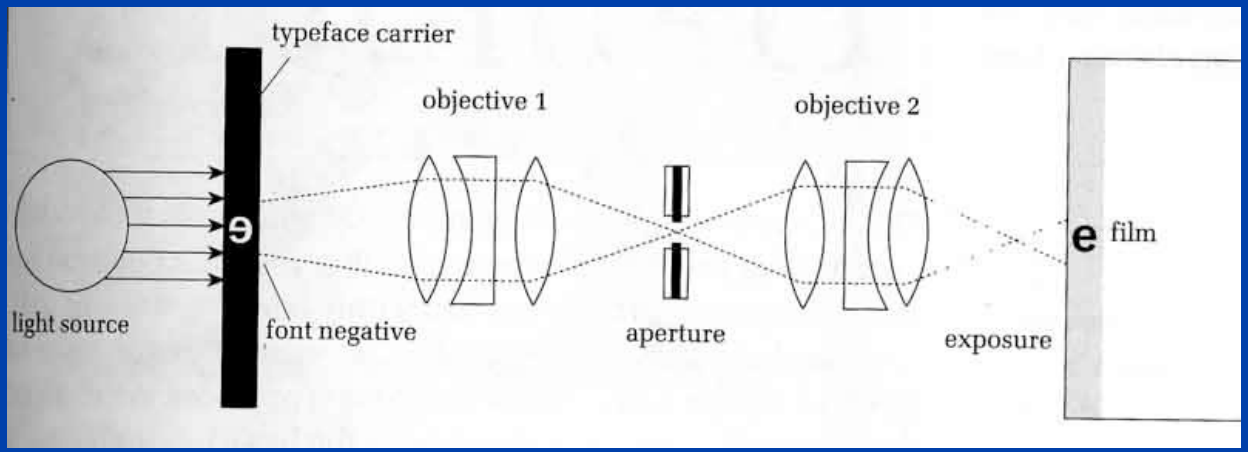
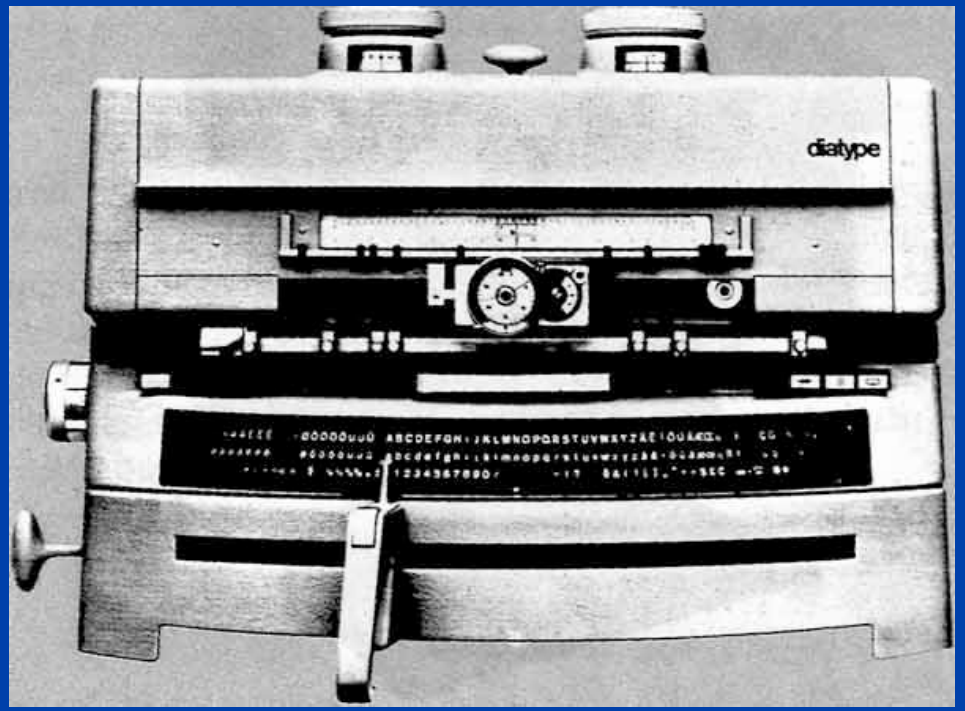
Peter Karow, Hamburg

Digital Typography and Artificial Intelligence

When did typefaces become digital?

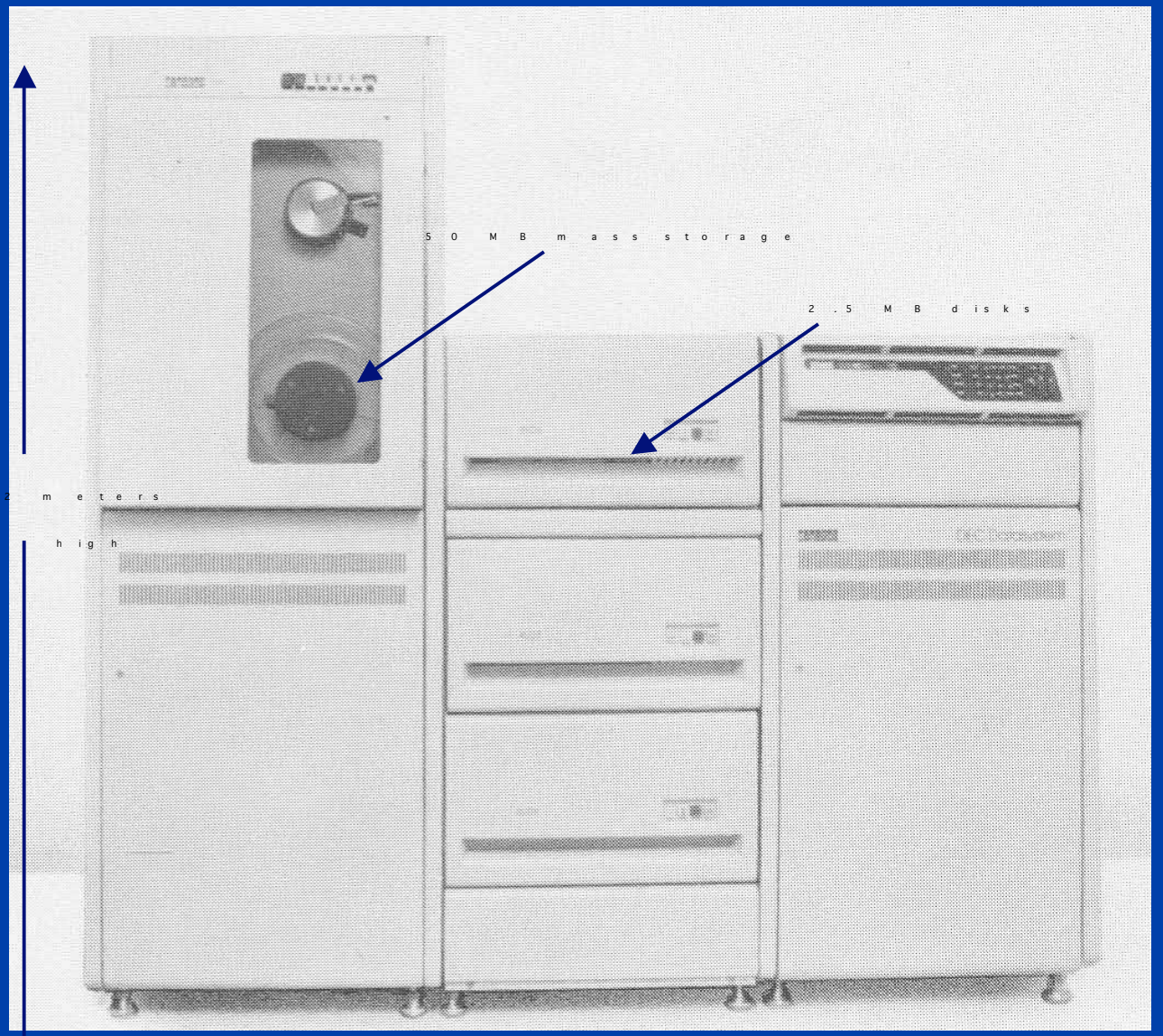
The target in 1972 :
Automation of Photo Typesetting





Our desktop in 1974

Our “PC” in 1980

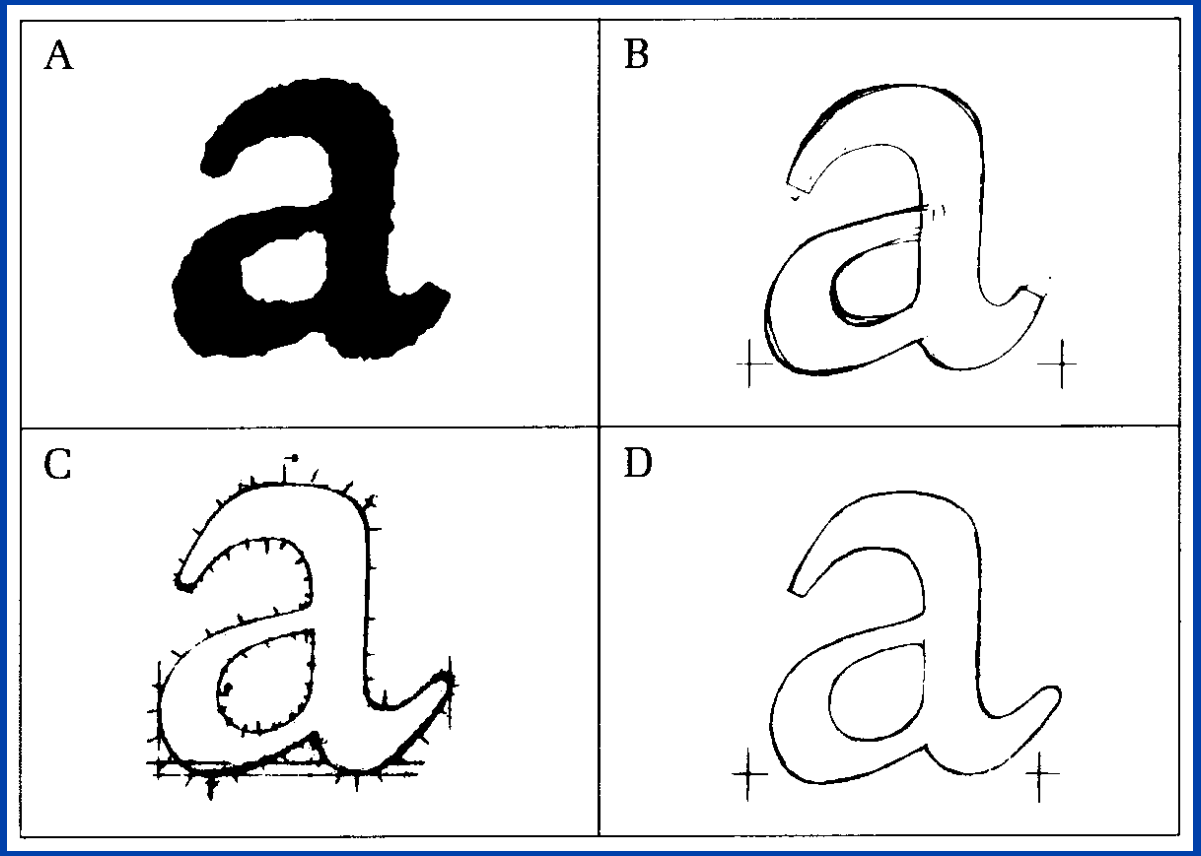


First Ikarus brochure, Warsaw 1975

Digital Typefaces

1. Formats
2. Variations
3. Interpolation
4. Rasterizing
5. Hinting
6. Autotracing
7. Grayscaling
8. Element separation

Subjects of digitizing



Results

Bitmap (left)

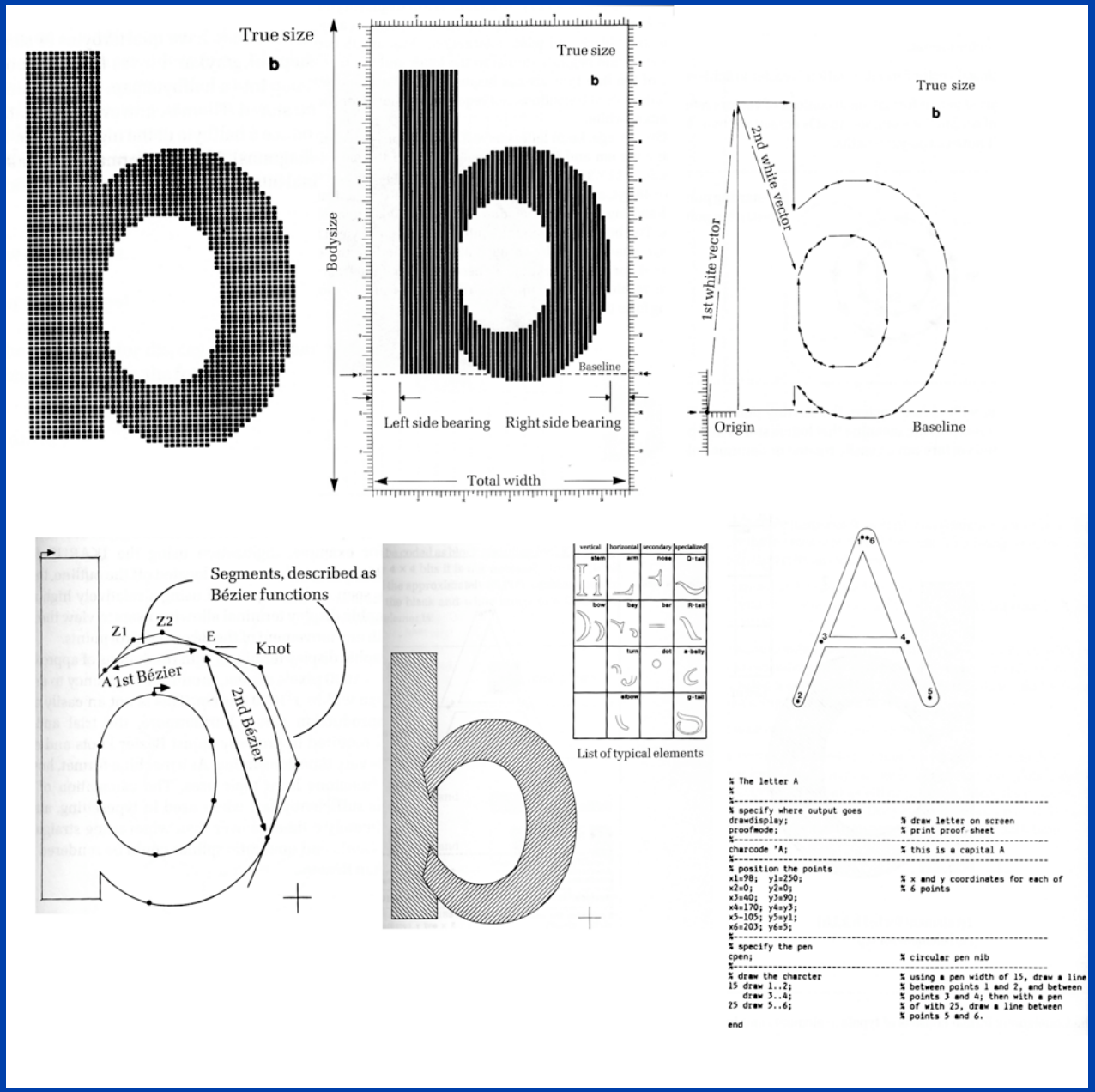
Run length (middle)

Vector (right)

PostScript (left)

Elements (middle)

Metafont (right)



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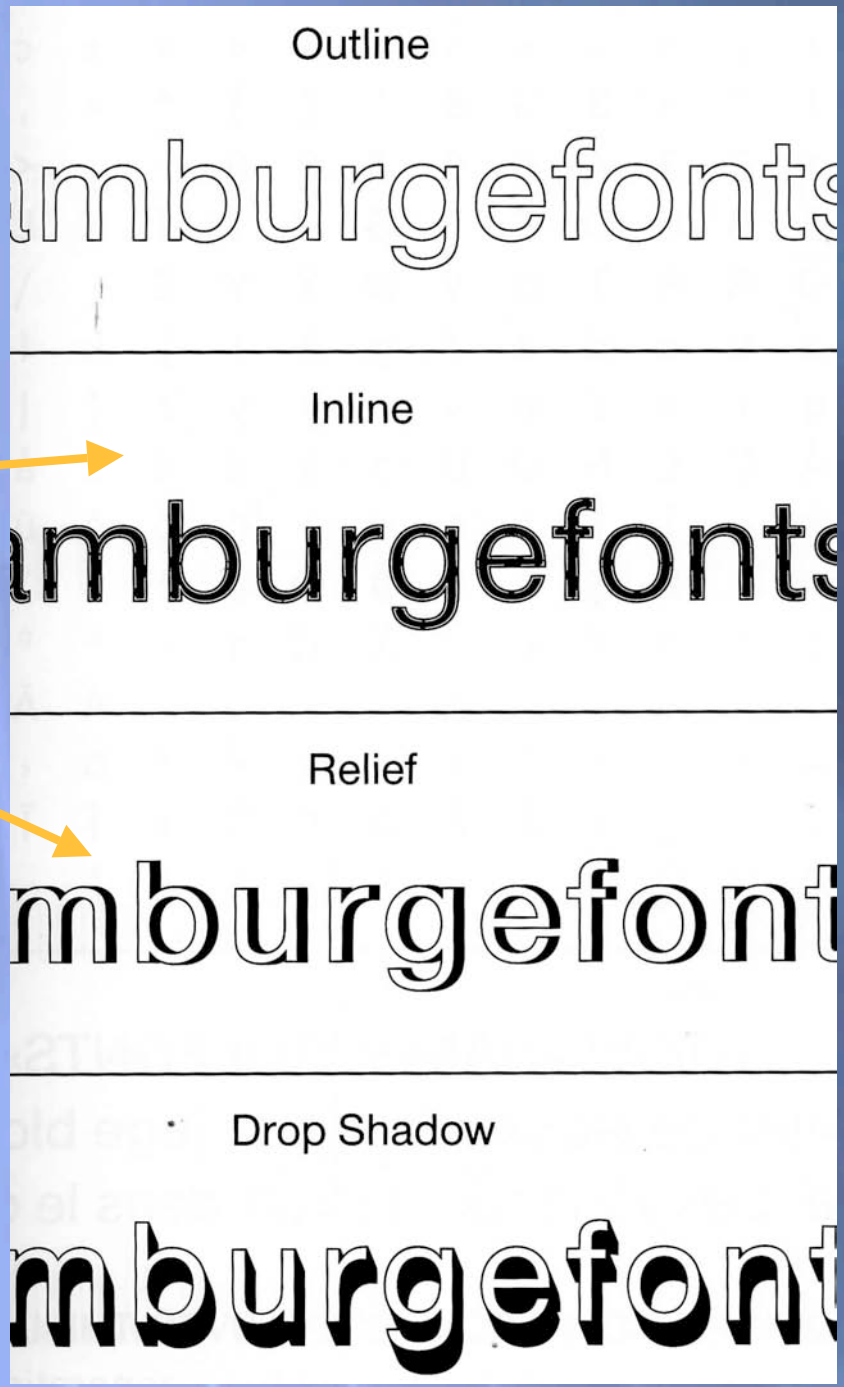
Range of Variations

1. Continuous Enlarging
2. Contouring
3. Italizing (not Slanting)
4. Expanding/Condensing
5. Rounding
6. Shadowing
7. Antiquing

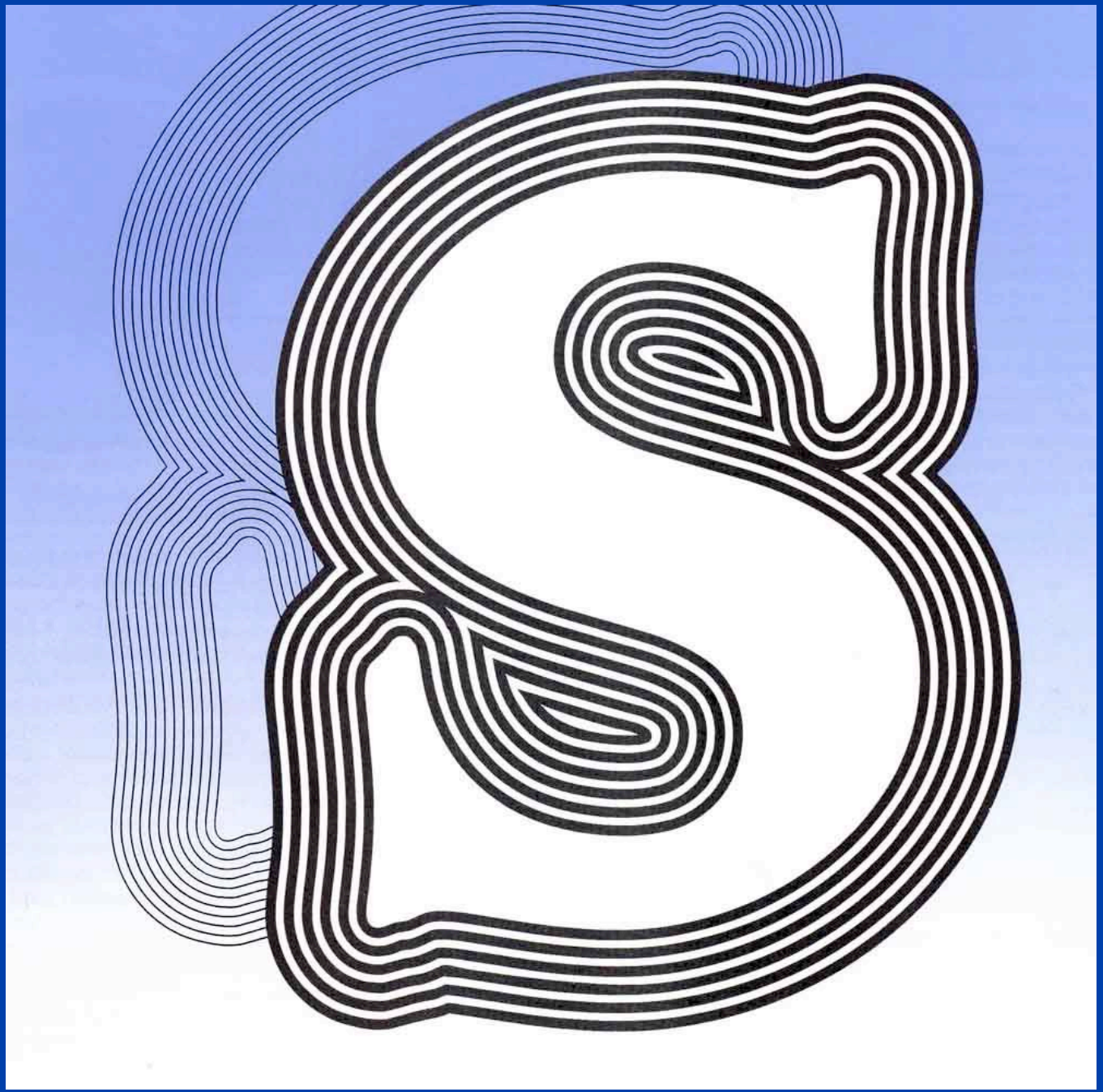
In 1973, the first variations of typefaces were calculated as such:

contouring and shadowing



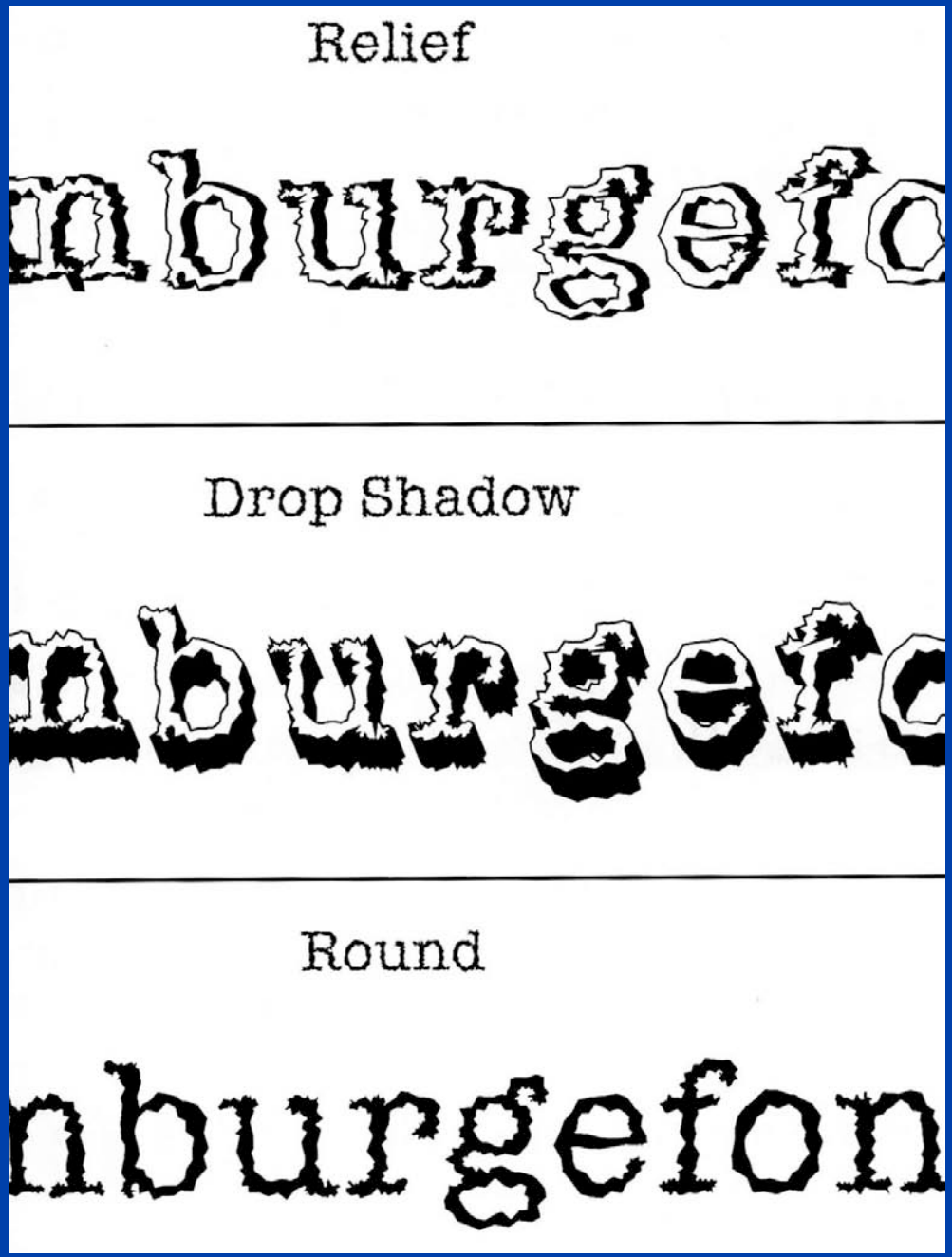
It was the birth of digital typefaces.

Contouring



The font

"Ice Age" with variations



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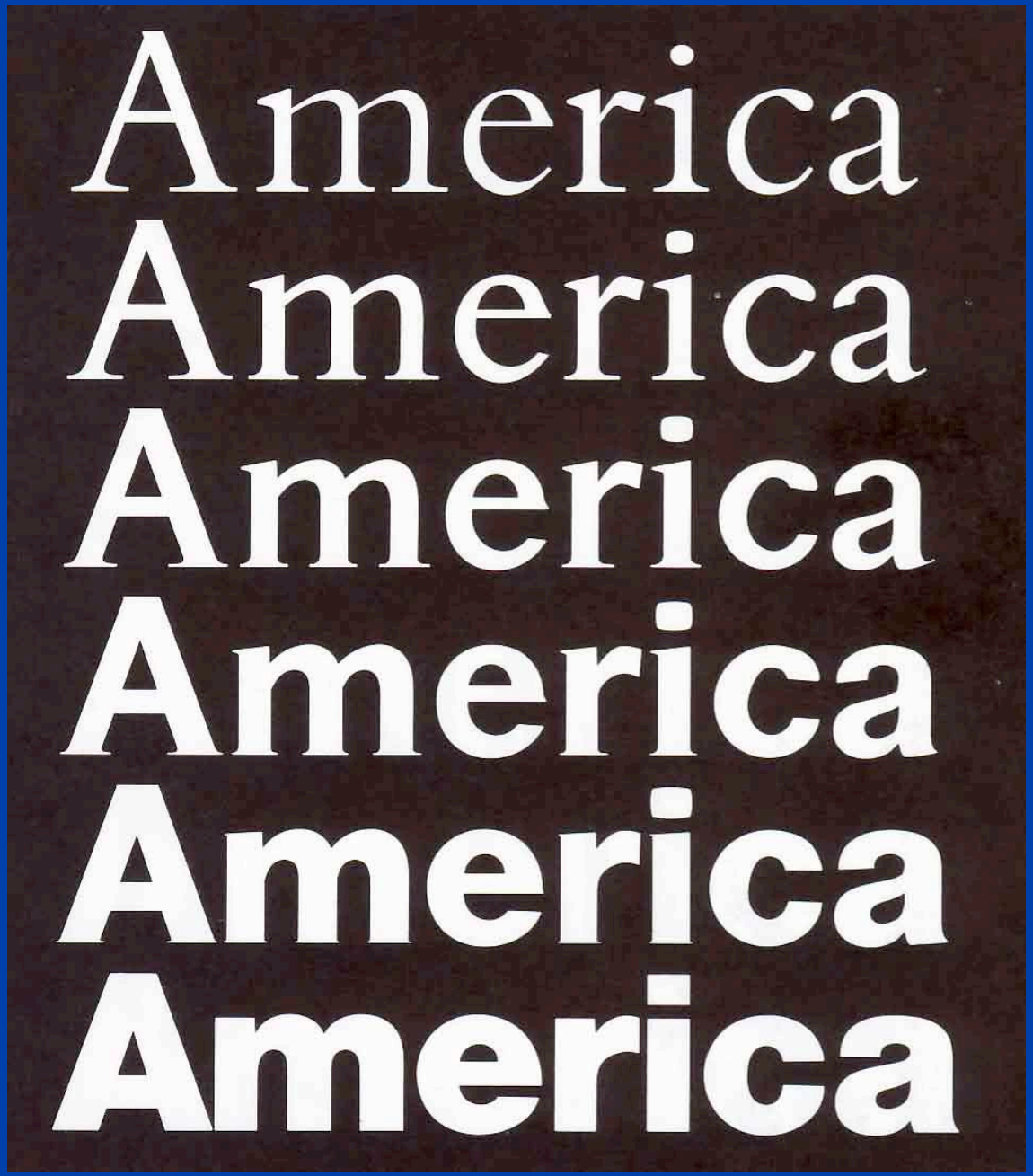
Interpolation
of
hybrids



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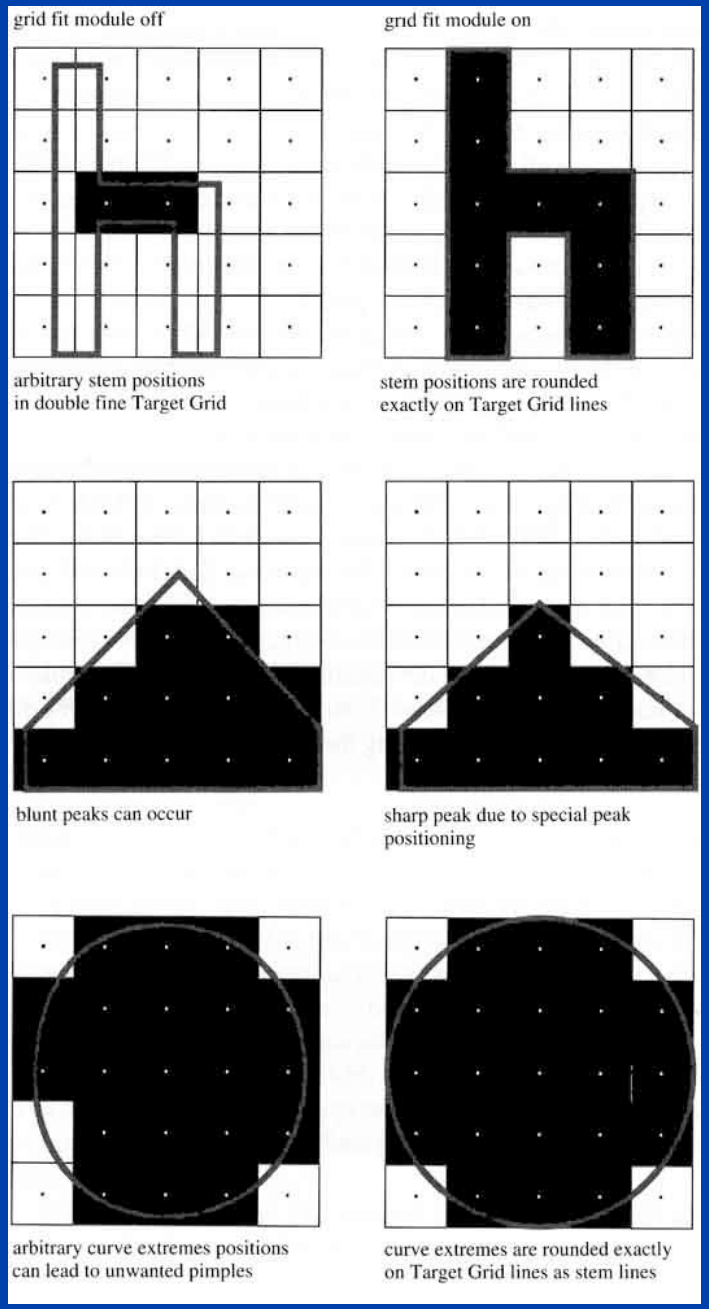
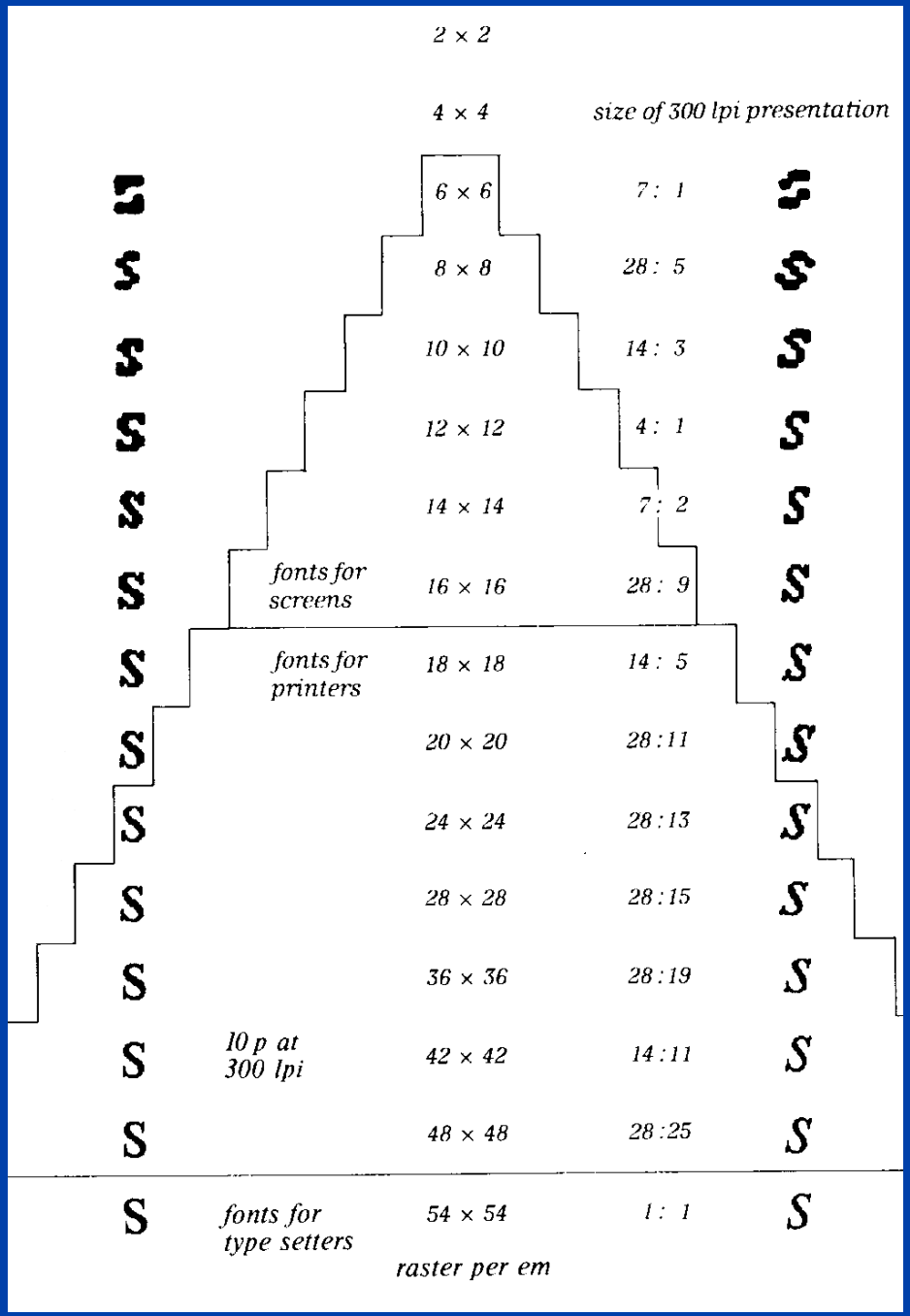
Typical accidents from rasterizing (left)



Various resolutions



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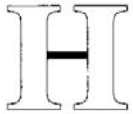
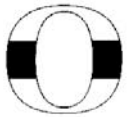
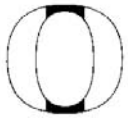
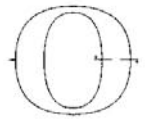
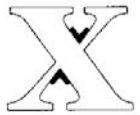
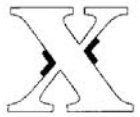
Basic hints in 1985

- stems 
- bar 
- bow 
- arch 
- (half-) serifs 
- extrema 
- inclination 
- peaks 

17 hints after the first refinements in 1987

Icon	Instruction	Meaning
	stem	Keeps stroke width of stems, defined by two straight vertical borders, consistent
	bar	Keeps width of bars, defined by straight horizontal borders, consistent
	bow	Keeps width of bow, defined by two round vertical borders, consistent
	arch	Keeps width of arches, defined by two horizontal borders, consistent
	curve stem	Keeps width of vertical stems, defined by one straight and one curved border, consistent
	curve bar	Keeps width of horizontal strokes having one straight and one curved border, consistent
	counter	Keeps width of white spaces (counters) consistent
	weight	Maintains canonic consistency of related stroke widths
	slant	Keeps width of diagonal strokes consistent (diagonals)
	extreme	For placement of curve point lying on extremes (deepest, highest, furtherst left or right control points)
	serif	Controls horizontally drawn serifs and part serifs
	bar serif	Controls vertically drawn serifs and part serifs
	overhang	Use baselines to control arch overhangs
	tension	Straightens shallow curves at small point sizes (Optima switch symbol)
	spot	Adjusts stroke width for white or black writing engines
	delta	Special instructions in TrueType to correct the resulting bitmaps at a certain point size
	dropout	Maintains a minimum width for strokes

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7. Gray scaling
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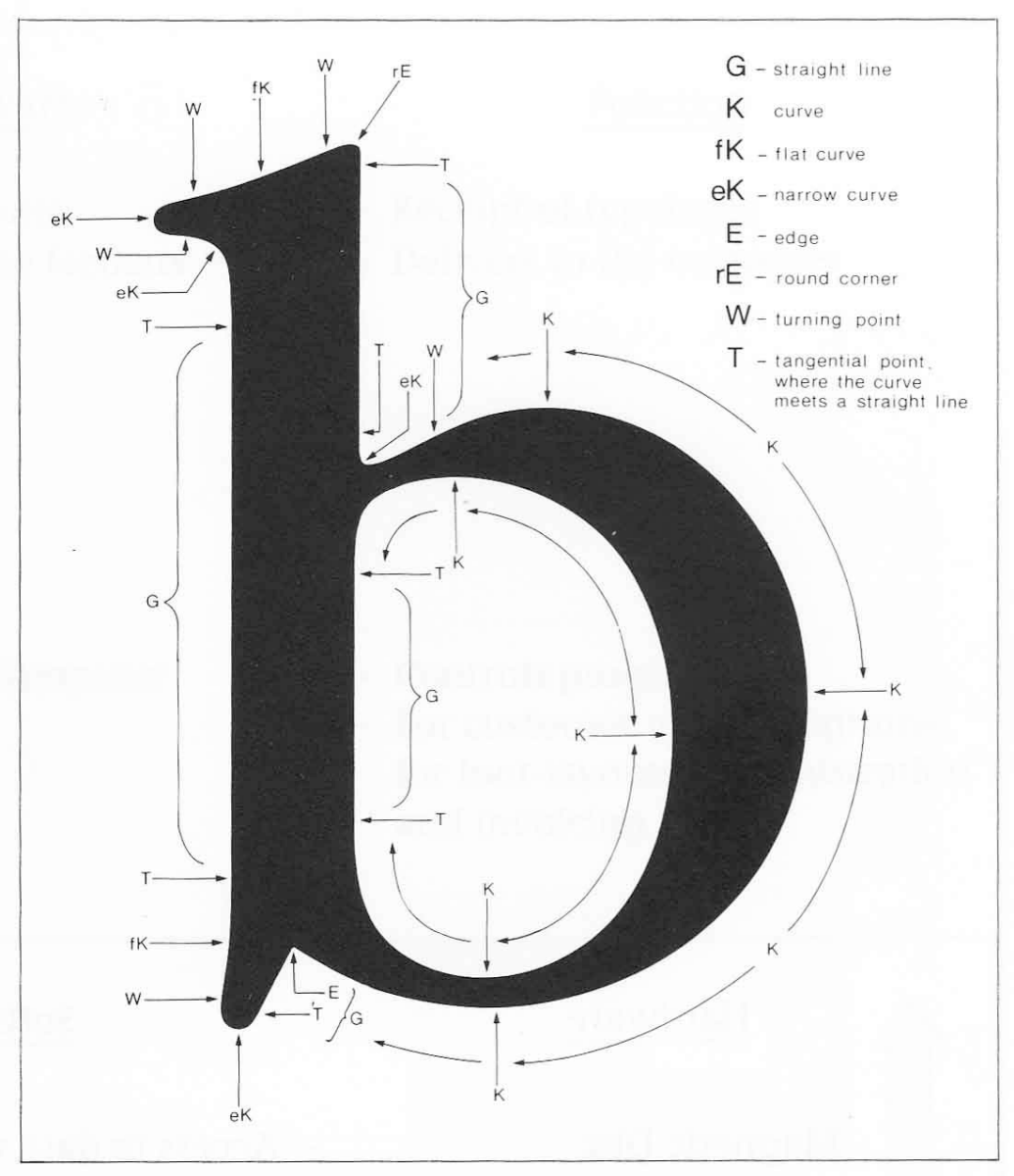
Autotracing has to recognize at least the following elements:



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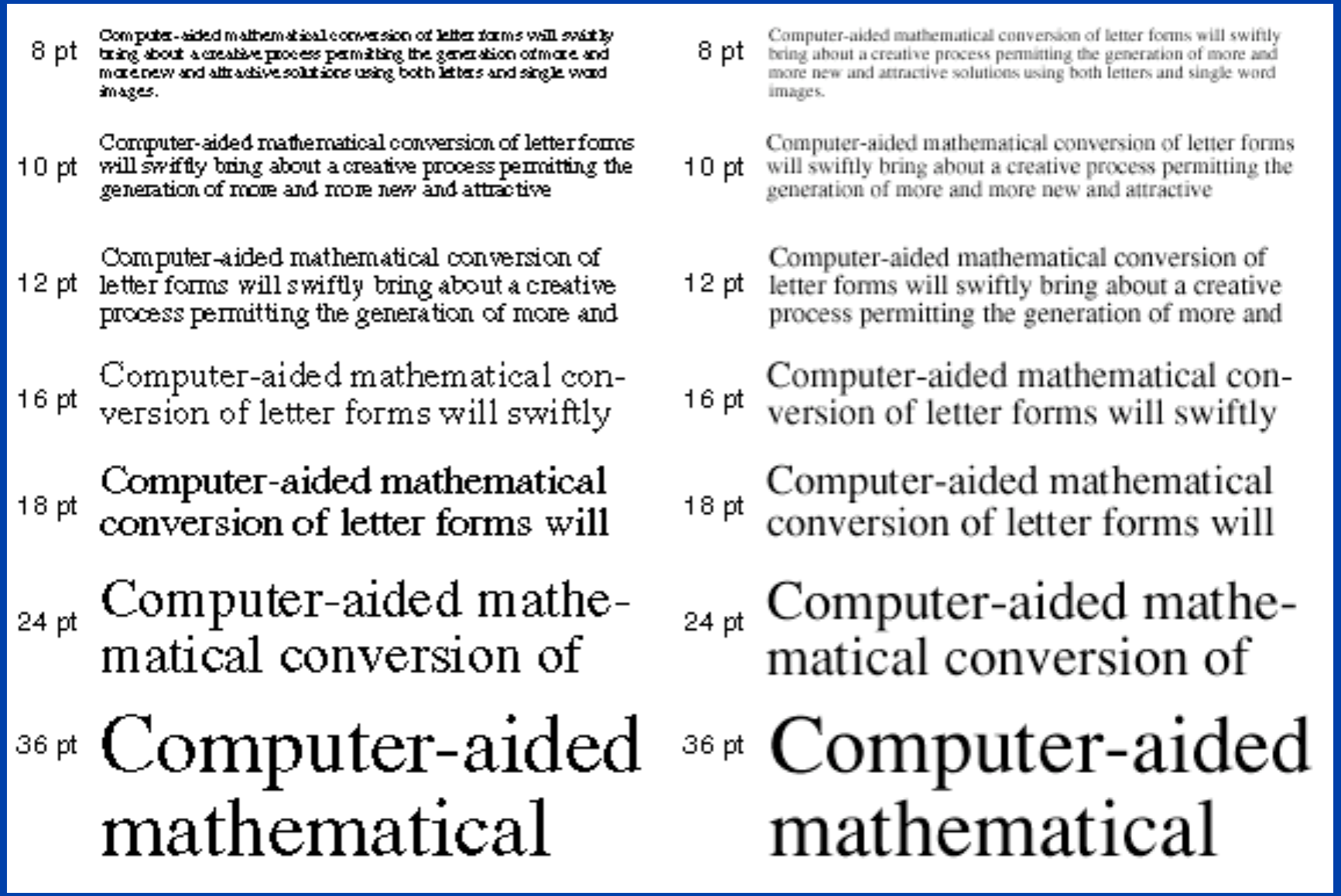
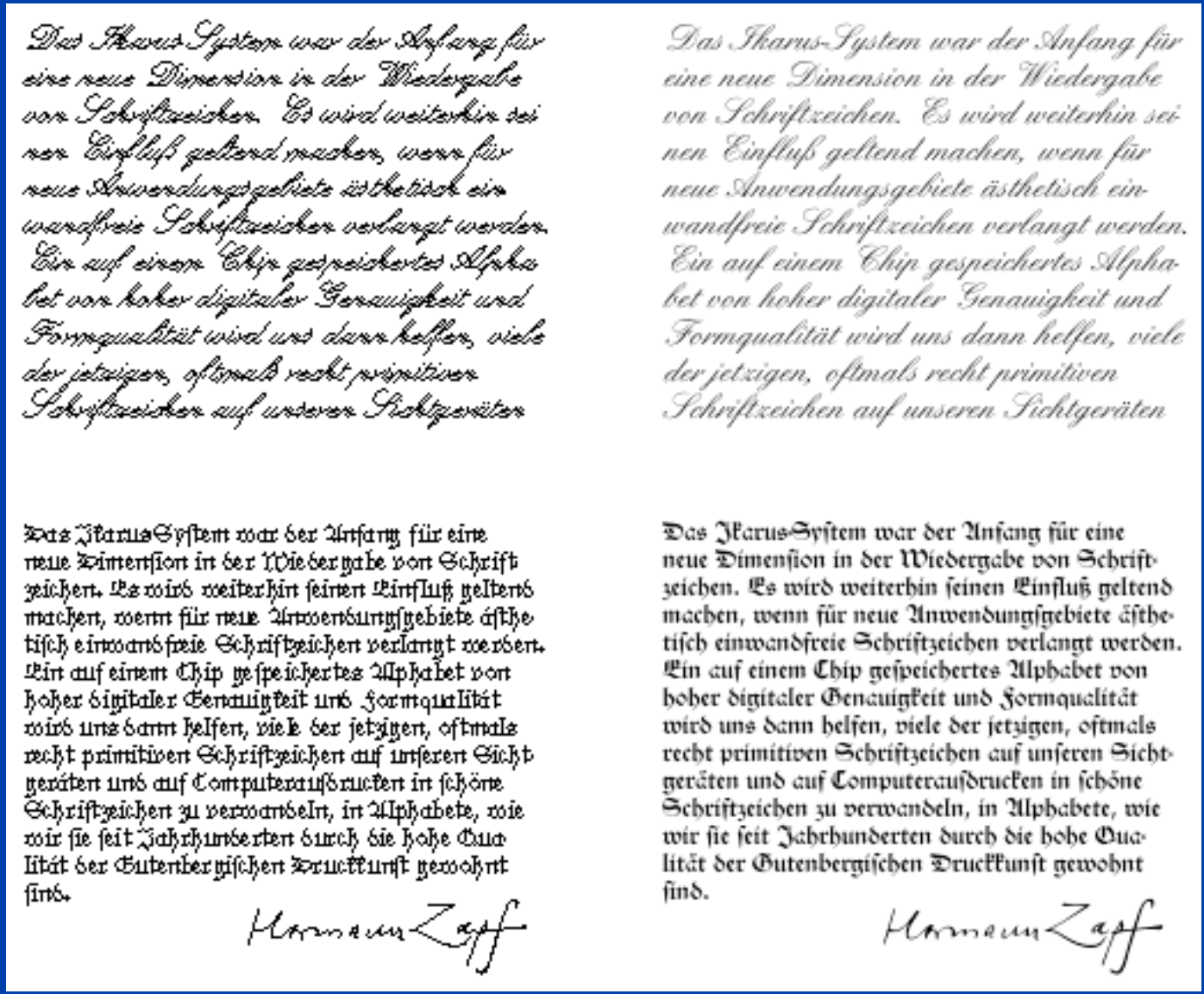
Comparison of various point sizes



Comparison of script typefaces

bitmapped

grayscaled



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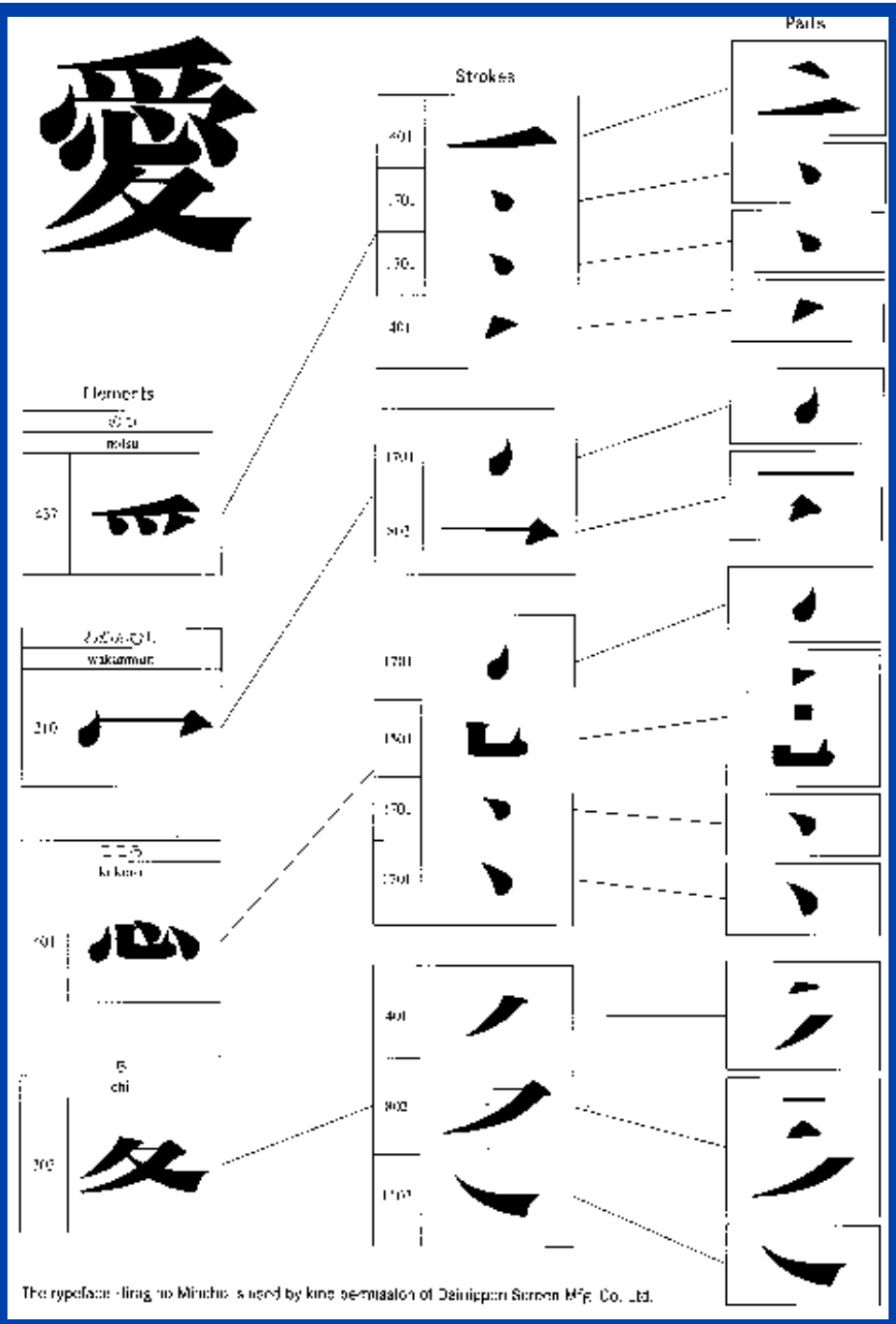
Element separation on 3 levels:

→ elements

→→ strokes

→→→ parts

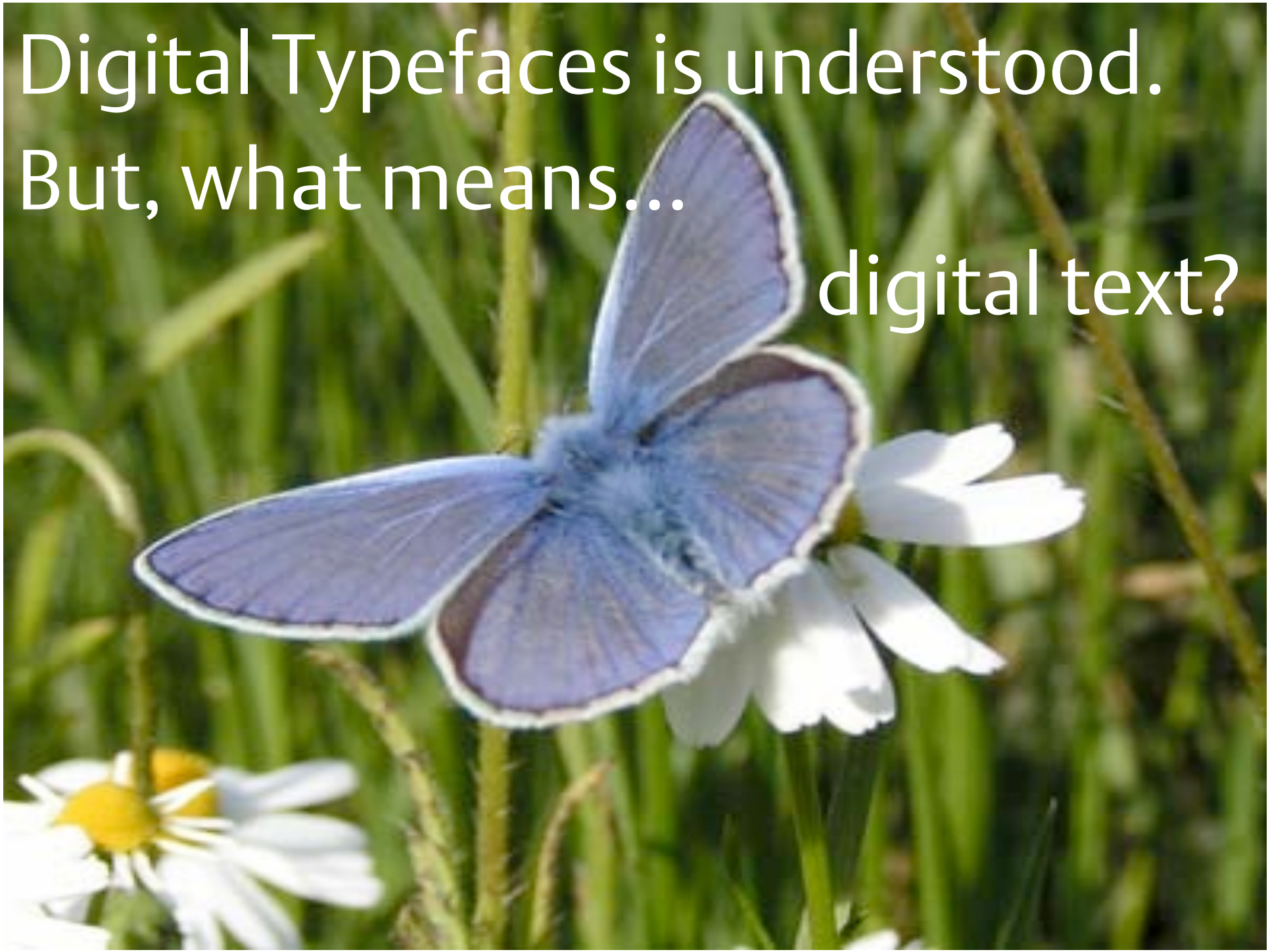


Advantageous reasons for using element separation:

1. Saves money

2. Avoids arbitrary effects of handwriting

	# being different	# being real different (4% deviation)
Kanji	7 000	7 000
	(x 3)	
Elements	21 000	17 000 *(80%)*
	(x 3.3)	
Strokes	70 000	14 600 *(23%)*
	(x 3)	
Parts	210 000	6 600 *(5%)*
	▲ **Showing 4% deviation** due to handwork (h) and digitisation (d)	▲ Regularized to keep out effects of h & d
Needed memory	Image 6.3 MByte Instructions 2.0 MByte Administration 0.14 MByte **Total ~ 8.5 MByte**	Image 0.26 MByte Instructions 0.13 MByte Administration 1.126 MByte **Total ~ 1.5 MByte**


Digital Typefaces is understood.
But, what means...
digital text?

Digital Text

1. Context based character choice
2. Kerning
3. Optical Scaling
4. Paragraph composition (*hz*-program)
5. Chapter composition
6. Digital ads

hz-program

hz-program

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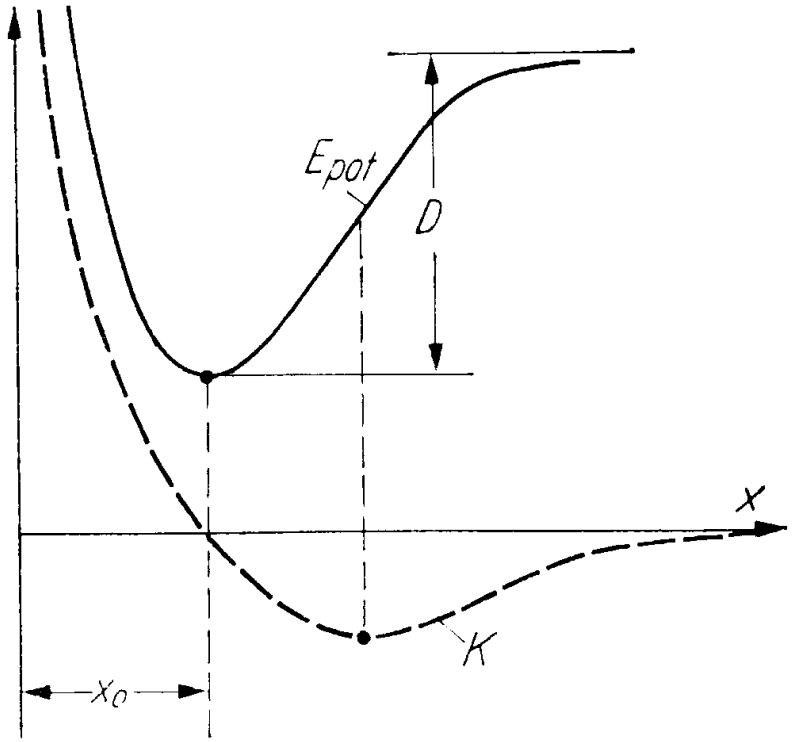
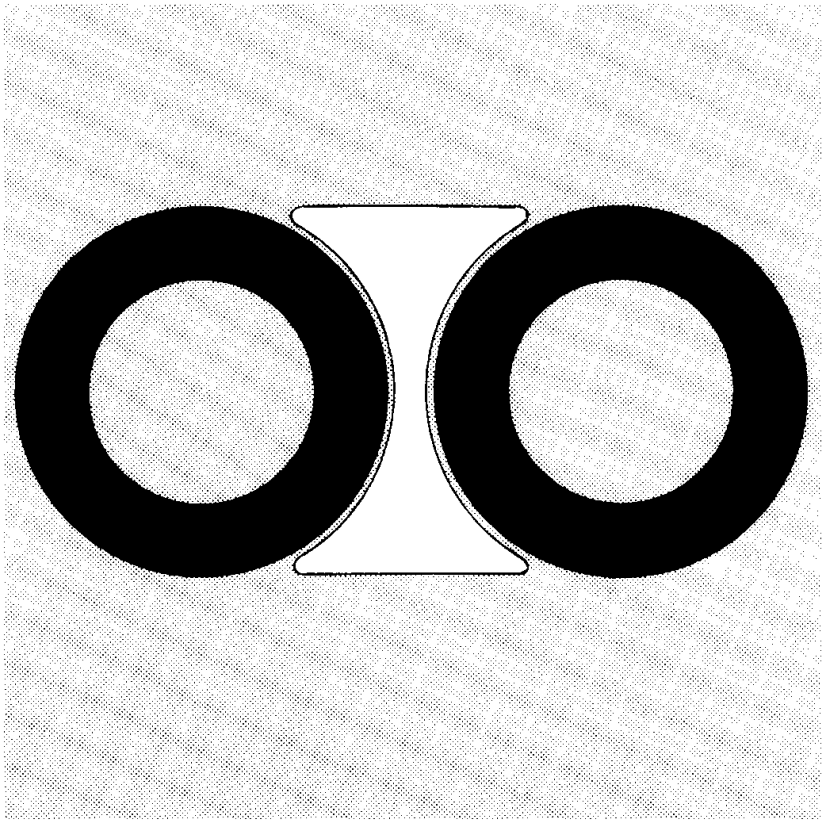
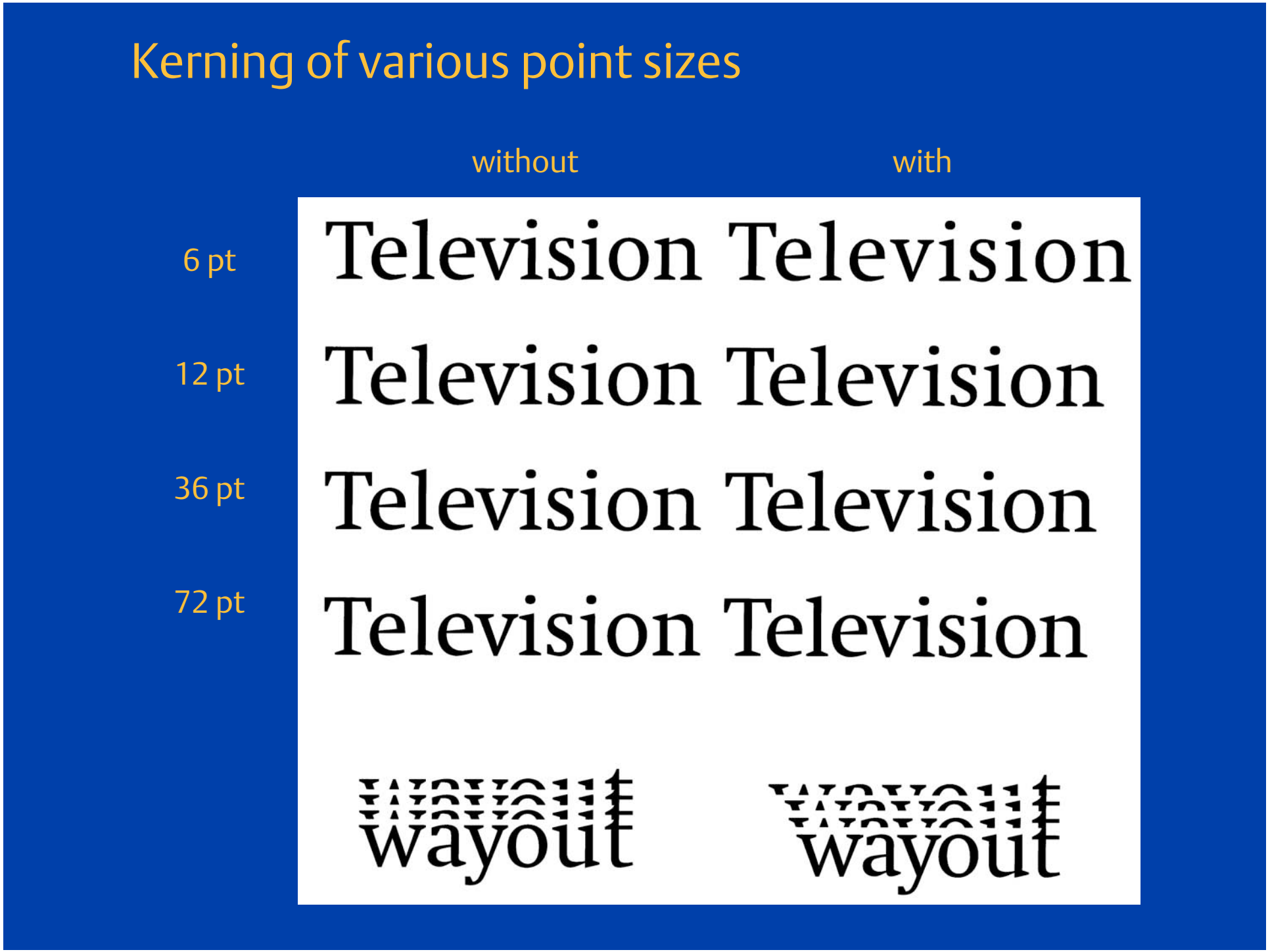
Theoretical aspects of kerning

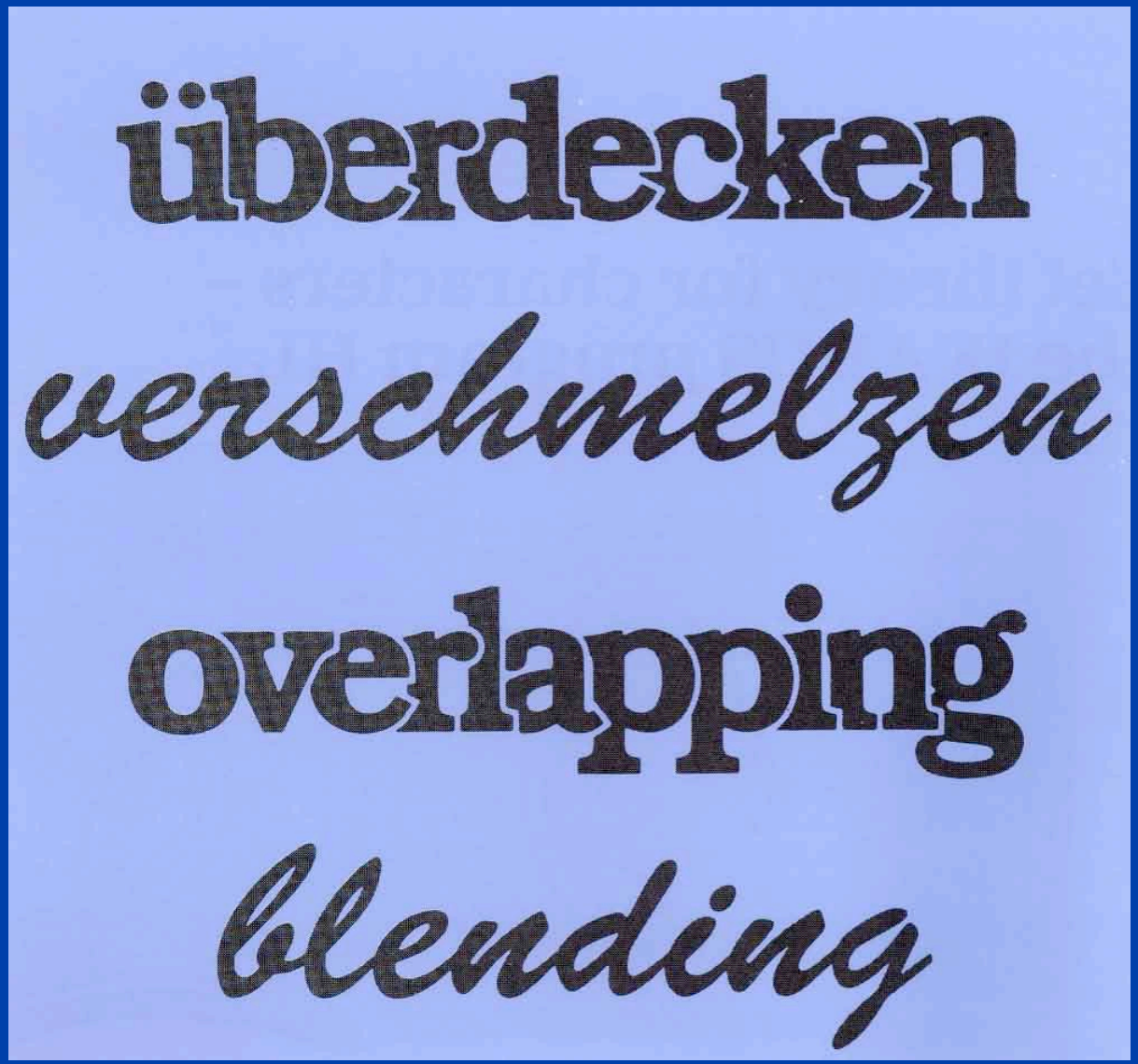




Kerning of various point sizes



Kerning can also be used for overlapping and blending



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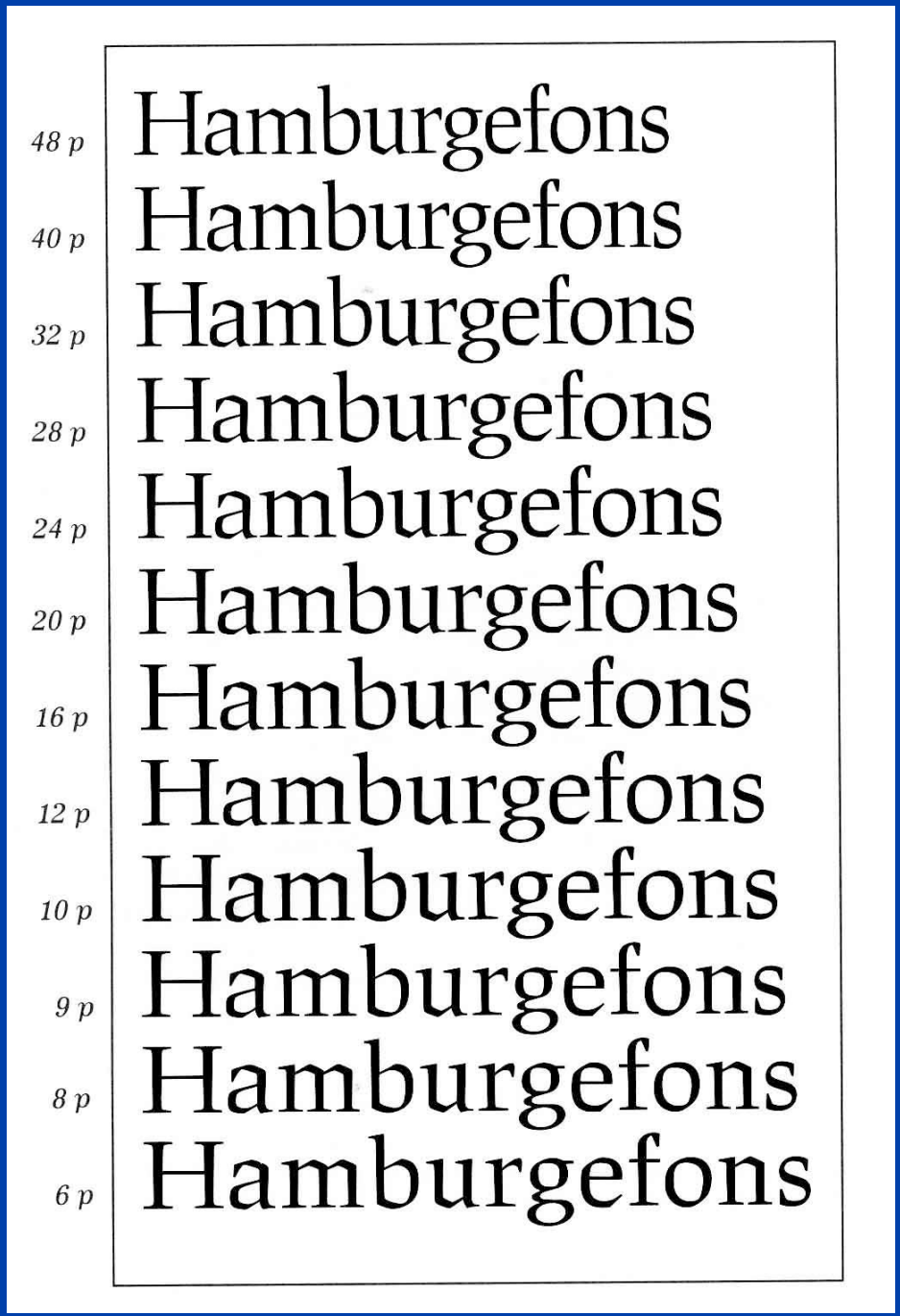
Optical scaling
of text fonts has
these characteristics:

An enlargement of the
point size by a factor of 2
reduces
stem widths and spaces
by approximately 7%.

These characteristics
are reversed for
bold faces.



Digital Text

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Paragraph composition with the *hz*-program

His Secret

Hyphenation turned off.

To the left the hz-program: 38 lines, last lines of paragraphs ok.

To the right today's software: 40 lines, short last lines, larger spaces.

What makes the Gutenberg Bible the unattainable masterpiece of the art of printing? The printing on his handpress? Can't be really, because of today's standards, the inking was not of extraordinary quality. We could order hand made rag paper also in our day. Maybe the secret of his beautiful pages is in the proportions of the columns on the paper. But this we are also able to copy. Therefore only the composition is to be considered closely.

How could Gutenberg get those even gray areas of columns without disturbing or unsightly holes between words? His secret: the master achieved this perfection by applying several characters of different width combined with many ligatures and abbreviations out of his type case. He finally created 290 characters for the composition of the 42-line Bible. An enormous time consuming job to realize his idea of good typographic lines: the justified lines of even length, compared to the flush-left lines of the works of the famous mediaeval scribes.

But with Johannes Gutenberg's unusual ligatures and abbreviations, today we can't apply this old principle for contemporary composition. Now we can get help through the versatility of modern electronic software and formats like the Multiple Masters to receive a perfect type setting in our production, to achieve Gutenberg's standards of quality: The *hz*-program, named after Hermann Zapf.

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← *too short*

← *a creek*

← *too short*

hz-program
for
magazine work

In 1996
the *hz*-program
was
implemented
by Adobe
for their program
InDesign.

Magazine Composition

left two columns:

hz-program (most left) compared with today's software,

narrow columns, hyphenation on.

right two columns:

hz-program compared with today's software (most right),

narrow columns, hyphenation off which is unusual and used as a test.

Hermann Zapf 1986:

Writing is the visual reproduction of the spoken word, its primary objective being to convey a text to the reader without difficulties, or distraction, and without disturbing the flow of reading with unnecessary embellishments. The letters have no self-fulfilling purpose, neither are they a medium for self-presentation of a designer. Everything which makes reading difficult or time-consuming, or is detrimental because of its unsual form, has to be avoided.
The new technical possibilities of type composition - with all its limitations - also determined the form of the letters. The infinite possibilities provided by today's electronics are used for example to develop types of our time, without historical hangovers. Ideally, the *hz*-program comprises (1) kerning on the fly, (2) optical spacing, (3) expanding and condensing plus optical scaling from Multiple Master fonts and (4) justification per paragraph. It is the non-plus-ultra in typography.

hz: 10 hyphens, 3 lines less

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Today's software: 12 hyphens, 3 more lines, bad in line 11 and 12

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Today's software: spaced out words are worst typography, line 14 has a ligature!

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2 pages:

before Paragraph hyphenation

Location for hyphenation

For over 2,000 years the tools of thought have changed little in essence; basically it has been ink, paper, and the means of applying one to the other. But the computer will surely give intellectual activity a new shape. The question is, what shape will emerge? And what form for the printed word?
There are now more than five million computers in the United States, and for some time the amount of computing power has been doubling every two years. The average computer user now has access to information that would fill the Library of Congress and can control as much computing power as a large university computing center. Will this reduce the need for books, or make it unnecessary to print and distribute books in the ways of the past?
There are laser printing units using xerography that can print a complete book from the digitised type page stored in disk memory banks. Such a custom book printer can churn out pages, verso and recto, at the rate of a leaf every second. A complete book of 124 pages would be ready for binding in sixty-two seconds. It takes little imagination to envision a bookstore of a decade hence filled with 'sample' volumes only. One would need only to pick a title and the book would be printed and bound on the spot. Such a bookstore could readily keep on hand three or four times the number of titles now stocked at a fraction of present costs, since there would be no shipping charges, no overstock or understock problems, and no returns.
Recently the Library of Congress has been working with publishers on a pilot project to test the use of optical discs for the storage and dissemination of journals and periodicals. The material would be copied onto twelve-inch discs that can hold up to 20,000 pages on a side. A reading machine would enable the user to read the material on the disc and give a command to the machine to print out the material on a connected high-speed printer.
What does this technology have to do with books as we know them? There are many predictions abroad today the shape of things to come in a computer age that is just emerging in the first flush of a new day. Books are only one means of disseminating information and cogitative writing in the midst of an increasing plethora of electronic options. Even the Congress of the United States seeks guidance. A recent Congressional resolution has asked for a study to explore the influence of the computer and video technologies on books, reading, and the printed word. An advisory committee, meeting at the Library of Congress, was told by Sen. Charles Mathias, Jr, to «set no limits to your vision for perhaps the future of the book is not as solid as it might appear». The committee is exploring four specific questions: What difference does it make that the forms and functions of books are changing? How do technology and literacy affect each other? Who is responsible for stimulating reading and the reading habit? How is publishing facing the challenges of new technologies?
The results of this study will be issued in, have you guessed it, a BOOK, entitled «The Book in the Future», to be presented by Librarian of Congress Daniel J. Boorstin to the Congress no later than December 1, 1984. Perhaps that is when we shall all learn what the outlook will be for this seemingly endangered species, or at least the official outlook.
Meanwhile, we who are gathered here today have the greatest vested interest in the book of the future as well as of the past: scholars, students, librarians, booksellers, publishers, and printers.
Henry Stevens of Vermont, the nineteenth-century bookseller, once said, «Books are both our luxuries and our daily bread. They have become to our lives and happiness prime necessities.» I have pondered this saying often – «Books are both our luxuries and our daily bread». It has become a kind of motto, one that I believe is most apt for a printer... Books embody all the humanising arts that make thought tangible and give form to ideas, so that mind can touch mind over vast distances and through the ages of time itself.
Roderick Stinehour, April 1984, proceedings of the American Antiquarian Society, Vol. 94, Part I.

First part of paragraph

Second part of paragraph

2 pages:

after
Paragraph
hyphenation

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There are laser printing units using xerography that can print a complete book from the digitised type page stored in disk memory banks. Such a custom book printer can churn out pages, verso and recto, at the rate of a leaf every second. A complete book of 124 pages would be ready for binding in sixty-two seconds. It takes little imagination to envision a bookstore of a decade hence filled with 'sample' volumes only. One would need only to pick a title and the book would be printed and bound on the spot. Such a bookstore could readily keep on hand three or four times the number of titles now stocked at a fraction of present costs, since there would be no shipping charges, no overstock or understock problems, and no returns.

Recently the Library of Congress has been working with publishers on a pilot project to test the use of optical discs for the storage and dissemination of journals and periodicals. The material would be copied onto twelve-inch discs that can hold up to 20,000 pages on a side. A reading machine would enable the user to read the material on the disc and give a command to the machine to print out the material on a connected high-speed printer.

What does this technology have to do with books as we know them? There are many predictions abroad today the shape of things to come in a computer age that is just emerging in the first flush of a new day.

First part of paragraph

Hyphenation at a punctuation sign

Books are only one means of disseminating information and cogitative writing in the midst of an increasing plethora of electronic options. Even the Congress of the United States seeks guidance. A recent Congressional resolution has asked for a study to explore the influence of the computer and video technologies on books, reading, and the printed word. An advisory committee, meeting at the Library of Congress, was told by Sen. Charles Mathias, Jr, to «set no limits to your vision for perhaps the future of the book is not as solid as it might appear». The committee is exploring four specific questions: What difference does it make that the forms and functions of books are changing? How do technology and literacy affect each other? Who is responsible for stimulating reading and the reading habit? How is publishing facing the challenges of new technologies?

The results of this study will be issued in, have you guessed it, a BOOK, entitled «The Book in the Future», to be presented by Librarian of Congress Daniel J. Boorstin to the Congress no later than December 1, 1984. Perhaps that is when we shall all learn what the outlook will be for this seemingly endangered species, or at least the official outlook.

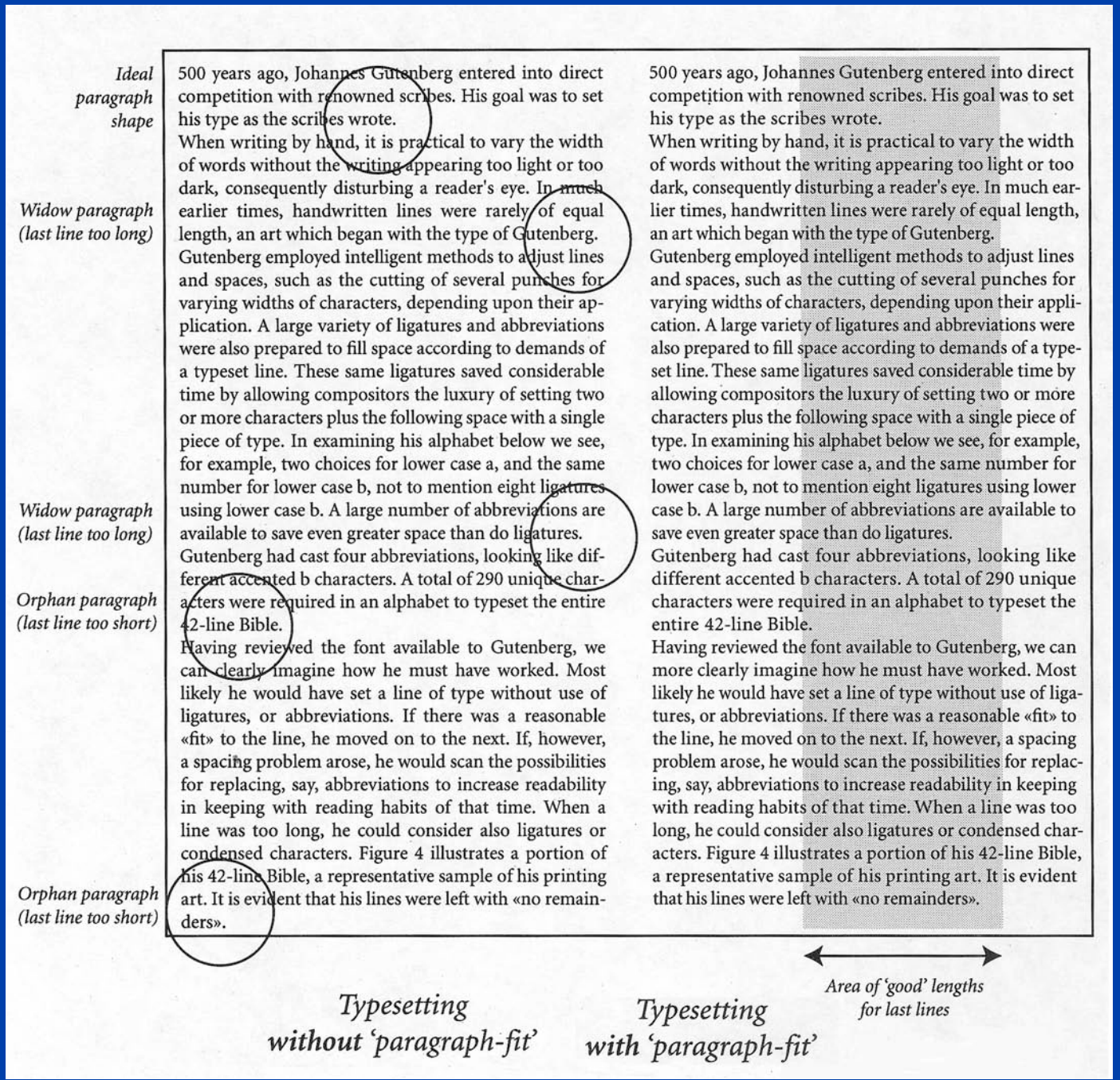
Meanwhile, we who are gathered here today have the greatest vested interest in the book of the future as well as of the past: scholars, students, librarians, booksellers, publishers, and printers.

Henry Stevens of Vermont, the nineteenth-century bookseller, once said, «Books are both our luxuries and our daily bread. They have become to our lives and happiness prime necessities.» I have pondered this saying often – «Books are both our luxuries and our daily bread». It has become a kind of motto, one that I believe is most apt for a printer... Books embody all the humanising arts that make thought tangible and give form to ideas, so that mind can touch mind over vast distances and through the ages of time itself.

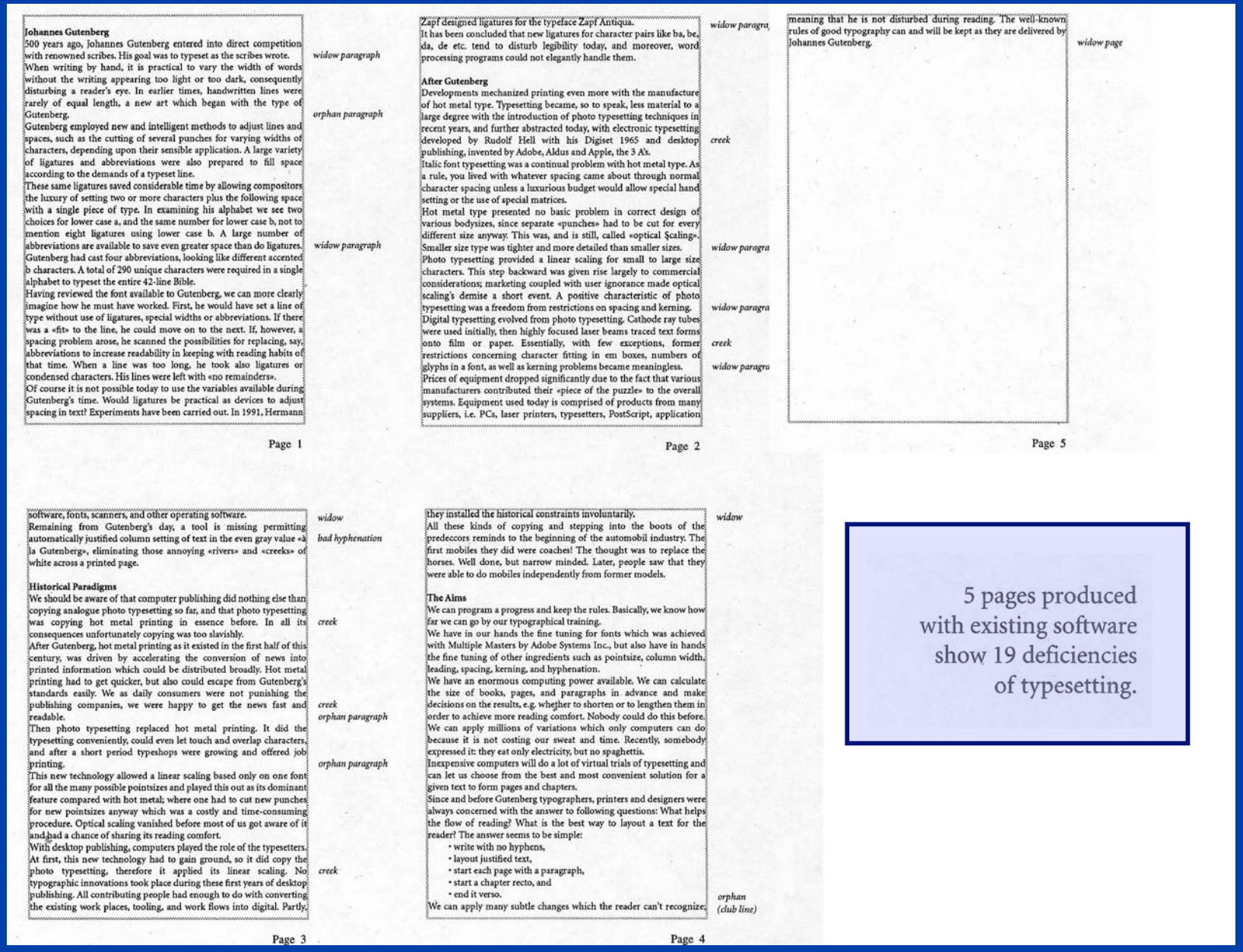
Roderick Stinehour, April 1984, proceedings of the American Antiquarian Society, Vol. 94, Part I.

Second part of paragraph

Paragraph-fit



Text before chapter-fit



Johannes Gutenberg
500 years ago, Johannes Gutenberg entered into direct competition with renowned scribes. His goal was to typeset as the scribes wrote.
When writing by hand, it is practical to vary the width of words without the writing appearing too light or too dark, consequently disturbing a reader's eye. In earlier times, handwritten lines were rarely of equal length, a new art which began with the type of Gutenberg.
Gutenberg employed new and intelligent methods to adjust lines and spaces, such as the cutting of several punches for varying widths of characters, depending upon their sensible application. A large variety of ligatures and abbreviations were also prepared to fill space according to the demands of a typeset line.
These same ligatures saved considerable time by allowing compositors the luxury of setting two or more characters plus the following space with a single piece of type. In examining his alphabet we see two choices for lower case a, and the same number for lower case b, not to mention eight ligatures using lower case b. A large number of abbreviations are available to save even greater space than do ligatures. Gutenberg had cast four abbreviations, looking like different accented b characters. A total of 290 unique characters were required in a single alphabet to typeset the entire 42-line Bible.
Having reviewed the font available to Gutenberg, we can more clearly imagine how he must have worked. First, he would have set a line of type without use of ligatures, special widths or abbreviations. If there was a «fit» to the line, he could move on to the next. If, however, a spacing problem arose, he scanned the possibilities for replacing, say, abbreviations to increase readability in keeping with reading habits of that time. When a line was too long, he took also ligatures or condensed characters. His lines were left with «no remainders».
Of course it is not possible today to use the variables available during Gutenberg's time. Would ligatures be practical as devices to adjust spacing in text? Experiments have been carried out. In 1991, Hermann

widow paragraph

orphan paragraph

widow paragraph

Page 1

Zapf designed ligatures for the typeface Zapf Antiqua.
It has been concluded that new ligatures for character pairs like ba, be, da, de etc. tend to disturb legibility today, and moreover, word processing programs could not elegantly handle them.

After Gutenberg
Developments mechanized printing even more with the manufacture of hot metal type. Typesetting became, so to speak, less material to a large degree with the introduction of photo typesetting techniques in recent years, and further abstracted today, with electronic typesetting developed by Rudolf Hell with his Digiset 1965 and desktop publishing, invented by Adobe, Aldus and Apple, the 3 A's.
Italic font typesetting was a continual problem with hot metal type. As a rule, you lived with whatever spacing came about through normal character spacing unless a luxurious budget would allow special hand setting or the use of special matrices.
Hot metal type presented no basic problem in correct design of various bodysizes, since separate «punches» had to be cut for every different size anyway. This was, and is still, called «optical $caling».
Smaller size type was tighter and more detailed than smaller sizes.
Photo typesetting provided a linear scaling for small to large size characters. This step backward was given rise largely to commercial considerations; marketing coupled with user ignorance made optical scaling's demise a short event. A positive characteristic of photo typesetting was a freedom from restrictions on spacing and kerning.
Digital typesetting evolved from photo typesetting. Cathode ray tubes were used initially, then highly focused laser beams traced text forms onto film or paper. Essentially, with few exceptions, former restrictions concerning character fitting in em boxes, numbers of glyphs in a font, as well as kerning problems became meaningless.
Prices of equipment dropped significantly due to the fact that various manufacturers contributed their «piece of the puzzle» to the overall systems. Equipment used today is comprised of products from many suppliers, i.e. PCs, laser printers, typesetters, PostScript, application

widow paragra

creek

widow paragra

widow paragra

creek

widow paragra

Page 2

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widow page

Page 5

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Remaining from Gutenberg's day, a tool is missing permitting automatically justified column setting of text in the even gray value «à la Gutenberg», eliminating those annoying «rivers» and «creeks» of white across a printed page.

Historical Paradigms
We should be aware of that computer publishing did nothing else than copying analogue photo typesetting so far, and that photo typesetting was copying hot metal printing in essence before. In all its consequences unfortunately copying was too slavishly.
After Gutenberg, hot metal printing as it existed in the first half of this century, was driven by accelerating the conversion of news into printed information which could be distributed broadly. Hot metal printing had to get quicker, but also could escape from Gutenberg's standards easily. We as daily consumers were not punishing the publishing companies, we were happy to get the news fast and readable.
Then photo typesetting replaced hot metal printing. It did the typesetting conveniently, could even let touch and overlap characters, and after a short period typeshops were growing and offered job printing.
This new technology allowed a linear scaling based only on one font for all the many possible pointsizes and played this out as its dominant feature compared with hot metal; where one had to cut new punches for new pointsizes anyway which was a costly and time-consuming procedure. Optical scaling vanished before most of us got aware of it and had a chance of sharing its reading comfort.
With desktop publishing, computers played the role of the typesetters. At first, this new technology had to gain ground, so it did copy the photo typesetting, therefore it applied its linear scaling. No typographic innovations took place during these first years of desktop publishing. All contributing people had enough to do with converting the existing work places, tooling, and work flows into digital. Partly,

widow

bad hyphenation

creek

creek

orphan paragraph

orphan paragraph

creek

Page 3

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All these kinds of copying and stepping into the boots of the predeccors reminds to the beginning of the automobil industry. The first mobiles they did were coaches! The thought was to replace the horses. Well done, but narrow minded. Later, people saw that they were able to do mobiles independently from former models.

The Aims
We can program a progress and keep the rules. Basically, we know how far we can go by our typographical training.
We have in our hands the fine tuning for fonts which was achieved with Multiple Masters by Adobe Systems Inc., but also have in hands the fine tuning of other ingredients such as pointsize, column width, leading, spacing, kerning, and hyphenation.
We have an enormous computing power available. We can calculate the size of books, pages, and paragraphs in advance and make decisions on the results, e.g. whether to shorten or to lengthen them in order to achieve more reading comfort. Nobody could do this before. We can apply millions of variations which only computers can do because it is not costing our sweat and time. Recently, somebody expressed it: they eat only electricity, but no spaghettis.
Inexpensive computers will do a lot of virtual trials of typesetting and can let us choose from the best and most convenient solution for a given text to form pages and chapters.
Since and before Gutenberg typographers, printers and designers were always concerned with the answer to following questions: What helps the flow of reading? What is the best way to layout a text for the reader? The answer seems to be simple:

- write with no hyphens,
- layout justified text,
- start each page with a paragraph,
- start a chapter recto, and
- end it verso.

We can apply many subtle changes which the reader can't recognize,

widow

orphan (club line)

Page 4

5 pages produced with existing software show 19 deficiencies of typesetting.

Text after chapter-fit

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Page 2

4 pages produced with chapterfit software show:
no deficiencies with respect to typographic rules,
all pages end with a paragraph to avoid widows and orphans,
an even number of pages allows to start a chapter recto and end it verso.

Remaining from Gutenberg's day, a tool is missing permitting automatically justified column setting of text in the even gray value «à la Gutenberg», eliminating those annoying «rivers» and «creeks» of white across a printed page.

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Page 3

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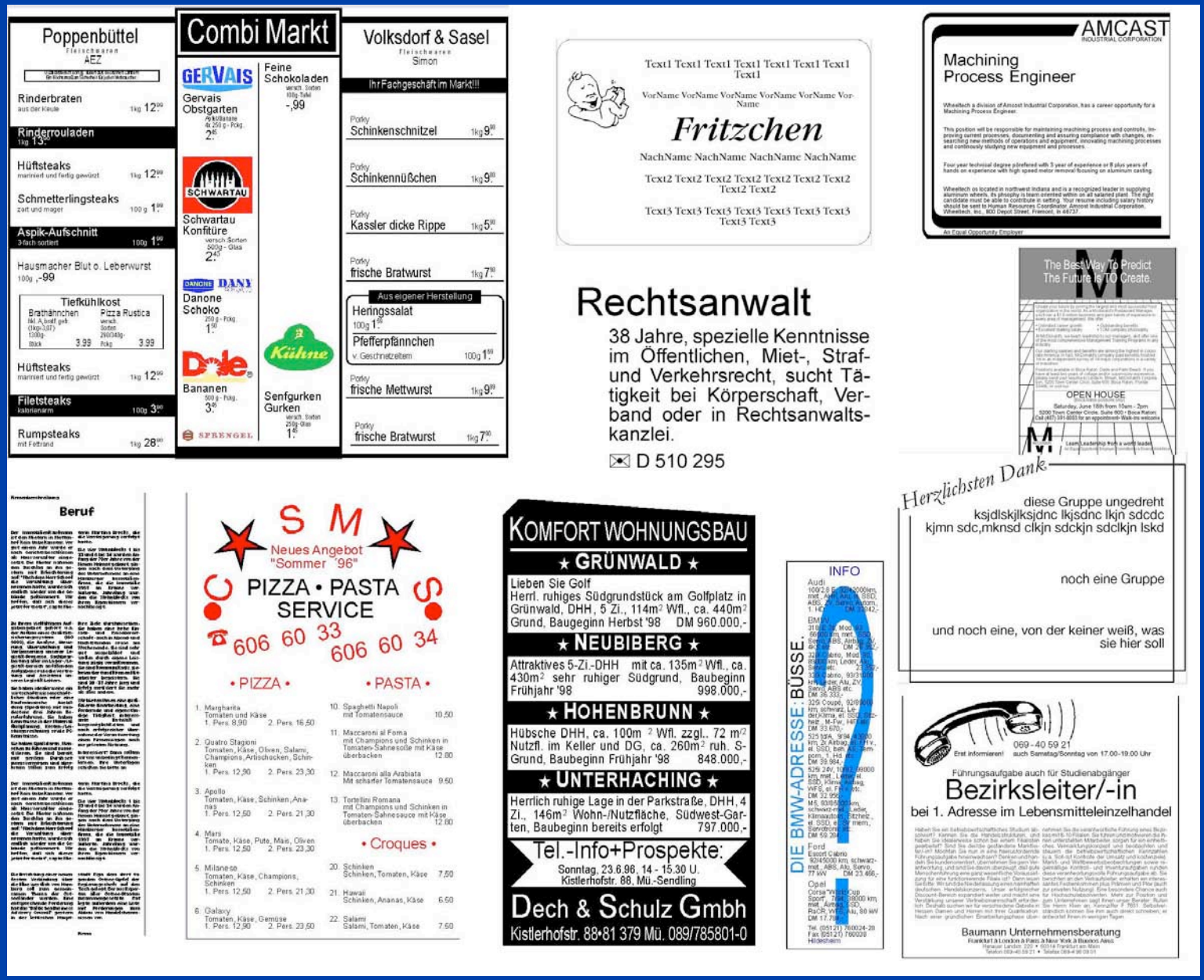
Page 4

justified paragraph

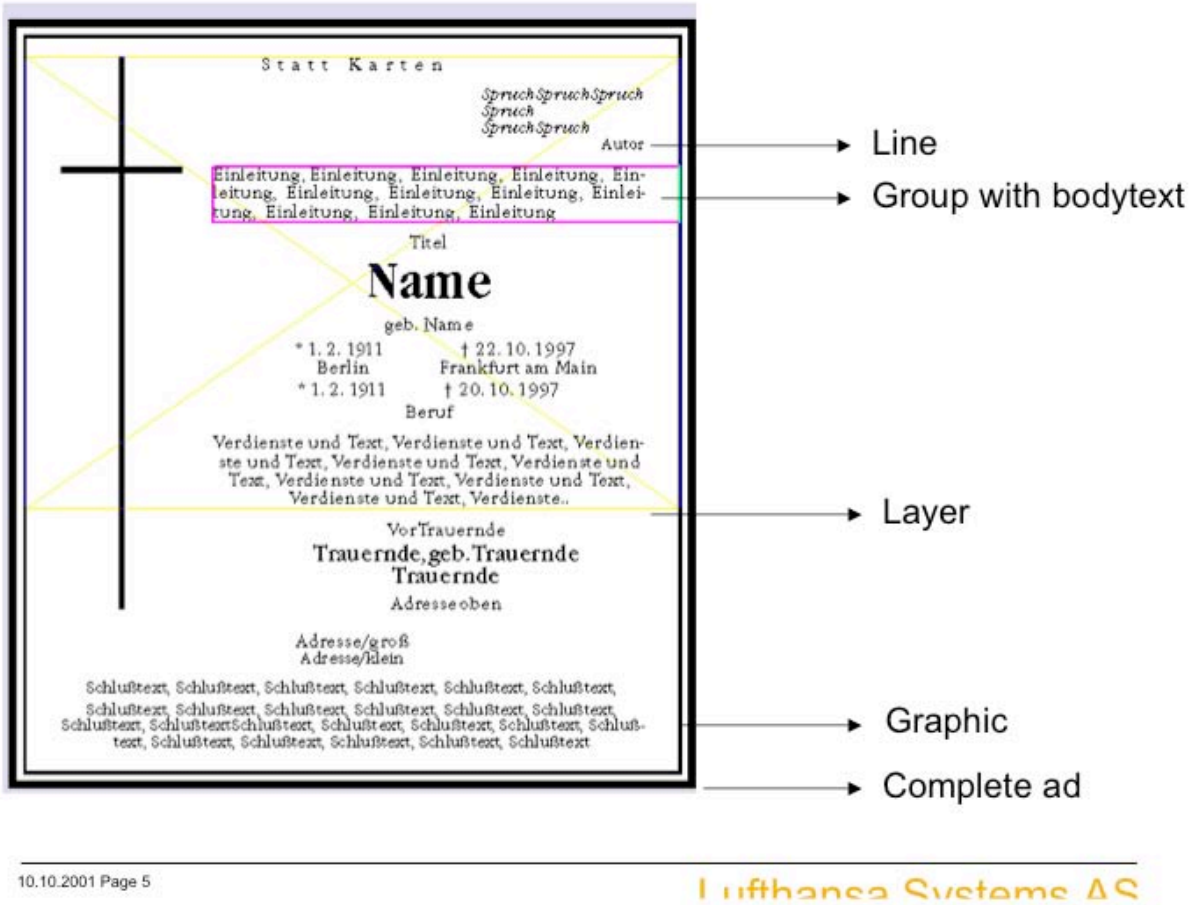
Digital Text

1. Context based character choice
2. Kerning
3. Optical Scaling
4. Paragraph composition (*hz*-program)
5. Chapter composition
6. Digital ads

Various ordinary ads



Structuring of an ad



Levels of Hierarchy

- Point — anchor points, determining the shape of a contour
- Contour — inner and outer contours of a character
- Character — a letter or a logo
- Line — one or more characters
- Group — one or more lines, headlinetext and body text
- Layer — one or more groups
- Graphic — one or more layers
- Ad — one or more graphics, the complete ad

Birth notices

Max has got a little sister
from now on

Mary-Lou Wolff

The parents Emily & Peter
are very happy too

Max has got a little sister
from now on

Mary-Lou Wolff

The parents Emily & Peter
are very happy too

Max has got a little sister
from now on

Mary-Lou Wolff

The parents Emily & Peter
are very happy too

The software starts with a template,

changes the picture element,

and rearranges the text lines.

Obituaries

Location where additional text could be generated.

No additional text has been generated:

therefore, the text below has been enlarged.

Statt Karten

Nimmer vergeht, was Du liebend getan.
Adding text
and even more text
and another line
and still more lines
lines
lines
lines
we find the bodysize of the text decreased.

Wir trauern um

Nicole Hand

geb. Tergani

* 13. 4. 1934 † 27. 7. 2002

Wir werden sie nie vergessen.

In stiller Trauer
Ludwig Weide
Maria Schiedel geb. Weide
Markus Schiedel
Lara und Sebastian

Ronnenberg, den 28. Juli 2002

Die Trauerfeier findet am 1. 8. 02 auf dem Ronnenberger Friedhof statt.
Bestattungsinstitut Muster, 12345 Hannover

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Polyommatus
Icarus
(Ikarus-Bläuling)
Dankeschön