Urban Redevelopment and City Centre Growth

Using syntactic analysis to help create better city centre

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0 Abstract

This paper reports a research which has applied space syntax methodology to an on-going urban design project. One main goal of the project is to make an urban area occupied by a large hospital an integral part of the historic centre of Linköping city, Sweden. It is hoped that a better integration of the two shall help bring a richer pattern of street life to an area predominantly occupied by institutional activities and further enhance the practical and symbolic role of the existing city centre. Axial analysis was used to model the spatial structure of Linköping city at varying levels in order to clarify the larger context of site design, and the implications of that structure for movement and use were assessed in the light of previous research findings. The same technique was employed to evaluate sketching designs, taking into account both spatial conditions as offered by the existing structure and the goals of the project. Among other findings the analysis showed that regardless of system size, the integration core of the context area of site design is largely confined to the grid system of the city centre of Linköping, while system intelligibility deteriorates substantially once that area is extended well beyond the city centre itself. Embedding the sketching designs in their context area then revealed that the proposed configuration by and large has succeeded in extending the grid system of the city centre into the hospital area at issue, thereby also improving the overall integration of this part of the city. Both exercises are contributing to the development of a guideline with which more detailed plan design will proceed.

Keywords: city centre, design, evaluation, intervening, urban

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1 Introduction

Urban areas accommodating large institutions like the hospitals tend to present themselves as a distinct problem for urban design when the attempt is to incorporate such areas into an existing city centre. To be perceived truly an integral part of a city centre, it seems that the institutional area at issue should share some common qualities with that centre in terms of physical form and use of street space, in addition to geographical vicinity. At the same time, the area should also possess plan properties which are appropriate to the functioning of a large institution.

How can these seemingly conflicting goals be achieved through design? If the plan design of an institutional area is to contribute to the extension of a city centre, it would seem that its pattern should embody at least two kinds of continuity: continuity in layout principles underlying that city centre, and continuity in the kind of accessibility or use enjoyed by the centre area, among other things. It is the view of this paper that a good knowledge of the two kinds of continuity can be acquired by a morphological analysis of design schemes as well as the development area and its larger context. An on-going project, "The university hospital in Linköping - vision year 2000", is reported here to show how space syntax methodology (Hillier & Hanson, 1984) has been applied to actual design which aims at integrating a hospital area into the city centre of Linköping, Sweden.

After decades of successive expansion and rebuilding, the university hospital in Linköping has accumulated a large building stock which is more than what is needed by its various functions. But while there are plans to upgrade the hospital area and to find new uses for some of its old buildings, the owner of the hospital premises (the Linköping municipality) has yet to develop a programme about the exact use and spatial form of the part to be upgraded. It turned out to be the consulting party - the White Architects, taking the initiative to propose a scheme which intends to bring more urban life into the hospital area and at the same time make that area contribute to the extension of the city centre.

Space syntax analysis was brought in to clarify the larger context of the redevelopment area and to probe guiding principles for master plan design at the early phase of the project. The plan layout of the Linköping city was modelled at varying levels to identify its integration structure(s), and the implication of that structure for movement and use was assessed in the light of space syntax theory and findings from previous research. The same procedure was applied to the evaluation of sketching designs, taking into account both spatial conditions as offered by the existing structures and the goals of redevelopment.

The paper is organised in three sections. Section one gives a brief description of the Linköping city and its historic centre in order to provide a minimum background about the overall physical context of the redevelopment area. This is followed by a presentation of the university hospital area, with due attention paid to its layout features and its relation to the surrounding areas. Section two focuses on the axial structure of the city centre of Linköping, which is defined both as an independent system and as part of a larger structure, and that of the hospital area, which is also analysed on its own and as an embedded part. A discussion of the integration and intelligibility properties of these existing structures then tries to clarify the spatial context of the redevelopment area and clues for design position-taking. In the last section the White Architects' scheme is presented, and its layout design is embedded into the axial system of Linköping to explore the different integration patterns arising from the insertion. The section ends with an evaluation of the scheme with respect to given goals and some suggestions for more detailed plan design.

2 Linköping city and its historic centre

Linköping is a medium-sized city located in the southeast region of Sweden. Its present city centre was laid down in as early as the 18th century. Most part of the city was however built in this century and has grown up mainly along the Stångån river, extending from northwest to southeast in an elongated band form (Figure 1). The densely developed part of the city is defined on the northwest and northeast by the railway, and on the west and south by a ring road and large green areas, respectively. Outside this boundary, the city has expanded towards north and southeast basically in the form of enclave-like residential developments. Most industries are located in a district north of the city, separated by the railway. To the west, across a wooded area, is situated the Linköping University, a large educational institution which makes Linköping also a university town.

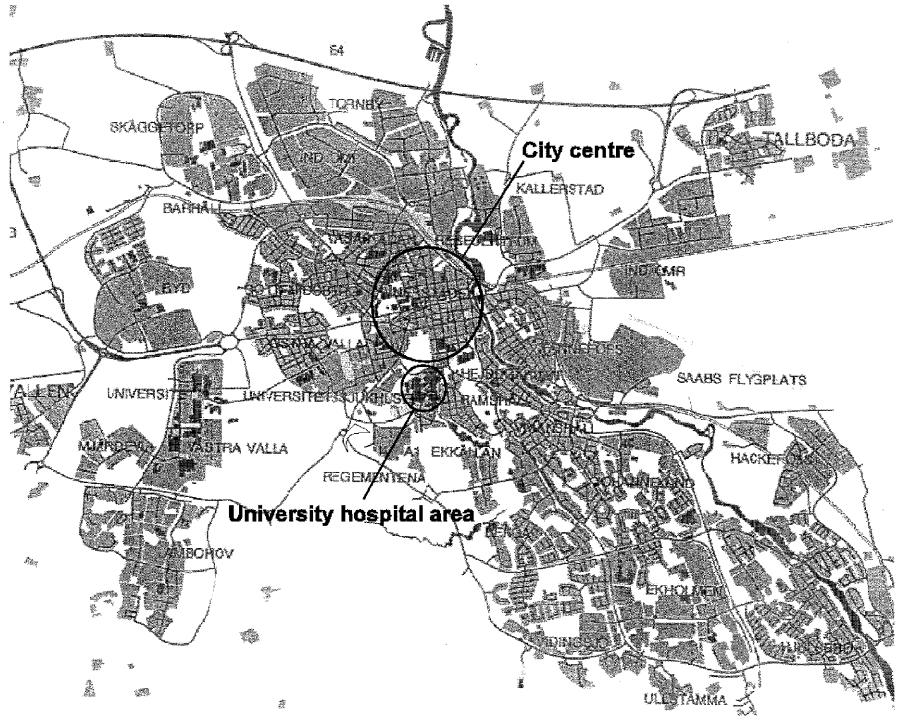


Figure 1. Map of Linköping City, Sweden.

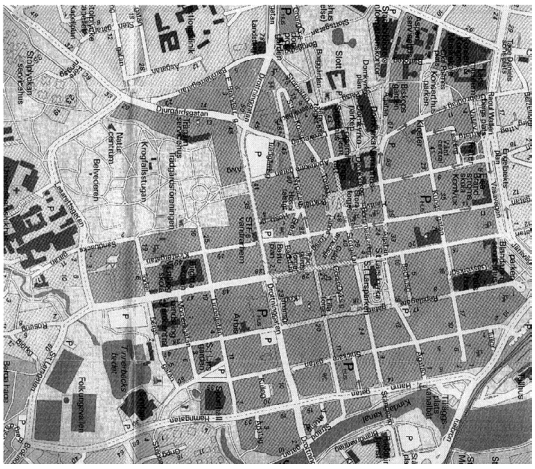


Figure 2. Map showing the city centre of Linköping as it is today.

The city centre of Linköping is a sharp contrast to the rest of the city in two major aspects as far as layout pattern is concerned. About one square kilometre in size, the historic centre is dominated by a gridiron street system, with typical block sizes varying between 80m by 140 m to 100m by 160m (Figure 2). Whereas most urban areas outside the centre are laid out more or less irregularly, determined either by topographical conditions or by man-made factors.

The city centre of Linköping is also a tightly organised area. Except in the peripheries, where large green areas or parks create huge "holes" in between the centre and its surrounding areas, the centre itself looks very much like one continuous solid, knitted together by a grid. Streets are not only important traffic corridors, but also the dominating public spaces. Whereas the rest of the city is composed basically of smaller areas more or less separated by urban arteries and by green areas of varying sizes. The grid system of the city centre of Linköping might have found its extension towards north and east had it not been stopped by the railway and the Stångån river, and towards west and southeast had it not been stopped by parks and by areas occupied by large institutional buildings to which the university hospital also belongs.

3 The university hospital area

The overall layout of the university hospital in Linköping is one which we often find in large institutions, namely an enclave or campus arrangement. Though adjacent to the city centre and to an urban area on the east, spatially the hospital area is almost completely disconnected from its surroundings by green areas on the north and west, and by a creek on the east side (Figure 3; also cf. Figures 1 and 2). There are three street connections between the hospital area and city circulation system, and one of these is, in effect, part of a street belonging to the city centre (Sandbäckgatan). But the main entry to the hospital area is located at its south edge, where the built area of the city ends by a huge field presently occupied by the military.

Internally, the hospital area is divided into two building zones by an access street winding through the area in a north-south direction. West of the street lies the newest building complex of the hospital, housing most of its main functions. While the building zone east of the street consists basically of older buildings brought about by successive expansions in the past. These buildings are at present occupied by the university's medical school and some of the clinics. It is above all this part of the area which is now on the developer's upgrading agenda.

As there is a nursing school and a city clinic located at the southern end of the city centre, in terms of functional linkage, the northeast corner of the hospital area appears to have a closer relation to the city centre than the rest of the area. Spatially, though, the two institutions are distanced from the hospital area by two street blocks and a main road delimiting the city centre on the south.

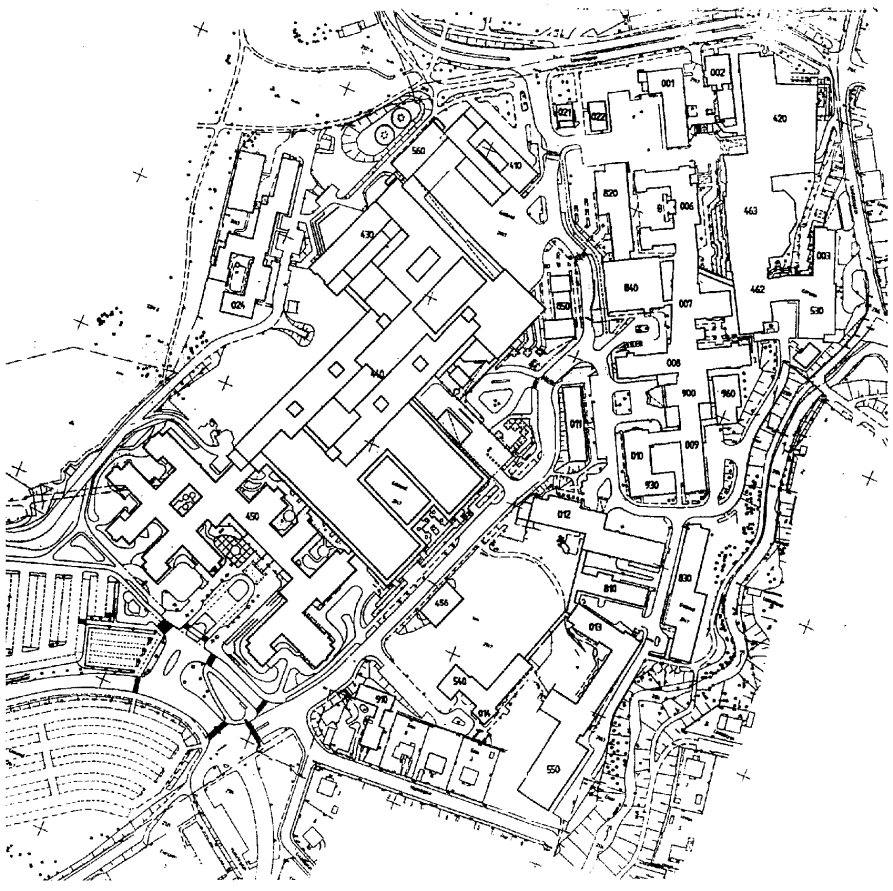


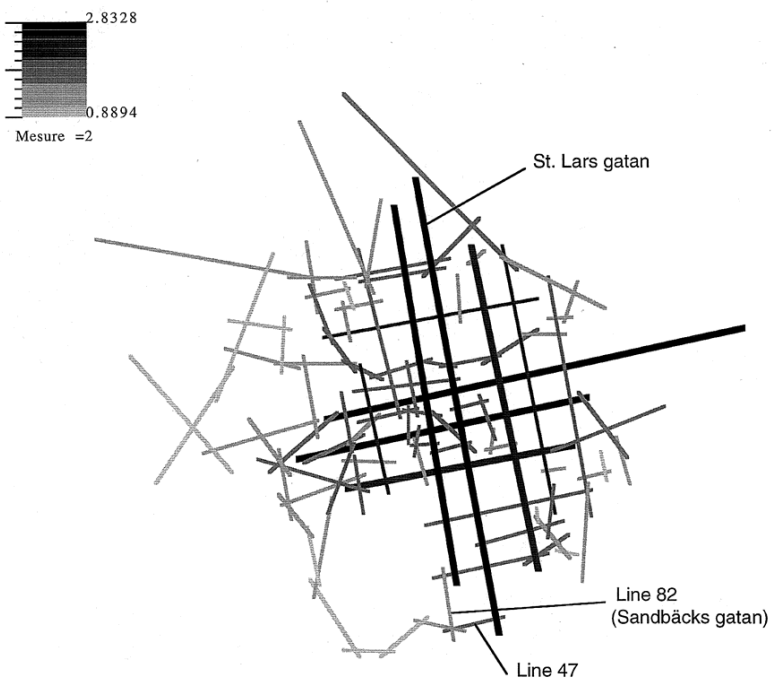
Figure 3. Plan drawing showing the university hospital area in Linköping as it is today.

4 Syntactic analyses of existing structures

4.1 The city centre of Linköping

The axial structure of the city centre of Linköping was analysed at three levels, focusing first on the integration pattern of the centre itself and then on patterns arising from embedding it in larger areas. The purpose was to find out whether there were similar configurational principles underlying the city centre and its surrounding areas.

Figure 4 is a map showing the integration structure of the centre, with its axial system defined according to the delimitation of the city map. As the map shows, the centre has a characteristic integration structure with 10% core overlapping with streets which are in fact also the "core" of its grid system in the exact meaning of the word. The less integrated spaces of the centre are represented mostly by minor streets or back-alleys filling the interstices of the grid, while the few most segregated spaces are all spread around its periphery. In other words, according to the wheel analogy (Hillier et al., 1987), the integration core of the city centre of Linköping looks very much like a "wheel" which has the hub and all the spokes but lacks the outer frame. A correlation analysis of connectivity and integration shows that the centre also has a highly intelligible structure (r2 = 0.6968; Figure 5).



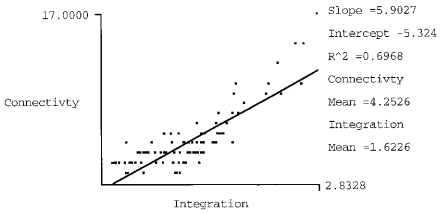


Figure 4. The city centre of Linköping, Integration map with 10% core spaces indicated in bold lines.

Figure 5. Diagram showing correlation between the connectivity and integration properties of the city centre of Linköping.

Embedding the centre in an area which extends southwards in about one mile resulted in an integration pattern which is quite revealing. As shown in Figure 6a, despite the fact that the area is now more than twice as large as the city centre in area size and axial system (285 axial lines), a large portion of its integration core still overlaps with that of the centre. While the segregated spaces are clustering mostly around the southeast corner of the area and around areas adjacent to the university hospital. The intelligibility of the area deteriorated considerably as compared to the city centre (r2 = 0.2591), meaning that, as a whole, its spatial structure may appear far less legible for people passing by or moving about the area. Both syntactic features thus seem to suggest that, in terms of configurational principles, the city centre of Linköping has already lost some of its continuity in this part of the city.

The top ten integrating spaces of the area, though, are spread in a way which makes the southeast corner of the city centre seemingly more accessible to the southern half of the city. In particular, one of the strong integrating spaces happens to be the street segment (line 47) which intersects with one boundary street (Sandbäcksgatan) of the hospital area, thus linking the area also to the main street (St. Larsgatan) of the city centre.

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Extending the study area into the size which constitutes most of the inner city of Linköping produced an integration pattern which shows no significant difference from the original one (Figure 6b). Since almost all the top integrating spaces of the system are overlapping with the grid system of the centre. The integrating core did extend more towards the west and northwest of the centre this time, though. This among others indicates that, in terms of accessibility, the integration structure of the larger system tends to patronise the northwest part of the city rather than its south. And the fact that most of the segregated spaces of the system are clustering in its southern part also supports this conclusion.

The intelligibility of the area is found to be even lower than that of the former enlarged system (r2 = 0.2282). This again seems to suggest that, beyond its current boundary, the historic centre of Linköping in fact hasn't found much extension in the surrounding areas, in terms of plan pattern as well as its underlying principle.

4.2 The university hospital area

Analysed as an isolated area, the spatial system of the university hospital area appears at once simple and fragmented (Figure 7). Simple, because the most integrated spaces of the system are all represented by the only (through) street of the area. And once

Figure 6a & b. Integration maps showing the city centre of Linköping as it is embedded in larger areas: (a) integration pattern obtained from embedding the centre in an area extending southwards in about one mile; (b) integration pattern obtained from embedding the centre in an area which constitutes most of the inner city of Linköping.

one is inside the area via that street, one is guaranteed to be in the most accessible part of the area where the hospital's main entrance is also located. Fragmented, because the circulation system of the area is composed by many shorter space segments which are basically cul-de-sacs leading to the various building groups spread over the whole area. Though rich in underground connections, lack of circulation loops at the ground level seems to have turned the whole area into two super blocks, impenetrable from the surroundings due to absence of through streets, and labyrinth-like from within because of fragmentation in local circulation networks.

Embedding the hospital area in the larger system of the city turned the whole area into a very segregated zone, a predictable pattern given that the whole area south of the city centre is far less integrated as compared to rest of the system (Figure 8). On the other hand, the analysis also shows that the northeast corner of the hospital area is in fact edging the integration core of the larger system, hinting at outer conditions for improving its relation to the neighbouring city centre (cf. Figure 6a).

4.3 Existing structures examined

Though the exact implication of the existing structures for space use and movement can not be confirmed without correlating systematic observations to the spatial modelling, analyses so far done seem to have clarified quite a few things about the spatial context of the hospital area which is interpreted as follows:

I. Comparative analyses of the city centre of Linköping in different system definitions show that the centre itself has an integration structure which is both well distributed and highly legible. These configurational qualities, however, are to a large extent lost in an area which constitutes approximately the inner city of Linköping. For regardless

Figure 7. The university hospital area in Linköping, Integration map with 10% core spaces indicated in bold lines.

Figure 8. Integration map showing the university hospital area being embedded in larger context area, with core spaces indicated in bold lines.

of changes in system size, the integration core of the area is confined largely to the grid system of the original centre, and system intelligibility deteriorates sharply once the study area extends well beyond the grid system of the centre. More specifically, the kind of integration core which interfaces well with the basic ingredients of the city - street blocks where denser pedestrian uses take place daily, can no long be retrieved once the grid system of the centre is embedded into larger context areas. While the few strong integrating spaces which do extend out of the original grid are all represented by thoroughfares best used by speedy, vehicular traffic.

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II. According to studies which related systematic observation of street space use to syntactic analysis, the integration and intelligibility of urban layouts are two significant factors which have implications for pedestrian movement to a varying degree (Hillier et al., 1993; Peponis et al., 1989; Ye, 1993). If the same lawfulness applies to the case of Linköping, then the above reported data seems to tell us that, in principle, there may exist a strongly unbalanced distribution of street space use in the city, with pedestrian movement in and around the city centre denser and more predictable according to the integration property of its grid, and beyond the city centre far more diffused and less predictable.

III. The loss of configurational continuity outside the city centre of Linköping, seems to be related to at least three obvious factors. First, west and northwest of the city centre, immediately outside its boundary, the grid system of the centre in fact dissolves into one consisting of a network of main roads and local residential streets whose arrangements may have been determined more by local needs than by consideration about the overall integration of the city. Second, south and southeast of the city centre, topographical conditions or difficult terrain seem to have prevented the grid system of the centre from expanding according to the same principles underlying the system. And, third, large green areas and parks, sometimes also accommodating large institutional buildings, are containing the grid system of the original centre from permeating into its surrounding areas where topography or urban circulation system does not act. Because of these basic constraints, it seems that the integration pattern of the city as it is today can not be changed markedly unless drastic measures are adopted in spatial re-planning at the city scope.

IV. But the analyses have also disclosed important clues, suggesting that if a redevelopment or re-building project is careful enough to take every advantage as offered by the existing structures, then there are still various possibilities to achieve improvements in the *spatial transition* between local areas, with long term implications for maintaining certain continuity in spatial integration and pedestrian movement at the global level. This may prove to be particularly relevant in the case of the university hospital area, where we found that there are inner as well as outer conditions for re-design which could make at least part of the area better integrated with the larger system. And it seems that, if any redesign action succeeds in letting one or two strong integrating spaces either go through or by-pass the hospital area, then not only the hospital area itself might become more accessible for its surrounding area, but integration between the centre and this part of the city could be improved as well.

5 Design schemes analysed

5.1 A scheme obsessed with enclave creation

Before proceeding to examine the White Architects' scheme it would be of some interest to have a look at another upgrading scheme for the hospital area, proposed by the Carlstedt Architects in Linköping few years ago (Figure 9). The Carlstedts' scheme is basically an attempt to reshape the outdoor environment of the hospital area by means of landscaping and traffic control. It is the stated aim of the scheme that an upgrading of the area should lead to the creation of a hospital park which emphasises the exclusive character of a large institution. Instead of creating open spaces with genuine, urban features, the scheme wants to "privatise" the "publicness" which the hospital area has enjoyed until present. At the overall level, the scheme thus seeks to enhance the boundaries of the hospital area by layout and landscaping measures, making access to, and traffic through the area if not more difficult than at least less easy. Within the area, it makes no attempt to break down the super block east of the through street, so that spatial connections between the main hospital complex and the city centre and areas east of the hospital enclave might be improved.

Figure 10 is a map showing the integration pattern of the hospital area as "upgraded" according to the Carlstedt's scheme. As the analysis suggests, the reorganisation of open space in the area has brought almost no changes to the distribution of its integration core as compared to the existing structure. At the same time, excessive landscaping along the upper part of the through street has resulted in more segregated spaces around that part, making the already fragmented open space of the area even more complicated. Re-running integration analysis of the Linköping city with this scheme embedded shows that the segregated status of the hospital area remains unchanged (map omitted).

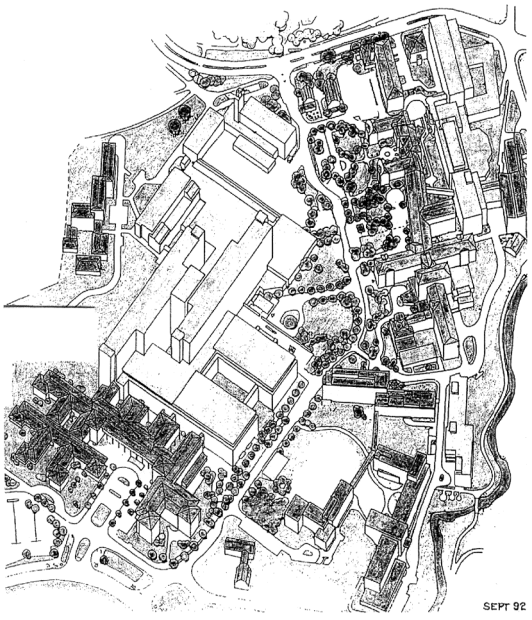


Figure 9. A plan design which proposes to up-grade the hospital area basically by investing more landscaping in the local area and by further enhancing its enclave character.

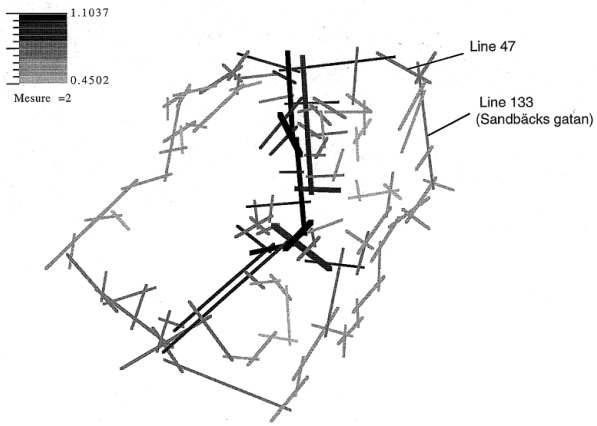


Figure 10. The university hospital area in Linköping, Integration map of an up-grading scheme for the area.

5.2 The White Architects' scheme

Instead of focusing on small scale and local improvements, the White Architects' scheme looks at the upgrading of the hospital area as a big urban design issue and thinks big (Figures 11a, b & c). Stated in a nutshell, rather than maintaining the forbidden, enclosure character of a large institution, the White's scheme seeks to create better accessibility for the hospital area and bring more street life into the area. Instead of keeping the area for institutional uses only, the scheme intends to bring in more diversity in land use pattern and tenant composition. The ultimate objective of the scheme is to create a richer pattern of use in this area and let the re-designed area also make contributions to the extension of the city centre. The scheme proposes to achieve these objectives by adopting the following design measures.

At a large scope, part of the hospital area and its surroundings shall be reorganised to, (a) facilitate cross-spatial-boundary exchanges between medical activities within the city centre and those at the university hospital; (b) create a "traffic corridor" between the city centre and the hospital area and beyond, for vehicular as well as pedestrian movement; (c) create an "ecological corridor" which links the city park north of the hospital area to the green area west of it, with pedestrian paths winding through.

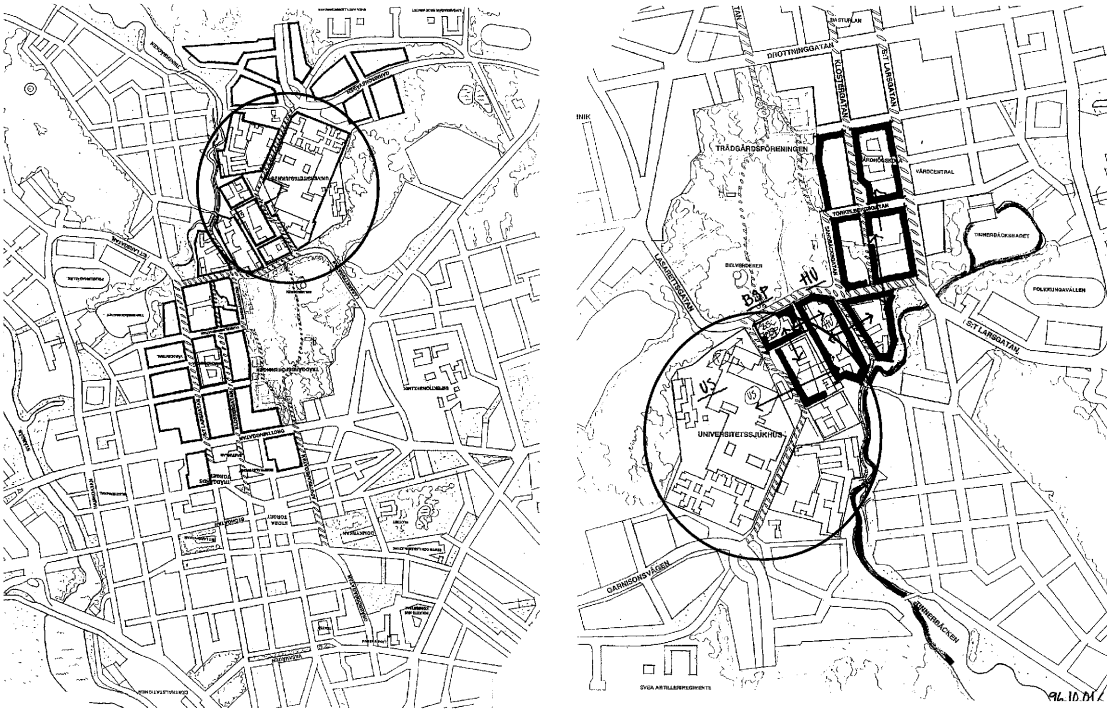
At the local level, circulation at the ground level and street blocks shall be rearranged to: (a) straighten the existing through street so that the link between the northern and southern entries of the hospital area can be improved; (b) subdivide the east half of the area into blocks comparable in size with those in city centre to add more "traditional streets" to the area; (c) insert new buildings and rebuild the old ones on those new blocks to make room for activities and uses other than medical and educational ones; (d) create an integrated circulation system incorporating streets and alleys, squares and small parks, and indoor corridors accessible to the general public.

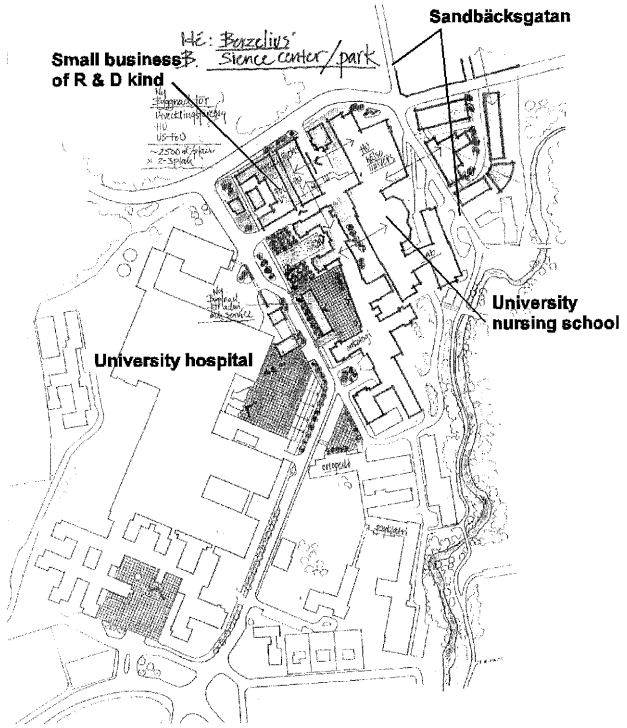
Though at this stage the White's scheme remains largely an outline design, an analysis of its context area with the proposed configuration embedded has already yielded results which are both informative and inspiring. As shown in Figure 12a, even though the integration core of the context area looks almost the same as the one before insertion (cf. Figure 6a), the overall accessibility of spaces in and around the hospital area is considerably improved in terms of integration value. In particular, axial lines 1, 82, 133 and 48, which are to play an important role in the spatial as well as functional transition from the city centre to the hospital area, are now all among the top 15% integrating spaces of the system. While the rest of the proposed street configuration (the straightened through street and the new ones) are among spaces well above the lower 50% of total integration value of the system.

Embedding the design in a larger area produced a less impressive integration pattern as compared to the former (Figure 12b). Not only did the integration core shift northwards, but the integration value of axial lines 48, 82 and 133 also declined to exclude them from the top 20% integrating spaces. This, among others, seems to provide evidence supporting our earlier observations, namely that the grid system of the city centre of Linköping tends to render the west and northwest part of the city more accessible when the majority of the inner city is taken into account. It, at the

same time, has also rendered another fact clearer, namely changes made in areas south of the city centre tend to have implications first of all for this part of the city. And this, after all, is something which the White's scheme hopes to achieve, i.e. an improvement in the relationship between the city centre and the university hospital area.

How about implications for other desirable patterns of use, for example pedestrian flow from the city centre to the hospital area (and vice versa) via the park in-between them? Explorations of design consequences along that direction produced a result which is as interesting as the one shown in Figure 12a. By simplifying the pedestrian system inside the park a bit to add five more axial lines to the system of Figure 12a,





Figures 11a, b & c Illustrations showing part of the White Architects' scheme for the re-design of the university hospital area in Linköping:

(a) sketch showing the overall relations between the city centre of Linköping and the hospital area, the key idea here is to extend the basic street-block principle of the centre to the hospital area and beyond;

(b) sketch showing the northwest corner of the hospital area which is to be reorganised to emphasise its functional as well as spatial linkage to the city centre across a boundary street;

(c) plan sketch proposing a new local circulation system for the hospital area and new building groupings to house small businesses devoted primarily to research and development.

we got an even better integration pattern for the system. Not only did line 133 (Sandbäcksgatan) become part of the 10% integration core, but the two new pedestrian segments (lines 287, 288) turned out to be among the top 15% integrating spaces of the system as well. On the other hand, the two pedestrian segments numbered 289 and 290 remained "green" in the colour scale of the space syntax software, indicating that a pedestrian route through the park would function more as a "green", quiet promenade than some lively used urban street.

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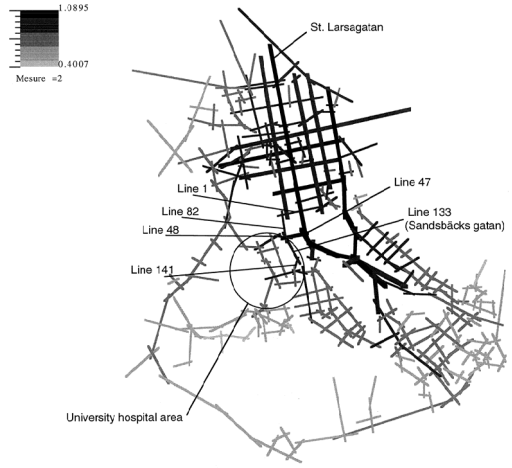

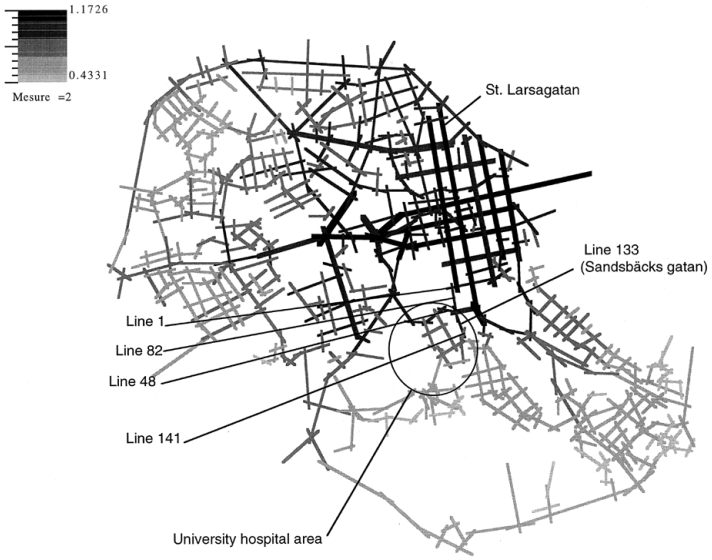

Figures 12a & b. Integration maps of the city of Linköping with White Architects' plan design embedded: (a) pattern obtained from embedding the design in a system including the city centre and the area extending southwards from it in about one mile; (b) pattern obtained from embedding the design in a system including most part of the inner city of Linköping; core spaces are marked out in bold lines.

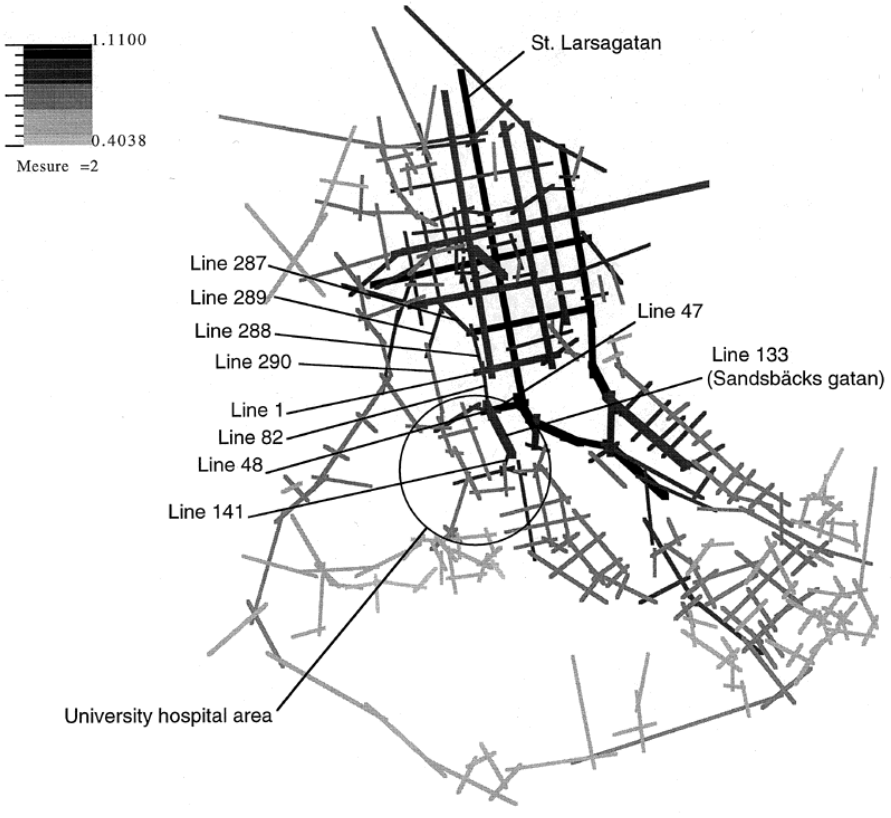

Figure 13. Integration map of the city of Linköping with White Architects' plan design embedded; system defined to include the city centre and the area extending southwards from it in about one mile, plus pedestrian paths traversing the city park north of the hospital area.

5.3 Concluding comments

Thus, if no significant alteration is to be made on its present configuration, it seems that, in principle, the White's scheme should be able to provide support to its main goal. For according to integration analysis, the scheme appears to have succeeded in extending the grid system of the city centre towards the hospital area, not only in the surface feature of a layout but also in its underlying principle, thereby contributing to the overall integration of this part of the city. And by introducing a new circulation arrangement into the hospital area which implies more alternative routes and better visibility, the scheme has also created better conditions for pedestrian movements to permeate into the area from its surroundings, thus (potentially) bringing more street life into the area.

If what has been clarified by syntactic analysis is to be accepted as a starting point or guiding principle, then further design probably should focus more on the detailed treatment of street spaces to enhance the overall effect as brought about by outline design. This may include investing more design treatment in the spot where axial lines 47 and 133 intersect, and in the spot where the southern end of line 133 intersects with line 141 and a pedestrian bridge across the creek east of the hospital area (cf. Figure 11a and Figure 13). Since by their spatial location and integration properties, both places tend to play an important role in interfacing the hospital area to its surrounding areas: the former is likely to work more as an "entry" to the area from the city centre, while the latter as a transitional space where a good orientation to (pedestrian) movements from three different directions seems to be needed. A successful design treatment of these convex spaces, then, should be able to contribute more to the visual quality of the new street layout of the area, in addition to good accessibility.

The most important insight emerging from this project is that, as a supporting tool space syntax analysis can effectively contribute to decision-making in the earliest stage of design. By clarifying the spatial context of a site at the sketching phase, the method helps designers to better understand the limitations and possibilities as offered by an existing structure. And by evaluating a proposed design in relation to its stated goals and to the existing structure, it enables us to appreciate the merits (or shortcomings) of alternative designs in greater confidence. Both exercises prove to be the fundamental help needed by large urban design projects.

Acknowledgements

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