Laying the Foundations for Public Participation and Value Advocacy: Interaction Design for a Large Scale Urban Simulation

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ABSTRACT

Supporting public participation is often a key goal in the design of digital government systems. However, years of work may be required before a complex system, such as the UrbanSim urban simulation system, is deployed and ready for such participation. In this paper, we investigate laying the foundations for public participation in advance of wide-scale public deployment, with the goal of having interaction designs ready when the system is put into such use. Moreover, in a highly politicized domain such as this one, value advocacy as well as factual information plays a central role. Using the theory and methods of Value Sensitive Design, we address three design goals toward public participation and value advocacy, and provide evidence that each of them was achieved: (1) enabling indirect stakeholders to become direct stakeholders (i.e. enabling more people to interact directly with UrbanSim in useful ways); (2) developing a participatory process by which these stakeholders can help guide the development of the system itself; and (3) enabling participating organizations to engage in value advocacy while at the same time enhancing overall system legitimation.

Categories and Subject Descriptors

H5.3. **[Information interfaces and presentation]**: Group and Organization Interfaces—*Evaluation/methodology, Theory and models.*

General Terms

Design, Human Factors.

Keywords

Human values, value advocacy, bias, conflict, democratization, legitimation, direct and indirect stakeholders, simulation, urban development, public participation, Participatory Design, Value Sensitive Design

1. INTRODUCTION

Supporting public participation is often a key goal in the design of digital government systems for use in the public arena. Yet for complex systems, the development of the back-end components may require significant time – on the order of years – before they are ready to be made available for use by citizens and relevant organizations. Such efforts face a common problem: when and how should the interaction design be undertaken to support public participation for such systems? On the one hand, waiting until the system is fully functional and ready for operational use makes sense, since it allows designs for participation to be pursued and evaluated using real-world pilot projects. But waiting makes it more difficult for requirements for public participation to impact the development of the back-end system; in the worst case, waiting could result in support for public participation being simply painted on top of a complex system for which functionality had already been determined. On the other hand, pursuing the development of public participation tools earlier affords such an opportunity, although not in actual contexts-of-use with a deployed system. Further, how to do such early design and development well remains an open question.

We present the results of pursing the second option – of laying the foundations for public participation at the same time the back-end for a large-scale system was being developed – in the context of simulations to support urban planning. In many regions throughout the United States and worldwide, there is great concern about such issues as traffic congestion, resource consumption, lack of sustainability, and sprawl. Elected officials, planners, and citizens grapple with these difficult issues as they develop and evaluate alternatives for major land use and transportation decisions, such as building a new rail line or freeway, establishing an urban growth boundary, or changing incentives or taxes. UrbanSim, on which we base much of the work reported here, is a simulation system for projecting the long-term impacts of such alternatives. Results from UrbanSim simulations are presented in the form of indicators. The overall goals of the alternate plans, and which impacts are particularly important to consider, are reflected in the choice of UrbanSim indicators and how they are described and interpreted.

Moreover, in a highly politicized domain such as urban planning, value advocacy as well as factual information plays a central role. Yet how to support both without undermining the overall legitimacy of the system is a difficult problem.

Within this larger framing, the work reported here addresses three specific design goals. First, we sought to enable indirect stakeholders to become direct stakeholders. We focused our work on relevant organizations and developed the Indicator Perspectives Framework, a structure that enables different partner organizations to present their own perspectives on which indicators are most important and how they should be interpreted. Second, we wanted to create a participatory process

by which these organizations could influence the choice of and priority with which new indicators were to be developed. Third, we sought to enable the participating organizations to engage in value advocacy while at the same time enhancing the overall legitimation of the system. To do so, we appropriated and extended a design pattern that balances factual information with advocacy. We then evaluated our design through a user study with engaged citizens.

2. RELATED WORK

In this section we first provide more detail about the domain of urban simulation and the particular system we are developing. Second, we describe prior work on Value Sensitive Design, which provided the theory and methods for our work. Finally, we survey some related work in participatory design and explicate how we integrated aspects of participation.

2.1 UrbanSim and Indicators

UrbanSim [6], [27] is a simulation system for projecting the impacts of alternative policies and transportation infrastructure projects over periods of 20-30 years. It is implemented as a set of interacting component models that simulate different actors or processes within the urban environment. The system is open source, and freely available for download from the project website at http://www.urbansim.org. To date, it has been applied operationally in Houston, Texas, and is being transitioned into operational use in the Puget Sound region in Washington State (Seattle and surrounding cities), and in Salt Lake City, Utah. The UrbanSim group has also worked with other agencies in applying UrbanSim in the urban areas around Detroit, Eugene, Honolulu, and San Francisco. There have also been research and pilot applications in such diverse regions as Amsterdam, Burlington, Durham, El Paso, Melbourne, Paris, Phoenix, Tel Aviv, and Zurich.

Indicators provide the principal means for presenting UrbanSim simulation results to the users so that the results can be assessed and compared [8]. As used in the planning literature [18], an indicator is a variable that conveys information on the condition or trend of an attribute of the system, taking on a specific value at a given time. Examples of indicators in UrbanSim include the population density in different neighborhoods, the ratio of car trips to bus trips for the region, and the projected cost of land per acre in different parts of the region, each under different possible scenarios and for 30 successive years. Indicator values may then be displayed as tables, graphs, charts, or maps.

2.2 Value Sensitive Design

In the tradition of careful consideration of human values in the design of technology (e.g., [28], [29]), Value Sensitive Design provides a principled and systematic means for considering human values proactively throughout the design process [13], [16]. Value Sensitive Design and closely related theory and methods have been used successfully to conceptualize value tensions and corresponding design trade-offs in information systems [16], [23], to understand the value-oriented user experience of specific technologies [17], [22], and to design new or redesign existing technologies in response to value analyses and user experience [5], [11], [23], [25]. Stakeholder analyses are central to Value Sensitive Design. Both direct stakeholders (those individuals who interact with the system or its output directly) and indirect stakeholders (those individuals who do not directly touch the system but are nonetheless substantively affected by its use) are considered [16], [17].

As in other applications of modeling in highly politicized domains [21], for UrbanSim to support effective public participation and democratic decision-making, it is important that the stakeholders judge its use as legitimate. Otherwise, simulation results could be constantly questioned or even simply dismissed when serious discussion takes place. Design to support legitimation is thus a key issue in the work. However, many aspects of how UrbanSim is appropriated into the decision-making process are outside our scope. Therefore, we have reframed the issue as enhancing UrbanSim's *legitimation potential*, that is, its potential to support legitimation of the overall process. The research reported here expands upon earlier theoretical and design work on UrbanSim's legitimation potential [5], which, in turn, built upon the theory of communicative action of Jürgen Habermas [19]. Key to legitimation potential is communicative action – speech or interactions in which all participants aim toward mutual understandings, without manipulative or strategic actions. In our current work we sought to build on this theoretical foundation in both the design process and in the resulting design for and systematic evaluation of UrbanSim's indicator system.

We also considered freedom from bias, that is, the absence of systematic and unfair discrimination, as both an end in itself as well as in support of legitimation. Prior work on bias in information systems [14] alerted us to the distinction between perceived and actual bias, the need to manage biases (actual or perceived) within our system design, and the possibility for new biases to emerge over time. In the context of this work, we envisioned two issues for our interaction design: (1) in order to avoid misperceptions, the need to demarcate technical information about the indicators from active advocacy for the use of specific indicators or for particular transportation and land use policies, and (2) the need to provide a reasonably straightforward means for emergent biases to be addressed through the modification of existing or addition of new indicators and perspectives.

2.3 Participatory Design

Given an emphasis on tools for public participation, in this work we also sought to incorporate concepts and techniques as appropriate from Participatory Design. In its classic form, Participatory Design is a philosophy and design method that brings the users of technology into the design process as co-equal design partners [3], [12]. As developed in Scandinavia in the 1970s and 1980s, it is focused on the workplace. The researchers work with an organization or set of organizations, e.g., publishers and graphics unions in the seminal Utopia project [4]. Participatory Design substantively embeds democratic values into its practice, specifically the value of workplace democracy. Following its initial development, Participatory Design has been used in or adapted to a variety of other contexts, including work with children [9], participants with disabilities [30], and urban planning and transportation [2], [10] More broadly, many of the techniques originally developed in the Participatory Design work, such as paper prototyping, are by now standard practice in interaction design – but typically stripped of the original political commitments.

In our work, we share the commitment to democratization of information technology. That said, within the overall activity of developing and deploying a large scale urban simulation, with many direct and indirect stakeholders, as well as many types and sources of technical information and perspectives, a unitary co-equal co-design process with all stakeholders across all aspects of the simulation is impractical. Thus, we employed a targeted co-design process that accounted for these diverse aspects within the overall activity. Within the bounds of an organization's Indicator Perspective, the organization's control is stronger than that of co-equal co-design; while within the process of recommending additional indicators, the organization's control is weaker than that of co-equal co-design. As such, the balance of power for aspects of the design shifts depending on what was being designed.

3. THE DESIGN PATTERN

As part of addressing the three design goals enumerated in Section 1, we appropriated and extended a design pattern [1] of clearly demarcating a more factual presentation of information from value advocacy and opinion. This overall pattern, while not a common one in interaction design, is familiar in other domains. One example occurs in traditional print journalism, in which newspapers have an editorial and opinion section, separate from the news sections. Another example, more closely parallel to the work reported here, is the way that information is often presented in voter information pamphlets. As a specific case in point, in the Washington State Voter's pamphlet each initiative is presented in three sections. One section is an official title and a factual description of the initiative (including legal and fiscal impacts), written by the State Attorney General. The other two are arguments in favor and against the initiative, along with rebuttals, written by organizations representing the proponents and opponents of the given initiative. This design pattern does not assume there is such a thing as an entirely neutral presentation – for example, the official title of an initiative is a frequent subject of lawsuits – rather, it is based on a more nuanced claim that a useful separation can be made between elements that are primarily descriptive and ones that are primarily in support of advocacy.

Our system design involves providing descriptive technical information alongside a range of organizational perspectives. Specifically, UrbanSim's indicator system includes a set of web pages, divided into Technical Documentation and Indicator Perspectives, as well as infrastructure to compute, display, and browse the indicator values. The Technical Documentation provides a description of the available indicators [5]. It includes a categorized list of all available indicators, with each indicator name linked to a separate page for that indicator. Each of these indicator description pages in turn includes a definition, discussion of how to interpret the results, the code used to compute the indicator value, test cases, and other elements.

The Indicator Perspectives Framework provides a mechanism for different partner organizations to present their own perspectives on major land use and transportation issues, on which indicators are most important, and on how best to evaluate alternative scenarios of land use and transportation. Each perspective includes one or more web pages that present this information, including links back to specific indicators in the Technical Documentation. While a preliminary description of the perspectives appeared in [5], the bulk of the material in this paper has not been previously reported.

Novel aspects of this design pattern include the tight coupling of both the technical information and multiple stakeholder perspectives with a sophisticated simulation system, an interactive format for browsing results, and the large amount of technical information to convey. In addition, our overall interaction design incorporates a process that allows the participating organizations to provide recommendations for developing new indicators and component models.

4. DESIGN GOAL 1: ENABLING INDIRECT STAKEHOLDERS TO BECOME DIRECT STAKEHOLDERS

Our first design goal toward laying the foundation for public participation entailed enabling one group of indirect stakeholders – relevant organizations – to become direct stakeholders of the system. Specifically, we sought to do so by developing the *Indicator Perspectives Framework.*

4.1 Partner Organizations

To create the Indicator Perspectives, we started with a small number of organizations chosen with an eye to providing a range of political and economic views, as well as serving a variety of roles in the region. Pragmatically, we had to find organizations interested in working with us. In agreeing to participate and produce an Indicator Perspective, organizations were agreeing to represent their own views in the system but did not need to come to agreement with the views of other participating organizations (or, for that matter, the views of UrbanSim designers and developers). We gave preference to organizations that already had published views on which trends were of particular concern to them, to make it easier to put together UrbanSim-specific perspectives.

Clearly, a small starting set of organizations will not cover the full spectrum of concerns, but we wanted a reasonable range of views and roles even in the initial prototype. Our initial partners were a nonprofit group, a government agency, and a business association: Northwest Environment Watch, King County Benchmark Program, and Washington Association of Realtors.

- Northwest Environment Watch (now Sightline, http://www.sightline.org) is a regional environmental organization that focuses on sustainability. One of its projects is the "Cascadia Scorecard Project," an indicators monitoring project that follows seven key trends including transportation, pollution, and health.
- King County is the most populous county in Washington State, and includes the cities of Seattle, Bellevue, and Redmond. The King County Office of Management and Budget maintains a benchmark program (http://www.metrokc.gov/budget/benchmrk), which tracks indicators for important trends in the county regarding growth, transportation, the environment, and other issues, as identified in adopted countywide planning policies.
- The Washington Association of Realtors (http://www.warealtor.com) is a business association of realtors in Washington State. It maintains a government affairs department, and provides training, consumer information, and other services. It also publishes a set of

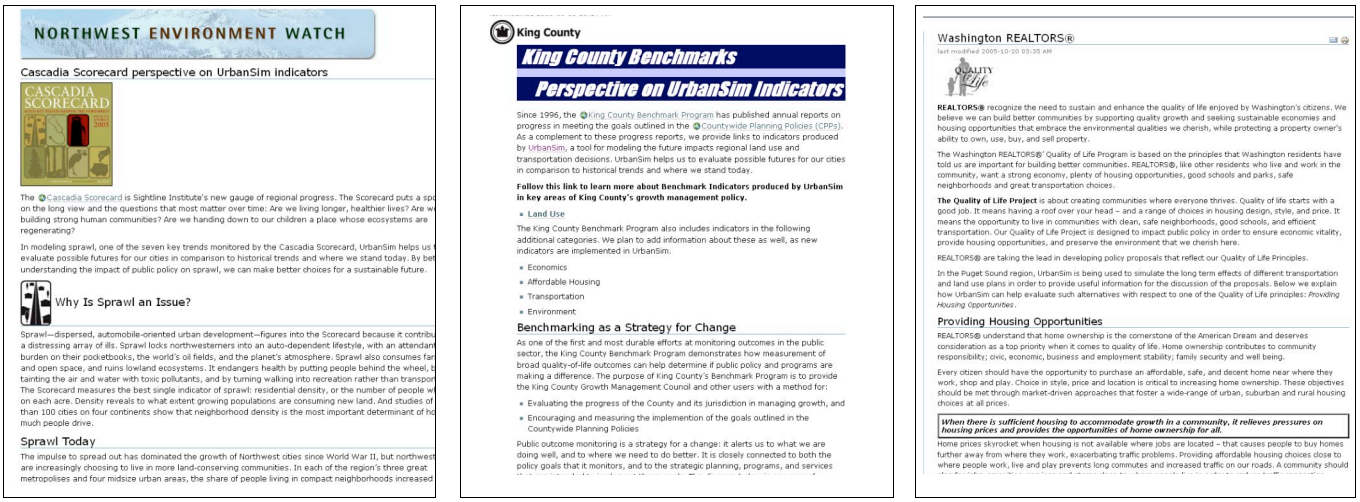

Figure 1. Indicator Perspectives for Northwest Environment Watch, King County Benchmarks, and Washington Association of Realtors

policy guides on housing, zoning, real estate development, land supply, and related topics, which include discussions of trends and indicators of particular relevance to these issues.

4.2 The Three Indicator Perspectives

We helped each of the three partner organizations write the pages of their perspective. For creating and editing the perspectives, we used the Plone content management system (http://plone.org), which provides a simple web-based editor and tools for controlling visibility of different parts of the site.

After making the initial contact, describing the project, and starting to build a working relationship, we asked our contacts in each organization whether they would like to put together an Indicator Perspective web site themselves, or have us design an initial draft version that they could react to. In each case the partner asked us to write the initial draft, which we based on existing material from the organization. We then invited our partner organizations to either edit the perspectives directly themselves, or to give us feedback and requests for changes. Members of one of the organizations edited their site themselves after we provided an initial draft. The others gave us feedback and requests for several rounds of editing, and members of our research team made the actual changes.

Each of the resulting Indicator Perspectives has a unique design reflecting the organization's published materials (see thumbnails in Figure 1).

The Northwest Environment Watch perspective first describes their Cascadia Scorecard project. The perspective then concentrates on one particular issue in the Scorecard, namely sprawl: "dispersed, automobile-oriented urban development." It describes the costs of sprawl, including oil consumption, greenhouse gas emissions, destruction of farmland and open space, and relegating walking to recreation rather than transportation. The Cascadia Scorecard uses two key indicators of sprawl: "Population Density" and "Fraction of Population Living in Compact Neighborhoods." The perspective does the same, linking to the corresponding UrbanSim indicators in the Technical Documentation. Population Density is useful when computed at a neighborhood or finer level of geographic detail, and the results displayed as a choropleth map. One can then see the patterns of compact urban areas and low-density suburban and rural areas. "Fraction of Population Living in Compact Neighborhoods," on the other hand, provides a single number for the entire region, which characterizes whether the predominant development pattern is overall low-density sprawl, or has compact urban areas and lower-density rural areas.

The King County Benchmark Program site first describes the benchmarking program. It lists the principal indicator categories in the program, which correspond to key areas of King County's growth management policy: land use, economics, affordable housing, transportation, and the environment. It then describes how benchmarking and simulation can be coordinated elements in a strategy for change: benchmarking to help determine whether public policy and programs are in fact making a difference in the county at present, and simulation to project the values of indicators into the future for alternate policy scenarios. The "land use" category is in turn a link to another page. (The other categories are ones for which UrbanSim did not provide indicators at the time the perspective was developed.) This second page provides descriptions of the land use indicators in the King County Benchmark Program. Each description provides a link to the corresponding UrbanSim indicator, and states the desired outcome for that indicator, based on countywide planning policies.

The Washington Association of Realtors page is organized around the Washington Realtors Quality of Life program, which includes both a set of principles and specific policy recommendations. The principles identified in the Quality of Life Program are a strong economy, plenty of housing opportunities, good schools and parks, safe neighborhoods and great transportation choices. The perspective then describes how UrbanSim can be used to simulate the long term effects of different transportation and land use plans with respect to one of the Quality of Life principles: Providing Housing Opportunities. There are a set of policy recommendations regarding housing opportunities, for example: "Having an adequate supply of housing is dependent on having sufficient land capacity set aside for those housing units otherwise there will be multiple negative impacts on the community." The perspective includes links to

relevant UrbanSim indicators that can help assess how well the policy recommendation is supported by alternate scenarios, such as "Population," "Number of Households," and "Acres of Vacant Developable Land."

Comparing the three perspectives, the Northwest Environment Watch perspective advocates in a straightforward manner for a particular point of view on sprawl and urban growth. It is a coherent viewpoint, which is valuable for stakeholders to see, yet would not be appropriate for the Technical Documentation. The King County perspective covers many of the same issues, with a similar desired direction. However, even though it is similar in desired outcome to the Northwest Environment Watch perspective, this information is presented as implementing adopted government policy, rather than itself advocating for a position. Finally, the Realtors Perspective, like that of the Northwest Environment Watch, is again more solidly an advocacy one. Its positions are at two distinct levels: first, quite general principles (e.g., "Providing Housing Opportunities"), and second, specific policy recommendations.

5. DESIGN GOAL 2: ENABLING INCREASED PARTICIPATION IN GUIDING INDICATOR DEVELOPMENT

A second design goal was enabling increased participation by a broad range of organizations, not only in providing perspectives on the results from UrbanSim, but also in guiding the future development of the system itself. We focused our initial work on the prototypic activity of selecting and prioritizing the development of new UrbanSim indicators.

One would expect that any organization developing an Indicator Perspective would quickly want to have additional indicators at its disposal, and indeed, this was our experience as we worked with our three initial partner organizations. To address this, we created an *Indicator Recommendation Process* integrated with the activity of developing an Indicator Perspective. Through this process, the participating organizations could recommend new or extended indicators to the UrbanSim development team that would better support their perspectives.

These recommendations (along with recommendations from other sources) make salient the issue of prioritizing the implementation of additional indicators and other work on the system. Given a world with limited resources – of time, money, data availability, and theoretical understanding of urban environments – how should we decide which additional indicators to implement, and in what order? In Section 5.1, we describe a principled strategy that we developed to address this issue. In Section 5.2, we report on the new indicators that were added in direct response to organizational requests resulting from the development of the Indicator Perspectives.

5.1 A Principled Prioritization Strategy

As noted above, recommendations for new indicators make salient the issue of prioritizing the implementation of additional indicators. Moreover, implementing a new indicator might imply work on many aspects of the simulation to allow the required data to be produced. Toward the overall goal of enabling effective participation by organizations in the future development of the system, we developed a principled strategy to address this issue, rather than simply building new indicators on an *ad hoc* basis.

Our strategy involves a triangulation among priorities arising from three different sources: (1) coverage of the space of potential indicators, (2) organizational partner and stakeholder concerns, and (3) pragmatics.

Coverage of the space of potential indicators has perhaps the strongest theoretical grounding of these three sources. Early in the work on employing Value Sensitive Design in the design of interactions around UrbanSim indicators, we developed a number of typologies of indicators of what people value in urban environments. Our goal was for these typologies to be comprehensive – for any given value, people should be able to locate it in each typology. As an exemplar, in one typology, the top-level categories were Economic, Environmental, and Social. (These top-level categories are typical in taxonomies of indicators for sustainability as well [20].) Then under Environmental, for example, were the sub-categories Air, Water, Land/Vegetation, Animals, and Resource Consumption, with further sub-sub-categories under each of those. This taxonomy, or one like it, thus serves as one source of priorities for implementing additional indicators. If there are significant gaps in the indicator suite – for example, if a major category is not represented – then this gives a clear signal that work may be needed there.

There are some complications. First, we recognize that the typologies we are currently working with do not represent the full range of worldviews of all the stakeholders. But at the same time, some categorization is needed [23]. In future work, we hope to extend stakeholder participation to include shaping and generating additional typologies. Second, not all aspects of the urban environment that people value fall within the realm of the modeling activity (e.g., breadth and quality of theatre and musical offerings). Third, many indicators pertain to multiple categories. For example, "Mean Household Income" is of course a kind of economic indicator; but when computed at the neighborhood level, it is also very reasonably classified as Social, as a measure of concentrations of wealth and poverty in the region. In this case we view the indicator as filling multiple roles. Finally, we do not want to apply a rigid counting scheme (for example, demanding that there be an equal number of indicators in all categories). After all, a single compelling indicator that nicely captures some phenomenon is better than four somewhat relevant ones (even though the count would be one instead of four). Yet some rough parity is appropriate.

The second source of priorities is organizational partner concerns. If we are working with an organization to develop or extend an Indicator Perspective, an Indicator Recommendation from such a partner represents a significant priority for future work. For any given Indicator Recommendation, part of our job as UrbanSim designers and implementers is to serve as a source of expert information for the collaborators on what indicators are available, which are straightforward to develop, which are hard but possible, and so forth; but not to say that the recommended indicator is not important.

But again, there are some further issues. One of our explicitly supported values is facilitating the democratic process. As part of supporting that value, if an issue is of importance to a significant number of stakeholders, then this implies a priority to develop one or more indicators that allow these stakeholders to assess alternate scenarios in light of that issue. But we do not want choosing the next indicator to implement to be a simple

Table 1. Indicator Development in Response to Partner Organization Recommendations

CATEGORY	NUMBER PRIOR IND.	NUMBER NEW IND.	TOTAL NUMBER IND.	EXAMPLES OF NEW INDICATORS
Employment	8	0	8	
Environmental Impacts	0	4	4	• Greenhouse Gas Emissions • Gasoline Consumption per Capita
Households and Population	10	1	11	• Fraction of Population Living in Compact Neighborhoods
Land Use & Real Estate Dev.	23	0	23	
Transportation	0*	8	8	• Percentage of Trips by Single Occ. Vehicle • Percentage of Trips by Mass Transit

majority vote on what is important: we also need to consider issues of moral import. For such issues, this lends priority to those indicators, even though only a minority of stakeholders might be affected, as in the case of wheelchair access.

The third source of priorities is pragmatics: ease or complexity of implementing the indicator, data availability, legal requirements, funding, and similar considerations. These are clearly important, but we do not want them to dominate the decision-making process. Our strategy for prioritization thus serves as a check on allowing funding and other pragmatic considerations to unduly influence the implementation priorities.

5.2 The Indicator Recommendation Process in Action: 13 New Indicators

Through our work on developing Indicator Perspectives with the three organizations, numerous recommendations for new indicators were made. Of these, 13 new indicators were developed (24% of UrbanSim's total active, documented 54 indicators) in response to identified gaps in our current taxonomy and partner organization recommendations.

Table 1 provides a list of the number of new indicators by category, with examples. For example, two key classes of recommendations for both Northwest Environment Watch and King County were for environmental and transportation indicators (e.g. for greenhouse gas emissions). These partner organization recommendations played a pivotal role in raising the priority of developing these indicators in the overall UrbanSim workflow. The taxonomy also reinforced the priority of adding the environmental and transportation indicators: even though "Environmental" and "Transportation" are two of the five top-level categories in our current taxonomy, until recently we did not have any indicators of environmental impact; and transportation indicators were only available in the third-party travel model and not integrated with the indicator system, as indicated by 0* in Table 1. In both cases, the absence of indicators was due to significant technical obstacles, in particular, closer integration with a third-party travel model. Another example of a new indicator written in response to a partner recommendation (this one from the "Households and Population" category) is the "Fraction of Population Living in Compact Neighborhoods" indicator discussed in Section 0. Thus, through the Indicator Recommendation Process (including our prioritization strategy), participating organizations were able to guide effectively the development of new indicators in UrbanSim prior to wide-scale system deployment.

6. DESIGN GOAL 3: ENABLING VALUE ADVOCACY WHILE ENHANCING OVERALL SYSTEM LEGITIMATION

Given our goal of supporting public participation and informed democratic deliberation and debate, value advocacy plays a central role. Moreover, as demonstrated by the results reported in Sections 4 and 5, the Indicator Perspectives as a framework and in practice enabled participating organizations to become direct stakeholders in UrbanSim. However, by introducing a mechanism for value advocacy into UrbanSim, have we inadvertently undermined the overall legitimation potential of the system? We hypothesized that our design pattern of providing both technical description and value advocacy, with a clear demarcation between these components, would avoid undermining legitimation in this way. To test this hypothesis we conducted a user study of the system and its component elements with respect to these value issues.

Undertaking an evaluation at this stage is another example of our overall strategy of laying the foundation for public participation before wide-scale system deployment. Although we lack the luxury of evaluating the system in use on a major public decision, we reap the benefit of having the results in hand at a time when they can influence further system evolution.

6.1 Participants and Methods

Twenty citizens (10 women, 10 men; mean age = 42 years, range = 19 to 63 years) participated in a 90 minute semi-structured interview. Participants were recruited from 4 representative neighborhoods in Seattle by flyers and, when available, mailings to neighborhood email distribution lists. By and large, participants were well educated (25% some college, 25% college graduates, and 50% post baccalaureate degree).

The value-oriented interview questions and task activities drew in structure on prior research [5], [17], [25]. A companion technical report [15] provides the full evaluation instruments. The first set of questions and associated tasks served to introduce participants to each of the three Indicator Perspectives and the Technical Documentation. Participants were directed to interact with each part of the system and asked to identify information (e.g., for an Indicator Perspective: "What is one of the main points of this Indicator Perspective?" or for the Technical Documentation: "Looking at the documentation for Residential Vacancy Rate, what can this indicator tell about housing prices?"). The presentation order of the Indicator Perspectives was counter-balanced with that of the Technical Documentation.

Table 2. Percentage of participant responses for each grouping in the indicator system

Question	Level 1			Level 2		Level 3
	Envir. Watch	King Cnty.	Realtors	Ind. P. Frame	Tech Doc.	System as a Whole
Do you agree or strongly agree that…						
1. *X* is reasoned or coherent.	95*	90*	85*	82*	90*	85*
2. *X* is informative.	80*	80*	80*	89*	89*	100*
3. *X* is useful for supporting diverse opinions.	37	68	56	83*	85*	100*
4. *X* is useful for advocating for certain views or values.	89*	70	95*	94*	71	89*
5. *X* is useful for supporting the democratic process.	68	90*	67	89*	70	89*
If *X* were the only information UrbanSim provided about indicators, …						
6. would that be alright or not alright? (% alright)	15*	30	15*	25*	20*	55
7. would that unfairly discriminate against someone/something? (% no)	20*	25*	10*	35	35	55

Note: An * indicates percentages significantly different from 50% based on a two-tailed binomial test with $\alpha = .05$ significance level.

The second set of questions assessed how participants perceived the support for legitimation by different elements and combinations of elements of the indicator system. These groupings were defined as follows: (a) Northwest Environment Watch Indicator Perspective, (b) King County Benchmark Program Indicator Perspective, (c) Washington Realtors Indicator Perspective, (d) the more general Indicator Perspective Framework, which could be comprised of any number of individual Indicator Perspectives including the three current ones; (e) the Technical Documentation, and (f) the indicator "system-as-a-whole" which included both the Indicator Perspective Framework (d above) and the Technical Documentation (e above).

To assess legitimation, participants evaluated each grouping in terms of (1) coherence, (2) informativeness, (3) usefulness for supporting diverse opinions, (4) usefulness for advocating for certain views and values, and (5) usefulness for supporting the democratic process (e.g., "The Northwest Environment Watch Indicator Perspective is informative. Do you strongly disagree, disagree, neutral, agree, strongly agree, or can't tell? Why or why not?"). Participants also provided judgments about (6) the validity of using the grouping in isolation from other aspects of the system (e.g., "If the Technical Documentation were the only information UrbanSim provided about indicators, would that be all right or not all right? Why or why not?"), and (7) whether or not the grouping unfairly discriminated (e.g., "If the Technical Documentation were the only information UrbanSim provided about indicators, would that unfairly discriminate against someone or something? Why or why not?").

6.2 Results and Discussion

We report the results from the second set of questions here. For Questions 1 – 5, the "can't tell" option was rarely used (on average 5% per question); thus this data was dropped from the analysis. For Questions 6 and 7 a greater number of participants expressed uncertainty. Here we took a conservative approach and counted an unsure evaluation as not supporting a judgment of legitimation. As shown in Table 2, based on two-tailed binomial tests, most participants viewed each grouping as coherent (82% to 95% depending on the grouping; $p < .05$) and as informative (80% to 100% depending on the grouping; $p < .05$). Therefore, in terms of the two most basic criteria – coherence and informativeness – most participants viewed all of the groupings as "supporting legitimation." In addition to being coherent and informative, most participants viewed the system-as-a-whole as useful for supporting diverse opinions (100%, $p < .0005$), advocating for certain views or values (89%, $p = .001$), and supporting the democratic process (89%, $p = .001$). Thus, most participants perceived the system-as-a-whole to simultaneously support both value advocacy and access to technical information.

Based on the design pattern of demarcating a more factual presentation of information from value advocacy, we hypothesized that as the design provides increasing support for diverse perspectives alongside technical information, more participants would judge the system to support legitimation. We next conducted an analysis to test this hypothesis. Specifically, we first identified three levels of increasing comprehensiveness and balance of information as follows: "Level 1" contained the individual indicators perspectives (a, b, and c); "Level 2" contained the Indicator Perspective Framework (d) and the Technical Documentation (e); and "Level 3" contained the indicator system-as-a-whole (f). For each question, we used Cochran's Q to test for differences among the three levels in the percentage of participants who viewed all of the groupings at that level as supporting legitimation. Results showed significant differences for three questions (Question 3 "support diverse opinions," $p < .0005$; Question 6 "all right or not all right," $p < .0005$; Question 7 "does not unfairly discriminate," $p = .002$).

For these three questions, we then conducted pairwise McNemar tests to determine the nature of the differences among the three levels. For Question 3 ("support diverse opinions"), significant differences were found in all pairwise comparisons, with Level 3 (100% agree or strongly agree for the system-as-a-whole) better supporting legitimation than Level 2 (60% agree or strongly agree on both the Indicator Perspective Framework and the Technical Documentation) ($p = .008$), and Level 2, in turn, better supporting legitimation than Level 1 (20% agree or strongly agree on all three individual Indicator Perspectives) ($p = .008$). For Question 6 "alright or not alright" significant differences were found between Level 3 (55% alright for the system-as-a-whole) and the other two levels (5% alright for both the Indicator Perspective Framework and the Technical Documentation; 5% alright for all three individual Indicator

Perspectives) (p = .002). For Question 7, the only significant difference was between Level 3 and Level 1, with 55% of participants saying that the system as a whole "does not unfairly discriminate", as compared to only 5% saying that none of the three individual Indicator Perspectives unfairly discriminates (p = .002). Taken together, these quantitative results support the hypothesis that more participants view the system-as-a-whole as supporting legitimation than any of the individual components.

The qualitative data also supports this trend of increased support for legitimation by the system-as-a-whole. In this context, some participants emphasized a *balance between the technical and advocacy information* (e.g., "the Technical Documentation gives a ton of statistical analysis and facts… it's not biased to a certain issue, so just laying down the facts. … And then from the three Indicator Perspectives, from what I've seen they're not trying to single anyone out") as well as *balance among the diverse views* represented in the system (e.g., "just looking at [the system-as-whole], it seems a good balance… of opinions or points of view"). For other participants the indicator systems' *relative completeness* lent support for legitimation to the "system-as-a-whole" (e.g., "Yes, it appears complete to me. It would give me enough information I would need to make my decision at a town meeting"). Still other participants saw the support for legitimation of the system-as-a-whole tied to the system's *extensibility*, so that even if the system was not yet complete it could readily be extended as needed (e.g., "Yeah, [the system-as-a-whole is] all right… I imagine the framework including the ability to either create your own [Indicator Perspective] or something else along those lines…. There may be indicators that someone wants that [UrbanSim] doesn't have but [UrbanSim developers] need to add that indicator and off you go").

This is not to say that some participants did not view the system-as-a-whole as *incomplete* – missing for example common language across constituencies, public comment tools, or access for less organized groups – or as potentially subject to *strategic communication*. Roughly 45% did so. For example, one participant described a strategic use of another modeling system as follows: "J___ […] who does transportation issues, he had this program. … It was this model of transportation planning kinds of things where he could plug in data and get back this modeling information…he would bring this stuff to meetings with him. He was the only one that has access to it because there was nobody else that had that level of expertise…. So people sitting in the room with him were at a distinct disadvantage." Yet others saw the structure of the indicator system and the commitment to broad access as checking this type of strategic communication. For example, another participant said: "…if you were talking about on a very micro level your new building going up that would impact the neighborhood in a whole lot of ways… on either side of that I'm sure you could fact pick to support, you know, the developer could fact pick to support that this is a good thing. And the neighborhood that was against it could fact pick to support that it was a bad thing." Thus, for the latter participant, the system's support for legitimation depends not only on the technical features and information in the system, but also on who has access to the system and the social context of its use.

Finally, we note some surprising results about the Technical Documentation on its own. We had expected participants to view the Technical Documentation as largely separate from the work of value advocacy, and not in itself useful for supporting the democratic process. However, as shown in Table 2, that was not the case (71% viewed the Technical Documentation as useful for advocating for certain views and values, and 70% as useful for supporting democratic process). The qualitative data provides some insight into participants' reasoning here. Specifically, the Technical Documentation was seen as *providing information* that interacts with democratic decision-making in important ways, from simply the amount of available information (e.g., "the more information the better") to the way in which information can underlie the type of complex deliberation key to democratic process (e.g., "I would think that the basis of any dialogue would have to be facts, data, and assertions that are objectively verifiable.") and democratic decision-making (e.g., "the more information people have, the more likely they are to have a basis for their decision making … you have to have facts to advocate for a viewpoint"). The Technical Documentation also contributed to participants' perceptions of *transparency* (e.g., "You can go back and see where the information came from, that it's not being just fed to you from some mysterious source") and *unbiased information* (e.g., "Basically, because it doesn't have a bias … this is the math from the data map, what you do with the data is up to you, it's a matter of here's what the data is"). Moreover, the Technical Documentation – when available to all parties – was seen to *help equalize power differentials* for individuals with diverse viewpoints ("[The Technical Documentation is] what levels the playing field for whatever opinions people were to throw out and how to fit it into what we're looking at").

7. PRELIMINARY WORK ON A PUBLIC COMMENT PROCESS

For individual citizens, we recognize that the current Indicator Perspectives Framework and Technical Documentation provide a one-way flow of information. In the longer term, we envision augmenting these with additional opportunities for participation, such as commenting tools, discussion forums, and perhaps a

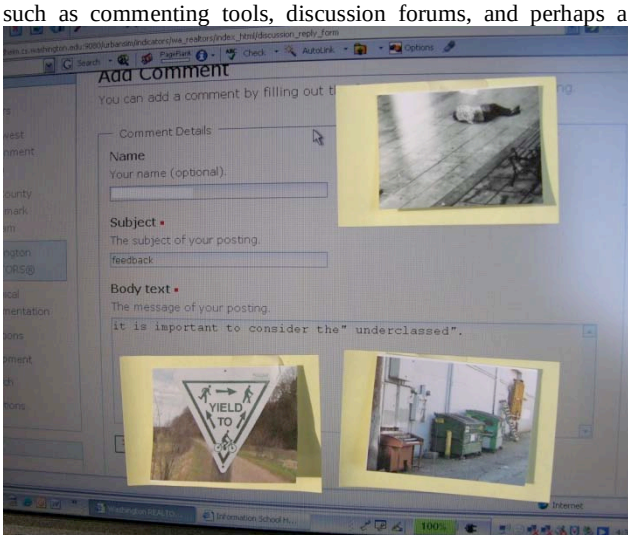

Figure 2. Experimenting with the Comment Tool, including adding photos of neighborhood scenes, during a user study. The text comment ("it is important to consider the 'underclassed' ") is surrounded by photos of a person sleeping on the sidewalk, a yield sign on a walking/running/bicycling trail, and dumpsters in an alley.

Wikipedia-like "Agorapedia" that would allow individual citizens, as well as organizations, to participate in the construction of political and civic content. As a first step, at the end of the semi-structured interviews with engaged citizens we asked participants to experiment with a commenting tool and provide feedback. A novel feature of the comment tool design was a facility for posting photos that citizens could take of evocative scenes in the urban landscape using suitable cell phones or other inexpensive digital cameras. We simulated this tool by providing a diverse set of photos, mounted on stickies, for pasting on the computer screen (Figure 2). Participant comments ranged from neutral to strongly favorable toward adding such a capability.

8. REFLECTIONS

In structuring how to lay the foundations for public participation prior to wide-scale system deployment, a compelling way to proceed is to find processes that enable actual participation, rather than, for example, simply asking a focus group to imagine what it would be like to participate in the future. In our case, through the Indicator Perspectives and Recommendation Process, participating organizations were able to influence system evolution even at this early phase.

Our design process for the Indicator Perspectives was simplified by the three initial partner organizations already having a substantial amount of material that could be adapted to draft their perspectives. As the Indicator Perspectives Framework expands to encompass a wider range of organizations, to support our values of fairness and balance, we may need to more actively solicit partner organizations to fill gaps, and to provide more in-depth assistance to these organizations in identifying suitable indicators, and developing and maintaining a perspective. At the same time, we will need to be attentive to the challenges of scaling up the number of participating organizations, given limits on the amount of in-depth technical assistance we could provide.

There is a fundamental difference between participants who engage in co-design with opportunities to directly the influence the system, and participants who provide important evaluative information about others' co-design efforts. In the former case, participants are rewarded through their ability to influence the system; in the latter case, participant rewards are more removed (or monetary). These roles are distinct and both important. Moreover, given the desire for wide-spread public participation, it is important to recruit a broad spectrum of individuals to participate in the evaluation activities. In the evaluation of the Indicator Perspectives Framework reported here, participants were primarily educated, middle-class citizens; in further work, it will be important to bring in a much more representative cross-section of the residents in the region, including youth, seniors, and underprivileged citizens.

At this juncture it is useful to ask: "How do we know that our Value Sensitive Design approach made a difference in the final design? After all, wouldn't thoughtful designers have done much the same thing using traditional approaches?" While this might sometimes be the case, we believe our systematic use of Value Sensitive Design impacted our design in several ways, including making salient in the design process the indirect as well as direct stakeholders, focusing our design attention on the key values, in particular on legitimation, and directing us to design with communicative action in mind and to make explicit our process for prioritizing what to work on next. Further, the use of Value Sensitive Design helps ensure that values are considered in a systematic way, rather than just relying on unarticulated work practices or *ad hoc* insights of the designer.

We would also argue that this question is not the only one that should be asked. The final design is important, but, in a contentious domain such as urban planning, the process by which the design was produced is equally important for the legitimacy of the result. Here, Value Sensitive Design provides principled guidance for the design activity, for example, providing a response to the charge that the designers are unfairly privileging their own values in the system design, or that important stakeholder groups are being unwittingly ignored.

9. CONTRIBUTIONS

For large scale digital government systems there are good reasons to design for public participation in advance of wide-scale system deployment, yet how to do so well is challenging. The work reported here provides paradigmatic examples for doing so, in the context of a sophisticated simulation system in urban planning. Three of these contributions flow from our design goals, as follows:

- A framework that enables one key group of indirect stakeholders – relevant organizations (e.g., advocacy groups, government agencies, and business associations) – to become direct stakeholders in digital government systems for use in the public arena.
- A process for relevant organizations to help guide the development of the system.
- A design pattern that enables value advocacy by relevant organizations while enhancing overall system legitimation potential.

Additional contributions include:

- A principled strategy for prioritizing further work, which triangulates among conceptual coverage of elements in the domain, stakeholder interests, and pragmatics.
- Paradigmatic examples of evaluation criteria and questions for assessing value-oriented aspects of complex systems.
- An extension of Value Sensitive Design that provides a way to integrate stakeholder participation and co-design using selected techniques from Participatory Design, thus providing a partial answer to the question: "What is the role of participation in Value Sensitive Design?"

In parallel with the work reported here, work on underlying components of the UrbanSim system has proceeded, and we expect that it will be ready to enter the public arena in a significant way in the next year. It is our hope that the work reported here will then bear fruit as these activities converge, resulting in a system with much stronger support for public participation. More broadly, we hope the work reported here will be useful to others as they seek to lay the foundations for public participation in advance of deployment of other large scale digital government systems.

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