ADDED VALUE: Implementation of User Requirements in City Simulators

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Abstract. The following contribution discusses the possible consequences of the concept of City Simulators and Digital City Models, which can be obtained from a previously conducted user inquiry in an Urban Planning Department. At the core of the examination are the additional benefits (added value) and the increasing acceptance of digital planning techniques by its users which can be made possible by the implementation of user requirements in City Simulators. Various experiments for cooperative planning in the urban space are formulated.

1. Definitions, Background Knowledge and Preparatory Work

Digital City Models are used to model selected features of real cities in virtual format so that different future urban developments can be simulated. Models of this kind can be classified as Digital Cities.

Urban planning is viewed here as the service area of community administration that relates to the maintenance and design of shared living space and concentrates on solving the problems that arise in urban planning.

A City Simulator can be regarded as a simulation device suited to conveying the multitude of spatial relations within urban configuration and for developing urban-spatial ideas, thus obtaining "true to reality" insights into model situations. Sensor-based environment simulation (coined by Markelin and Fahle, 1979) encompasses a range of mapping procedures and techniques that create the necessary conditions for simulating human perception, human experience and action in existing or planned situations. Digital City Models have meanwhile become widely-used instruments of modern city planning. However, the model purposes connected with Digital City Models vary considerably: documentation of spatial objects and assets of all kinds (buildings, green areas, infrastructure, proprietorship) or space-oriented utilisations (housing, commercial–industrial utilisation, recreation), archiving of the architecturally important building objects for archaeology and preservation of historical monuments, provision of a three-dimensional employment model for urban development and architecture competitions, creation of a three-dimensional orientation framework for building-related building record or building-related historical information, provision of a working model for the city of tomorrow, etc. City Simulators above all support experimentation with the urban area that, besides the convenient navigation in the virtual urban area, primarily simulates planning relevant changes in the urban area in scenarios and variants, as well as comprehensively balancing and documenting qualitative and quantitative aspects.

Modern concepts of Quality Management have formulated the user validation of processes and products of all kinds as important main task (Quality Management standards require product development to be based on the needs of their users, cf. Pepels, 1998; Scheibler and Campbell, 1999). If this knowledge is applied to city planning, in particular Digital City Models resp. City Simulators, valuable results can be achieved for an improved and usable conception.

The preparatory work for this contribution included the formulation of a series of concepts as examples such as: (*i*) "Multi-dimensional" Digital Cities (different levels of detail – LOD – depending on the viewing point and planning phase; different possible variants of the townscape viewed at the same point in time and versions – storage of the various development phases of a townscape at a certain data acquisition time); (*ii*) Development of a "Data Pipeline" concept intended to handle a townscape which is permanently changing; (*iii*) Integration of various Digital City concepts in a "Space-related Content Management System" (SCMS); and finally (*iv*) Quality testing of Digital City concepts by the users of those concepts (i.e. validation).

2. Problem, Aim and Methods

A central problem in dealing with digital planning techniques, especially City Simulators, is their lack of acceptance. An improvement in the level of acceptance could, from the point of view of the authors, be achieved by considering concrete user requirements and needs by the formulation of benefits which can be derived from the use of digital planning techniques. The main target is the formulation and realization of additional benefits ("added value") and the improvement of acceptance by clients of the aforementioned measures. By user validated test series applying to work areas such as urban design and urban planning (building-regulation, master planning) concrete experience in cooperative, experimental dealing with urban area in the context of a CAVE-environment shall be gained which should contribute to the improvement of the conception of City Simulators.

3. User Requirements and Needs

Based on a previously conducted user inquiry in a "large" (Austrian) Urban Planning Department, the following items shown in Table 1 can be listed as a contribution to the formulation of user requirements and needs concerning the concept of City Simulators and Digital City Models. (The questions regarding requirements were divided into two areas: data requirements and system requirements. The question of the three-dimensionality of the City Model was of particular interest. The method selected was a structured survey of the future users of the “Digital City”, the addressee was an “internal” client, in other words the staff of the Urban Planning Department cf. Voigt et al., 2004):

TABLE 1. Items contributing to formulation of user requirements and needs.

	User Requirements and Needs
Task areas	The task areas where three-dimensional City Models could be particularly important were: building regulation plans, design of urban space, expert opinions on townscapes.
Datasets	A digital City Model should contain at least the following datasets: buildings, vegetation, roads, bodies of water, green areas, walls, urban structures, boundaries, civil engineering structures; also: age of buildings, façades, roofs, the surface structure of roads, colour schemes; in addition: contents of the building regulation plan, building volume model.
Scale of resolution	The scale and resolution should based on the scale range from 1:250 to 1:500. Different levels of detail should be available: block model, volume model, architecture model.
Geometrically measurable attributes	The geometrically measurable attributes should include: main fronts (building heights, building widths), building storeys, roof shapes, eave height, building height, true size of trees, groups of trees.
Metadata	The metadata relating to geometric data selected included: zoning, three-dimensional development capability (contents of building regulation plan), characteristic urban planning values.
Multimedia-data	The “multimedia” data that should be linked to a three-dimensional City Model included: video, pictures, graphics, maps.
Processing methods	The processing methods desired included: archiving of information, looking up current and historical information, modifying and updating, supplementing, measuring (geometry), generating simulations (e.g. visualizations and noise, energy and wind simulations), presentation of models and simulations.
Interfaces	The important interfaces are those between CAD, GIS and the database.

It should be noted that this list is only an example. It does, however, contain important details, the implementation of which would improve the acceptability of Digital City Models with the user. As regards the mentioned aspects, the concepts of City Simulators and Digital City Models are to be examined.

4. Additional Benefit (Added Value)

At the outset it is important to point out the benefits which can be derived from the use of digital planning techniques by illustration of the resulting potential work relief and acceleration, by facilitation of access to these techniques, an increased ease of use and by improvement of the cost–benefit relation.

Additional Benefit (‘‘added value’’) can, from the point of view of the authors, be obtained from the following situations:

1. from the pooling of resources for the generation of information via data management within an institution (e.g. magistrate of a city—city planning) resp. between several institutions;
2. from the multiple usage of one and the same information by several users / institutions (different administrative units of a city, infrastructure providers (power, telecommunications, supply and disposal, etc.), freelance planners and architects, citizens, politicians, etc.);
3. from the combination of quantitative and qualitative information (e.g. visual information as to the quality of a street as a defined space/urban space and quantitative urbanistic variables such as construction volume, site density).

Concerning the required cooperation for the data management we refer to the so-called model of the Prisoner´s Dilemma (Matzner, 1982:79) which is derived from the theory of strategic games: two or more persons (institutions) are confronted with a decision to be made independently between two alternatives with the same content. Whatever the result of the decision, the effect based on the result of the decision not only influences the (economic) result for one person (institution) but also that of the other persons (institutions). Within the area of conflict between cooperation and non-cooperation with the objective of risk minimisation, one can prove by means of this model that a (voluntary or enforced) cooperation produces best resp. good results both in a group and individually. Within the context of Digital City Models, this implies a cooperation of all those who are interested in a high-quality creation and management of digital, space-oriented data. This requires corresponding data management.

In this context the “city and building-up volume¡± is to be considered as a key figure throughout the urban spatial configuration process: If the various Levels of Detail of digital city models (LOD) are to be put to meaningful use for planning purposes it is decisive as to which “volume’’ is modelled. The Following approaches may prove interesting: gross cubic capacity, urban spatial volumes, energetic volume etc. Various referential heights are to be considered: the eaves height, the lowest point of intersection of the building with the ground, the authorized permissible referential height, the basement bottom, etc. Various forms of building parametrification seem feasible in this context (Voigt et al., 2002a).

5. Conclusion: User-Validated Test Series

Carrying out detailed user-validated experiments for cooperative planning in the urban space is regarded as a precondition concerning the further development of City Simulator and Digital City Models. In this connection the numerous experiences with innovative simulation environments are to be considered (cf. Knight & Brown, 2000).

Table 2 acts as thematic framework ("performance specifications") for functions to be supported by means of simulators: The enumerated scope of topics, however incomplete, shows a great variety, calling for priorities concerning technical implementation (cf. Voigt et al., 2002b).

TABLE 2. Thematic framework for functions supported by simulators.

	Experimenting with Urban Space
Urban configuration: Checking spatial impact and value of individual experience	volumes, silhouettes, space profiles, proportions, public spaces, squares and streets, relation of "positive and negative space'', sequence of public spaces, distant and close-up impacts of urban space dominants ("landmarks''), large-scale projects, constructional-infrastructural single projects, etc.
Grouping, shaping and structuring of building volumes	spatial organization spatial densification, variants of mass distribution, height development adding and grouping in the context of building up structure models, shifting of single objects, object groups or entire models rotation scaling of models in all axes of space, "deformation'' and "morphing'', etc.
Arrangement and distribution of building volumes in a defined framework	e.g. defined by: urban-constructional characteristic values, maximum building height, specifications regarding incidence of light and distances, topography, solar supply, city climate, aerodynamic conditions noise pollution, infrastructure equipment, population density, etc.

Variations of the individual objects or of object groups in the constructional-spatial context	characteristics of space, dialogue situation, confrontation situation, building up of building gaps, solitary object, urban-spatial problem- and conflict situation, positioning of the building (in the street area), roofscape, variation of eave and gable positions, texturing and structuring of facades, colour development of variants and determining alternatives, etc.
Changes concerning existing stock	supplementation of stock demolition of single objects, deconcentration of interior courtyards, etc.
Urban-spatial detail questions	planting, configuration of surfaces, city furnishing, art within public space, sign posting (e.g. visibility and legibility in different viewing situations), poster application, path tracking, lighting, etc.
Temporary space installations	temporary facades (posters, scaffolding) festivals various installations in space, etc.

The user-validated implementation of this series in a CAVE-like environment (cf. Achten et al., 2004; Chan et al., 1999; Kieferle and Wössner, 2001) should contribute to the improvement of the conception of City Simulators. The further development of City Simulators must aim at obtaining an “added value”.

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