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Chapter 9

Geographical visual information systems (GVIS) to support urban regeneration: design issues

Xiaonan Zhang [1], Nigel M Trodd [1], Andy Hamilton [2]
1. Telford Institute of Environmental Systems (TIES), School of Environment and Life Sciences, University of Salford, M5 4WT
2. School of Construction and Property Management, University of Salford, M7 9NU

1. INTRODUCTION

Urban planning is complex. It combines data and opinion on social, political, economic and environmental issues. In western societies, planners are responding to new challenges to make planning more transparent e.g. e-democracy, open government, and it has been argued that any solution should increase participation in the process. New technologies could be employed to promote dialogue and make the process less confrontational and easier to understand. The research at the University of Salford is designing and building a prototype which links emerging virtual reality (VR) and Internet technologies with (more mature) geographical information technologies. These geographical visual information systems (GVIS) are being designed to facilitate participation by multiple stakeholders in urban regeneration projects. In this chapter we consider how such a prototype can adopt a framework based on theories of learning and how that framework can be used to evaluate impacts of GVIS in urban planning.

The chapter introduces public participation in urban planning and reviews developments in GIS, VR and Internet technologies. A learning theory is outlined based on Kelly's theory of personal constructions (1955) and is mapped to functions available in GIS, VR and Internet technologies. Research is based on a case study of the Chapel Street Regeneration Project, Salford. The study identifies two stages of planning process - developing and selecting planning options - that offer opportunities for these technologies to engage stakeholders, and in particular the public, with the planning process. Design options for a GVIS are considered and methods of evaluating a learning system approach to GVIS are presented.

2. URBAN PLANNING AND PUBLIC PARTICIPATION

If a "city is a drama in time" (Geddes 1905, in Cowan 1998), then it is important to involve every citizen in writing the scenario and playing active roles in the drama. The sense of involvement not only gives citizens a greater meaning to their lives but also fosters a sense of responsibility which is often lacking in modern society (Ingram, 1998). These opinions are

reflected in a movement from 'planning for the public' to 'planning with the public' (Klosterman, 1999; Roberts and Lloyd, 1999).

Whittick, (1974) defined public participation 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'. Participation should involve the public putting forward ideas and comments at the early stages of planning process (Sarjakoski, 1998). It should be a continuous dialogue between the public and other stakeholders (McConnell, 1981). Rydin (1999) argues that in most planning activities participation is still narrow and low-level. It is usually undertaken in the late stages in the planning process and mostly based on consultation documents and public meetings (DETR, 1998; Bickerstaff and Walker, 2001). There is an argument for the public to be involved at earlier stages (Alterman *et al.*, 1984).

Two key factors have been identified for effective public participation.

- Availability of and access to information
  To participate in planning process, public require access to the necessary information about the planning work and have opportunities to express their opinions. Lack of information about planning activities and the limited opportunities for participation in planning policy decisions have been highlighted as key problems (Barlow, 1995).

  Many authors propose that GIS technology could be used to increase public access to information and optimise their participation in the planning and policy-making process (e.g. Weiner *et al.*, 1995, Myers *et al.*, 1995 and Nedovic-Budic, 2000). They envisage that people should have access to information presented at a level they understand and through media with which they are familiar.

- Communication and interaction
  Planning requires a dialogue between and among stakeholders. Dialogues between public and professionals can be inhibited by the lack of a common terminology and the alien jargon and alienating media used to convey ideas. Three-D representations of cityscapes offer more natural fora to exchange ideas (Sarjakoski, 1998) and Al-kodmany (1999) has shown that visualisation tools allow residents to directly participate in the design of their neighbourhood.

Nowadays, tools such as GIS, VR and Internet could be employed to achieve the goals of effective participation.

3. DESIGN ISSUES 1: TECHNOLOGY

The last two decades have seen the dramatic development of information technologies and their ubiquitous adoption. In this section, the current use of three information technologies, namely GIS, VR and Internet, in urban planning are outlined and the integration of these technologies is considered.

3.1 GIS

GIS is a special information system, as the data it handles are all referenced with geographical location. It focuses on spatial entities and relationships and pays specific attention to spatial analytical and modelling operations (Maguire, 1991). GIS are a powerful tool for storing and handling geo-spatial data and have been adopted in many market sectors, such as telecommunications and natural resource management.

GIS research has, since the early years, "moved from primitive algorithms and data structures to the much more complex problems of database design, and the issues surrounding the use of GIS technology in real applications" (Goodchild, 1992). Although GIS are adopted widely, their potential remains unfulfilled (Batty, 1993; Douven *et al.*, 1993).

Until recently GIS users have been limited to specialists and professional users. This is attributed to two reasons:

1. Low accessibility.
   Expensive software and data, poorly catalogued and protected databases are barriers to non-profit organisations and the general public (Nedovic-Budic, 1998). As a user group the public requires tailored "small and beautiful" GIS by which they can solve some simple spatial problems like "where is…?", "what is at location…?" and " what if…?" by themselves.
2. Weak visualization
   The user interface is crucially important as it is the only part directly seen and 'is' the system for the user (Frank and Mark, 1991). Most commercial GIS-user interfaces are based on the use of windows, icons, menus, and pointing devices (Egenhofer and Kuhn, 1999). These interfaces are too often an impediment to effective problem solving or decision-making (Medyckyj-Scott and Hearnshaw, 1993).

The emergence of web-based GIS increases access. Through the Internet, people can transmit data and access tools to conduct analysis and create GIS presentations (Peng, 1997). Although the Internet-based GIS creates many benefits for the public, such as the convenience of access and the low cost, problems of tedious interface and difficulty of use are still not solved. Virtual reality (VR) offer potential to facilitate public use of GIS tools as it increases the engagement of the user by coming closer to natural ways of interacting with the world than would happen with maps or other static models (Jacobson, 1992; Neves and Camara, 1999).

3.2 Virtual Reality

VR is a human-computer interface in which the computer creates a three-dimensional, sensory immersing environment that interactively responds to and is controlled by the behaviour of the user (Pimmentel and Teixeira, 1995). Its characteristics are response to user actions, real-time 3D graphics and a sense of immersion. By using multimedia, users can gain real time response to their actions by graphic and sound in a virtual

environment. An example is that as a 'person' walks along a street, the sound heard by that person would change continuously based on their location relative to the sound source. The richness of this experience facilitates a users' learning and understanding (Pont, 1993).

As with GIS, links between VR and the Internet have been developing. Virtual Reality Modelling Language (VRML) is a standard format for the web (Rohrer and Swing, 1997) that lets you quickly build virtual worlds incorporating 3D shapes, animation and sound effects. Since 1994, the most important developments in VR have not been in technologies, but in the adoption of VR technologies and techniques to increase productivity, improve team communication, and reduce costs (Brooks, 1999).

3.3 Internet

In the last decade of the twentieth century, the Internet emerged as a new information and communication technology. At the end of 1999, 1 in 5 households in the UK had Internet access compared with 1 in 20 only 2 years earlier (Corrigan and Joyce, 2000). It provides a more efficient way for people to access information and disseminate their opinions as it not restricted by time or physical distance. Corrigan and Joyce (2000) and Craig (1998) demonstrate the usefulness of the Internet to improve the productivity of public services and contact with government representatives. Local planning authorities are beginning to realise the potential of the Web as a communication device. A number of examples exist where local authorities have placed important planning documentation such as Structure Plans and Development Plans on the web for public consultation (Carver and Peckham, 1999).

3.4 GVIS

It is a widely held view that integrating GIS, VR and Internet technologies can facilitate greater and more effective participation in planning activity and thereby strengthen and democratise the process. Research in this field is attracting considerable attention e.g. the Centre of Advanced Spatial Analysis (CASA) of UCL and the urban simulation team in Los Angles (Batty *et al.,* 1998; Dodge *et al.,* 1998; Jepson *et al.*, 1996). Although these demonstration systems suggest that the technologies exist to provide functions for public participation the published literature is notable for the absence of formal theory in the design of this type of systems. A lack of theory may undermine the development of GVIS and inhibit longer-term progress through rigorous evaluation. Formal theory helps to explain the success (or failure) of these systems and better understand the likely impediments to future system. An objective of the University of Salford research is to develop a robust framework for the design of GVIS.

4. DESIGN ISSUES 2: LEARNING SYSTEMS AND GVIS

4.1 Learning system theory

Learning can be defined as the synthesis and analysis of information obtained through communication and interaction. It can be argued that urban planning is a learning process as it is information-rich, complex and benefits from stakeholders sharing a greater understanding. The exchange of information and ideas between stakeholders creates an informal learning environment. As such, the planning process can be considered within the framework of a theory of learning. Of the many theories of learning, Kelly's "personal construct theory" (Kelly, 1955) is an appropriate approach for urban planning (Hamilton *et al.*, 2001). Kelly states that people look at their world through patterns that they construct and try to fit to the real world. Without these patterns the world would make little sense to people. Patterns are constructed based on an individuals experiences i.e. "personal constructs". People change and revise their patterns in order to explain better their view of the world. It is noted that personal experiences include interaction with both tangible and intangible features of the world (Kelly, 1955).

To relate the learning theory to urban issues, personal constructs are formed by making sense of our direct experiences of life in the city, or indirect experiences through newspapers, books, TV and other informing media. The social interaction also lead to the building of personal constructs. Furthermore, when social interactions take place with a group, it is possible for us to envision new and more creative ways of dealing with a problematic situation by actively considering alternative constructs (Figure 1).

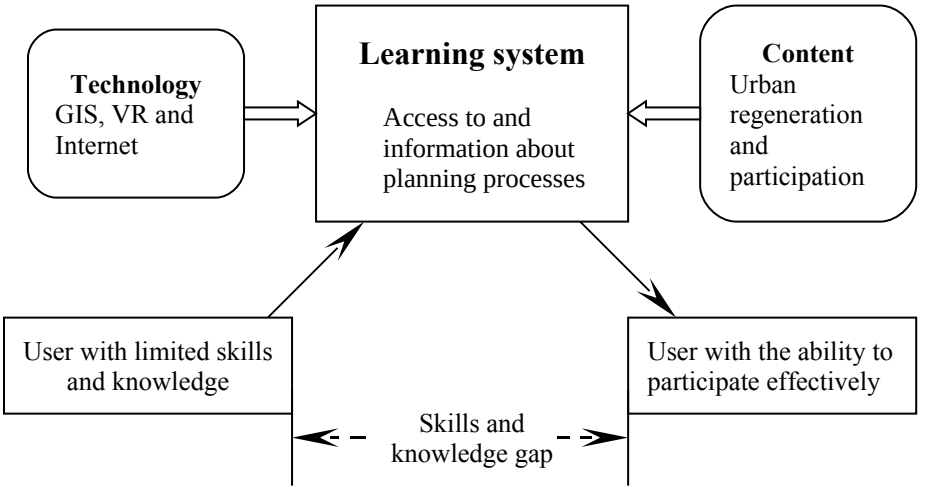

Figure 1. Effect of a learning system to enhance participation in planning.

Three aspects of the learning system are needed to enhance participation in the planning process, namely access, analysis, and comprehension (Zhang *et al.*, 2001). The current system to gain aaccess to information for a particular proposal can be a burden to the public because the time involved may be incompatible with their lifestyle or incur a financial penalty due to loss of earnings. Furthermore, gaining access does not improve

matters unless the information is presented in a way that they can comprehend. Experimenting with alternative scenarios is another essential part of the learning system. To fully understand the planning issues, people need to analyse the information they get. The alternatives also need to be analysed and evaluated. In order to do that, public need tools to interact and refine the information. The tools may not be as complicated as the ones for the professionals but at least they can achieve some analysis functions. It has been postulated that allowing people to analyse planning proposals followed by debate between public and other stakeholders can lead to greater consensus in the final plan.

It has been observed that many people find it difficult to participate effectively in planning systems because they lack the necessary skills and knowledge (Hamilton *et al.*, 2001). A learning system could be built to bridge the skill and knowledge gap identified (Figure 1). On the one side, the planning process and participation issues are "the content" of the system. On the other side, technologies like GIS, VR and Internet provide functions that are needed to build a learning system.

4.2 The strengths and limitations of technologies to enhance learning

In the light of the learning system theory, the strengths and limitations of each technology in each of the aspects of the learning system have been evaluated (Figure 2). GIS allows people to process information and detect spatial patterns and relationships. GIS is classified as high in terms of analysis. It is not rated as highly for access or comprehension. VR is classified as high for comprehension and the Internet provides an effective way for people to access information.

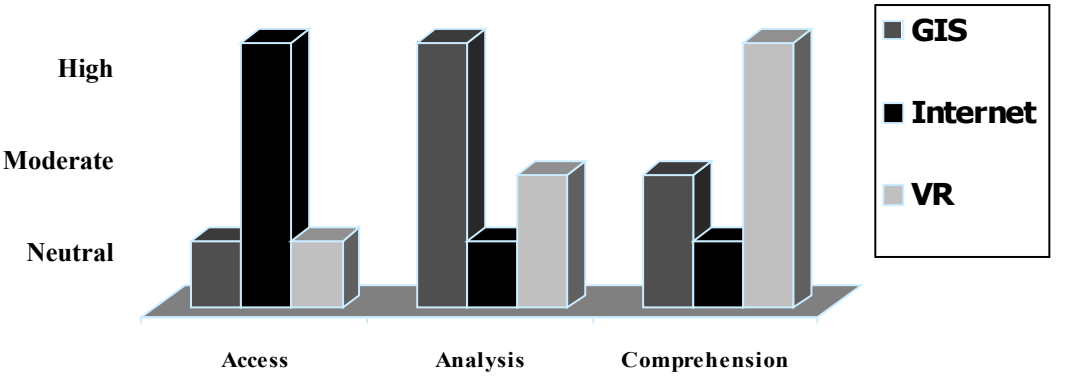

Figure 2. GIS, VR and Internet in Information Learning System (Source: modified from Hamilton et al., 2001).

5. PROTOTYPE DESIGN AND EVALUATION

This chapter has identified design issues associated with the technologies and learning systems methodology. It follows that a prototype is designed to combine the strengths of the technologies and implement features of a learning system. The research prototype is being designed around a common geospatial database for the Chapel Street Regeneration Project, Salford.

Chapel Street is the main thoroughfare through the city of Salford (Figure 3). It is also one of the main approaches to the centre of Manchester. Over the past thirty years Chapel Street has declined as a commercial and retail centre and in 1998 the City Council launched a major regeneration project. The project is funded by decline public and private sector organisations and involves residential and business communities.

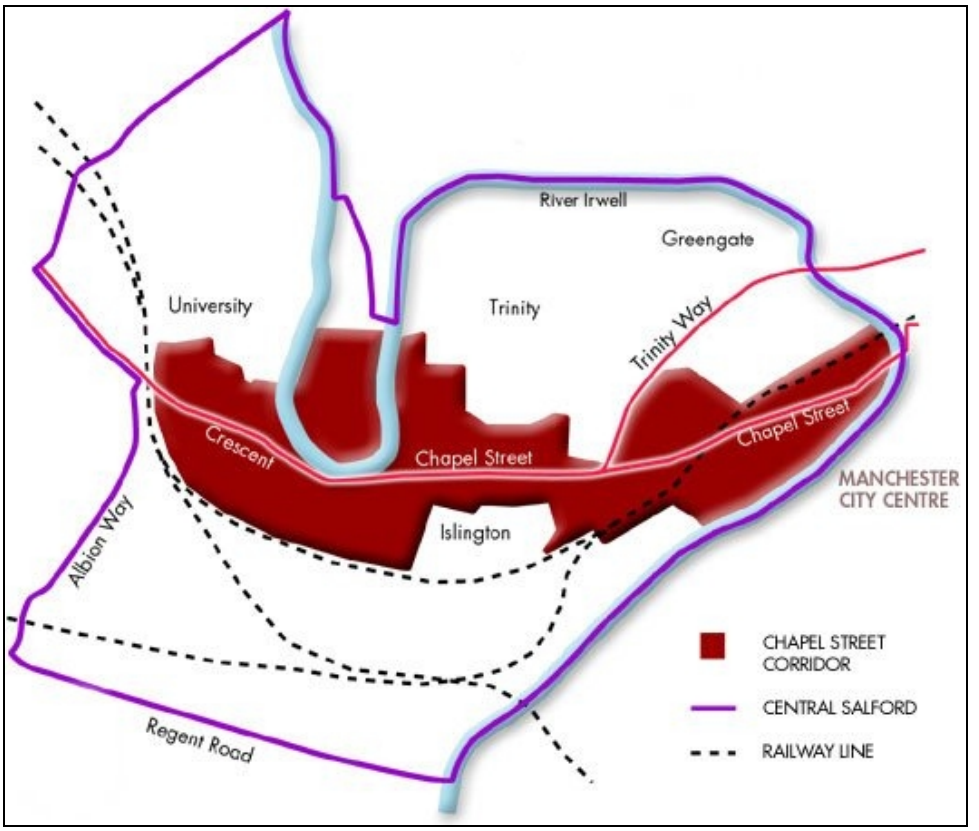

Figure 3. Chapel Street Regeneration Corridor, Salford, UK.

The Chapel Street case study provides a complex platform for the design and evaluation of a learning system-based GVIS. The prototype will be developed in parallel with regeneration plans and is intended to complement existing activity rather than replace it. The main benefit of using an established urban regeneration project is the ability to compare old and new approaches to participation. Before the prototype can be developed, however, it is necessary to identify those aspects of the planning process that it will address.

5.1 Urban planning system: user needs

In keeping with the aim of this research the planning process was studied for key stages which represent the best opportunities for the use of GVIS to support public participation.

Kammeier (1999) suggested that planning support systems should support clarifying the planning options, simulating alternative proposals, assessing shortlisted projects and implementing the decision. These coincide fairly closely with Skeffington's observations (1969) that the main opportunities for public participation in a local plan are at the stages of surveys of facts, developing planning options and discussing favoured proposals. If these proposals are mapped to Yeh's model of the planning process then 4 stages can be identified which are most conducive to public participation (Figure 4). By comparison GIS is most useful whilst analysing the existing situation, and developing and selecting planning options because of the need for spatial analysis in these stages. The stages of modelling the existing situation and developing and selecting options offer greatest potential for using VR because it facilitates presentation and interaction.

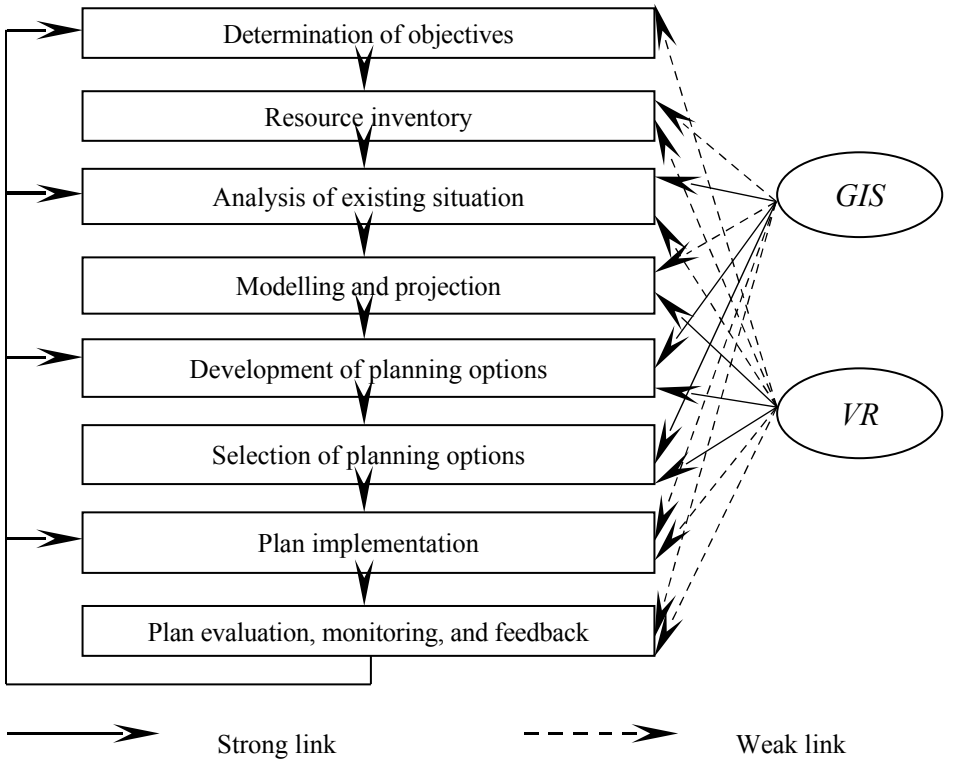

Figure 4. GIS, VR and public participation in planning process (modified from Yeh, 1999).

Combining these assessments allows us to identify 2 stages in the planning process that are best suited to developing and testing a GVIS prototype, namely developing planning options and selecting planning options (Figure 5)

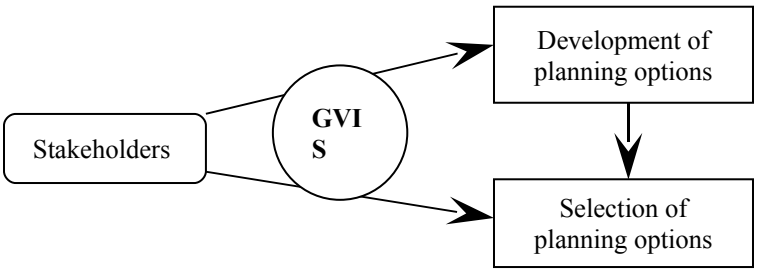

Figure 5. Planning stages for developing and evaluating a GVIS.

5.2 Learning system components

The prototype has been designed as 3 modules that each focus on an element of the learning system.

5.2.1 Analysis module

The analysis module uses spatial analysis functions to process data and support queries such as "where is…?", "what is at location…?" and " what if…?". In particular the module will develop decision support functions such as multi-criteria analysis.

5.2.2 Comprehension module

A 3D model of Chapel Street Corridor has been built based on the same geo-spatial database of the analysis module. In this module, user can navigate and query the planning area. Main features are the provision of functions to switch between before and after views of the area based on possible scenarios and the geo-referencing of multimedia information such as video clips and panoramic photographs. The module is also designed to improve communication between stakeholders by allowing them to comment on various aspects of the regeneration plan, attach those comments to a visual object and to retrieve the comments of other participants.

5.2.3 Access module

The module is mainly about the access of the planning related information through the Internet and/or Intranet. Users are allowed to access the information via a popular Internet

browser. All the functions of the former two modules would be transplanted/linked in the user interface that means uses can access them by Internet or Intranet.

5.3 Evaluating GVIS as a learning system

The question of whether or not new technologies improve complex tasks such as urban planning is often very difficult to answer. The evidence is usually qualitative, may be contradictory and rarely allows the system developer to make an objective evaluation. In particular it is difficult to assess the impact of combined technologies. Implementing learning system theory in the design of a GVIS prototype enables the research to reduce the system into three objectives. These objectives transcend the technologies and therefore provide a useful frame of reference for evaluating combined GVIS. Failure to achieve one of objectives can be used to focus further research and development of the prototype system.

6. SUMMARY

Stakeholders, including the public, are being encouraged to participate in urban regeneration. To do so they need to be able to contribute to and benefit from the planning process. Recent studies have created virtual environments as a mechanism to facilitate the communication of planning information and postulate on the near-future appearance of cityscapes. At the same time community-based GIS researchers have argued that GI technologies can help to secure active participation of leading individuals and groups at early stages in the planning process and numerous authors promote the Internet as a forum for interaction between participants. In this chapter the authors have presented the case that integrating GIS, VR and Internet technologies can increase participation in planning process. More importantly, applying learning systems theory to the design of GVIS creates a framework that can be used to optimise participation.

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