Problems of diacritic design
for Latin script text faces

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Introduction

Early in the development of the Latin script, special marks, separate in nature from the basic letters, began to be used. Since the innovation of movable type, these *diacritics*, or *accents*, have been a special challenge for the type designer. Their size, spacing and design can be critically important for the reader, but can also cause many problems—with letter fit and line spacing in particular. The design of these additional marks, and their harmony with the rest of the typeface, is important to success.[1]

This essay focuses on these problems and the techniques designers have used to address them. After a review of the definition, origin and classification of diacritics, each major problem is identified and analysed, with an emphasis on how they have been, or could be, overcome. The analysis concludes with a review of remaining problems, some recommendations for the type design community, and comments on the future of diacritic design.

Sources

Any study of this sort is potentially prone to difficulties with sources and assumptions. Very little has been written on the design of diacritics. Albert Kapr, in his 450-page tome on *The art of lettering*, dismissed discussion of diacritics: 'It would take us too far if we were also to discuss italic letters, umlaut, accents, signs and figures individually.'[2] The main body of guidance can be found in two documents, one of which remains unavailable to the public.

Microsoft's *Character design standards* is the only publicly available guide to the development of basic diacritics.[3] It is intended to 'state the general rules for character shapes in Latin based languages', and covers glyph shapes for the most common Latin characters. The section on diacritics is short, and does not try to address the design of diacritics, but provides useful information on diacritic placement.

A more comprehensive guide to diacritic design has been under development at AGFA Corporation (now Agfa Monotype Corporation) for over ten years, as part of a larger manual entitled *Type design standards*.[4] Designers at this firm and its parent companies have done extensive research into both general and specific design issues, but have yet to complete and publish this internal manual for a public audience. Many thanks are due to them for sharing their work and allowing it to be noted here.

Both of these documents give valuable help regarding the design of specific diacritics, though they are mostly focused on European usage. They do not, however, give designers broad guidance on difficult design problems as attempted in this essay. Despite this, both are excellent and well-researched sources, especially for information on individual accents.

Because of the lack of breadth of sources regarding diacritic design, much of the analysis is based upon direct study of the typefaces themselves. This can

1. Tibor Szántó, 'Languages and typefaces', *Monotype Newsletter*, 78 (1966), p. 13.
2. Albert Kapr, *The art of lettering*, trans. by Ida Kimber (Munich: K.G. Saur, 1983), p. 312.
3. Vincent Connare, *Character design standards* <http://www.microsoft.com/typography/developers/fdsspec/> 8 July 1999.
4. Agfa Corporation, *Type design standards* (Wilmington, Mass.: Agfa Corporation, 1996).

be misleading. The temptation is great to assume that every unique feature has a specific purpose, that every differentiation is intentional. In reality, some of these characteristics are just as likely to be mistakes, or the result of a designer's ignorance. This is especially true when diacritics are a subsequent addition to an already existing typeface, or when they are added by someone other than the original designer.

To avoid making false assumptions, the analysis is limited to design features that are either documented to be intentional or that clearly address a particular design problem. In the latter case, there may well be some features that were not specifically added to solve a certain problem, but nevertheless have that effect. Whether intentional or not, these solutions can be a valuable model for contemporary designers, and so are discussed here.

Limitations

This essay is limited in scope to Latin script typefaces, and particularly those intended for text setting. The design of non-Latin diacritics is just as worthy of study, but would require a different analytical strategy. Typefaces designed strictly for display use, or for special effect, are not considered, as the design of their diacritics can be eclectic and related more to graphic design than text typography. Italic and bold faces, though important, are not fully covered due to limitations of research time and dissertation length. Finally, this essay does not attempt to be an exhaustive study of individual diacritics, nor give prescriptive recommendations on their design.

Definition, origin and classification

Figure 1. Examples of letters with diacritics.

Diacritics are marks added to glyphs to change their meaning or pronunciation. They are also commonly called *accents*, or *diacritical marks*. These marks can be made above, below, through, or anywhere around the letter. The name comes from the Greek word διακριτικός, meaning 'that distinguishes'.[5]

Although most diacritics are separate from the base letter, some connect to the base. This raises the question of whether such marks are truly diacritics, or if the new combination is simply a new extended Latin glyph. For example, is ç an independent letter, or should it be thought of as a combination of *c* and ¸? Although most people consider it an independent letter, this essay will discuss it as a combination, as the design problems are the same, and solutions applicable to ç can also be applied to ę and ţ.

Origin

The origin of Latin script diacritics is evolutionary. They have been an integral part of the script since its earliest days. Robert Estienne is credited with introducing accent marks for French in his *Dictionarium* of 1530, but the history goes back much further.[6]

A sign similar to an acute accent was used in Roman inscriptions to indicate a doubled consonant.[7] The dot on *i*, the most common Latin script diacritic, is possibly a carryover of this for words such as *filii*, and was used in medieval

Figure 2. Two enlarged images of the 'dotted' i from medieval manuscripts: one of the earliest uses—from a 13th century Psalter, Paris, Royal MS 2 B. ii, f. 7, British Library; and a later example from the Metz Pontifical, Fitzwilliam Museum, Cambridge.[8]

5. Florian Coulmas, *The Blackwell encyclopedia of writing systems* (Oxford: Basil Blackwell, 1996), p. 126.

6. R.A. Downie, 'Languages of the world that can be set on 'Monotype' machines', *Monotype Recorder*, 42.4 (1963), p. 18.

7. Lawrence Keppie, *Understanding Roman inscriptions* (London: Batsford, 1991), p. 21.

8. Janet Backhouse, *The illuminated page* (London: The British Library, 1997), p. 74; Donald M. Anderson, *Calligraphy: the art of written forms* (New York: Dover, 1969), p. 86.

Figure 3. Early examples of type with the 'dotted' i: from the workshop of Johannes Fust and Peter Schöffer, Mainz; from Johannes Schönsperger's workshop—both enlarged.[9]

manuscripts as early as the thirteenth century. With the advent of printing, the mark became common. Not only did it have linguistic meaning, but may have been a means to save space and distinguish the letter within the dense gothic texture.[10]

In recent centuries, diacritics have been used to apply the Latin alphabet to a wider range of languages.[11] Coulmas explains this need:

> *...for many languages the Roman, Greek or Cyrillic alphabets are too restricted and require substantial augmentation with special characters and diacritics. Vowels, vowel quality, tones and suprasegmental features such as stress and intonation especially are poorly represented by alphabetic scripts and, therefore, languages in which these features are numerous and phonemic usually pose problems for the creation of a suitable orthography.*[12]

The International Phonetic Association has always preferred new letters over use of diacritics for these additional needs, but has given accents limited acceptance in recent years.[13] The easy availability of accents on typewriters, and the lack of typewriters with new, unique letters, dramatically increased the use of diacritics in the last century. When there were multiple options for writing Navaho, for example, the one most easily produced on a typewriter won out.[14]

Classification

For many years, especially in most digital fonts, diacritics were limited to the most common accents: *acute*, *grave*, *circumflex*, *dieresis* and *tilde*. But with a growing number of diacritics in use there is a need for a better understanding of diacritic features—the aspects of the marks that affect their design and placement. These features are visual, not linguistic, and can help classify the increasingly broad range of diacritics in use.

The Unicode Standard 3.0 has 82 separate diacritics assigned to the *Combining Diacritical Marks* range (U+0300..U+036F).[15] These characters are intended to represent diacritics that could be used with a variety of base characters. For example, the COMBINING TILDE (U+0303) is commonly combined with *n* to form *ñ* for Spanish and Portuguese. It can, however, also be combined with vowels to signify nasalisation. Unicode treats versions of diacritics that appear above letters as different from those appearing below, or through, so there are three combining tildes: *above*, *below* and *through*.

With the exception of four Greek combining marks, these diacritics are intended primarily for use with Latin letters.[16] They can also be used with other scripts, such as Cyrillic. This is not, however, the full inventory of Latin accents. There are a few diacritics in use that have yet to be added to *The Unicode Standard*. For ease of discussion, these will not be considered here.[17]

Diacritics can be classified according to their horizontal features and vertical positioning, as outlined in table 1. As with Unicode, multiple versions of diacritics with different vertical positioning are treated separately—because they pose different design challenges. Note also that these features are not prescriptive. A *circumflex*, while usually symmetric, may have an asymmetric

9. Jan Tschichold, *Treasury of alphabets and lettering*, trans. by Wolf von Eckardt (New York: Reinhold, 1966), p. 70; p. 66.

10. Richard A. Firmage, *The alphabet abecedarium* (Boston: Godine, 1993), pp. 119–120.

11. George L. Campbell, *Handbook of scripts and alphabets* (London: Routledge, 1997), p. 102.

12. Florian Coulmas, *The writing systems of the world* (Oxford: Basil Blackwell, 1989), p. 176.

13. International Phonetic Association, *Handbook of the International Phonetic Association* (Cambridge: Cambridge University Press, 1999), p. 159; Geoffrey K. Pullum and William A. Ladusaw, *Phonetic symbol guide* (Chicago: University of Chicago Press, 1986), p. xx.

14. Robert W. Young, 'Written Navaho: a brief history', in *Advances in the creation and revision of writing systems*, ed. by Joshua A. Fishman (The Hague: Mouton, 1977), pp. 459–470.

15. The Unicode Consortium, *The Unicode standard, version 3.0* (Reading, Mass.: Addison-Wesley, 2000), pp. 368–371.

16. One of the Greek marks, the COMBINING GREEK YPOGEGRAMMENI (U+0345), or iota subscript, is actually used for some Latin-based alphabets in North America.

17. Two deprecated diacritics originally intended for Vietnamese (U+0340, U+0341) will also be omitted from discussion. The general issue of Vietnamese diacritics is covered later..

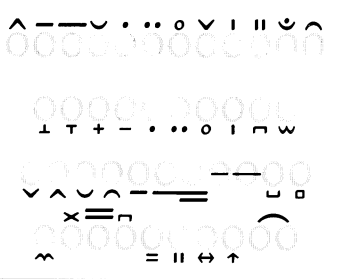
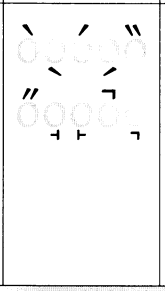
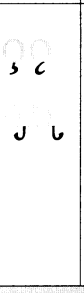
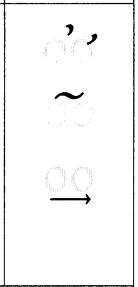
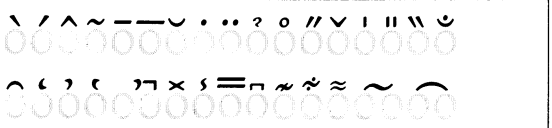
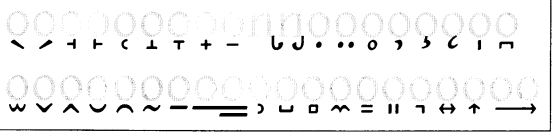
<table>
<tr><th colspan="5">Horizontal features</th></tr>
<tr><td>Symmetric—diacritic is mirrored from left to right along a clear axis</td><td colspan="4">Asymmetric—diacritic is different on left and right sides and may not have a simple optical centre</td></tr>
<tr><td colspan="2">Centred
optical centre of diacritic is aligned with that of the base glyph</td><td>Offset
optical centres of base and diacritic are not aligned</td><td>Variable
alignment changes according to base</td><td>Right
diacritic is aligned to the right of the base glyph</td></tr>
<tr><td colspan="2">  </td><td>  </td><td>  </td><td>  </td></tr>
<tr><th colspan="5">Vertical positioning</th></tr>
<tr><td>Above—diacritic rests over base glyph</td><td colspan="4">  </td></tr>
<tr><td>Top Right—diacritic connects to upper right corner of base</td><td colspan="4">  </td></tr>
<tr><td>Through—diacritic is vertically centred through middle of base</td><td colspan="4">  </td></tr>
<tr><td>Below—diacritic sits below base</td><td colspan="4">  </td></tr>
</table>

Table 1. Classification of diacritics by horizontal features and vertical positioning.

design. This is merely an attempt to classify basic characteristics for discussion purposes. The appendix gives a summary of this information for each diacritic.

The process of diacritic design centres around decisions made regarding these features. Design problems with a single diacritic often have solutions that are applicable to other accents with similar features. Designers can feel overwhelmed by the task of drawing a full range of Unicode diacritics, but with some study of these features, the workload can be significantly reduced.

Design challenges

> *...a typeface that is suitable for printing a non-accented language may look quite wrong when accents are added to it which cannot be brought into complete harmony with the original character of the typeface.*[18]

If all diacritics were simple in shape—such as a perfectly circular dot—and if all base glyphs were lowercase, symmetrical and had unchanging stroke weight, the design and positioning of diacritics would be trivial. That is, however, not the case. Type designers face a myriad of challenges as they attempt to design accents that are clear, harmonised with base glyphs, but yet do not cause difficulties with the spacing of letters and lines.

18. Szántó, p. 13.

These challenges, or problems, are a result of the distinctive nature of many diacritics and their interaction with the letters around them. The following sections focus on five different problems that designers must overcome to create successful diacritics: asymmetry, width harmony, vertical spacing, capitals, and cultural preferences.

Problem: Asymmetry

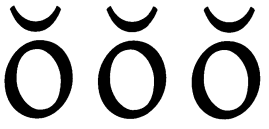


Figure 4. Even slight misalignment of diacritic to base can look wrong and be distracting to the reader.

Balance is important in type design. The upper right terminal of an *s* must be balanced with the lower left terminal or the shape looks either top heavy or weighed down. If the alignment of the terminals (which also depends on their shape) is misbalanced, the letter seems ready to topple over to one side or the other. It is a similar situation with diacritics.

First of all, the size and weight of the diacritic must balance with the base glyphs with which it is used—a topic for a later section. The horizontal alignment of diacritic to base must also be such that the two look balanced. For *symmetric/centred* diacritics with symmetric base glyphs, it is sufficient to align the centre of the diacritic *bounding box*[19] with that of the base. If, however, either is *asymmetric*, then some other measure must be used. There are even instances where apparent misalignment is desirable, as will be described later.

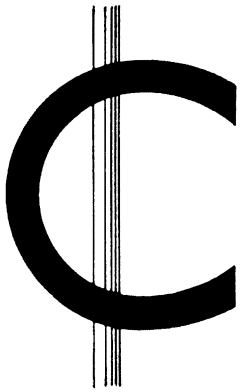


Figure 5. Various centres of C, from left to right: area, first moment (gravity), second moment (inertia), third moment (speculated to be true optical centre), mathematical.[21]

Optical alignment

David Kindersley, a lettercarver who studied with Eric Gill, was appalled at the spacing of letters used on signs for street names. So he began a long quest for a means to automatically space letters.[20] As an experienced carver, he knew what good spacing ought to look like, but wanted to quantify it in some way. A critical part of his strategy involved finding a letter's *optical centre*.

He believed that the key to aligning a letter in its space (the area including the whitespace between letters) was to align the optical centre of the letter with the mathematical centre of the space. But how could the optical centre be found? He used graph paper to measure area at first, but soon moved on to create optical machines that measured the light values in a similar way, and eventually began to use computers for his measurements.

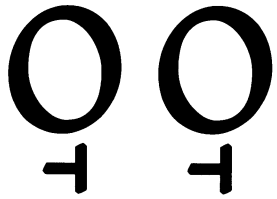


Figure 6. With asymmetrical diacritics it is not enough to align centres of bounding boxes (left). The diacritic appears to be too far to the right. Optical alignment (right) is much better.

A letter could have many 'centres', with most of them determined mathematically (figure 5). He guessed that the optical centre fell somewhere between the centre of the bounding box and the centre according to area. He imagined the letter placed on a fulcrum, and moved left and right until balanced. The balance point would be on, or near, the optical centre. He then used that information in his spacing calculations.

Although he was generally successful in his endeavour, it would be difficult to directly apply his tools for spacing today. They are too complicated and have never been built into modern font development tools. His work on optical centres, though, can be very helpful for diacritic alignment, even without objective measurements.

With his concept of balance in mind, it can be relatively easy to guess at the optical centre of any letter or diacritic. Horizontal positioning, then, of *asymmetric/centred* diacritics involves aligning the estimated optical centres of both diacritic and base with one another, as in figure 6.

There is, however, another way to determine the optical centre. Though not formally articulated in print, it follows established principles in type design by considering the shape of the counter. Some letters, due to ascenders and descenders, have counters that are offset from the Kindersley optical centre, such as b d h p q. For these letters, a better centre is found by using the optical centre of the counter, rather than the glyph as a whole (figure 7).

19. The *bounding box* of a glyph is the rectangle formed by the left, right, upper and lower extremes of a glyph's outline, not including any intercharacter space.

20. David Kindersley, *Optical letter spacing for new printing systems*, 2nd rev edn (London: The Wynkyn de Worde Society, 1976).

21. p. 9.

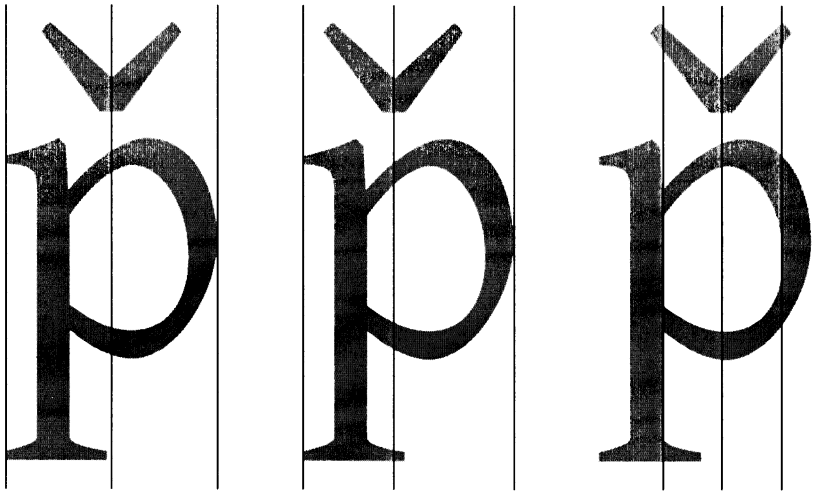


Figure 7. Three different measures of optical centre: the mathematical centre (of the bounding box), the estimated Kindersley optical centre, and the optical centre based upon the counter's Kindersley centre. The mathematical centre may be acceptable, but the normal Kindersley centre is clearly not. The final option gives the best initial alignment, but may need further visual adjustment.

Base glyph asymmetry

Optical alignment strategies, however, do not apply in some cases. *Asymmetric/right* diacritics are aligned according to the right edge of a letter. *Asymmetric/variable* ones connect to their base glyphs, and change the place of connection dependent on the base glyph (figure 8).

Even *symmetric/centred* diacritics need to depart from standard alignment at times—particularly when the base glyph is asymmetric. Figure 9 shows two examples of this using precomposed base/diacritic combinations encoded in Unicode.[23] The first, LATIN SMALL LETTER D WITH DOT ABOVE (U+1E0D), works neither with simple bounding box nor optical alignment. The *dot* needs to be further to the left to avoid the ascender. The designers of *Arial Unicode MS* chose to avoid the problem by raising the diacritic, but that solution would not work very well in long paragraphs of text—it would require too much line spacing.

Ąą Ęę Ǫǫ

Figure 8. The ogonek, *used for Polish, Lithuanian and other languages is one of the* asymmetic/variable *diacritics. Detailed information on its design and alignment has been prepared by Adam Twardoch.*[22]

ḍḍ ḍ ṛṛ ṛ

Figure 9. Examples of alignment options—both successful and not. From Gentium *and* Arial Unicode MS.[24]

The next, LATIN SMALL LETTER R WITH DOT BELOW AND MACRON (U+1E5D), illustrates another issue. In some cases, *above* and *below* diacritics may require different alignment strategies. If both *macron* and *dot* are aligned optically with the *r*, the *dot* seems misaligned, but if they are both aligned with the stem of the *r*, the *macron* is clearly wrong. The best solution seems to be to align the *macron* with the top half of the base and the *dot* with the lower half. *Arial Unicode MS* seems to attempt an optical alignment for both, but with an unsatisfactory result.

Designers can be thankful that situations like this are rare. Modern technologies such as OpenType[25], however, increase the possibilities for diacritic positioning. They also require modern designers to think through even these rarer situations.

22. Adam Twardoch, *Polish diacritics: how to?—ogonek* <http://studweb.euv-frankfurt-o.de/twardoch/f/en/typo/ogonek/ogonek.html> 28 August 1999.

23. The Unicode Consortium, p. 480.

24. Details about typefaces used in illustrations are listed following the Bibliography.

25. John Hudson, *Windows Glyph Processing* <http://www.microsoft.com/typography/developers/opentype/> 7 November 2000.

Acute & grave

There are even some common situations that can be challenging. Every designer of modern fonts, even for basic Western European languages, has had to choose the design and position of the *acute* and *grave*. Although this essay does not attempt to give detailed discussion on individual diacritics, these accents deserve special attention. Not only are they common, but very troublesome and have a long history of design.

These two accents are the most well-known examples of *asymmetric/offset* diacritics. All members of this family are normally not aligned with the base character either simply or optically. They are intentionally misaligned, for both historic and aesthetic reasons.

Designers do not, however, agree on their design or alignment. Microsoft's *Character design standards* describes two different alignment strategies. Both methods begin with an imaginary line through the visual centre of the base glyph, here called the optical centre.

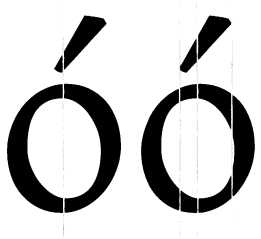


Figure 10. Two methods of aligning the acute accent.

The first strategy places the 'front'—the lower, typically thinner, end—of the *acute* and *grave* just through the line. The second strategy, used at both Monotype and Mergenthaler Linotype, is much more objective. It places the 'front' one-third on one side of the centre, leaving the other two-thirds on the other side. If necessary, further visual adjustment is made.[26] The results can be very different, as illustrated in figure 10.

Type design standards contains a lengthy section on these glyphs, with many examples. Though not dogmatic in intent, it provides some helpful hints for those looking for a starting point for their design. For a quick approximation, the authors suggest starting with 'a mark roughly 40 to 60 percent of the width of the lowercase *o*, at an angle of roughly 35 degrees from the horizontal'[27], with later adjustment if needed. It is less specific about horizontal alignment:

> *To position the accents horizontally, shift them to the left and right over the lowercase letters requiring accents until you find acceptable positions. The accents should appear to balance over the letters, the acute extending slightly to the right in relationship to the optical center of each letter, the grave extending slightly to the left.*[28]

The authors then continue with further guidance on how the design and alignment could be refined. Their method recognises that alignment is truly visual. It will very likely differ between fonts, or even between glyphs from the same font. Indeed, the examples they cite show a wide variation. This combination of technique and example can be very helpful, and could be valuable for other diacritics as well.

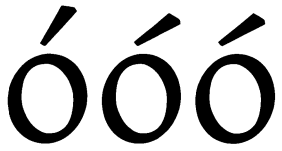


Figure 11. Alignment is dependent on slope.

The angle of slope also affects the alignment. A highly vertical slope lends itself well to a highly offset alignment. The same alignment looks unbalanced when the slope is reduced, so a more centred one is needed (figure 11). This raises a question: Is there an optimal slope? A full investigation of this topic is beyond the scope of this essay. There is, however, a historic pattern that ought to be considered when designing these accents.

Throughout the first four hundred years of printing, the *acute* was distinctly vertical in nature (figure 12), as was the *grave*. They were also significantly offset from the centre, although this varied widely. This remained the case even with the early hot metal designs of the twentieth century.

New technology, however, inspired new designs, and there began to be a change. These new faces started to have accents that were more horizontal and aligned more centrally. This was especially true of some of the typefaces designed for phototypesetting, such as *Monophoto Photina* (figure 13). As noted

26. Vincent Connare, *Diacritics design standards (for Latin based languages)* <http://www.microsoft.com/typography/developers/fdsspec/diacritics.htm> 21 September 1999.

27. Agfa Corporation, p. 10–4.

28. p. 10–5.

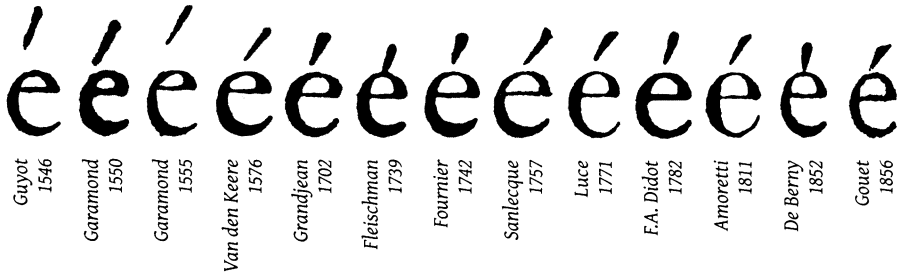


Figure 12. Examples of acute *from before 1900.*[29]

Figure 13. Accents from Monophoto Photina.[30]

Figure 14. Three versions of Caledonia: *original metal, early digital (Monotype), later digital (Linotype).*[31]

by the authors of *Type design standards*, angles less than 45° are now more common, and are treated by many as a normal starting point for designers.

Many fonts that originally had steep accents were even modified for the new style. *Caledonia*, in hot metal form, had a steep, offset *acute*. Photosetting versions had a similar angle, as did Monotype's first digital rendering. In Linotype's later digital version the acute became like *Photina* (figure 14).

Despite these distinctive changes, there has been no sudden abandonment of the vertical form. It was a gradual change in taste and style. Contemporary typefaces show a mix of angles. Revivals and historically inspired typefaces have begun to return to more vertical styles, but many designers still choose the flatter form.

Automated solutions

As is clear from these examples, the asymmetry of diacritics and their base glyphs can be a challenge to the designer. No single alignment strategy is always appropriate, even for the same diacritic. Alignment also depends on the nature of base glyphs and is different for various letters.

Despite the subjective nature of diacritic design and alignment, new technologies can have a useful role in the process. The design itself remains in the hands of the designer, but algorithms can be developed for alignment using the concepts of features and optical alignment.

Modern font tools, such as RoboFog[32] and FontLab[33] support the scripting (programming) of actions with the Python[34] language. This can be used to measure bounding boxes and even guess at optical centres. Once these are set (and adjusted manually, if necessary), a script can automatically create new composite glyphs using the data.

Such tools also support *attachment points*, also called *anchors*.[35] These are extra points added to the glyph data that define how diacritics ought to 'attach' to base glyphs. For example, the alignment of an *acute* over vowels could be defined by adding an 'attach at' point on each vowel, and an 'attach with' point on the *acute*. A script could then automatically create all needed combinations by moving the acute until its 'attach with' point has the same coordinates as

29. H.D.L. Vervliet, *Sixteenth-century printing types of the low countries*, trans. by Harry Carter. (Amsterdam: Menno Hertzberger, 1968), p. 229; H.D.L. Vervliet and Harry Carter, *Type specimen facsimilies II* (London: The Bodley Head, 1972), p. 18; Ibid.; Vervliet, *Sixteenth-century printing types of the low countries*, p. 253; Daniel Berkeley Updike, *Printing types*, 3rd edn, 2 vols (London: Oxford University Press, 1962), I, facing p. 243; Geoffrey Dowding, *An introduction to the history of printing types* (London: Wace, 1961), p. 62; p. 68; Updike, I, facing p. 213; Dowding, p. 66; Gerard Unger, 'The types of François-Ambrose Didot and Pierre-Louis Vafflard. A further investigation into the origins of the Didones', *Quaerendo*, 31.3 (2001), 165–191 (p. 166); Updike, II, facing p. 175; facing p. 185; P. Jannet, *Spécimen des noveaux charactères destiné à l'impression de la Bibliothèque Elzévirienne suivi du plan de la collection* (Paris: Jannet, 1856).

30. Hugh Williamson, *Methods of book design*, 3rd edn (New Haven: Yale University Press, 1983), p. 38.

31. W.A. Dwiggins, *Caledonia* (type specimen) (London: Linotype), p. 5; Monotype Typography, *Monotype quality digitised typography* (Redhill: Monotype, 1986); Linotype AG, *LinoType Collection* (Frankfurt: Linotype, 1990).

32. Petr van Blokland, et al., *RoboFog* <http://www.petr.com/robofog/>.

33. Yuri Yarmola, et al., *FontLab 4 for Windows* <http://www.fontlab.com/>.

34. Guido van Rossum, *Python* <http://www.python.org/>.

35. FontLab, Ltd., *FontLab 4 for Windows User Manual* (2001), p. 301.

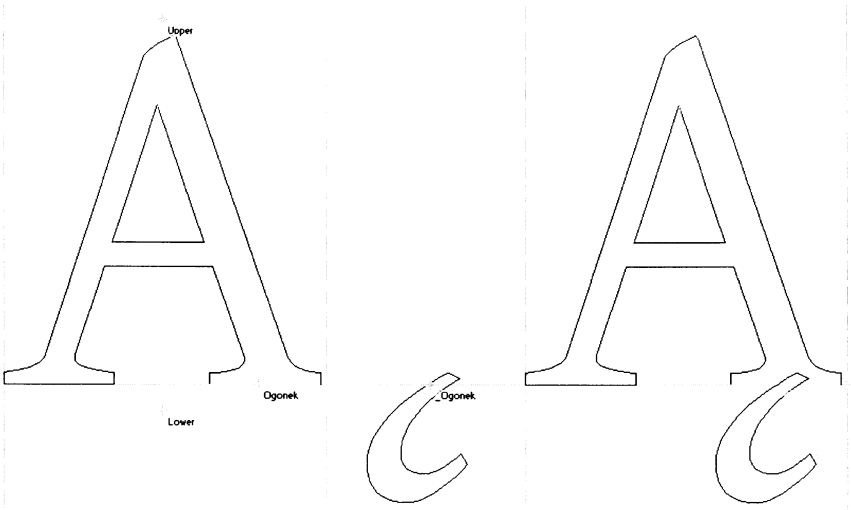


Figure 15. Combining A *with* ogonek *using anchors in FontLab.*

the 'attach at' for each vowel. This does not remove design responsibility from the designer—the attachment points still need to be defined—but can make the process of creating composite glyphs much more efficient and less error prone.[36] OpenType font technology can even use these points to align accents automatically, without prior creation of composites.[37]

Problem: Width harmony

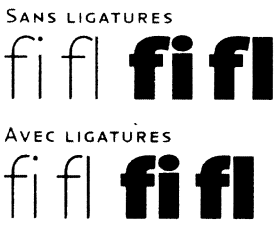


Figure 16. Ligatures from Parisine.[38]

Even if diacritics are satisfactorily aligned with corresponding base glyphs, there can be problems—with other glyphs. The simplest example of this is the *fi* ligature. Here the dot on the *i* often conflicts with the hook of the *f*. One solution is to design a new glyph where the dot is removed and the hook extended into the space above the *ı*. Another is to design the *f* so that it does not conflict. Jean-François Porchez found a creative solution for his *Parisine* typeface—his ligature retains the dot, but shortens the hook (figure 16).

But what if the *i* has two dots—*ï*? In most Western European languages there is no problem. French uses *ï*, but only to separate vowels that should not produce a diphthong, as in *naïveté*, so a troublesome combination such as *fï* would not appear. This cannot be assumed, though, as many other languages use the *diaeresis*. It is not limited to the *ï*, either—consider the Turkish word *kêfî*. These are all problems specific to the *f*, but are made much worse because the *diaeresis* and *circumflex* are often wider than the *i*.

This type of interaction becomes an even greater problem in bold faces, and is not limited to the *f* (figure 17). Sans-serif faces also face challenges due to the lack of space normally allowed for serifs. Although the *diaeresis* is the most obvious troublemaker, these interactions can also be found with other wide diacritics (e.g. the *tilde*).

Figure 17. The problematic i-diaeresis *combination in various bold weights of typefaces:* Adobe Caslon Pro, ITC Charter, Hoefler Text, Poppl-Laudatio, Gill Sans, Helvetica Neue, Trebuchet MS.

36. Unicode contains over 430 separate base/diacritic combinations in its various Latin ranges—a daunting number to be created manually.

37. Adobe Systems Incorporated, *OpenType specification: GPOS—The glyph positioning table* <http://partners.adobe.com/asn/developer/opentype/gpos.html> 20 August 2002.

38. Jean-François Porchez, *Spécimen de charactères & vignettes typographiques* (Paris: Porchez Typofonderie, 2001), p. 14.

Recognition of this problem goes back to the early typefounders. Although others undoubtedly understood the situation before him, Fournier was the first to articulate this problem of setting wide diacritics over thin letters. He wrote, specifically in relation to Greek types (although he also mentioned its applicability to other scripts):

> *...the rough or smooth breathing is set as thin as possible on a shank of precisely the same thickness: the wider ones such as these, ˜ ˆ ˙ ˝, are kerned on the top side in so far as they exceed the thickness of the shank.*[39]

He saw that technical adjustments were needed to allow diacritics to fit with most vowels, particularly the *iota*. This was imperative with technologies that did not allow kerning.

The general problem is a mismatch between the widths of diacritics and base characters. When the diacritic is wider than the base, it has the potential to collide with other glyphs in the vicinity and needs some sort of adjustment.

Strategies

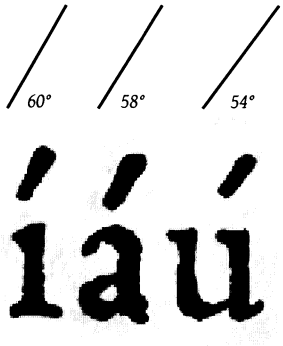


Figure 18. Representative diacritics from De Aetna *(enlarged) with the angles of their slope.*[40]

Designers have been very clever in their attempts to harmonize the widths of diacritics and base glyphs. This harmonisation does not just reduce collisions. It affects the whole balance and relationship between diacritics and the normal alphabetic letters.

As already mentioned, this careful attitude to the design of diacritics began early. Pietro Bembo's famous dialogue, *De Aetna*, published by Aldus in 1495, uses a type that illustrates a harmonised approach to diacritic design. The *acute* accents used in the publication show an effort to make the angle steeper for thinner letters (figure 18). These diacritic/base combinations would have been cut as single pieces of type, which would have made it more natural to alter the shape for each letter. Granted, a careful review of the publication will show great variance in the angles, due to the inaccuracies of punchcutting. The general tendency, however, is that the angle for *i* is noticeably steeper than that for wider characters, such as the *u*.

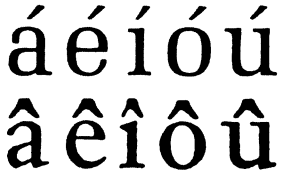


Figure 19. Accents from Melior[41] *and 16 point* Dante[42] *(enlarged).*

This primary strategy—redesigning diacritics specifically for certain base glyphs—remains the most common technique used to this day. Hermann Zapf's *Melior* has varying acute designs. *Dante*, a handsome face designed by Giovanni Mardersteig and cut by Charles Malin, also shows a thoughtful approach. The *circumflex* on the *î* is compressed horizontally, giving it a better visual balance (figure 19).

Applied to the *diaeresis*, this compression can be accomplished by reducing the space between the dots. If that is not sufficient, or if a reduction in space is not wanted, the dots may be reduced in size. This seems to be standard practice, although extreme reduction can lead to a glaring mismatch between it and the dot on the *i*. In very bold or condensed types this may be unavoidable.

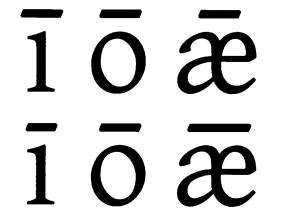


Figure 20. Macrons of the same size, then matched with base width.

The adjustment of diacritic design to base glyph width ought to be carried one step further for the *macron*. Fonts that contain this diacritic normally have only one design. It may fit well over the *o*, but can look too big or too small with other letters. Because of optical illusions, the same macron can seem to be too short over an *æ*, and too long over an *i*. The best solution, though not implemented in any major fonts, would be to have the length vary with each type of base glyph (figure 20).

39. Pierre-Simon Fournier, *Fournier on typefounding*, trans. by Harry Carter (New York: Lenox Hill, 1973), pp. 164–165.
40. Pietro Bembo, *De aetna* (Venice: Aldus Manutius, 1495), from the collection of the Plantin-Moretus Museum.
41. Hermann Zapf, *About alphabets; some marginal notes on type design* (Cambridge, Mass.: M.I.T. Press, 1970), p. 81.
42. John Dreyfus, 'Giovanni Mardersteig's work as a type designer' in *Into Print* (London: The British Library, 1994), p. 183.

Figure 21. Designs for the diaeresis *from various types. Matthew Carter's* ITC Charter *uses slight reduction.*

His design for Georgia *uses less reduction, but adds slight reduction of space between the dots.*

Univers 65 Bold *uses a similar approach, and keeps the dots square, while the dot on* i *has become rectangular.*

Futura Extra Bold Condensed *pushes all techniques to the extreme—and goes a bit too far.*

Rotis Sans Serif 65 *actually enlarges the* diaeresis*—hopefully just an oversight and not an intended feature.*

Optima *illustrates an elegant balance.*

Kerning

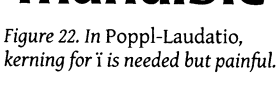


Figure 22. In Poppl-Laudatio, *kerning for* ï *is needed but painful.*

The most simple solution to diacritic/glyph collisions is kerning. This can be useful, but does not really address the underlying problem—the diacritic/base width mismatch. Kerning is inherently language-dependent, as it is impractical to add kern pairs for every conceivable combination across language families. Even with *class-based* kerning, first introduced by Apple in their GX technology[43], this would be difficult. Kerning can also severely upset letterspacing (figure 22). Overdependence on it, and less concern for matching widths in the design, can be a short-term fix, but not a long-term solution.

Problem: Vertical spacing

A careful review of figure 21 reveals another issue in the design of diacritics—vertical spacing. In some fonts (*Optima*, for instance) there is little or no difference between the height of the *i-dot* and the *diaeresis*. In most faces, though, there is a height difference. At times, this seems purposeful. *ITC Galliard* has a high *i-dot,* appropriate for its lively design. Raising the *diaeresis* to the same level might cause too much vertical separation and look odd. More often, though, such a noticeable difference seems to have no design merit and may be a mistake. In the case of the *Gill Sans* family, all consistency is abandoned—even the shape of the *i-dot* changes.

Figure 23. Height differences between i-dot *and* diaeresis. ITC Galliard *shows an intentional difference.*

Gill Sans Light *is typical, showing a lower height for the diaeresis, but with a disturbing difference in design.*

Gill Sans Regular *reverses the heights.*

Gill Sans Bold *chooses a middle ground, but could easily benefit from a unified height between the two diacritics.*

This lack of correlation between the *i-dot* and *diaeresis* may seem strange. Some designers, however, consider the *i-dot* to be a special diacritic, only used for the *i* and *j*, that has little correspondence to other accents. This is particularly true for typefaces that are calligraphically inspired.

Figure 24. Diacritics from Apple Chancery, Caflisch Script Pro, Lucida Handwriting, Poetica, Sanvito.

43. Apple Computer, 'The 'kern' table' in *TrueType Reference Manual* <http://developer.apple.com/fonts/TTRefMan/RM06/Chap6kern.html> 7 November 2000.

Figure 25. Diacritics from Arial, Times New Roman, Palatino Linotype *and* ITC Charter.

In a more general sense, there are two philosophies toward the vertical alignment of diacritics.[44] One method is to align the bottoms of all diacritics with that of the *acute* and *grave*. This is seen mostly, but not exclusively, in sans-serif faces. Monotype's *Times New Roman* is the clearest example of this method for seriffed fonts. It is interesting to note that Linotype's version of *Times* does not follow the same philosophy.

A second, more common, method is to align them according to their vertical centres, as can be seen in *Palatino Linotype*. A reasonable mix of these two methods can be seen in *ITC Charter*, where shorter diacritics such as the *tilde* and *diaeresis* are centred, but larger ones are bottom aligned (figure 25).

Multiple diacritics

There is also the problem of multiple diacritics. Some languages use up to two or three per letter, with one stacked above the other.[45] This can cause typographic difficulties, as the line spacing required to manage these stacks of diacritics can get extreme. This has not been a great problem for most designers in the past, because few people were interested in typesetting these unusual languages. With increased appreciation and understanding of non-European cultures, and increasing computer usage in developing countries, these issues have become more important for type designers of today.

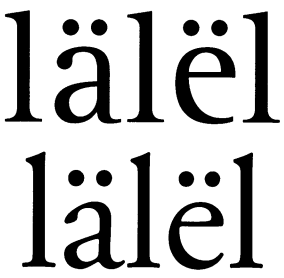


Figure 26. Rotis Serif *has less space for diacritics than* Adobe Garamond.

There are four different strategies that can be used to reduce the problems of multiple diacritics. The first is to ensure that there is generous space between the x-height and tops of the ascenders, in order to make the second level of diacritics seem less separated from the line. Faces such as *Rotis* would not be good candidates for multiple diacritic use, whereas *Garamond* designs have more room (figure 26). If multiple diacritic use is important, it should be considered from the very beginning of the typeface design process.

The second technique is to change the design of the diacritics to take up less vertical space. For example, the *acute*, *grave* and *circumflex* can have a wide variety of slope. When used for languages with multiple diacritics, the design of those accents can become more horizontal. The author's *Gentium* font family includes two sets of some diacritics, specifically for use in such situations.

Figure 27. Multiple diacritics from Gentium, *showing normal and alternate diacritic designs and alignment.*[46]

Spacing can also be enhanced by altering the vertical alignment of diacritics to use a more compact structure. This is illustrated in *Gentium*, where the alternate set uses reduced space between base and diacritic, as well as tighter vertical spacing between diacritics.

The final technique is to redesign specific diacritic combinations and treat them as a single mark. The Vietnamese writing system uses many diacritic combinations, and typographic history has shaped them into new forms, specific to that language, but with some variation in design. These forms take up less vertical space, so lines can be set closer together (figure 28).

Creative solutions

Some issues of vertical spacing have few, if any precedents. For example, what should be done with *below* diacritics? Many of the same issues of vertical spacing for *above* diacritics can apply to *below* ones. Should they be vertically centred or all align at the top? How should they relate to descender length?

44. Connare, *Diacritics Design Standards*.

45. The Ticuna language of Peru contains words like *nüxṹ*.

46. J. Victor Gaultney, *Gentium: a typeface for the nations* (Reading: 2002), p. 9.

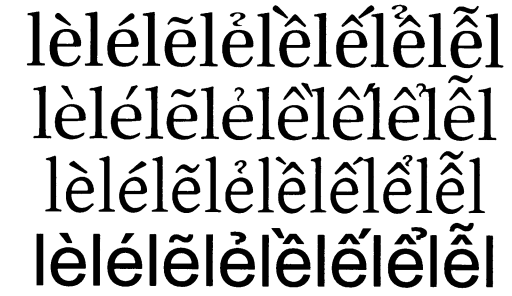


Figure 28. Vietnamese diacritics from Vtopia *(based on* Utopia*),*

Palatino Linotype,

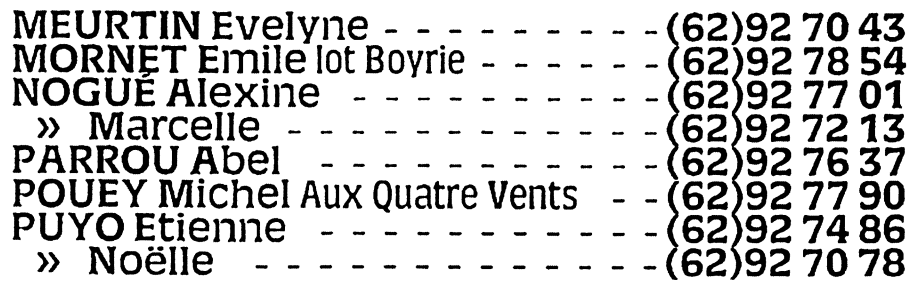
Gentium, *and*

Arial Unicode MS.

Figure 29. Below *versions of diacritics can be different from* above *ones. Here the shape is affected by descender length.*

The placement of *below* diacritics needs to balance that of their *above* equivalents, but their design need not be the same (figure 29). In some cases, a *below* has a different phonetic meaning than the equivalent *above*.[47] In this situation, contemporary designers have great freedom to innovate and find solutions that work.

A model for innovation can be found in the work of Ladislas Mandel. He has designed many bitmap typefaces for telephone directories, and has shown great creativity in his work. His *Clottes (France)* typeface needed diacritics (including the *i-dot*) that were clear, despite the very small body size (figure 30).



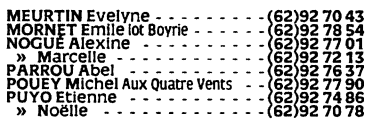


Figure 30. Mandel's design for Clottes (France)*, enlarged and actual size.*[58]

Mandel knew it would be impossible to shrink the diacritics and still make them noticeable, so he shrunk the base glyphs. Note the shortened *e* when used with *diaeresis*. Even the base of the *i* is reduced in size. Although they look odd when enlarged, these innovations work well at their intended size. Finally, he used the same technique for *É*, which leads to the next challenge—capitals.

Problem: Capitals

As with stacked accents, diacritics for capital letters face the challenge of line spacing. Something often has to be adjusted for accented capitals to work well in text—either the diacritic, the capital, or both. Yannis Haralambous, when discussing a project to provide a multiple-script font for the Ω typesetting system, wrote:

> *...it is quite natural to assume that placing diacritics does not affect the shapes of either the base character or the diacritic itself. Often this is true, but there are times when typographical quality requires special shapes.*[49]

He is correct that reshaping is not necessary in many cases, particularly if capitals are short and accents somewhat flat. In the majority of digital fonts there is no difference between the *circumflex* used for capitals and that used for

47. International Phonetic Association, p. 193.

48. Olivier Nineuil, 'Ladislas Mandel: explorateur de la typo française', *Étapes graphiques*, 22 (1999), 44–66 (p. 54).

49. Yannis Haralambous and John Plaice, 'The design and use of a multiple-alphabet font with Ω', in *Electronic publishing, artistic imaging, and digital typography*, ed. by Roger D. Hersch, Jacques André and Heather Brown (Berlin: Springer-Verlag, 1998), pp. 126–137 (p. 129).

smaller letters. Technologies that allowed use of a single shape for both capital and lowercase diacritics encouraged such designs. This unity of shapes was, however, not necessarily the default prior to the digital age. In addition to this, reshaping may not be *necessary* in many cases, but it may be *desirable*, because it allows more freedom in design. It also allows text for accented languages to be set in a more compact manner—a great virtue.

Reshaping accents

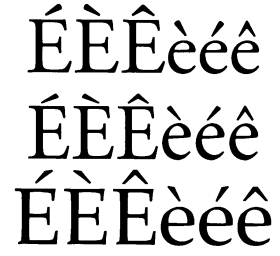


Figure 31. Capital and lowercase diacritics from Adobe Garamond, Minion *and* Palatino Linotype.

Figure 32. Accents from original metal 12 point Sabon *(enlarged)*[50]*, and digital versions from Adobe and Monotype.*

Figure 33. Altered capitals from Schadow-Antiqua schmalfett *(enlarged).*[51]

Figure 34. A-ring in Times New Roman, Georgia, Arial, Verdana.

Figure 35. Accented capitals from Antique Olive *(enlarged).*[53]

If the designer sees a need for reshaping, the question becomes what to change. The diacritic is the most malleable, so it is commonly the first candidate.

As noted earlier, metal types had accents that were more vertical than horizontal. If those long, tall accents were placed above capitals, the body size would have needed to be much larger. Once diacritics began to be used with capitals, those accents sometimes had their slope reduced, and could be shortened as well. Even today, the digital types that use this technique are often those designs that hearken back to classic forms (figure 31).

This reshaping was actually the norm for metal types. It can be seen in both serif and sans-serif styles, and from various eras. In the transition to phototypes and digital there was a sharp shift away, toward having capital accents identical to those used for lowercase letters. This coincided with the overall changes in diacritic slope noted in types such as *Caledonia*. *Sabon*, as designed initially for metal type, had very vertical accents that were radically altered for capitals. Digital versions from Adobe and Monotype, however, use a single design for both cases (figure 32).

So which is correct? It could be argued that the freedom from the body size restrictions in metal fonts allowed designers to finally get what they may have wanted all along—the ability to put full-sized diacritics on top of capitals. On the other hand, the same could have been accomplished in earlier technologies by using a larger body size. The post-metal change is more likely to be a result of misused technology. Accented base/diacritic combinations in photosetting and digital systems were commonly constructed out of floating components. Although it was possible to use a separate component for capitals, it was simply easier to use a single one for all uses, which also saved space in the font.

It remains unknown whether the reduction in the vertical size of diacritics seen in metal types was an intentional design choice, or just an acknowledgement of the limits of technology. The motivations of those who originally managed the transition to photo and digital types is equally opaque. In any case, the use of reduced diacritics was, and remains, a viable option for contemporary designers.

Other options

On rare occasions, such as with Mandel's telephone directory fonts (figure 30) and Georg Trump's *Schadow-Antiqua schmalfett* (figure 33), the capital was also reduced in size. Instead of resorting to this highly noticeable change, most designers reduced the space between the accent and capital. This is now normal practice.[52]

In extreme situations, the diacritic can even be attached to the capital. This is common with the *Å*. About half of the text type families in the *FontFont Catalogue 2000* are this way, as well as four of the most common types in use today (figure 34). The acute and other accents can also be connected, as in Excoffon's *Antique Olive* (figure 35).

The most interesting case study of reshaping is the *diaeresis*, or, when used for German, the *umlaut*. Capitals with diacritics, in general, have been problematic for printers—the extra protrusions above the cap height could require

50. *Sabon-Antiqua* [type specimen] (Frankfurt: Linotype).
51. *Schadow-Antiqua* [type specimen] (Stuttgart: C.E. Weber).
52. Connare, *Diacritics design standards*.
53. Kapr, p. 398.

kerning above the body. Moving the dots of the *diaeresis* as to no longer rest above the letters (or only slightly above) fixes the problem.[54]

Figure 36. Umlauts *from original drafts of* Optima *and* Melior.[55]

Typically, the dots are moved out to the sides and down for *A* and *O*, and together and down for *U*. The original designs for Hermann Zapf's *Optima* and *Melior* show this adjustment (figure 36). By this time there was little technical need to move down the dots (those on *Ë* have not changed, for example), so the motivation for the design was aesthetic, not technical.

For many decades, there was a strong German movement toward the creative design of the *umlaut*. A direct descendant from Gothic script forms, it was different in meaning, but not necessarily in design, from the *diaeresis* used for French. The *umlaut* changed the quality of vowels, whereas the *diaeresis* separated them.[56] So the *umlaut* had a distinct purpose, unique to German.

This cultural attitude can be seen in fonts from German foundries. Figure 37 gives a sampling of some capital *umlaut* designs from German companies operating during the middle of the twentieth century. Note the unique treatment of the dots for each letter. It is clear that there is an *umlaut* there, even if the alignment and orientation of the dots is different.

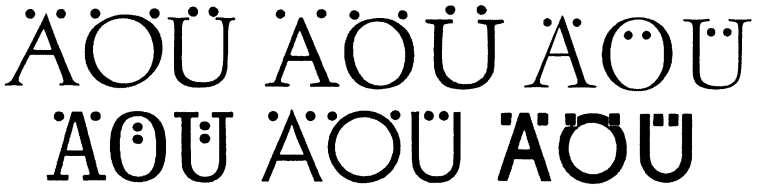


Figure 37. Examples of reshaped umlauts in German fonts (enlarged): Palatino *(Stempel, 1950),* Trump-Mediäval *(1954),* Garamond-Antiqua *(1950),* Schadow *(1952),* Futura-Buchschrift *(1932),* Super-Grotesk *(1932).*[57]

The surprising fact is that when these fonts were released outside Germany, the design of the *umlaut* often changed to the more international shape and alignment.[58] Modern digital versions consistently use only the international forms. Without smart rendering technologies, a digital font can only include one version or the other, and the international forms were chosen (figure 38). These have now become the standard even in Germany.

Figure 38. Digital versions of uppercase umlauts: Palatino Linotype, Trump Mediaeval, Optima *and* Futura.

This change was not limited to phototypesetting and digital fonts. German foundries have had to cater to markets outside Germany for many years. A 1928 specimen of 10 point *Futura* includes both German and international forms (figure 39).

Figure 39. Capitals with diaeresis/umlaut *from 10 point* Futura *(1928), enlarged. Only one version of Ü was included in the sample.*[59]

The point of such detail here is to show that the reshaping of diacritics can be motivated by both technical and cultural purposes. It is also a reminder of the creative possibilities for solving diacritic design problems.

54. Lucian Alphonse Legros and John Cameron Grant, *Typographical printing-surfaces* (London: Longmans, Green, and Co., 1916), pp. 79–80.
55. Zapf, p. 49, 81.
56. Robert Bringhurst, *The elements of typographic style*, 2nd edn (Point Roberts, WA: Hartley & Marks, 1997), p. 276.
57. Kapr, p. 342, 345, 348, 402, 417, 432.
58. This even happened within Germany, where a type specimen for *Optima* intended for a German audience used the international forms: *Typorello 3: Optima-Antiqua* (Frankfurt: Stempel).
59. Christopher Burke, *Paul Renner* (London: Hyphen Press, 1998), p. 106.

Shorter capitals

If none of the various options for reshaping diacritics is desirable, it is possible to minimise or eliminate it altogether—through use of smaller capitals throughout the font. In a sense, this is also a type of reshaping, but a global rather than a local one. Shorter capitals result in more space for diacritics.

Large capitals, drawn straight from inscriptional forms, and found commonly in types of earlier centuries, are seen less and less in contemporary fonts. There seems to be a healthy trend toward diacritic-friendly capitals. This is particularly true of fonts produced in Europe, where accented capitals are a necessity.[60] Paul Renner deliberately designed the capitals of *Futura* to work well with the German language—not necessarily because of diacritics, but due to the frequent use of capitals in German text.[61]

Problem: Cultural preferences

Each of the problems so far has a linguistic/cultural dimension. The design and alignment of the *ogonek* depends on whether the language being typeset is Polish or Lithuanian.[62] Width issues are affected by the frequency of letter pairs in the language. The stacking of *circumflex* with *acute* is different for Vietnamese than for African languages. Capital accents have strong cultural patterns and influences.

There is a natural tendency for a designer to specialise in those features of fonts that are most important to the linguistic environment in which they live. Such tendencies are not always conscious. They can grow from a preference, rather than a calculated decision. This is not at all bad. It is valuable for a design to spring from inner resources, and not just from reason. An understanding of these cultural preferences can help a designer create fonts that are useful to a wider audience. It can be difficult, though, to balance these preferences and design fonts that meet the needs of a broad international community.

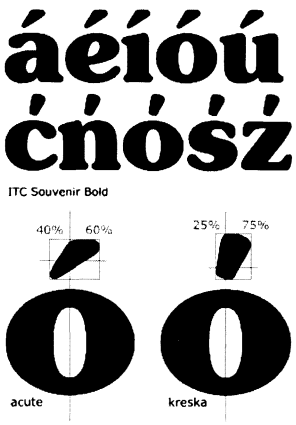


Figure 40. Examples of the traditional acute *(top) and the Polish* kreska *(middle).*[64]

Similar, but different

As with the *umlaut/diaeresis*, diacritics that look similar may not really be the same. The *cedilla*, when used for French, can have three forms—the traditional connected design, a comma-like unconnected one, or a stroke that crosses the bottom curve of the *c*. Portuguese and Catalan readers, however, prefer only the traditional shape.[63] A diacritic can have accepted design variations for one language that are not acceptable for another.

Another example of this is the *kreska*, used for Polish. At first, it seems to be identical to the acute, and is encoded as such in Unicode. The preferred form, however, is more vertical and shifted to the right (figure 40).

A similar situation occurs in Czech, where the *acute*-like *čarka* is used. Oldřich Hlavsa, in his typographic tome *A book of type and design*, discusses the topic of Czech diacritics.[65] To him, the angle of the *čarka* is not important—it is the terminal shape. In comparing Czech versions of *Bodoni* and *Empiriana* (figure 41), he writes about the *Bodoni*: '...the rounding of the top portion of the stroke over the "á" and "ý" [is not] appropriate.'

He continues about another similar, but different, diacritic—the *haček*: 'In the Bodoni we are struck...by the inadequacy of the mark over the "č", "ň" and

Figure 41. Czech diacritics from Bodoni *and* Empiriana.[66]

60. This trend was noted after a perusal of various font catalogues, and *FontFont Catalogue 2000* (Berlin: FontShop International, 2000) in particular.

61. Burke, p. 105.

62. Twardoch, *Polish diacritics: how to?—ogonek.*

63. Connare, *Diacritics design standards.*

64. Adam Twardoch, *Polish diacritics: how to?—kreska* <http://studweb.euv-frankfurt-o.de/twardoch/f/en/typo/ogonek/kreska.html> 28 August 1999.

65. Oldřich Hlavsa, *A book of type and design*, trans. by Sylvia Fink (London: Peter Nevill, 1960), p. 454.

66. p. 455.

"ž". It is actually the inverted French circumflex accent, which spoils most of our faces cast by typefoundries abroad.' To most eyes, the *Bodoni haček* might seem adequate—anything larger would look out of place. He is referring, however, not to the size, but to the shape and strength of contrast that is better implemented in *Empiriana*. It is definitely not an inverted *circumflex*.

Size & weight

Size is important, though, and Hlavsa continues with comments that are applicable to diacritics of all languages:

> *Only those diacritical marks can be regarded as appropriate which suit the letter to which they belong in the following respects: by an absolutely equal weight, adequate size, congenial design, as well as by maintaining the contrast and the mutual position of the shaded and of the hairline strokes. Furthermore, the dot over the 'i' and the rest of the diacritic marks must be located on the same level, which should not be placed too high.*

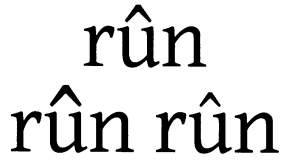


Figure 42. Which circumflex is the right size? It may depend on the language.

This is excellent counsel. The only problem is in the definition of size and weight. The perception of these has a strong cultural bias. As with issues of legibility, the 'right' size can be influenced by what one is used to seeing. Consider the situation where a relatively small community speaks a minority language that has little literary tradition. If the written form of their language uses diacritics, and the only font for their language has very large diacritics, people may prefer large diacritics because that is what they learned to read.

This has another linguistic dimension. The role and importance of diacritics in a language can affect their design. The French language, for example, can be understood even if diacritics are missing. It is not correct, but in most cases the meaning is communicated. In this language, accents carry little of the semantic meaning, so their strength in a line of text can be reduced without compromising communication.

Gbogbo ènìyàn ni a bí ní òmìnira; iyì àti ẹ̀tọ́ kọ̀ọ̀kan sì dọ́gba. Wọ́n ní ẹ̀bùn ti làákàyè àti ti ẹ̀rí-ọkàn, ó sì yẹ kí wọn ó máa hùwà sí ara wọn gẹ́gẹ́ bí ọmọ ìyá.

Figure 43. Diacritics are a vital part of the Yoruba alphabet.

In Yoruba, one of the major languages of West Africa, diacritics are critically important (figure 43). One of their roles is to mark tone. This gives them a linguistic status equal to independent letters such as *o*, *i* or *n*. They carry much of the semantic meaning and cannot be eliminated without severe miscommunication. For this language, accents must be strong and unambiguous.

In these linguistic situations, the legibility of diacritics becomes a major issue. Ovink, a leader in legibility research, found that the size, more than the shape, of the dot on *i* and *j* contributed to its correct recognition.[67] This can be applied to other diacritics as well. Larger diacritics can improve legibility.

Solutions

Figure 44. The Polish kreska *in* Palatino Linotype.

Is it possible to design acceptable fonts in such a diverse cultural and linguistic environment? Yes, but it requires careful planning and research. Powerful new technologies, although complex to implement, may also be needed.

One strategy is to design diacritics with multi-lingual use in mind. The *acute* and *grave* in *Palatino Linotype*, for example, are perfectly acceptable for Polish as they have a steeper slope than is typical (figure 44).[68] This does not make the font less useful for French or Yoruba, but rather maximises its utility in a global market. Charles Bigelow and Kris Holmes recognised the impact of broad use in their design for *Lucida Sans Unicode*. They wrote:

> *To aid legibility, or at least to increase decipherability, the diacritics require greater differentiation. Accordingly, we designed the lowercase diacritics of Lucida Sans Unicode to be slightly taller and a little different in modulation than those of the original Lucida Sans.*[69]

67. Herbert Spencer, *The visible word* (London: Lund Humphries, 1969), p. 35.

68. Twardoch, *Polish diacritics: how to?—kreska.*

69. Charles Bigelow and Kris Holmes, 'The design of a Unicode font', *Electronic Publishing*, 6.3 (1993), 289–305 (p. 295).

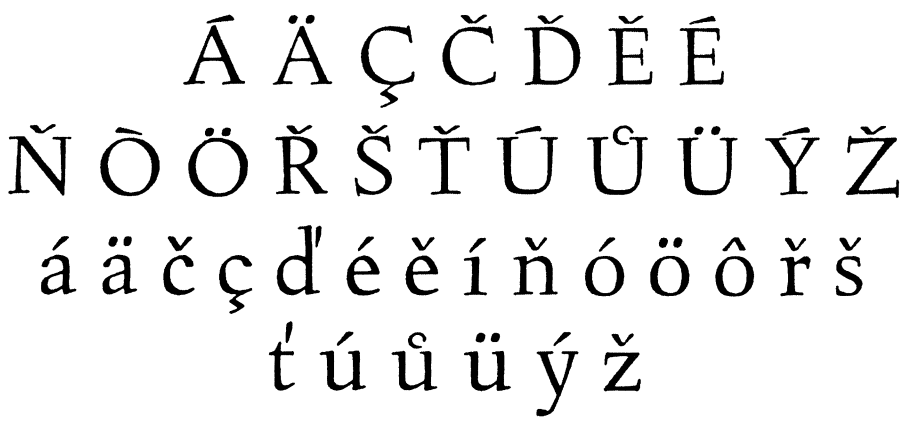


Figure 45. Czech letters from Menhart's Figural. *The diacritics show a uniquely Czech style to his design.*[70]

Another strategy is to limit the target languages for a font, and design diacritics specifically for those languages. Oldřich Menhart was a Czech calligrapher, type designer and typographer who epitomised the role of the ethnic designer. His types have a strong Czech character. His diacritics show a unique design that is particularly well suited for his language (figure 45). Paul Hayden Duensing writes of his work:

> *This became one of the man's lifelong goals: to share the richness of his culture with the world by creating designs that serve the endogenous Czech literature with an uncommon degree of 'rightness' and also display the Czech national style to the rest of the world....he understood that the particularly large number of accents used in the Czech language presented problems which were not satisfactorily addressed by most of the types of the time.*[71]

This strongly ethnic design was rare. It was more common for fonts used in eastern Europe to be purchased from western foundries and expanded to include the necessary diacritics.[72] This is still widespread today, even with digital fonts. The advantage with this approach is that diacritics can be carefully tuned for a specific use.

This specialisation can also be built into plans for globally useful fonts. With the font tools available to designers today, alternate versions of fonts can be produced without great difficulty. There can be separate versions for different language groupings. There is nothing new about this strategy. As seen with *Futura*, it was possible to buy special versions of certain letters, even in metal type. Major, not just minor, variations were also completed. Vox cut a French version of *Times New Roman*, revising fourteen glyphs to make them more like the *Romain du Roi*. Monotype created a German version with lighter caps.[73]

With use of recent technologies, the benefits of alternate fonts can be delivered in a single font file. OpenType fonts can contain language-specific glyph substitution information.[74] The problem in figure 40, where alternate diacritics for *ITC Souvenir Bold* are needed for Polish, can be solved with a single OpenType font.[75] Applications now commonly keep track of the language of text in the same way they store text formatting information. If the language is Polish, the *o-kreska* form is substituted. Otherwise, for French or Yoruba, the default *o-acute* is used.

70. Hlavsa, p. 146.

71. Paul Hayden Duensing, 'Oldřich Menhart' in *Fine print on type*, ed. by Charles Bigelow, et al. (London: Lund Humphries, 1989), pp. 119–124 (p. 122).

72. Hlavsa, p. 454.

73. Bigelow and Holmes, pp. 298–299.

74. John Hudson, *Windows glyph processing: part two: glyph processing in detail* <http://www.microsoft.com/typography/developers/opentype/detail.htm> 16 January 2001.

75. Twardoch, *Polish diacritics: how to?—kreska.*

The business of diacritics

Most accented letters are type-founders' step-children... [76]

The role of the designer is to use the technologies available to design fonts whose diacritics work well as graphic elements and are sensitive to cultural needs and preferences. Even if a designer has conquered the problems of asymmetry, width harmony, vertical spacing, capitals and culture, there remains one more challenge—economics. Although this essay is focused on the design of diacritics, a brief interlude into the business of creating fonts with accents can be helpful.

Economics refers to the monetary costs of producing diacritics, but also to the time and attention accents receive from both designers and foundries. All type technologies have had the potential to produce elegant and effective diacritics, but to what extent were they used, and how important was it to those in charge?

It is difficult to find this information without extensive research into foundry records. Little has been written directly by the foundries, but it is clear that printers, who faced the task of setting accented text, were decidedly negative, even when publishing in manufacturers' publications, such as the *Monotype Recorder*:

> *The quarrel which I as a printer have with phonetic alphabets is their use of diacritic marks, that is the dots, blobs, and lines appearing above and below some of the symbols and even turned letters... From the printer's point of view diacritic marks are an abomination. Not only do they break off when printing or when making flongs in preparation for places, but they also have a passion for filling up and printing as blurs.*[77]

Some linguists even argued against them, on behalf of printers, because they realised that they might cause problems with publication:

> *...diacritic marks constitute a difficulty and a danger... Printers find that dots and accents wear out more quickly than the letters, and are therefore apt to become indistinct in print.*[78]

Legros and Grant, the renowned printing technologists, knew little about linguistics, but felt that the use of accents ought be completely abandoned.[79] They saw the introduction of diacritics as a colossal mistake:

> *With the spread of religion over the world, the missionaries, usually educated men, have left, as has been said, examples of their erudition: but unfortunately they have shown little knowledge of typography, as is evidenced by the selection made by them of the miscellaneously accented characters with which they have unhappily endowed the scripts of many countries.*[80]

Foundries, however, may not have had such a negative attitude. Unusual accents required special orders, and that created revenue. They also discovered ways to address diacritic problems. Linotype had a two-line system that could be used to manage some overhangs. It was developed for advertising layout, not diacritics, but partially met the need.[81]

Economic pressures actually stimulated the addition of accents to fonts, as manufacturers wanted to increase their potential markets.[82] The quality of such expanded character sets, however, were often poor. The rush to bring revised fonts to market outweighed the quality concerns of even the most renowned foundries.[83]

76. Jan Tschichold, 'Of what value is tradition in type design?' in *Typographic Opportunities in the Computer Age* (Prague: Typografia, 1970), pp. 52–55 (p. 53).

77. P.V. Daley, 'Phonetics and the printer', *Monotype Recorder*, 37.1 (1938), 14–17 (p. 15, 17).

78. International Institute of African Languages and Cultures, *Practical orthography of African languages* (London: International Institute of African Languages and Cultures, 1927), pp. 4–5.

79. Legros and Grant, p. 79.

80. p. 535.

81. p. 79.

82. Hermann Zapf, *Hermann Zapf and his design philosophy* (Chicago: Society of Typographic Arts, 1987), p. 24.

83. Fred Smeijers, *Counterpunch* (London: Hyphen Press, 1996), p. 171.

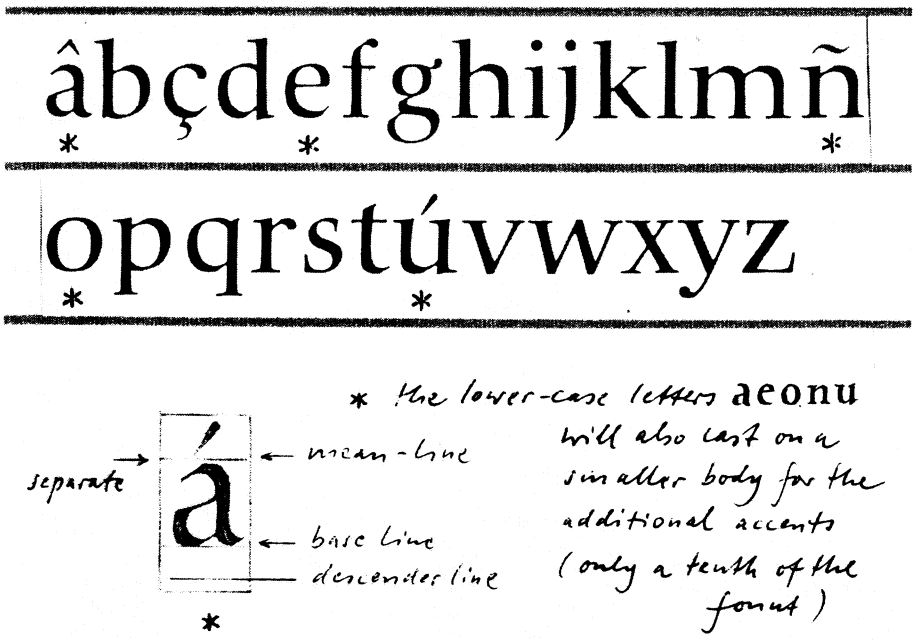


Figure 46. Excerpts from the second drawing for Hunt Roman, illustrating the special piece accent design.[84]

There were situations, however, where economic concerns and technical ingenuity were matched with a desire for fine typesetting. In 1961, the Hunt Botanical Library commissioned a font from Hermann Zapf for their exclusive use. It was intended for handsetting, and needed to include accented characters due to the scientific nature of their publications. An exclusive production of type was normally expensive, but their need for accented letters would have further increased the cost. Freed from the limitations of matrix sizes and mechanical constraints, Zapf could apply a technique used for capital accents to lowercase letters and reduce cost at the same time.

He designed the accents as pieces that could be combined with lowercase letters that had been cast on a smaller body (figure 46). This reduced the number of matrices needed by 16, and produced a font of only 90 characters.[85] It was a clever way to implement diacritics within economic constraints.

Contemporary designers who wish to support diacritics beyond the western European set will need some of this creativity. The time needed to design and implement an expanded range of accents is not trivial and can be costly. Current font development tools can ease this burden, but it requires some investment of effort to learn the technology and put it into service.

As with the traditional type foundries, individual designers can find an economic advantage to supporting a wide range of accents. It can open up markets and gain commissions, especially among corporate clients who need multi-lingual solutions.

The path forward

What does the future hold for diacritic design? The world of the type designer has been changing rapidly. If current trends continue, this world will become increasingly multi-lingual, technical and independent.

The need for fonts with a broad range of accents is growing. The impending expansion of the European Union eastward will require fonts to support Central European accented combinations. These will likely become standard, rather than separate 'CE' versions. This will also enable a wider range of Latin diacritic support, extending beyond Europe and into Asia and Africa.

84. George H.M. Lawrence, ed., *Hunt Roman: the birth of a type* (Pittsburgh: The Pittsburgh Bibliophiles, 1965), p. 29.

85. Zapf, pp. 69–70.

Type design will, unfortunately, become even more technical in nature. No longer will designers be able to focus just on Bézier curves—they must understand Unicode and OpenType. This is already the situation, and will not likely change soon. FontLab and other current font development tools are keeping up with new advances, and are attempting to make them more accessible, but the nature of the technologies are complex. It is precisely these technologies that are needed for rich diacritic support, so designers will need to use them in order to meet the need for a wider range of diacritics.

Designers will also likely find themselves in increasingly independent situations. Changes in the type industry, enabled and then forced by digital technologies, have seen major foundries shrink and depend more on independent designers. Legions of independent type foundries have sprung up. More and more of type production rests in the hands of the designers, rather than in the staff of manufacturers. As a result, the addition of diacritics, once a standard role of the foundry, is now almost completely dependent on the designer.

The need for expanded diacritic support is clear. The technologies are in place, but designers will need to take the active role.

Remaining problems

The ideal world is one where people of any language that uses Latin diacritics can typeset their language with ease and produce high quality typography. Despite the efforts of many dedicated designers, there are still barriers to this ideal.

There remain some theoretical challenges that have yet to be met. This essay will hopefully stimulate more discussion, research and publication on diacritic design. Italics, bold faces and sans-serifs deserve greater investigation. The concept of optical alignment needs further refinement and integration into font tools. The issues surrounding kerning and diacritics are ripe for study and development.

The advances in technology that hold the most promise for diacritic support still remain in their infancy. The language-specific behaviours of OpenType have not yet been broadly supported in applications. What support exists for OpenType is still spotty, limited to Microsoft and Adobe applications, and works for only certain languages—mostly from Europe. Type foundries other than Adobe have been slow in their support, with independent designers a long way behind.

The standards for diacritic design remain poor, as a direct result of the last few rapid technology transitions in the industry. There is a huge body of digital fonts in use and on the market that have mediocre diacritic design, and these fonts are influencing designers who unknowingly perpetuate bad practice. Foundries have made few efforts to fix these designs, likely due to the many other pressures on them, including economic ones. They also suffer from a dearth of information on what constitutes good diacritic design.

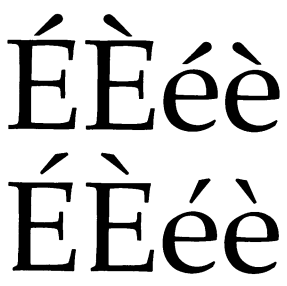


Figure 47. Improvements in the design of diacritics from Palatino (Adobe, 1997) to Palatino Linotype (2001). Note the removal of rounded terminals, a better slope, and a differentiation between capital and lowercase versions.

There are notable exceptions, such as Linotype's recent revisions to *Palatino* (figure 47), where diacritics have returned to better forms. Still, many fonts such as *Sabon* and *Futura* deserve attention. Long-standing problems remain in hundreds of fonts, such as the unification of capital and lowercase forms and the disturbing disparity between the designs of the *i-dot* and *diaeresis*.

For many years, the type community was effectively limited to Western European diacritics. This has been changing now to include Central and Eastern European ones, but there is still little momentum to support the whole Unicode range of diacritics. Without a reasonable business model to support their development, the wider range will continue to suffer. This is an especially acute problem for small independent type foundries.

A final remaining problem, and a contributor to those already mentioned, is the lack of unified development routines for the preparation of diacritic-rich fonts. Even if OpenType were universally supported by applications and all the necessary glyphs designed, foundries would still need to write special data files and complicated routines to make them work. This is simply beyond the resources of most independent designers.

The need for design guidance

So what can be done to enable and encourage the development of fonts with good diacritics? There are two areas where designers need guidance—*design* (the shape and alignment of accents) and *implementation* (the technical areas of encoding and font behaviour).

Designers need more sources of information on how diacritics ought to appear, including guidance on cultural preferences. This should include detailed information on individual diacritics, along with historical information as well as recommendations as to current best practice. Microsoft's *Character Design Standards* is valuable, but it is limited to a small range of accents and only discusses alignment issues. Agfa's *Type Design Standards* could be an indispensable resource if it were completed and made available to the type design community at large.

A better resource might be an online collection of design information that is easily revisable and expandible. It ought to be dynamic, and welcome contributions from historians, designers and linguists. This is possible, but to be successful, it would require cooperation from organisations such as Agfa and Microsoft, as well as some source of funding for development and ongoing maintenance.

How might such design information be organised? This essay presents discussion of diacritics grouped by problem, but the same information could be organised by individual diacritic, or by the classification features mentioned earlier. Additional information, such as on sans-serifs, could be organised together. All of these are important ways to interact with design information. One possible solution could be a single body of information that is accessed via different structures, depending on need.

One more type of information would be valuable to diacritic designers: linguistic data, such as frequencies of base/diacritic combinations in use around the world. For writing systems that use multiple diacritics, it would be helpful to know which diacritic pairs are most common as well. If these were available to the public in an organised resource, the result might be greater support for non-European diacritic use.

The need for implementation guidance

With the increased technological sophistication of modern fonts and font tools, the designer can easily become overwhelmed. To develop internationally useful fonts requires a large amount of planning that is currently left up to the designer or foundry. A large corporation, like Adobe, can afford to invest in data and tools that are used to produce hundreds of fonts, but the individual designer or smaller foundry simply cannot afford the investment.

Unicode is an international standard that defines character encoding, but the designer must still decide which glyphs should be assigned to individual code points, what alternate glyphs should be included, and the rules for substitution. Generally accepted glyph sets and related files, though not elevated to the status of international standards, would assist developers and allow them to share font programming code. Tools could then be developed to build fonts based upon these glyph sets.

For example, an open specification could be developed that defined all the diacritic glyphs and behaviours needed to support European and African languages. This would include a list of glyphs with prescribed PostScript names and font programming code for technologies such as OpenType, Apple Advanced Typography (AAT)[86] and SIL International's Graphite[87]. The designer would then design glyphs with the appropriate names, and use a special font tool that would build the font automatically. This would allow the designer to build diacritic-rich fonts while knowing little about the linguistics of a particular language or the intricacies of the technologies at work.

There are already models for this type of tool. Apple's AAT Font Tool[88] takes a font as input and enhances it with new behaviours. It does not design new shapes, but adds the programming code that allows the glyphs to be used by the Mac OS in intelligent ways.

The only argument against this approach is that fonts might need different behaviours. A font whose capitals are modest might not need to include small caps, for example. Another font might require special smart ligatures uncommon to others. In the first case, the lack of small caps with expected glyph names could be noticed by the tool, which would then not generate the normal OpenType small caps code. In the latter, the font designer would have the freedom to modify the standard data to support that special need.

A useful complement to these standards and tools would be a sample font, including programming code, that would be freely available and implement the features necessary for broad diacritic support. It could be a model for both design and implementation, and be integrated with the tools discussed earlier.

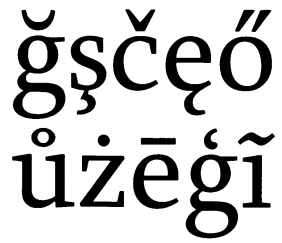


Figure 48. Diacritics from Sylfaen.

John Hudson, in coordination with Geraldine Wade, designed the *Sylfaen* font as a model for font developers (figure 48). It was integrated with the WRIT (Web Resource for International Typography) project under development at Microsoft. Despite all the efforts that were invested in both font and resource, the project was cancelled in 1998. Although a subset of the font is now included in Windows, the full font, unfortunately, remains unavailable.[89]

The role of the designer today

In the midst of design uncertainty and complex technology, how can type designers move forward in developing diacritics for their typefaces?

The first step is to consider diacritics early in the process of designing a new typeface. *What languages does this font need to support? What types of diacritics are needed? How will that affect the width of letters, the length of ascenders, the height of capitals, etc.?*

The second is to design as many of the diacritics listed in Unicode as might be needed for the font. Designing them as a group can help to ensure consistency and unity of design. It can also save significant amounts of time. This is a good step even if the implementation issues are not yet solved. Revision and refinement can happen at a later time.

The third is to stay abreast of technology. Type designers should not have to become type technologists, but need to be aware of technical developments that could make implementation easier. It is likely that new tools that save time and effort will emerge not from commercial companies or foundries, but from the type design community itself due to the scriptable nature of modern font tools. So it will be helpful for designers to build relationships with the technologists within the type community.

The final step is to use the tools, techniques and information available to develop diacritics that are well-crafted and appropriate for the language being typeset. The goals are harmony and balance. Menhart sums up the purpose of diacritics:

86. Apple Computer, *Apple Fonts/Tools* <http://developer.apple.com/fonts/> 8 May 1998.

87. SIL International, *Graphite: rendering complex non-Roman scripts* <http://graphite.sil.org/> 16 November 2001.

88. Apple Computer, *AAT Font Tool* <http://developer.apple.com/fonts/Tools/index.html> 2 April 1999.

89. John Hudson, 'Sylfaen: foundations for multiscript typography', *Type 3* <http://www.atypi.org/members/publications/type3/sylfaen-1.html>.

> *...[accents] ought to help the reader by making the text more legible, gently and unobtrusively bringing to his attention the change in pronunciation and the proper phonetic values of the letters...*[90]

Every major problem of diacritic design has inspired designers to innovate and find solutions. They have used the technology available to them to develop ways to handle these accents. By taking advantage of the freedom of sophisticated digital type, designers can continue to innovate, like their predecessors. Diacritics, once seen as 'type-founders' step-children' can then become fully-fledged members of the Latin typographic family.

90. Oldřich Menhart, *Tvorba písma a graphická úprava knihy* (Brno: 1958), quoted in Duensing, p. 122.

Appendix—Summary of diacritic features

Unicode	*Diac*	*Unicode name*	*Shape*	*HPosition*	*VPosition*
0300	◌̀	COMBINING GRAVE ACCENT	Asym	Offset	Above
0301	◌́	COMBINING ACUTE ACCENT	Asym	Offset	Above
0302	◌̂	COMBINING CIRCUMFLEX ACCENT	Sym	Centred	Above
0303	◌̃	COMBINING TILDE	Asym	Centred	Above
0304	◌̄	COMBINING MACRON	Sym	Centred	Above
0305	◌̅	COMBINING OVERLINE	Sym	Centred	Above
0306	◌̆	COMBINING BREVE	Sym	Centred	Above
0307	◌̇	COMBINING DOT ABOVE	Sym	Centred	Above
0308	◌̈	COMBINING DIAERESIS	Sym	Centred	Above
0309	◌̉	COMBINING HOOK ABOVE	Asym	Centred	Above
030A	◌̊	COMBINING RING ABOVE	Sym	Centred	Above
030B	◌̋	COMBINING DOUBLE ACUTE ACCENT	Asym	Offset	Above
030C	◌̌	COMBINING CARON	Sym	Centred	Above
030D	◌̍	COMBINING VERTICAL LINE ABOVE	Sym	Centred	Above
030E	◌̎	COMBINING DOUBLE VERTICAL LINE ABOVE	Sym	Centred	Above
030F	◌̏	COMBINING DOUBLE GRAVE ACCENT	Asym	Offset	Above
0310	◌̐	COMBINING CANDRABINDU	Sym	Centred	Above
0311	◌̑	COMBINING INVERTED BREVE	Sym	Centred	Above
0312	◌̒	COMBINING TURNED COMMA ABOVE	Asym	Centred	Above
0313	◌̓	COMBINING COMMA ABOVE	Asym	Centred	Above
0314	◌̔	COMBINING REVERSED COMMA ABOVE	Asym	Centred	Above
0315	◌̕	COMBINING COMMA ABOVE RIGHT	Asym	Variable	Above
0316	◌̖	COMBINING GRAVE ACCENT BELOW	Asym	Offset	Below
0317	◌̗	COMBINING ACUTE ACCENT BELOW	Asym	Offset	Below
0318	◌̘	COMBINING LEFT TACK BELOW	Asym	Offset	Below
0319	◌̙	COMBINING RIGHT TACK BELOW	Asym	Offset	Below
031A	◌̚	COMBINING LEFT ANGLE ABOVE	Asym	Offset	Above
031B	◌̛	COMBINING HORN	Asym	Variable	TopRight
031C	◌̜	COMBINING LEFT HALF RING BELOW	Asym	Centred	Below
031D	◌̝	COMBINING UP TACK BELOW	Sym	Centred	Below
031E	◌̞	COMBINING DOWN TACK BELOW	Sym	Centred	Below
031F	◌̟	COMBINING PLUS SIGN BELOW	Sym	Centred	Below
0320	◌̠	COMBINING MINUS SIGN BELOW	Sym	Centred	Below
0321	◌̡	COMBINING PALATALIZED HOOK BELOW	Asym	Variable	Below
0322	◌̢	COMBINING RETROFLEX HOOK BELOW	Asym	Variable	Below
0323	◌̣	COMBINING DOT BELOW	Sym	Centred	Below
0324	◌̤	COMBINING DIAERESIS BELOW	Sym	Centred	Below
0325	◌̥	COMBINING RING BELOW	Sym	Centred	Below
0326	◌̦	COMBINING COMMA BELOW	Asym	Centred	Below
0327	◌̧	COMBINING CEDILLA	Asym	Variable	Below
0328	◌̨	COMBINING OGONEK	Asym	Variable	Below
0329	◌̩	COMBINING VERTICAL LINE BELOW	Sym	Centred	Below
032A	◌̪	COMBINING BRIDGE BELOW	Sym	Centred	Below
032B	◌̫	COMBINING INVERTED DOUBLE ARCH BELOW	Sym	Centred	Below
032C	◌̬	COMBINING CARON BELOW	Sym	Centred	Below
032D	◌̭	COMBINING CIRCUMFLEX ACCENT BELOW	Sym	Centred	Below
032E	◌̮	COMBINING BREVE BELOW	Sym	Centred	Below
032F	◌̯	COMBINING INVERTED BREVE BELOW	Sym	Centred	Below

0330	◌̰	COMBINING TILDE BELOW	Asym	Centred	Below
0331	◌̱	COMBINING MACRON BELOW	Sym	Centred	Below
0332	◌̲	COMBINING LOW LINE	Sym	Centred	Below
0333	◌̳	COMBINING DOUBLE LOW LINE	Sym	Centred	Below
0334	◌̴	COMBINING TILDE OVERLAY	Asym	Centred	Through
0335	◌̵	COMBINING SHORT STROKE OVERLAY	Sym	Centred	Through
0336	◌̶	COMBINING LONG STROKE OVERLAY	Sym	Centred	Through
0337	◌̷	COMBINING SHORT SOLIDUS OVERLAY	Asym	Centred	Through
0338	◌̸	COMBINING LONG SOLIDUS OVERLAY	Asym	Centred	Through
0339	◌̹	COMBINING RIGHT HALF RING BELOW	Asym	Centred	Below
033A	◌̺	COMBINING INVERTED BRIDGE BELOW	Sym	Centred	Below
033B	◌̻	COMBINING SQUARE BELOW	Sym	Centred	Below
033C	◌̼	COMBINING SEAGULL BELOW	Sym	Centred	Below
033D	◌̽	COMBINING X ABOVE	Sym	Centred	Above
033E	◌̾	COMBINING VERTICAL TILDE	Asym	Centred	Above
033F	◌̿	COMBINING DOUBLE OVERLINE	Sym	Centred	Above
0346	◌͆	COMBINING BRIDGE ABOVE	Sym	Centred	Above
0347	◌͇	COMBINING EQUALS SIGN BELOW	Sym	Centred	Below
0348	◌͈	COMBINING DOUBLE VERTICAL LINE BELOW	Sym	Centred	Below
0349	◌͉	COMBINING LEFT ANGLE BELOW	Asym	Offset	Below
034A	◌͊	COMBINING NOT TILDE ABOVE	Asym	Centred	Above
034B	◌͋	COMBINING HOMOTHETIC ABOVE	Asym	Centred	Above
034C	◌͌	COMBINING ALMOST EQUAL TO ABOVE	Asym	Centred	Above
034D	◌͍	COMBINING LEFT RIGHT ARROW BELOW	Sym	Centred	Below
034E	◌͎	COMBINING UPWARDS ARROW BELOW	Sym	Centred	Below
0360	◌͠	COMBINING DOUBLE TILDE	Asym	Right	Above
0361	◌͡	COMBINING DOUBLE INVERTED BREVE	Sym	Right	Above
0362	◌͢	COMB. DOUBLE RIGHTWARDS ARROW BELOW	Asym	Right	Below

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Typefaces

Unless otherwise noted, examples are shown using the *Gentium* font family, prepared by the author as part of MA requirements. Other typefaces shown are listed here with information on the designer(s), format, manufacturer, and publication year of the version used for examples, if known. Typefaces designed prior to 1900 are not listed as information on them is included in footnote references.

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Apple Chancery, Kris Holmes, Charles Bigelow (Apple, 1994)

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Caflisch Script Pro, Robert Slimbach, based upon the handwriting of Max Caflisch (Adobe, 2001)

Caledonia, William A. Dwiggins—metal (Linotype, 1938), digital (Monotype; Linotype, 1990)

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Dante, Giovanni Mardersteig (Officina Bodoni, 1951)

Figural, Oldřich Menhart (Monotype, 1940-1948)

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