Urban Studies, Vol. 33, No. 10, 0000–0000, 1996

Bottom-up Neighbourhood Revitalisation: A Language Approach for Participatory Decision Support

Ernesto G. Arias

[Paper received in final form, July 1996]

Summary. Urban planners have become increasingly aware of the importance of implementation in the formulation of policy. This concern has guided on-going efforts of the Urban Simulations and Information Systems Laboratory (SIMLab) at the University of Colorado in developing interactive three-dimensional planning simulations and games. These simulations are used as decision-making tools to help neighbourhood residents to help themselves in making decisions that shape the housing and communities where they live. The present paper describes the conceptual aspects behind the development of these tools, applies the tools to the redevelopment of the COLE neighbourhood in Denver, Colorado, and critiques the limitations of the tools and discusses their future applications.

Introduction

Planning is a problem-solving process that centres around decision-making. The implementation of outcomes (policies and plans) is the central aim of planning. The decision-making process calls for answers to 'What?', 'How?' and 'Why?'. Given the constraints on what can be accomplished when addressing these questions in situations involving diverse interests, planning is largely about implementation. "Policy not implemented is not policy—resources must be committed, rules enforced, and behavior changed" (Grigsby *et al.*, 1977). In addition, urban planners recognise that if research is to help them in policy implementation, it should define the problem in a way that is amenable to solution, reduces areas of disagreement, suggests directions consistent with opposing positions, and determines what different stakeholders are willing to do to resolve the problem as they perceive it (Grigsby and Rosenburg, 1975).

The challenge and insight described above, along with increased awareness of the value of participatory planning, have in great part guided the development of decision-support tools and approaches that help participants in community planning situations at the Urban Simulations and Information Systems Laboratory at the University of Colorado (SIMLab). Central to these tools is the development of a common language based on

Ernesto G. Arias is in the College of Architecture and Planning, the Institute of Cognitive Science/and the Center for Lifelong Learning and Design at the University of Colorado, Boulder, CO 80309, USA. Fax: 303 492 6163; e-mail: ernie@spot.colorado.edu. *The author wishes to acknowledge the students of the ENVD 4420 Senior Planning Studio, Spring 1990, whose participation made possible the project reported here. They were S. Baldwin, P. Chesebrough, C. Choate, A. Dhus, J. Foy, F. Groth, D. Hollis, J. Jacquart, S. Richman, M. Schock, B. Sullivan, C. Toebe and J. Wallace. Thanks are also due to the participating staff members of the City of Denver Planning Department and, last but not least, to all the neighbours of the COLE Coalition and its leadership for their involvement.*

0042-0980/96/100000-00 $6.00

games and simulations to support implementation in domains—such as neighbourhood redevelopment—characterised by conflicting points of view and a lack of resident participation. The SIMLab is supported by the College of Architecture and Planning and the Center for Lifelong Learning. As a research facility, the SIMLab pursues the development of tools and technologies to support participation, frame discussion and gain informed compromises through distributed understanding.

This participatory tool-development experience is the focus of this paper, which begins with a discussion of the nature of the physical simulations and games and some important concepts behind their development. The paper then describes an effort to support citizen participation with these tools as a central element in the revitalisation of Denver's Cole neighbourhood. The paper concludes with a critical analysis of the tools, probable future developments given the limitations of the tools, and their potential applications for physical planning domains such as neighbourhood revitalisation.

Context Behind the Need for a Common Language

The decision-making process for implementation needs special support mechanisms when different interests and opinions conflict, when alternative proposals compete for limited resources, and when it is considered important that several stakeholders need to be enabled and encouraged to participate in the planning process. Nonetheless, major constraints to implementation stem directly from the nature of planning problems, such as those inherently associated with community redevelopment and neighbourhood dynamics. These problems are situated in a context of constantly changing conflict—i.e. multiple interest groups seek to maximise satisfaction of their preferences, while preferences fluctuate as new stakeholders enter and old ones leave or shift their perspective. In addition, the decision context changes even as resolution takes place. Against this background, planning decisions are often difficult to support in that they address problems that are by nature 'wicked'—i.e. they are ill-behaved and ill-structured (Rittel and Webber, 1984).

These problems are ill-behaved because they lack evaluative clarity and thus a 'no-stopping point' (Simon, 1981). An ill-behaved problem cannot be solved once and for all. Due to the lack of evaluative clarity within and among stakeholders, judgments about a proposed (or even implemented) solution inevitably differ among participants. As stakeholders come and go and new aspects of problems surface, judgments also change over time. Often, judgments are of an 'on demand' nature. Therefore, they change 'on-the-fly' as stakeholders present pros and cons while striving to reach a distributed understanding behind a compromise.

At the same time, planning problems may be ill-structured because they often lack a set of commonly acknowledged dimensions for defining the problem. Each stakeholder has a (sometimes narrow) view of the problem and an agenda to satisfy his or her goals. Stakeholders are often unaware that achieving their own goals can worsen conditions for other stakeholders. It is not only unclear how to solve an ill-defined problem but also how to frame what exactly constitutes the problem and how to judge a proposed solution. The problem may take the form of vague dissatisfaction and an imprecise demand for improvement. Many urban planning problems fall into this category.

Many decision-making settings in urban planning are characterised by the participation of several stakeholders with different backgrounds and roles. Neighbourhood issues, for example, involve residents, city councils, businesses, developers and local financial and educational institutions. Sometimes, acceptable trade-offs leading to informed compromises, not consensus, are all that can be achieved. Stakeholders may make decisions following an ongoing negotiation process dominated by bounded rationality or even apparent irrationality. Many individuals and interest groups are not experienced in decision-making and need support to make informed decisions. Further support is needed to ensure an efficient interaction and collaboration among inexperienced stakeholders.

Important tools in complicated, dynamic decision-making situations are the various types of physical models designed to enable people to visualise the possible outcomes of different decisions. Because wicked-problem situations are typified by fuzzy borders, unclear criteria and shifting opinions, many of the most affected stakeholders, the average residents of a neighbourhood, cannot effectively contribute to problem resolution. The ill-behaved and ill-structured nature of many problems means that participants lack an algorithm for framing and resolving them. Formal approaches can provide elegant algorithms to derive optimal solutions, but not until the representation of the problem is framed by the affected stakeholders. Sophisticated and highly abstract models are hardly appropriate to support the decision-making efforts of lay persons. Yet, many stakeholders in urban planning problem situations are lay persons and thus inexperienced in decision-making.

Developing a Common Language

Limitations to the modelling of choice behaviour using more well-defined approaches, such as expressed preference methodology, stem directly from the nature of planning problems and the context described above. How to address these limitations in a planning and policy-making context has been in great part the basis for the development of social interactive planning approaches complemented by physical-visual models. Over the past 10 years, the SIMLab has developed these models and used them as games and simulation tools in a wide variety of participatory planning and learning efforts in domains ranging from natural resource management in regional planning to neighbourhood revitalisation in urban planning.

Prototypically, these tools are developed to help users to frame or to address domain-specific problems and their associated interventions—for example, a simulation to analyse zoning decisions or a game to understand policies affecting neighbourhood change. They include

(1) a horizontal, simulation gameboard;
(2) a language comprising three vocabularies of three-dimensional physical elements that provide the tools with their descriptive, evaluative and prescriptive capabilities; and
(3) a set of rules and protocols developed for each game application to guide the interactions between the players, and those between the language and the board.

Identified stakeholders in real decision situations act as players and are selected based on whether they are *affected* by or are *effecting* a planning action. Thus, the selection identifies the members of the *critical coalition* for a planning action (Arias, 1994).

The gameboard is usually a map which affords easy visualisation of the setting of concern in terms of its crucial spatial attributes—such as location and size of study area, right-of-way dimensions of corridors—and pre-emptive descriptors, such as slopes or floodplains. Usually, it includes only those areas that define the setting under study—a district, a city block, a street corridor. The board also usually includes a learning space that introduces the user to the various capabilities of the tool, and explains the basic rules and protocols that govern the interactions between players and the tool, and between players and players, and provides information management in the simulation or game. The elements of the various vocabularies of the language are then placed on top of the gameboard. It is the interaction between the vocabulary elements and the board that allows players to focus on the argument. It enables them to complement subjective aspects, such as emotion or intensity of conviction with more objective considerations, such as descriptions of functionality. It also permits added flexibility in the discussion to describe the situation further—for example, to make evaluations, to make changes or modifications to the situation, or to describe a problem solution.

The central purpose of these tools is to assist participants who 'can't plan' by helping them to make decisions, to resolve conflict and to learn. To this end, the tools are developed to transform tacit knowledge into distributed understanding in order to frame planning problems, identify alternative solutions and make the selection for implementation through informed compromises. Therefore, it is important that outcomes are reliable and valid, and that all stakeholders understand and agree on the intended meaning of a common language. Accordingly, some conceptual issues behind the development of the language are worth mentioning.

The three-dimensional language is composed of three vocabularies of elements or 'languages of pieces' as users refer to them, with meanings associated with these pieces—for example, descriptions of land use in the neighbourhood such as yellow or red blocks representing residential or commercial uses. To facilitate valid and reliable associations, the elements in a vocabulary are developed across a spectrum of abstractness—from 'high abstraction' to 'high verisimilitude'—by using the physical dimensions of shape, size and colour of physical objects as represented. Through the associations of these physical attributes with meaning, and through the interactions between the language and the gameboard, the tool gains representational capabilities that facilitate the expression of the descriptive, evaluative and prescriptive thinking of the stakeholders. Once decisions related to abstractness are made, generally three types of elements are developed within the space of alternatives created by the three dimensions:

(1) elements of a vocabulary that represent the empirical aspects of the decision problem (descriptive);
(2) those elements in a vocabulary that can express the evaluatory aspects of both empirical and policy-making aspects of the problem (evaluative); and
(3) those that represent policies, plans and decisions (prescriptive) (see Figure 1).

Although many of the ground rules as to how a description is allowed to develop are predetermined in the descriptive phase—for example, the laws governing vehicular movement—much of the definition and use of the evaluative and prescriptive elements is left up to the participants. In fact, the most successful games are those in which participants themselves develop a consensus regarding possible alternative policies (prescriptive pieces) and their evaluation criteria (evaluative pieces), even though the actual evaluations of a policy may show profound differences across different interests. In short, whereas the descriptive pieces more or less set the physical and legislative boundary conditions for problem-solving, the meaning and uses of the evaluative and prescriptive pieces are often developed throughout the game in a complex process of social interaction between players. In fact, even new pieces are added to the vocabularies during the course of using the tool.

The physical language is also designed to overcome the psychological anxieties that some stakeholders may initially experience in addressing problems through a participatory approach. Thus, for example, the abstractness of elements is designed according to the competency levels of users, and the 'learning space' of the gameboard allows an incremental introduction to the language and its basic representational capabilities. The simple look and feel of vocabulary pieces and the tactile experience of handling them can encourage the participation of people who would not dare to touch a more 'sophisticated' tool, let alone a computer. Therefore, the language must appear simple enough so that all stakeholders feel sufficiently confident to understand what it means. To this end, the development of the language must meet several requirements that themselves form the basis for evaluation of the tools as follows:

—*Relevancy*. The language should empha-

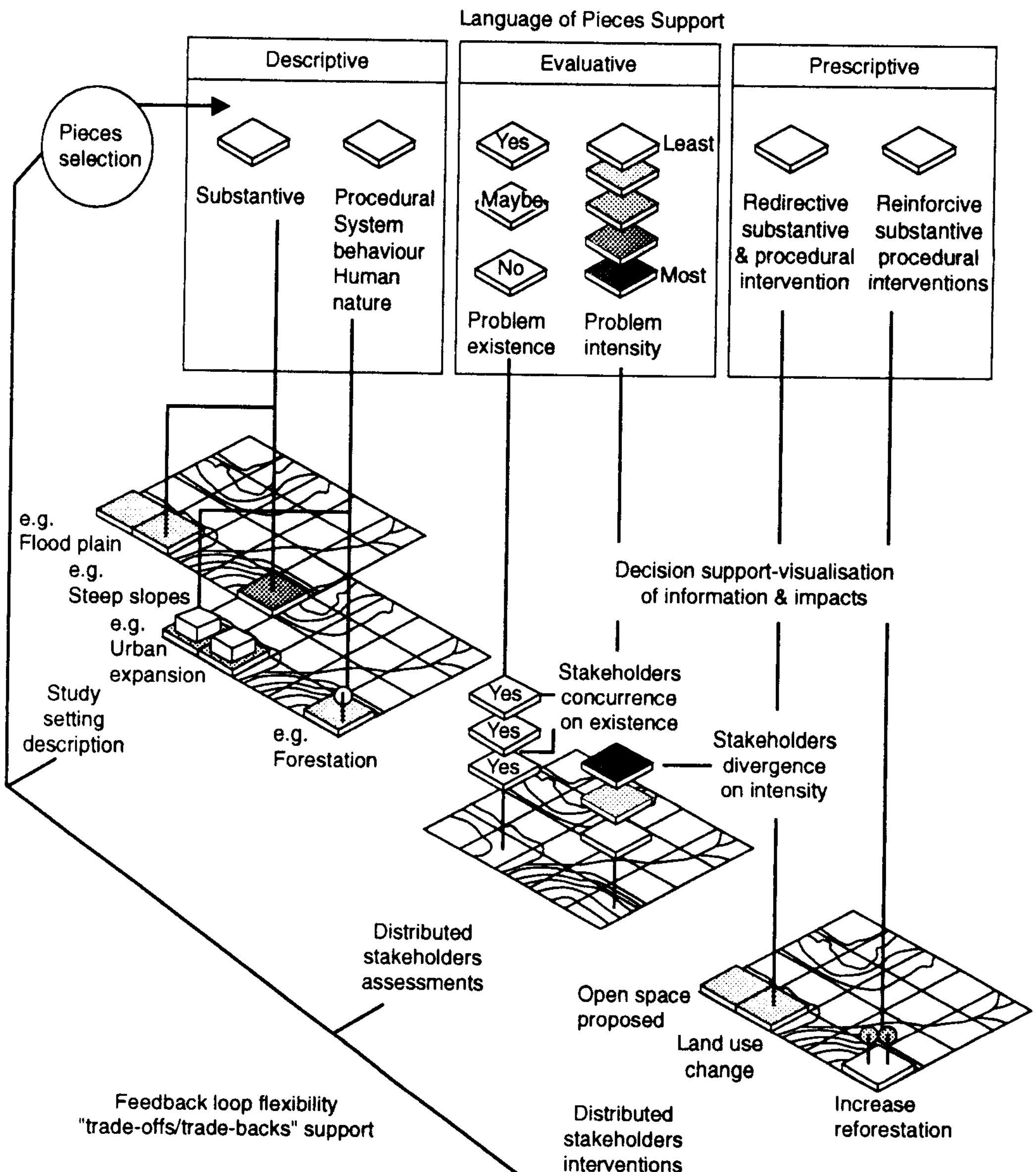

Figure 1. A common language: elements of the three vocabularies in a language provide descriptive, evaluative and prescriptive support to decision-making through their interactions with the gameboard.

sise relevant aspects of the situation and omit irrelevant ones. For example, the building materials used in a house do not figure in a zoning problem. Thus, the material should not be represented in the pieces in a zoning exercise.

—*Flexibility*. Degrees of freedom in decision-making must be reflected by the possible ranges of selection and arrangement of pieces. Location, orientation and combination of pieces should correspond to aspects of the physical system that can be determined by the decisions to be made.

—*Verisimilitude*. The level of abstraction of gameboard and pieces must conform to the abstraction ability of the stakeholders. Along these lines, tools may also contribute to cognitive development by increasing the abstraction capabilities of players.

—*Transparency*. Mappings between aspects of the real situation and characteristics of the pieces should be as intuitive as possible. For example, the size of a house can better be visualised by the size of a piece than by its colour.

—*Evolutionary adaptability*. The meaning of the language (gameboard and pieces) while developed specifically for each domain application, should allow for evolution through modifications by the players during use.

—*Simplicity*. Finally, the language (gameboard and pieces) should be as simple as possible, within the limits defined by the above requirements.

Over time, the SIMLab experience with these tools has demonstrated that certain characteristics of the approach (participatory, experiential and interactive) to support decision-making with them can contribute to address some disadvantages of quantitative approaches to decision-making (such as expressed preference models), or conflict resolution in applications such as neighbourhood redevelopment as reflected in the following:

—*Participatory*. Face-to-face interactions enhance distributed understanding of the problem, support trade-offs and, through dialogue, facilitate informed compromises in the resolution of conflict (Jung, *et al.*, 1994).

—*Experiential*. The actual selection, board placement and movement of the game pieces support a clearer understanding of the situational variables (Palmer *et al.*, 1993). They also maintain a focus on interactions while defining a problem as it changes and while identifying alternative interventions.

—*Interactive*. Interactions between players and the rules and meaning of the language of pieces support the ability of stakeholders to change their minds in a flexible manner as the distributed understanding among players is constructed (Arias, 1993).

These characteristics of the approach help interest groups with a concern which we have been aware for some time—i.e. to scan intervention alternatives and to assess their implications as opportunity or threat (Grigsby and Rosenburg, 1975). They provide affordances for cooperation among stakeholders through a focused dialogue which leads to shared understandings that can overcome the symmetry of ignorance (Rittel, 1984) among different interest groups. And they facilitate a flexible way to represent the complexity in interactions between actions (policies, plans, decisions) and their consequences in real-world planning problems.

Helping Neighbours to Help Themselves

The SIMLab has extended the above approach and tools beyond educational applications into real-world planning domains. One such application was in the Cole neighbourhood of Denver, Colorado (Arias *et al.*, 1990). The neighbourhood is a representative example of the deterioration and ailments facing America's inner-city neighbourhoods. The Cole neighbourhood is located to the north-east of the CBD and comprises a 4 square-mile area of 88 city blocks (see Figure 2). According to the 1990 census, the neighbourhood included about 5000 people, about 1200 residential units and a mix of industrial and commercial activities. In 1990, Cole was considered one of the worst neighbourhoods in Denver. It was hit hard during the 1980s by an ailing economy, rapidly increasing crime due to drugs and gangs, loss of some of its stable families that left for safer areas, housing vacancy rates close to 20 per cent, deterioration and abandonment of over one-third of its housing stock, and the lack of institutional concern and support (see Figure 3). In addition, its unemployment level was estimated at over 15 per cent, which was more than double the city-wide average of 6 per cent at the time. All these

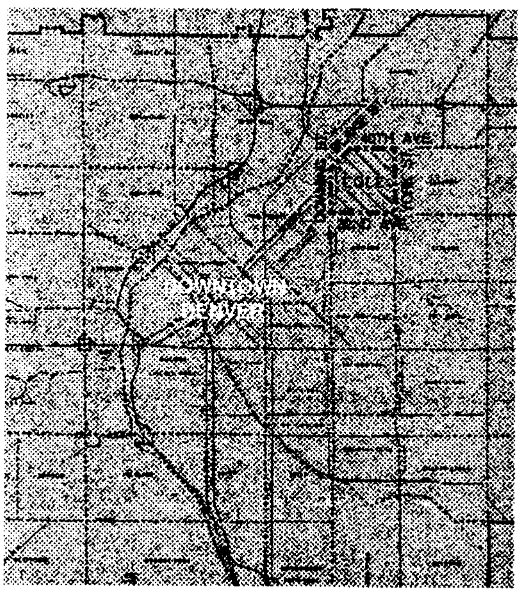

Figure 2. The location of Cole, an inner-city neighbourhood.

conditions overshadowed the neighbourhood's proximity to downtown Denver, and they reinforced the high apathy and low pride of its residents (PCDD, 1989; PCDD, 1990).

The Need for Planning Assistance

Out of this dim picture in the late 1980s emerged an alliance of stakeholders—a core group of residents, one bank, the school district, churches and the police department, among others—who were totally devoted to changing trends in the social, economic, physical and educational condition of the neighbourhood. In response to this group of motivated stakeholders, the newly formed Neighbourhood Planning Division of the mayor's office, under the Federico Peña administration, and the Denver Planning Department, selected Cole as one of three target neighbourhoods for revitalisation, not gentrification. The $7.5m commitment to this effort was not nearly enough to resolve all problems, but perhaps enough to arrest the downward trends (PCDD, 1989). Cole became the initial test case for the city's planning initiative.

The mayor intended the neighbourhood revitalisation to be a grass-roots effort that would permit the neighbours to decide how the money would be spent. To accomplish this goal, the Cole Neighborhood Coalition was formed, together with a Coordinating Task Force and a City Technical Team. The neighbours were expected to participate through the coalition at all levels of issue identification, programme development and implementation.

The SIMLab's involvement can be traced to two factors. First, any grass-roots effort gives rise to concerns over the competence of the stakeholders who are asked to participate and to make valid and reliable revitalisation decisions for the whole neighbourhood. In this case, the participants in general were poor with an average educational level not higher than elementary school. They had very limited verbal and graphic communication capabilities, and an extremely limited conception and understanding of 'their' neighbourhood (Foy, 1991). In addition, there was a lack of neighbourhood information such as social, economic and physical inventories (housing, crime, infrastructure, social services).

Secondly, conflicts were likely to arise among the stakeholders when deciding how the money would be spent over the 3-year disbursement period. These conflicts threatened the process of identifying priorities in the allocation of the redevelopment funds. The conflicts arising out of the initial unstructured participation were of the type that frequently occur in framing a wicked problem—for example, "my street or block is in worse condition than yours" or "redevelopment of commercial areas is more important than parks and residential streets" or "why redevelopment funds for the street and not my house?". It was at this time and for these two reasons that the then Planning Director and the Neighborhood Planner got together with the SIMLab to develop some common languages to help the coalition of neighbourhood interest groups to move forward in their redevelopment plans for Cole.

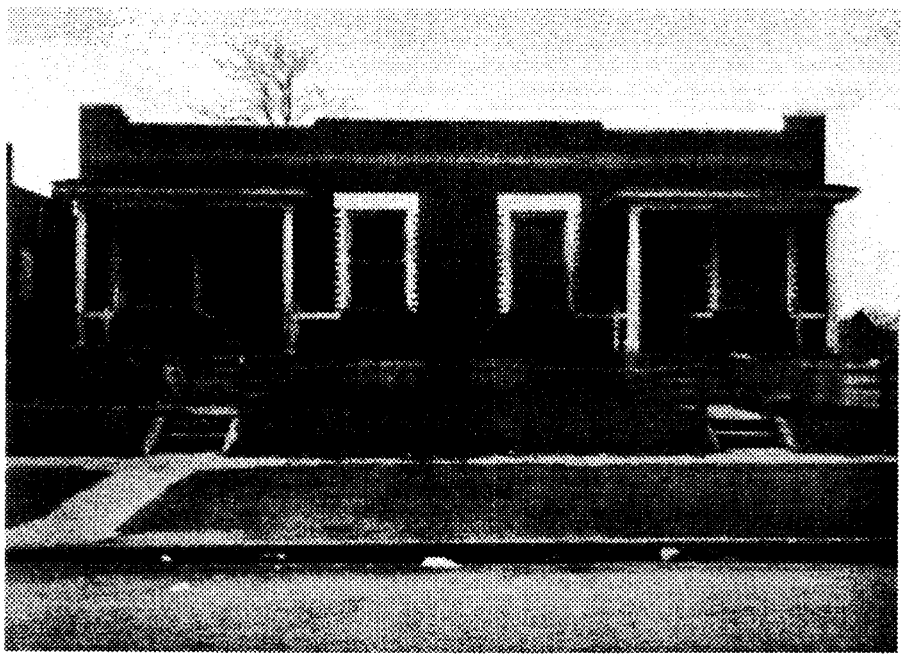

Figure 3. Cole's locational advantage is overshadowed by, among other ailments, its great proportion of deteriorated infrastructure and abandoned housing units.

The Planning Tools and Their Applications

Three major tools were developed for the Cole neighbours to resolve conflicts while planning for the physical revitalisation of public areas, blocks and streets as well as for private property improvement (through a low-interest loan programme). The neighbours called the tools 'the neighbourhood model', 'the street model' and 'the information system' (see Figures 4–9). Development of the models represented a joint effort among the neighbours in the coalition, the Denver Planning and Community Development Department and 13 planning and architecture students at the SIMLab.

The Neighbourhood Simulation Tool. This tool was developed to help the neighbours to strengthen their perception of issues and opportunities distributed over the entire neighbourhood (see Figure 4). Through the experiential use of its vocabularies of 'pieces', as the neighbours referred to the physical elements of the language over the board, the simulation allowed neighbours with different interests and agendas to reach common descriptions and evaluations of the condition of Cole, including zoning and land use, concentrations of crime, vacancies and abandonment or specific condition of housing units, neighbourhood blocks and streets. For example, six neighbours in a 4-hour session would first go over a property-by-property description of Cole. The description represented their distributed understanding of the housing in the neighbourhood. The various types of housing from single-family detached to multi-family attached were described. This description was carried out by using the 'yellow housing' pieces from the descriptive vocabulary. Then, neighbours would start evaluating the neighbourhood in terms of various concerns such as crime, housing condition and abandonment, or land-use incompatibility, among others. Discussions in the evaluative session would be carried out through the model, complemented by other media such as videos, or slides of neighbourhood streets, houses, buildings, and other data provided by the

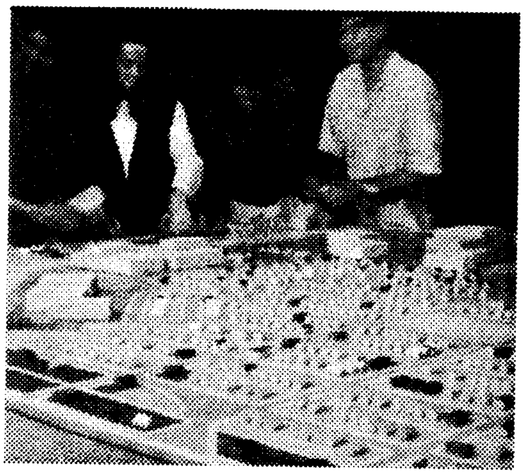

Figure 4. The neighbourhood model: its vocabularies of 'pieces' helped neighbours to visualise and identify neighbourhood-wide needs, and to describe and evaluate their spatial distributions.

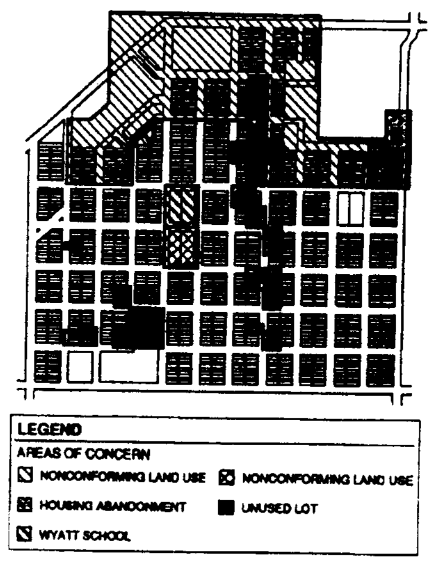

Figure 5. The neighbourhood model enabled the identification of priority areas for redevelopment funding. These were then addressed in more detail with the street model.

Planning Department. Once compromises were reached, neighbours would then place evaluative pieces over the descriptive ones. For example, they would place a 'black roof' piece over the yellow housing piece when such a location was evaluated as being in 'poor condition' or 'abandoned'.

The distributed descriptive and evaluative understanding made it easier for neighbours to visualise the extent and spatial distribution of physical and social problems in 'conflict zones', as the neighbours called them—zones with abandoned structures affording high incidence of crime—and then to identify areas of concern for redevelopment needs such as housing deterioration, street and alley improvements, commercial-zone revitalisation, and improvements to neighbourhood facilities (schools and nurseries, playgrounds, block gardens, public-transit routes, etc.). Thus, neighbours were able to reach informed compromises in funding allocation priorities for intervention (see Figure 5). In addition, this tool provided the coalition with the capability, within limits, of managing neighbourhood change—for example, looking at underutilisation of the built environment and monitoring the concept of the susceptibility to change in the neighbourhood on an ongoing basis (Anselin and Arias, 1983).

Perhaps the tool's most important revitalisation application was that it allowed neighbours to interact with each other and together to visualise the distributions of physical problems both over space,—for example, deterioration or abandonment along a street corridor or in certain blocks versus others—and across the neighbourhood population—for example, safety and crime or household unemployment in terms of socio-economic characteristics). The interaction and visualisation were important in forming the basis for a distributed understanding among neighbours with different interests and in turn facilitated discussions to reach informed compromises as to the identification of redevelopment priority areas for funding to be addressed in more detail by the Street Model.

The Street Simulation Tool. This tool allowed the neighbours to zoom in on priority areas for intervention that were identified by using the neighbourhood tool. Descriptive, evaluative and prescriptive vocabularies were developed for public right-of-ways and

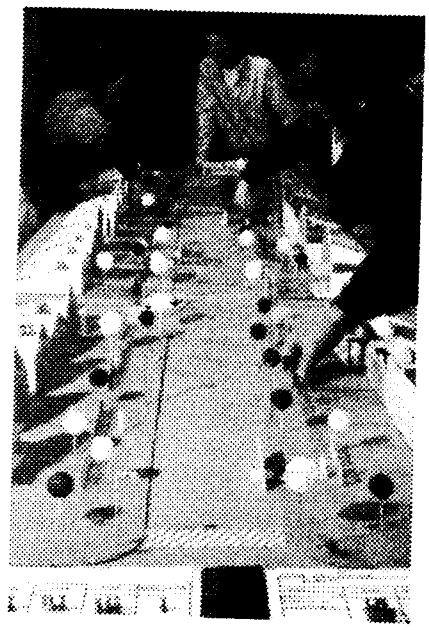

Figure 6. The street model: its vocabularies of 'pieces' helped neighbours to interact and to attain distributed understandings of their street descriptions, together with evaluations of private and public-property needs.

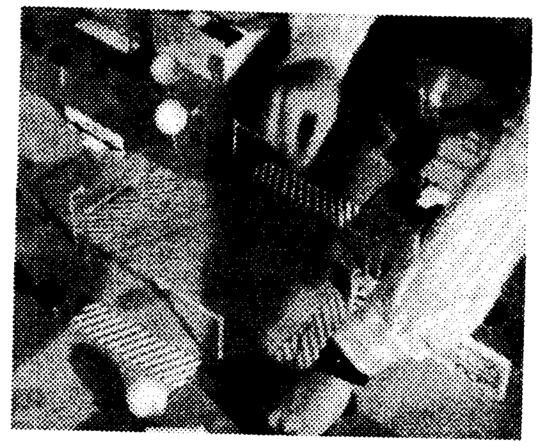

Figure 7. The street model helped neighbours to prescribe solutions such as increasing safety in a major intersection along a commercial district.

private properties (through funding available for both) and for street improvements and private-property improvements (through low-interest loans) (see Figure 6). It allowed neighbours living in the identified blocks to describe in more detail existing conditions along the streets and houses as they knew them. The evaluative elements assisted them in identifying the existence of problems and their intensities distributed over 'their street'. It then supported neighbours in prescribing possible interventions (see Figure 7).

The meaning of the prescriptive elements of the vocabulary included the dimension of costs—for example, the costs of trees, street lights or traffic lights. This dimension then supported trade-offs and trade-backs after neighbours designed their street improvements in an unconstrained manner—i.e. their 'ideal street'. A computer programmed with the implementation costs for all prescriptive elements was part of the simulation tool. As some of the neighbours physically placed elements to address a problem, another neighbour used the computer to keep track of costs. After the ideal street was completed by all the participating neighbours, the neighbour in charge of tallying costs would let the participants know whether their prescribed solution was within budget. If it was not, then a phase of trade-offs and compromises followed until an acceptable solution met the budget.

The Neighbourhood Information System. This computer information system was developed in a coordinated fashion with the neighbourhood and street simulation tools above (see Figure 8). Its purpose was to provide the neighbours with the necessary information to make informed decisions using the simulation tools, and to help them to manage the information generated from the simulation tools. In this manner, the neighbours could use the system over time to build the information base for making and tracking decisions. To ensure usability and usefulness of the system, the tool provided a simple user interface, while a driver linked two powerful yet affordable off-the-shelf programmes—AutoCad 10 and dBase 4—thus giving the neighbours understandable graphic representations of statistical information.

A base map was digitised on a property-by-property basis with the legal property as

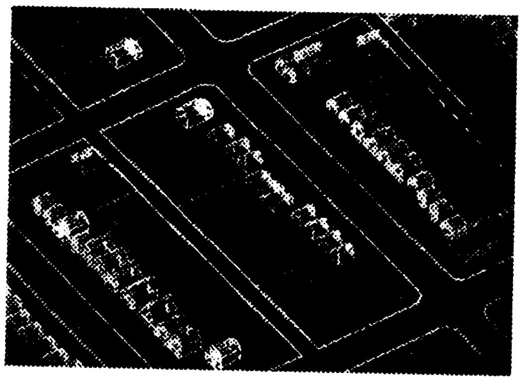

Figure 8. The neighbourhood information system supported the models through data visualisation including the three-dimensional description of building types in a block.

Figure 9. The neighbourhood information system contained information complementing the meaning of vocabulary elements—for example, the definition of poor condition was complemented by a photograph.

its unit of analysis, thereby developing the capability to construct city blocks and larger areas of the neighbourhood through aggregations of these units of information in the database (see Figure 8). In this manner, the system was also correlated to the neighbourhood and the street simulation boards, which were also developed on a property-by-property basis. The units, as semantic objects in the graphic maps, were given meaning by using the data associated with each property in the statistical database—value, land use, proximity to facilities, number of residents, or values of housing condition—as well as in the graphical database—for example, other information complementing numeric data such as photographs of building condition, written text documents, or videos (see Figure 9).

Neighbours could deposit information generated from the other tools on a unit-by-unit basis. They also could retrieve information by searching for all objects with one or more attributes—"show me all houses that are abandoned or valued over $10 000"—or by displaying all attributes of one object—"show me the condition of this property". In this manner, support information in the system's database could be recalled to inform decisions in the simulation tools. It could give meaning to pieces in the vocabulary, such as housing condition (good and poor) by recalling stored photographs, thus enabling neighbours to reach informed compromises of meaning when selecting a piece from the language (see Figure 9).

Development, Deployment and Lessons Learned

To reflect the concerns of neighbours, the design and development of the tools were carried out in collaboration with interested neighbours. Seven neighbours were also trained to use the various tools and all multimedia support systems. Their involvement ensured the grass-roots-participation objective from development to deployment of the tools to the broader group of concerned stakeholders in the neighbourhood (Figure 10). In addition, two members of the Planning Department were trained to use the tools to ensure their continuity and maintenance—for example, maintaining the implementation-cost database in the information system. These efforts were carried out to attain the objective of minimum outside interference and to maximise eventual self-reliance by the neighbours in their revitalisation process.

Several important practical and conceptual outcomes emerged from the experience. Results from the deployment of the models were unfortunately not rigorously maintained. However, the neighbourhood database in the information system was built in a

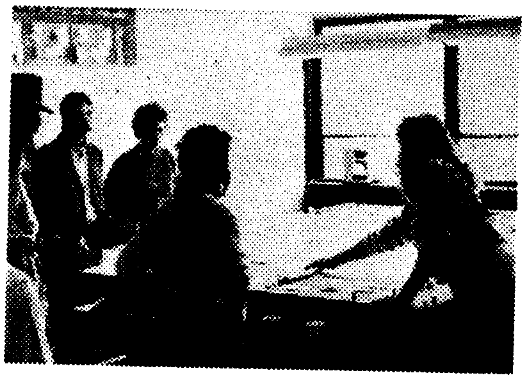

Figure 10. Some outcomes: neighbours learned how to use the neighbourhood model in order to facilitate its deployment with larger audiences in revitalisation sessions.

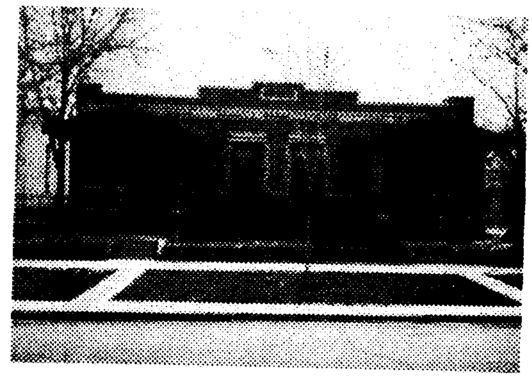

Figure 11. Some outcomes: housing identified in the revitalisation sessions as being in poor condition has begun to be restored through low-interest home-improvement loans.

comprehensive manner as a result of the information generated from the sessions using the tools over time. Additionally, these tools were used educationally by children in various classes in the elementary and middle schools.

Some of the practical results included the identification of neighbourhood high-priority areas that would receive funding over the period of the grant. Neighbours were able to make these decisions by using the neighbourhood model (see Figure 5). Likewise, they used the street model to propose street redevelopment efforts along the public rights-of-way—for example, sidewalks, landscaping, street crossings, lighting, tot-lots and block gardens; and identified candidate private properties for low-interest restoration loans along streets in the priority areas (see Figure 11).

The application and use of these tools was limited after the University's involvement through the SIMLab ceased. This outcome may have been in part the result of too short a period of introduction and support of the approach using the tools. It also was the result of changes in various leadership positions (for example, facilitators) in the coalition after the first 2 years of the project. While the new group had similar commitments, it pursued its objectives through different approaches. Although it would have been interesting to compare the relative effectiveness of these approaches with the games and simulations approach, such assessments were never made. Finally, changes in the planning department personnel took place as the mayor's office changed hands. Since such withdrawals of outside support are inevitable, they should be planned for at the outset.

The use of these models was not tested in any rigorous way, given that different activities were being carried out to attain various objectives within different deadlines—for example, the design of the tools, resolution of conflict, and the supporting of decision-making to prescribe revitalisation actions. However, reflecting on the limited Cole experience, and the experiences with over 60 similar physical planning simulation games, has made us aware of some of their benefits and limitations compared to more traditional, computer-based simulations. As discussed below, both benefits and limitations have pointed us in the direction of integration of computational functionality with these physical tools.

While traditional computer-based simulations rely mostly on predetermined evaluatory aspects and provide limited definitional freedom (in accordance with multicriteria and preference modelling), three-dimensional simulation games provide ample definitional flexibility through the addition of various types of three-dimensional game pieces. Further, even though traditional simulation games are so well defined that they can be conducted entirely on a computer, three-dimensional gaming simulations are played on a physical gameboard, which allows for the placement and replacement of the game pieces as a result of social interaction among participants (Jung *et al.*, 1994). The formalisms required for efficiently representing the dynamics of such interaction in computer environments are lacking (Winograd and Flores, 1986); hence, we cannot (and should not) rely on computer-based simulations alone (Schneider and Arias, 1996). The following features are some of the 'added values' brought about by the real-time social interaction among neighbours, and made possible by the use of three-dimensional gameboards and game pieces.

Continuity of argument. Unlike computer-based simulations, the endowment of game pieces with meaning and the definition and redefinition of rules can take place without the cognitive interruption of a computer and its user interface. For example, as players move and place a piece representing a street light in a particular location, they argue the point that higher levels of illumination at night would make them feel safer as they walk from the bus stop to home. Their oral argument, including subjective factors such as intensity of conviction (emotion) or description of functionality (level of illumination), are complemented by the artifact (the three-dimensional language element) representing the objective factors of the argument (specific location or even higher levels of illumination). This continuity is especially important given recent findings that, even for friendly computer-user interfaces, the added value of real-time modelling and plan evaluation can be lost almost entirely in the cognitive burden of having to 'work' the computer (Reitsma *et al.*, 1996). Similar arguments can be found in a comprehensive review by Landauer (1995) of studies into the usefulness and usability of computers.

Comprehension and retention. For various reasons, the experiential characteristics of selection, placement and replacement of the physical elements facilitate comprehension and retention more than in the case of computational simulation on a screen. For example, in the case of augmenting comprehension, capability to elicit the tacit knowledge of other points of view associated with a problem is greater and occurs more rapidly through face-to-face interaction among neighbours. The language supports the ability to describe, evaluate and prescribe (critical thinking) flexibility and interactively among a neighbour, the tool and other neighbours.

In the Cole experience, after the baseline survey of 115 neighbours, a greater understanding of the boundaries of the neighbourhood was evident in the cognitive maps of 'my neighbourhood' by neighbours who had used the tools than by the ones who had not used them (see Figures 12 and 13). Cognitive definitions of neighbourhood have been studied for some time (Sanoff, 1973; Stea and Blaut, 1972). These definitions have been important to planning because they inevitably structure reality (Huxtable, 1973; Lynch, 1960). Therefore, discrepancies between the cognitive and the political definitions of a neighbourhood are relevant in that their existence represents limits to neighbourhood participation in policy-making processes. For example, these limits can be apparent when addressing neighbourhood revitalisation needs through processes such as the capital improvement programme. In such a process, it is fair to assume that neighbours are less motivated to participate in planning a capital improvement project that is beyond 'their cognitive neighbourhood' than a project that is within 'their cognitive neighbourhood'.

Intuitive understanding. If properly designed, the meanings associated with the physical three-dimensional attributes of the gaming simulation are intuitive. For example, using the colours green, yellow and red for the evaluative vocabulary allows for an intuitive selection of an evaluative element by a

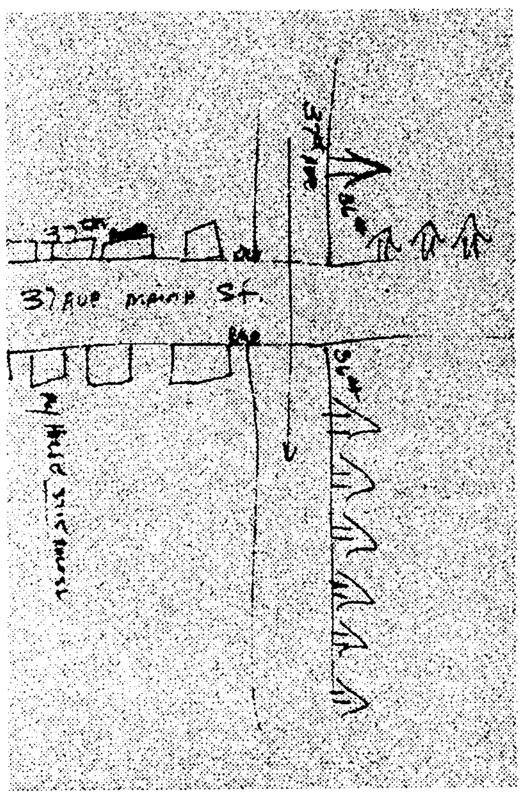

Figure 12. Cognitive map of 'my neighbourhood' from a survey representative of neighbours who did not use the models.

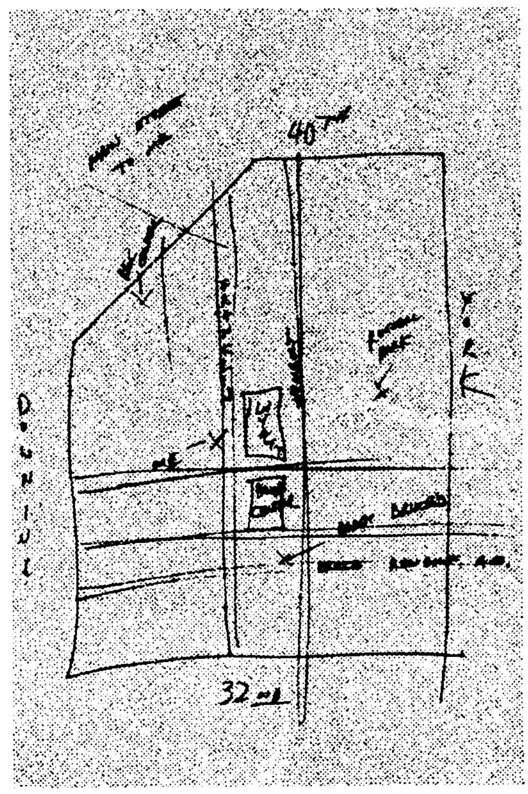

Figure 13. Cognitive map of 'my neighbourhood' from a survey representative of neighbours who did use the models, or who helped as facilitators (Foy, 1991).

player to express agreement, indecision or disagreement within a simulation.

Ease of use. Endowing the three-dimensional physical tools with meaning is something that neighbours can do easily through social interaction with each other. Thus, neighbours can develop a common language of gaming elements which can be easily used to make the selection, placement and relocation of pieces on the gameboard closely follow the arguments and reasoning applied in their negotiations. This attribution is extremely difficult to support with our current set of logic formalisms used for computer representations (Winograd and Flores, 1986).

Conflict resolution, distributed understanding and problem/solution ownership. Taken collectively, the various benefits just described give the tools some advantages over their computational counterparts in the ability to resolve conflict by facilitating discussions and bringing tacit knowledge of problems from the different stakeholders to a distributed understanding from which informed compromises can be reached. In addition, the face-to-face participation capability offered by these tools better affords shared ownership by the players of the solution to the problem and leads to the formation of critical coalitions that support implementation (Schneider and Arias, 1996).

Critique

The development and application of the three-dimensional simulation–games approach have identified great potential in supporting critical thinking and distributed understanding via face-to-face interaction—

both necessary in the resolution of ill-structured problems within contexts of conflict. However, the following several problems are associated with the physical nature of the board games and thus limit their applicability to various aspects and forms of policy-making.

Intrinsic motivation. The games are not self-motivation. For example, in the case of Cole, neighbours' awareness that funding to implement change in their neighbourhood was a reality and that a plan was needed to describe how to use the funds, was probably the major motivation behind the use of the tools. In addition, the neighbours needed the facilitators and leaders to organise the neighbourhood planning effort.

Process vs state information. The dynamic aspects of planning problems—for example, changes in rates and frequency of behaviour in systems such as speed of vehicular flow in streets—are difficult if not impossible to represent with static three-dimensional game pieces. Appropriately to incorporate processes and the dynamic behaviour of many urban systems into the gameboard paradigm, the games must be endowed with computational facilities.

Point vs non-point phenomena. While game pieces can easily represent the location of point phenomena such as a source of light or noise through location over the board, they are not well suited to represent non-point phenomena, intensity and volume. Yet, especially in problems such as safety in neighbourhood streets, such phenomena as volume of traffic are important and hence must somehow be incorporated into the design of a gaming-simulation tool.

Aggregation/disaggregation. The physical tools do not allow flexible aggregation and disaggregation of phenomena and processes. For instance, two separate tools had to be developed to address neighbourhood-wide concerns (the neighbourhood model) and the more specific issues at the block or street level (the street model). Yet, computational functionality such as that found in geographical information systems (GIS) does allow efficient zooming in and out of particular areas, thereby permitting policy-making problems for various levels of spatial aggregation to be addressed.

Quality control. It has become apparent in the various simulations that more efficient ways to record session-generated data than those presently used (filling out forms during sessions with the neighbours and then entering them into computer databases) need to be explored. Lack of efficient quality control and tractability of the negotiation process were observed at times to impede the process and cause confusion as to the past and current state of the negotiations.

Future Developments: A Computational Gameboard

Based on the displayed strengths of the three-dimensional approach and the need to ameliorate its inherent limitations, we are now developing a computationally INTERactive SIMulation-gameboard (INTERSIM) at the Center for Lifelong Learning and Design in Computer Science (Fischer *et al.*, 1995). These efforts have been carried out also in collaboration with the Fraunhofer Institute for Computer Graphics in Darmstadt (Jung *et al.*, 1994). The INTERSIM project has at its core the creation of a prototype to integrate systems that support new paradigms of interaction with simulations—with an emphasis on support for shared interaction to mediate social aspects of learning, design and planning. To this end, it integrates the use of physical objects—to support and encourage face-to-face interaction among the participants—with virtual objects—to provide computational support for the model underlying the simulation (see Figure 14).

Unlike its three-dimensional physical predecessors, the new integrated environment will have capabilities for flexible display of the setting being planned. Different settings can be visualised as overlays on the same

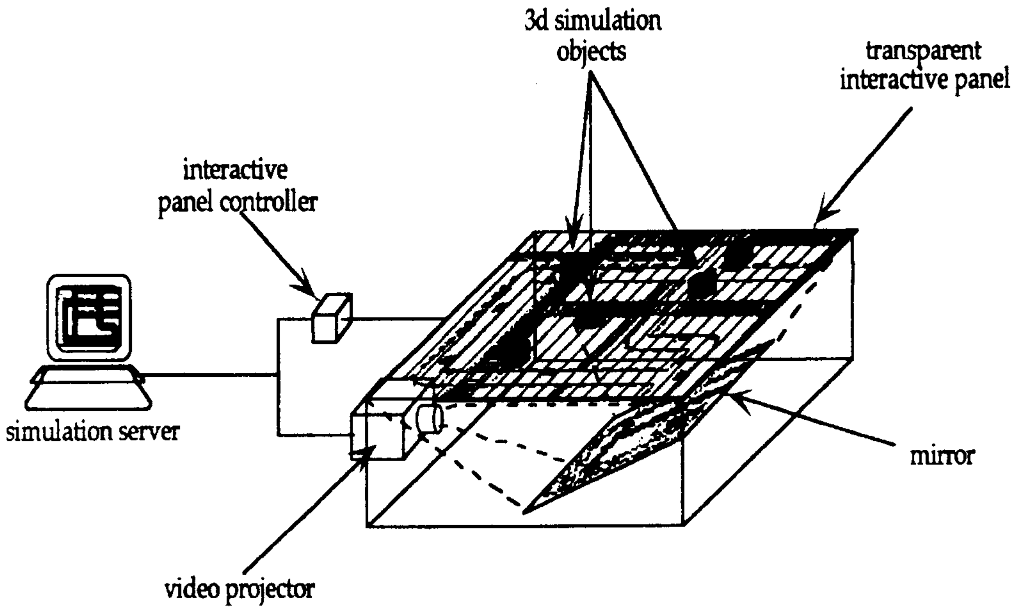

Figure 14. Future developments: the INTERSIM being developed under NSF support combines the advantages of a social interactive approach utilising tactile languages together with computational power.

gameboard monitor—for example, changes from one neighbourhood to another or relocating easily from the whole neighbourhood to a particular block or street within it. Simulations can be controlled and simulation results, and data, visualised through computational windows. For example, consequences for the safety of a street from cars moving at 25 mph instead of 40 mph can be visualised without moving away from the gameboard. Likewise, information can be stored in databases as it is produced during planning sessions. Thus, computational functionality can be integrated into the simulation–game environment to enhance the contributions of the physical simulation–games approach while retaining the games' participatory, experiential and interactive characteristics and ameliorating most of their observed limitations.

Conclusions

This paper has focused on the importance of implementation in relation to planning concerns, such as participation and critical coalitions, and their possible extensions through research. For instance, challenged by such insights, the participatory, experiential and interactive design of the three-dimensional tools described above has allowed users, such as the Cole neighbours, to pursue by themselves the functions of research. If research is to play a role in policy implementation, it must help to define the problem in a way that is amiable to solution; to reduce areas of disagreement; to suggest directions that are consistent with opposing positions, and to determine what the different stakeholders are willing to do to resolve the problem as they perceive it (Grigsby and Rosenburg, 1975).

Further, these insights—when integrated with decision-making and conflict resolution—continue to raise interesting challenges to guide future technological innovation, such as the computational gameboard, for planning praxis. Pursuing such innovations has also made us even more aware that decision-making behind urban planning problems cannot be supported only by tools which reside either totally outside (physical simulation games) or totally inside the computer (virtual simulation games). This understanding has in turn shed light on the development of integrated computational tools for participatory efforts. In this development, we must realise that the real need in the design of supporting systems in planning is for tools which support conflict resolution and implementation by facilitating the integration of the virtual and real worlds, not by translating them into an 'either or' type of support, but rather by providing users with the flexibility to move along this spectrum. That is, a flexibility must exist that will allow for the proper division of labour between both worlds when addressing a particular problem, rather than forcing users to fit the situation to a decision support tool or approach.

References

ANSELIN, L. and ARIAS, E.G. (1983) A multicriteria framework as a decision support system for urban growth management applications: central city redevelopment, *European Journal of Operations Research*, 13, pp. 300–309.

ARIAS, E.G. (1988) *Resident participation and residential quality in U.S. public housing*. PhD thesis, University of Pennsylvania, Philadelphia.

ARIAS, E.G. (Ed.) (1991) The contingent nature of participation and housing research, *Guru Nanak Journal of Sociology*, Special International Housing Policy Issue, 10 (1–2), pp. 81–99.

ARIAS, E.G. (1993) Housing preferences and their intensity, in: E.G. ARIAS (Ed.) *The Meaning and Use of Housing*, pp. 169–199. Vol. 7, Ethnoscapes Series: Current Challenges in the Environmental Social Sciences. London: Avebury.

ARIAS, E.G. (1994) Decision support in locational analysis: an integrated approach, in: S. JOSSE (Ed.) *GIS '94 Proceedings*, pp. 129–143. Wiesbaden: Institute for International Research.

ARIAS, E.G., JACQUART, J., FOY, J. and HOLLIS, D. (Eds) (1990) *COLE neighborhood: a revitalization framework*. Technical Report to Denver Neighborhood Planning Division. College of Architecture and Planning, University of Colorado. Boulder, CO.

FISCHER, G., ARIAS, E.G. and EDEN, H. (1995) *Shared interaction in support of design, learning and planning*. The National Science Foundation, CISE Program Grant No. CDA 9529549. Center for Lifelong Learning and Design, University of Colorado, Boulder, CO.

FOY, J. (1991) COLE neighborhood instruments: research methods final report, in: A. DAVIDSON (Ed.) *Experiential learning of the urban planning process*. SIMLab Working Paper Series, College of Architecture and Planning, University of Colorado, Boulder, CO. (unpublished).

GRIGSBY, W.G. and ROSENBURG, L. (1975) *Urban Housing Policy*. New York: APS Publications, Inc.

GRIGSBY, W.G. ET AL. (1977) *Re-thinking Housing and Community Development Policy*. Philadelphia: University of Pennsylvania.

GRIGSBY, W.G., ROSENBURG, L., STEGMAN, M. and TAYLOR, J. (1971) *Housing and Poverty*. Philadelphia: University of Pennsylvania.

HUXTABLE, A.L., (1973) How we see or think we see the city, *The New York Times*, Section 2, 25 November, p. 26.

JUNG, V., ARIAS, E.G. and GIGER, C. (1994) *Design of integrated decision support tools for sustainable environmental planning*. GRIS 94–3, Technische Hochshule Darmstadt, Darmstadt, Germany. May.

LANDAUER, T.K. (1995) *The Trouble with Computers: Usefulness, Usability and Productivity*. Cambridge, MA: MIT Press.

LYNCH, K. (1960) *Image of the City*. Cambridge, MA, MIT Press.

PALMER, R.N., KEYES, A.M. and FISHER, S. (1993) Empowering stakeholders through simulation in water resources planning, in: K. HON (Ed.) *Water Management in the '90s: A Time for Innovation*. pp. 451–454. New York: ASCE.

PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT (PCDD) (1989) A neighborhood revitalization program for Denver's bond funds, in: MAYOR'S OFFICE (Ed.) *Explanation for Bonds*. pp. 1–5. Denver: Planning Department.

PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT (PCDD) (1990) Proposed COLE revitalization program, in: MAYOR'S OFFICE (Ed.) *Denver's Summary Report*, pp. 1–6. Denver: Planning Department.

REITSMA, R.F., ZIGURS, I., LEWIS, C. ET AL. (1996) Experiment with simulation models in water resources negotiations, *ASCE Journal of Water Resources Management and Planning*, 122, pp. 64–70.

RITTEL, W.J. (1984) Second-generation design methods, in: N. CROSS (Ed.) *Developments in Design Methodology*, pp. 317–327. New York: John Wiley & Sons.

RITTEL, W.J. and WEBBER, M.M. (1984) Planning problems are wicked problems, in: N. CROSS (Ed.) *Developments in Design Methodology*, pp. 135–144. New York: John Wiley & Sons.

SANOFF, H. (1973) Youth's perception and categorizations of residential areas, in: W.F.E.

PREISER (Ed.) *Environmental Design Research, Vol. 1*, pp. 127–136. Stoudsburg, PA: Dowden, Hutchinson and Ross.

SCHNEIDER, K. and ARIAS, E.G. (1996) Support for wicked planning problems: an integration of real and virtual stakeholders in planning simulations and games. Paper submitted to *Simulation and Gaming Journal*.

SIMON, H.A. (1981) *The Sciences of the Artificial*. Cambridge, MA: MIT Press.

STEA, D. and BLAUT, J.M. (1972) *From city models to model cities: theory and research on the growth of environmental cognition*. Paper submitted to the *Symposium on Conceptual Issues in Environmental Cognition*. EDRA, Los Angeles.

WINOGRAD, T. and FLORES, F. (1986) *Understanding Computers and Cognition: A New Foundation for Design*. Norwood, NJ: Ablex Publishing Corporation.