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BUFFERS AND DUALITY

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"To see a world in a grain of sand
And a heaven in a wildflower;
To hold infinity in the palm of your hand,
And eternity in an hour."
William Blake, *Auguries of Innocence.*

Common sense tells us that rivers, rails, coastlines, and abstractly equivalent lines across the geographic landscape serve not only as barriers to flows of people, goods, and services, but also as transmitters of these flows. The manner in which they serve as such has captured the imagination of geographers for many years. Nystuen (1967) sees the margin of an advancing forest adjacent to a lake as either accelerating or retreating in growth depending on the manner in which trees propagate seed (by wind or by squirrel). In a different environmental context, but an abstractly similar argument, Nystuen also sees the oyster as a boundary dweller in the fragile margin of Chesapeake Bay, anchored in the sandy shores of the land while deriving food from the fluctuating wavy water boundary that washes over the shore. Abler, Adams, and Gould (1971), in their classic textbook on elementary spatial analysis, reflect on barriers and carriers as do various more recent texts.

Duality

The basic idea, however, of geographic lines having a dual role may well be as old as the human race; what child has not noticed that the bridge used to cross the creek can also be used as a dock from which to launch paper boats downstream? Enduring ideas remain fertile because their simple, elegant character permit many interpretations.

Duality is a concept that is useful when looking at the whole of an entity. A purely dual situation is one that exhibits perfect symmetry. The non-Euclidean world of projective geometry exhibits complete duality of statement: "two points determine a line" and "two lines determine a point" are equally valid projective statements (Coxeter, 1955). In the Euclidean world they are not, of course, equally valid statements. Parallel Euclidean lines do not meet in a point. This sort of pure symmetry is possible only in abstract worlds:

"barriers are carriers" and "carriers are barriers" can become equivalent only in abstract geographic space.

Buffers

One way to mitigate the barrier/carrier dichotomy associated with real-world geographic lines is to expand the dimension of the geographic line. Mark Jefferson's provocative early twentieth century maps illustrate this idea. Jefferson's introduction of a 10 mile buffer behind each railroad line in Europe (Figure 1) causes one to grasp simultaneously where there are, and where there are not, both rails and civilization, (Jefferson, 1928). Spreading the line offered extra insight into process: the role of the railroad in settlement patterns. Jefferson's map employs a jump in dimension to offer extra insight: from the one dimensional cartographic line representing the railroad to the two dimensional rail buffer swath. Jefferson's jump is in Euclidean dimension; indeed, the underlying mathematics on which the additional insight is based is discrete in its logical form. There are gaps between Euclidean dimensions.

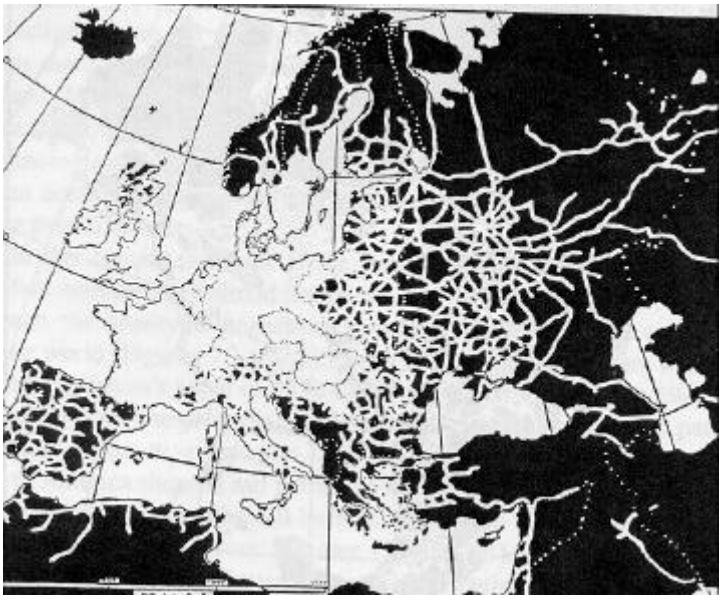

Figure 1. Mark Jefferson's map of Europe, *The Civilizing Rails* (1928) (reference below), provokes a strong visual image of the role of the railroad in the settlement of this region. Buffers tracing railroad routes are 10 miles wide. Cited here along general guidelines communicated by Jefferson family.

A different strategy to analyze the duality of barrier and carrier was employed by Arlinghaus and Nystuen (1990) using fractional dimensions (fractals) based on continuous mathematics (Mandelbrot, 1983). Often, condominium complexes are built to take advantage of some interesting natural view; nonetheless, residents also generally wish easy access to and from their homes. In this case, an ideal planning situation might seek to maximize public interest (in view and access) and minimize environmental damage. The fractal approach offers cuts of the land with a view of the water out the front with a road in the back. It minimizes coastal damage by maximizing space-filling characteristics of the

cuts. A local Michigan condominium developer pursued actual development of this project and found that the costs of dredging were prohibitive. Self-similar space-filling curves were used to generate a shape that spoke to one abstract mini-max principle; at the applied level however other issues precluded actual project realization.

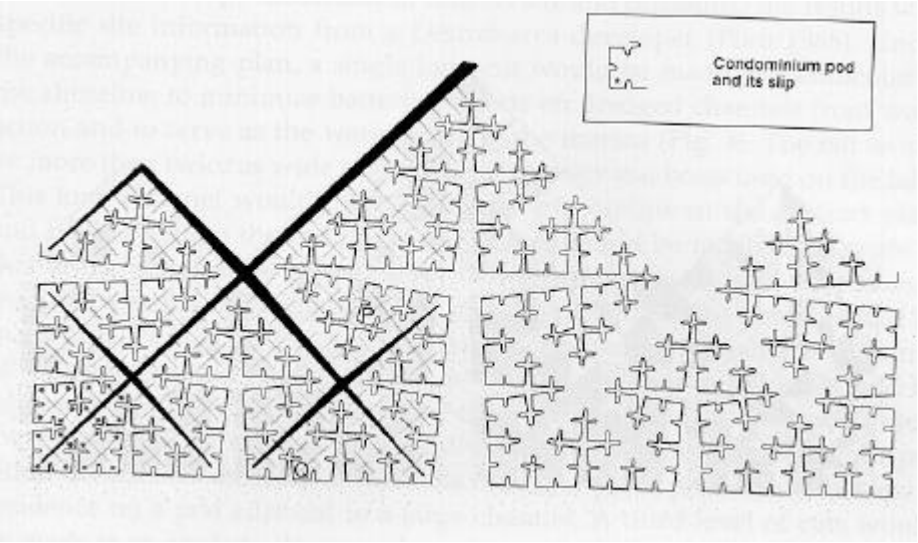

Figure 2. Space-filling marina based on fractional dimensions for dual land/water access; base map used to generate map that appeared in Arlinghaus and Nystuen, Geographical Review article cited in references.

In the map of Figure 2, the boundary is allowed to fill space (gain higher fractional dimension) until a condition of optimal exchange across, and flow along, the housing/marina complex boundaries is achieved. Dimensional alterations can create various degrees of resolution of abstract dual situations, and they can do so from a fundamental viewpoint that is either discrete or continuous. Such resolutions are of course particularly useful when they mesh with real-world economic and other considerations. Failure to find such a fit does not however mean that such an approach should be abandoned. The planning effort driven only by the bottom line is just as ineffective as the planning effort driven only by abstract concepts.

The U.S. Route 12 Buffer and Virtual Classroom

The man-made carrier of the railway line, vital in opening up new territories, suggests capturing disparate human characteristics in various buffers and using these buffers to tap perhaps unforeseen resources. The railroad can represent far more than a cartographic line on a map. Goodman and Jacobs, in a current education project, are creating a community of education travelers, in both actual and virtual space, within the set of schools, museums, universities, and other educational institutions along the U.S. 12 buffer (from Detroit to Aberdeen, Washington; Figure 3).

The Route 12 Project was created as a means through which diverse elements of local and national communities can come together. It is an educational network, both electronic and physical, that is unfolding in the counties along Route 12. Teachers and students, alike, use the network to share ideas, lessons, research, local historical information, and a host of

other educational resources. The child from the inner city of Detroit becomes "adjacent" to colleagues on farms in rural Idaho. Indeed, one exchange has seen students from Detroit sharing first hand, their view of information about the development of the U.S. auto industry with students from Bowman, North Dakota. The North Dakotans in return offer to the Detroiters a view of critical dependence of a town, not on the automobile, but rather on the railroad. Extension of contact in space, coupled with expansion of a line to a buffer, mitigate self-centeredness; apparently of particular importance in geographic education in a country of physical extent as vast as is ours. As with Nystuen's oysters in Chesapeake Bay, the child "barometers," physically fixed in positional locale along the US-12 corridor, become movable in virtual space. This movement frees the imagination to participate in diverse educational activities not previously easily available and such freedom serves also to defeat geographic isolationism so common when the child's world is only a tiny part of the globe. The virtual classroom, developed along the computer networks in this geographic corridor, offers an exciting basis for developing cross-cultural understanding.

The initial development of this classroom rests, however, on traditional field methods in which both Goodman and Jacobs go to the participants and expend substantial effort assessing what sorts of resources might be available at different locations and convincing individuals of the merits of participation based on the resource assessment. To date, Jacobs has made three trips across the entire corridor. He has also made partial trips, hauling a classroom of 6th grade students from Detroit Open School across U.S.12 to the western edge of Michigan. Indeed, as James Edwards, principal of Walker Elementary school (in Canton, Michigan) put his vision of the Route 12 Project: it is "a program that could not only supplement a child's regular education, but also give him or her a stronger sense of community and belonging. This feeling of community is invaluable for the students' holistic educational process. Broad local support is imperative if we expect our children to assume responsibility for and leadership in their community." It is to this broader sense of community that the Route 12 project speaks.

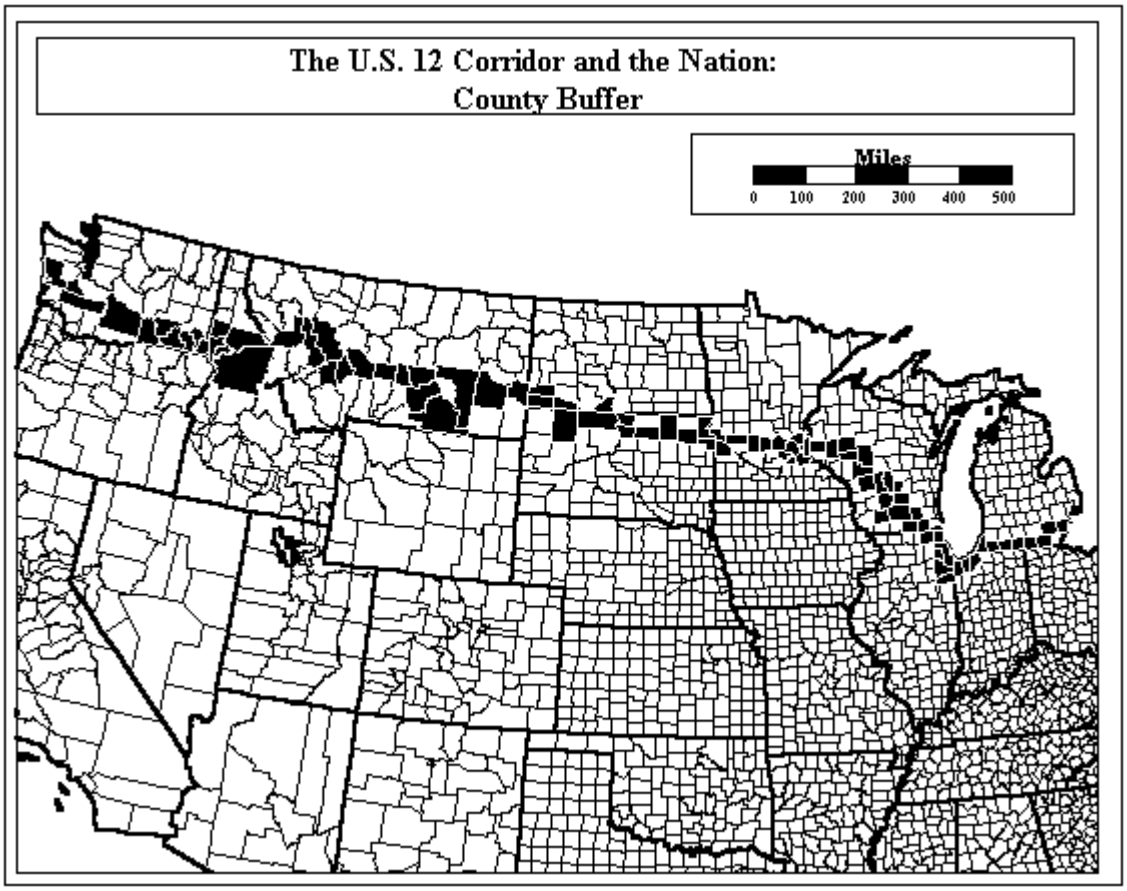

Figure 3. The U.S. 12 County buffer. Counties adjacent to U.S. 12 are shown in black, with white boundaries. Mapping done in Atlas GIS, v. 3.03. Information being mapped from U.S. Bureau of Census.

Not only does the Route 12 Project fit within the pragmatic view of the school principal's broad assessment of student education, but also it fits within the broader scholarly realm of previous geographical and mathematical analyses. The Euclidean extension of the U.S. 12 route, in the style of Jefferson, to a zone of buffers based on county boundaries permitted the capture of a set of schools and the creation of a virtual U.S. 12 classroom. Visual implementation of positional data was executed in the Euclidean world of GIS; the technology matched the dimension and faithfully portrayed data associated with this Euclidean buffer.

When Jacobs made three trips covering the buffer, with children from various schools within the buffer, his effort reflected that of Arlinghaus and Nystuen in filling in between the integral dimensions. The difference is that while his travels fill a gap in the real world, the electronic world of the GIS is not routinely based on a mathematics that fits fractional dimensional analysis. Thus, unlike the work of Arlinghaus and Nystuen in which the mathematics did fit the environment, it is left to the future to fill in this piece in the abstract setting of the Route 12 Project. The correspondence between scholaraly ideas is, at this stage, asymmetric.

Asymmetry

Often when one thinks of interweaving the abstract and the applied, the abstract is discarded if it does not meet the test of application. There is asymmetry in considering the merits these two different approaches have to offer. Indeed, the practical approach of an overlay, exhibited by county buffer superimposed on Route 12, could offer to municipal authorities across a broad spectrum of geographic scales, from the city, to the county, to the state (for example), of convincing evidence on the merits of overlay legislation. From a practical and applied standpoint, one must, at some level, confine laws to geographically defined and confined regions. Often, however, natural features, educational concerns, and other far-flung notions transcend political boundaries. The geographic literature, newspapers, and other sources are filled with example. One quite standard one involves watersheds (Figure 4).

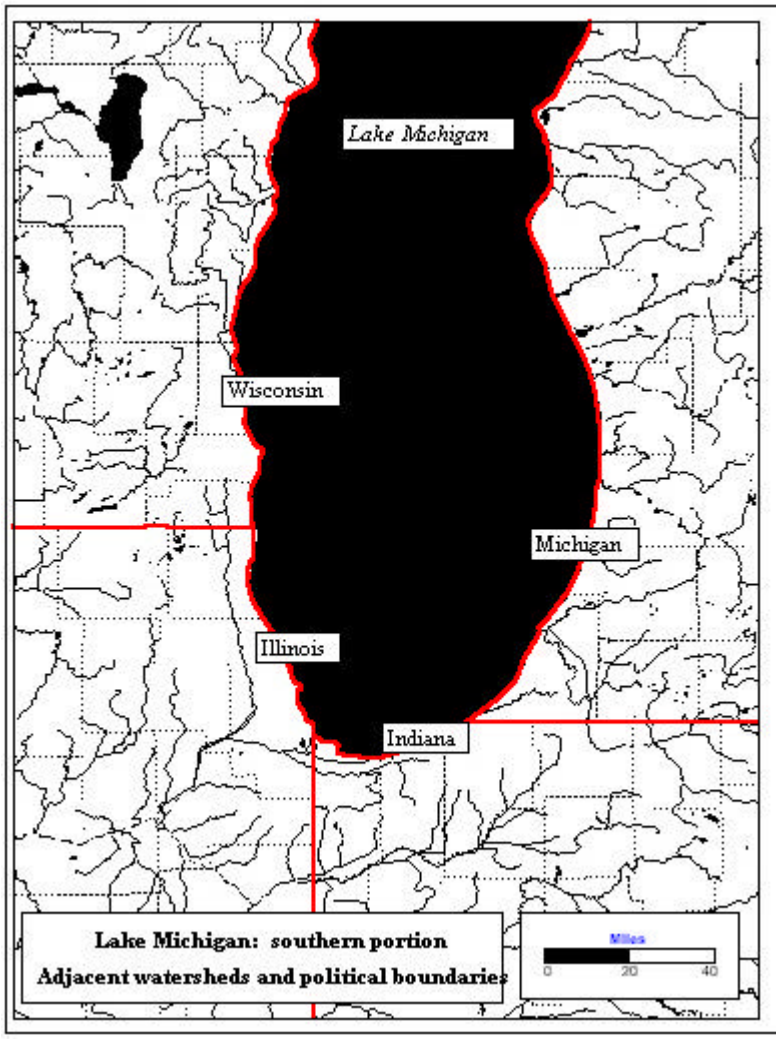

Figure 4. Natural watercourses overlain with political boundaries at the county and state levels. Base map from Atlas GIS, v. 3.0.3 with hydrological layers superimposed from the Digital Chart of the World.

Developers and municipal authorities often care how new development will affect an adjacent neighbor. But, what does "adjacent" mean? All too often, it simply means "shares a man-made boundary." This meaning illustrates that it is the man-made boundaries that dominate: the Route 12 classroom suggests that even when man-made boundaries help to define geographic extent, it is possible for concerns other than the political to become dominant. Thus, in the watershed example, if "adjacent" instead means "shares a watercourse with" then the watershed, rather than the political entity, has become the fundamental planning unit. A brief glance at almost any map that shows both drainage networks and political boundaries illustrates that they have little in common (Figure 4). The fit is bad. Here, perhaps, the abstract idea of using the drainage basin as a fundamental unit should take the lead and laws of units more local than a drainage basin made to fit within the basin…a case in which the abstract guides the applied.

Applied Geography of the U.S. 12 Project

The Route 12 Project approach also has precedent, in the applied realm, in other parts of the world. One traditional way to stretch a child's view or imagination is to do so physically, through travel or through direct contact with others his or her age across a spectrum of geographically distant points and cultures. Hence the presence of field trips, pen-pals, and other time-tested strategies are common in the pre-collegiate curriculum. The presence of electronic networks offers yet other imaginative ways to achieve similar ends; when these are coupled with electronic mapping capability they not only stretch viewpoint, but increase geographic awareness and knowledge, as well.

When GIS is introduced, the spatial connections that are being forged in the virtual classroom of U.S. 12, become evident visually. As did Jefferson's maps, the map of the U.S. 12 county buffer (Figure 3) presents a clear image of geographic position in relation to a network. Jacobs introduced census data into the U.S. 12 Buffer to illustrate locations of linguistic groupings along the U.S. 12 network. Students thus use maps to find not only their position along the U.S. 12 classroom, but also their position based on heritage in the broader linguistic family tree of mankind (Figure 5 exhibits one map from a set of about 100 different ones that Jacobs has generated).

The maps are employed not merely to show the power of electronic mapping, but also to form images in fertile young minds that would certainly not easily have been available in pre-GIS mapping days. Maps that are tailored to the project at hand, that are inexpensive, and that can readily be given to each child, offer great promise in overcoming educational inadequacies so evident in the pre-collegiate geographical curriculum.

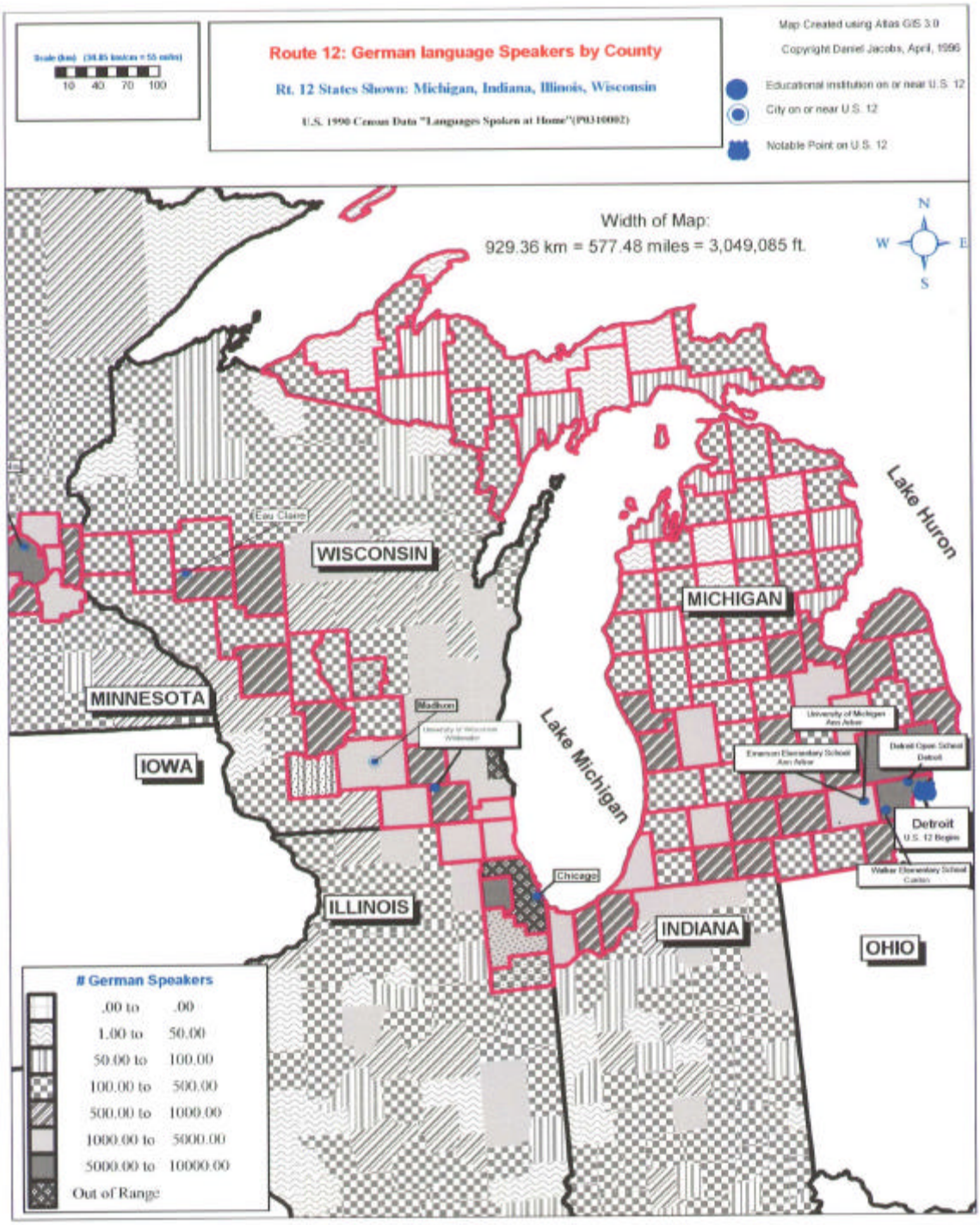

Figure 5. Jacobs' map of German speakers in the eastern portion of Route 12 county (and state) buffers. The U.S. Census measures 24 distinct language categories under the heading of "Languages Spoken at Home." Basemap: Atlas GIS, v.3.0.3; data: U.S. Bureau of Census.

As are roads, rails, and rivers, natural languages are also both barriers and transmitters. Jacobs and Goodman capitalize on this observation to communicate disparate concepts within a single virtual classroom. In so doing they weave together the regional "dialects" of the urban/rural as well as of urban/suburban, rich/poor, and various permutations of these and other socio/demographic indicators, into an educational fabric far richer than the sum of its dichotomous parts.

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