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04.15.11.N - #31 w/ Power Point

PROPOSAL TO
MATHEMATICALLY LIMIT GERRYMANDERING IN CALIFORNIA

Background

The practice of drawing legislative districts has been fertile ground for political manipulation and a source of public disillusionment if not disenfranchisement in California. With few limits on the creativity of lawmakers to draw districts, many districts have assumed tortured shapes that appear to have much more to do with providing partisan advantage to politicians than to meeting the needs of communities they are designed to serve.

Summary

This proposal suggests that a mathematical formula be applied which would cause districts to be more compact, that is, shaped in a way where the length and width of the district are not vastly different and where the perimeter consists generally of straight lines rather that a series of convolutions. The formula suggested is simple and can be applied easily with the use of existing software programs that can calculate area and perimeter of virtually any shape.

Proposal

I propose that the following geometric ratio be applied to any legislative district drawn in California. This ratio is not dependent on the size of the district, only upon the shape of the district.

$P / \sqrt{A} \leq R$, where

P is the distance around the perimeter of the proposed district

/ is divided by

√ is square root

A is the area within the proposed district

≤ is less than or equal to

R is the ratio between the numerator and the denominator.

R, within limits, could be any arbitrary number chosen by the legislature but in order to set a reasonable standard for R, I would recommend that R be equal to the average of the ratios of the distance around each California county divided by the square root of the area of that county, so that

$R \leq p_c / \sqrt{a_c}$, where

p_c is the average distance around the perimeter of the counties

a_c is the average area within the counties.

Combining these two creates the following formula: $P / \sqrt{A} \leq p_c / \sqrt{a_c}$

Analysis

If the above combined formula were applied, legislative districts would be formed in a way where they were at least as "compact" that the average of the counties within the state. Since the counties in California were originally drawn with a wide range of shapes which were presumably anchored in some geographic and historical considerations, having a standard based on the average of these shapes would be both practical and not entirely arbitrary.

The attached sheet shows a number of examples and is intended to illustrate how this formula works.

The circle is the most compact of all geometric shapes. Figure 1 is a small circle with a diameter of 3. This could be 3 inches, 3 kilometers or 3 miles. Figure 2 is a larger circle with a diameter of 10. Comparing these two circles demonstrates that even though they are different sizes, they have identical ratios (R) of 3.54 : 1. Thus, it is the shape, not size of a geometric pattern that determines the ratio (R).

Figure 3 is a square, which is also a very compact geometric shape. It has a ratio of 4 : 1. Compare this with figure 4, a rectangle where the height is three times the width. Here the ratio is 4.62 : 1.

Figure 5 is identical to Figure 4 except that one side has an irregular shape which increases the perimeter without increasing the area. This results in an even higher ratio of 4.88 : 1.

Figure 6 is a rough approximation of the shape of Assembly District 29. The ratio for this district appears to be less than 5. Compare this with Assembly District 52, which appears to have a ratio of greater than 6.

These ratios were determined by simulations made with the help of computer assisted drawing software. With the proper off-the-shelf software, a more complete analysis of all of the counties to determine what the value of R should be could be completed without much difficulty. However, it will be necessary to set some guidelines in the analysis in regard to how district lines will be drawn across bodies of water. Where a boundary contours to rivers and shores, many small curves are involved and this could significantly increase how the length of a perimeter is calculated. It may be necessary to say, for instance, that in calculating ratios, points one mile apart will be established on the natural boundary and linked with straight lines rather than following the numerous small convolutions of the natural shape.

Conclusion

The use of a mathematical ratio of perimeter to area to establish reasonable standards of compactness for legislative districts is technically simple and non-partisan. Whether applied by the legislature itself or by a special commission, the implementation of this proposal as one guide to draw assembly districts could render any attempts to gerrymander largely ineffective.

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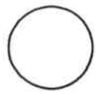

FIG. 1

CIRCLE
DIAMETER: 3
PERIMETER: 9.4248
AREA:7.0686
AREA SQUARE ROOT: 2.6587
RATIO: 3.5449/1

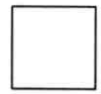

FIG. 3

SQUARE
HEIGHT: 3, WIDTH: 3
PERIMETER: 12
AREA:9
AREA SQUARE ROOT: 3
RATIO: 4

FIG. 5

IRREGULAR CONCAVE SHAPE
HEIGHT: 9, WIDTH: 3
PERIMETER: 24.694
AREA:25.652
AREA SQUARE ROOT: 5.064
RATIO: 4.876

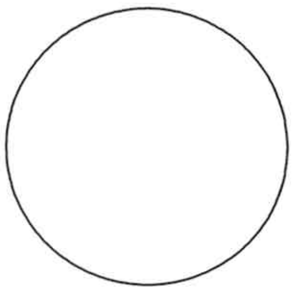

FIG. 2

CIRCLE
DIAMETER: 10
PERIMETER: 31.4159
AREA: 78.5398
AREA SQUARE ROOT: 8.8623
RATIO: 3.5449/1

FIG. 4

RECTANGLE
HEIGHT: 9, WIDTH: 3
PERIMETER: 24
AREA:27
AREA SQUARE ROOT: 5.1962
RATIO: 4.6188

FIG. 6

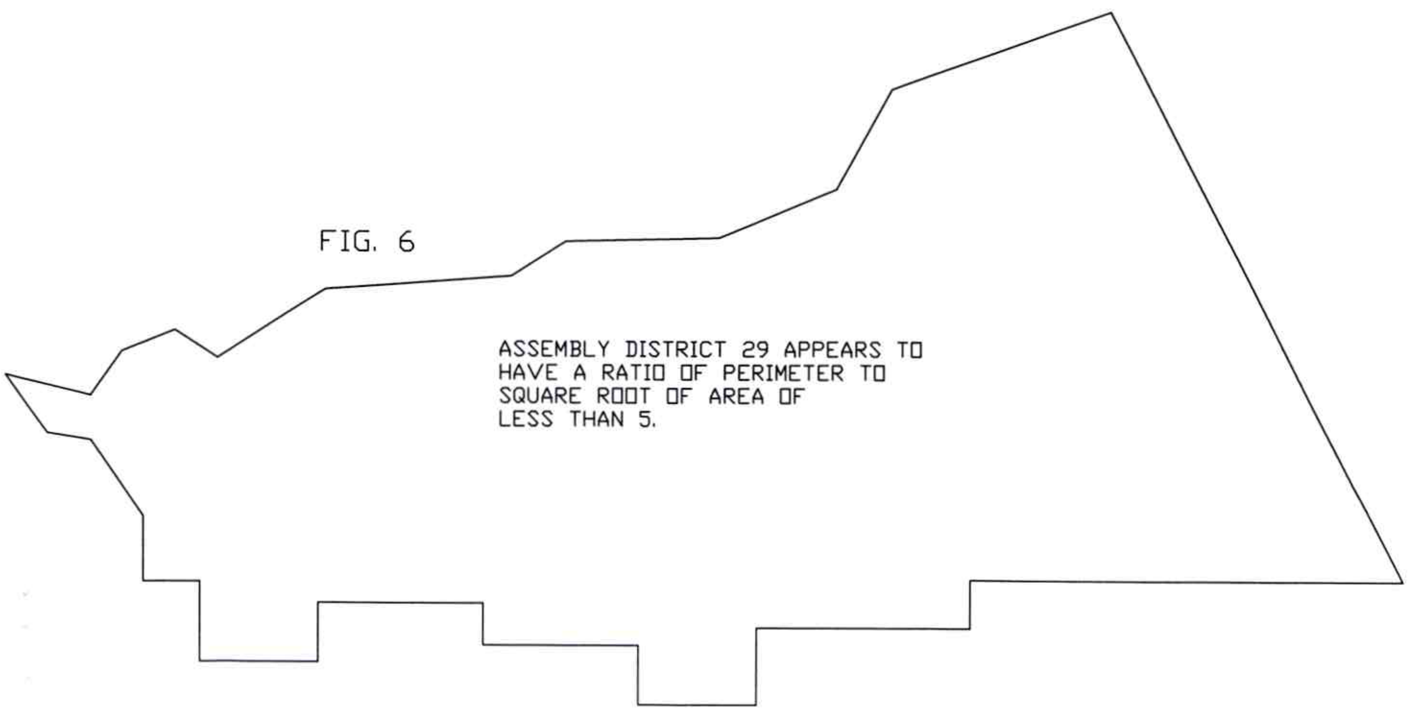

FIG. 7