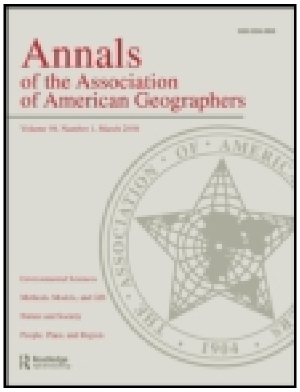

Annals of the Association of American Geographers
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/raag20

Toward Structured Public Involvement: Justice, Geography and Collaborative Geospatial/Geovisual Decision Support Systems

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Version of record first published: 14 Dec 2009.

Toward Structured Public Involvement: Justice, Geography and Collaborative Geospatial/Geovisual Decision Support Systems

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This article addresses how collaborative geospatial/geovisual decision support systems (C-GDSS) can achieve greater measures of spatial justice within an institutional, democratic framework for public goods allocation. Current public participation geographic information systems (PPGIS) and participatory geographic information science (P-GIS) literature identifies issues of scale and consensus as problematic for such systems. C-GDSS deployments aimed at achieving spatial justice through small-scale, consensual processes fail when scaled to large processes involving heterogeneous groups where consensus is not realistically achievable. For this case study, we identify a significant deficit in the quality of public involvement in transportation infrastructure (TI) planning and design in the United States. We call this the *Arnstein Gap*. This exists in part because professionals lack confidence that they can integrate community cultural values, despite C-GDSS use, and have come to fear public engagement. To close the Arnstein Gap using C-GDSS we reconsider relationships among landscape, justice, and difference. The nature of power in the U.S. democratic polity and TI's role is examined and a geographical justice framework is derived from Rawls's (1971) theory of justice. We argue that within the normative framework of Jeffersonian democracy in the United States, spatial justice cannot be attained through an epistemology of distributional justice. Instead, it can more feasibly be attained by increasing procedural justice and access to justice. From these principles we develop a more suitable methodology for reflexive, large-scale group deployment of such systems termed structured public involvement (SPI). SPI holds that large-scale, nonconsensual collaborative TI planning is not oxymoronic, nor is it morally or practically inferior to other options. Methodological consideration is given to how geospatial and geovisual technologies can be used in TI design to elicit and respect cultural preferences. SPI consists of a reflexive public involvement framework that situates these technologies as dialogic media in participatory, nonconsensual collaborative planning and design. Two SPI case studies are discussed. AMIS is a participatory multicriteria/GIS corridor evaluation methodology and CAVE is a fuzzy-logic-based visual evaluation methodology. Anonymous real-time public process evaluation data demonstrate SPI's high performance. We discuss impediments, such as project sponsor's preferred Arnstein level, public participation patterns, professional resistance, and other considerations. This work has implications for collaborative public goods decision making using geovisual/geospatial methods in participatory democracies.
Key Words: Arnstein Gap, collaborative geovisual/geospatial decision support systems, procedural justice, structured public involvement, transportation infrastructure.

本文讨论了对于公众资源的分配，合作形地理空间/地理可视决策支持系统（C-GDSS）如何可以在一个体制化，民主化的框架内实现更大的空间正义。当前的公众参与地理信息系统（PPGIS）和参与性地理信息科学（P-GIS）的文献指出了这些系统所存在的规模和共识问题。C-GDSS 的应用旨在谋求协商一致的进程失败时，实现较小空间规模的空间正义，当大尺度的进程涉及到不同种类的群体，往往导致谋求协商一致的过程实际上是做不到的。对于本案例研究，美国的交通运输基础设施（TI）的规划和设计，我们发现了公共参与质量存在显著的亏空。我们称之为阿恩斯坦差距。这个差距存在的部分原因是因为专业人员对他们能否整合社区的文化价值缺乏信心，尽管使用了 C-GDSS，他们仍旧担忧公众的参与。若要通过使用 C-GDSS 而弥合阿恩斯坦差距，我们需要考虑景观，公正和差异的相互关系。本文对美国民主政体权力的性质和 TI 的作用进行了检查，根据罗尔斯（1971）的司法理论，推导出一个地理正义的框架。我们认为，在美国杰斐逊式民主的规范框架内，空间正义是无法通过分配公正的认识论而实现的。相反，通过提高程序正义和接近正义，空间正义更容易被实现。从这些原则，我们制定了一个更合适的方法论以供反思，这种系统在规模较大的群体上的应用被称为结构化的公众参与（SPI）。SPI 认为，大规模的，难以协商的协作性 TI 规划并非是自我矛盾的，在道德上和实际操作上也不比其他的选择差。如何在 TI 的设计中使用地理空间和地理可视化技术来征求和尊重文化上的优先选择，我们对此给予了方法

Annals of the Association of American Geographers, 100(1) 2010, pp. 57–86
Initial submission, March 2008; final acceptance, May 2008
Published by Taylor & Francis, LLC.

论方面的考虑。SPI 包括一个自反性的公众参与框架，将这些技术作为对话媒体，在提高参与，规划和设计难以协商的协作中加以使用。本文对两个 SPI 个案进行了讨论。AMIS 是一个参与性的多标准/地理信息系统通道评价方法，CAVE 是一个基于模糊逻辑的可视化评价方法。匿名的、实时的、公开的处理评估数据展示了 SPI 的高性能。我们讨论了各种障碍，例如项目赞助商中意的阿恩斯坦水平，公众参与的模式，专业人士的抵触，以及其他因素。对于使用地理可视化/地理空间方法，在参与性民主的范畴内，协作达成公共物品的决策，本项工作对此具有影响。*关键词：阿恩斯坦差距，协作形式的地理可视化/地理空间决策支持系统，程序正义，结构化的公众参与，交通基础设施。*

Este artículo de refiere a la manera como los sistemas de apoyo para la decisión geovisual/geoespacial colaborativa (C-GDSS, por su acrónimo en inglés), pueden alcanzar medidas más grandes de justicia espacial, dentro de un marco institucional democrático para la asignación de bienes públicos. La actual literatura sobre sistemas de información geográfica de participación pública (PPGIS) y ciencia de la información geográfica participativa (P-GIS) identifica los temas de escala y consenso como problemáticos para aquellos sistemas. El despliegue de C-GDSS destinados a obtener justicia espacial por medio de procesos consensuales de escala media falla cuando se escala a procesos de mayor envergadura que involucran grupos heterogéneos, en los cuales es realista pensar que el consenso es inalcanzable. Para este estudio de caso, identificamos un significativo déficit en la calidad de la participación pública en la planeación y diseño de la infraestructura del transporte (IT) en Estados Unidos. A tal condición le damos el nombre de *Brecha Arnstein*. En parte esto existe porque los profesionales no confían en poder integrar los valores culturales comunitarios, a pesar del uso de C-GDSS, y han llegado a desconfiar del compromiso público. Para cerrar la Brecha Arnstein utilizando C-GDSS decidimos reconsiderar las relaciones entre paisaje, justicia y diferencia. Se examinaron la naturaleza del poder en la política democrática de EE.UU. y el papel de la IT, y se derivó un marco de justicia geográfica a partir de la teoría de justicia de Rawl (1971). Argüimos que en el marco normativo de la democracia jeffersoniana de Estados Unidos, la justicia espacial no podrá lograrse con una epistemología de justicia distributiva. En vez de eso, aquélla podría alcanzarse más fácilmente mediante el incremento de la justicia de procedimiento y el acceso a la justicia. A partir de estos principios, hemos desarrollado una metodología más apropiada para un despliegue grupal reflexivo y a gran escala de lo que se designa como sistemas de participación pública estructurada (SPI). Los SPI presuponen que el planeamiento TI colaborativo, no consensual y de gran escala no es oximorónico, ni es práctica o moralmente inferior a otras opciones. Se le da consideración metodológica al modo como las tecnologías geoespacial y geovisual pueden utilizarse en el diseño de TI para sacar a flote y respetar las preferencias culturales. Un SPI es un marco reflexivo de participación pública que sitúa estas tecnologías como medios dialogísticos en planeamiento y diseño colaborativo y participativo no consensual. Se discuten dos estudios de caso SPI. AMIS es una metodología de evaluación participatoria de multicriterios/GIS y CAVE es una metodología de evaluación visual de lógica difusa. Los datos anónimos para la evaluación de procesos públicos en tiempo real demuestran el alto desempeño de los SPI. Discutimos impedimentos, tales como el nivel Arnstein preferido del patrocinador del proyecto, los patrones de participación pública, la oposición profesional y otras consideraciones. Este trabajo tiene implicaciones para la toma de decisiones sobre bienes públicos de origen colaborativo, mediante el uso en democracias de participación de métodos geovisuales/geoespaciales. *Palabras clave*: *Brecha de Arnstein, sistemas de apoyo para la decisión geovisual/geoespacial colaborativa, justicia de procedimiento, participación pública estructurada, infraestructura del transporte.*

For some time it has been believed that geospatial/geovisual decision support systems (GDSS; Jankowski and Nyerges 2001) hold significant promise for improving collaborative decision quality by functioning as a more intuitive, inclusive, and comprehensive data platform for stakeholder input and analysis (Environmental Systems Research Institute 2009). GDSS include a set of methods and tools, such as geovisualization, geographic information systems (GIS) multicriteria decision support methods including the analytic hierarchy process (AHP; Malczewski 1996; Jankowski et al. 1997), real-time electronic polling technologies, Web-based information solicitation and delivery systems, group systems ware, and traditional facilitation methods. These tools are often combined and then embedded into a complex institutional framework to address real societal problems. In many of these cases the system managers and stakeholders share an increasing desire for, and reliance on, GDSS and a commitment to the further development of more effective, flexible geospatial decision support that improves participatory design and management (e.g., Federal Highway Administration [FHWA] 2009). GDSS that are designed around collaborative principles are termed *collaborative* GDSS (C-GDSS). Some argue that GDSS might help to reach more inclusive, more equitable, and ultimately more sustainable outcomes for these difficult problems (Mennecke, Crossland, and Killingsworth 2000). Sustainability can be a slippery concept, but here it is defined as a decision that satisfies the maximum proportion of stakeholders and therefore leads to more robust, legitimate, and hence durable decisions. We agree that collaborative geospatial and geovisual decision support offers potential; however, as MacEachren and Brewer (2004, 3) observed, "we know very little about the impacts of shared visualization on group work or how to design effective group geovisualization tools."

Current public participation geographic information systems (PPGIS) literature approaches geospatial collaboration from an empowerment or mobilization perspective (Craig, Harris, and Wiener 2002; Elwood 2002a, 2002b; Elwood and Ghose 2004). PPGIS work strongly emphasizes access to justice on the part of disadvantaged populations and it typically deals with local-scale questions (Ghose and Elwood 2003, 18). Attention is being paid to integration of informal stakeholder practices into decision systems (Elwood and Leitner 1998, 2003) and making GIS more responsive to stakeholders (Ceccato and Snickars 2000), particularly those without the advantages of access and formal training. According to Sieber (2006, 491) "[PPGIS] projects have tended to be guided not by esoteric academic interests but by grassroots groups and community-based organizations (CBOs) that use GIS as a tool for capacity building and social change." Participatory geographic information science (P-GIS) shares some of these goals. P-GIS adopts a methodological focus on how geospatial technology can be used to solicit and incorporate stakeholder values (Jankowski and Nyerges 2001). Group interactions with GIS are now being studied carefully with the aim of improving knowledge transmission from participants to experts (e.g., Hopfer and MacEachren 2007) and developing an understanding of the effect of organizational culture on GIS adoption and use (Cai et al. 2006). Other studies examined the ways in which groups really use GIS and how these practices can be investigated experimentally (Nyerges, Jankowski, and Drew 2002; Voss et al. 2004; Jankowski et al. 2006). These studies, however, typically focused on relatively small groups with professional training (e.g., DeVos et al. 2007). And, as Nyerges (2005) said, "scaling analytic-deliberative participation to large groups is a challenge—as scale matters." Complicating factors of larger scale processes include their "complex nature, multiple actors and tacit criteria" (Andrienko et al. 2007, 841). What can collaboration mean for large, culturally and socially heterogeneous groups? How can these groups interact effectively with responsible governmental agencies, and expert design and management coalitions, using geospatial and geovisual methods?

This article addresses the collaborative properties of GDSS at a larger geopolitical scale. Our aim is to improve C-GDSS performance when embedded in the existing democratic structures for public goods allocation and management in the United States. This article situates C-GDSS within a framework of procedural justice developed from John Rawls's (1971) theory of justice. We use the term *structured public involvement* (SPI) to describe this methodology. We begin by outlining the problem domain in the case study area of transportation infrastructure (TI). Stakeholder assessments of public involvement quality characterize a maldistribution of decision authority in the form of the Arnstein Gap (Bailey and Grossardt 2006, 339). We argue that purely technical GIS research cannot solve this problem and that individual cognition and expert-group usability issues are overemphasized compared with the functioning of larger scale C-GDSS within a broader sociopolitical framework—there's too much GDSS and not enough C. In particular, the necessary articulations among democratic theory, spatial justice, and geospatial technology are weak (Walters, Aydelotte, and Miller 2000). This disproportionate effort in part accounts for current poor GDSS performance in solving U.S. public good allocation problems (Connelly 2006). Because improving spatial justice lies at the heart of the rationale for C-GDSS deployment, we consider how spatial justice can be theorized using Rawls's (1971) notions of procedural justice and access to justice. We argue that distributional justice, in the form of perfectly equitable distribution of costs and benefits across diverse populations and regions, is not attainable. Designing systems around this goal contributes to their failure. Instead, we argue that a closer approach to distributional justice is possible through an epistemology that maximizes what Rawls (1971) termed *procedural justice* and *access to justice*.

Methodologically, the necessary attainment of stronger procedural justice and access to justice can be helped by considering more carefully the role of GDSS in the negotiation among people, process, and the production of the cultural landscape. As things stand in TI design, these technologies are not deployed in ways sensitive to stakeholder needs. We examine a continuum of literature from communicative planning to planning technologies with the aim of identifying an appropriate role for the C-GDSS technologies. We argue that classic, Habermasian consensus is not a realistic or feasible goal for such large-scale processes. More strongly, we hold that they cannot be designed around this principle, or they will fail. But consensus and justice should not, indeed must not, be conflated. We believe that a strong measure of justice can be achieved through what Mouffe (2000, 103) terms "conflictual consensus." On the other hand, we do not mean that elite privilege should be maintained. Far from it; the Arnstein Gap illustrates that a redistribution of decision authority is a prerequisite for increased justice.

From this theoretical and methodological analysis we develop a C-GDSS framework termed SPI. SPI aims to use geovisual and geospatial methods to allow a more faithful inclusion of the cultural and social values of large numbers of public participants with diverse opinions into public goods allocation. Satisfying this aim requires methodological advances in collaborative geospatial and geovisual applications. We present a brief summary of two case studies. The first outlines the analytic minimum impedance surface (AMIS) GIS/multicriteria methodology for participatory highway corridor routing that includes diverse social, environmental, engineering, and natural concerns. The second features the casewise visual evaluation (CAVE) method, a fuzzy-set-based approach to modeling visual preference in cases where the ratio of known to possible inputs is low. Moreover, an acute and ongoing problem for GDSS research is developing meaningful performance indicators (Slocum et al. 2001, 14). These indicators must be relevant to stakeholder concerns (Rowe and Frewer 2000). We present performance evaluations that gauge how well SPI protocols satisfy stakeholders. We conclude by discussing impediments to SPI and evaluate the potential for improving public goods allocation using C-GDSS.

In the following analysis, we recognize the different nuances attached to the terms *public involvement* and *public participation*. We associate public involvement with formal, institutional citizen involvement in transportation and infrastructure processes and public participation with a broader realm including questions of environmental management. In our discussion, we respect the definitions of the authors concerned.

Transportation Infrastructure Planning and Design in the United States

Enormous quantities of public money are spent on TI in the United States and GIS and geovisual methods are widely used, yet decision performance is poor. In 2003 gross government expenditure on TI in the United States was $227.5 billion, of which approximately $149.1 billion was spent by state and local governments (Bureau of Transportation Statistics 2008). Public involvement in TI decision making is increasingly mandated at all scales from local neighborhood bicycle paths to the selection of transcontinental interstate corridors (National Environmental Policy Act [NEPA] 1969; FHWA 1976, 1991, 1996, 2001, 2006; Weiner 1999). Over the last decade, public involvement has become an integrated feature of TI initiatives, such as context-sensitive design (FHWA 1997, 2001), and the Transportation and Community and Systems Preservation (TCSP) program (FHWA 2005b). It is also fast becoming regarded as essential by all stakeholders, including residents, interest groups, commercial organizations, and state and national transportation agencies (Howard/Stein-Hudson et al. 1996; Wilson 1996; O'Connor et al. 2000; Campbell-Jackson 2002). Public involvement professionals are being appointed by some state agencies (Cunningham et al. 1996; South 2002, 18).

Despite this apparent proliferation of mandates, and an increasingly widespread discourse among TI planners and engineers of its merits, public involvement in TI has been, and in many cases continues to be, highly problematic. It is no secret that public skepticism and mistrust of TI designers, planners, and other professionals remains high (Carpenter and Kennedy 1988; Rahman 1993; Susskind and Field 1996; Maier 2001; Barnes and Langworthy 2004a; Krek 2005), or that public involvement processes are viewed with suspicion by many of the stakeholders they are intended to serve (Dorcey 1994; Unsworth 1994; Rubin and Carbajal-Quintas 1995; Rivera and Wooten 2003). This is because despite these mandates, the precise aims, form, method, and content of public involvement often have not been specified. Implementation is left to coalitions of state and local transportation agencies and their partners, including civil engineering, landscape architecture, and urban design firms. The results of what can be called unstructured public involvement have been uneven: According to one survey undertaken following the 1991 Intermodal Surface Transportation Equity Act (ISTEA), "many states . . . responded to ISTEA in a perfunctory manner" (Hoover 1994, 48).

Recent literature clearly illustrates the problematic effects of the strategic coupling of initiatives and legal mandates requiring specific forms of public involvement, such as environmental impact statements (EIS) and associated activities, with global understandings of public involvement (Pisano 1995; Dickinson 1996). As Bickerstaff and Walker (2001, 431) noted, "motivations for seeking public involvement have been instrumental in nature rather than drawing on wider substantive and normative arguments." Concurrently, a rather instrumental literature has come into being within the U.S. transportation community that addresses public involvement in terms of "managing," "controlling," or "containing" what are seen as its negative aspects (Creighton 1980, 1981; Dilley and Gallagher 1998; Montana Department of Transportation 1998; CH2M Hill 2001; Few 2001; Jackson 2001), or that will "guarantee success and acceptance by the public" (Transportation Research Board [TRB] 2004, 1), or suggests methods that "increase chances of voter approval" (Hoover 1998, 32). Training programs for responsible authorities are aimed at "getting people on board" (Transportation Research Board Committee on Public Involvement 1998). Unfortunately, under these circumstances, the result of public involvement efforts by responsible functionaries is often that "their procedures tend to create two sides in any contest and thus legitimate certain discourses while closing off possibilities for other views to be included in state-sponsored planning documents" (McCann 1997, 641). Public involvement thus serves the aims of select, powerful, and vocal stakeholder factions rather than the wider range of stakeholder groups (Voogd and Woltjer 1999, 847). An alternative and equally unsatisfactory outcome is that the perceived difficulty of incorporating public views effectively into large-scale TI projects overwhelms functionaries. This can lead to processes aimed at "picking publics properly" (Comeau and Rodriguez 2000) or "placing public" (Booth and Richardson 2001) and that ultimately become "characterized by public exclusion rather than public involvement" (Lidskog and Soneryd 2000, 1465). This situation often presents itself as a Gordian knot for authorities charged with formalizing and implementing public involvement (Schwartz 1996). The result is clear: There is not much collaboration.

The Arnstein Gap

In 1969, planner Sherry Arnstein proposed an eight-step scale characterizing levels of public involvement in planning (Arnstein 1969). Arnstein's Ladder is well known to the professional planning and design community (Brenneis and M'Gonigle 1992; McCoy, Krumpe, and Cowles 1994; Wondolleck, Manring, and Crowfoot 1996; Maier 2001) despite debate with her scale and nomenclature (Laurini 2001, 24). Arnstein's work is held in high regard: In 2005 she was inducted into the American Institute of Certified Planners Hall of Fame and selected as a National Planning Pioneer by the American Planning Association (2005).

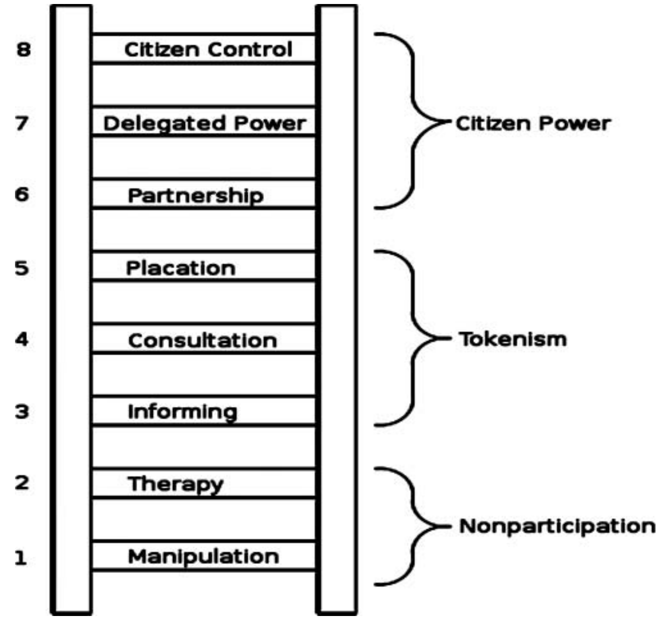


Figure 1. The Arnstein Ladder of citizen participation.

We were curious about the extent to which the ladder could be useful as an index for measuring perceptions of public involvement in TI. No direct measurements exist in the literature. During the last few years the research team has been using the SharpeDecisions/Fleetwood radio-frequency electronic polling system at a range of public meetings dealing with actual TI proposals and designs. The Arnstein Ladder (Figure 1) is shown, and the following questions are asked:

1. In your experience, how would you characterize public participation in transportation planning and design processes using this ladder?
2. Where should public participation in transportation planning and design processes be located?

Responses were coded using integer numbers 1 through 8 corresponding to each step on the ladder (Figure 2). The polling software allowed responses to be collected anonymously and in real time. This database currently contains more than 600 responses from various forums in Kentucky, Indiana, Arizona, and Alaska. So far the results are strikingly similar among these

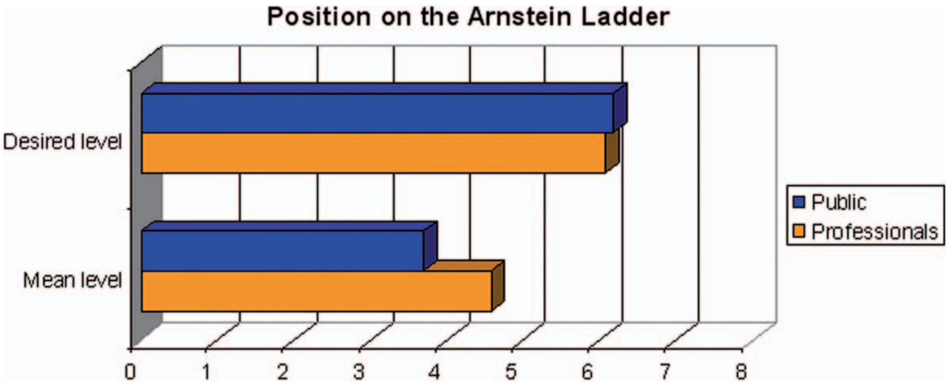


Figure 2. Stakeholder position on the Arnstein Ladder.

groups and between the states. Several professional groups were also sampled using the same protocol. At the Transportation Research Board's 2006 Annual Meeting, fifty-nine transportation professionals with a mean length of professional public involvement experience of 7.2 years were surveyed. An identical survey of twenty-eight local planning professionals was conducted at the 2006 Bridging Boundaries conference in Louisville, Kentucky. Another survey was undertaken with sixty-three respondents at the 2007 Annual Conference of the American Planning Association. All professional groups generated statistically identical mean positions.

Response to the first question shows that, although the situation is not ideal, actual public confidence in these processes is not at rock bottom (as would be indicated by Arnstein's terminology *manipulation* or *therapy*). The mean value is 3.6, somewhere between informing and consultation. Data for the second response indicate a strong agreement that, across all types of projects and circumstances, the closest named step on the ladder to the ideal point is partnership. This finding suggests that the public clearly recognizes the expert domain of engineers and planners. This is significant because commentators and academics have often assumed (sometimes implicitly) that the most desirable condition is the top rung of "citizen control" (Vanderwal 1999). Indeed, according to Campbell and Marshall (2000, 321), "Much of the existing literature concerning public involvement in TI and other applications focuses on the failure in practice of many initiatives to achieve an often unspecified notion of 'true' or 'full' participation." We have found that many TI professionals assume that the public prefers, and will demand, "full" participation (i.e., citizen control). This leads professionals to fear loss of autonomy or project control, or even their own obsolescence. In no case so far, however, do we find that the public prefers "citizen control." The mean for the first number is lower than the second by 2.5 steps on the ladder. We call this difference between the perceived and desired positions the Arnstein Gap (Bailey and Grossardt 2006, 339). The Arnstein Gap is a heuristic metric by which the existing quality deficit of public involvement can be measured. It is useful in that it characterizes a complex set of issues in a single, easily comprehensible index. The Arnstein Gap indicates that the public desire a TI planning and design system that is more directly responsive to public needs.

When the professionals' results are compared with those from the public, it is clear that the professionals manifest what we term a professional conceit; that is, they believe that public involvement is more effective than the public does. An unpaired t test was employed to investigate differences between the responses of the professionals and the public. This generated a p value of 0.0271. Therefore, we can say with 95 percent confidence that the difference is significant. Nevertheless, it is instructive that these professionals agree strongly with the public on the ideal extent of professional domain in TI.

There is a direct relationship between stakeholder perceptions of the level of public involvement and the manifold problems in TI design (Bickerstaff and Walker 2001, 2005). One study finds that a "Cause of public involvement failure" in the TI design process is that "decisions were made prior to public involvement"; that is, the system functions at a low level on the Arnstein Ladder (Minnesota Department of Transportation 2006). Another is that project sponsors are "not prepared for meetings" (Minnesota Department of Transportation 2006). These findings are consistent over time and for different types of TI projects, but the problems are not merely empirical or logistical. As Barnes and Langworthy (2004b, 8–9) note, "there has been little attempt to develop [more general] theories within the context of transportation projects, possibly because systematic public involvement is a relatively recent development in this field." Therefore, if the goal of public involvement is to close the Arnstein Gap, or to increase stakeholder satisfaction with TI planning and design processes and their outcomes while conforming to a certain set of ethical principles regarding stakeholder involvement (Kaner 1996, xiv; Voogd and Woltjer 1999, 845; IAP2 2000), an epistemological reframing is required (Davies 2001). We argue for a more profoundly geographical consideration of the context of TI improvement and the methods used in TI design.

A Geographer's View of Public Involvement in TI

Although geographers have been contributing directly to planning and management at regional levels for some time (Boyce 2004), some have criticized their peers for failing to be as visible and active as they perhaps should be (e.g., Peet 1977; Demko 1988). Hanson (2003, 465), for example, chided urban geographers for their "disinclination to make clear the links between research and possible action." This applies especially to TI. Few TI agency officials or professionals understand what geography is or does. In non-U.S. contexts, the relationship between human geography and applied planning practices is visibly closer; for example, in The Netherlands, "human geography has traditionally been an applied, practical science" (Musterd and de Pater 2003, 549). Certainly geographers have made considerable efforts to integrate geospatial and visualization capacities into transportation decision making (e.g., Yamada and Thill 2003), but these efforts are often isolated from broader consideration of geographies of public involvement. Meanwhile, a growing literature on collaborative geographical decision making including PPGIS (Ghose 2001; Elwood 2002a, 2002b; Elwood and Ghose 2004) and reflexive sociological analysis of GIS (Harvey and Chrisman 1998; Schuurman 2000; Nyerges, Jankowski, and Drew 2002) seeks to open space for action on the part of informal or underrepresented stakeholders. With the exception of the work of Nyerges, Ramsey, and Wilson (2006), however, there has been little interaction between these currents of thought and participatory TI planning and design, perhaps because the TI system is quite rigid and conservative and the large-scale and conservative management culture for these projects creates a unique set of challenges for effective geographical engagement.

Nevertheless, these problems are all geographical. They are described and analyzed using spatialized dimensions: In many cases, the problem is defined as a spatial problem (e.g., environmental justice), the data framework is spatial, and the solutions involve determining the location of, or facilitating certain uses of, public goods with the objective of distributing costs and benefits in a geographically "just" manner (Harvey 1972). This goal is also termed *environmental equity* (Bowen et al. 1995) or *spatial justice* (Dikeç 2001).

We begin with a realist perspective on landscape; that is, we accept that landscape is knowable to residents and observers and that it embodies certain cultural values. The challenge lies in how to apprehend this knowledge without reproducing elite privilege (Duncan and Duncan 1987). Therefore, a brief discussion of the relationship between power and the landscape is necessary. Here we define two geographic moments implicated in landscape production through TI. The first is the relationship between landscape and power. Mitchell (2000, 141) argues that cultural geography is ultimately about the analysis of power: "the landscape emerges as a social compromise between threat and domination, between the imposition of social power and the subversion of social order. In turn, the very *form* of landscape results from these interactions." Too often, the emergence of that landscape (i.e., the planning and design of it) has been the nearly exclusive domain of the state and its technicians. Or as Mitchell (2000, 144) put it, more pointedly, "landscape seeks to regularize or naturalize relations between people." He argued that cultural geography must become interventionist in cultural politics (Mitchell 2000, 294). In TI design, this means that the questions "Who shapes the landscape?" and "How?" should be examined in light of the documented Arnstein Gap.

The first goal for the geographer is to develop an understanding of how people realize themselves in place. What values do citizens and involved parties have, and how are these values connected with the form and content of the (local) built environment and the landscape? These questions are fundamentally geographical ones that have been addressed with respect to urban design under the rubric of New Urbanism (Katz 1994; Moule and Polyzoides 1994) and through a range of critical works that examine the ways in which ideologies find expression in New Urbanist landscapes (Harvey 1997). Cultural geographers have analyzed how new landscapes become associated with TI (Weber 2004) and showed how ideologies invoke social, economic processes that result in certain characteristic forms being embedded in the landscape (Murray-Wooley and Raitz 1992; Raitz 1996). Cultural geography as a process-based method (H. Yeung 2003), however, is rarely defined and invoked proactively by the TI design community.

Moreover, in the negotiations among politicians, engineers, planners, and public, geovisual and geospatial technologies are important. TI planning and design already relies heavily on these technologies, which are, ironically, often shorn of their geographic context when used by engineers and planners (Simkowitz 1989; Landphair and Larsen 1993, 1996; Sutton 2004; A. Chakraborty 2006). Ideally these technologies must help the community elucidate its often hidden, taken-for-granted goals and values. Such values should then be incorporated into the planning and design framework of the engineers, planners, designers, and architects who create the final infrastructure product. This product must then find resonance with the lived experience of the communities in question. The second geographical moment is centered on how geospatial and geovisual technologies can function as dialogic elements that allow exchange between professionals and the public of visual and spatial preferences and cultural values that reflect participants' relationships with their landscapes. The connection between these two geographical moments is the power to shape the landscape. Moreover, this interaction is rendered more complex by the covert, or sometimes overt, insertion of ideologies of place, or particularist geographic imaginaries, by factions in the TI design process that might or might not accord with those of other, less powerful, stakeholders. It follows that the second goal for the geographer is to develop and apply methods that connect community values effectively, that is, in ways that respond to stakeholder concerns, with the location, the physical form, and design of TI. Therefore, in the following sections, we consider how power is imbricated in landscape production through TI in two ways: theoretically, by means of critical reflection on the nature of justice in a participatory democracy; and, methodologically, by analyzing how power is devolved through stakeholder relationships with C-GDSS.

A Political Geography of TI in the United States

In the becoming of what Mitchell (2002) termed the *dialectial landscape*, the political geography of TI shapes the milieu within which the landscape is altered by development, and at the same time, the landscape, its appearance, and its attributes condition the preferences and desires of its inhabitants. In the context of TI this relationship is influenced by the democratic polity within which these projects take place. This means that processes designed to evoke and capture citizens' landscape values must articulate with the existing political and ideological systems, including commonly accepted, geographically differentiated, and often untheorized notions of democracy and justice (Sandrine 2004). It follows that one important task is to characterize Hartshorne's (1939) "areal differentiation" by understanding the particular social, legislative, and physical context of public involvement in TI and to use this knowledge to design and apply methods that help residents and professionals share their worldviews (Connor 2006). This section examines the historical regulatory framework for public involvement in TI in the United States, focusing on the democratic principles that underpin it.

Methods designed to make highways more compatible with landscape were detailed by the Highway Research Board in the 1930s (e.g., Nichols et al. 1937) and have been discussed frequently since (e.g., Adams 1981; Peaks and Hayes 1999; Lockwood 2000; Otto 2000) but the integration of public involvement with these methods is relatively recent. At the federal level, the National Environmental Policy Act of 1969 first required environmental and other impacts of TI to be disseminated (Section 205). The TRB established its Committee for Citizen Participation, which later became the Committee on Public Involvement, in 1973. The FHWA published guidelines for public involvement in TI in 1976 (FHWA 1976). But the first specific mandate for public involvement appeared in the 1991 ISTEA (FHWA 1991). Federal regulation 23 CFR 450.212 states "Public involvement processes shall be proactive and provide complete information, timely public notice, full public access to key decisions, and opportunities for early and continuing involvement." As a result, public involvement began to be addressed directly and more specifically by relevant federal agencies in the mid-1990s (e.g., FHWA 1995; U.S. Department of Transportation 1996). ISTEA's provisions were augmented by the 1998 Transportation Equity Act for the 21st Century or TEA-21 (FHWA 2002). In 2005 the entire federal highway program was subsumed under the new rubric of the Safe, Accountable, Flexible, Efficient Transportation Equity Act or SAFETEA-LU (FHWA 2005a).

Moreover, during the 1990s cross-cutting initiatives such as environmental justice (Executive Order 12898 1994) further codified the requirement for public involvement in the form of access to meetings and information related to TI proposals (Tennessee Department of Transportation 2006). For example, context-sensitive design (CSD) is a set of TI design guidelines originally promulgated by the FHWA in the mid-1990s under the rubric Flexibility in Highway Design (FHWA 1997). CSD calls for "a collaborative, interdisciplinary approach that involves all stakeholders to develop a transportation facility that fits its physical setting and preserves scenic, aesthetic, historic, and environmental resources, while maintaining safety and mobility" (U.S. Department of Transportation 2006). CSD's aim is to improve public satisfaction with the process and the designs through a respect for the values of individual communities and regions rather than imposing a uniform design template over the landscape. State departments of transportation have adopted CSD principles and in some cases have integrated these into their public involvement plans (Tennessee Department of Transportation 2006), but CSD is presented in the abstract and to be realized it requires a methodology that allows professionals to access public values and opinions prior to the presentation of specific design options.

Since NEPA, many states and some local government coalitions have promulgated complementary and parallel legislation such as environmental quality acts that mandate various forms of public involvement in environmental decision making (e.g., State of California 1970; North Central Texas Council of Governments 1984). These often apply to TI because of the scale and nature of these projects. A number of states have considered transportation more specifically and have established goals or best practices for public involvement in TI (Tennessee Department of Transportation 2006). These measures are often written around the federal codes mentioned earlier. They call typically for identification of significant stakeholders and inventory meetings of various types, and they "promote," "ensure," and "encourage" vague, but popular, concepts such as "two-way communication" and "meaningful public involvement." Sometimes these measures specify timelines for decision making. Each federal agency and state interprets these requirements differently. Within a state, different projects call for different forms and levels of public involvement because each state has its own set of agencies that handle TI decision making, and each project, by nature of its scale and differential impacts, energizes its own design coalition.

The formal linkages between abstract, or ideological, notions of democracy and public involvement principles for TI are not clearly specified in the current literature or practice, but agencies allude to certain political concepts. For example, the FHWA's Interim Advice on Public Involvement (FHWA 1995) leads with Thomas Jefferson's quote: "I know of no safe depository of the ultimate powers of society but the people themselves." According to the FHWA (2003), the primary goal of public involvement is "Acting in accord with basic democratic principles" which "means that public involvement is more than simply following legislation and regulations." Clearly, the FHWA recognizes that public involvement is an embedded political process that extends into domains beyond the location and form of TI. Therefore, we require a definition of participatory democracy that frames the public involvement process, embeds geovisual and geospatial decision support systems effectively within it, and establishes meaningful criteria against which the performance of the process can be gauged.

Landscape, Difference, and a Geography of Justice

Because the aim of public goods management in general, and TI investment in particular, is to improve spatial justice, we consider how best to frame spatial justice. To help organize the various claims regarding justice, we turn to Rawls's (1971) *A Theory of Justice*. Rawls posited three aspects of justice: distributional justice, or who gets how much; procedural justice, or how we decide who gets how much; and access to justice, or who should be included in the deliberations. First, it is necessary to state our initial condition for this analysis. Unfortunately, no public infrastructure project will have exactly the same effects, good or bad, on everyone (Harvey 1973). This necessarily unfair distribution of costs and benefits means that decisions about what to build, where, and how cannot rely exclusively on simplistic or assumed fairness criteria. A robust definition of justice must be provided and its links to public involvement made clear. Moreover, to broaden the scope of justice we must find a way to be part of the decision process and intervene before the decisions are made, to become "interventionist in cultural politics," as Mitchell (2000, 194) says; that is, to participate in deciding what, where, and how to, or not to, plan or build. Here, we examine Rawls's framings of procedural justice and access to justice and how these relate to what he terms *distributive justice*.

Harvey was one of the first geographers to adapt the Rawlsian analysis, compressing distributional and procedural justice into "a just distribution justly achieved" (Harvey 1973, 116). Since the 1970s, however, clear differences have emerged between Rawls's formulation and Harvey's trajectory of justice. For example, in *Justice, Nature and the Geography of Difference* (Harvey 1996), the environment is more than a tableau across which human justice unfolds. Power and class in their geographical specificity are critical preconditions from which justice emerges ideologically and how it is then operationalized (Harvey 1996). This dialectical materialist reasoning leads to a geographical environment that is an active agent in human socioeconomic and cultural systems (Harvey 1996).

Rawls's formal analysis helped frame an ongoing exploration of spatial justice among geographers (e.g., Knox 1982; Pirie 1983; Reynolds and Shelley 1985; Walzer 1993; Smith 1994). Critical cultural geography's approach has been to play one off against another, arguing that power controls process and thus creates unjust distributions through the use of just processes (Smith 1997). For example, Walzer's (1993, as quoted in Harvey 1996, 350–51) description of radical particularism cleaves closely to a notion of procedural justice: "Justice is rooted in the distinct understanding of places, honors, jobs, things of all sorts, that constitute a shared way of life. To override that understanding is to act unjustly." Harvey (1996), defending the notion of distributional justice, rightly pointed out that that leaves the door open for all manner of patently distributionally unjust outcomes to be legitimized. Others, such as Hay (1995), Hay and Trinder (1991), and Trinder et al. (1991), have evaluated the extent to which procedural justice also requires the expectation of a consistent set of rules and distributive justice is subdivided into modes of formal equality and substantive equality. These differ by virtue of how entitlement to equal outcomes is determined; that is, by who has acquired access to distributive justice claims. Le Grand (1991, 66), with "informed individuals choosing over equal choice sets," aspired to use aspects of procedural justice to capitalize on the observation that not all sets of goods have equal value to all individuals.

Frequently, however, only distributional justice is highlighted in discussions of justice, with questions of access and procedural justice addressed indirectly if at all (Chakraborty, Schweitzer, and Forkenbrock 1999; Joss and Brownlea 1999; Pfeffer et al. 2002; Roberts 2003). Researchers have focused their attention on the deployment of various concepts of scale in struggles over equity and justice, working with an implied notion of justice that is primarily distributional in the context of environmental justice (Silvern 1999; R. Williams 1999; Deverman 2003; Harwood 2003; Kurtz 2003; Larson and Claussen 2004). Spatial and social extents of distributive impacts have been gauged (Most, Sengupta, and Burgener 2004; Jerrett et al. 2001), combined with alternative methods of analyzing the impacts, such as cost–benefit processes (Schweitzer and Valenzuela 2004). Such distributional analyses constitute a more straightforward technical analysis involving reproducible processes and thus results. Conversely, measuring the justice or fairness of procedural justice without recourse to its distributive outcomes is more problematic (Lowry, Adler, and Milner 1997; Syme and Nancarrow 2002; Perrons and Skyers 2003). In some cases, the questions of procedural justice are even forefronted, as in exploring how public resources should be allocated in natural resource management (Lawrence, Daniels, and Stankey 1997; Ikeme 2003; Maguire and Allan 2003; Hobson 2006). Even these discussions, however, work from the researcher's theoretical stance regarding the definition of procedural justice. They do not take into account the participants' views of how just or fair an outcome was (Taylor, Godschalk, and Berman 1995).

Sociologists have tested taken-for-granted assumptions about procedural justice by gathering participants' judgments (Molm, Peterson, and Takahashi 2003). This research showed that participants had the highest opinion of other participants and rated the exchanges most fair when they engaged in processes of reciprocal exchange where each participant offered what they judged to be a fair amount without formal expectation of an equivalent offer—that is, when participants trusted each other to make just distributions on their behalf. Conversely, when participants engaged in formal negotiation, in accord with contractual law, they emerged with the lowest opinion of their counterparts. This opinion was largely unaffected by the actual distribution of benefits arrived at through the different processes; that is, the distributional justice outcomes. In short, when the process was elevated to a confrontation, formal or otherwise, such adversarial arrangements led to general dissatisfaction with the outcomes. Analogously, arrangements that might otherwise have been unsatisfactory to participants based on strictly distributional justice grounds were more acceptable when arrived at by processes that did not posit adversarial solution methods. Reciprocity between the participants fostered an enhanced sense of trust that translated into increased satisfaction with outcomes (Molm, Peterson, and Takahashi 2003). In the TI domain, participants are often confronted by two or more professionals offering differing adversarial opinions of the correct answer; that is, one that can be adjudicated using a quantitative distributional justice metric. Stakeholders often resolve this apparent conflict by weighing the long-term legitimacy of the sources instead of examining the content of the competing arguments.

If this is so, then, geographers' operationalizations of justice have been partial. In some cases geographers, in parallel with professionals, have continued to treat individuals as subjects of research rather than partners. Transportation professionals measure the distribution of crashes and congestion on the commuting population and geographers measure the distribution of polluted air and airport noise on a different subset of the population. Understandably, they reach differing conclusions about what constitutes distributional justice. Under both scenarios, however, the supposed beneficiaries of their analysis are unable to contribute in a way that more fully realizes the multiple facets of justice in planning and designing TI. Fischer (2000) has shown that infrastructure professionals behave differently when approaching questions from the point of view of citizens and parents. In some cases professionals behave like the public participants they had previously criticized as lacking in knowledge and unprofessional. Under these conditions, trust and legitimacy (process) are prior to data in stakeholders' decision-making processes.

Certain distributional justice criteria have been formalized by TI authorities. For example, environmental justice (FHWA 1994) seeks to distribute the benefits and problems of TI equally among disparate socioeconomic and ethnic stakeholder groups. Other TI decisions are driven by imputed distributional justice that allows states to justify many projects through the quantification of costs and benefits. For example, a popular justification for roadway widening is to relieve traffic congestion (Marye 1940; TRB 1975). Because there is never enough money to relieve all congestion, typically money is spent on the most congested roads or (worse) in anticipation of congestion. This argument holds that those experiencing the most traffic congestion, the highest crash rates, and the highest noise and air pollution levels are unfairly impacted and should thus be relieved of some of their costs or burden (Youngkin et al. 2003). These analyses are problematic because untheorized yet formulaic methods are used to decide who is adversely impacted and in what way (Bevan et al. 2006). Such opaque distributional justice calculations ultimately lead to decisions about what to build where. This focus on distributive justice ironically undermines the achievement of spatial justice. Moreover, the right of the professional to make these determinations is asserted because professionals are skeptical either of the technical competency of the general public, sometimes questioning their right to participate by calling them "uninformed," for example, or of their civic-mindedness, anticipating strategic behavior that will prevent them from accepting a solution. This problem is exacerbated by the widespread belief among professionals that individuals will act in their own self-interests when faced with questions of general public infrastructure and thus in some way pervert the intent of broad-based public involvement.

Nevertheless, because distributional justice cannot a priori be fully attained, we argue that procedural justice and access to justice are necessary aspects of TI planning and design (Taylor 1991). If participants can agree that the method whereby decisions are made is just for all parties, this can mitigate the inevitable problem of unrealized distributional justice (Bell 2004). Rawls (1971, 118) anticipated this problem and proposed a solution with his concept of the Veil of Ignorance that makes "strategic behavior" by the public difficult, if not impossible. This principle holds that if the planning and design questions can be presented to the public in such a way that is it difficult for them to determine how certain responses will benefit them and others might not, then their best strategic move is to work toward rules that protect them if they were to be the most adversely impacted.

Mobilizing Justice into a Public Involvement Framework

To design a more procedurally just public involvement process around C-GDSS, then, it is necessary to mobilize these abstract arguments about democracy, justice, and the production of the cultural landscape into specific principles around which the process should be designed. The justice framework shapes both the principles of public involvement—that is, the short-term goals for the project at hand with respect to volume, quality, diversity, and use of information input—and long-term goals of the public involvement processes that reach beyond determining the location, shape, and other physical attributes of the TI development (Frewer 1999). To this end we propose acknowledging four key sets of actors in U.S. TI design: (1) the broad range of stakeholders often subsumed in literature under the rubric of "the public"; (2) the professionals, or coalitions of design experts centered on civil engineers in alliance with one or more of landscape architects, architects, urban designers, and planners, typically employed by, or contracted to, the state; (3) appointed and elected political officials and their offices such as state departments of transportation (DOTs); and (4) theoreticians. A typical model for TI improvement is that a transportation need is defined by a DOT or sometimes a federal agency. The responsible DOT is then charged with managing and financing the development, sometimes alone and sometimes with federal cost sharing. The DOT will typically contract with a lead civil engineering firm, which in turn forms a consortium by subcontracting planning, architecture, and other relevant professionals. Public involvement is usually undertaken by the primary or secondary subcontractors. The theoreticians' influence is limited to the knowledge acquired by involved professionals during their training.

We assume and, based on the Arnstein Ladder data presented earlier, we argue that citizens concur that a certain level of technical expertise and control is both mandatory and desirable in this system. Civil engineers and other qualified professionals must establish design parameters around which TI can be built. For example, they must define minimum levels of safety and service (e.g., American Association of State Highway and Transportation Officials 1995). Simultaneously, the designer's notions of the feasible option range, or the design envelope, must be conveyed as fully as possible to the public and other stakeholders so that they can be evaluated meaningfully. Then, public values and preferences must be converted into a language that the designers can understand and apply (Laurian 2004).

Dialogic Technologies/Technologic Dialogies

The relationship among technology, people, and process needs examination. One key methodological consideration is the reflexivity with which geospatial and geovisual methods are used to facilitate dialogue among stakeholders, agency professionals, and technical experts. Typically, feedback from public to expert is highly constrained or nonexistent (Hughes 1998). TI processes often involve authorities requesting public presence at city hall forums where experts solicit feedback on a small set of predetermined plans or options, or as public involvement professionals sometimes wryly describe this, DAD, for "decide, announce and defend" (Campbell-Jackson 2002, 3). In this case, public participants know that they are responding to and being controlled by professional input, rather than the reverse.

In an effort to address chronic problems of expert privilege in planning and design, much recent work by geographers, planners, political scientists, and public administration theorists calls for a more developed theory of communication between stakeholders. We characterize these works along a continuum ranging from communicative planning to planning technologist. Communicative planning examines communication as the basis for more effective public involvement (Forester 1985; Yiftachel and Huxley 2000). It is variously referred to as dialogic planning (Bohm 1996; Innes 1996), collaborative planning (Healey 1997; Innes and Booher 1999a, 1999b), participatory planning (Forester 1994), community dialogue (Helling and Thomas 2001), or simply public involvement, among most of the formal transportation community (FHWA 1996, 2001). Where it is theorized, it reaches back most often to Habermas's theory of communicative rationality (Habermas 1984; Forester 1989; Healey 1997; Skollerhorn 1998; Ploger 2001). Agreement on ideas is seen as a realistic expectation of reasonable people engaged in ongoing dialogue (Forester 1994; Innes 1995, 1996; Healey 1997; Klosterman 1999). The efficacy of Habermas's theory of communicative action is dependent on the achievement of what Habermas (1990, 93) called "consensus without force."

Some theorists retain faith in the Habermasian ideal speech tradition, arguing for more sophisticated forms of civic discourse (e.g., Innes 2004; Rios 2008). These works call for and legitimate consensus-seeking research (Innes 1998). The strength of this ideological coupling is evident in professional discourses, such as in the American Planning Association's Neighborhood Collaborative Planning Bibliography (American Planning Association 2006). This lists twenty-six references under the heading "Consensus Building/Visioning/Public Involvement." Collaborative planning in the absence of consensus is not addressed. For these approaches to work, participants must exercise deliberative rationality to reach common ground. The reasons for common interest are presupposed, but these do not necessarily hold in real large-scale participatory processes. Flyvjberg (1998, 215) criticizes this approach on the grounds that "Habermas lacks the kind of concrete understanding of relations of power that is needed for political change."

This lack places Habermasian ideal speech into tension with normative functionality, and citizen participation becomes modified by a game-theoretic interest group modality. As a result, according to Jones (1997, 742), "We might . . . dispense with the hope of ever arriving at an ideal speech situation. To hold on to such an 'ideal' notion, even as a heuristic, necessarily entails a companion belief in a neutral language, a concept that is both theoretically problematic and unachievable in the practice of planning."

As Healey (1997, 72) notes, however, "The body of work now labeled under the communicative umbrella varies not just in its inscriptions. It also has different emphases." For more than a decade some communicative planning theorists have been working with alternative theories of democracy to address the thorny issue of consensus. These theories include Mouffe's (1994) model of "agonistic democracy." Taking issue with the desirability of consensus as a Habermasian processual result, Mouffe (2000, 104) claims, "We have to accept that every consensus exists as a temporary result of a provisional hegemony, as a stabilization of power, and that it always entails some form of exclusion." Moreover, according to Mouffe (1994, 6), "Democracy is in peril not only when there is insufficient consensus, but also when its agonistic dynamic is hindered by an apparent excess of consensus, which usually marks a disquieting apathy." Within this strand of communicative planning, there are shades of weight attached to the individual versus group collective action problem. For example, Voogd (2001) introduced the concept of social dilemmas to highlight how conflicts between individual self-interest and group interest could not be resolved by communicative planning approaches. Without a methodological solution to realizing what Mouffe (2000, 103) terms "conflictual consensus," however, the tension between idealized communicative practice and the instrumental rationality of the institutional structures that define, fund, mandate, contain, and execute planning directives is never far from the surface. As Mouffe (2000, 103) writes, "the prime task of democratic politics is not to eliminate passions from the sphere of the public, in order to render a rational consensus possible, but to mobilize those passions towards democratic designs."

Here, though, the phrase "democratic designs" is highly problematic. Agonistic democracy without methodology is still not a practical proposal. In this respect, we follow McGann (2005), who argues that "While . . . consensus fails as a basis for deliberative democracy, . . . a theory of deliberative democracy based on majority rule is still possible. . . . I argue that although political decision-making is inevitably coercive, it is still possible to distribute coercive power equitably." Therefore, we believe that agonistic democratic expression must be fostered, consensus is not possible and should not be the objective, yet the framework within which power is exercised should allow the equitable distribution of coercive power. The caveat here is that the "equitable" must make sense to participants. It does not have to accord with principles espoused by detached observers. Moreover, in much of this literature, theoretical discussion is not embodied with frameworks for actually realizing public participation dealing with concrete issues in a more meaningful way.

Planning technologist work takes a more methodological approach. This paradigm views technologies as enabling mechanisms capable of encouraging participation, facilitating dialogue, and structuring input to reach stronger, usually defined as more consensual, outcomes (Kane 1990). This began decades ago with the use of models and plans in public forums and charettes (Batty 1994) and extended through the application of plan drawings, computer-aided design (CAD), renderings and other electronic 2-D visualization media, to 3-D and now virtual reality visualizations. Communication and analysis technologies include nonelectronic modes such as facilitation methods (Kaner 1996) and decision theory. More recently, GIS has been integrated to varying degrees into public involvement in infrastructure planning (Budic 1994), policy making (Sweeney and Rogers 1998), and environmental management (Cinderby 1999). The scope has been broadened to include the role of information and communication technologies (Turner, Holmes, and Hodgson 2000; Brail and Klosterman 2001; Keskinen 2001). Consensus plays a key role in the planning technologist discourse in the sense that these technologies are often applied to public and group involvement problems with the explicit aim of reaching or forging consensus (Schwartz 1996; Schwartz and Eichhorn 1997). To the extent that stakeholders do not participate in this, or the goal is not achieved, they are considered irrational. The relationship among people, process, and technology remains problematic because communicative planning literature rarely speaks to the specific properties and capacities of geovisual/geospatial technologies or their application, and the planning technology literature does not always treat technologies as geographically and socially embedded discursive modalities (Jankowski and Nyerges 2001).

Effective public involvement situates geospatial and geovisual technologies as elements within a dialogic epistemology (Walker and Daniels 2001). These technologies should communicate values from stakeholders to professionals back to stakeholders and thereby into the landscape through TI. They must also function as technologic dialogies; that is, their use should elicit inter- and intrastakeholder dialogue that otherwise is hard to encourage. They should help us "make sense together" (Forester 1989, 17), even if this dialogue does not take the form of a classic consensus, or convergence, on structural design or placement. For example, GIS application in transportation typically features spatial or network optimization over one or more dimensions (e.g., Loo and Kai 2005; Verma and Dhingra 2005). In many such applications, though, public involvement has not been solicited or theorized and priority setting is defined by the elite, sometimes the individual researcher (Salah, Bedran, and Isam 1999). Another classic information flow problem in TI design deals with visualization. Highway engineers speak of level of service (LOS) when evaluating highway improvements (TRB 1970). This parameter is a compound index of flow rate, vehicle speed, safety, and mean distance between vehicles. Civil engineers have shown that it is not comprehensible to nonengineers (Park and Kho 2006). Rather than attempting to educate the public about LOS, it is more instructive to render various LOS scenarios in geovisual mode and evaluate public responses. For these visualizations to be truly dialogic, however, this requires a feedback mechanism through which analytic engineering and design valuations can be generated and introduced into the decision system. Arnstein (1974, 47) moved that "the principal, and easily overlooked, potential use of interactive graphics . . . is to provide information to the public to involve them clearly and directly in model building and the political process." To the degree that this can be achieved within this democratic polity, other benefits accrue. As political scientist David Held (1990, 259) argued, "If people know opportunities exist for effective participation in decision-making, they are likely to believe participation is worthwhile, likely to participate actively and likely, in addition, to hold that collective decisions should be binding."

We distinguish our approach from participatory or collaborative planning that holds consensus as an ideal (Margerum 2002). For geographical reasons (i.e., both scale and cultural differentiation) we do not recognize consensus on design as a realistic or achievable goal given the conditions under which these decisions are made. First, these questions involve large-scale multistakeholder involvement in highly complex, often contested projects (Krek 2005). Consensus-seeking approaches might be embedded within the larger public involvement protocol, but the final objective is not unanimity or anything approaching it. Attempts to hybridize formal expert multicriteria approaches with Delphi-type processes that permit goal and criteria modification have worked in smaller settings, but theorists recognize that cost and time limitations can restrict this approach to "small samples of opinion leaders and stakeholder representatives" (Keeney, Von Winterfeldt, and Eppel 1990, 1011). In view of the scale of TI decision making discussed here, this form of consensus-oriented approach is not workable. Moreover, method is not independent of the cultural context of its creation and application. For example, decision theorists have observed how cultural preferences and expectations for consensus can affect resource management using formal multicriteria methods (Ridgley and Rijsbermann 1992). This means that it would not be appropriate to assert that the framework developed here applies to different contexts such as TI planning in, for example, European (Stamatiadis 2001; DeJong and Geerlings 2005) or Asian contexts (Schwartz et al. 2003).

These observations do not mean that there is no possibility of justice or that a nonconsensual collaborative framework is morally or practically inferior to consensus-seeking approaches. Indeed, pursuit of consensus in environments of uneven power will inevitably result in inequities in one or more facets of justice. This is recognized by FHWA (2003) in their more pragmatic definition: "Consensus does not mean that everyone agrees enthusiastically but that all influential groups and individuals can live with a proposal." So long as all stakeholders are considered influential, we agree with this framing.

Structured Public Involvement

We use SPI (Bailey and Grossardt 2002) to describe protocols developed from the preceding principles. The programmatic goal of SPI is to increase spatial justice by integrating geovisual and geospatial tools into the dialogic epistemology already detailed. The proximate aim of SPI is more simply stated for the benefit of professionals and stakeholders: to increase public satisfaction with the TI design process and product. To the extent that the Arnstein Gap can be closed, this will move us in the right direction, but given the geographical complexities within which this decision making takes place, realizing this aim is far from simple. The core principles of SPI application can be described as follows. SPI assumes that engineers, planners, and designers are experts in the technical field and their technical input should be respected (Thomas 1995). Only community members, however, know their own cultural, spatial, and social preferences, and these knowledges and preferences should be sought and respected to the greatest extent possible. The process should be framed around Rawls's Veil of Ignorance to minimize the impact of an individual's strategic behavior on all other participants. This means soliciting input anonymously, simultaneously, and equitably through a one-person, one-input system.

Geospatial and geovisual technologies can be helpful in negotiating an understanding of these preferences between public and professionals but only when employed reflexively. In no case should a process be organized exclusively around a particular technology in such a way that the operators of the technology are excessively privileged in decision making. Further, SPI holds that the traditional definition of consensus is not necessarily achievable, nor is it necessary for the attainment of strong measures of procedural justice, access to justice, and, ultimately, distributive justice. SPI takes the form of a reflexive, iterative, and distributed protocol for organizing the integration of professional and nonprofessional input into complex infrastructure design problems (Figure 3).

SPI consists of a set of linked dialogic processes featuring a reflexive use of geospatial methods, geovisual methods, or both. SPI repositions the planner or designer as a consultant and facilitator to the design process. Professionals do not attempt to appropriate complete control of the process or determine its outcomes (i.e., seek to maintain or widen the Arnstein Gap). Each facet or step of the plan or design should show how it is accountable to the cultural preferences, or design inputs, of the public, thereby demonstrating the quality of the professionals' responses to public input and increasing public confidence in the legitimacy of the outcomes (Konisky and Beierle 2001). Public input should be generated and documented prior to the initiation of the process of creating designs or plans. The methods of generating and documenting public input should be efficient, accurate, and transparent to the public. All public inputs should be incorporated into the analytic model, regardless of professional conceit (i.e., judgment on the suitability of specific inputs into the design on the part of the designers). This framework allows professionals to access stakeholder values that guide solutions with a high level of technical, financial, and political performance. Figure 4 shows how SPI addresses justice deficits when compared with current best practice public involvement.

During the last ten years the research team has integrated SPI into a variety of TI planning and design processes. The scale, complexity, and duration of the studies vary, but all involved close collaboration with a range of partners, including planners, architects, landscape architects, civil engineers, stakeholder groups, and local and state government officials. They include participatory routing analyses using a GIS/multicriteria decision support system for an interstate highway corridor (Grossardt, Bailey, and Brumm 2001) and an electric power transmission line corridor (Jewell et al. 2009), visual aspects of rural highway design (Bailey, Brumm, and Grossardt 2001), transit-oriented development in a low-income minority neighborhood (Bailey, Grossardt, and Pride-Wells 2007), noise wall design in humid zones and in arid landscapes (Bailey and Grossardt 2006), and participatory visual evaluation of large-scale bridge structures (Bailey et al. 2007). This section discusses what we have learned about these problems and critically evaluates the results.

Analytic Minimum Impedance Surface for Highway Corridor Analysis

AMIS is a participatory multicriteria/GIS corridor evaluation methodology designed to allow comparative evaluation of proposed highway corridors (Grossardt, Bailey, and Brumm 2001). The purpose of AMIS is to integrate social, engineering, environmental, and other landscape features into a geospatial decision platform that facilitates comparative quantitative analysis of corridors. This application can be considered a hybrid PPGIS/institutional application in the sense that environmental, socioeconomic, and cultural input factors are defined, aggregated, and valued by stakeholders but the framework within which participation takes place is determined by transportation agencies according to legislative remit.

A criterion called *impedance*, or *net social cost*, was developed from an AHP model (Saaty 1990). It represents a reluctance to develop the highway through that particular attribute. The higher the impedance, the less likely the route is to use that location. A total of sixty-nine elements were identified in facilitated meetings with a state highway agency and these were categorized using a stakeholder-driven affinity grouping

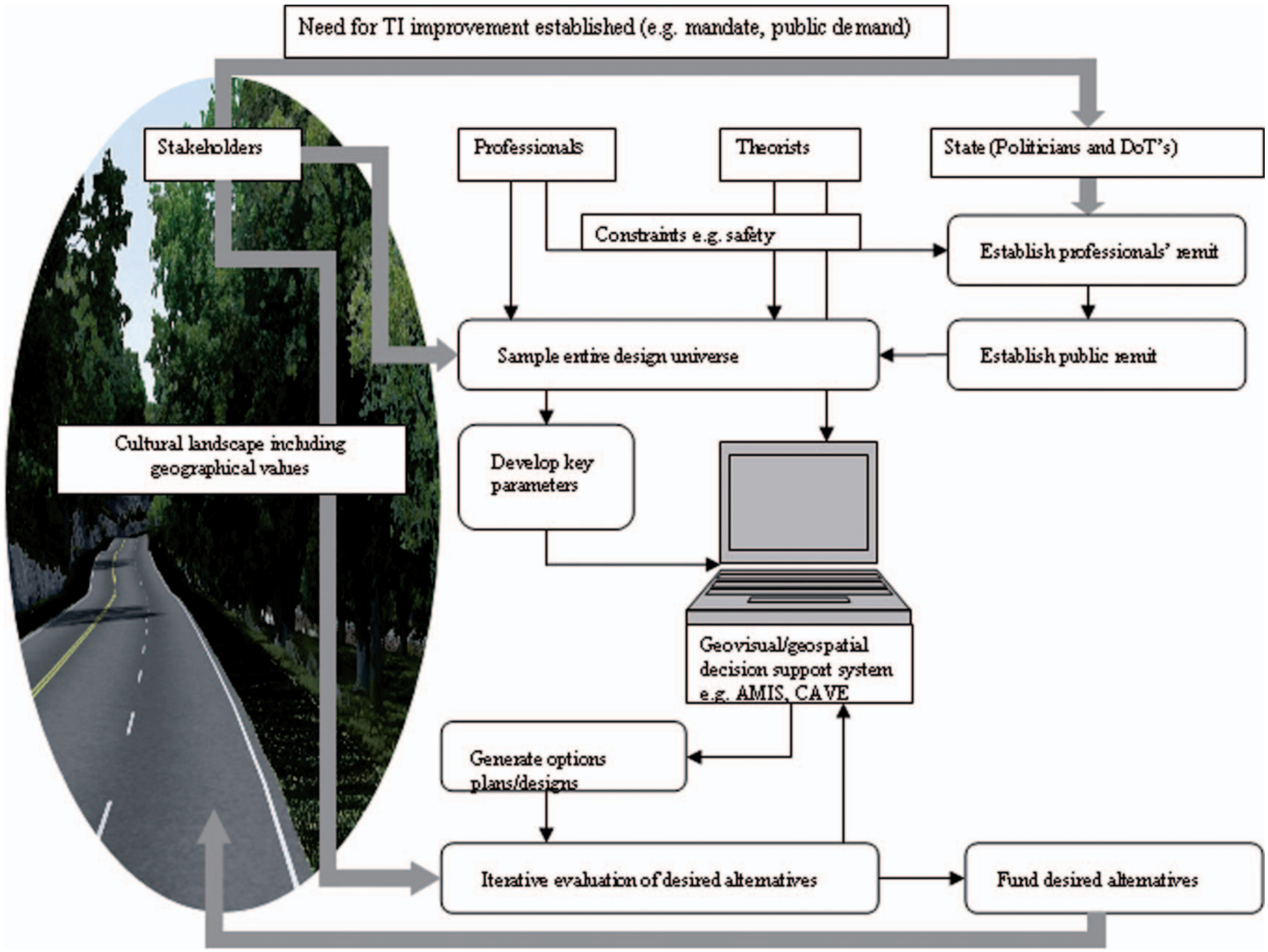


Figure 3. SPI process model showing dialogic use of geovisual/geospatial technologies in U.S. context.

process. These elements ranged from engineering considerations such as steep slopes, to human-created features like fish ponds, to regulatory and environmental features such as wild and scenic rivers, and to socioeconomic considerations such as low median income. At first, impedance values were elicited for each element through facilitated focus group meetings, then these elements were aggregated by the participants into affinity groupings, and finally the groupings were weighted for impedance. A three-level AHP hierarchy was used to weight classes of features against each other and elements within a class against each other. ArcView was used as the analysis and output platform. The output is a raster decision landscape representing net social cost over which various logical operations can be performed, such as summation of net origin–destination impedance to find minimum impedance paths within a user-specified range, the generation of an inventory of features affected by a specific routing, or the factor contributions (e.g., units or meters of specific item coverage) along low-impedance corridors. Least cost routing routines, with sensitivity parameters, were scripted and applied to generate a range of least cost (net social impedance) corridors across the landscape (Figure 5). The AMIS decision landscape possesses different qualities than a GIS within which features are stratigraphically added (e.g., Gilbrook 1999).

The core premise of AMIS is to move routing questions away from immediate contestation over specific landscape features and into a more analytic framework about cultural values and aims. This was intended to allow the GIS to work more reflexively, as capacities to elicit and augment public preference information obtained through other media are considered a significant component of its expert decision support capacities (e.g., Yamada and Thill 2003).

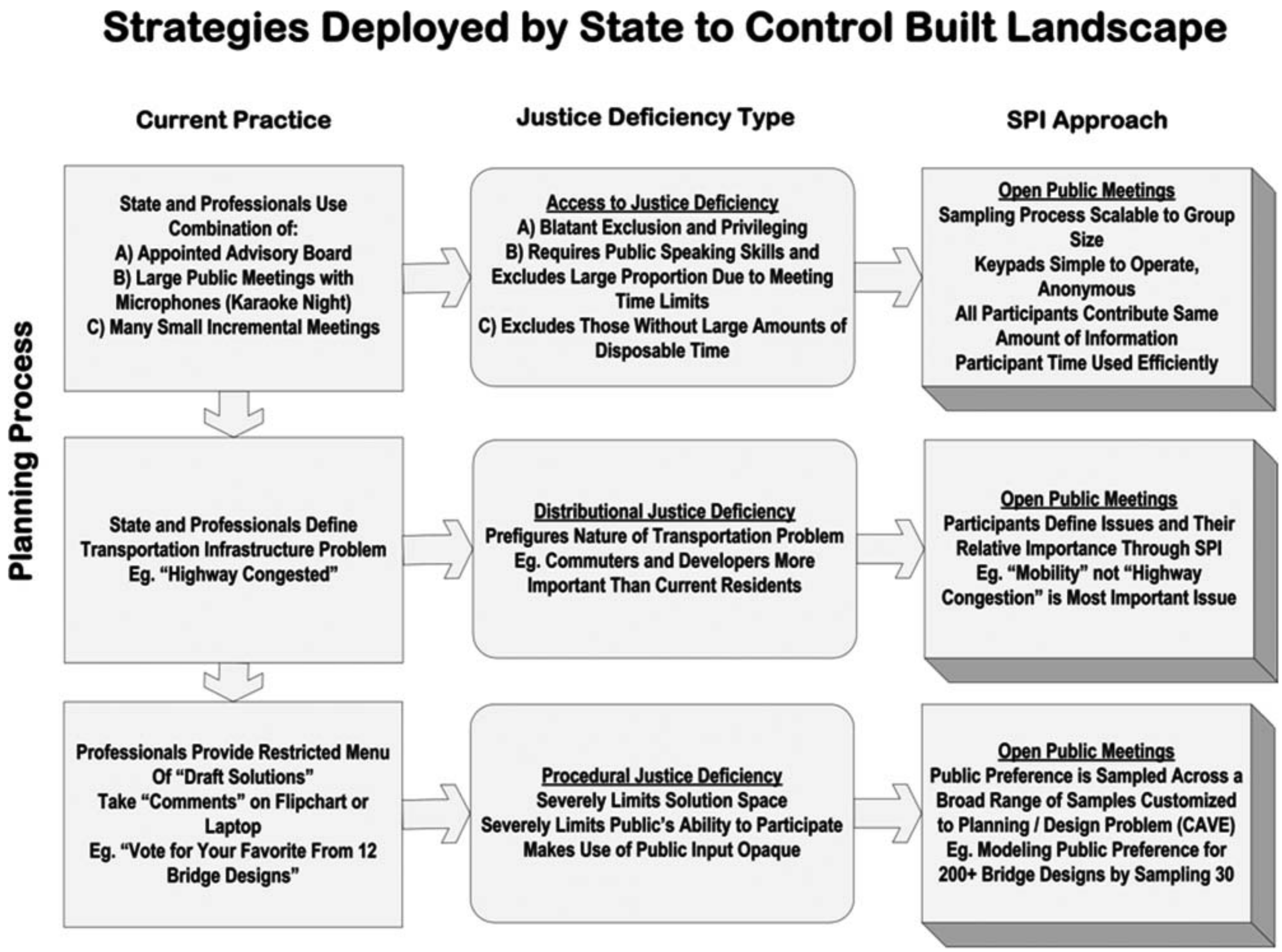


Figure 4. Strategies deployed by state to control built landscape.

Then, AMIS was integrated into an SPI protocol for multistakeholder highway corridor evaluation in southern Kentucky. During this protocol, AMIS functioned as a dialogic element when featured at public meetings. For example, a caving group participated when environmental valuation data were gathered from stakeholder groups. The transportation system managers and engineers were not aware of the existence or location of these caves or the strength of feeling regarding these caves or their recreational potential until AMIS was introduced and explained. As a result, a secure geospatial information-sharing system had to be developed in collaboration with stakeholders in an initial environment of incomplete trust. Once complete, this approach enabled the caves to be located and prioritized without the recreation group's proprietary raw geospatial data being surrendered to state and local authorities. The research team's presence as a nonaligned third party allowed this arrangement to succeed. The highway corridor alignments then took account of the presence of caves. Another interesting finding was that engineering professionals provided lower impedance values for engineering factors than all other participants. This finding was helpful in reducing public skepticism regarding the value of nonprofessional inputs based on the false but pernicious assumption that engineering variables would strongly control the route of the corridor. Its performance in these respects demonstrated that, when embedded in real, complex decision environments, AMIS, like other GDSS, performed in a highly dynamic and unanticipated manner by eliciting values dialogue that might otherwise not have been forthcoming (Mennecke and Crossland 1996; Nedovic-Budic 1998; Ghose 2001).

Casewise Visual Evaluation for Highway Noise Walls

Visual aspects of TI are extremely important for many communities, but the problems associated with public involvement in visual evaluation are manifold

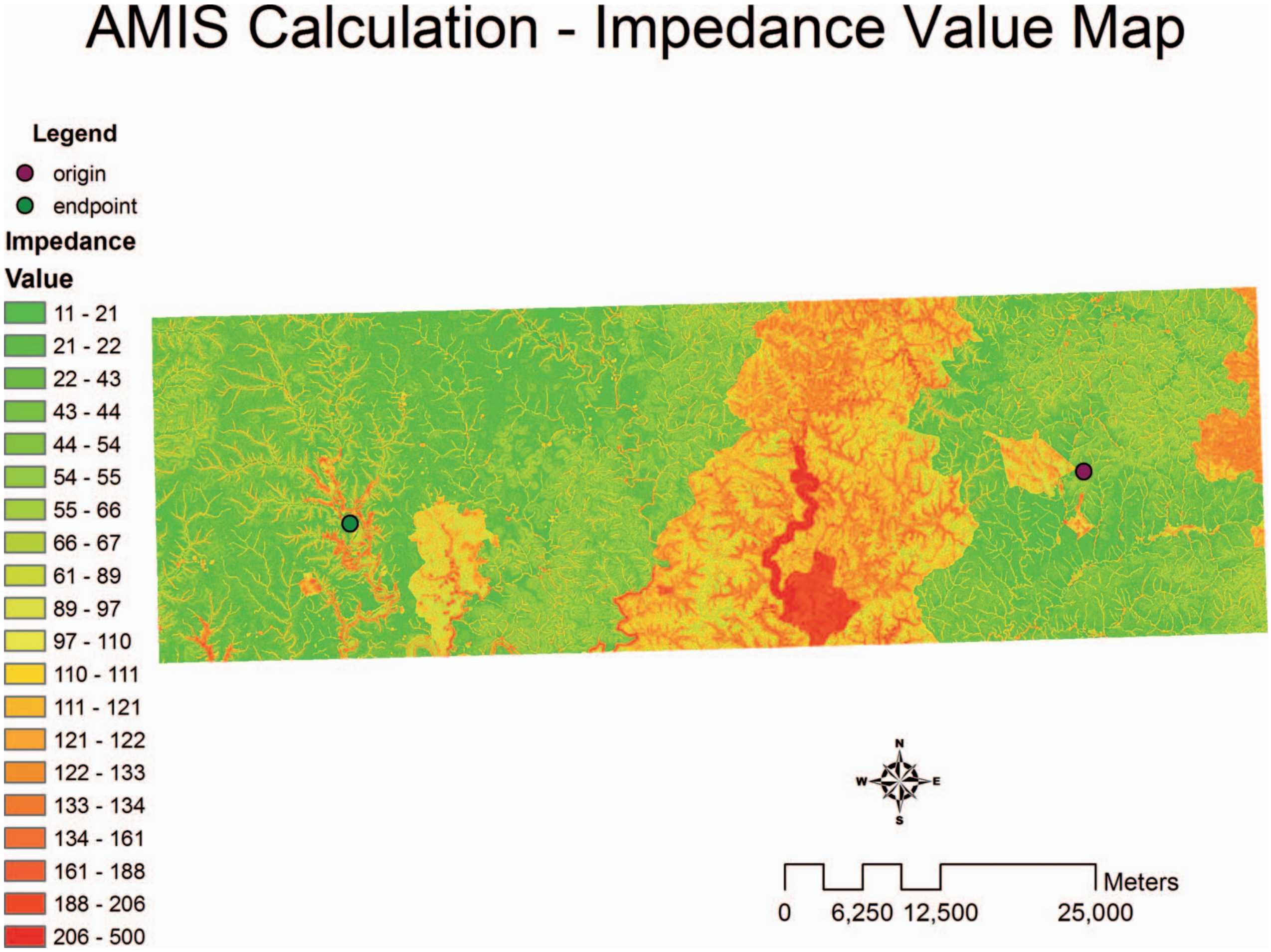


Figure 5. AMIS calculation—Impedance value map.

(Steinitz 1990; Sheppard 2001). In real public protocols, as opposed to lab experiments, input sample size is constrained by the number of visualizations that can be shown and scored by large groups of public participants. Even with an efficient protocol using electronic polling and multiple display computers, it is not feasible to score and discuss more than twenty to thirty images during a facilitated two-hour meeting. This typical input sample size does not allow reliable statistical analysis if the number of component elements is realistically large (Whitmore, Cook, and Steiner 1995; Stamps 1999). Further, if the relationships between the inputs and outputs are assumed to be complex and nonlinear, they are not easily tractable with techniques based on general linear models.

Poon (2005, 767) wrote that "much spatial knowledge is qualitative, not just quantitative, where data are mined in categories rather than continuous terms." Recognizing this, geographers have employed techniques such as Q-method (Hawthorne, Krygier, and Kwan 2008) and fuzzy system modeling to various domains including participatory coral reef evaluation (Ridgley and Ruitenbeek 1999), residential quality assessment (Malczewski and Rinner 2005), and analytic hierarchy methods (Banai 1993; Jiang and Eastman 2000). Fuzzy set modeling is an appropriate methodology for participatory visual evaluation because, in addition to ontological veracity (i.e., a more direct connection with participants' categorical, natural language understandings of image content), the problem possesses characteristics of complexity and nonlinearity in a data-poor environment (Zadeh 1965). We designed a fuzzy-set theoretic-based nonlinear modeling process called CAVE (Bailey, Brumm, and Grossardt 2001). Superficially, CAVE resembles the well-known Visual Preference Survey (VPS; Nelessen 1994) in that community feedback is gathered on visualizations of sample developments using a Likert-scale scoring system with regard to parameters such as suitability or desirability. Each image, however, is considered to be a composite of meaningful design elements, each of which consists of a number of classes. The complete matrix of these design elements with their classes is called the *design vocabulary* (Bailey, Grossardt, and Pride-Wells 2007). Preference responds in a complex, nonlinear manner to variation in any one of these parameters. Using a small number of visualizations (i.e., a subset of all possible design combinations), public preference is gauged and classified. By mapping known output (community preference) to known inputs (design elements), a preference knowledge base can be built around the known points using fuzzy set theoretic neural network algorithms. This enables preferences for untested design combinations to be estimated. Designers can use this as part of a planning support system (Brail and Klosterman 2001) to locate preference plateaus, or high points that represent desirable design combinations, and preference sinkholes, or low-preference design combinations that should be avoided (Figure 5).

The design vocabulary in CAVE protocols demonstrates how geovisualization can mediate between community preferences and design practice. Experts require guidance to be presented in terms that they can work with, and therefore the CAVE method input parameters are determined by professionals. SPI using CAVE can be applied to aesthetic evaluation of any TI development with inputs that can be characterized using elements that vary along linear scales. The design vocabulary is case and region specific; that is, it is context sensitive. It is negotiated through a series of facilitated meetings with relevant design experts (e.g., landscape architects for noise walls or highway berms). A literature survey is performed and then a brainstorming session is undertaken using stock images to determine which parameters are significant. The group then works to eliminate overlapping parameters and to establish meaningful classes for each of the inputs. To ensure that community values are not being neglected, a pilot scoring session and CAVE model build is performed using focus groups. Once the design vocabulary has been reviewed and agreed on, it forms the basis of the SPI protocol. Much more extensive outreach is then performed to increase sample data input.

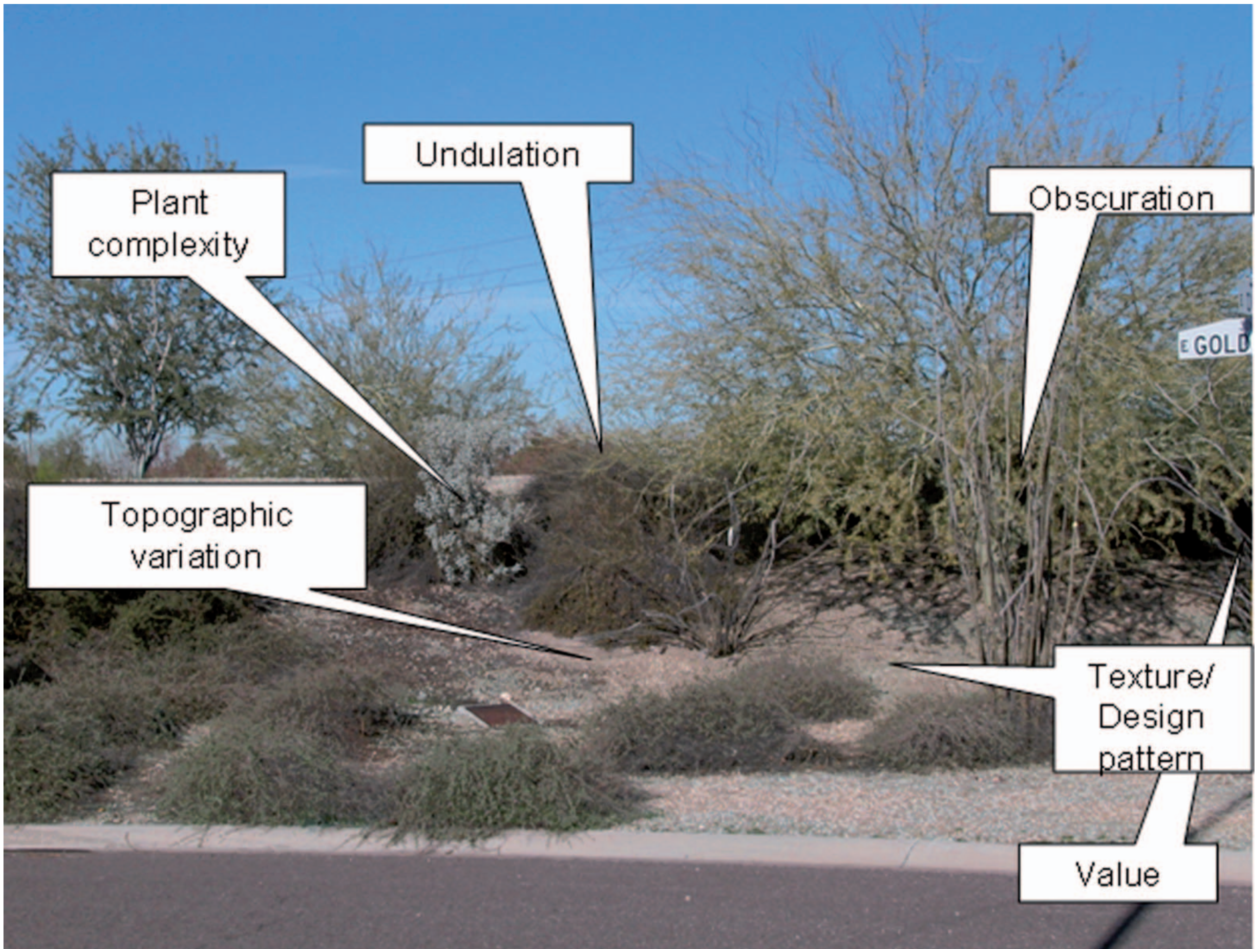
CAVE helps designers to estimate local cultural preferences for aesthetics reliably without the need to develop and score one visualization for every possible design alternative. At the same time it brings a more analytic framework to bear on the problem of visual evaluation than the VPS, for example. Empirically, CAVE allows a short series of meetings to generate useful context-sensitive preference information for the design team. Public participants do not contact the design vocabulary directly unless they ask for the design terminology to be explained at a meeting. There is no need for an architect to develop a professional understanding of massing, density, and typology among citizens, for example. Because the community preference knowledge base is structured around professional terminology, however, it is easy for professionals to use for alternatives analysis. Similarly, the preference input into the model is entirely public domain. With SPI, these input data come from anonymous real-time polling at public meetings. In this way the decision envelope is partitioned into public and professional domains that accord with preferred Arnstein Ladder levels.

In an initial noise wall study, the team gathered a palette of images suitable for humid climates in the eastern United States. These images were then parameterized by a landscape architecture team. This design vocabulary was found to be not suitable for arid western zones. The parameter "hue" for example, which exhibited a wide range in the eastern case, was shifted toward sepia and neutral colors in the arid zone case. This meant that a color defined as "light" in the eastern case possessed a very different meaning in the arid case. Figure 6 shows a sample berm-type noise wall in arid land context with the design vocabulary highlighted.

Results of SPI Process Evaluations

Evaluation of public participation presents many challenges (Rosener 1978; Rowe and Frewer 2004). In the transportation community, formal quality evaluation criteria are lacking or deficient (Szyliowitz 2002). If evaluation is performed, quality is gauged informally by the state transportation agency based on number and intensity of complaints received in response to a specific design proposal (Pima Association of Governments 2005). Evaluation bodies are often made up of the design and engineering elite and their peers (Pima Association of Governments 2005). Criteria such as the inclusiveness of the process and the quality of the decision are outlined, but the indicators used to gauge these criteria are often problematic, if they are gauged at all. The TRB (1999) proposed thirty-two metrics, each gauged by agents of the design authority. There are many reasons why this situation is not consistent with the broader democratic goals espoused by TI planners, design coalitions, and public agencies such as the FHWA (1995, 2003).

A key premise of procedural justice underpinning SPI is that "in exchange for participation in a fair and open process, citizens often are willing to support the



Input variable	Classification system			
Material texture	Earth berm	Smooth Stone	Patterned Stone	
Wall color (value)	Light	Medium	Dark	
Plant complexity	Most simple	Simple	Complex	Most complex
Obscuration	0-10%	11-25%	25%+	
Design pattern	None	Basic	Geometric	Curvilinear
Undulation	None	Staggered	Undulation	
Topographic variation	Low	Moderate	High	

Figure 6. Context-sensitive noise wall showing design vocabulary.

outcome of the process even if their preferred alternative is not selected" (O'Connor et al. 2000, 2). SPI results so far bear this out. During the final public meeting of each protocol the electronic polling system was used to gauge public satisfaction with the SPI process. We called an anonymous real-time vote and asked "Evaluate your satisfaction with this process." An integer scale of 1 (*lowest*) through 10 (*highest*) was used.

Figure 7 shows that SPI consistently demonstrates very high process satisfaction across a wide range of TI applications. Third-party verbal evaluations are congruent with the numerical evaluations; for example, in the Transit Oriented Development study, neighborhood participants observed that they had "never seen this level of public involvement before in a similar project" and they explicitly recognized the "value of

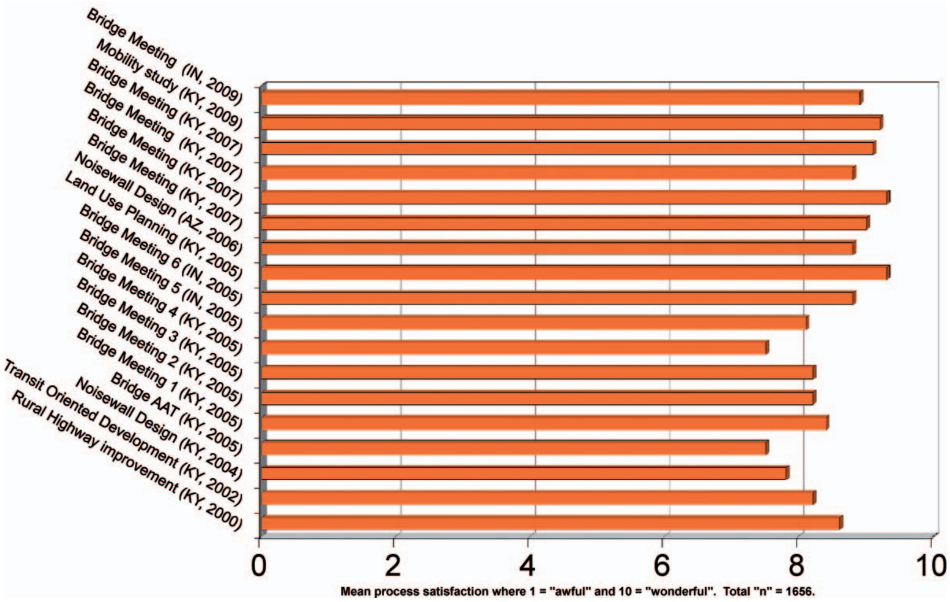


Figure 7. Mean satisfaction with SPI processes, results from 2000–2009.

the SPI process for efficient use of participants' time" (Bailey, Grossardt, and Pride-Wells 2007, 250). Compared with unstructured public involvement that results in nonparticipation, confusion, or outrage, SPI ensures that the time spent on engagement is not infeasible, nor do commitments grow with each meeting into an infinite and unknowable future. The importance of this is clear from stakeholder evaluations. This is one reason why respect for participants' time should be recognized as a principle of public involvement. More is not necessarily better (Rydin and Pennington 2000).

Successful public involvement is not only about the public, however. SPI protocols require close cooperation with engineers, designers, and other professionals (Khisty 1996). Full and active collaboration on their part is critical in defining a meaningful design envelope within which it is agreed that public participation will count (Albrechts 2002). To achieve this embeddedness, professionals need to be reassured up front that their opinions and knowledge matter. On some occasions we noted unease with the idea that the public, or "uninformed" stakeholders, would be exercising design authority. This concern can find expression in TI professionals' need to clarify the public's role to them (O'Connor et al. 2000; FHWA 2003). Professionals able to resist impulses to tell the public they were "wrong" or to adjudicate the cultural suitability of preferred designs found SPI more useful. In several cases we found that showing the professionals the Arnstein Gap findings was one way of illustrating the problem and emphasizing that the public believes in a role for professionals. Once this confidence was established, designers worked on opening the design process to the extent feasible without worrying about usurpation of their remit or of ceding design input improperly to unqualified participants.

Conclusion

We have argued that successful C-GDSS deployment in large-scale public goods questions requires theoretical and methodological attention. In our C-GDSS case study domain, TI decision making, the power relations that structure the decision-making system control both the aims that geovisual and geospatial technologies serve (i.e., the epistemology of spatial justice) and the way in which geovisual and geospatial technologies are employed (i.e., the methodology). For TI, the problems with group decision making are complex and deeply rooted historically (Klein et al. 1993). Moreover, even under theoretical conditions of complete transparency, power differentials would militate against professionals and the public feeling as though they can achieve equilibrium. These issues work against elimination of the Arnstein Gap. Nevertheless, evaluations show that SPI using AMIS or CAVE reconfigures, and in some cases inverts, the power structure implicated in the production of the cultural landscape through TI planning and design (Walters, Aydelotte, and Miller 2000). SPI aims to avoid what Harvey (1996) termed *militant particularism*, in this case triggering or augmenting stakeholder conflict over specific visual or spatial aspects of TI plans or designs, and instead uses the geospatial and geovisual technologies to elicit cultural and visual preferences that respect community values and to facilitate dialogue about these values. We are optimistic that, in the medium term, SPI using CAVE and AMIS and other methods can improve TI decision quality and thereby over time reduce this gap.

In the longer term, SPI processes can contribute to what Docherty, Goodlad, and Paddison (2001) termed *civic capacity*. As they noted, "Citizen participation may be fostered as much by the creation of opportunity structures that build confidence in the efficacy of participation as by the intrinsic levels of civic culture" (2225). In several SPI projects third-party evaluators noted that participants expressed a desire to have their neighbors involved and a snowball effect was documented, with numbers participating in SPI meetings increasing over time (e.g., Bailey and Grossardt 2004, 47). Better quality public involvement in TI entails less litigation because the process is more defensible. For example, in Florida, "proactive public involvement" has been found to result in "fewer appeals to management or requests for administrative hearings" compared with "districts that practiced reactive public involvement" (K. Williams 1997, 8).

Nevertheless, alteration and transformation of the landscape by means of TI development is a complex, inevitably contested process and there are limits to what SPI or any other participatory protocol can achieve (Peelle et al. 1996). These limits are bounded by the structural conditions existing in a specific participatory democracy, methodologically by the integration of theory into practice, and empirically by training, technical, and logistical considerations. The first structural problem is the nature of power in a democratic polity. In U.S. TI, no single entity exercises complete authority over design and building. Typically, the remits of advisory board and design committees are specified and what gets built depends strongly on what is available for their inspection. This calls for a tightly specified information feed among the public, the professionals, and the political system (Connelly 2006). In the case of TI, Silverman (2003) found that the role of citizens' advisory boards was constrained by their actual limited political power. During SPI work the research team has not possessed the direct power to ensure that designs are built (Pacione 1999). To some degree, the performance evaluations also reflect the project sponsors' preferred Arnstein Ladder positions. In our experience, ways can be found to contain the proportion of citizen control exercised regardless of the aims of the professionals and theoreticians involved. This can be stated in other ways: For example, professionals' trust in the public has been shown to function as a predictor of proactive citizen involvement (Yang 2005). Therefore, to realize its potential benefits, SPI depends heavily on its indirect influence, including instrumental performance evaluations such as those discussed earlier, to convince elected and, to some extent, appointed political officials of its merit. We acknowledge that this success is partly related to the elective component of the local political system. To claim overtly, as some planners have done in response to SPI, that the public is "uninformed" and therefore should not be permitted to participate at this level in TI decision making is practically and philosophically untenable for many such officials.

Another issue is the quality of the "representation" achieved by the participation. This unavoidably rests on normative assumptions. We believe that those who elect to participate and are provided with the forums and tools to do so should be able to voice their satisfaction or otherwise with designs, processes, and outcomes. The larger question of how to define representative participation and then how best to elicit and evaluate this type of participation is a thorny one that is not resolved through SPI (Bates and Wahl 1997; Carr and Halvorsen 2001; Webb and Rhodes 2002; Prevost 2006). We note that in the context of SPI the public involvement, if viewed as a sampling routine, could be considered biased, stratified, or numerically inadequate. SPI, however, fits participation within the current TI public involvement framework. No special or additional meetings were held for any of these projects. This made SPI feasible because it reduced barriers to implementation on the part of project sponsors and professionals. At the same time, it allowed relatively large numbers of attendees at public meetings—up to 300 per event—to participate fully and equally. This satisfied a procedural justice criterion and it helped assure professionals that the available public input at a meeting was as fully captured as possible. SPI data permit demographic sampling that verifies the extent to which the public meeting attendance matches the overall demographics for the region in question.

Despite these caveats, this work shows that it is possible to design geographically context-sensitive TI using geovisual and geospatial methods embedded in SPI protocols. We demonstrate that in the United States the participants strongly respect C-GDSS protocols arranged around a geographically appropriate notion of justice. Further, we believe that the dimensions of these issues and the manner in which they arrayed are not unique to the TI domain. For example, as Sheppard (2005, 1515) noted, "In the fields of forest sustainability assessment, public participation, decision support, and computer technology in spatial modelling and visualization need to be integrated." Similar issues related to the convergence of (geo)visualization, geospatial, and decision support technologies and increasing demands for public involvement exist in other landscape-sensitive domains such as parks management (Dombeck, Williams, and Wood 2004; Speller and Ravenscroft 2005). Therefore, although our argument is predicated on TI in the United States, we believe this geographical consideration resonates with other complex multistakeholder C-GDSS decision-making domains involving justice, public goods, and the cultural landscape.

Acknowledgments

The authors would like to thank all of the stakeholders who have contributed to the success of SPI protocols over the past ten years, particularly members of the public who have given their time and commitment to working on these TI-related issues. We also appreciate the cooperation of various official agencies, including the Kentucky Transportation Cabinet; the Indiana Department of Transportation; Woodford County Planning, Jeffersonville City, Indiana; and our partners in the field of engineering and the nonprofit sectors, such as Transit Authority of River City, Bluegrass Tomorrow, and many others.

We would like to thank a number of GIS theorists for their illuminating and helpful discussions over the years regarding the design and application of GIS/geovisual methods and their broader role in society. We are grateful to, among others, Shivanand Balram, Steve Cinderby, Suzana Dragicevic, Sarah Elwood, Rina Ghose, Francis Harvey, Mei-Po Kwan, Tim Nyerges, Kevin Ramsey, Carl Steinitz, Nadine Schuurman, and Matt Wilson. We would also like to acknowledge our intellectual debts; in particular, to David Harvey for his ever-significant work on geography and justice; Stephen Sheppard for his work on collaborative visualization; and Johan Woltjer in the field of critical spatial planning.

We dedicate this article to the work of two pioneer theorists in public involvement, Sherry Arnstein and Henk Voogd.

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