after all, type may look different along a circle than along a straight line), and we need a simple way to make this alteration.

- Text along a seal almost always comes in two parts. The top part along the top of the seal is typeset along a convex path, the circle itself. But there is a bottom portion, and this is set along the inside of a larger circle. This text must be set along a non-convex path, and so we must address and deal with the issue of non-convex typesetting to successfully typeset the seal.

The centering is relatively easily done, since we can pretend to set the type at 9:00, and measure the angle of the ray connecting the final letter with the circle's origin. Half this angle is the angular offset we use to recalibrate the rotation angles of the letters, which we do before creating the characters.

We handle kern information by storing the kern information in a third file in the initial, measuring process. In the second step, Metafont reads this information in and uses it to modify the width information of the characters. Of course the kern file is just an Ascii file, and we can edit any of the values if some fine tuning of the kerns is needed.

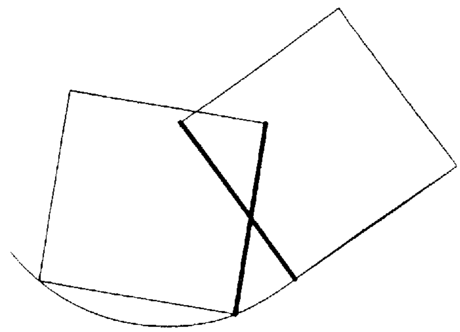

Figure 32: *Where to put neighboring letters on inscribed text.*

Finally, we handle the typesetting of the bottom portion of the text of the seal as another application of Metafont's handy `solve` macro. Progress along any Metafont path can be measured using a so-called time parameter t. In any pair of characters, we imagine drawing a line along the right edge of the left member of the pair, and another along the left edge of the right character. `solve` can find the proper value of t to use when placing the right-hand character so the two lines intersect at the tops of the types.

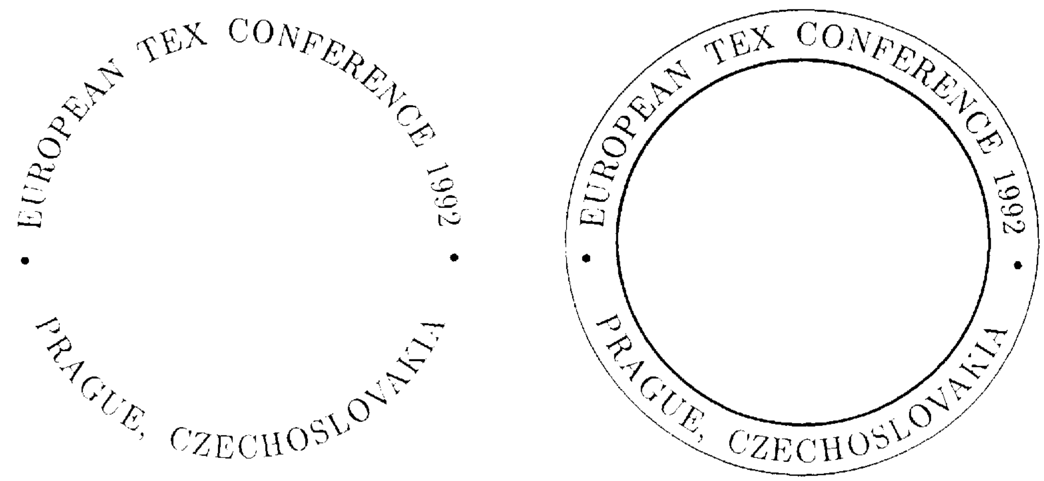

Figure 33: *A possible letterhead logo?*

Figure 33 shows an example of this "logo" typesetting which might be appropriate for a conference.

Generation of letterforms by mathematical means was first tried in the fifteenth century; it became popular in the sixteenth and seventeenth centuries; and it was abandoned (for good reasons) during the eighteenth century. Perhaps the twentieth century will turn out to be the right time for this idea to make a comeback, now that mathematics has advanced and computers are able to do the calculations. Modern printing equipment based on raster lines—in which metal "type" has been replaced by purely combinatorial patterns of zeroes and ones that specify the desired position of ink in a discrete way—makes mathematics and computer science increasingly relevant to printing. We now have the ability to give a completely precise definition of letter shapes that will produce essentially equivalent results on all raster-based machines. Moreover, the shapes can be defined in terms of variable parameters, making it possible for designers to perform valuable experiments that were previously unthinkable. (This is drawn from the preface to *The Metafont-book* of Donald E. Knuth.)

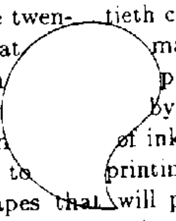

Figure 34: *Embedding an irregular figure in text.*

6 What Else?

There are three additional applications of TEX-Metafont communication that I can think of. Are there any more? I feel sure there are plenty.

Near the centre of the State of New-York lies an extensive district of country, whose surface is a succession of hills and dales, or, to speak with greater deference to geographical definitions, of mountains and valleys. It is among these hills that the Delaware takes its rise; and flowing from the limpid lakes and thousand springs of this regions, the numerous sources of the Susquehanna meander through the valleys, until, uniting their streams, they form one of the proudest rivers of the United States. The mountains are generally arable to the tops, although instances are not wanting, where the sides are jutted with rocks, that aid greatly in giving to the country that romantic and picturesque character which it so eminently possesses. The vales are narrow, rich, and cultivated; with a stream uniformly winding through each. Beautiful and thriving villages are found interspersed along the margins of the small lakes, or situated at those points of the streams which are favorable to manufacturing; and neat and comfortable farms, with every indication of wealth about them, are scattered profusely through the vales, and event to the mountain tops. Roads diverge in every direction, from the even and graceful bottoms of the valleys, to the most rugged and intricate passes of the hills. Academies, and minor edifices of learning, meet the eye of the stranger, at every few miles, as he winds his way through this uneven territory; and places for the worship of God, abound with that frequency which flows from unfettered liberty of conscience. (From *The Pioneers* of James Fenimore Cooper.)

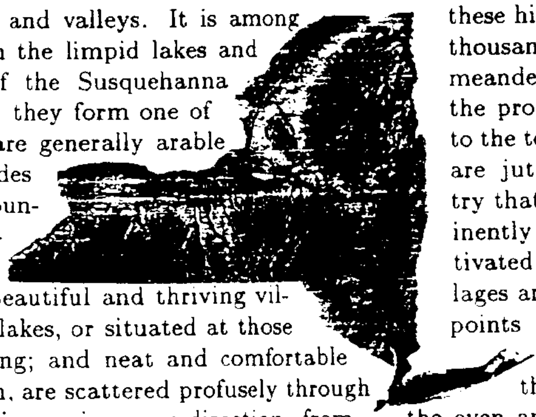

Figure 35: *Embedding the State of New-York.*

The first, about which I will say very little, is an application of data display using TEX. I hope to talk about it at a conference like this in a year or two.

The second was suggested to me in conversation with Yannis Haralambous. I might like to embed some irregularly shaped object within text, as in figures 34 and 35. I pass to Metafont the coordinates of the outline of the object. Metafont can measure the points at which horizontal baselines intersect the path, and obligingly pass that information back to TEX. TEX can use that information in a `\parshape` command to create the properly shaped paragraph.

Yannis and I have begun talking about yet a third application of these principles, and that is toward typesetting in Korean. The bad news is that there are over 2000 "letters" in the Korean "alphabet," far too many for any single font. The good news is that these letters—actually syllables—are composed from less than 30 separate components. Each component represents a sound in the Korean language. Each component can be coded as a Metafont macro. We are optimistic that the source file can pass to Metafont the order in which the sounds make up the syllable. Syllables appear to be built up from the phonemic components in straightforward ways.