

A Numerical Topology of the Eisenhower Interstate Highway System

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The Eisenhower Interstate Highway System recently celebrated its fiftieth anniversary, and not long before that (in 1991) celebrated its "completion." There are still new highways in various stages of planning and construction, so it remains a work in progress, but it clearly forms a cohesive network, the most visible such network in the United States.

The system has become an essential part of how we think of American geography, coming to rival the layout of the fifty states and at a lower level of counties. Instead of the "Missouri World Series" as a name for a tournament between St Louis and Kansas City, we talk about a "I-70 Series." Phrases like "inside the Beltway" or "the 128 corridor" define social geographies in Washington and Boston respectively. And in Los Angeles, it is a commonplace that the Freeway is King.

This is not a new phenomenon. Transportation has defined American geography since the earliest European settlement: post roads, canals, turnpikes and railroads formed corridors, districts, and boundary lines for centuries before the highway. For every "Beltway" there is a Chicago "Loop," and for every "You're from New Jersey? What exit?" there are a dozen "wrong side of the tracks."

The interstate system has another quality besides the creation of corridors, boundaries and districts: it orders and grids the country. In creating the basic numbering plan for the highways, its creators followed a tradition that includes not only previous highway systems (including the 1920's U.S. Highway System), but street layouts dating back to William Penn's Philadelphia, the initial "nine squares" of New Haven, and the very definition of United States territory, the 1785 Land Ordinance with its grid of 6 x 6 mile townships. It has become so common for American cities to lay out streets in a square grid with numerical names that it can be surprising to go to countries where this practice is unknown. Learning to navigate even older American cities like Boston, where what grids there are are haphazard and streets change names seemingly at whim, can be daunting to those raised in orderly Omaha or Chicago.

The Interstate numbering system is simple: the base highways run north-south or east-west, and are numbered between 1 and 99. North-south routes are odd, east-west routes are even, and are numbered in order from south (I-8) to north (I-96) and west (I-5) to east (I-95). Numbers divisible by 5 denote the most important trans-national routes. Local spurs and bypass loops are designated with three-digit numbers, with odd and even prefixes respectively, followed by the two-digit number of the main route they connect to.

But as anyone who has lived in a grid city knows, the grid always has exceptions, The underlying physical geography of a place has no relationship to the surveyed lines of latitude and longitude that defined the national township-and-range system, which in turn tend to define the mid-American street grid. In the same way, you can't run a highway system straight

across the country: the idea is to connect cities and increase trade, and there are mountains and lakes to cross and get around. And sometimes, people want to go diagonally across the country, not just across and down like a giant crossword puzzle.

The immediate inspiration for this map was a graphic image created in 2006 by Chris Yates, laying out a simplified interstate system as a cartogram, a form similar to mass-transit users, squaring off and simplifying routes. As was noted by many on its release (myself among them), the image is full of faults, not least the elimination of Wisconsin. Nevertheless, it was intriguing.

I decided to try and view the entire system topologically, conforming the map as much as possible to a 100 x 100 square formed by the numbering of the system. Pretty much immediately, problems cropped up, as the system itself is riddled with holes and inconsistencies. Nevertheless, it mostly worked.

Some ground-rules quickly emerged:

- I would try to keep the "5-roads" as my guideposts and conform everything else to them (but what do you do when I-80 and I-90 become one road in Ohio and Indiana?).
- One roadway = one line.
- Two-digit routes would be drawn with a heavier line weight than three-digit routes. Where they share a pathway, the heavier line takes priority.
- State boundaries would be topologically correct: every road intersection and state boundary road crossing would be shown in the correct order.
- Odd-prefix three-digit routes (i.e spurs like I-394) would be shown as straight lines, and even ones (i.e. loop roads like I-494/694) would be made of circular arcs.
- As much as graphically feasible, routes would be encouraged to lie along their numbered place in the grid for as much of their length as was graphically feasible.
- A minimum of ¼ inch would fall between each major intersection. Mostly.
- I would use only straight line segments and arcs. No other curvy bits.

In spite of these rules, fudges had to be performed in several places. I-99 in Pennsylvania is clearly out of order, as is I-82 in Washington state. Truly diagonal highways like I-26 in the Carolinas or I-43 in Wisconsin only get to follow their "numeric path" for a token part of their distance. Really all you can do in these cases is shrug and do the best you can.

I hope the poster will be of interest to you; it was certainly fun to make.

-May 2007