VEPS – Virtual Environmental Planning System
First steps towards a web-based 3D-planning and participation tool

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1. INTRODUCTION

A city is not only a space, but also involves culture, social aspects and environment. As a result, urban planning is a multi-disciplinary process. The general objective of urban planning is "to provide for a spatial structure of activities which in some way is better than the pattern existing without planning" (Hall 1992, p4). Achieving the objective is not only the matter of planners and governments, but also concerned with the cooperation among investors, architects, engineers, computer professionals and the public.

1.1 Urban Planning and Public Participation

Efficient public participation can help government officials and other professionals to create better planning alternatives. Here public participation is defined as the means by which members of the community are able to take part in the shaping of policies and plans that will affect the environment in which they live" (Whittick, 1974). The sense of public participation not only gives public meaning to their lives but also brings with it a sense of responsibility which is often lacking in modern society. Furthermore, it is believed that more sustainable city development will be achieved based on such approach (Rydin, 2000).

Although most authorities have made intensive efforts to publicise their planning proposals and try to attract more attention of public, narrow and low-level participation still occurs in most planning activities (Rydin, 2000). Involving the public is once again high on the agenda of central and local government and is an increasingly mandatory component of programmes aimed at improving service provision, regeneration, revitalizing democracy and achieving sustainability.

However, making sense of what is going on is not straightforward. Not only is the concept of 'public involvement' or public participation' itself notoriously ambiguous and contested, but the methods used were not suitable for meaningful involvement. That is because in most cases, the public lack sufficient knowledge about the qualities of place, problems, potential solutions and they need help to question their assumptions and take-for-granted preconceptions (Campbell & Marshall, 2000; Healey, 1998). New methods of participation need to be proposed to supplement traditional ones like public meeting and consultation documents.

1.2 Technologies and ePlanning Systems

It is envisaged that some existing Information Communication Technologies (ICTs), for example Internet, Geographic Information System (GIS), Virtual Reality (VR) and Computer-Aided Design (CAD), could be used to produce such kinds of new methods for improving and facilitating more effective public participation in planning. The rapid development of these technologies provides new opportunities to improve the planning processes (Chen, 1999; Huang, 2003) and make better use of resources.In recent years, the number of web-based systems for urban planning using virtual reality (VR) and/or GIS is increasing rapidly. In addition, many countries around the world have intended to modernise the planning process or already initiated such movement (Curwell et al., 2005, Pendleton, 2004).

ePlanning, which 'offers considerable opportunity for early and rapid change to the future delivery of planning services, with an emphasis on electronic delivery' (ePlanning, 2004), emerged during last decade. The main aims of ePlanning are to enable more people to get involved in planning; to increase openness, efficiency and effectiveness; to arrange the delivery of planning service to meet citizens' needs. To design a good ePlanning system, two aspects need to be carefully considered, namely access and comprehension (Hamilton et al., 2001), which will be illustrated one by one below.

First of all, in order to effectively participate in the planning process, it is essential for the participants to get access to relevant information at any time anywhere. The over-riding benefit is that the public participation in the planning process will be more successful if all parties have a time and location independent way of communication.

Secondly, new technologies like Virtual Reality could decrease the complexity of spatial information if it is used in a proper way. Former researches claimed that normal 2D maps are not as good as three-dimensional (3D) virtual models in regard to presenting detailed geo-information about an area for lay people (Hamilton et al., 2001; Zhang, 2004). Thus, 3D City Models can make the regional planning process more comprehensive and more transparent for all involved parties as less interpretation of 2D maps is necessary. Especially public without any training in interpreting planning maps could benefit from an intuitive understanding of 3D-Models instead of 2D-Maps.

1.3 Current problems and the way forward

Some of the critical judgments for environment planning are best made using 3D data, for example water run-off, site area and wind shadow can only be approximated using flat plans. Many of these analyses can be undertaken using GIS given accurate height data and appropriate spatial queries, but 2D representations of the results are not intuitively understandable without extensive training. Up to now, the possibilities with current existing technology are limited: real interactivity, interoperability and fast and secure data transmission are mostly not possible. The state of the art in ePlanning is limited to text or 2D maps but 3D visualization is rare, especially interactive visualization.

To sum up, there is still a lack of real and high level of applications in the ePlanning area although some local government in Europe has employed new ICT technology, for example, world wide web (WWW) has been used to provide on-line services (Pendleton, 2004). Moreover the diffusion of this kind of new approaches towards the public is still an open challenge (Huang, 2003). This paper describes a collaborative project taking place in North West European (NWE) region which is aiming to address the issues by explore the potential of ICT and develop an Internet-based the EU-funded INTERREG IIIB Project – "Virtual Environment Planning Systems" (VEPS).

In this paper, we also describe a methodology for designing these systems. The vast literature that covers computer use for this kind of application – spanning modeling, monitoring, management and so on – seems to pay little or no attention to the needs and requirements and different user groups and audiences. (Haklay, M. E., 2003). A proper methodology is needed to make sure the successful ePlanning system is designed and implemented, which could satisfy different requirements of various user groups

The paper is structured as follows: firstly explains the main aim of the VEPS project; then describes the issues of the pilot project, the case study of Rosensteinviertel in Stuttgart, Germany; then illustrates the structuring process of transforming initial scenario to final system solution (e.g. defining the scenario and stakeholder profiles as well as technical requirements based on Stuttgart VEPS case study) and finally shows examples of the first implementation steps towards successful ePlanning and participation via Internet using 3D-VEPS.

2. VEPS-PROJECT

2.1 AIM of VEPS – Virtual Environmental Planning System

The VEPS project aims to improve the knowledge base on the potential of Information and Communications Technologies (ICT) for territorial development in the North West European (NWE) region specifically on the use of ICT for ePlanning, consultation and communication of citizens' views on planning issues.

Some cities are already using 3D visualisation in the planning process, e.g. Edinburgh (UK), Nantes (France), and Stuttgart (Germany). These systems generally have low levels of user interaction. The state of the art in ePlanning is presently limited on sending and receiving (citizen's) comments on-line. VEPS aims to improve interactivity by trying to integrate interactive 3D visualisation to improve the understanding of planning decisions and consequences. Therefore, existing and already used tools, technologies and data shall be used (e.g. 3D city models, digital terrain models, etc.). In case of being successful VEPS will allow a two-way consultation process. The stage at which citizens may view and respond to planned changes can either be at the Master Plan stage for an area or at a development proposal stage. Aim of VEPS is to enable citizens to upload their own alternative planning scenarios and view the results in terms of visual and environmental impact (or at least set comments directly on the maps) as well as download and view the details of the planned development. If 3D-visualisation may (interactively) be used via internet mutual understanding of planning contents may be improved by exploring what-if scenarios (cf. http://veps3d.org/site/54.asp).

VEPS therefore is a step towards an alternative approach to planning consultation. An interactive 3D-visualisation of planning contents allows the viewer to experience highly complex information without the need for training because they can see the impacts of a planning development and the visual and environmental consequences in an easily understood format.

The current issues for the planning consultation process may be summarised as:

- Complex information in planning consultation is "dumbed down" to a level that can be understood by the average member of the public who does not hold a qualification or diploma in planning
- Full information is presented and the citizen would have to receive training in order to understand the highly accurate and highly complex information
- Plans/maps require training to read and interpret correctly and often contain ambiguities

A key part of the outcome of funding the VEPS project work should be to assess if this is the right technology and approach to addressing these planning consultation issues.

Considering these aspects, the aim of VEPS is mainly subdivided into 3 objectives:

- Share technical competencies between NWE partners in the field of 3-dimensional visualisation, ICT applications to promote public participation, environmental modelling, data collection and use for ePlanning in territorial development in NEW
- Develop a common architecture and methodology drawing on transnational experience and the knowledge of planning regulations and sustainability metrics in NWE, to enable citizens to view (3D if possible and sensible) and respond to planned changes via home PCs
- Refine and implement a test-bed system in a number of demonstrations in the NEW region, thereby increasing transnational experience. Evaluate and iteratively refine the methodology and the system architecture and applicable open standards

2.2 Partners and EU-Project-Programme of VEPS

The VEPS-project is supported through the INTERREG IIIB North West Europe Programme, which provides support to transnational cooperation projects that seek to improve territorial development and cohesion in the North West Europe area

(cp.: http://europa.eu.int/comm/regional_policy/interreg3/index_en.htm).

The VEPS project directly addresses the INTERREG IIIB NWE Measure 2.2: "Improved access to the information society" and also objective 3: "improving the knowledge base on the potential for territorial development of North West Europe".

Transnational cooperation in North West Europe is about approaching common themes (e.g. ICT for planning consultation) through joint projects which will benefit from working across regions to achieve sustainable territorial development together.

The VEPS project is a collaborative project which has eight academic and industry partners located in the United Kingdom, in France and inGermany, working alongside with associated planning authorities.

2.3 Project structure

VEPS is divided into single development steps:

there are two main sections of the project. First part is to define the examples of each partner by finding and defining the scenarios and use cases. This includes the definition of the concerned stakholders and the dealing with different requirements and wishes according to the different user groups. Therefore, workshops in all countries/cities of the VEPS-Partners have been hold. Planners, administratives, citizens and other important persons collected their requirements and wishes considering VEPS. Summarizing these results gave an overview of different requirements and different use levels of such a system. Out of the results the basic requirements of such a participation and planning system have been defined as well as different user groups have been described (cp. chart):

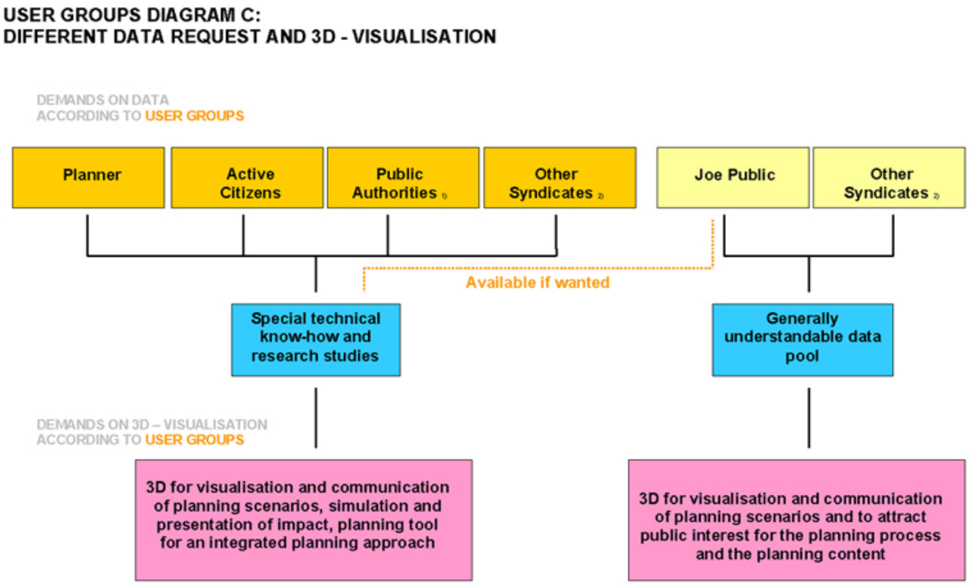

Figure 2.3 user groups data requests

Second part of the project includes the system implementation, evaluation and testing process of VEPS. As first step we develop documents for the implementation working with the pilot project Rosenstein (q.v. 2.4 Pilot roject: Rosensteinviertel Stuttgart). This implementation documents help to develop the other case study sytems much faster and help to develop a development structure wich can be used later on from everybody using VEPS. Out of this implementation documents the first prototype of a participation tool will be developed and tested with stakeholders of Rosensteinviertel.

At the end we will have a participation and communication tool allowing different levels of use with different requirement standards for different planning requests.

2.4 Pilot project: Rosensteinviertel Stuttgart

2.4.1 Introduction of task of pilot project

To give the scenarios a common structure and to develop guidelines how to define user and system requirements one of the demonstration projects has been chosen as pilot project. Rosensteinviertel of Stuttgart is an urban district located in the city centre and shows a lot of existing different land use. In the event of a big urban development project (Stuttgart 21) new areas will be developed, new structures in the existing area will come into being and the transport system will be changed.

VEPS shall enable the residents to compare different planning scenarios and the related consequences and enable them to comment those scenarios – in text and map form. To explain difficult planning contents and the realtion between different planning issues as well as to demonstrate the consequences of the different planning alternatives the illustration using 3D-models will ease the comprehension of the planning contents for all non-planners.

There are several partners related to the district like an organization of dedicated residents, the Stuttgart Planning Department and other Planners helping to find out which requirements are wished to have in such a system. These partners will also help us evaluate the concrete example by testing and evaluating the prototypes and the further modells of VEPS.

2.4.2 Description of the case study project Rosensteinviertel

Description of Rosensteinviertel

The Rosensteinviertel is an urban quarter and part of the city centre of Stuttgart. It is part of Stuttgart 21, a huge transport and urban development project which will change the whole face of Stuttgart's inner city and transfer a lot of ground into other land use. Today, the Rosensteinviertel consists of wasteland, railway areas and built-up areas and presently is divided into several areas with different urbanistic patterns and diverse land use. Pesently 7000 habitants are living in the Rosensteinviertel as well as just under 10 000 are working in this district. The demographic trend is dominated by seniors and most of the residents are foreigners.

In the course of Stuttgart 21 several railway areas will be set free for developing new urban areas. Residential and office areas are planned. In future 14 000 habitants will live in the quarter and more than 20 000 employees will move into the district (cp. Das Rosensteinviertel, Stadtplanungsamt Stuttgart, 2004).

These plans mean big changes for the area and of course for the residents living there now. To show consequences of planning proposals and to find the best possible solution VEPS shall be implemented as participation and commenting tool, showing the residents the effects of different planning proposals and allow them to participate actively in the planning process (cp. Das Rosensteinviertel, location and site decription, content of planning scenario, 2005).

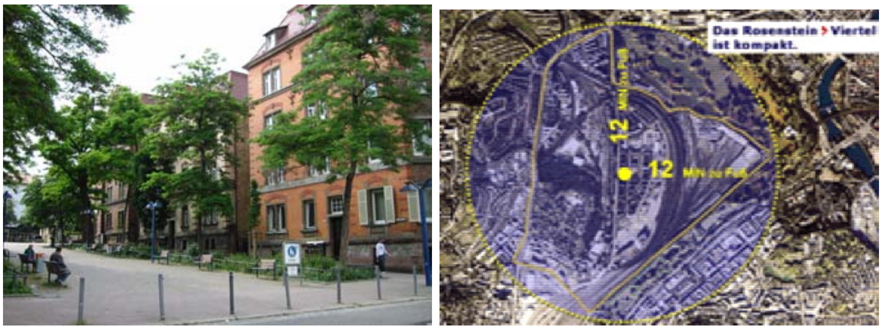

Figure 2.4 Rosensteinviertel: characteristic street and location of the district

Use of VEPS for Rosensteinviertel development

The participation model for VEPS to be used in this use case will be based on a website. The website on one hand gives all necessairy information concerning the district, the development plans, the existing data, etc. Also the functionality of VEPS will be explained. On the other hand there will be the linkage to the VEPS participation tool which will offer a commenting tool consisting of 2D and 3D maps and a comment and discussion platform. In a later phase of the implementation it shall be possible to change planning proposals interactively in the 3D-mode, but to get there many small steps are essential.

First prototype will show different planning proposals out of the architectural contest which has been held for the further development of the area. The plans will be shown as 3D city models. In the first prototype the users can add comments to specific topics of the planning proposals, they may discuss them or just mark what they think is not good. They can add the comments with or without linking it to the map. In the first prototype the 3D visualisation will “only” show the plans in real view and illustrate the different planning proposals for the Rosenstein development.

2.4.3 Partners – Evaluation – Public Administration

Beneath the varity of testing possipilites for VEPS one of the reasons to choose Rosensteinviertel as a case study and later on as pilot project is that we have a lot of dedicated partners willing to cooperate and test VEPS (as already mentioned in 2.4.1).

For evaluation, workshops and meetings with all or parts of the involved parties have been held or will be held in future. The residents’ initiative as well as planners from the city department and other planning related persons are willing to test our prototypes and will help us evaluate and implement the VEPS as a planning and participation tool.

3. DESIGN PROCESS OF STRUCTURING DOCUMENTS

There is a huge amount of researches to combine Internet, GIS and VR technologies for use in urban and environment systmes. However, there seems little concern for the theoretical way of designing such combined systems and evaluating their utility. A well-understood and salable development process needs to be developed to bridge this gap. This section illustrates a design process, namely modelling and matching process, which offers a roadmap for partners which is a well-understood methodology of transforming the initial planning scenario to the final system solution.

The process of selection and implementation is usually associated with a methodology or approach in order to ensure that models, methods, and data are adequately selected and fruitfully exploited. The modelling and matching process is produced based on the Human-Centred Approach. On one hand, users need to be the focus during the whole development process and the interactive design should be possible to take place within an integrated framework. However, on the other hand, designers cannot just follow what users say completely, since users tend to make decisions that are consistent with their preferences, which may not help to improve system performance (Khosla, et al., 2000). Designers need to match their requirements to the technologies in terms of the balance between them. The spirit of the process is illustrated in Figure 3.1 below:

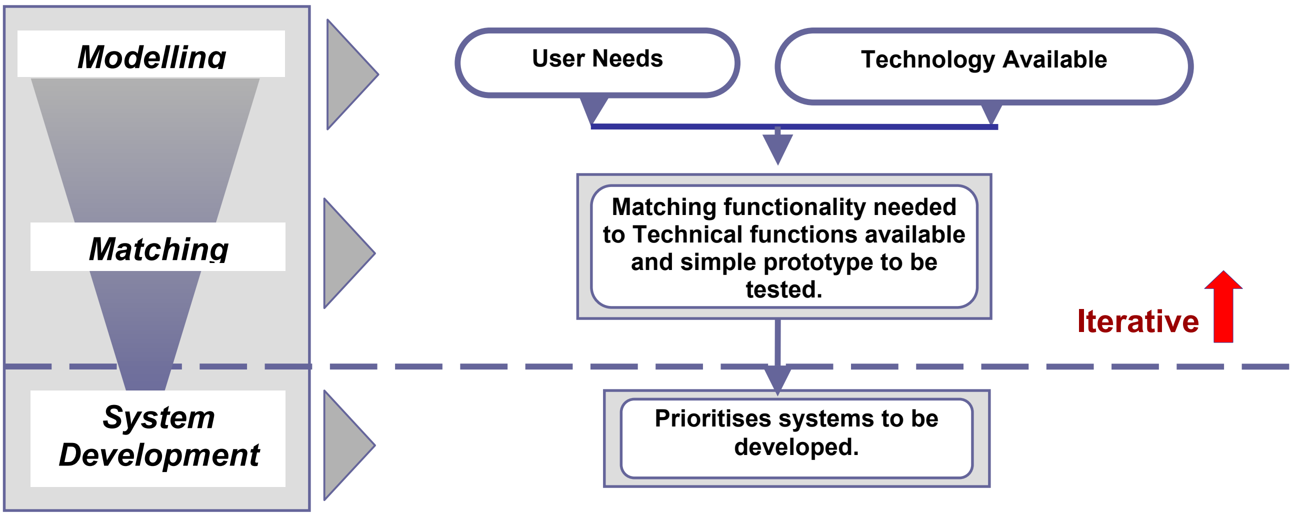

Figure 3.1 System Development Plan

3.1 Overview of the Process

There are five stages in the modelling and matching process design, shown in Figure 3.2, which are:

From 'Background Information' to 'Context Model';

From 'Context Model' to 'Descriptive Model';

From 'Descriptive Model' to 'Technical Model';

From 'Technical Model' to 'Interactivity Model';

From 'Interactivity Model' to 'High-level Design Specification'

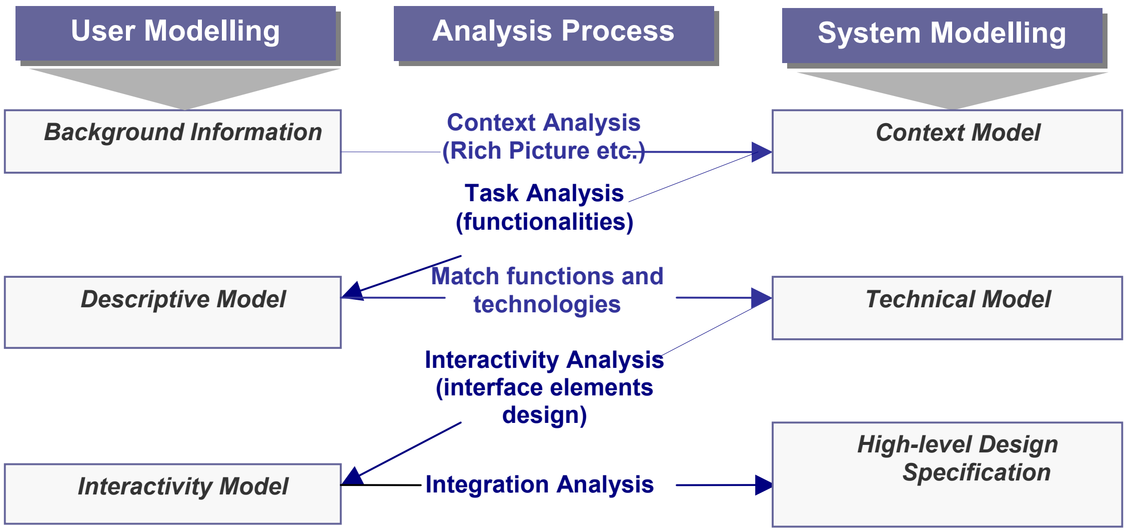

Figure 3.2 Modelling and Matching Process

In the design of any complex artefact a range of representations, or models, is essential during the design process. A model is a representation of something, constructed and used for a particular purpose. A good model is accurate enough to reflect the features of the system being modelled, but simple enough to avoid confusion. In the proposed design process four models should be produced before final system specification, namely 'Context Model'; 'Descriptive Model'; 'Technical Model' and 'Interactivity Model'. The roles of these models in the design process are illustrated below:

Context Model: The context model is the summary of the scenario checklist and stakeholders' checklists, based on the analysis of the rich picture. Scenario checklist, stakholders's checklists and rich picture could be served as the starting point of exploratory discussion documents with stakeholders in a problem situation. This is particularly important as poor consideration of stakeholders' viewpoints will result in a system that will be poorly or not maintained. The purpose of the context model is to give a top-view of the system's context and its related stakeholders, so that the 'user needs' addressed in Figure 3.1 could be captured correctly from the very beginning of the system development. In the context model, the proposed system is treated as a 'black box'. Related stakeholders' profiles and their relationship with the proposed system are the concern of this model.

Descriptive Model: The descriptive model describes the behaviour of the system as seen by its stakeholders. Use case diagram is applied to present this model. It could be served as the basis for discussions about technical development of systems within VEPS.

Technical Model: The technical model is a product of the matching process shown in Figure 3.1, to ensure that user needs could be balanced by available technologies and data. This model transfers the descriptive model to designers' language. The process of generating the technical model could be used to guide the architecture development and help with maintaining related development tasks. In addition, the technical model could be served as a good tool to facilitate the communication among partners.

Interactivity Model: Human understanding of geographical space will be affected by the interface of geo-based system. As a result, interface design is a key issue to make an ePlanning system user-friendly (Chen, et al., 2005). The interactivity model considers the interface elements design based on the human factors analysis.

Unified Modelling Language (UML), which provides a large number of well-known techniques and concepts for modeling various kinds of software artifacts from different perspectives or viewpoints, will be used in the design process to present some of the models.

3.2 Design Process in the Rosensteinviertel project

One of the demonstration projects, namely Rosensteinviertel in Stuttgart, which was described in the previous section has been chosen as the pilot project to give the scenarios a common structure and to develop guidelines how to define user and system requirements. The first three stages of this process will be addressed next in the paper.

3.2.1 First Stage: From 'Background Information' to 'Context Model'

In terms of modelling and matching process, the scenario checklist is an important data collection method for the first stage, which concerns collecting and analysing background information to create the context model. At this stage, the scenario checklist summarises and illustrates the scenario in the 'one-page' document, which could be used to capture and define various stakeholders involved in the proposed system and to state their motivations and expectations for the proposed system. As the result of the scenario checklist of Rosensteinviertel project, we got the following case study description:

SCENARIO: Urban (re-)development
Case Study: Rosensteinviertel

Content:

- Fora and discussion platform
- interactive illustration of different planning scenarios for Stgt 21 and their consequences(noise, traffic, green spaces, views etc.), what – if- scenarios
- choosing of prefered planning design (and/or)…
- interactive revisional options for the users
- background information (history of Rosensteinviertel, expirtises of planning consequenses – noise, description of actual state of area, results of architectural competition, further procedure, further plannings)

Purpose:

- participation of most possible amount of residents, unions, syndicates
- data exchange platform for planner, departments, etc.
- simplified data exchange via up- and download of design versions, modification proposals, comments, etc.
- participation via internet and maybe via a public pc in public utilities of the district
- content of 2D- plans will be illustrated as 3D-city modells which will increase the understanding of the 2D- plans contents

Form:

- rich picture
- descriptive model
- interactive model
- 2 to 3 varying interfaces depending on usergroups in the district (planners, administration, Joe Public: adolescents – seniors)

Figure 3.3: case study description of Rosensteinviertel

Although the scenario checklist is a good basis for creating a context model, it is useful to further explore the motivations of all stakeholders. Thus, for the context model, it is useful to produce stakeholders' checklists, which specifically focus on the viewpoints of key stakeholders. A stakeholder checklist describes a number of characteristics of the users whose needs and requirements must be met in the new computer system. The purpose of the stakeholder checklist is to ensure that the right level of terminology is employed, the system suits their level of computer and task expertise, and so forth. There are no hard and fast rules for selecting the information that should go into a stakeholder checklist, but any information that helps to specify the capability of users to handle systems is beneficial. For Rosensteinviertel project, we defined the following stakeholders: urban planners/architects, investors/project managers, citizens, and local authorities. The checklist for them mainly includes five parts, namely Basic Characteristics, Knowledge and Experience, Motivation and Expectation, System Requirements, Required resp. Desired data.Several stakeholder workshops were held in Stuttgart during this stage in order to capture stakeholders' information and preferences. Brainstorming method was used in these workshops and its result was organized into different stakeholder's checklist.

The scenario checklist and stakeholders' checklists consist of the background information, which is the startpoint of the process. Based on the background information, rich picture can be produced to describe the context of the system and finally leads to a context model.Rich picture is mainly about making drawings to indicate the elements in the human situation. It should illustrate how we see the situation at present, its main stakeholders and issues. Using rich picture, we could describe the context of the proposed system, explore existing problems for different stakeholders and reveal the real issues affecting system development. For Rosensteinviertel project, four stakeholders are the focus in the rich picture (i.e. main stakeholders identified in the scenario checklist), which are circled in the diagram. The other four items, namely planning issues, planning alternatives, planning budget and environmental impacts, are issues concerned by defined stakeholders (see Figure 3.4 below).

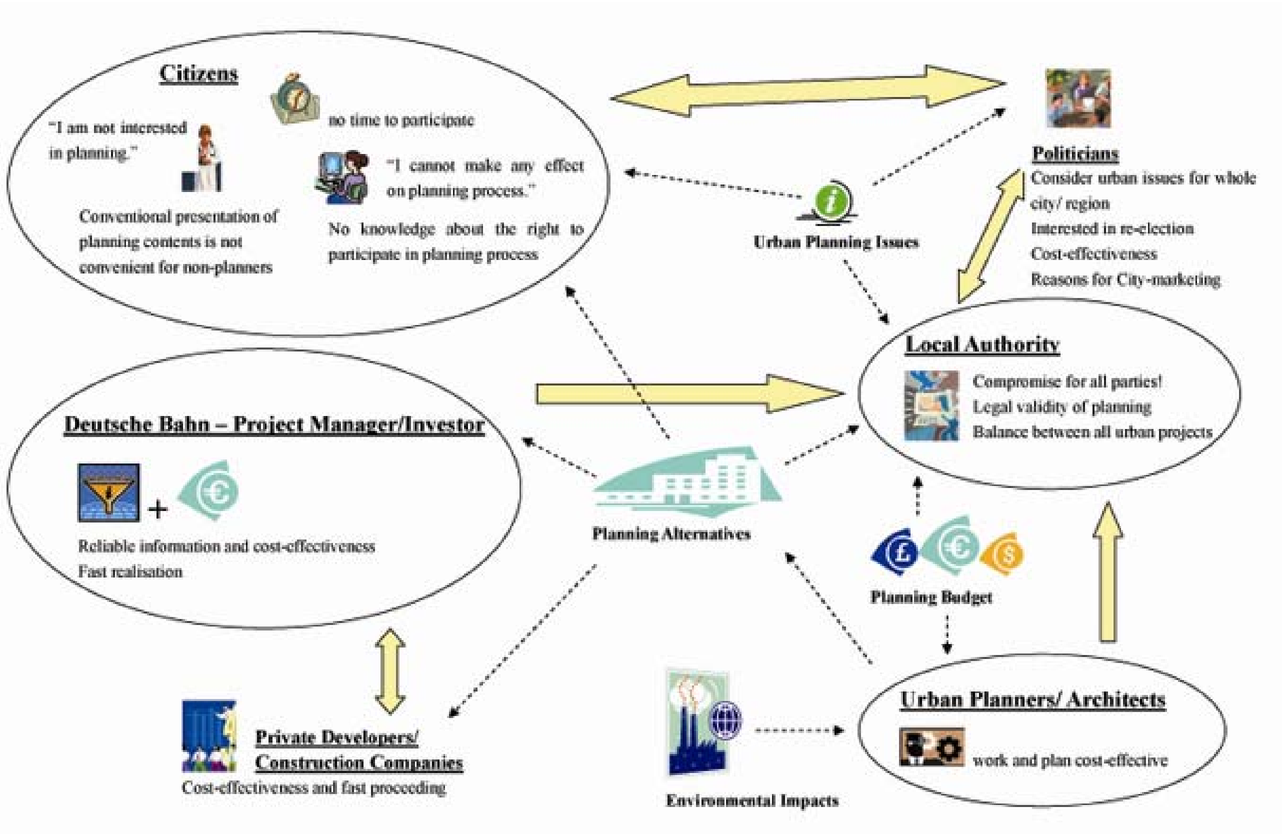

Figure 3.4 Rich Picture of Rosenstein Project

The context model is the summary of the scenario checklist and stakeholders' checklists, based on the analysis of the rich picture. Figure 3.5 below shows the context model of Rosensteinviertel project.

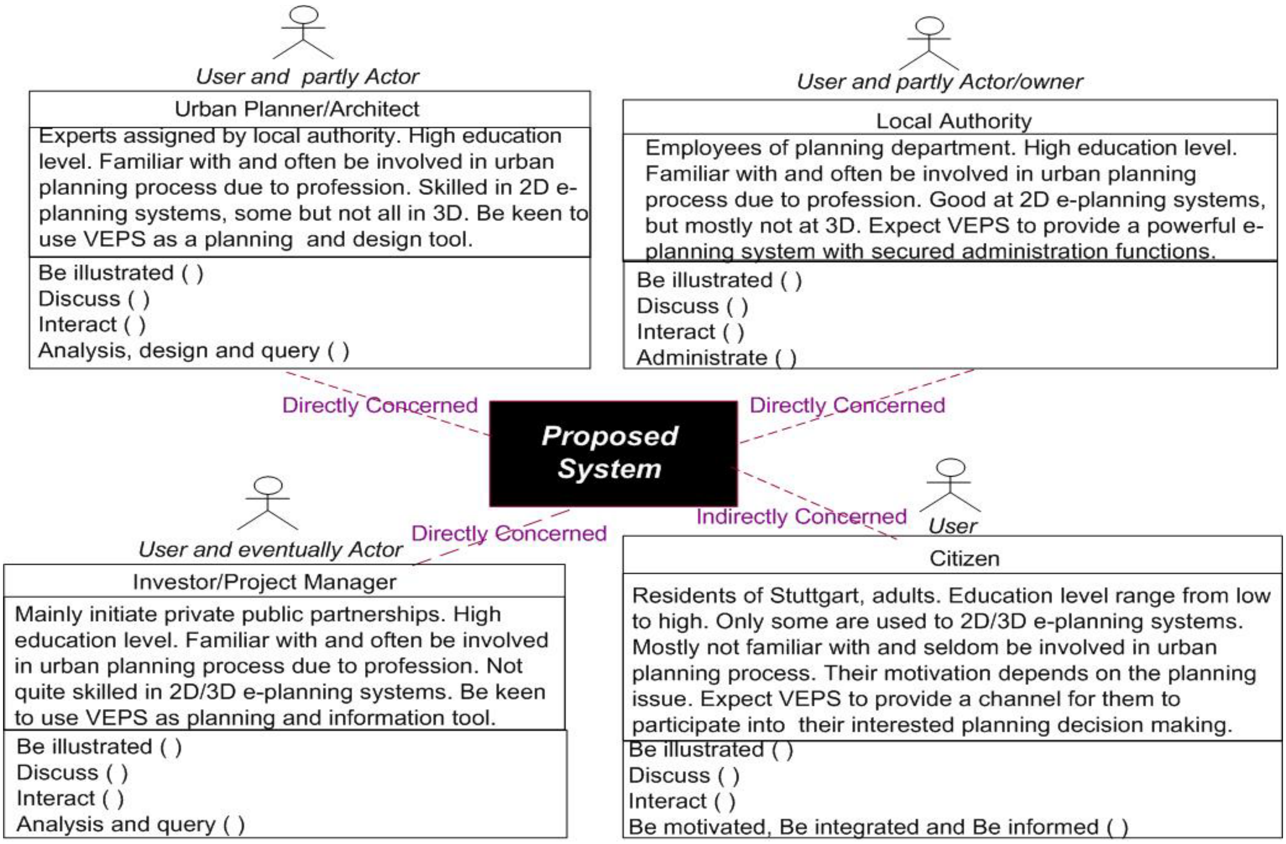

Figure 3.5: Context Model of Rosensteinviertel Project

3.2.2. Second Stage: From 'Context Model' to 'Descriptive Model'

The descriptive model is important in VEPS, as it is the way of communication what is involved in the design of a system to the technical team responsible for technical design and implementation.

At this stage, task analysis is adopted to get concrete tasks that users could do with the system, in terms of the top-level requirements in the context model. Task analysis is a methodology which is supported by a large number of techniques to help the analyst collect and arrange data systematically, to make explicit the requirements to be fulfilled by people and systems, and to optimise the capabilities of both components. The purpose of a task analysis is to contribute to design by transferring some knowledge from one group of people to another. It is used to gain an understanding of what people do in existing circumstances. The task analysis for Rosensteinviertel project specified three common functions for all four stakeholders and one specific function for each of them.

The result of task analysis could be used to define the functionality of the proposed system and for producing the descriptive model. The descriptive model describes the behaviour of the system as seen by its stakeholders. For Rosensteinviertel project, 23 use cases were defined in total (see Figure 3.6 below).

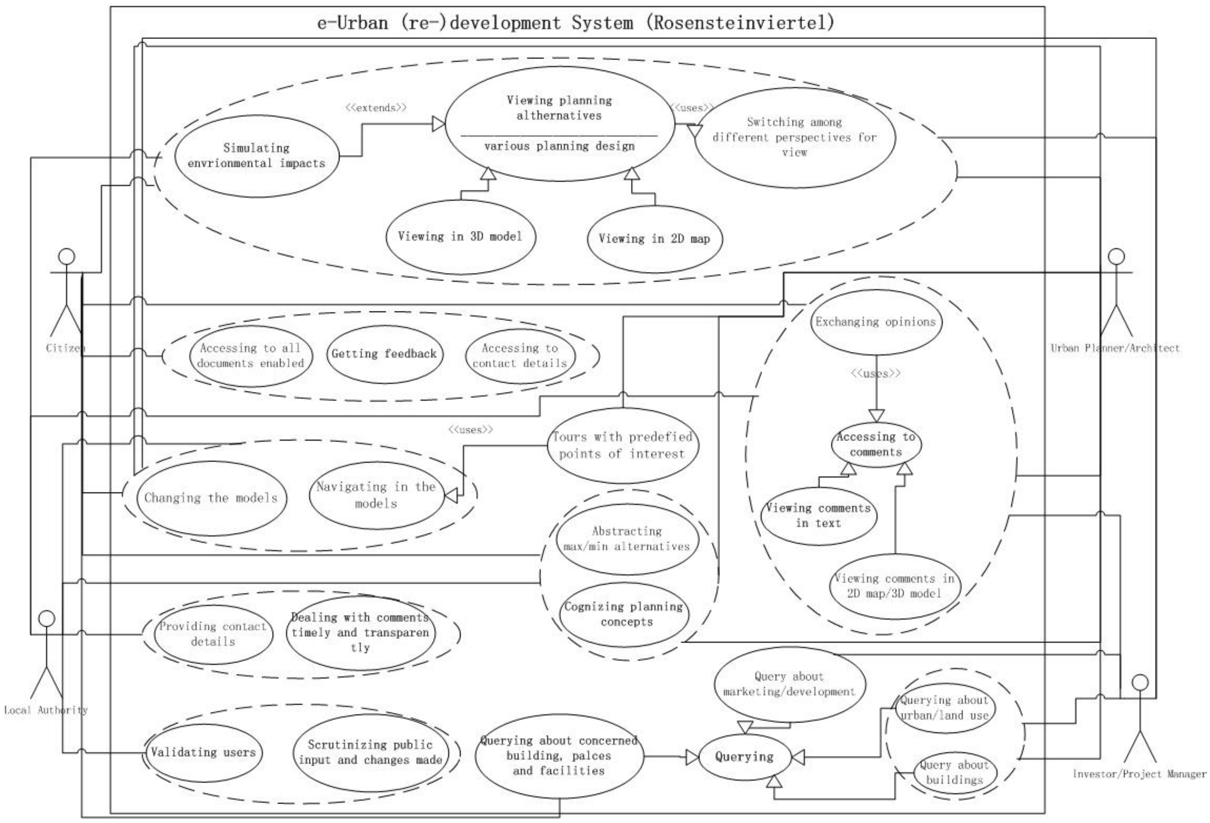

Figure 3.6: Descriptive Model of Rosenstein Project

3.2.3. Third Stage: From 'Descriptive Model' to 'Technical Model'

This stage focuses on the development of system architecture after matching the user requirements with available technologies. For Rosensteinviertel project, use cases of the system were grouped in terms of their relevance shown in the descriptive model and the system was divided into four sub-systems to be implemented separately at the beginning of this stage (see Figure 3.7 below). The Participation Tool is one of the four sub-systems. For each sub-system, one technical model will be produced before coding.

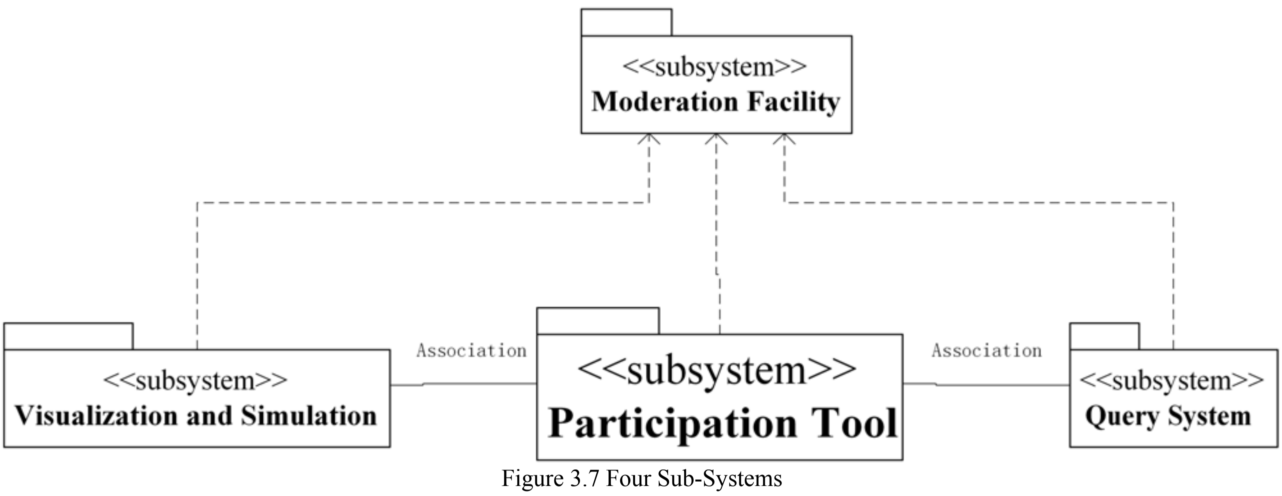

Figure 3.7 Four Sub-Systems

In the next section, the first step of implementation of Participation Tool will be illustrated. The implementation process started with transferring Participation Tool concered use cases to the technical model.

4. FIRST STEPS OF IMPLEMENTATION: PARTICIPATION TOOL

According to the descriptive model produced at the second stage, we defined two main functions for the Participation Tool sub-system:

Provide discussion forum for all stakeholders ('one-to-many' communication)

On one hand, this system could be a truly transparent system that all comments should be made available to create an open forum for discussion. Stakeholders could access the system 24 hours per day, 7 days per week, via Internet. That is to say, they could leave their comments, view comments of others and reply to their interested comments at any convenient time. During this process, all stakeholders could see and participate in the debate honestly, transparently and open. This could ensure more informed contributions.

Provide 'question and answer' function for the public to the local authority ('one-to-one' communication)

On the other hand, the system could also allow the 'one-to-one' communication. E.g. Local residents could leave comments only to local authorities, instead of putting the comments in an open forum. In this case, the related local authority could view the comments and give the feedback to the resident only. As a result, the need for the public to contact the local planning office by other means will be reduced. This could ultimately result in a more informed public, whilst releasing staff resources to concentrate on other works.

The Participation Tool concerned use case diagram is shown in Figure 4.1 below:

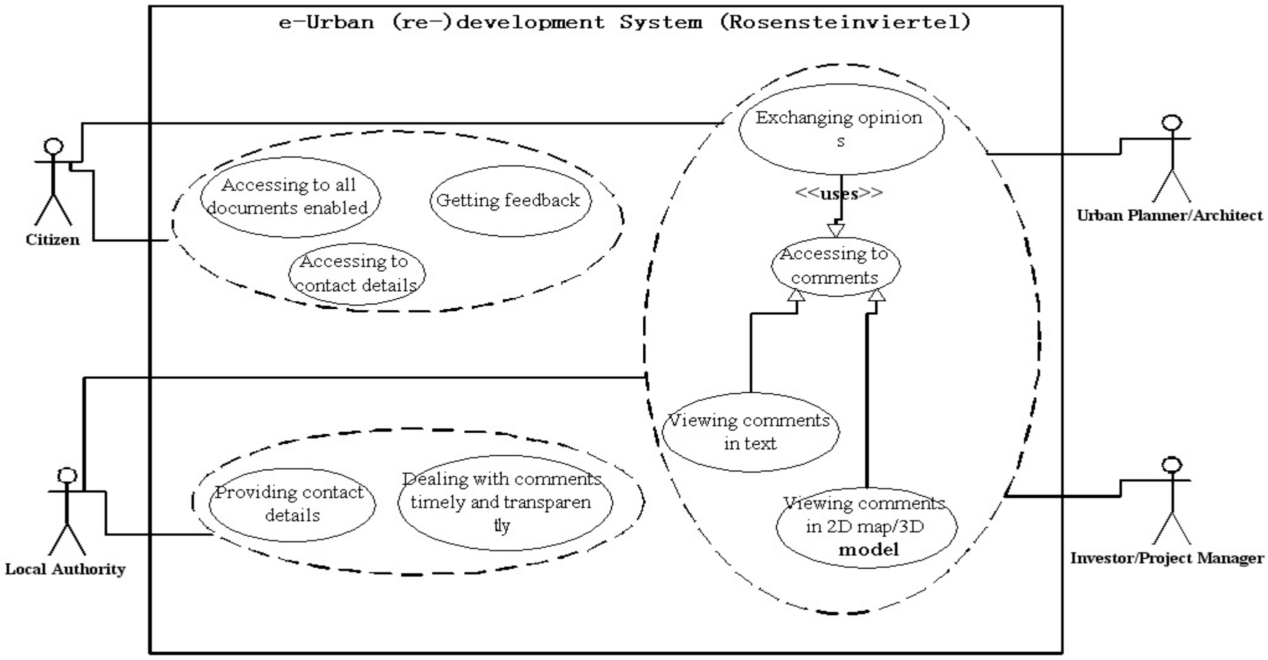

Figure 4.1 Participation Tool Concerned Use Case Diagram

We believe that Participation Tool could be more useful if it is facilitated with visualization and simulation functions, so that the spatial information could be more comprehensive to stakeholders, especially to non-prefessional citizens. Recently, lots of open source softwares emerged to help normal users understand the spatial information and the most representative one is Google Earth. Google Earth could quickly zoom from space down to street level and combine imagery, 3D geography, maps, and business data to get the total picture in seconds. It has been widely accepted that Google Earth is useful to plan a trip, find a house or local business, and even explore the world. The idea from Google Earth will be adopted in the Participation Tool development for VEPS project as well. Texts, 2D maps and 3D models will be combined together to make the tool more easily to use. Two example systems based on which Participation Tool are currently developed are shown in Figure 4.2 below:

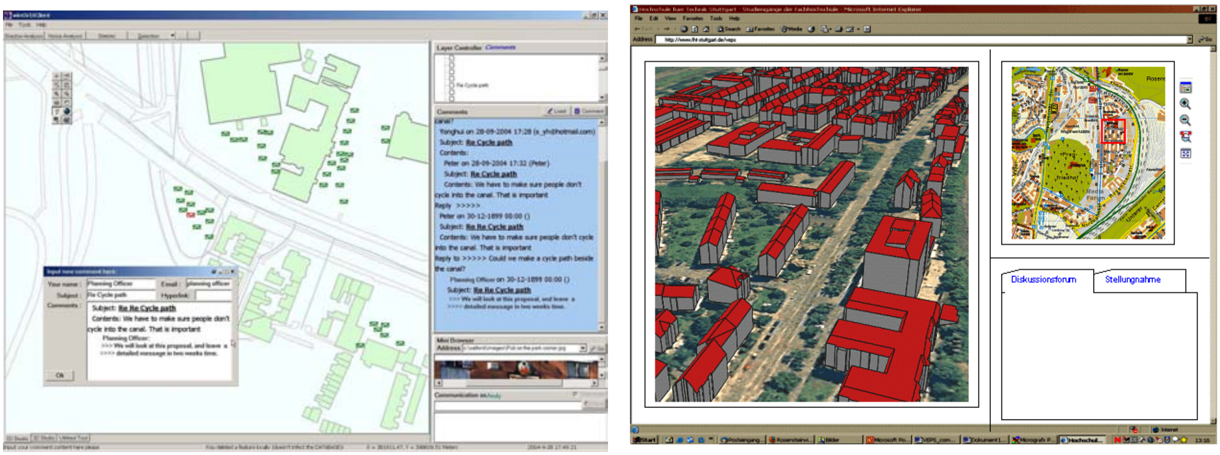

Figure 4.2 Two Example Systems of Participation Tool (3D-modell © Stadtmessungsamt Stuttgart)

5. FINAL COMMENT

Stuttgart and Salford partners in VEPS are currently working on the technical model for Participation Tool. The first prototype will be tested by the public before Feburary 2006. The efforts we will put on before the implementation of participation tool will be mainly from two aspects:

To carry on the design process

The interactivity model, which considers the interface elements design according to the human factors analysis, will be produced after the technical model for final system specification.

To consider evaluation issues for design and prototype development

We will consider evaluation issues especially for two stages: design stage and implementation stage:

At design stage:

To see if the functionality desired by end users is considered and designed correctly before actual implementation of the prototype. The questionnaire will be designed for and filled by the VEPS prototype developers.

At the implementation stage:

to see if the functional usability is really delivered to end users via physical prototype. Questionnaires will be designed for and filled by prototype end users.

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City of Stuttgart for making available the 3D city model

and Fraunhofer IGD for making available their software.

6. ANNEX: REFERENCES

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