A Conceptual Participatory Design Framework for Urban Planning

The case study workshop ‘World Cup 2014 Urban Scenarios’, Porto Alegre, Brazil

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Abstract. This paper focuses on the definition of a conceptual participatory design framework for urban planning. Traditional planning methods can no longer satisfy the growing demands on sustainable urban planning in regard to factors such as complexity, problem size, and level of detail and these limitations make the development of new approaches necessary. Expert knowledge as well as insights from stakeholders and community members needs to take part equally in the decision-making process since they are responsible for a broad understanding and acceptance of final planning decisions. Therefore, a participatory framework is presented in the following, which integrates needs and requirements of stakeholders. In order to enable diverse groups of stakeholders to act conjointly, we propose the application of interactive decision support tools, which will leverage general conclusions especially to solve crucial planning decisions.

Keywords. Decision-making process; stakeholder participation; shape grammars; procedural model; urban planning.

INTRODUCTION
This article describes a conceptual participatory design framework for urban planning that integrates various forms of available knowledge and provides enhanced support for stakeholder participation within urban planning. This framework has been initially implemented and tested as a participatory planning workshop in Porto Alegre, Brazil, called World Cup 2014 ‘Urban Scenarios’, which took place from 19. to 28.06.2010 at Universidade Federal do Rio Grande do Sul (UFRGS). As a result, urban design
scenarios for the years 2014, 2025 and 2050 were developed with the support of participatory planning techniques during a workshop. The main challenge was to evolve, access and combine cross-disciplinary planning knowledge within a team of stakeholders with various personal and professional backgrounds, such as architects, urban and traffic planners, representatives from the municipality, and public community. This paper provides insights and suggestions for implementing similar workshops, aiming to increase the success of participative planning processes.

**MOTIVATION**

**Global Situation**
A multitude of facets need to be considered when it comes to sustainable urban planning besides the planning of the pure urban fabric. In particular, new more flexible and iterative planning approaches need to be developed within the design process (UN-Habitat, 2009), that overcome the limitations of traditional master planning techniques. Further, these new approaches need to include an orientation towards participatory actions and implementations, e.g., through links to budgets, projects and citywide or regional infrastructure. There are several concepts to understand a city as a dynamic system consisting of stocks of resources and flows of interrelated networks. These stocks and flows need to be tightly coupled to participatory approaches because of their interrelating and iterative nature. These concepts structure the urban fabric into systems of resources such as people, material, energy, water, waste, space and information and are used to derive models for the interrelated behaviour of urban systems. As an example of new, alternative approaches for the development of a dynamic system, Angélil and Hebel (2010) abandoned the classical understanding of urban system modeling and addressed a “paradigm shift to a circular understanding of urban metabolisms”.

**Participatory Urban Planning**
A brief look on modern cities reveals that rapid environmental, social and economical changes are seriously affecting urban qualities. Thus, the goal of such participatory planning processes is to raise urban qualities through benefitting especially from the participation of stakeholders for sustainable urban planning. The interactive distribution of insights and intelligence can significantly increase the effectiveness of planning proposals and create new perspectives that are usually not considered within the formal planning process. Stakeholders represent an important stock for decision-making. Sustainable developments must make use of this and involve participatory approaches for urban planning to organize and manage the continuous demand for efficient stocks and flows in order to regard the needs of future generations (Laws et al., 2004).

*Figure 1*
Final visualization of the proposed scenario for 2050 in Porto Alegre, Brazil, Area 1 (Jan Halatsch, Matthias Bühler)
Decision Support Tools in Urban and Regional Planning
The following three areas can be distinguished for supporting a participatory design and planning process: describing design, providing tools to support design, and automating design generation. According to Erhan (2003), design support research emphasizes (a) how computers can assist designers, and in what area, (b) how design problems can be represented for computational support, (c) how computers can generate solutions using these representations, and (d) how computers can help to evaluate the quality of the generated solutions. In architectural and urban design several design decision support tools exist (Achten, 2009; Kieferle, et. al., 2007; Turkienicz, et. al, 2008; Beirão, et. al, 2008). However, new requirements exist for decision support tools to support community design, e.g., in the field of participation, new urbanism and sustainability (Toker, 2007). An example of a tool for design diagnosis during early phases of architectural design is ‘Architectural programming (AP)’. Some initial decision support tools have been developed as urban simulation models and implemented in regional planning processes (Waddell, 2002; Borning et. al, 2008). The visualizations generated from these systems are then used to assist regional planning agencies to evaluate alternative land use regulations, transportation investments and environmental protection policies. A further development is an environment supporting the interactive design of urban spaces that integrates behavioural and geometrical city modelling (Vanegas, et. al, 2009). Urban design variables can be more intuitively accessed and visualized within such an environment, resulting in urban scenarios that consider proposals for highways, accessibility studies, population and projected employment distribution, among others.

A CONCEPTUAL PARTICIPATORY DESIGN FRAMEWORK FOR URBAN PLANNING
New approaches for sustainable urban planning need to consider stakeholder or community feedback besides expert knowledge – especially when the goal is to achieve urban quality-related development such as environmental protection, social inclusion and local identity. However, one major problem in participatory urban planning is to provide a common information base suitable for integrating the comprehensive and interdisciplinary explicit (expert) and tacit (local stakeholder, experience) knowledge (Polanyi, 1966) on urban patterns and processes. Therefore, design support tools are heavily challenged to provide an integrative solution for participatory design workshops.

The ‘World Cup 2014 Urban Scenarios’ participatory design workshop applied a collaborative modelling platform that was first presented within the Swiss National Research Project NRP 65 ‘Sustainable Urban Patterns’ [4]. This platform is the base for the presented participatory design framework. The workshop served as a first real-world test case with three interconnected steps: collaboration, simulation and design. These steps facilitated the iterative modification of an urban model through a series of participatory meetings and decision steps.

The process of the workshop included the following steps: (1) sustainable development guidelines for Porto Alegre were conceived. (2) The views were formulated in the form of design briefings in order to deduce sustainable urban design patterns. (3) The stakeholder group suggested key variables for the identification of the focus areas in Porto Alegre using their expertise and knowledge about local problems and potentials. (4) Simulation and evaluation tools were used to compare the performances of different scenarios with each other. This enabled the stakeholders to validate and weight trade-offs of their decisions. As a mutual conclusion the stakeholders made the point that the participation of a cross-disciplinary group is of great importance to strengthen the design process. Even more worth mentioning is the observation that this approach seems to support sustainable developments through the combination of future planning techniques with local awareness of the stakeholders.
A participatory design framework was developed that integrates the needs and requirements of stakeholders and supports a broad-based understanding and acceptance of final planning decisions. In order to support the participation of various stakeholders, including planners, architects, policy makers and concerned parties during participatory workshops, we propose the use of a set of interactive decision support tools that facilitates achieving a consensus on the planning decisions (Table 1).

**Collaboration**
The participatory method ‘Architectural Programming’ is a decision support tool used in the early stage of architectural and urban design. It is used and evaluated for the gathering of needs and requirements of stakeholders (Kunze and Schmitt, 2010; Pena, 1977). The concept of an architectural programming workshop (Fig. 2 and 3) is to provide stakeholders with an integrated view on the planning facts and concepts for potential planning solutions and to incorporate personal and expert knowledge.

Each of these programming cards describes one particular aspect represented by a simplified sketch or diagram, which is accompanied by textual and numerical attributes. The results are (a) a structured card matrix and (b) development task definitions (Fig. 4) which can weighted and jointly agreed inside a stakeholder workshop.

<table>
<thead>
<tr>
<th>Modules</th>
<th>Description</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>Definition of the requirements and development tasks</td>
<td>Architectural Programming</td>
</tr>
<tr>
<td>Simulation</td>
<td>Definition of street network and accessibility Assignment of the super grid and highway network Derivation of the internal grid</td>
<td>AxiMagic, PurdueSim, PurdueSim</td>
</tr>
<tr>
<td>Design</td>
<td>Definition of building types and urban patterns</td>
<td>CityEngine</td>
</tr>
<tr>
<td>Simulation</td>
<td>Evaluation Optimization, quality metric needed, loop until criteria</td>
<td>CityZoom</td>
</tr>
<tr>
<td>Design</td>
<td>Definition of the grid style Plot subdivision, implementation of building types and urban patterns</td>
<td>CityEngine, CityZoom, E.on software Vue</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Evaluation, presentation and information about the entire process</td>
<td>Social Network Interface, Exhibition</td>
</tr>
</tbody>
</table>

*Table 1*

**Modules of the Participatory Design Framework**

In the following section the interactive decision support tools will be associated with the three modules of the Participatory Design Framework.

*Figures 2 and 3*

Architectural programming workshop with experts, urban planners, architectural students and public.
A website establishes as a Social Network Interface like a channel of communication between the workshop participants and the population of the city and a network of national postgraduate programs in architecture and urbanism. The website can be used by workshop participants to post updates on the results from each workshop session, and from the community to provide ideas and feedback to the workshop. Final results of the workshop could be published in form of an exhibition for a bigger audience.

**Simulation**

AxiMagic [1] is a spatial analysis tool utilizing the Space Syntax model to represent the potential pedestrian and vehicular mobility in the urban street network (Fig. 6). Correlations in the utilized Space Syntax model permit the identification of the main thoroughfares and also the identification of the districts most central streets and spaces. This information is strategic for the location of commercial activities and to the identification of potentially unsafe areas.

PurdueSim supports the interactive design of urban spaces. Highways, accessibility, population and planned employment are simulated at interactive rates and support the design process (Vanegas, et al., 2009). Editing of urban design variables is performed intuitively and visually using a graphical user interface (Fig. 5). Any design variable can be constrained or changed. The design process uses an iterative dynamical system for reaching equilibrium. This system includes an interactive agent-based behavioural modelling system and adaptive geometry generation algorithms.

CityZoom [1] provides a computational environment where different performance models can be interactively operated, seeking to optimize urban planning regulations (Turkienicz, et. al, 2008). The developed models include building construction...
potential, solar radiation impact, pollution dispersion, luminance and illuminance (Fig. 7). Each of these models corresponded to a module that implements them in the computational environment. The correlation between the results of different performance models enables the designer to optimize urban regulations according to different attributes. Comparative assessments are made possible between different urban configurations related to one or more attributes.

**Design**

The Architectural Programming matrix is finally used to derive the internal grid and to define design rules and design guidelines in form of conceptual sketches (Fig. 8). These guidelines are validated in a participatory process and translated and described as building types and urban patterns (Fig. 9). The paradigm of an urban pattern is used as an interface for the implementation of the procedural model (Kunze and Schmitt, 2010).

Building types and urban patterns were implemented in a procedural urban model with the CityEngine software [2]. Procedural urban modelling offers several advantages compared to 3D analog models (Halatsch, et. al, 2008). Different urban design scenarios for the years 2014, 2025 and 2050 could be communicated to participants already during the workshop. Jointly identified problems could be optimized and evaluated immediately. The CityEngine consists of several procedural and interactive tools to layout street networks, align and subdivide shapes, and procedurally generate architectural 3D content by using CGA shape grammars. This set of tools supports the generation and editing of very large and detailed 3D models while significantly reducing the design time.

Final renderings were created with E.on software Vue [3] and were discussed with stakeholders on the final exhibition of the workshop.

Figures 6 and 7
AxiMagic and CityZoom
(Pablo Colossi Graziotin, Vaneska Paiva Henrique, Karen Paiva Henrique)

Figures 8 and 9
Sketches (Benamy Turkienicz) and implemented urban pattern (Jan Halatsch)
CASE STUDIES
We studied five areas in Porto Alegre, Brazil, which are locations for the World Cup 2014 (Table 2). Twelve cities in different states were chosen as World Cup host cities. Manaus, Fortaleza, Natal, Recife, Salvador, Cuiabá, Brasília, Belo Horizonte, Rio de Janeiro, São Paulo, Curitiba and Porto Alegre.

In this paper we will present the results of the three mainly researched areas in Porto Alegre (Fig. 10-12): (a) area 1 GreenTech, (b) area 2 Protásio-Norte and (c) area 3 Integration District. With the application of the participatory design framework urban design scenarios were developed and evaluated for these areas in 2014, 2025 and 2050.

Area 1 GreenTech
The GreenTech area was originally devised for the city’s industrial expansion and still exhibits characteristics such as industrial plants, warehouses and large storages. The area presents serious problems regarding water drainage and sewage infrastructure. Some of the most important facilities located in this area include Salgado Filho International Airport, metro stations, the Docks, the Nautical Park and single family and collective housing. The Arena do Gremio will be built in this area.

Inside the stakeholder workshop it was figured out that this area is a strategic urban plan for the development of the northern area of Porto Alegre, using the airport as a pole for development. The urban design scenarios for the GreenTech area showed that this area will be the centre for high tech and environmentally friendly industries, services and logistics (Fig. 1). The strategy to attract industries to GreenTech is the convenient proximity to the airport, highways, industrial clusters in the metropolitan region, and waterways leading to a major seaport in the Atlantic Ocean. To compensate for the inherent air pollution produced by air and ground transportation, a large portion of the existing vacant land in the district, will be established as a natural reservation laying at both sides of BR290, the main highway connecting Porto Alegre to the north of Brazil.

Area 2 Protásio-Norte and Area 3 Integration District
These two areas are mainly occupied by low density single family housing. Protásio-Norte is located at an intersection between one of the major radials of the city. Important educational facilities are located close these areas. Recently, new residential developments in the area are being promoted, in spite of its

Table 2
Case studies in Porto Alegre, Brazil

<table>
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<tr>
<th>Case Studies</th>
<th>Description</th>
<th>Size</th>
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</thead>
<tbody>
<tr>
<td>Area 1</td>
<td>Entrada da Cidade - Tecnoverde/GreenTech</td>
<td>1.142 hectares</td>
</tr>
<tr>
<td>Area 2</td>
<td>Rua Tenente Ary Tarrago - Protásio-Norte</td>
<td>52 hectares</td>
</tr>
<tr>
<td>Area 3</td>
<td>Avenida Manoel Elias - Bairro Integração/Integration District</td>
<td>100 hectares</td>
</tr>
<tr>
<td>Area 4</td>
<td>Campus do Vale, Agronomia - Vale do Conhecimento/Knowledge Valley</td>
<td>51 hectares</td>
</tr>
<tr>
<td>Area 5</td>
<td>Estaleiro do Só - Passeio do Sol/Sunwalk</td>
<td>51 hectares</td>
</tr>
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</table>
lack of commercial, health and leisure infrastructure.

The area Protásio-Norte is part of the strategy of integration between the south and the north of Porto Alegre. The plan for this area consists of a sustainable residential development using a commercial centre to stimulate the upgrading of the area. Special attention will be given to green housing design and to encouraging the use of public and private green spaces (Fig. 13). Protásio-Norte is also devised as an alternative transportation hub allowing the population of Porto Alegre and neighbouring towns to access the rest of the metropolitan region, eliminating the need to pass by the city centre.

The Integration District is the main part of the strategy of integration between the south and the north of Porto Alegre. The district is intended to be a subsequent development of Protásio-Norte area. It consists of residential developments adequately adapted to the terrain and local vegetation conditions, particularly to a creek surrounded by dense vegetation that runs through the middle of the district from south to north, and serves as a natural green corridor in the development.

CONCLUSION AND ACKNOWLEDGEMENTS

This paper presents a conceptual participatory design framework for urban planning. The framework integrates various forms of available knowledge and provides support for stakeholder participation at crucial decision-making phases in urban planning. Since urban revitalization and enhanced urban qualities are likely to become significantly challenging tasks for planners in the coming decades, new methods need to be used in order to leverage implicit and tacit knowledge and to make both available to planning processes in general and in a meaningful way. The presented framework aims to give an initial vision of the possibilities that the combined use of planning and simulation tools can bring, particularly when integrated and accelerated with human cross-disciplinary knowledge.

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Figure 13
Final rendering of the areas 2 and 3 shows the urban design scenario in 2050 (Jan Halatsch, Matthias Bühler)
REFERENCES