



Population & Land Allocation

*Evolution of Geospatial Tools Helps
Citizens Engage in Land-Planning Process*

Wisconsin's recent Smart Growth legislation mandates citizen input in comprehensive land-use planning. Finding new and interesting ways to involve citizens in the land-use planning process has become an important goal for planning professionals. Here, we explain the land-allocation process and how citizens can become involved in making community land-use choices. We also introduce a user-friendly automated tool, called "PlaceIT," that allows users to create alternative growth scenarios and that provides analysis and feedback for each scenario.

During the booming economy of the 1990s, communities throughout the United States grew in population, both from births and immigration. People were also on the move; suburbs and small cities became the most populated areas, often surpassing major urban areas. In many cases, the location of growth has been unguided, leading to sprawling patterns of development accompanied by aesthetic blight, environmental degradation, traffic congestion, school crowding, and a host of other problems.



The faces of sprawl

Engaging Citizens

Many states and communities responded by enacting "smart growth" laws or similar provisions designed to promote land use planning. The resulting concepts for comprehensive planning include citizen involvement in planning processes and "ownership" of the resulting plans. However, it is difficult to motivate citizens to participate in what has been largely the realm of professionals. Arcane and jargon-laden language, difficult concepts, opaque data, lengthy and boring meetings, and closed processes have hindered citizens from becoming more involved.

We believe it *is* possible for citizens to become involved in planning and guiding land-use decisions, and for them to act upon their oft-expressed revulsion of the problems associated with poorly planned development. We have seen evidence of this in a pilot project within the Town of Verona, (Dane County, Wisconsin) reported in other *Land Information Bulletins* (see *Shaping the Citizen Planner*, 2001; *Web-Based Community Planning for the Citizen Planner*, 2001; and *Farmland Preservation and GIS*, 2000).

A necessary component of successful citizen engagement is tools and procedures that capture citizens' interest while supporting necessary analyses and education in underlying concepts. Since no one has the "right" answer for managing growth, such tools and procedures need to be interactive as well—supporting the ability to generate and analyze alternative growth scenarios.

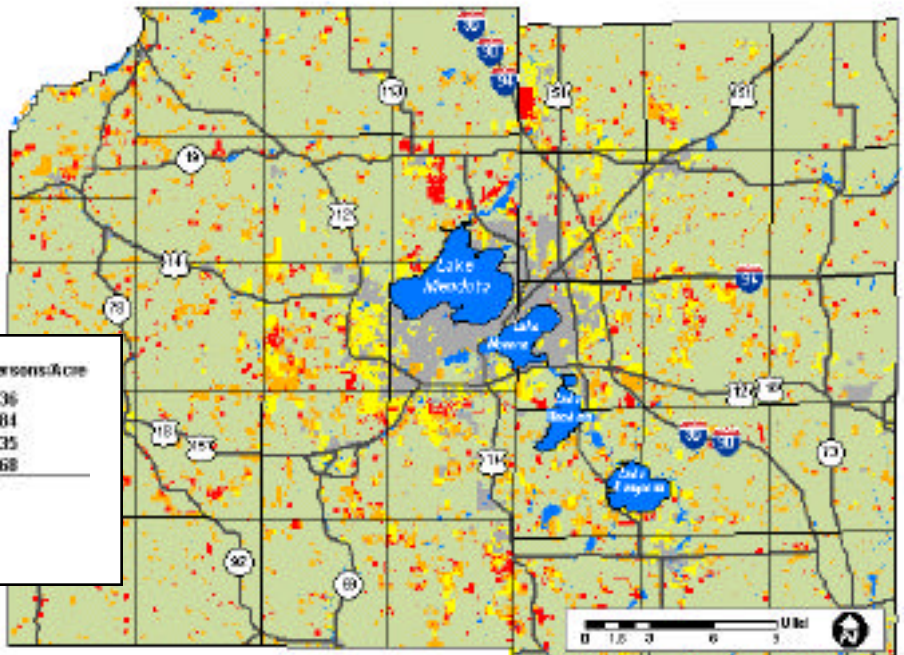
Geographic information systems (GIS) have been widely used for various land use

Dane County Sprawl Index

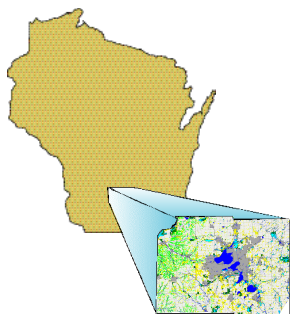
Land use in Dane County from 1970-1997 shows patterns of sprawl in which more land is being developed while becoming less dense with people. Developed space per person has more than doubled since 1970.

Legend	Population	Developed Acres	Persons/Acre
1970 Development	290,272	34,733	8.36
1990 Development	367,085	62,875	5.84
1995 Development	383,236	90,495	4.35
1998 Development	407,584	110,799	3.68

□	Township Boundaries
—	Major Highways
■	Lakes
■	Agricultural / Open



Dane County, Wisconsin



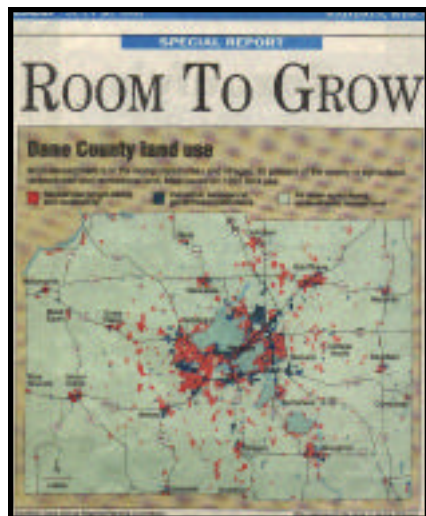
planning activities: gathering, storing and manipulating data; and providing maps and analysis. Recently, the UW-Madison Land Information and Computer Graphics Facility (LICGF) has developed a user-friendly application that extends the capability of popular GIS software. PlaceIT (Population Land-Use Allocation Exercise using Information Technology) is designed to:

- engage citizens in the planning process while conveying land-use allocation concepts
- support the creation of alternative growth patterns
- provide feedback on the impacts of the generated scenario

Where to Grow?

Planners predict that Dane County's population will continue to grow rapidly—a conservative estimate puts 72,000 more people in the county by the year 2020. Where will they live? Planners, developers, current residents and others need to ask this question, which has been addressed by Dane County Executive Kathleen Falk in her planning guide, *Design Dane!* (Falk, *et al.*, 1998), and at land use forums sponsored by the county.

Obviously, new housing will be needed to accommodate growth. But where should it go, in what form, with what impacts on the environment, social services, and transportation? What land uses will accompany residential development (e.g. commercial areas)? What kind of additional infrastructure (utilities, roads, sewers, etc.) will be needed? And, what current land uses will be changed as a consequence? To make informed choices to guide future growth, we need to be able to reliably speculate about answers to these questions. We need to know what we currently have available for growth, and what land limitations we face.



A few years ago, headlines in a local paper proclaimed that Dane County has "Room To Grow." The article suggested that 85 percent of Dane County is rural and open space, available for development. This figure, however, provided false comfort; a more careful analysis using tax parcel data shows that much of this "open space" consists of productive farmlands, environmentally sensitive areas such as steep slopes and wetlands, and even water bodies and highway rights-of-way. Using the more precise parcel data, less than 50 percent of Dane County land can accurately be classified as undeveloped (see map, p. 6).

The reality is that how we develop land involves tradeoffs. Every acre of land that goes into residential land use (as well as the commercial and transportation uses that are inevitably needed to support residential land use) is an acre lost from other uses: agricultural production, wildlife habitat, flood mitigation, and so forth.

Allocation: Making Tough Choices

We are faced with choices; choices about what lands to develop and the acceptability of tradeoffs associated with their conversion. Ideas and opinions about where and how to develop are abundant and diverse. At one extreme, some developers believe that everyone wants a five-acre lot with a big house in the country. At the other extreme,

some environmentalists might suggest that everyone should live in cities, within "high-density" development such as apartments and condominiums.

Somewhere in between are those who suggest market-based approaches, letting the buyer choose housing, but with guidance and limitations from public agencies. These might include programs to protect our remaining wetlands and most productive farmland (see *Land Information Bulletins: Environmental Corridors*, 1998; and *Farmland Preservation and GIS*, 2000) while promoting greater urban density and some development of other rural parcels.

Making these tough choices about future land uses involves a process called allocation. If residential development averages about four people per acre, then we must allocate

Methods of Allocation

Planners and others involved in community development and demographics recognize four general methods for allocating land uses. These are:

Gestalt: A user views the entire landscape, integrating variables from various maps to produce a set of potential developments through "mental integration" and manual delineation or on-screen digitizing. The Dane County Workshop with the analog "Pop Dot" exercise (see page 8) is an example. Participants use their own criteria and create allocation maps derived from their mental models of appropriate development. Evaluation of the effects of these allocations is predicted by examining other maps to determine what existing land uses would have been converted to residential use.

Interactive: An initial placement of a development receives immediate feedback concerning impacts, and allows modifications. The PlaceIt application in our land-use planning classes and in the town of Verona tested an interactive process for allocation. Like Gestalt processes, users select parcels based on viewing and interpreting other sources of information (displayed with the parcel map on a monitor). They receive immediate interactive feedback on what kinds of land are converted and whether there are development restrictions.

Scenarios: A user establishes criteria, restrictions, preferences, and then places development. If a quantitative "land-suitability" model is used, parcels (or other land units) can be allocated by score (i.e., land most suitable for development is allocated first). We have

looked at several commercially-available approaches to scenario building such as:

Community Viz, Scenario Constructor Module—sets up constraints, indicators, variables, assumptions. Development then triggers warnings and calculates indicators according to variables.

WhatIF—Development related factors are overlaid to create zones. Then suitability is determined by pre-specified criteria such as land-use goals and restrictions. Units from the overlay are selected based on fit with criteria. Future patterns can be predicted by allocation according to trends in order of precedence.

Model Builder—Factors are combined by overlay in raster environment and analyzed according to "weighting" of factor importance and quantifying evaluation criteria. This is a standard "weighting and rating" suitability modeling technique.

Agents: A user predicts future development with an agent-based model, which creates independent elements (also called cellular automata) that make decisions (in this case, development choices) based on community values. For example, a community opinion survey might include questions about housing preference. The automata's behavior would reflect the range of opinions. A few would go for huge houses on large tracts, many would want modest houses, and some would prefer apartments or condominiums. The CommunityViz commercial software package includes a "Policy Simulator," an agent-based modeling tool that works from specified assumptions and existing conditions. Agents with values and preferences inhabit the virtual landscape, making decisions that result in map of likely changes.

The planning process can help us identify what is potentially available for development, and conversely, what should be protected from development.

18,000 acres of residential land to accommodate the expected 72,000 additional people in Dane County. Of course, development proceeds incrementally—a parcel at a time, in many different locations—so we can't just put a big circle on the map and say 'this is where we'll develop for the next 20 years.'

The planning process can help us identify what is potentially available for development, and conversely, what should be protected from development. If we take this one step further and allocate land that is potentially available for a particular use such as housing, we can begin to envision patterns and processes—and hopefully guide the inevitable development into areas that maximize housing value and minimize detrimental effects.

Allocation can become a useful exercise—whether done on a paper map, a computer screen, or on a recently introduced interactive medium—a touch-screen “table” called “Smart Board.” (see sidebar, p. 11) The allocation exercise can be helpful as a means to generate discussion and evaluate alternative development scenarios, and to help citizens understand planning processes and concepts. It can:

- make the finite availability of land for particular uses apparent. For example, as explained in subsequent sections, an allocation exercise can be done on a base map consisting of “growth management factors.”
- show the spatial patterns of development. For example, we can see the difference that housing density will make in finding enough land for 72,000 new residents, or we can see the difference in land use conversion (land subsumed for a new purpose) between scattered rural versus peri-urban development.
- highlight the potential tradeoffs between alternative land uses, providing immediate and explicit feedback on potential impacts of alternative scenarios.
- generate discussion about existing land-use issues and resource patterns of interest and concern, and help citizens gain insight into possible alternatives.

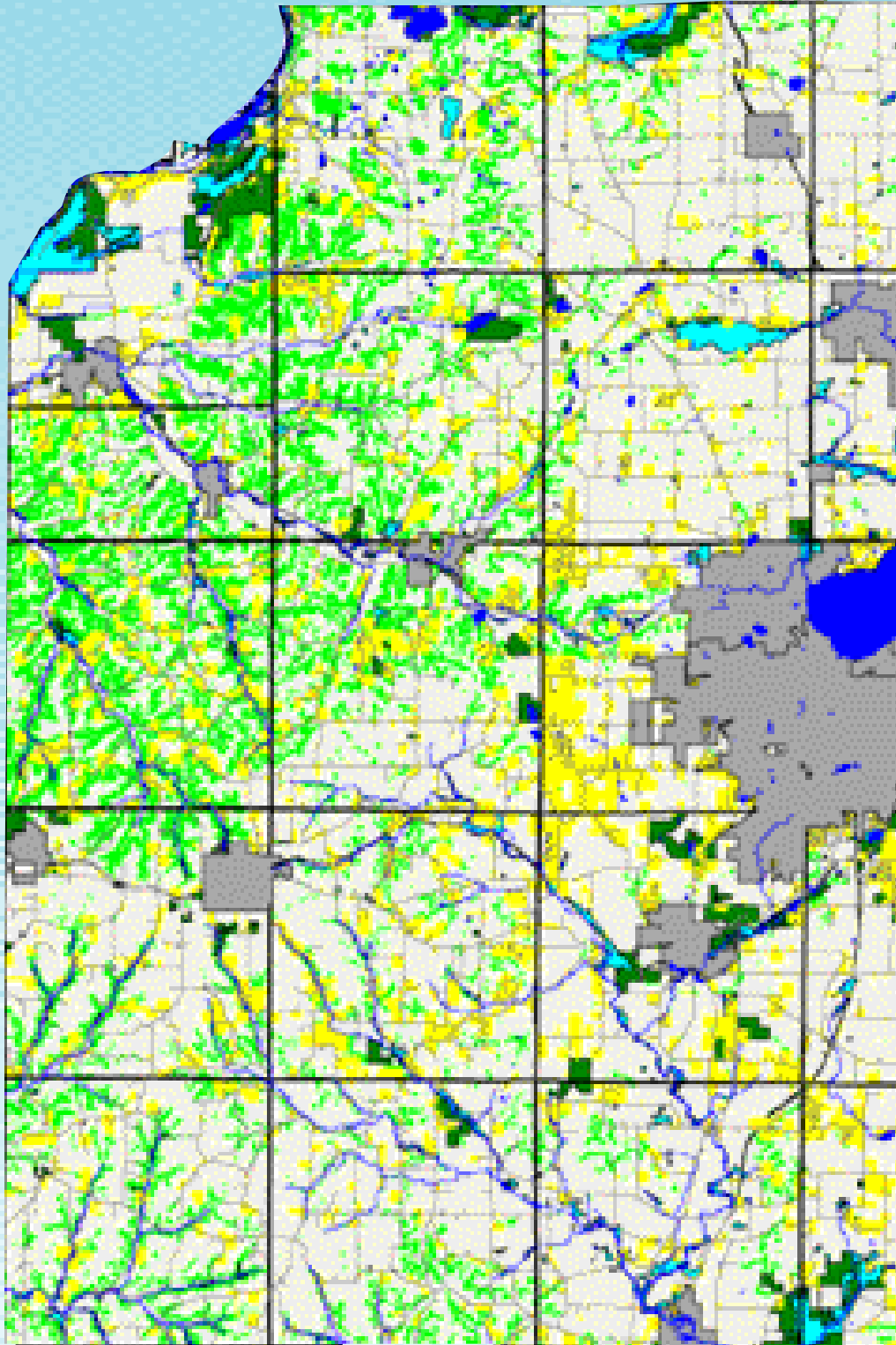
In other words, tools for land allocation can help drive a visioning process for what a landscape might look like at some future date and can directly or indirectly (by feeding allocation statistics into models) provide an indication of what the consequences of those land use choices might be.

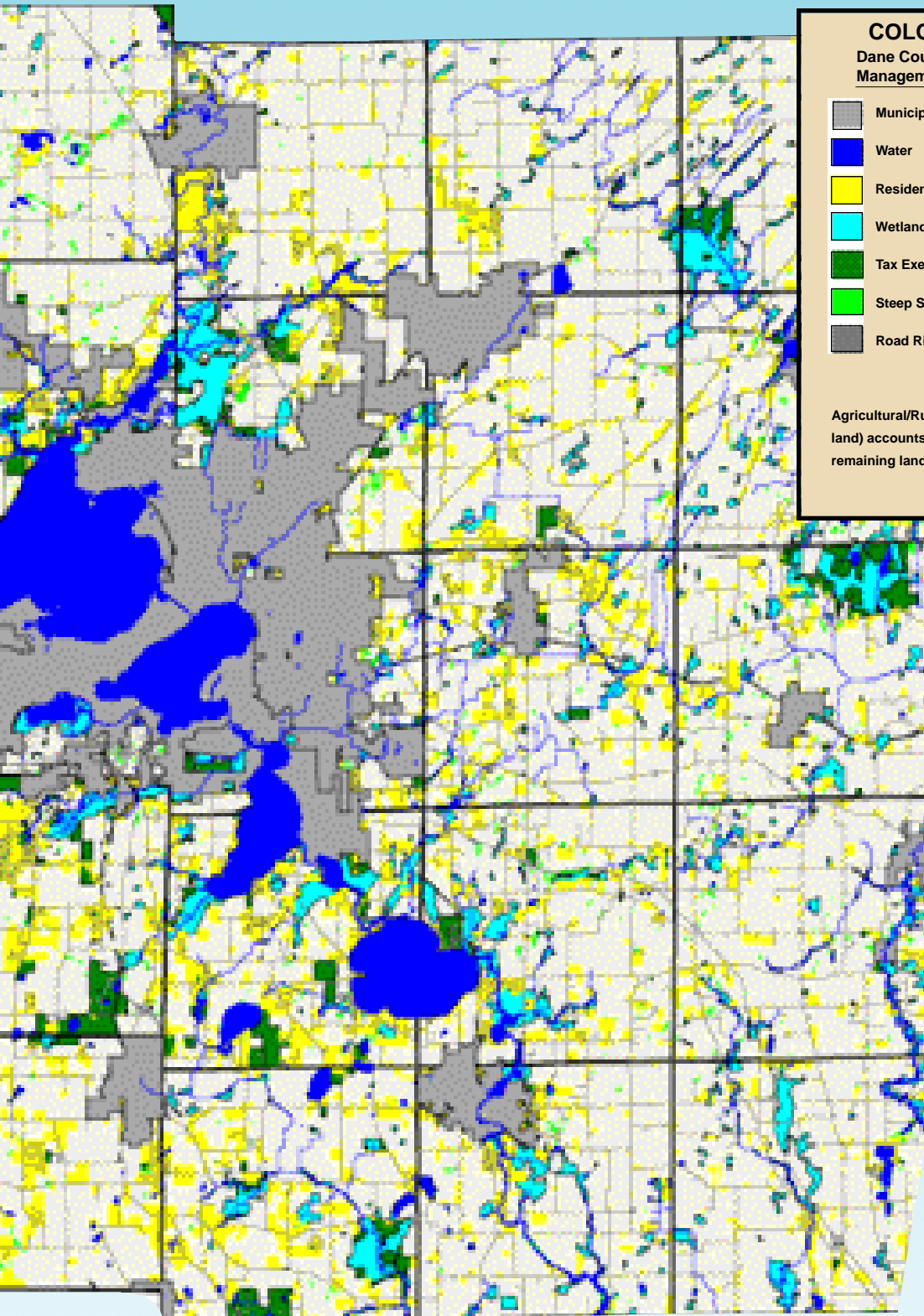
PlaceIT—What is it?

The concept for PlaceIT was developed during a hands-on exercise for several land-use forums held in Dane County in 1997-98. These forums were attended by several hundred citizens representing a cross-section of county residents. In an exercise called “Pop-Dot,” small groups of participants placed sticky-dots on large maps to designate areas they thought appropriate for future residential development (see photo, p. 8). The maps portrayed factors related to both growth opportunities and constraints such as existing development, wetlands, and steep slopes (see GMF map, pp. 6-7).








Dane County Growth Management Factors

Grow Management Factors (GMF) are physical and cultural features of land that modify, limit, or restrict development. For the purposes of PlaceIT, the map shows land that might be available for development and land that is off limits. Based on our seven basic factors (see color key at right), less than half of all Dane County remains undeveloped.





COLOR KEY
 Dane County Growth Management Factors

	Municipal	10.6%
	Water	7.6%
	Residential	11.9%
	Wetlands	2.8%
	Tax Exempt	3.6%
	Steep Slopes	7.9%
	Road Rights-of-way	6.1%
		50.5%

Agricultural/Rural (undeveloped land) accounts for 48.6 % of all remaining land.

Different dots represented different numbers of residences (dot color) and development density (dot size). Four categories ranged from urban high density (1000 people/40 acres; 13 dwellings/acre) to rural low density (50 people/400 acres; one dwelling/15 acres). Each group was responsible for allocating 40,000 new residents—the expected growth in Dane County by 2020.

The resulting maps represented a survey of preferences for land use planning. Staff at LICGF digitized the dots, and then produced several maps that combined results for each density. They looked for patterns through overlay analysis, and evaluated the impact by querying the physical and cultural features beneath the dots.

Several participants suggested that an automated version of this exercise could be very informative, so we created a version based on the popular ArcView software (other GIS software could be used). The first prototype used a fixed "dot" size—40 acres, which is an easily generated subdivision of the public land survey system. We used this version as part of the broader GIS-assisted land-use planning training course provided to

Here, Dane County land-use forum participants work on a “Pop-Dot” exercise. Among them are two county-board members who are on different ends of the political spectrum: One is a lifetime resident of Dane County, a staunch conservative and rural land owner. The other is urban-oriented, and the director of the midwest office of the Sierra Club. UW-Madison Professor Rick Chenoweth (at right) is observing how this exercise helps them more clearly understand the values that underlie choices about development and the consequent spatial patterns. For example, this exercise confirmed that an environmentally oriented strategy favors development within and near already developed areas, whereas a strategy that maximizes landowner return might scatter development throughout the scenic western part of the county.



participants in the Shaping Dane’s Future project (see *Land Information Bulletin*, Shaping the Citizen Planner, 2001). These included members of the Town of Verona Land Use Planning Task Force, county planning staff, county board members, and others. Comments on this version indicated that a parcel-based version would be more appropriate—this is the level at which land use decisions such as subdivision platting and zoning variances might be made to accommodate development.

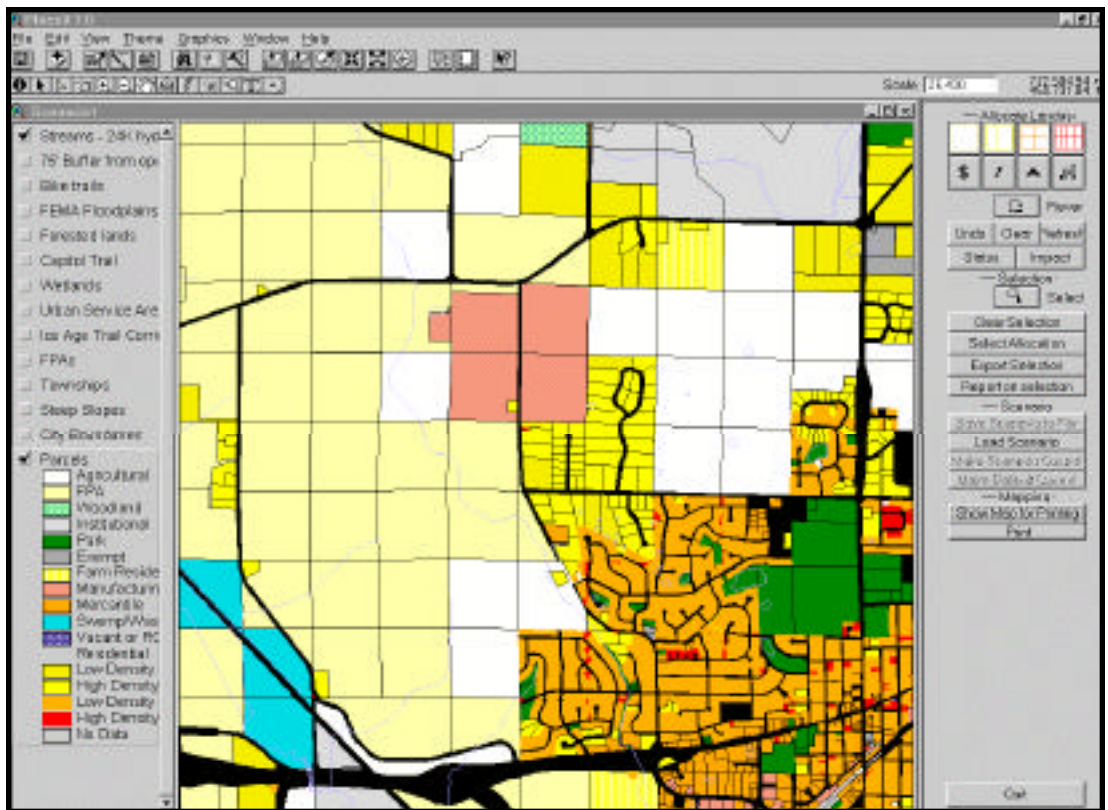
How PlaceIT works

PlaceIT is an ArcView 3.2 extension, programmed in Avenue scripting language. It operates through the ArcView user interface. (LICGF plans to also use VisualBasic programming, allowing PlaceIT to run in ArcView 8.1) As a component of ArcView, the user is able to turn off or on additional layers (e.g., themes that depict development opportunities or constraints), zoom and pan, search for areas fitting criteria and other routine GIS functions. The user operates at a parcel level, presumably the unit for land-use decisions, though it could be easily programmed to operate on a different unit of analysis. Users can accomplish two tasks. In the first, they can select parcels and "develop" them for residential use at a selected density level. They are provided with immediate (and later, summary) information about the amount and type of land that has been "converted." The second allows for allocation of land in multiple categories, as a tool for developing a land-use plan over time, and to allow comparison of alternatives.

PlaceIT is a component of ArcView that allows the user to turn off or on additional layers (e.g. themes that depict development opportunities or constraints), zoom and pan, search for areas fitting criteria and other routine GIS functions. The allocation report below is a summary report showing number of acres in each land use type.

In addition to ArcView's standard tools, the interface has a dialog with tools and buttons that run Avenue scripts. A set of icons allows the user to select the types of land uses that will be included in the allocation process. For example, our version includes four levels of residential density, industrial use, parks/open space, and commercial land-use categories, though whatever categories are desired could be

Acres	Landuse
0	Low Density Res
216	High Density Res
0	Low Density Urb
120	High Density Urb
-216	Agriculture
-127	FPA
0	Woodland
0	Institutional
0	Park
0	Exempt
0	Farm Residenc
0	Manufacturing
0	Mercantile
-18	Swamp/Waste
0	Vacant or ROW



ArcView summary tools can generate statistics on the type and amount of land to be converted from current uses.

Population		Acres		Land Use Type
Change	Current	Change	Ratio	
0	217	24	22.9	Low Density Rural
38	161	244	115.9	High Density Rural
0	51	0	0	Low Density Urban
227	1	123	122	High Density Urban
Total Obj	283	-23	260	Agri/cultiv
378	8234	-127	916	PRA
	125	0	125	Woodland
	714	0	714	Institutional
	836	0	836	Park
	-277	0	277	Exempt
	488	0	488	Form Residential
	164	0	164	Manufacturing
	80	0	80	Miscellane
	767	-18	785	Swamp/Wood
	23	0	23	Water or PDM

included in the scripts. With these tools, the user can change land uses interactively over an entire jurisdiction, one parcel at a time. A summary report can be generated showing the total number of acres in each category, with changes noted. You can save changes as a new scenario for future comparisons with other land-use plans.

When a user selects a parcel for a land-use allocation, the system will provide a warning if that parcel is currently in a restricted-for-development category. In our working version, the user is warned if the selected parcel is already developed or within an environmental corridor or farmland protection area. You can also choose a "subdivision" mode, allowing you to add or delete selected parcels interactively. These are then highlighted and temporarily allocated to residential use. These areas can be summarized as to impact, or saved out as individual polygons (in an ArcView shape file), for further analysis.

Selected parcels can be fed into ArcView summary tools that will generate simple statistics on the type and amount of land to be converted from current uses. These data can also be linked to impact-assessment models such as water-quality models, transportation-congestion predictions, fiscal-impact reports, and so forth.

The Next Step

PlaceIT will continue to evolve, incorporating many small improvements. New versions will offer more interactive feedback as parcels are selected, the ability to easily change the land-use choices palette, and a window with running statistics on land use allocations as these are made. The long-term evolution of the tool should include linkages to additional impact assessment models, so that the user is able to determine likely impacts of allocation choices easily.

Acknowledgements

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For more information, see *Planning Analyst* (forthcoming, Spring 2002 by ESRI Press; www.ESRI.com), or contact the Land Information & Computer Graphics Facility, UW-Madison, B-102 Steenbock Library, 550 Babcock Drive, Madison, WI 53706; 608-263-5534.

Smart Board provides interactive format for allocation

The denouement of the parcel-based version of PlacelT was also the unveiling of a prototype display technology—a large-format touch-sensitive display monitor that is mounted horizontally. This device, called “Smart Board” makes it possible for a crowd to gather around the table and use a finger (or other pointer) to select parcels on the display. Any software, including ArcView enhanced by PlacelT shown here, can be used.

For an event in June 2001, we invited the Verona Land Use Planning Task Force and other public officials to comment on the utility of this display table. They were given a PlacelT-based exercise asking them to allocate undeveloped parcels for future residential use. One task force member went through an entire sequence of parcel selections and evaluations, building a scenario that projected where the town could develop under the proposed land-use plan. The display table provided a visual and interactive means for the group to engage in the process, and the PlacelT software provided the mechanism for allocation and impact assessment needed to evaluate the selections.

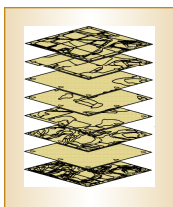


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