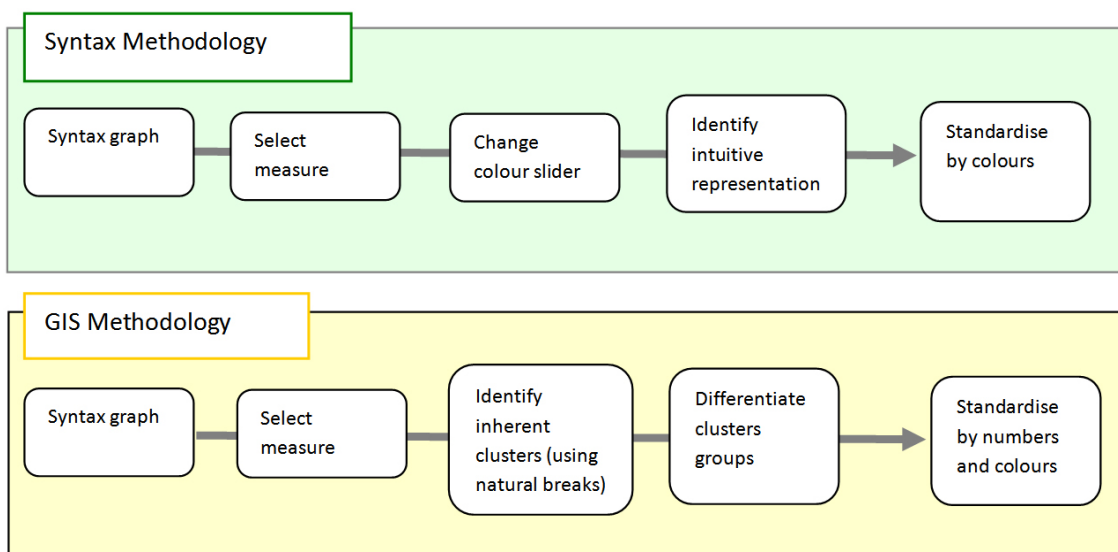


Figure 4

Simplified process for producing visualisations in typical space syntax software (top) and in GIS with increased sensitivity to colour differentiation (bottom)

In order to create a constructive collaborative environment and so develop a methodology that conforms to cartographic best practice while allowing for exploratory analysis of space syntax visualisations it was necessary for both sets of researchers to rethink their methodological assumptions. When a space syntax specialist selects a particular graph colouration by changing the colour scale, they are emphasising different values in order to change the balance of the map – i.e. to make segments warmer or colder. To reproduce these types of representation in the GIS it would be necessary to allow for easy manipulation of the data by non-specialist users in order to enable exploratory analysis using a range of visualisations according to the space syntax approach. At the same time, by undertaking this process using standard GIS functionality in MapInfo, it should also be possible to 'demystify' the process of producing space syntax visualisations for GIS users who are less familiar with space syntax.

In the previous section it was suggested that natural breaks provided an appropriate basis for colouring the syntax maps because it successfully matches the distribution of the data. It was therefore decided to develop this further as the starting point for producing space syntax visualisations in the project's GIS platform. Figure 4(top) represents the process of creating a typical space syntax visualisation in Depthmap, figure 4(bottom) shows the method developed on the SSTC project. (In both cases, exportation of the data into a statistical package would follow.) The visualisations produced by this process are shown in Figure 5(a-c). In this example we map segment choice which, since the interesting part of the distribution lie near the top of the range, it was necessary to differentiate segments with the highest values. In order to do this we extracted the top four clusters which we could then differentiate further. Next, we classified the segments within these top four clusters using natural breaks, with eight intervals from red of green – identifying more natural clusters in the data. This enabled us to further segment the top four clusters to enable the emphasis to be placed on the warm colours. We then classified the remaining clusters in eight intervals from blue to green. This method is more preferable than simply selecting the top 10% or 20% of values because the intervals for these percentage points are somewhat arbitrary and the difference between values in the top 10% and those, for example, in the 11th% of values may not be significant or contain any variation.

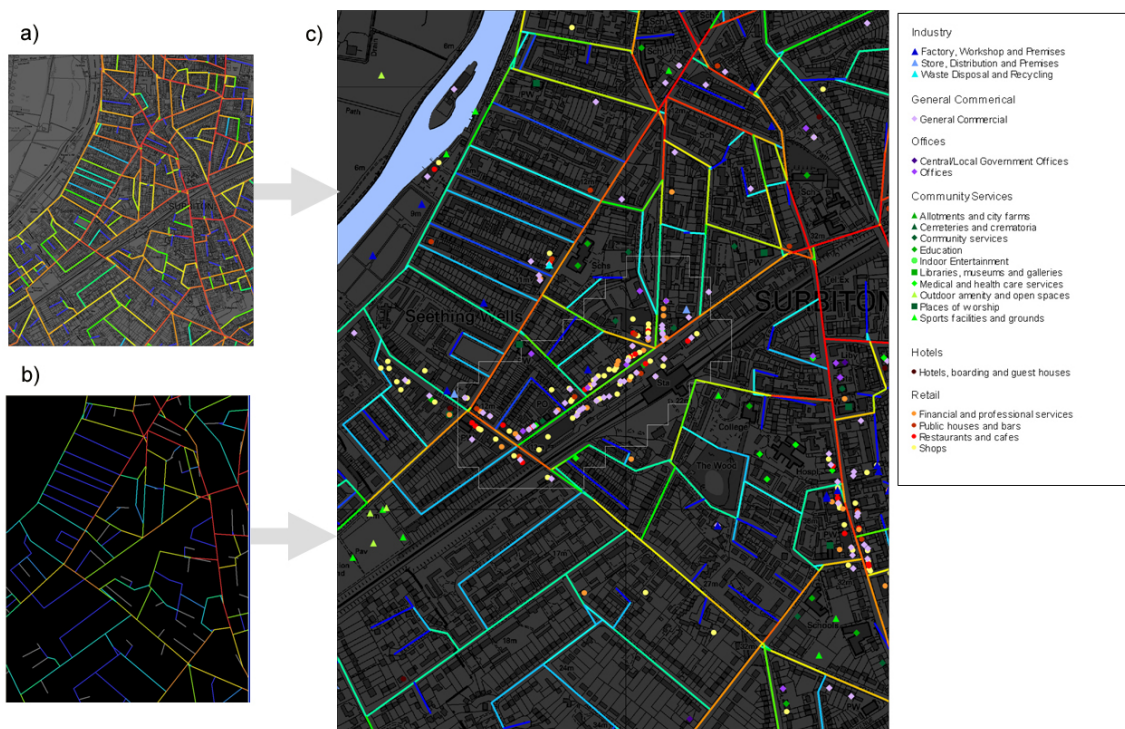


Figure 5

Combining GIS and space syntax approaches to create a space syntax visualisation in GIS – with address point data overlaid.

The end result of the described process for Surbiton is highlighted in figure 5(a-c), where graph (a) shows the base natural breaks measure, graph (b) shows the Depthmap view preferred by the space syntax researchers and graph (c) shows the final visualisation overlaid with address point data. An Ordnance Survey map is used as the background layer – which enables visualisation of plot sizes, the location of local geographical features and landmarks such as the river, the street and rail network to be visualised alongside the segments. Each component of the map creates greater understanding and knowledge of the town centre. This method provided a 'de-mystified' statistical and intuitive description of the process executed in Depthmap that 'picks out' the configurational phenomena of interest to the space syntax researcher, while also conforming to an easily reproducible statistical process in GIS which is also consistent with cartographic best practice. This method satisfied the requirements of all disciplines involved in the project.

5. Lessons for using GIS with space syntax

A number of practical implications have arisen from the implementation of space syntax in a GIS environment. The example provided in the previous section has demonstrated how GIS can facilitate cross-disciplinary collaboration and symbiosis between different methodological perspectives. With just a basic competency in GIS a space syntax researcher was able to conduct exploratory analyses of syntactic variables within a GIS working environment and produce a series of visualisations in which the spatial configuration was highly differentiated.⁴ A precautionary note is required here. GIS affords the ability to create maps with many different variables overlain on the syntax graph but with more variables the risk of producing a confusing representation with too much colour complexity. It is important to strike the right cartographic balance.

The members of the SSTC project team discovered that the integration of space syntax into a GIS environment is not simply a matter of technical capability or tokenistic acknowledgment of contrasting methodological approaches; rather there is a need to reveal and critique the theoretical models from which methodologies arise. In this case, the differences in the methodological approaches were closely related to the theoretical perspectives on how different disciplines conceive of 'space'. In space syntax research 'space' is conceptualised as a contiguous network of open space in the built environment, whereas for human geographers trained in GIS the terms 'space' and 'spatial' refer to the geographical distribution of phenomena across a surface. This is not simply a question of semantics but relates to fundamental questions of ontology. Human geographers struggle to see space syntax as other than geometrically reductive despite its theoretical concern with the built environment as society-in-space, whereas space syntax practitioners can perhaps be overly dismissive of cultural theory that asserts what Lefebvre (Lefebvre 1991 {original: 1974}) called the social "production of space" through human activity and social structures.

For human geographers also, there is a need to get beyond the desire to integrate disparate datasets in a large GIS database, which sometimes risks becoming an end in itself rather than a basis for a genuine engagement across disciplines. In the SSTC project, some basic assumptions of GIS visualisation techniques needed to be reconsidered in the light of space syntax methodology in order to increase their flexibility. Otherwise the intuitive, exploratory aspect so vital to syntactical analysis risked becoming neglected. Where visualisations were selected a priori on the basis of a preferred approach to data preparation and processing without regard to how space syntax graphs were actually used as part of the analytical process, the result was a series of visualisations that were not particularly sensitive to the structure of the built environment they were supposed to represent.

6. Conclusion

This paper goes some way to showing how the GIS can function in a collaborative mode. In doing so we identified a number of methodological differences between space syntax research and human geography that at the outset of the project were not obvious. They were concealed within an apparently complementary inter-disciplinary framework of the research. As the project developed it became clear that using a GIS for syntax analysis was more than a case of technical possibilities and functionalities, but actually required dialogue between the disciplines to enable a critical understanding of assumed methodological approaches.

It was evident from our experiences that GIS software does not lend itself easily to the detailed exploratory analysis which space syntax practitioners are accustomed. On the other hand whilst space syntax software enables the practitioners to easily manipulate syntax graphs in an exploratory environment they lack the cartographic functionality and do not effortlessly facilitate the investigation of important social and economic elements that comprise the essence of a place. These issues arise due to the differing requirements between methods, use and functionality of the disciplines. A useful idea for further work, building upon the experiences outlined in this paper would be to develop an exploratory tool enhancing the best practice features from both disciplines. Naturally this would facilitate the amalgamation of datasets and methods from the different disciplines to produce a specific useful and usable application based on the needs of inter-disciplinary users (Jones, Haklay et al. forthcoming). Such an exploratory tool would further facilitate collaborative research.

Notes

- 1 Historical GIS 2008, August 2008, University of Essex, UK
- 2 Confeego was developed in a commercial context and its researcher's version has relatively limited functionality.
- 3 Interestingly, this stage of exploration is a continuation of early space syntax work, where the limitations of black and white printing meant that typically the top 5% or top 10% of values were highlighted graphically in order to identify the 'core' of high values. Such representations are of course still used today: see Gil & Steinback, 2008 for example.
- 4 A version of the original map outputs were integrated into a web-based 'profiler' to provide a systematic method for the exploratory phase of the project. This can be seen at <http://www.sstc.ucl.ac.uk/profiler/>.

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