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Zal Usiskin's article certainly brings out some important issues, but I think that with regard to the situation in California some additional comments are in order.

California's K-12 educational system was once a source of pride, but first the Serrano Priest decision cut local control of school finance, and the infamous Proposition 13 cut the flow of state dollars to schools. Ever since, the schools have been in desperate straights. Like the pigeons used by B.F. Skinner in his famous behavioral experiments, California schools are kept at 80% of normal body weight and their behavior is thus easily manipulated. For years now, California's K-12 education expenditures per child have been among the lowest of any state as a fraction of per capita income. Many of California's schools today are depressing places, overcrowded and poorly maintained. The supply of qualified teachers, especially in areas like mathematics, cannot keep up with the demand, because schools do not have the money or the contractual freedom to bid market price for the services of the best qualified people. Instead, shockingly large numbers of teachers are on one kind or another of "emergency" credential. (The term "emergency credential" is being replaced, which should fool nobody.) Naturally, it is particularly difficult to hire and retain good teachers in neighborhoods with other severe social problems. Teachers get tenure more or less automatically, unless they prove clearly incompetent in their first two years. Districts where it is hard to hire good people have little incentive to evaluate beginners too closely, because of all the expense and trouble needed to find a replacement who may turn out to be no better than the teacher who was released. Indeed, only by intense special efforts can we keep new teachers from leaving in their early years on the job. We produce too few good teachers, we have trouble keeping the best ones in the classroom, and we too easily give tenure to others who should not stay.

> ***...California schools are kept at 80% of normal body weight and their behavior is thus easily manipulated.***

California has term limits, which only encourage politicians to meddle in amateurish and often destructive ways that allow them to posture about their concern for education without having to be around to face the consequences of their actions. (I saw this first hand when, as a school board member, I inquired about the law which determines the annual dollar amount the state pays to each district per student. I thought this would be just a "word problem," but after an hour I was totally confused. Nobody at the school district office or the County Office of Education could figure it out either, nor could anyone at the California School Boards Association. They finally put me in touch with their legislative specialist, who explained that when the law was modified some years earlier, certain parts of it were not removed, although they must now be disregarded!) To compound the political circus, the Governor, then a Republican, implements his education policies through a State Board of Education, which he appoints, and whose CEO is independently elected and happens to be a Democrat, some say with gubernatorial ambitions. The politics of education in California, like the state's geology, is unstable, and a lot of time and money goes into finding faults. The resulting swings of the educational pendulum, which Zal Usiskin so ably describes, have a greater amplitude in California than in most other places, and as any student of seismic forces knows, the amplitude is directly related to the energy of the quake. Not only did California endorse "whole language," for example, but it effectively labelled those who insisted on teaching phonics as somehow backward and recalcitrant.

In view of the situation, it was hardly surprising that somewhere in California some parents would get upset about the mediocre mathematics education their children were getting. One district, for example, adopted as the seventh grade text a book which had been written not as a text but as a supplement to a text. This supplement, whatever its other merits, con-

tained no explicit mathematical content at all. Parents grew irate when they were stonewalled by school officials who insisted that there was nothing wrong with the way mathematics was being taught, when in fact virtually no mathematics was being taught. These upset parents, now suspicious of the education establishment, organized into political pressure groups which found ready allies among the back to basics crowd and the political right wing. When it was announced that the California Mathematics Framework would be revised in 1997, two years ahead of schedule, the political jockeying turned into a full scale battle.

The Superintendent of Public Instruction, Delaine Easton, drew up a list of people to serve on the Framework Revision Committee, and the State Board of Education, reversing what they saw as a bias toward the status quo, quickly substituted its own choices for several of hers and convened the committee while she cried foul. I was not on Delaine Easton's original committee, but I was put on by the state board. (I do not know how I was chosen. I have a lifetime of experience as well as a Ph.D. in mathematics education, but I am not particularly conservative as an educator. My only book in mathematics education, Mathematics, An Exploratory Approach, explicitly opposes the drill and kill approach to teaching basic math. Maybe I was chosen because I was on a school board.) I accepted appointment to the committee, thinking it an honor, thinking I could help, and thinking I would get an education in the process. Only on the last count was I correct.

The committee of 22 was selected to be diverse geographically (rural, urban, suburban, north, south), ethnically, and in mathematical level (kindergarten through grad school). At best it would be difficult for such a group to reach consensus, but in this case it was made nearly impossible by California's naive public meeting law, which made it an illegal meeting if any three or more of us communicated by phone or e-mail outside of an official committee meeting!

If all this wasn't enough, the state legislature, acting entirely on its own, had set up a committee to draft mathematics standards for California, which were to be included in the Framework. However, the standards committee had no membership in common with the framework committee and the two groups never met together or communicated in any way. The Framework committee was to produce its document by a deadline several months earlier than the deadline for the standards, which the Framework was to include!

From day one, the framework committee was divided into camps of reformers and antireformers who viewed each other as enemies and would not listen to each other. Through the long, hot Sacramento summer, discussions became something to win or lose rather than to learn from, and it was difficult to get consensus on even the smallest details. I was one of very few who tried to be independent and in fact remained on relatively cordial, even friendly, terms with members of both camps, but I found the committee so frustrating that I publicly suggested that the state lock us away for several days with little beyond writing implements, a large stash of beer, and instructions not to come out until we could agree. Of course, nobody took that seriously, but it might have helped.

The committee produced a draft framework that had a lot of rough edges and really satisfied nobody. At least one committee member refused to sign it. Later, the mathematics standards were written into the Framework, which was extensively edited. The final result contains some atrocities and some valuable ideas. Among the latter, the curriculum is organized into five strands rather than eight, and a statement is included that all strands should not be given equal attention at every grade (This is at least in part a reaction to the amount of elementary school class time spent making histograms of things like ice cream flavors, which are not even ordinal variables, when the kids still can't add fractions.). I would like to report that the recommendation to make algebra a standard course in grade 8 is another outstanding achievement of the 97 Framework. At the time this seemed like a reasonable goal, since it is already done in many schools around the globe. The Framework Committee agreed that it would take California several years of careful work and planning to make algebra a standard course in grade 8, but they also realized that without a recommendation in this area no change would occur. How wrong we were about the effect of our recommendation. The Governor insisted on testing all 8th graders in algebra, whether or not they had a course in it, and school districts up and down the state mandated grade 8 algebra for all even though most of their seventh graders were not ready for al-

gebra in grade 8 and most of their grade 8 teachers were not ready to teach algebra. This is a prescription for trouble, and we have already seen plenty of it.

As you can see, the political circus they call education in California goes well beyond any question of the merits of reform in the math curriculum. They say California often sets the trends for the rest of the nation to follow. Decades ago that was the case when bumper stickers were all the rage. Maybe it's time to revive the one which said, "Don't follow me, I'm lost."

Loopy

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As a mathematician and sculptor, I try to create artworks that are infused with an underlying sense of pattern and structure. I hope that viewers of my sculpture will consciously or unconsciously develop an appreciation for the power of mathematical ideas to enrich art. Ideally, they will be inspired to try their own explorations in the area of mathematical art. This paper considers one sculpture in some detail and provides instructions for a paper model that lets one explore its structure.

Figure 1 shows a sculpture I call *Loopy*, made of painted aluminum. It is five feet in diameter, and stands eight feet tall on its steel base. I created it for an outdoor setting at a local hospital; it is intentionally colorful and joyous. There are thirty identically shaped loops, six in each of five bright colors: red, orange, yellow, green, and blue. My vision of the form is abstract; some viewers tell me they see it as a giant brain, but that was not a conscious intention of mine. ("No, it isn't a self-portrait," I tell people.)

On examination, most viewers can discover and articulate essential aspects of the structure and color pattern: Each loop crosses four loops of the four other colors. The ends of the loops always meet in groups of three of the same color. Around each five-sided opening, there is a spiral of five loops, one in each of the five colors. No loop crosses another of the same color. Each bolt is both the vertex of a regular pentagon and the midpoint of the side of an equilateral triangle.

Each loop began as a ten-foot long strip of aluminum that was drilled for bolt holes, rolled into a loop, primed, painted, and bolted into the assembly. Thus, the thirty strips together sum to 300 feet, the length of a football field. While this arithmetic may be impressive in its own way, there is a different sort of mathematical analysis that I wish to emphasize.

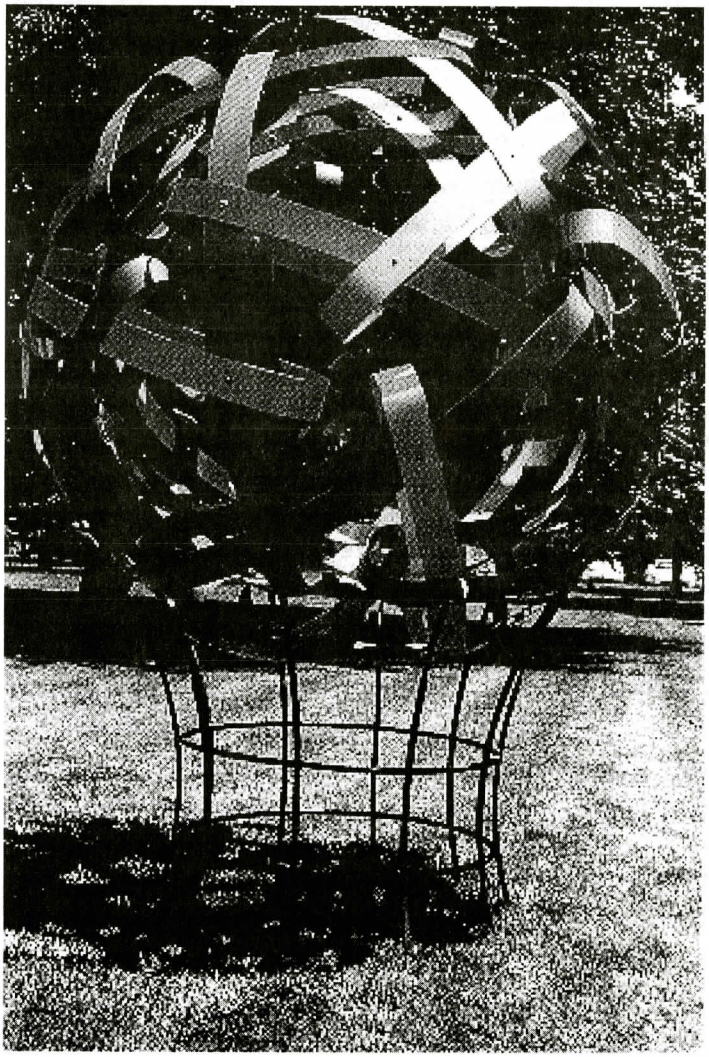

Figure 1
Loopy