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Interactive Simulation of Urban Environments over Time with Respect to Human Values

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1 ABSTRACT

The private and public sectors try to expand the scope of decision-making In return for a reduction of uncertainly concerning the decision- making environment. In many cases, neither planners nor citizens have sufficient information about how the various alternatives will play out over the long term and This represents a gap in informed decision making. Sophisticated urban simulation models can support such analyses by predicting the long-term effects of alternative policies. Again a simulation approach may be used to help professional as well as participant planners in learning about the problems they are facing and the available methods for dealing with them, and In providing relevant information about the external environment. But data is not the only element of effective democratic decision making. In a democratic society, public deliberation by citizens and their elected representatives must precede such major decisions. While urban simulation systems have been investigated for many years, do not simulate detailed interactive aspects. Instead, they use regular grids as spatial data structure. To better support the use of urban simulation systems in public deliberation, it is intended to design tools to support urban planners, citizens, and other stakeholders in their interaction with today urban indicators. The development of these tools is guided by Value Sensitive Design, theoretically grounded approach to technology design that accounts for human values throughout the design process. It is intended to introduce a simulation system for 4D cities that can simulate interactive three-dimensional urban environments over time. The main novelty of this research is that it does not rely on land-use simulation on a regular grid, but instead present a complete and inherently interactive simulation that includes visualizing alternative futures of urban environments as change over time. To meet these goals, technical documentation designed, indicator perspectives and household indicators are refined to help a variety of stakeholders, planners, modelers and citizens.

2 INTRODUCTION

Regional officials, urban planners, and citizens must grapple with issues such as traffic jams, resource consumption, and urban sprawl. Decisions about new freeways, transit service expansion, or land-use regulations are often controversial and expensive, with long-term consequences. Simulation is a technique for representing the workings of a complex system such as the governmental activities of a large city or the total economy of a multi-county region. Planning applications of simulation models will vary with the style of planning. Simulation models provide scenarios and projections of what is likely to happen. In policy planning limiting factors in local and regional change are identified and alternative approaches for moving away from an unsatisfactory social or economic situation are devised and tested.

Decision-makers must attempt to understand how different alternatives might affect land use, transportation, and environmental impacts over the next several decades. Without carefully considering longterm effects, the chosen alternative might lead to the exact opposite of the original goal. Because these decisions will affect the entire region for many years, it makes sense to inform decision making with long-term analyses that are as accurate as possible. Sophisticated urban simulation models can support such analyses by predicting the long-term effects of alternative policies. But, in regarding to the effective democratic decision making in a democratic society, in addition to providing accurate information, a design goal for an urban simulation system should also be able to facilitate public understanding and citizen engagement.

Participant planning refers to community forms of decision making which can involve neighborhoods, cooperatives or voluntary organizations. Spatial contiguity of individuals in the participant style of planning is an important, though not necessarily essential, requirement. Again a simulation approach may be used to help professional as well as participant planners in learning about the problems they are facing and the available methods for dealing with them, and in providing relevant information about the external environment. Value Sensitive Design is a theoretically grounded approach to technology design that

accounts for human values, such as privacy, fairness, and democracy, throughout the design process. The method has three key features: an interactional perspective, attention to indirect as well as direct stakeholders, and a tripartite methodology. An interactional perspective views values as stemming from a symbiosis of technology and social forces: People and social systems influence technological development, while technologies shape individual behavior and social systems.

To better support the use of urban simulation systems in public deliberation, tools are designed to support urban planners, citizens, and other stakeholders in their interaction with Urban Simulation indicators. The development of these tools is guided by Value Sensitive Design. To meet these goals, three tools are refined to help a variety of stakeholders planners, modelers, citizens: technical documentation designed to make information about indicators readily accessible; indicator perspectives that provide a platform for organizations to advocate for the use of particular indicators in decision making; and household indicators that let citizens look at simulation results from the viewpoint of their own household within the region.

A simulation system is presented that can simulate a three-dimensional urban model over time, which does not rely on land-use simulation on a regular grid, but instead builds a complete and inherently interactive simulation that includes variety of democratic society aspects. While urban simulation has been investigated for many years, even micro-simulation systems such as UrbanSim (Waddell.p,2002-2003) do not simulate detailed social aspects. Instead, they use regular grids as spatial data structure. Each grid cell represents a collection of households and businesses, but no social features is simulated. Including detailed urban community in an urban simulation is aimed. This will allow to create 4D cities i.e. interactive three-dimensional urban environments that change over time.

3   CHALLENGE OF URBAN SIMULATION INDICATORS

One of the most famous urban simulation system which is widely used,UrbanSim, is a complex software system that models a region's urban processes over the next several decades. The system takes hours to run, resulting in a massive database that contains detailed information about the region's households, jobs, travel routes, and real estate in each simulated future year. Our indicator tools aim to help stakeholders extract useful information from this very large database. UrbanSim currently supports 55 indicators for extracting information from simulation results, and one of our goals in the indicator tools is to support urban planners in developing new indicators for their particular region. Presenting simulation results with a consistent set of indicators for all the candidate policy alternatives can greatly enhance scenario assessment and comparison.

Most UrbanSim models are discrete-choice models, in which the probability that a given agent will make a particular choice is a function of a set of variables that measure the relative attractiveness of that choice. For example, in a residential location, the probability that a particular household will choose to locate to a residential unit within a particular area depends on household attributes, such as income and number of children, as well as attributes of the potential dwelling, such as cost and location. An external travel model simulates trips between the locations of various households and jobs. The resulting patterns of transportation use and congestion then give rise to accessibility measures for different locations, which in turn influence the desirability of these locations for housing or jobs.

So, User-centered design methodologies focus their attention on direct stakeholders, those who actually use the system.Value Sensitive Design emphasizes consideration of indirect stakeholders as well, those who do not use the system but are affected by its use. For UrbanSim, direct stakeholders are urban planners and modelers; indirect stakeholders include the residents of the region being modeled. Part of the UrbanSim vision is to empower indirect stakeholders to become direct stakeholders to let citizens interact directly with UrbanSim's output, and ultimately to run different simulations themselves. Finally, the tripartite methodology consists of conceptual, empirical, and technical investigations.The application of these investigations is both interactive and integrative; results from new investigations build on and integrate earlier ones. As part of supporting a democratic society, it is decided that the system should not a priori favor or rule out any given set of stakeholder values, but should allow various stakeholders to articulate the values most important to them and to evaluate alternatives in light of these values (Davis.j et al,2006).

4   VALUES IN DEMOCRATIC PLANNING

Commitment to three core values helps Urban Simulation achieve the goal of supporting democratic urban planning: democratic engagement, freedom from bias, and political legitimacy.

4.1 Democratic engagement

Democratic urban planning requires that citizens be engaged in decision making. While acknowledging that engaged citizenship is not simple to characterize. A democratically engaged citizen is one who participates in civic and political life, and who has the values, attitudes, opinions, skills, and resources to do so effectively (Carpini.M.X,2004). To foster engaged attitudes, consistent opinions, and enthusiastic participation, a planning system must provide information about the issues that form the substance of political life. Urban simulation helps fulfill that requirement by providing information about the potential impacts of land-use and transportation alternatives a major political issue. But providing information is not enough. Citizens must want to use it. Through urban simulation, it is intended to seek to foster such democratic engagement, not only to help citizens make more informed decisions, but also to encourage an attitude that can lead to participation in public decision making. Information systems, such as online discussion forums or tools for citizens to propose new policy and investment packages, for example, could provide new opportunities for citizen participation in urban planning. Of course, systems such as UrbanSim supplement not replace informal discussions, town meetings, and voting.

4.2 Freedom from bias

It is refered to bias in computer systems as computer systems that systematically and unfairly discriminate against certain individuals in favor of others (Friedman.B and Nissenbaum.H,1996). A system discriminates unfairly if it denies an opportunity or a good or if it assigns an undesirable outcome to an individual or a group of individuals on grounds that are unreasonable or inappropriate. To warrant the term biased, then, discrimination must be both systematic and unfair. Freedom from bias was first identified as an explicitly supported value, on that it was intended to support the simulation, because it is a moral good in itself. However, there are other reasons to support this value: Freedom from bias is instrumental in providing an equal opportunity to participate in a democratic society; stakeholders whose concerns are represented in the system could have a privileged place in deliberation relative to those whose concerns are not represented.

4.3 Political legitimacy

UrbanSim's legitimacy is crucial for its effective use in urban planning. Unresolved disagreements about its legitimacy might disenchant some stakeholders or cause the agency to stop using the system. The conceptual investigation of political legitimacy draws primarily on the work of Jürgen Habermas. The use of modeling software is just one part of the planning process, and even the best-designed system could be used in a process lacking in legitimacy. Because most factors are beyond control, it is focused on the modeling system's "legitimation potential" rather than the legitimacy of the entire decision-making process (Habermas.J,1979). Communicative action plays a key role in legitimation potential. Habermas defines communicative action as speech in which all parties aim for mutual understanding without manipulative or strategic designs. In communicative action, each utterance raises four validity claims, which they have been mapped to testable design goals. Achieving these goals helps establish urban simulation's legitimacy.

- Comprehensibility: Can a wide range of stakeholders understand the information provided?

- Accuracy and transparency: Are the models and data a reasonable representation of reality? Are the inner workings and design of urban simulation transparent to stakeholders so they can assess its accuracy?

- Clarity of intent: Is the intent behind the information, to advocate for a particular position, or to provide relatively neutral, factual information, clear to the users?

- Appropriateness with respect to values and norms: Is the information relevant to the stakeholders' values in the decision-making context? Although comprehensibility, accuracy, transparency, freedom from bias, and relevance to decision making are not new goals for operational models,(Fleischmann.K.R and Wallace.W.A,2005) trying these goals to the potential for achieving legitimacy helps us understand their significance for models that must support democratic decision making.

5 INTERACTIVE DESIGN OF URBAN SIMULATION INDICATORS

Part of our work described in this article is intended primarily to create an interaction design around urban simulation indicators through technical documentation, indicator perspectives, and household indicators.

5.1 Technical documentation

Technical documentation in being set to provide comprehensible, useful, factual information about the indicators to urban planners and other stakeholders, with an eye toward minimizing both actual and perceived bias (Winograd.T and Flores.F,1986). Feedback from urban planners, modelers, and policy experts has led to standardize the technical documentation for each indicator to consist of eleven sections, including (among others) its name, an informal definition, a more formal specification, known limitations, and advice for interpreting results. The technical documentation also includes the Structured Query Language (SQL) code used to compute the indicator from databases of simulation results, as well as input and expected output for a unit test to check the code's correctness (Borning.A et al,2005). Through interviews in which the planners interacted with this system, it has been obtained that they required much less time to complete each of four tasks using the technical documentation as compared with their current work practices. This result is evidence that the information fragmentation problem in terms of both consolidating information and making it readily accessible has been solved at least partially. This in turn would improve task performance by increasing comprehension and making indicator evaluation more meaningful. The results also supported our hypothesis that including live SQL code, unit test information, and limitations increases indicator transparency and comprehensibility.

5.2 Room for advocacy

In formative evaluations of design for technical documentation, much of the strongest feedback was about neutrality. Earlier documentation versions included a section describing the desired direction of change for the indicator. Given the goal of democratic urban planning, having stakeholders advocate values and put forth opinions is an essential and integral part of the overall process, not an inconvenient blemish on an otherwise clean technical exercise. In order to enable stakeholders to use indicators to represent and express their views, yet maintain the informative role of technical documentation, one solution is to construct indicator perspectives, which stakeholders can use to tell a story and advocate particular values and criteria for evaluating outcomes. In keeping with emphasis on fair representation, it is needed to choose partners that cover a range of views. Thus, it is logical to provide opportunities for broader involvement, actively soliciting partners as needed to ensure that the perspectives cover a wide range of political views and economic interests. Preliminary results of examining this hypothesis confirm that the indicator perspectives framework is indeed useful in advocating for specific views and values and will be a valuable source of information about urban simulation indicators.

5.3 Personal touch

While indicators such as population density and total vehicle miles traveled are familiar to urban planners who monitor or model regional trends, such aggregate measures are probably less compelling to citizens not well versed in urban planning. To reach these citizens, household indicators are created that show how policy alternatives could affect their own households (Davis.J,2006). Through such indicators, It is considered to encourage citizens to become involved in evaluating the impact of transportation and land-use choices. On the basis of this information, the application answers questions the users might pose: Where could I afford to live in the region? How long would it take to get to work? How long would I have to travel to get out of the city? Initial user study results support the hypothesis that citizens can more readily understand household indicators because they can compare such indicators directly to living, working, and getting around. Household indicators also aim to engage citizens by showing them how policy decisions could affect their lives in the long term. Earlier work on the technical documentation aimed to provide comprehensible, accurate, transparent, useful and relatively neutral technical information to urban planners. Household indicators, in contrast, focus on providing information that is comprehensible to citizens and clearly relevant to their own lives. However, commitments to accuracy, transparency and freedom from bias remain. In meeting accuracy commitment, it is intended not to oversimplify to enhance comprehensibility. The commitment to transparency presents the challenges of conveying uncertainty in simulation results and having results explanations at hand when questions arise.

6   INTERACTIVE SIMULAION RESULTS

Virtual worlds can be achieved by simulating time-depended phenomena such as urban growth, transitions in land use, changes in building density, changes in the wealth and cleanliness of urban neighborhoods, and changes due to transportation policies or infrastructure. Urban simulation can be made more comprehensible by visualizing alternative futures of urban environments. One of the approaches to tackle the problem is to make the simulation inherently interactive. In order to show how to use urban simulation as an efficient modeling tool for nowadays democratic communities, it is necessary to answer that how to model the three-dimensional geometry of urban environments as it changes over time due to the democratic society and human values. Evaluating that how urban planning applications can benefit from more detailed simulation can be as a concept of future works. The main contributions of this research is to extend previous procedural urban modeling methods by entering human value features appropriate for changing cities over time. Instead of creating a single static city, a sequence of urban configurations can be created at interactive speed that can be edited during simulation. The results of interactive simulation will be expessed here in three categories of making 4D image for future, achievement of democratic view in planning and coordination between planning and design.

6.1 Making 4D image for future

System of interacting urban simulations are applied due to the complexity of urban environments, while previous work in simulation uses drastic geometric simplifications and aggregation. For example, UrbanSim uses grid cells with a side length of 150m. While this is considered a micro-simulation it produces a gridded output and is still at a scale that does not capture any interesting visual geometric details for threedimensional urban visualization considering human values. The major challenge of this design is to integrate various components into a coherent framework and to make sure that all necessary quantities are simulated. Comparison to computer graphics simulations, While there is some initial work in urban simulation, the existing attempts are not developed far enough to be competitive. The main difficulty of such a large simulation system is to find a useful set of parameters to produce simulations of high quality by regarding to social values. Two series of simulations are shown in the columns in Fig.1. The left series shows the transition from low density to high density by considering physical elements. The right column shows a simulation for a transition of a city based on social values and sustainable development features such as sufficient green areas.
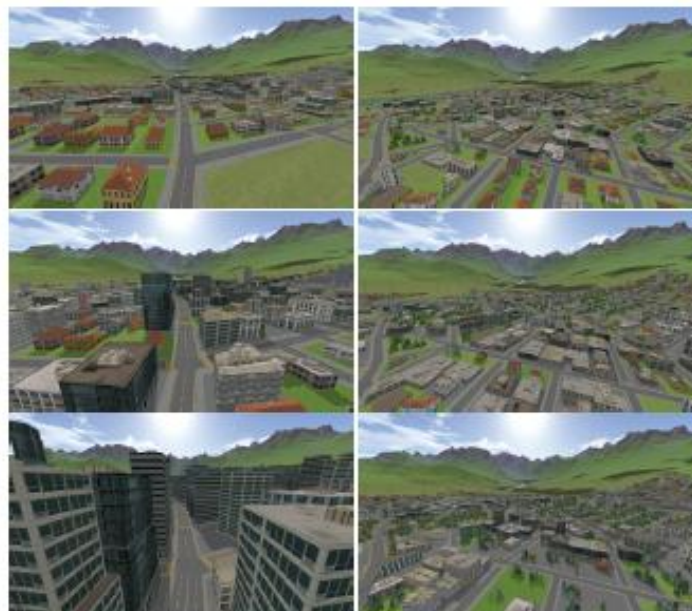

Fig. 1: The left series shows the transition from low density to high density by considering physical elements. The right column shows a transition of a city based on social values and sustainable development features (Weber.B et al,2009).

6.2 Achievement of democratic view in planning

Optimistic theorists have commonly argued that increased participation in democratic deliberation will produce better decisions, a more legitimate system, and a more sympathetic and public-spirited citizenry.

However, researchers have found little evidence to support this wishful thinking; indeed, the evidence indicates that participation in problematic processes will as easily produce cynicism, distrust, and a widespread desire to avoid being required to participate in political decision making processes at all. People are most interested in a process of governance that is usually invisible, with opportunities for imposing accountability when citizens feel the need. What people really want is for participation to seem unnecessary.

If citizens are to learn to engage in an effective democratic process of debate and compromise, they need to recognize that experts can disagree over goals and strategies in areas where there are value-driven choices to be made. They also need to be convinced that "details matter" when considering alternative approaches to important issues, and that details can matter for reasons that transcend particular interests. In other words, the process of deliberation and decision making, with its detailed considerations, needs to be explicitly oriented to substantive concerns.

This is precisely one of the ways that a design-centered process can make a difference, at least in so far as the design process is a careful study of the ways that details can matter, and to the extent that the public can be engaged in this process. Discussions of the importance of design have tended to get caught up in the issue of whether design can cause changes in social behavior. This is a misleading question, however, because design is already social action. Places are not just containers for social life, but themselves social accomplishments, things we do together, with more or less coherence, purpose and self-consciousness.

Design matters first and foremost because it is a practice of organizing our intentions in a series of explicit decisions concerning those qualities of the world we choose to recognize as significant. Urban design may matter most to the extent that its "logic of action" is shifted from a practice of creating visual and social effects by manipulating urban form to a practice of engaging others in the cooperative game of place making. Conceived in this way, urban design can link the sustained collaboration that gives coherent and meaningful form to diverse, complex places to a capacity for democratic self-government and the inclusive, vital, and open-ended quality of democratic culture.

The neighborhood provides a concrete image of a combination of uses into a "balanced mix" relevant to the practical geography of everyday life. The neighborhood unit is not just a nostalgic image, but a paradigmatic representation of the core value of urbanism as a particular normative condition: the extent to which each house, each project built in a community, contributes to the completion of a street, neighborhood or town; to the achievement of emergent possibilities; to a history that gives the place depth and meaning; and to the richness, variety, amenity, functionality, and pleasure of a shared world. Ideally, this is to be achieved not by the hand of a single designer emulating historic cities or working scenographic effects, but as the cumulative effect of individual projects of diverse architectural type and stylistic expression as an open conversation and not simply a scripted dialogue. Even as the mix of uses in a place changes, even as unpredictable social changes take place, the distinctiveness and quality of the place can be maintained.

In order to emphasize on the importance of moving from the scale of the lot and block to the scale of the region, the idea of a rural-urban transect offers a way to think analytically and systematically about neighborhoods, cities and regions as ecologies of diverse places in a way that makes explicit connections between issues of form, scale, geography, and social experience. The transect organizes empirical description of real places as built, experienced and lived, using a typological analysis that moves from the finest level of detail to the regional interlacing of human settlement and natural ecosystems. The gradient from rural to urban encompasses variations in the relationship between human settlement and natural conditions; in the articulations of public and private life; and in spatial morphology and building typologies associated with interconnected variation in managing relations of humans with each other and with nature.

As a transect-based analysis thus highlights ways that form matters at every level of scale, urban design acquires a clear purpose as a practice aimed at realizing the formative aspirations of a community. One of the key components in the production of urbanism is time and the expectation that no planner or designer completes the process, only provides conditions for a collaboration that includes not only current stakeholders but future cohorts. Emphasis on form-based coding is one way to create a framework for the collaborative capacity necessary to sustain certain qualities of place over time, elevating common practice to a consistent level while not constraining either excellence or individualizing impulses. Any design intervention can be regarded as contributing to the history of the place, and as participating in an open-ended but still coherent, goal-oriented process. Urban design becomes a medium in which civic connection can be

manifested in tangible form. At the same time, this also implies that a community has the political capacity to sustain the realization of a coherent urbanism, and come to terms with real divisions and conflicts in the community as it articulates a shared vision (Brain.D,2006).

The idea of a transect thus enables urban designers to build a place-making toolkit out of precise community analysis. A transect-oriented planning process can frame the issues in terms of an articulated range of interconnected differences, establishing the ability to debate each decision in terms of principles operationalized at different scales. To put it simply, it allows us to understand each building, development project, or design decision as tied not just to individual utility but to a process for sustaining place value.

In the context of design-centered public process, such analysis can become the scaffold for effective public discourse, enabling citizens to learn what is at stake if a particular decision were to be codified. Citizens can make clear and principled decisions about what goes appropriately where, avoiding absolute prohibitions in favor of the question of where something might actually contribute to the emergent quality of a place. The combination of analytical clarity and the flexibility of a system of transformation rules enables a continually improvised urban order, reflecting not just the vagaries of the market or the randomly aggregated aspirations of individuals, but a civic sensibility that infuses each individual project with a sense of responsibility for a positive collective outcome.

6.3 Coordination between planning and design

In spite of the expansion of participatory opportunities over the last couple of decades, ultimately the form and character of urban development is determined by developers' ability to work through a highly politicized and unpredictable regulatory process with their bottom line intact. The conventional planning process often produces documents that are little more than summaries of vaguely defined goals, transcriptions of public comment, and broad policy recommendations generally leaving implementation to the vagaries of negotiation between marketoriented entrepreneurs and bureaucratic regulators. Meanwhile, the low-density, automobile-dominated patterns built into current zoning ordinances, subdivision regulations, and conventional traffic design standards become the path of least resistance through the regulatory gauntlet. In a sense, the more "democratic" the public process seems to be, the less genuinely democratic the process of shaping the future of our communities has actually become. The conventional development regime has the effect of literally dis-placing politics, both in the sense that politics are removed from whole arenas of technical decision making, and in the sense that the politics of land use come to be increasingly about technical issues, rather than about the qualities of place.

Emphasis on a design-centered process has been reflected in the practice of allowing the public to engage the specific decisions about urban and architectural form in the context of a charrette, and broad efforts to establish a clear and collaboratively produced vision. This is not to say that simply proposing an urban ideal will bring about a revival of civic life, much less resolve all the challenging issues of social justice and democratization. There has not been explicit recognition of the ways that might more systematically engage the broader movement of civic innovation oriented to democratization, social justice, and environmental responsibility. Nor have the advocates of social capital and civic engagement generally recognized the potential importance of urban design.

Designers and planners generally need to work with a more sophisticated understanding of the conditions and possibilities of democratic politics. We need to get past the naïve notion of democracy that makes us think that a process becomes more democratic simply by including more people in the meetings. In practical terms, communities need to build civic capacity around an understanding of the complex forms of human settlement, not simply as the reflex of market activity or the unintended consequence of regulatory policy, but as a clear and purposeful reflection of a democratically constructed vision. Designers and planners need to face up to the political challenge implied in such a goal (Brain.D,2006).

The shaping of the urban environment needs innovative solutions like those that have emerged over the last

decade in connection to issues like watershed restoration and environmental justice. A design-centered and transectbased approach offers the possibility of a planning process capable of enabling effective engagement and constructing a sense of collective responsibility across even deep social and political divisions. At the same time, civic groups need to understand that cities might be made better on purpose, but that to accomplish this we need to get past the reduction of urbanism to social and economic functions apparently

beyond our control and understand the ways that design can matter as a medium in which to recognize, articulate and realize civic aspirations.

7 CONCLUSION

The following research aimed to inform public deliberation and decision making about major effects of entering human values in the process of urban simulation for a democratic society in order to support citizen discussion and comment. All these efforts are part of an overall agenda: to better support informed public deliberation and democratic engagement in the urban planning process. Our application of this method has led to five interaction design goals:

- Improve the system's functionality by developing new tools for stakeholders to learn about, select, and visualize indicators to use in decision making.

- Support citizens and other stakeholders in evaluating alternatives with respect to their own values.

- Enhance the system's transparency with respect to its design, assumptions, and limitations, so it is not a black box.

- Contribute to the system's legitimacy by providing information that is credible and appropriate to the use context.

- Foster citizen engagement in the decision process by providing tailored information and opportunities for involvement.

As a result it was demonstrated that the output of the interactive simulation can be drastically improved compared to previous work opening the door to new applications of urban planning.

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