The changing demographic, legal, and technological contexts of political representation

Benjamin Forest*

Department of Geography, Dartmouth College, Hanover, NH 03755

Edited by William A. V. Clark, University of California, Los Angeles, CA, and approved September 13, 2005 (received for review August 22, 2005)

Three developments have created challenges for political representation in the U.S. and particularly for the use of territorially based representation (election by district). First, the demographic complexity of the U.S. population has grown both in absolute terms and in terms of residential patterns. Second, legal developments since the 1960s have recognized an increasing number of groups as eligible for voting rights protection. Third, the growing technical capacities of computer technology, particularly Geographic Information Systems, have allowed political parties and other organizations to create election districts with increasingly precise political and demographic characteristics. Scholars have made considerable progress in measuring and evaluating the racial and partisan biases of districting plans, and some states have tried to use Geographic Information Systems technology to produce more representative districts. However, case studies of Texas and Arizona illustrate that such analytic and technical advances have not overcome the basic contradictions that underlie the American system of territorial political representation.

redistricting | gerrymandering | geographic information systems

Redistricting is a critical political issue, because different election district configurations create different electoral outcomes. Placing voters into districts strongly affects the balance of power between political parties and the relative power of ethnic-racial and political minorities. Redistricting can thus be a powerful tool for political manipulation.

In this article, I first describe the basic process of redistricting and its exploitation through the practice of gerrymandering. I then review the major theoretical conflicts underlying this system of political representation in the U.S. The use of districts to elect state and congressional representatives involves at least two sets of conflicting principles. First, districts must represent both an agglomeration of individuals (or individual voters) and unique regional communities. Second, the election system is expected both to divide political factions among districts (to encourage compromise and political moderation) and to provide representation to distinct communities of interest (which typically share political goals). I next turn to the legal context of political representation, describing how efforts to expand the franchise to racial and ethnic minorities have raised a host of questions about how to define, identify, and regulate gerrymandering. In the final section, I use case studies of Texas and Arizona to examine the use of Geographic Information Systems (GIS) and independent redistricting commissions to limit gerrymandering.

The inherent conflicts within U.S. political representation mean that both legal regulations and technological solutions to gerrymandering have met with limited success. Many of these issues are not new, but the increasing diversity of the electorate and the increased technical ability to shape voting constituencies mean that these questions of political representation have taken on special urgency.

Redistricting

American politicians have used redistricting strategically for nearly 200 years (1), but the practice has attracted renewed interest and criticism in the last 30 years and particularly since 1990. Census blocks or voting precincts are typically the basic units used to construct districts. In the 2001 round of redistricting, for example, Texas used 8,285 precincts and 675,062 census blocks to create 32 congressional districts, 31 state senate districts, and 150 state house districts (2). GIS technology is a particularly useful tool for redistricting, because it can display and manipulate demographic and political data associated with each block or precinct and rapidly analyze the effect of different district configurations on expected election results (3).

Although the rhetoric of redistricting often includes references to "traditional districting principles," these principles are typically aspirational rather than descriptive, a statement of how redistricting should be done, not an account of how it is done in practice. The creation of Arizona's Independent Redistricting Commission (IRC) in 2000 illustrates an especially telling attempt to both codify and use these aspirational principles to limit abusive redistricting practices.

In the November 2000 election, voters in Arizona amended their state constitution with Proposition 106. Now part of the state's constitution, the measure created the IRC to draw the state's congressional and legislative districts and decreed how the commission would create districts (4). The IRC began with equal-population districts in a "grid-like pattern across the state," to be modified only according to the following six "traditional" principles: (*i*) compliance with the Constitution and the Voting Rights Act; (*ii*) equal population; (*iii*) compact and contiguous districts; (*iv*) respect for communities of interest; (*v*) use of visible features and existing political boundaries; and (*vi*) political competitiveness. The first principle (*i*) reflects federal legal requirements and is absolute, but the others are followed only "to the extent practicable."

Proposition 106 also forbids the use of political data for the initial phase of the drawing process in an effort to eliminate partisan manipulation, although such data could be used to test compliance with the requirements once the districts had been drawn. The residence of incumbent candidates could not be considered at any point in the process. These detailed Constitutional instructions did not avert legal controversy: in 2004, a state court overturned the plans drawn by the IRC, because the districts were not deemed sufficiently competitive.

There are a number of lessons to be drawn from Arizona's experience, and I return to this example in the final section. The controversy over Arizona's districts may seem puzzling, because Proposition 106's six districting principles seem entirely reasonable and perhaps even seem to offer a foolproof recipe for "good" redistricting. Nonetheless, inherent conflict among these specific principles and among the more general principles underlying American political representation explains why reforms intended to curb redistricting abuses have so often failed.

This paper was submitted directly (Track II) to the PNAS office.

Abbreviations: GIS, Geographic Information Systems; IRC, Arizona's Independent Redistricting Commission; TLC, Texas Legislative Council.

*E-mail: benjamin.forest@dartmouth.edu.

Table 1. Hypothetical county election districts

District	Total population, %	Democratic voters, %	Democratic majority districts
City	40	90	4 of 4
Suburb	60	40	0 of 6
County	100	60	4 of 10

Certain reforms might be beneficial, but it is important to understand why many apparently common-sensical proposals often prove inadequate.

Gerrymandering

Gerrymandering refers to the manipulation of election district boundaries to change the outcome of elections. Unfortunately, there is no objective way to clearly distinguish gerrymandering from the redistricting process itself, because elections using districts almost always produce a "biased" result. That is, the proportion of votes cast for a particular party (or by voters from a particular racial group) rarely matches the proportion of representatives elected from that party (or preferred by that racial group) (5). Consequently, the judgment of what constitutes a gerrymander is a political and legal decision rather than a strictly scientific one.

A simple hypothetical example illustrates how a districting system can produce a "biased" result, even without deliberate effort. Imagine a county that contains a city with 40% of the area's population and suburbs containing the remaining 60%. The county commission consists of 10 representatives elected from 10 districts, each containing 10% of the county's population. Furthermore, imagine that 90% of the city's voters are Democrats, whereas only 40% of suburban voters are registered Democrats. (For the purpose of the example, assume that voters are spread uniformly in the 90:10 ratio within the city and uniformly in the 40:60 ratio in the suburbs.)

A "neutral" but naive redistricter might begin by drawing four urban districts and six suburban ones. Such districts would fulfill most, if not all, "traditional districting principles": They would have equal populations, they would respect traditional political boundaries (the municipal–suburban division), and they would (presumably) be compact and contiguous. Indeed, one might draw such plan without any reference to partisan information like the number of voters registered in each party in each district. Nonetheless, such a plan does not produce a proportional result. Although 60% of the county's voters are Democratic, only 40% of the county's representatives will be from districts with Democratic majorities (see Table 1).

This example illustrates one of the ways that the geographic concentration of voters can affect how votes translate into seats. Certain geographic distributions can produce electoral advantages, even under a "neutral" districting process, because they distribute votes efficiently (6, 7). In particular, a distribution that creates the maximum number of districts with relatively safe majorities (typically 55–60%), without packing any district excessively, tends to create a real advantage.

In the actual redistricting process, the number of districts with Democratic or Republican majorities is merely constrained, rather than determined, by the distribution of voters. In the above illustration, for example, one could easily create a proportional plan by drawing districts that crossed the city–suburban boundary to produce six Democratic-majority districts. A truly partisan gerrymander might create 10 districts with Democratic majorities by cleverly distributing Democratic voters in 10 city–suburban districts. In contrast, the two parties might agree on a bipartisan gerrymander that protects incumbent representatives and/or that gives each party five "safe" districts with large partisan majorities. Alternatively, one could also draw a plan with three safe districts for each party and four "competitive" districts that a candidate from either party had an equal chance to win. Even the definition of a "competitive" district is difficult, however, because incumbent representatives win reelection much more easily than challengers (8, 9).

Theoretical Conflicts in American Political Representation

Beyond the problems associated with defining and measuring gerrymandering, attempts to regulate such manipulations run afoul of the fundamentally contradictory principles underlying territorial representation. First, political representation in the U.S. incorporates the representation of both individuals and regional communities. Second, districts are expected both to force compromises by preventing domination by political factions and to provide for the representation of unique community interests.

Until the mid-1960s, there were few restrictions on how states drew congressional and legislative districts. Aside from a few isolated legal cases restricting overt racial discrimination, state legislatures could redistrict as they pleased. Yet between the 1920s and 1960s, the problem of malapportionment (unequal population among districts) became increasingly severe (10). As rural areas lost population relative to cities during the first half of the 20th century, rural legislators, who held the balance of power in most state assemblies, either refused to redistrict entirely or used redistricting to protect their own seats. Although rural areas grew underpopulated relative to urban ones, they retained the same number of representatives. By the early 1960s, these imbalances were often severe, with some urban state legislative districts containing >1,000 times the population of rural ones (3, 10).

Rural legislators defended these imbalances by appealing to the idea of regional representation. Districts represented the political interests of unique areas, rather than a fixed population or a fixed number of voters. Their opponents countered with the theory of numeric representation. Malapportionment violated the principle of equality and majority rule, because ballots cast by voters in rural districts carried far more power than votes in urban areas. From this perspective, legislators represent an agglomeration of individual voters rather than regions or communities. Although both arguments were politically self-serving, neither is absurd on its face. The same tension between representation by region and by population is enshrined in the federal government's split between the Senate and House of Representatives and was the subject of long-running debates in the 19th century (11).

The Supreme Court ruled in 1964 that severe malapportionment violates Constitutional principles of equality. The majority opinion seemed to settle the argument decisively in favor of numeric representation: "Legislators represent people, not trees or acres. Legislators are elected by voters, not farms or cities or economic interests" (12). The Court strengthened the equal population standard in a number of subsequent cases. Current standards require justification of any population deviation for congressional districts within a particular state, whereas legislative districts can have deviations of up to 10%. (States often design congressional plans to have zero population deviation to avoid possible legal challenges over malapportionment, even though census data are not 100% accurate.) Courts did not carry the principle of numeric representation to its logical conclusion, however, by requiring a system that defines voting constituencies by creating lists of voters, regardless of their location.

The current redistricting process thus embodies a fundamental contradiction between two theories of representation. Voting constituencies are defined territorially, but they must contain equal populations. Modern GIS help overcome the technical

challenge of this equal population requirement, but they do not resolve the conflict between territorial and numeric representation. This means that every districting plan can be criticized for failing to represent (regional) communities of interest, for malapportionment, or for both.

Territorial representation must also accommodate a second contradiction between American political traditions. In the *Federalist Papers*, James Madison articulated the principle of "antifactionalism" to justify the creation of a large republic (13). He argued that territorial representation ensures that no political faction would control or dominate a district, because geographic variation would provide a mixture of political interests. Successful candidates would need to appeal to two or more factions, providing an incentive for political compromise. For Madison, the capacity of districts to divide political groups was one of their major advantages.

On the other hand, a federal system acknowledges that different regions have different legitimate political interests. It is a short logical step to argue that different communities (whether or not these are regional) have distinct interests and values that deserve representation in elected assemblies. This issue becomes particularly acute when political minorities find that their votes are completely submerged within a large constituency. Consequently, contemporary conflicts over redistricting also embody the conflict between forcing compromise (antifactionalism) and providing representation for distinct communities of interest.

These two basic conflicts, between regional and numeric representation and between antifactionalism and community representation, are currently played out in the context of increasing racial and ethnic diversity. Immigration and internal migration have led to an increasingly heterogeneous population and increasingly complex residential patterns. Insofar as political interests are defined along lines of race and ethnicity and along divisions associated with immigration, conflicts over political representation have become increasingly complex as the U.S. population has become increasing diverse.

GIS offer one solution to this complexity but have more often served to exacerbate existing problems. Redistricting using GIS can "mirror the mosaic" of racial and ethnic diversity, giving each racial or ethnic group (or coalitions of minority groups) local majorities in election districts (14). Conversely, the same technology can be used to dilute the voting power of such groups and frustrate their ability to elect candidates of their choice. Either strategy can be characterized as gerrymandering, because each favors one set of political principles over others.

The conflicts over political redistricting and representation are driven not simply by the increasing demographic complexity of the U.S. population but also by legal developments that expanded the franchise beyond property-owning white males age 21 or older (15).[†]

Legal Developments in Political Representation

Three Constitutional amendments, coming at 50-year intervals, have extended the right to vote directly. African American men gained the right to vote (in principle) with the 15th Amendment (1870), women with the 19th Amendment (1920), and 18- to 20-year olds with the 26th Amendment (1971). Although this may appear to show a steady expansion of the right and ability to vote, these amendments actually represent high points in the expansion of the franchise, which also underwent considerable contraction over the same period (15). Indeed, African American men were effectively disenfranchised by the end of the 19th century, and blacks (men and women) did not regain the effective right to vote until passage of the 24th Amendment (1964), which forbid poll taxes, and the Voting Rights Act (1965), with its broad set of protections.

The expansion of the franchise has made elected assemblies more representative, but it has also changed what it means to be "representative." Madison's principal concern in the *Federalist Papers* was agricultural and industrial interests, both controlled by white male property owners. Madison's antifactionalism argument could treat political interests as literally disembodied, not attached to any particular person or to people sharing ascriptive characteristics (race, gender, etc.) The struggles to expand the franchise, however, have brought new attention to the idea of "descriptive representation" (16, 17). Under this principle, a "representative" assembly connotes one that "looks like" the population it represents. In the extreme, this view can lead to rigid numerical quotas for each relevant social group. Such questions over the definition of "representation" became central points of conflict as courts interpreted the Voting Rights Act, and Congress renewed and amended it after 1965.

The Voting Rights Act

The Voting Rights Act was one of the most important pieces of legislation in the 20th century. Not only did it give African Americans the effective right to vote, but it also fundamentally shifted the balance of power between states and the federal government. Congress renewed and amended the Act in 1970, 1975, and 1982, and it is due for renewal again in 2007. One of the most notable amendments came in 1975, when Congress extended the protections of the Act to include additional minorities, notably Latinos, Asian Americans, and Native Americans, on the basis of language.

The Act was a complex piece of legislation, but I will focus on Section 5, which gave the federal Department of Justice oversight over any change to a voting "standard, practice, or procedure." A jurisdiction covered by Section 5 must demonstrate that any change is not racially discriminatory. This provision became increasingly controversial after 1969, when the Supreme Court ruled that Section 5 covered the redistricting process (18). The Court extended oversight to redistricting, because racial gerrymandering could have rendered African Americans' new voting rights largely meaningless by permanently submerging minority voters in larger white electorates.

The shift in emphasis from access to the voting booth to voting power underlies many of the current voting rights controversies. Some commentators argue that this shift, although perhaps understandable, is fundamentally misguided and leads to racial quotas (19). Other scholars respond that the Voting Rights Act established a broader meaning to the right to vote, one that includes a right to representation (17). The Supreme Court has come down somewhere between these positions, limiting districting plans that either clearly dilute minority voting power or that use race as the "predominant" consideration (20).

Racial Gerrymanders

The Department of Justice (through its Section 5 oversight powers) and the courts have been used to challenging racial gerrymanders since the late 1960s. Through the 1980s, plaintiffs usually sought to overturn districting plans that minimized the number of nonwhite-majority districts. In contrast, after 1991–1992, plaintiffs in racial gerrymandering cases argued that states had drawn an excessive number of such districts. Both types of cases face similar problems, including the legal definition of a racial gerrymander and the empirical identification of such districts. Courts have reached a somewhat muddled set of legal standards for drawing nonwhite-majority districts. Unlike the equal population requirement, there is no clear baseline for defining the correct level of minority representation. Although

[†]Strictly speaking, the critical issue is the diversity of voters rather than the diversity of the population *per se*. Voting rights litigation considers total population, voting age population, and voting age population by citizenship.

proportionality could be used as an objective benchmark (where the "correct" level of minority representation is reached when the proportion of minority-preferred candidates in an assembly equals the proportion in the population), Congress specifically stated there is no right to proportionality when it renewed the Act in 1982. Indeed, even without this statutory limitation, achieving either racial or political proportionality using election by districts is nearly impossible, because the proportion of votes cast is rarely matched by the proportion of seats won (5). Geographer Ron Johnston has long argued that the so-called seat–vote mismatch is a fundamental effect of all district election systems (21).

The Supreme Court first focused, in the 1990s, on the shape of nonwhite-majority districts to identify racial gerrymanders. Democratically controlled legislatures created districts with extraordinarily irregular boundaries to avoid the tradeoff between nonwhite-majority districts and partisan advantage (22). Local jurisdictions also used convoluted boundaries to create separate black- and Latino-majority districts in areas where these two groups were relatively integrated (23). The Supreme Court struck down such "bizarre" districts but never articulated an objective standard for the shape of districts (20). By the middle of the decade, however, the Court turned away from a focus on shape to a standard based on the intentions behind redistricting plans: A legislature may consider race (and may be required to do so under the Voting Rights Act), but race cannot be the "predominant" consideration in a plan (24).

The Court revisited the issue on nonwhite-majority districts again in 2003, ruling that states are not bound to recognize minority voting power by creating or maintaining nonwhite-majority districts (25). In the appropriate circumstances, states may create districting plans with "influence" districts, where nonwhites are substantial minorities and can strongly influence, but not necessarily control, the election of candidates. This legal ruling was preceded by empirical work that suggested that nonwhites often need $<50\%$ to have a decisive influence on elections (26), and that the creation of nonwhite-majority districts can paradoxically reduce overall minority political power (22, 27).

Political Gerrymanders

Political (or partisan) gerrymanders present a different set of empirical and legal issues, although many of the same analytic techniques are involved. Vote totals provide a direct measure of a partisan gerrymander's effect, but the key empirical questions revolve around the effect of different districting plans on the ratio between seats and votes and the way this ratio changes with different vote totals (5, 28).

Scholars have developed several techniques for measuring the responsiveness and partisan bias of district plans (6, 21), but there is little scholarly consensus over the level of bias that defines a gerrymander or an "unfair" plan (29, 30). As illustrated by my hypothetical county districting problem above, variation in the geographic distribution of voters means that simple proportionality is rarely an adequate benchmark. Indeed, the seats–votes relationship inherent in territorial election systems and random variation in election results mean that measuring the bias of a plan precisely remains a difficult technical challenge. In a 2004 Supreme Court case, a fractured Court ruled there are practically no statutory or Constitutional restrictions on the political gerrymandering of congressional districts (31). Despite considerable empirical attention to the question of partisan gerrymandering, the Court argued there are no manageable standards for evaluating such claims.

Without a clear legal definition and broadly accepted empirical test for gerrymandering, the Department of Justice and the courts use a variety of criteria and methods to identify racially discriminatory districting. Consequently, scholars have developed several different strategies to identify gerrymanders. One set of innovative but ultimately misguided approaches uses computationally intensive methods to automatically draw a large number of districting plans. The characteristics of these hypothetical districts are used to establish the probability of creating a districting plan with, for example, one or two nonwhite-majority districts. The following example focuses on racial gerrymandering, but the same technique can be applied to partisan gerrymandering as well.

In one study of South Carolina, researchers created 10,000 districting plans (with 60,000 total districts) with algorithms using "race-blind" criteria such as equal population (within 1% deviation), compactness, and respect for county boundaries (32). The authors used these plans to derive the probability that a legislature would create a nonwhite-majority district without taking race into account. In this instance, they concluded that a black-majority district could be produced only through racial consciousness, because none of the 10,000 computer-drawn plans contained one.

This approach, although apparently objective and neutral, actually privileges one set of political principles over another. The algorithms used did not include, for example, municipal borders. If African Americans are segregated by city–suburban or suburban–suburban boundaries, randomly drawn districts efface the community of interest that may be generated by such municipal segregation. Although the technique could be easily modified to address this specific limitation, such approaches would always favor antifactionalism over communities of interest, because, within the parameters set by the programmers, all census blocks and tracts are completely interchangeable. One might respond by adding "communities of interest" to the database but, as I discuss below, this task has its own problems.

More broadly, such studies illustrate the difficulty of establishing a value-free approach to redistricting; political values are built into the algorithms used to automatically generate districting plans. To one degree or another, all redistricting technologies, including GIS, have such values and judgments built into them.

GIS Technology in Political Redistricting

When GIS came into common use during the 1991 round of redistricting, they were accompanied by considerable optimism that they would rationalize and democratize the process.[‡] Such powerful desktop technology offered the promise of transparency, accessibility, and empowerment: Plans could be analyzed quickly and efficiently, more groups would have the ability to produce plans, and more groups could promote their plans effectively.

Redistricting GIS have certainly provided some of these advantages. Interest groups have adopted the technology and sometimes made effective use of it. The Department of Justice has also made extensive use of GIS and other computer technology to enforce the Voting Rights Act, and that process has arguably helped to democratize political participation in the South more generally (33). Nonetheless, I believe that political parties have been the major benefactors of GIS technology. Parties have achieved unprecedented control over the outcome of elections by gaining the ability to create precise gerrymanders. Moreover, even where states have made a genuine attempt to expand the representation of interests in redistricting GIS, organizational and bureaucratic practices introduce severe constraints, so that the use of GIS in redistricting has the counterintuitive result of limiting, rather than expanding, access to

[‡]I base my arguments in this section on >50 interviews I conducted with staff members in the Department of Justice, software vendors, legislators, and legislative staff members in nine states in 2001–2003.

political representation. Finally, even where states have made use of new technology and have tried to eliminate partisan manipulation, they have not overcome the fundamental contradictions underlying American political representation.

Redistricting GIS and Partisan Control

Before the use of GIS (1981 and earlier), redistricting was done by hand and was so labor-intensive that an organization or state agency could produce only a limited number of plans. With GIS (1991 and after), a single individual could produce thousands of different plans and could use sophisticated spatial analyses to find gerrymanders that distributed voters efficiently. Indeed, one might say the speed and sophistication of redistricting GIS have turned gerrymandering from an art into a science. This change was manifested dramatically in Texas during the early 2000s (2).

In 2001, a closely divided Texas state legislature deadlocked over its new redistricting plans. A federal court drew new congressional districts, and a state redistricting commission, with a Republican majority, drew new state legislative districts. After the 2002 election, Republicans won a clear majority in the state legislature and reopened the redistricting issue by proposing a new congressional plan that favored Republican candidates. After an intense political struggle, the Texas legislature passed a new congressional redistricting plan that helped Republicans elect seven new members in the 2004 election.

Although redistricting GIS enabled Republicans to produce this effective gerrymander, the ability to use GIS to customize districts for each election is the most significant implication of the new technology. Before the 1990s, states and parties maintained a redistricting infrastructure and staff for only ≈1 year, once each decade. Two things changed in the 1990s, however. First, the extensive litigation throughout the decade meant that many states were forced to maintain a permanent redistricting staff and infrastructure. In North Carolina, for example, the final case from the 1990 round of redistricting was settled by the Supreme Court in 2001, 3 weeks after the Census Bureau released data for the 2000 round of redistricting (34).

Second, states and political parties no longer need to maintain a separate redistricting staff, because they can apply the technical skills and computer technology associated with GIS to many other areas of state administration and campaigns. By giving states and parties the means to create political gerrymanders frequently, GIS increase the potential level of partisan control over elections.

Institutional Practices of Redistricting GIS

Using GIS to increase partisan control is not surprising, because parties have always sought such advantages. Yet even where states use GIS to expand the representation of other interests, bureaucratic and institutional practices may end up limiting, rather than expanding, the kinds of representation possible in GIS. The redesign of Texas's redistricting GIS (called REDAPPL, for redistricting application) undertaken by the Texas Legislative Council (TLC) in the late 1990s illustrates this point (2).[§]

A lawsuit in the 1990s overturned a number of congressional districts in Texas as racial gerrymanders (35). As part of this decision, the court ordered the state to include "communities of interest" in REDAPPL to ensure they would not be broken up among several districts. This was a particular challenge, because the court provided little guidance for modifying the system. Consequently, the TLC staff devoted a lot of attention to this question and sought data that would reflect the multidimensional complexity of "community."

Despite these good intentions, the data on communities of interest that the TLC ultimately included in REDAPPL were not necessarily the "best" or most useful representations. Rather, information was included because the TLC had access to it in conventional digital form. The agency did not have the time or resources to systematically collect original data and information for the entire state, so they used data that were already available, that were (in their view) relevant to redistricting, and that could be easily imported into their system (2). Such processes are fundamental to how bureaucratic practices shaped the representation of community in the state's GIS.

The exclusive use of digital information was an obvious outcome of this process, but the further exclusive use of data defining boundaries was a less obvious result. The TLC included the boundaries of police beats, Justice of the Peace districts, school districts, and the like. The agency considered, but did not include, nonboundary data such as aerial photos and property appraisal information (used to set tax rates). There were no technical barriers to the inclusion of these data, but the agency determined there would be little benefit to having them in REDAPPL. Although such data might have relevance for communities of interest, the staff thought such information would not be especially useful in the process of drawing districts.

The TLC operationalized the legal rhetoric of the *Vera* decision to define "communities of interest" in ways that reflected both technical considerations and bureaucratic concerns over time, cost, and resources. The agency used boundary data, because they were easily available and because, in the view of the agency, such data would be most helpful to the users of the system. Boundary data, however, offer a thin conception of community. Communities of propinquity are communities of interest to the extent that they facilitate processes such as day-to-day interactions, the formation of community groups, and organizations of civil society. Particular boundaries neither perfectly contain nor perfectly represent such processes. By using boundaries as the sole representation of community, such technical representations freeze and misrepresent these dynamic practices.

These statements are not meant as criticisms of the TLC staff's professional judgment or practices. The *Vera* court's language assumed that "communities of interest" were objective knowable objects that GIS could represent unproblematically. As this example illustrates, however, such representations require significant technical work and bureaucratic decision-making. The ability to represent all possible "communities of interest" in all possible ways is a Sisyphean task, because "community of interest" is itself an imprecise concept, more useful for its rhetorical power than for its ability to define the precise boundaries of election districts.

Communities of Interest and Political Competitiveness

The experience of Arizona in its 2001 redistricting also illustrates how institutional solutions alone cannot overcome the contradictions inherent in American practices of political representation. Like Texas, the IRC sought to incorporate "communities of interest" into the redistricting process but unlike Texas, it systematically solicited input at public hearings to define specific communities. Unlike Texas, the IRC was also explicitly charged with creating politically competitive districts. The contradictions between representing communities of interest and creating politically competitive districts were revealed when the commission's districting plans were challenged in court (36).

Based on pubic testimony, the IRC identified >30 communities of interest and areas designated as Arizona Units of Representation (AUR). AURs included, for example, Native American reservations, areas of Hispanic concentration, urban–rural

[§]The TLC is a nonpartisan state agency that provides various technical services to the state legislature, including the maintenance and redesign of the REDAPPL system. The legislature, not the TLC, creates redistricting plans. Nothing in this article should be taken as a criticism of the TLC's highly professional and knowledgeable staff.

divisions, and municipalities like the City of Scottsdale (36). The IRC subsequently kept such communities and AURs within district boundaries and tried to put similar groups together in the same district.

The effort to place similar communities and Arizona Units of Representation in districts, combined with the failure to emphasize political competitiveness, led to districts that had relatively safe majorities for one party or the other. The court identified this as a fatal flaw in the redistricting process and suggested that the IRC could have kept communities of interest intact while simultaneously placing dissimilar communities within the same district to enhance political competitiveness.

Despite any shortcomings in the IRC's process, the principles of creating politically competitive districts and respecting communities of interest are typically in conflict. The former emphasizes the suppression of unique political interests, whereas the latter accentuates their expression. Moreover, citizens typically want to be in a district where they are in the majority or at least part of a winning coalition. The winner-take-all system means that voters in heterogeneous districts have a greater risk of voting for a losing candidate. Hence, citizens may desire competitive districts in general but quite rationally prefer to be in a district with a majority of liked-minded voters.

The IRC's innovative use of technology to solicit and represent public testimony to identify communities of interest could not overcome the inherent tension between Madisonian antifactionalism and community representation. It is possible to argue, as the Court did, that the commission struck the wrong balance, but these two principles can only be balanced, not reconciled. The "correct" equilibrium between these two principles is a matter of political rather than scientific judgment.

Conclusion

The growing demographic diversity of the electorate, combined with a trend toward political inclusiveness, reveals the tensions among the principles of U.S. political representation. The use of a district election system means that nearly half of the voters in a jurisdiction may vote for a losing candidate. Attempts to reconcile this "winner-take-all" system with efforts to increase the political representation of racial minorities and other "communities of interest" often produce results, such as "bizarre" nonwhite-majority districts, that offend other important Constitutional and ethical principles. Moreover, the territorial election system also gives political parties the incentive to create partisan gerrymanders.

The use of GIS technology for political redistricting seemed to offer a solution to these conflicts. By lowering the time, cost, and effort associated with redistricting, GIS aided legal enforcement of voting rights laws and opened the process, in principle, to a greater variety of citizen and community groups. Moreover, the ability of GIS to display and represent a greater variety of information, such as the location of communities of interest, offers the capacity to represent a greater variety of interests and perspectives in redistricting.

Unfortunately, GIS technology has generally not fulfilled these promises. First, the use of GIS tends to favor already powerful institutions and organizations. This is especially evident in the way GIS have facilitated increasingly sophisticated partisan gerrymanders. Second, bureaucratic and institutional practices can limit the ability of GIS to provide alternate representations of communities. Although one can conceive of GIS with "better" or more complex representations of community, the social routines associated with GIS mean that such representations are often not developed in practice.

Limiting the use of redistricting GIS to professional nonpartisan commissions may be better than allowing a political free-for-all, where political parties have vastly more power, expertise, and resources than citizens' groups. The experience of Arizona demonstrates, however, that even redistricting performed with advanced technology in an ostensibly neutral manner with explicit criteria can be problematic.

GIS have rationalized the redistricting process, but they have not produced better democracy. Although technical and institutional reforms can prevent the worst gerrymandering abuses, they cannot overcome the contradictions inherent in the American system of political representation. Sophisticated analytic techniques and GIS technology allow us to understand and predict electoral outcomes and effects with increasing precision. Although they hold out the possibility of a more "representative" electoral system, these tools cannot create a consensus on what "representative" should mean.

1. Morrill, R. L. (1981) *Political Redistricting and Geographic Theory* (Association of American Geographers, Washington, DC).
2. Forest, B. (2004) *Polit. Geogr.* **23,** 425–451.
3. Monmonier, M. (2001) *Bushmanders and Bullwinkles: How Politicians Manipulate Electronic Maps and Census Data to Win Elections* (Univ. of Chicago Press, Chicago).
4. *Arizona State Constitution,* Article IV, part 2, §1 (14).
5. Johnston, R. J., Pattie, C., Dorling, D. & Rossiter, D. (2001) *From Votes to Seats: The Operation of the UK Electoral System Since 1945* (Manchester Univ. Press, Manchester, U.K.).
6. Gelman, A. & King, G. (1994) *Am. J. Polit. Sci.* **38,** 514–554.
7. Gilligan, T. W. & Matsusaka, J. G. (1999) *Public Choice* **100,** 65–84.
8. Berry, W. D., Berkman, M. B. & Schneiderman, S. (2000) *Am. Polit. Sci. Rev.* **94,** 859–874.
9. Carey, J. M., Niemi, R. G. & Powell, L. W. (2000) *J. Polit.* **62,** 671–700.
10. Dixon, R. (1968) *Democratic Representation: Reapportionment in Law and Politics* (Oxford Univ. Press, New York).
11. Zagarri, R. (1987) *The Politics of Size: Representation in the United States 1776–1850* (Cornell Univ. Press, Ithaca, NY).
12. *Reynolds v. Sims* (1964) 337 U.S. 533.
13. Hamilton, A., Madison, J. & Jay, J. (1995) *The Federalist Papers* (Westvaco, Richmond, VA).
14. Clark, W. A. V. & Morrison, P. A. (1992) *Mirroring the Mosaic: Redistricting in a Context of Cultural Pluralism* (RAND, Santa Monica, CA).
15. Keyssar, A. (2000) *The Right to Vote: The Contested History of Democracy in the United States* (Basic Books, New York).
16. Pitkin, H. F. (1967) *The Concept of Representation* (Univ. of California Press, Berkeley).
17. Guinier, L. (1994) *The Tyranny of the Majority: Fundamental Fairness in Representative Democracy* (Free Press, New York).
18. *Allen v. State Board of Elections* (1969) 393 U.S. 544.
19. Thernstrom, A. (1987) *Whose Votes Count? Affirmative Action and Minority Voting Rights* (Harvard Univ. Press, Cambridge, MA).
20. Forest, B. (2001) *Ann. Assoc. Am. Geogr.* **91,** 143–166.
21. Johnston, R. (2002) *Polit. Geogr.* **21,** 1–31.
22. Lublin, D. (1997) *The Paradox of Representation: Racial Gerrymandering and Minority Interests in Congress* (Princeton Univ. Press, Princeton, NJ).
23. Clark, W. A. V. & Morrison, P. A. (1995) *Demography* **32,** 183–201.
24. *Miller v. Johnson* (1995) 515 U.S. 900.
25. *Georgia v. Ashcroft* (2003) 539 U.S. 461.
26. Cameron, C., Epstein, D. & Ohalloran, S. (1996) *Am. Polit. Sci. Rev.* **90,** 794–812.
27. Hill, K. A. (1995) *J. Polit.* **57,** 384–401.
28. Cox, G. W. & Katz, J. N. (2002) *Elbridge Gerry's Salamander: The Electoral Consequences of the Reapportionment Revolution* (Cambridge Univ. Press, Cambridge, U.K.).
29. Johnston, R. (2002) *Polit. Geogr.* **21,** 55–65.
30. Rush, M. E. (2000) *Polit. Geogr.* **19,** 249–260.
31. *Vieth v. Jubelirer* (2004) 541 U.S. 267.
32. Cirincione, C., Darling, T. A. & O'Rourke, T. G. (2000) *Polit. Geogr.* **19,** 189–211.
33. Lublin, D. (2004) *The Republican South: Democratization and Partisan Change* (Princeton Univ. Press, Princeton, NJ).
34. Forest, B. (2004) *Soc. Cult. Geogr.* **5,** 55–73.
35. *Vera v. Richards* (1994) 861 F. Supp. 1304.
36. *Arizona Minority Coalition for Fair Redistricting v. Arizona Independent Redistricting Commission* (2004) Superior Court of Arizona CV 2002-004380 and CV 2002-004882.