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Original Article

Analysis of patterns of spatial occupancy in urban open space using behaviour maps and GIS

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Abstract The article concentrates on emerging relationships between physical characteristics of urban open spaces and their uses. It draws on a combination of behaviour mapping and geographic information system (GIS) techniques – as applied to urban squares and parks in two European cities, Edinburgh (UK) and Ljubljana (Slovenia) – to reveal common patterns of behaviour that appear to be correlated with particular layouts and details. It shows actual dimensions of effective environments for one use or more of them and shows how design guidance can be arrived at, based on the particulars of the case study sites and cities. In addition, the value of this article is in exploring GIS, a tool that is currently irreplaceable in spatial analysis and planning processes for urban areas, as a detailed analytical and visualisation tool that helps to describe inner structure of places revealed by behaviour patterns.
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Keywords: public space; GIS; behaviour mapping; design; research

Introduction

The article relates to open space design, particularly to the relationship between the spatial characteristics of place and the dynamic of its use. It focuses on the characteristics of possible events in public open spaces such as squares and parks, and addresses them with regard to peoples' needs and their expectations, as well as places' opportunities for a variety of uses: from passive to active, and from spontaneous to organised. On this basis, it argues for more comprehensive ways of looking at usage-spatial relationships. Comments are based on the data collected from observation and behaviour mapping in two European cities, Edinburgh, UK (May 2002) and Ljubljana, Slovenia (May 2003).

The research problem addresses a lack of actual knowledge about concrete uses of open spaces, their placements and dimensions in places; and a lack of incorporation of any such knowledge into design process and its reflection in proposed design solutions. This article explores some aspects of search for forms of places (Treib, 2001; Lynch and Hack, 2002; Lawson, 2004). At the same time, it also addresses the applicability gap between environment-behaviour research and design of open spaces (Mitchell, 1993; Heide and Wijnbelt, 1996; Southwell, 2004).

The importance of appropriate knowledge in the field of urban design is also argued by Rapoport who emphasises: 'In urban design and planning, as in design at other scales, the need is for clear and explicit objectives based on real knowledge' (Rapoport, 1977, p. 4). However, addressing the physical environment, researchers' and designers' reactions to Rapoport's demand and the different operational tools that have emerged since, in people-environmental studies, have been mainly based on visual perception and people's general preferences (for example, Kaplan and Kaplan, 1989, and many others), and many times related to movement through a place (for example, Bishop, 2001), such as way-finding (for example, Passini, 1996; Ward Thompson *et al*, 2005). Another often used and currently popular approach, addressing the spatial relationship between the structure of places and uses in them, is Space Syntax (Hillier and Hansen, 1984; Foltête and Piombini, 2007). It is often used as a

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predictive tool of the likelihood of drawing people to a place. Its prediction on occupancy is based on the broad-scale spatial structure of places. Generally, it describes a very basic usage-spatial relationship with no references to what types of activities this occupancy might consist of.

The integration of global positioning system (GPS) technology in public space research, mostly in studying transitory ways of people in towns, is increasing in popularity (Nielsen, 2005; Calabrese *et al*, 2007; Coutts, 2008; van Schaick and van der Spek, 2008; Goličnik Marušić *et al*, 2009). Using this approach, places are described exclusively by traces of people's movement in/through places. In such studies, the individuals are selected and equipped with GPS devices, the instruments that provide direct information, relevant to the geographic information system (GIS). Thus, the behaviour-environment interactions and relationships are studied for the sample of citizens selected in advance, as opposed to uninfluenced observations and behaviour mapping, a technique where anyone who happens to be in a place during the observation is recorded.

GIS is currently irreplaceable in spatial analysis and planning processes (Al-Kodmany, 2000; Miller, 2003), as well as in small-scale analysis for place design (Thwaites *et al*, 2007), exemplified with approaches such as Multiple Centrality Assessment (Porta and Latora in Thwaites *et al*, 2007), Experiential Landscape (Thwaites and Simkins in Thwaites *et al*, 2007) and GIS Behaviour Mapping (Goličnik in Thwaites *et al*, 2007). These approaches demonstrate the application of integration of experiential and spatial dimensions of the outdoors and argue its role for environmental design disciplines. Goličnik and Ward Thompson (2010) argue that, although GIS offers opportunities for data analysis, it has been little used for more detailed mapping of open space use.

This calls for a need for deeper empirical knowledge about usage-spatial relationships and a concentration on GIS as a tool for provision of gained empirical knowledge about dynamic patterns of occupancies for better place design. Thus, the article explores behaviour maps themselves as a tool to negotiate design and effectiveness of GIS for spatial annotation and visualisation of observation and behaviour mapping.

In design, a (re)search for forms is usually the most intriguing and desired by designers. Spatial form and its properties (final design product) is usually a basic subject with which designers are concerned the most. This is often represented in designers' monographs and other publications which represent the ways designers describe their own work (for example, Robbins, 1997; Nicolin and Repishti, 2003).

Nevertheless, designers develop different preferences for ways of structuring their process of design, and hold strong attitudes about appropriate procedures. From this point of view, Lynch and Hack stress that, 'These personal styles help shield them from the anxieties of the open search' (Lynch and Hack in Swaffield, 2002, p. 58). They critically reason further that, 'since the design process should fit the problem as well as the designer, a personal style is also a limitation of possibilities, a latent distortion of the problem' (Lynch and Hack in Swaffield, 2002, p. 58).

Looking beyond the form itself, Treib asks: 'Of what value is a landscape design; what is its content?' (Treib, 2001, p. 119). He illustrates that: 'Social accommodation without a consideration of a place may lead to uncomfortable landscapes. Surrender to the restrictions of climate may produce landscapes devoid of beauty or human appeal. Visual beauty alone risks the danger of being sterile and removed from life' (Treib, 2001, p. 122).

This shows that a search for form of place is a complex issue and that it should address several viewpoints at once. Goličnik (2005a) asking urban designers and landscape architects about their attitudes towards design of public places finds out that among objectives such as client's preferences, construction ease, costs, artistic value of a design layout, ecological value of a design layout, context of the site and future users in urban parks and squares design, designers pay the greatest attention to these values in the following rank: artistic values, site context, ecological aspects, client's preferences, future users and finally to costs and construction ease.

Similarly, in general, the link between social science research and design is mostly based on subjects and matters of visual perception. In these different approaches, the physical relationships between spatial forms and their usage are addressed rather indirectly, either through cognition, people's needs and their voluntary/compulsory participation, or through physical form itself and places' integration within it. Goličnik (2005a) also showed that designers are quite confident in

their knowledge about uses of places. Eighty per cent of respondents were convinced that they can predict future uses of the places they design very well. However, at the same time, a comparison between data on actual uses (based on observation and behaviour mapping) and designers' suggestions of likely uses of the same places showed quite some differences (Goličnik, 2005a, 2008).

A more direct concern about spatiality of uses in the environments where they occur was brought up by Gans' (1968) idea about the effective environment. He saw its importance especially in its provision of a substitute for the concerns about a 'causal influence between physical environment and human behaviour in it', with a question of 'when, how, how much, and with what effects this causal influence does occur' (Gans, 1968, p. 11). This question of Gans implies a search of empirical knowledge about the subjects. Its importance lies in the thoughts that Gans has expressed further: 'Until data to answer my question are available, the planner is likely to continue to believe or hope that the effective environment will be exactly like the potential environment' (Gans, 1968, p. 11).

To sum up, this calls for a responsible and sensitive provision of (re)search about the physicality of spaces, which uses the language of the patterns of use(r)s. Therefore, the overarching general aim of this article is to debate a need for the examination of real and concrete usage-spatial relationships, and learning from them to contribute to public place design. The article is aiming to promote a better understanding, planning and design of public places in order to respond to actual uses; that is, social inclusion and well-being in urban public places in city centres.

Methodology and Data Collection

From a methodological point of view, the examination and expression of virtual usage-spatial relationships in places by mapping and map-making is suggested. Mapping and map-making are related to physical aspects of places and imaging, two subjects with which designers are usually quite familiar. This article speculates that a body of knowledge represented in such way may help designers and decision makers effectively when addressing design, evaluation and the re-design of parks or squares. Therefore, the findings presented here are argued on the basis of the empirical evidence collected in the central parks and squares of the case studies in Edinburgh and Ljubljana (Goličnik, 2005a), using observation and behaviour-mapping technique. Observation and behaviour mapping as a combined technique in studying the environment-behaviour relationship has been a known and used method for some decades (for example, Ittelson *et al*, 1970). This article emphasises its connection to GIS and argues by this for more comprehensive ways of looking at that usage-spatial relationship. The spatial-behaviour analysis, based on GIS, resulted in usage-based spatial articulation of places, representing shapes, sizes, densities and intensities of places' occupancies.

Case studies represent two urban environments with similar characteristics such as size, density, topography, cultural significance, and so on, but in different parts of Europe. Both cities, Edinburgh and Ljubljana, are middle-sized European cities, important national and international cultural, as well as political and university centres. In this respect, they have a similar atmosphere in terms of their daily routine. The historical old towns are partly transformed into pedestrian zones, and together with other areas of their city-centres' later developments are significant in terms of mixed land uses, from service, cultural and educational to residential. Comparable parks, park locations and their size and function, and squares in the old towns, as well as in other locations in city centres were selected within an area of about $2\,km^2$ in each city, nine in Edinburgh, and eight in Ljubljana (Figure 1).

Both cities belong to the mid-latitude temperate climate zone. Regarding the weather conditions, some daily circumstances might be very similar, but because they belong to different sub-zones – Edinburgh to the oceanic and Ljubljana to continental – they can be quite different. In mid-spring, a popular season for outdoor activities, similarities might be found, especially when conditions are dry. With regard to dampness and humidity, their frequency, duration, density and size of rainfall are more likely to be different. In the continental climate, heavy rain is usually a downfall, whereas in the oceanic climate types of downfall vary from mist or deep overcast drizzle to mild showers and heavy rain.

Data on parks and squares use in each city were collected in May (May 2002 – Edinburgh; May 2003 – Ljubljana). The month of May was chosen because the weather was likely to be warm and the outdoor activity pleasant. A day observation

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Figure 1: Maps representing the selected sites included in a case study in Edinburgh, UK and Ljubljana, Slovenia.

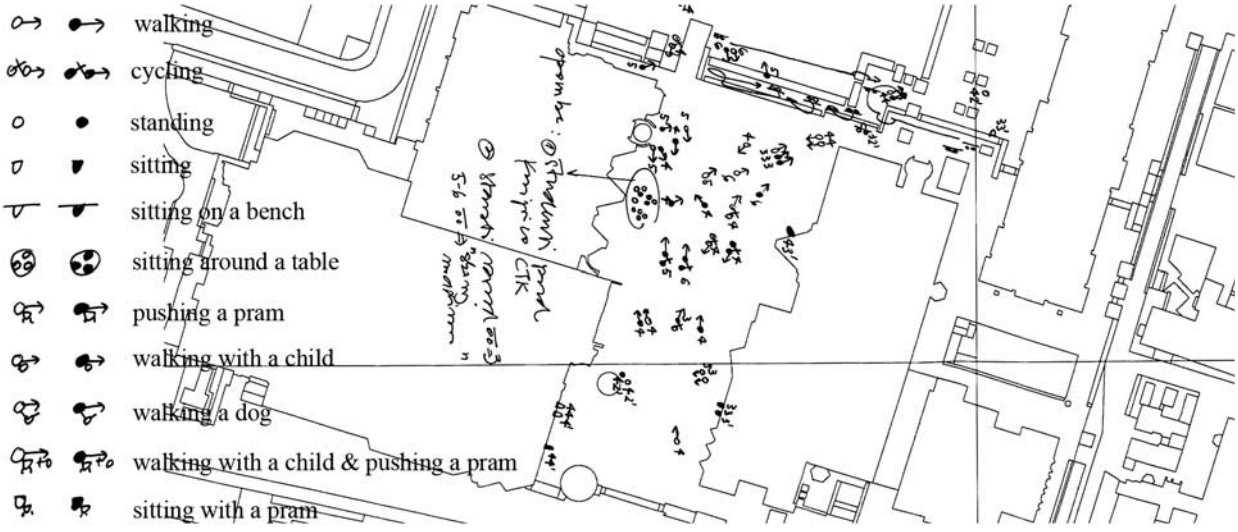

Figure 2: Some symbols used for manual mapping (left) and an example of behaviour map as recorded during observation, Trg Republike, Ljubljana (right).

unit represents four sections: morning (10:00–12:00), early afternoon (12:00–14:00), afternoon (14:00–16:00) and late afternoon (16:00–19:00); during the week as well as weekend. The observations were usually conducted from one location in a setting, from where a good overview across a place was provided. As some places were too big to be observed, with one overview across the entire place, they were divided into more sub-areas, usually three or four. Each such spatial unit was observed for 10 min. All together, two parks, six squares and one square-like street were observed in Edinburgh; and two parks, five squares and a park-like square in Ljubljana; 105 observations were made in Edinburgh and 106 in Ljubljana.

Originally, data were collected manually. Open-ended set of symbols were defined, which were placed on a map of place in scale 1:1000 when any such certain activity was actually seen in a place.

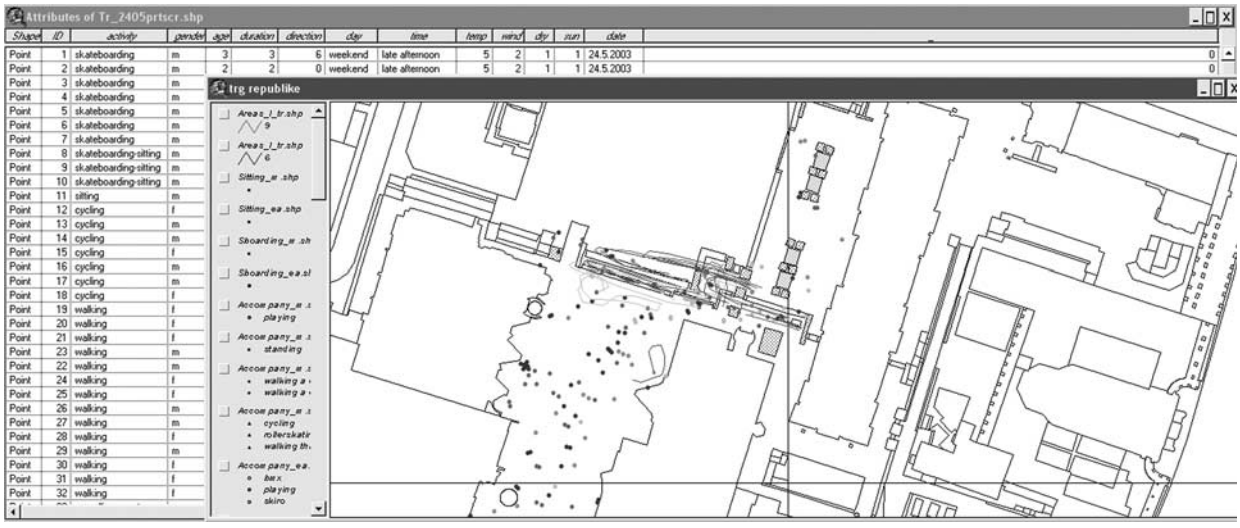

Figure 3: GIS behaviour map, Trg Republike, Ljubljana.

However, such records were accompanied by some qualitative information as well, such as duration of an activity, estimated age of the participant (age group), direction of movement and date describing the weather conditions at the presence of the activity (Figure 2).

Every symbol recorded manually was transmitted into its digital variant in the same way. A map of the observed area was projected on the computer screen. The location of the re-recorded activity was identified with the cursor and clicked when the location was verified. All the attributes of each re-mapped symbol were described in the attached table under its given serial number. Following such a procedure, every database of each place consists of layers of information, based on a day-order structure. Point symbols within the layers represent single users originally recorded in the place. Properties of an activity included in symbols developed for manual behaviour mapping and the characteristics of other circumstances, such as weather conditions, time of day and day of the week, captured within symbols and matrixes of original records, are described in the table attached to those point symbols visualised on the map (Figure 3).

Behaviour Maps as Scripts of Empirical Knowledge

Behaviour maps provide a shorthand description of the distribution of behaviours throughout the place. The major value of behaviour maps, as a research tool, lies in the possibility of developing general principles regarding the use of space that apply in a variety of settings. GIS behaviour maps extract behaviour evidence into layers of spatial information to give a better understanding of the individual and collective patterns of use that emerge in a place (Figure 3). The overlap of behaviour maps can show some characteristics and changes in using chosen open spaces in terms of activities, number of people engaged, gender and all the other variables that are explored (Figure 4).

This section comments on actual uses in the observed squares and parks to illustrate the role that observation and use of GIS databases can play in public space design, monitoring and decision making. However, evaluation and negotiation of the configuration of spatial forms with patterns of uses are final challenges in the implementation of GIS in the context of this article.

First, the article pays attention to squares. The discussion is focussed on two squares, the Bristo square in Edinburgh and the Trg Republike in Ljubljana. The latter is located in the civic centre of Ljubljana, with explicit mixed land uses, from service, commercial, cultural, educational, political to residential. Its general spatial structure consists of two sub-positioned longitudinal platforms, attached to the surroundings with steps and ramps. One platform has a built frame along both of the longest sides, the other along one side only. The open side borders on a car parking area. This whole complex was built in the 1970s. From a

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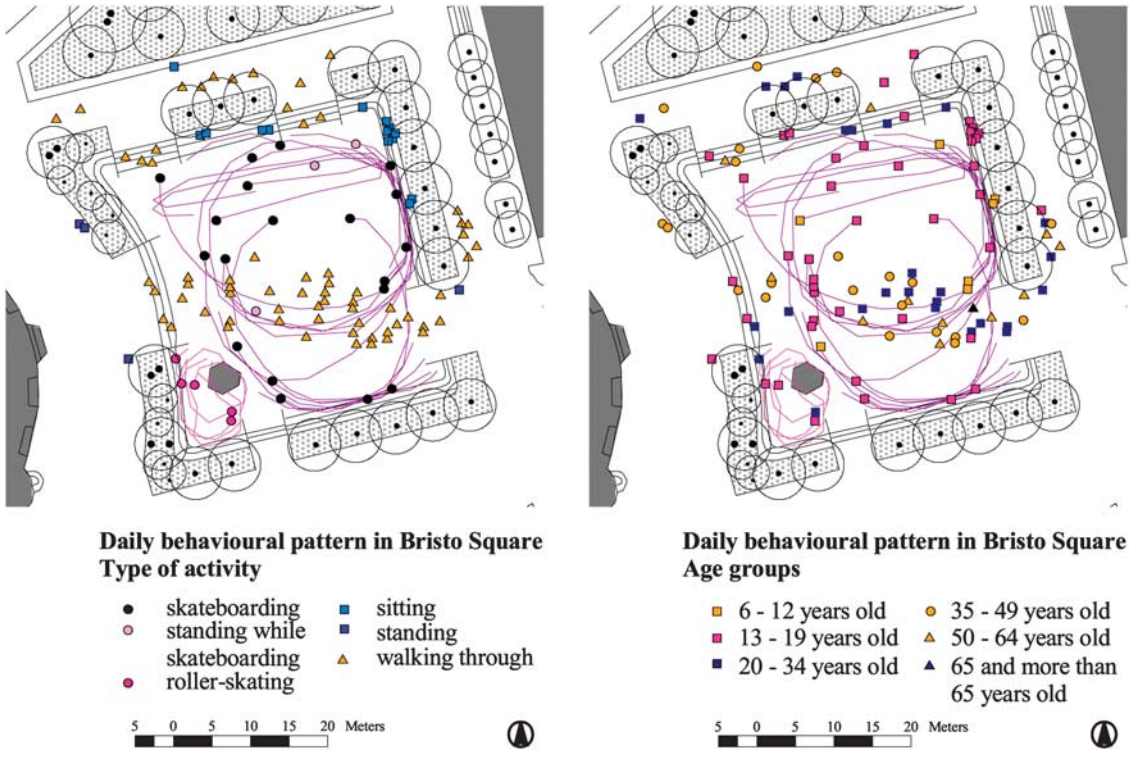

Figure 4: The usual example of a daily occupancy in Bristo Square, Edinburgh, ranged with regard to the type of activity and age group to which any participant belongs.

usage point of view, Trg Republike is regularly occupied by the usual everyday uses such as walking, cycling, sitting and standing, but it is also often enriched by a specific use, skateboarding. Other long-stay active uses such as playing, bmx-acrobatics, and propelling scooters were present occasionally.

Bristo Square was renovated in the early 1980s, as a part of bigger project to solve the main local traffic communication system. It is a squared, enclosed space with no ramps, but it is attached to a spatial frame that ensures that the sunken platform, the core of the place, is accessible to wheelchairs, prams, bikes and the like. This enclosure is composed of a voluminous edge of stairs along each side, on some sides explicitly partitioned into shorter sections. Along the sides, large planting beds with low trees finally define the edges. Thus, compositionally, it expresses a strong spatial connection with the university hall. This reflects its initial character, designed as a place for gathering and ceremony. Its spatial context of land uses is predominantly educational, service and residential. People of all ages and gender pass by on a regular basis, sometimes resting in the area attached to the sunken platform on its northern part. Young male participants are often engaged in active skateboarding or roller-skating, usually in the afternoons or at any time during the weekend when the weather is predominantly dry.

Second, this article comments on cumulative maps of three large parks involved in the study; the Meadows and the Princes Street Gardens in Edinburgh, and the Tivoli Park in Ljubljana. All the parks included are green spaces with no large built structures and with a similar policy of maintenance.

Tivoli is the only big public park in the centre of Ljubljana. It carries out the functions, meanings and importance of a public park on its own. Tivoli and Princes Street Gardens share the attributes of spatial content such as a social programme, in terms of the nearness of galleries, churches, outdoor cafés and a children's playground in an adjoining area. The sense of place of each is as a space for a short rest and to relax. Although different in size and topography, both have traditional park features such as benches and fountains. Their location and the spatial features of their context are set by a railway corridor and the slopes of a hill. Tivoli has also some other

Figure 5: Dimensions of supportive and disruptive environments for skateboarders, exemplified from the cumulative evidence represented on assembly behaviour maps in Trg Republike, Ljubljana and Bristo Square, Edinburgh.

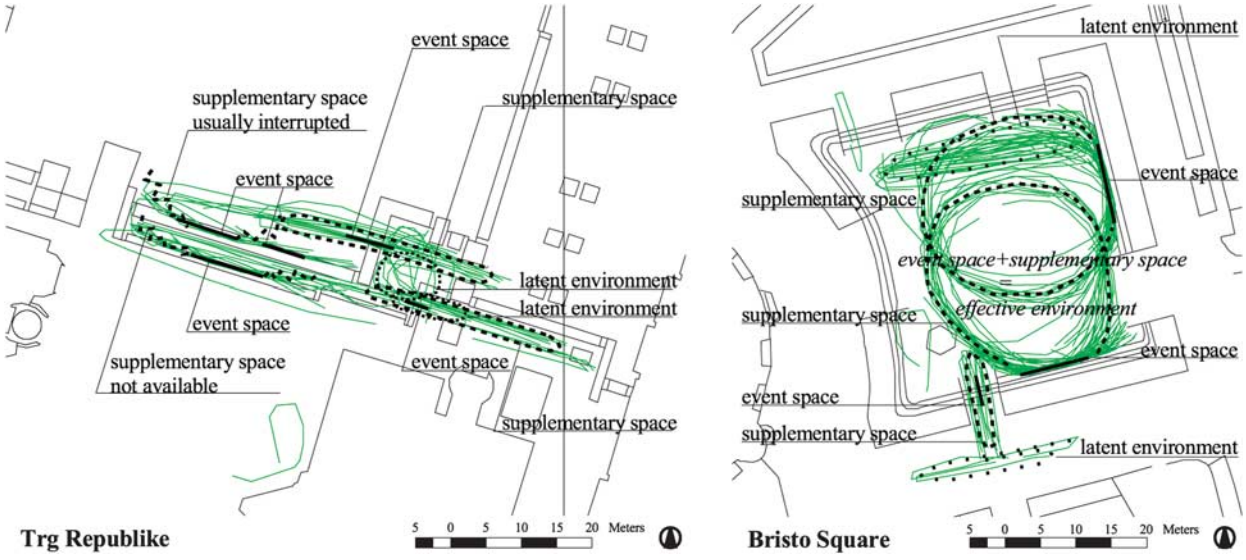

Figure 6: Inner-structure of skateboarders' behaviour patterns revealed as the 'event', 'supplementary', 'effective' and 'latent' environments for skateboarders in Trg Republike, Ljubljana and Bristo Square, Edinburgh.

characteristics of spatial content that are not found in Princes Street Gardens but that are found in the Meadows, the other central public park of Edinburgh. These are size (see Figure 1) and overall shape, the meaning, in terms of passive and active recreation, and their context, in terms of the nearness of student accommodation. Tivoli has inner articulations and some slight slopes in some parts, whereas the Meadows is completely flat, and has no articulation besides its main walkways' system and tree lines along them.

Patterns of occupancies for skateboarding: Shapes and dimensions

Skateboarders are a small and particular example of public space use. However, a study of their activities addresses general concerns about democracy and (social) sustainability, two overall goals of current beliefs in spatial planning and design. Accordingly, achieving public places of social interaction and diversity of uses has been discussed, valued and encouraged often in recent

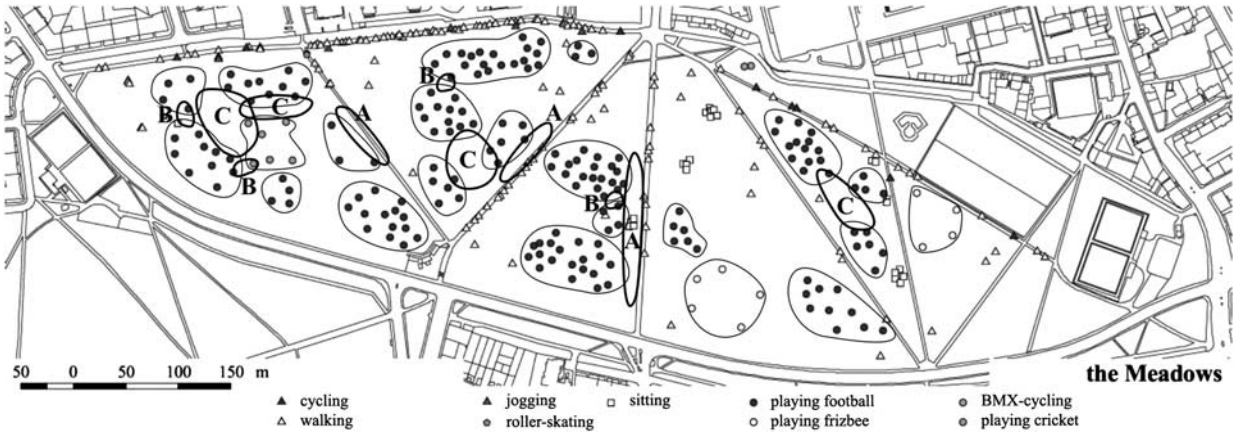

Figure 7: An illustration of different types of voids between uses and between them and physical environment. A speculation on their importance may provide crucial clues about necessary needed supplementary spaces for their overall comfortable co-habitation in a place.

years (Gehl, 1987; Gehl and Gemzøe, 1996; Worpole, 2000; Hajer and Rijendorp, 2001; Ward Thompson, 2002; and many more).

Following a closer examination of conducive places for skateboarders, further discussion is limited to some concrete examples to illustrate the potentials of patterns of occupancies of places. Neither Bristo Square (Edinburgh) nor Trg Republike (Ljubljana) was planned as a skateboarders' platform, but a certain articulation of those places has stimulated its users to be there and to use it for their pastime. However, this certain articulation in itself does not ensure optimal use. The size, shape and vertical articulation of the available space are of key importance.

The empirical evidence (Figure 5) shows that an action such as a 'jump on a step, slide over and jump off' is successful in the middle of quite long steps. The 'sliding event' most likely takes about 5 m, or more. As this 5 m space occupies the middle of the step, the necessary full length of the step required needs to be at least 15 m, not necessarily continuous in level height along it. The dimensions of the examined steps most frequently used are about 20 m or more. A short part of the north side of Bristo Square is less than 15 m long, and, as recorded, it is used less frequently than the most intensively used parts.

A preparation for such 'jump-slide' actions requires some more space to hand before the step. The Bristo Square study shows that skateboarders usually approach the middle of such a long step, following a curve of a circular line of at least 20 m in diameter. Thus, in Trg Republike, although the upper line of two steps in the setting is long enough and was used for 'sliding over', the narrow platform that leads into the next pair of stairs, heading to the platform of the car-parking area, does not make a circular approach towards the step possible.

A ramp, low wall and staircases, which define the sides of these long steps, create a sub-platform underneath, before the big opening of the car parking place. It could eventually provide an area for a partial travelling on a 'potential' circular line, which a skateboarder may follow as a preparation for sliding over a step. However, the parking place is so intensively used that even a short travelling of a couple of metres on this circular line to participate and experience a full engagement in skateboarding 'jump-slide-jump' event is disrupted. The Bristo Square analysis shows that such full engagement can be considered when a skateboarder approaches a step along this circular line in at least 5 m of his journey. It would suggest at least about 3 m clearance from the step as a minimum supplementary space for the jump. In Trg Republike, this space is usually not available.

The examined cases show that steps that merge into a flat platform are essential elements that attract skateboarders; but this merged, flat area is crucial to enable their actual use. Physical traces of actual activities, represented as graphical information on the map, elucidate the inner structure of the effective space for skateboarders, reflect its usability and in this way, address spatial capacity of a place. In Trg Republike, the capacity of the supplementary space, the available space that actually enables the complete activity to

happen fully, was simply not big enough to support skateboarders' complete active involvement (Figures 5 and 6). Equipment such as boxes and some other light structures, which skateboarders brought to the stage, evoke latent environments.

The research showed that in design, that is, search for appropriate and comfortable spatial structures and articulations for one or more uses is of key importance to create effective environments, which according to the nature of any particular activity consists of its own space of the event, merely literary activity itself such as sliding along the step when skateboarding, and its supplementary space, this available space that allows the users to be comfortable and fully engaged with its activity.

Occupancies in parks: Contacts and buffer zones between them

An overall characteristic, resulting from observation of all three main parks (Goličnik, 2005a), is reflected in the complementary concerns of frequency and diversity of recorded uses in them. The Meadows and Tivoli share many of the kinds of activities indicated. Either type of activity, from active (for example, playing, playing football, flying a kite) to passive (sitting on the grass, sitting on a bench, lying down), and from transitory to long stay in parks, can be realised in many different ways. Transitory activities range from simply walking, cycling or roller-skating as transportation, to their different variations such as walking a child, pushing a pram, walking a dog, which may occur for more recreational reasons, to pure recreation such as jogging. Parents were often seen sitting with prams, or dog walkers with dogs, while those people walking with children were often engaged in more active participation, either having a little play along the way, or in any favoured area on the lawn.

The discussion so far raises an important recognition that neither a configuration of environment *per se* nor dimensions of usage required for its successful placement, but a minimum supplementary space is an important issue to be considered in public space decision making and design. Focusing on the relationship between uses in places on the case of a daily occupancy on quite a busy day in the Meadows shows that a 'point contact' at shorter or narrower sides of areas of occupancies (see B in Figure 7), and 'in between space' along such areas (see C in Figure 7), seem to be significant for their comfortable occupancy. This reflects a concept of 'buffer zones' of activities, which may address a successful spatial co-habitation of occupancies in places.

The buffers required by different groups and activities produce a combined picture of buffer zones that remain almost constant across a large park as a whole. Figure 8 illustrates an area in the Meadows, Edinburgh, which always remained unused by long-stay active users, throughout the observation period: a cumulative account of the minimum buffer zones for the whole park.

This pattern shows that central areas of green patches were hardly ever left unoccupied by groups of active users. Narrower corners of longitudinal triangular patches were barely used by big groups, until they reach a width of about 80 m. The pattern shows minimum buffer widths as follows: about 2 m from inner edges, about 16 m from outer open and about 7 m from outer solid edges. The main communication route across the Meadows, lined on each side by a double row of trees, results in a buffer zone similar to that of the open outer edge on the south, that is, 16 m. In bigger patches, those more than 30 000 sq m minimum buffer widths are 4 m from the inner edges, and in smaller patches, about 2 m.

GIS Behaviour Maps as a Tool for Provision of Empirical Knowledge

Goličnik (2005b, 2007) argues that GIS databases can serve as an inventory tool, providing basic descriptions and information about activities in places. They offer an understanding of those places by patterns of spatial occupancy with regard to their elementary characteristics, those that describe their peculiarities when being carried out. Maps, as products of visualisation, can represent the spatial data of behaviour patterns as patterns reflecting occupancies at different times of a day, or days of a week; as patterns structured by the duration, nature or type of occupancy; as patterns showing the occupancies only under pleasant weather conditions and the like. It offers a transparent examination of places through different combinations of attributes of behaviour patterns. Further, it enables a designer to look at places from any desired combination of those attributes that may most intrigue him or her (for example, Figures 4 and 9).

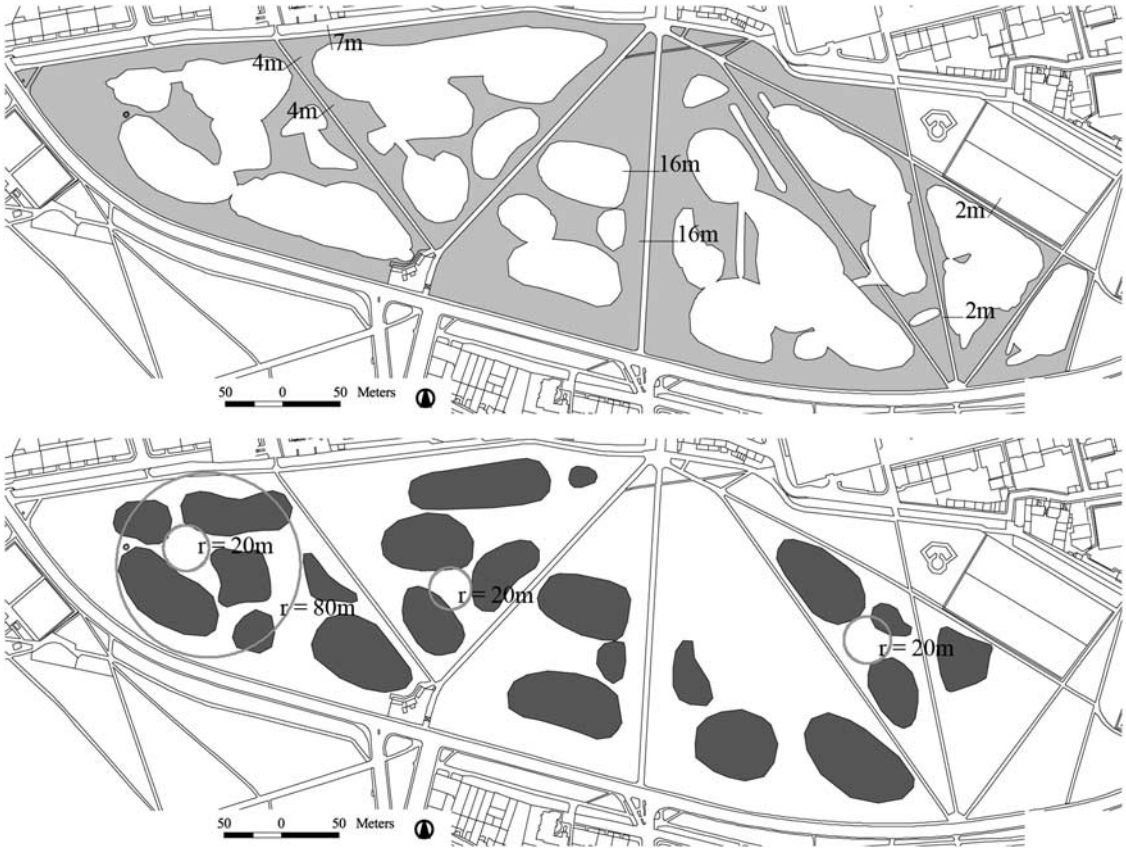

Figure 8: Cumulative minimum buffer zone for The Meadows park, Edinburgh (left) and relationships between size and shape of a patch and its occupancy by long-stay active uses in the Meadows, Edinburgh, based on records from a daily pattern (right).

This visualisation (Figure 9) shows that, generally, afternoons are the busiest parts of a day in the park. Regarding the operative principles of occupancies discussed earlier, it also shows information about filling up places. The morning/early afternoon situation and the late afternoon situation display similar patterns. They reflect a situation in which occupancy responds to the given spatial characteristics of places. The afternoon situation, on such a basis, exemplifies a further aspect, when occupancy also relies on the distribution of already carried out uses in the place.

In addition to providing information about different elementary peculiarities of patterns of occupancies, maps can show the results that have arisen from deeper investigation. Accordingly, what can be presented are the values of rates of use, participation of users engaged in any one activity and their intensity of use, the nature of the spatial-temporal involvement of activity and the like. Such a demonstration is based on the patterns gained from the original observation and behaviour mapping, but labelled with the results derived from the statistical calculations, or any other reasoning based on the interaction between two components, which has resulted in a new one. Behaviour patterns, visualised as general facts, based on the observations, are now used to spatially demonstrate other and new aspects. Goličnik (2005b) shows that such GIS implementation can contain information such as how often a certain activity has happened, how intensively it has been participated in per certain temporal unit, how the patterns of each certain activity were differentiated with regard to the presence of others, and so on.

Thus, GIS maps also embed the knowledge that brings the indirect insights of usage-spatial relationships. Accordingly, the information that shows some indirect essences about occupancies and places of their engagement, preserved in places as key informative facts about users and sites, enables us to see abstract notions and

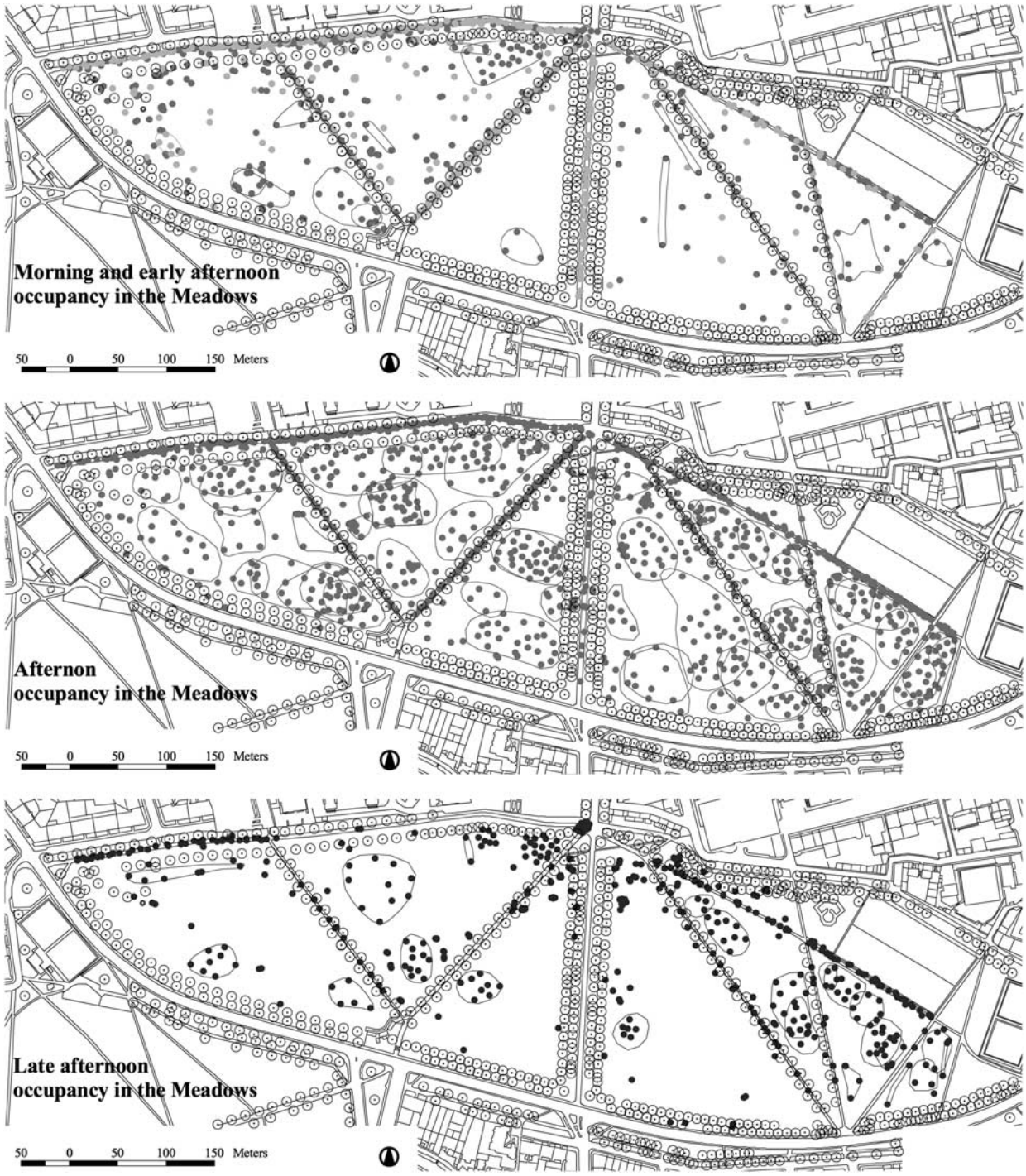

Figure 9: Patterns of spatial occupancy in the Meadows, Edinburgh, specified according to times of day, from late morning and early afternoon, afternoon, and late afternoon.

primarily, non-spatial characteristics linked to physical environments.

When searching for knowledge about under- and over-use, for example, or about any other overall views that require multi-layered reviews, GIS analysis seems particularly appropriate. This article exemplifies such implementation when studying the intensity of occupancies (Figure 10). By studying the qualitative objectives of places, generally addressed as the suitability or conduciveness of

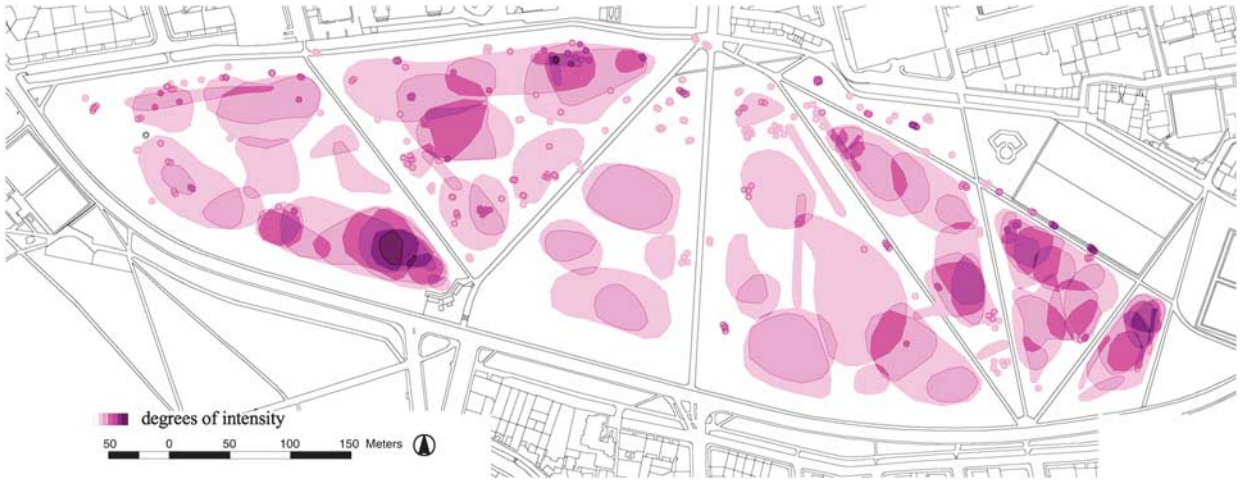

Figure 10: Cumulative intensity of spatial occupancy by long-stay active and passive uses, from a low to high degree in the Meadows, Edinburgh.

places to occupancy, such analysis enables us to refer knowledgeably to them of the cumulative spatial capacity of places. This may result from generated patterns of different intensities of occupancies and the voids between them. Although the overall behaviour patterns and their interpretation address a common spatial capacity of places, voids between them in daily patterns of use reflect buffer zones between activities, and they refer to the effective distribution and cohabitation of diverse use in a place.

Discussion

If the demand in practice for all-inclusive designs calls for the importance of empirical knowledge, the technical possibilities performed by GIS can show and reflect on richness of its contents. In this article, the initial contents of the empirical knowledge directly reflect the information recorded through the observation. A GIS application upon it elucidates different aspects of this basic information about the usage-spatial relationship, and provides a variety of different information derived further from this original collection. From this point of view, especially because this knowledge is visualised on maps, it also reveals the possibility for more effective design-research integration, and stresses the effective incorporation of empirical knowledge in design. A systematic observation and recording of collected data with GIS, especially based on cumulative assembly maps, revealed empirical knowledge about stimulating and effective environments for single or multiple occupancies in squares and parks in city centres.

Once a certain body of any empirical knowledge is established, its place and the manifestation in design are in question. Thus, as for any other concern benefiting the evolution and progress of a design, from the initial ideas about a spatial composition to all sorts of spatial analysis related to the designed place and its context, the notions referring to dimensions and spatial characteristics of the relationships between activities and places could be included in a design process. It is seen as a controlling mechanism in a design process, which may help to estimate suitability and conduciveness of a new emerging design to expected, wanted or incidental future use.

A specific value of an empirical knowledge gained by GIS behaviour mapping lies in the notion about the effective environment, that what happens in any particular environment depends on those who use it. A consequential challenge results then in the demand to know (more) about those who use. It is also important when, in design, the aim is to provide the so-called loose-fit landscapes (Ward Thompson, 2002; Franck and Stevens, 2007), especially parks, which are larger and where the physical limits are further apart, and in which the presence of uses themselves structure the resilience of the potential environment to become effective for one or more of them.

An analysis of these different parks shows that spatial articulation is the clue to spatial occupancy. Activities, especially those significant for active group games form patterns, buffered by

voids, in several quite predictable ways. There are three types of buffer zones that different, active, long-stay users need: Buffer between an edge, whether solid or transparent, and active users (for example, informal football). Compact groups, for example, of informal football, are likely to require a distance of at least 4 m from an inner transparent edge, such as a tree-lined path. Activities forming looser and smaller groups, such as a few frisbee players, are likely to occupy a space closer to an inner edge, for example, at least 2 m from a path. Buffers between a number of adjacent active groups occupying different territories – the minimum 'common open' area between activity spaces – are more difficult to define precisely in terms of surface area, since the activities taking place depend on the size, shape and edge qualities of a green patch. However, an abstract form that can describe the minimum activity buffer space commonly needed between a group of activities is a circle of radius 20 m.

For one of the usual skateboarder's actions, which consists of approaching an elevated spatial element such as a step, to jump on it, slide along, and then jump off it, the necessary full length of step required needs to be at least 15 m. The adjacent area before such a step should allow a skateboarder to approach it along a curve of a circular line of at least 20 m in diameter, and to undertake virtually a jump-preparation journey on it of at least 5 m. Thus, a platform at least 3 m wide, attached to a long step, would allow such a minimum jump-preparation journey.

Although a long step attached to a clear and flat platform facilitates a sliding action, a set of a couple of steps stimulates skateboarders to jump over it. Compositions of steps are attractive as sitting places too. This examination also showed that sitters' and skateboarders' actual effective environments do not overlap. Sitters are searching for sheltered (not necessarily from sun), back-covered, less-exposed areas, and places with a view of either attractive landscape or actions.

Hence, while urban designers might create potential environments, people create effective environments. The challenge is not only to see to what degree or how much of a potential environment can be transformed into an effective one, but also to discover its inner structure. Empirical knowledge, stored in digital interactive GIS databases and, through selection, on maps, can provide some insights into different dimensions of the usage-spatial relationship, such as gender or age differentiations and the like.

At the same time, it is important to bear in mind limitations of the findings based either on accuracy of recordings or consideration of other relevant aspects that may influence space occupancies. The socio-economic context, the functions and density of the surrounding area may vary and are certainly likely to influence the activities and level of use within a space. In this study, the sites chosen were roughly comparable with regard to such considerations, but this potential limitation must be recognised before generalising to other parks in different (for example, suburban) parts of other towns and cities. Well-used (and well-maintained) city parks are likely to be perceived as safe places to visit, sit on the grass, and so on, but this may not be true for emptier or poorly maintained spaces, or where there is no surrounding land use that provides informal policing of the area.

The accuracy of recording the location of observed activities on a map will have some degrees of error, even when all researchers are trained and tested for inter-observer reliability. Recording the location of activities by use of GPS might appear to offer a more accurate way of locating individuals, but the practical difficulties of implementing this are considerable: either the observer(s) need to take the GPS recorder to the point where each person is located, disturbing park users' privacy, or a large number of GPS monitoring devices need to be handed out to park users as they enter the space. This latter approach might lead to intervention effects and inhibit natural behaviour, but would derive a considerable volume of data for analysis, complex though that analysis would be in densely populated areas.

Conclusion

The key overall contribution of this article is in the reflection on the physical attributes of places by the physical dimensions and spatiality of the different uses that occupy them. Operationally, the representation of any nature of the relationship between uses and places as a visual image is a crucial contribution, especially because the imaging and visualisation are the elementary designers' media.

However, the empirical knowledge gained by behaviour mapping, brought up in this article, is seen as an addition and a complement to other research approaches and tacit designers' knowledge. Such empirical knowledge brings a

good template and/or a starting point for further post occupancy evaluation analysis, as well as benefits to public participatory processes in planning and design decision making. It is especially important when addressing user-groups such as youngsters or elderly people, even homeless people, who may not respond to the participation, but whose preference and existence in a place is important, especially when talking about democratic, all-inclusive design.

A direct contribution that this article brings to the design practice lies in some initial empirical knowledge about dimensions and spatial requirements, for example, urban skateboarding in squares. It also illustrates how some activities can be contiguous, while others require 'buffer' zones between them for effective use. Such information can help designers as well as decision makers when discussing variations in spatial plans for public space; there might be concerns either about any of the available plot's basic characteristics, such as size and shape, which may be more or less likely to support or inhibit a particular use. Alternatively, the information might give hints on the general layout of a place, such as how it should be articulated so that the desired uses might be most likely occupy it in the future.

Whatever technique is used or can be expected to be used as the most efficient one in the future, taking into account IT development, GIS as a tool, with the ability to produce and use databases, remains of key importance. The further practical challenge linked to any similar studies in the future is in the technical field of computer software. Having the appropriate and affordable equipment for recording digital data directly in the field, a programme that could support a simultaneous coding of all sorts of behaviour attributes, such as gender, type of activity, its duration and the like, as well as any other conditions regarding the weather, time of day or any other relevant aspects, would be very helpful. It would make the data gathering and its preparation for further analysis much more efficient and the whole process more researcher(s) friendly.

References

Al-Kodmany, K. (2000) GIS in the urban landscape: Reconfiguring neighbourhood planning and design processes. *Landscape Research* 25(1): 5–28.

Bishop, I.D. (2001) Predicting movement choices in virtual environments. *Landscape and Urban Planning* 56(3–4): 97–106.

Calabrese, F., Kloeckl, K. and Ratti, C. (2007) Wikicity: Connecting the tangible and the virtual realm of a city. *Geoinformatics* 10(8): 42–45.

Coutts, C. (2008) Greenway accessibility and physical-activity behaviour. *Environment and Planning B: Planning and Design* 35(5): 552–563.

Foltête, J.C. and Piombini, A. (2007) Urban layout, landscape features and pedestrian usage. *Landscape and Urban Planning* 81(3): 225–234.

Frank, K.A. and Stevens, Q. (eds.) (2007) *Loose Space: Possibility and Diversity in Urban Life*. London: Routledge, Taylor & Francis Group.

Gans, H.J. (1968) *People and Planning: Essays on Urban Problems and Solutions*. London: Penguin.

Gehl, J. (1987) *Life between Buildings: Using Public Space*. New York: Van Nostrand Reinhold.

Gehl, J. and Gemzøe, L. (1996) *Public Spaces – Public Life*. Copenhagen, Denmark: The Danish Architectural Press.

Goličnik, B. (2005a) People in place: A configuration of physical form and the dynamic patterns of spatial occupancy in urban open public space. PhD thesis, Edinburgh College of Art, Heriot Watt University, Edinburgh.

Goličnik, B. (2005b) Public urban open spaces and patterns of users: Exploring behaviour data using GIS. In: B. Martens and A.G. Keul (eds.) *Designing Social Innovation: Planning, Building, Evaluating*. Toronto, Canada: Hogrefe, pp. 167–175.

Goličnik, B. (2007) GIS behaviour mapping for provision of interactive empirical knowledge, vital monitoring and better place design. In: K. Thwaites, S. Porta, O. Romice and M. Greaves (eds.) *Urban Sustainability through Environmental Design: Approaches to Time, People and Place Responsive Urban Spaces*. London: Routledge/Taylor and Francis, pp. 136–140.

Goličnik, B. (2008) Parki in njihovi uporabniki. Parks and their users. *Urbani izziv* 19(2): 10–17, 133–139.

Goličnik, B. and Ward Thompson, C. (2010) Emerging relationships between design and use of urban park spaces. *Landscape and Urban Planning* 94(1): 38–53.

Goličnik Marušić, B., Nikšič, M., Tominc, B., Bizjak, I. and Mladenovič, L. (2009) Informacijska tehnologija, urbana mobilnost in izboljšanje kakovosti življenja: z GSM-i do analiz stanja in potreb kolesarstva v Ljubljani. Information technology, urban mobility and improvement of quality of life: state of the art and needs regarding cycling in Ljubljana using GIS. Ljubljana, SLO: Urbanistični inštitut Republike Slovenije. Urban Planning Institute of the Republic of Slovenia. Research report.

Hajer, M. and Rijendorp, A. (2001) *In Search of the New Public Domain: Analysis and Strategy*. Rotterdam, the Netherlands: NAi Publishers.

Heide, H.T. and Wijnbelt, D. (1996) To know and to make: The link between research and urban design. *Journal of Urban Design* 1(1): 75–90.

Hillier, B. and Hansen, J. (1984) *The Social Logic of Space*. Cambridge: Cambridge University Press.

Ittelson, W.H., Rivlin, L.G. and Prohansky, H.M. (1970) The use of behavioural maps in environmental psychology. In: H.M. Prohansky, W.H. Ittelson and L.G. Rivlin (eds.) *Environmental Psychology: Man and his Physical Setting*. New York: Holt, Rinehart & Winston, pp. 658–668.

Kaplan, R. and Kaplan, S. (1989) *The Experience of Nature: a Psychological Perspective*. Cambridge: Cambridge University Press.

Lawson, B. (2004) *What Designers Know*. Oxford, UK: Architectural Press, an imprint of Elsevier.

Lynch, K. and Hack, G. (2002) The art of site planning. In: S. Swaffield (ed.) *Theory in Landscape Architecture*. Philadelphia, PA: University of Pennsylvania, pp. 57–58.

Miller, H.J. (2003) What about people in geographic information science? *Computers, Environment and Urban Systems* 27(5): 447–453.

Mitchell, C.T. (1993) *Redefining Design: From Form to Experience*. New York: Van Nostrand Reinhold.

Nicolin, P. and Repishti, F. (eds.) (2003) *Dictionary of Today's Landscape Designers*. Milano, Italy: Skira.

Nielsen, T.S. (2005) *The Potential for the Exploration of Activity Patterns in the Urban Landscape with GPS-positioning and Electronic Activity Diaries*, *Life in the Urban Landscape*. Proceedings of international conference for Integrating Urban Knowledge and Practice, CD Conference proceedings, Gothenburg, pp. 2–14.

Passini, R. (1996) Wayfinding design: logic, application and some thoughts on universality. *Design Studies* 17(3): 319–331.

Porta, S. and Latora, V. (2007) Multiple centrality assessment. In: K. Thwaites, S. Porta, O. Romice and M. Greaves (eds.) *Urban Sustainability through Environmental Design: Approaches to Time, People and Place Responsive Urban Spaces*. London: Routledge/Taylor and Francis, pp. 101–105.

Rapoport, A. (1977) *Human Aspects of Urban Form*. Oxford: Pergamon Press.

Robbins, E. (1997) *Why Architects Draw*. Cambridge, MA: MIT Press.

Southwell, K.J. (2004) The utility of behavioural science in landscape architecture: investigating the application of environment-behaviour theory and its research methods to fit the spatial agenda of design. PhD, Edinburgh College of Art, Heriot-Watt University, Edinburgh.

Thwaites, K., Porta, S., Romice, O. and Greaves, M. (2007) *Urban Sustainability through Environmental Design: Approaches to Time, People and Place Responsive Urban Spaces*. London: Routledge/Taylor and Francis.

Thwaites, K. and Simkins, I. (2007) Experiential landscape: Revealing hidden dimensions of people-place relations. In: K. Thwaites, S. Porta, O. Romice and M. Greaves (eds.) *Urban Sustainability through Environmental Design: Approaches to Time, People and Place Responsive Urban Spaces*. London: Routledge/Taylor and Francis, pp. 141–145.

Treib, M. (2001) The content of landscape form: Limits of formalism. *Landscape Journal* 20(2): 119–140.

van Schaick, J. and van der Spek, S. (eds.) (2008) *Urbanism on Track: Application of Tracing Technologies in Urbanism*. Amsterdam, the Netherlands: IOS Press.

Ward Thompson, C. (2002) Urban open space in the 21st century. *Landscape and Urban Planning* 60(2): 59–72.

Ward Thompson, C., Findlay, C. and Soutrhwell, K. (2005) Lost in the countryside: Developing a toolkit to address wayfinding problems. In: B. Martens and A.G. Keul (eds.) *Designing Social Innovation: Planning, Building, Evaluating*. Toronto, Canada: Hogrefe, pp. 37–47.

Worpole, K. (2000) *Here Comes the Sun: Architecture and Public Space in Twentieth-century European Culture*. London: Reaktion Books.

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