Typesetting with Varying Letter Widths: New Hope for Your Narrow Columns

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Introduction

The line-breaking algorithm based on optimum fit, which serves as a basis of the TEX typesetting engine is considered to be of very high quality. However, there are still a large number of line-breaking problems where the results are not satisfactory. Especially when typesetting text in narrow columns with justified line margins, its optimising criteria can usually be met only by enlarging the amount of white space allowed (`\emergencystretch`). This introduces unacceptable distortions in the overall grayness of the page appearance.

One way to tackle this problem is to go back to an ancient technique used by Gutenberg for typesetting his 42-line Bible: extend the set of font types by letters with width variations. If one succeeds in selecting optimal typefaces modified to suit individual lines, one can minimize the annoying "holes" which otherwise occur within the pages.

When considering this approach, we come to the METAFONT system that makes it possible to keep constant stem width even when the width of individual letters is modified, and to use the current optimum-fit algorithm of TEX for finding suitable line breaks within the paragraphs to be typeset. A real implementation would require the typesetting system to be rewritten completely, especially its line-breaking algorithm. However, even with lower effort, we can happily explore this method and perform various (æsthetic) experiments.

This paper demonstrates the potential of a simple method of implementing the idea of extending font types by using letters with width variations. Selecting optimal typefaces modified to suit individual lines should make it possible to minimize the annoying "holes" which otherwise occur within paragraphs.

We will present the results of paragraph breaking using TEX and the improvements we can get using iterated line-breaking, based on variants of the fonts modified by width distortion. We will discuss benefits and limitations of this method.

The average document

When a TEXist, on a lovely summer day, enters his `\bye` and leaves the real world for the gates of TEX's brackets, they will be surprised to find that the quality of the average document at the dawn of the twenty-first century is still less than satisfactory. They might analyse more texts and realize that, nevertheless, the situation is better than some five years ago. The initial enthusiasm over the mere existence of DTP systems declines and both the designers and users of those systems start to exhibit a certain self-discipline in re-acquiring the achievements of this 500-year-old science called typography.

The vast majority of small typesetting problems encountered in the process of plain composition that arise from the competition of three paradigms (uniformity, information and structure) can be solved by any program that aspires to being called "the typesetting system". It is a must if we want to tackle hyphenation, ligatures, kerning, ties and various types of dashes. However, in the presence of this, there is much less progress in an area which attracts the user's attention very quickly and with great intensity:

How is it that this issue — so important to typesetting masters in the good old days — is so ignored by almost all present-day DTP systems? If we want to avoid sparse typesetting, perhaps we cannot apply just a simple algorithmic approach. With only a little exaggeration, we can say that, with respect to the goal of producing consistent grayness on the page, digital composers are still at the typewriter level. With despair we observe that even when TEX is relatively better because of the optimum-fit line breaking algorithm, it cannot avoid all problems.

What, in fact, is sparse composition? We could say, for example, that it is plain composition, where the inter-word spacing is in the range of 66 to 150 per cent of the width of the ideal space, as specified by the font designer. But even in documents typeset with TEX, we can often find spaces that exceed this limit by several magnitudes. Philip Taylor [6] shows how to try to improve such results but there is a general consensus that, for example, justified narrow columns are unsolvable if the regular level of grayness of the text is the main criterion. With decreasing `\hsize` the problems of the line breaks suddenly jump out.

Narrow columns today

Why do we need those narrow justified columns anyway? Isn't the natural answer simply to put 70 characters on a line — the most pleasant number for the eye of our reader [5]? No way! Typesetting is always a compromise between ergonomics and overall design that may require parts that are hard to produce (flowing around pictures, newspapers). Unfortunately, we cannot simply forget the existence of narrow columns. A more typical approach to this problem is letterspacing, a solution which is awful yet widely used. We can only wonder how a method so heartily frowned upon[1] has found its way into present-day typesetting. With today's greater cultural awareness, letterspaced words can particularly confuse readers used to certain national traditions that use it for e m p h a s i z i n g when appropriate italics was not at hand. Only by slowing down and asking "why did they emphasise *this* word" can we realize that it stands on a line by itself and is letterspaced only in order to justify the text. The flow of information is significantly disturbed.

A much more acceptable solution is to use raggedright lines rather than justify them. The reasons preventing the composer from picking up this style for any narrow column are, to be true, irrational. However, typography, as a discipline serving irrational beings, has to accept them. People simply *want* justified columns. It is like architects (often compared to typographers), who would have a hard time thrusting non-linear walls upon their customers; we treat books with unjustified margins with a certain disdain: we tolerate it only where justified lines would lead to much greater violation of the overall grayness than would unjustified lines.[2]

So we would like a different tool in our fight with sparse typesetting. One possibility is the approach presented in the remainder of this text — that is, to typeset using typefaces containing wider or narrower variants of characters while preserving all of their design characteristics. This way we give the typesetting algorithm one more degree of freedom in its search for optimum breaks; the algorithm is not constrained to change only the width of interword spaces. Some situations viewed as critical with regular systems become easier to solve (for example, lines with a minimum number of spaces — the more letters we have on the line, the more we can slightly vary their widths and get a reasonable result). We have more letters than spaces in regular texts but we cannot alter their width as much as we can the white spaces. To find out how practical and applicable this idea might be, we used experiments exhibited later in this article.

[1] "A man who would letter-space lowercase would steal a sheep." F. Goudy

[2] Another example of an algorithm broken by users' solutions is hyphenation in esperanto. The authors of this language are allowed to hyphenate at any point in a word; users of the language, however, have come up with various artifical constraints that have led to hyphenation patterns that are the same (or bigger) in size than those of other natural languages. . .

Is it moral to play with such a terrible thing?

Wider M's. Narrower O's. Isn't it a Greek gift which, in an attempt to make the page more regular, will break up the visual well-being of the reader because their brain will be confused with strange abnormalities in the shapes of letters? It's a weighty question. Superficial specification of the problem might even lead to the notion of a result that a master typographer will condemn — what's going on here might seem to be a *mixing of fonts* in its worst form because we suddenly have dozens of different typefaces, maybe even a different font for each line, whereas it is generally accepted to have at most three or four fonts in the whole document. However, here the intent is not to have the document as fancy as possible (goals of designers spitting around fonts and typefaces) but to stifle any irregularity. The modifications to the characters shouldn't exceed the limit beyond which they are recognized without a more thorough examination. This limit would need to be derived from empirical tests; it will vary for both different readers and different typefaces. The first estimate assumes modifications should not be greater than 5 per cent of the original width of the character. Another requirement is to maintain a uniform look to the whole line, which is the greatest unit that the reader really perceives.

It is hard to predict if there will regreses appear frequent, an uncertain feeling of incorrectness or that it is simply harder to read.[3] We need to make many practical tests and we will probably not be able to generalize results to other font families.

It is useful to remember that we are primarily speaking about minuscules; the text of a title on

[3] The paths of human vision are strange. As an example, consider the long-standing dispute about sans serif typefaces: they ought to be more readable because they do not disturb the reader with serifs and lead the eye more quickly to the important shapes of the letter, and yet it seems to be less convenient because it lacks the bounding box of line that leads the reader's eye along.

which the eye will spend a longer time and thoughtlessly explore the shapes erquires different principles than plain paragraph, where the main goal is to pass on the information and disappear.

Historical reminiscences: When in doubt, it is always good to look into the history, to experience gained by past generations. When studying historical contexts, we can see that some variations on this method were used by many typographers who needed precisely justified documents. Oldřich Hlavsa [4] gives an example of varying characters that can be found in a catalogue of type from 1920.

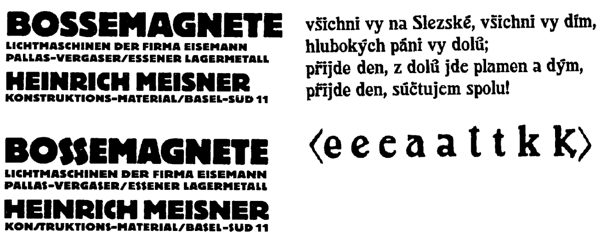

Figure 1: With variant typefaces, it is relatively easy to create justified but still closely tied advertisement. *(left)* Only a closer look at Preissig's solution for the design of a book of poetry shows modified letters. *(right)*

VojtĽch Preissig has also added variants of some letters to his font to get lines with regular light and a more beautiful appearance.

It is also important to note that in traditional hot-metal typesetting it was quite common to have (almost linear) contraction of width, up to about 1 per cent. It was achieved by strong tighting of the screws, taking advantage of the elasticity of the typesetting alloy.

What about "John-from-Good-Mountain"? If we were to consider the above examples as sporadic fads, we can go deeper to the roots, to Johann Gutenberg's workshop. The exact records about his "art of multiplication of books" are not known, but what we do know is that the admired uniform grayness of his 42-line Bible was accomplished by using dozens of ligatures, often abbreviations, placing punctuation to the middle of inter-word space and especially by using a vast set of character types. It was the selection of characters with variant widths which allowed him to typeset those perfectly justified lines that inspired Europe and that were so akin to good manuscripts. We can assume that his goal was nothing less than to achieve uniformly distributed white space in the whole document. The great amount of work that he devoted to the problem confirms how great a problem sparse typesetting was for the old typographers.

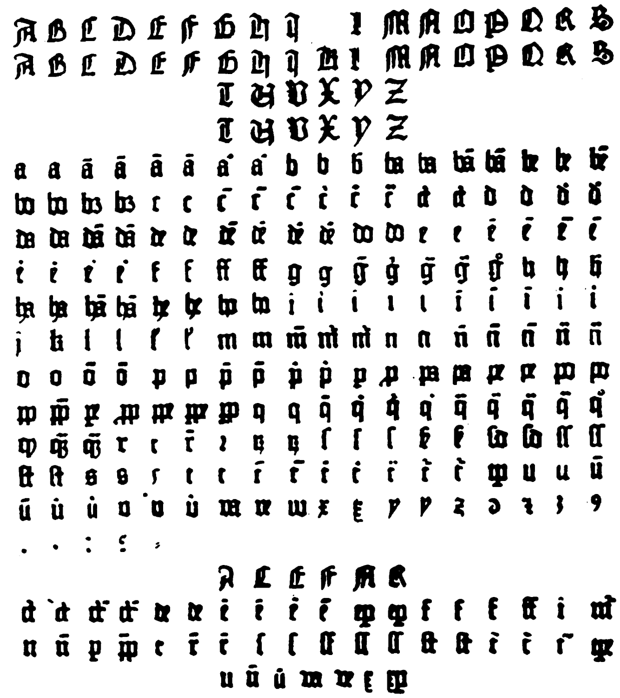

Figure 2: The typeset used in Gutenberg's Bible had hundreds of items.

The quest

When exactly typographers lost the need to create pages with perfect uniformity in grayness is not known. Probably this tradition did not survive the switch over from texture typesetting to the rounded italic typefaces of the present. Leaving the distinct vertical casts of the letters, the effort to make the mirror of a page into the regular grid has vanished and a much simpler method for line justification has predominated along the centuries: widen the interword spaces. Other techniques, as we have shown, run through the history of typography; they were, however, never used widely. I believe it was not caused by æstetic condemnation but by overwhelming technological difficulties. Not until electronic typesetting brought simpler ways for experiments with these micro-typographical effects and make it possible to include them in our documents.[4]

[4] The really practical and transparent use of variant-width characters would of course mean a really new generation of the line-breaking module to typesetting algorithms. Such a task is far beyond the scope of my thesis, which discusses these ideas. Nevertheless, URW started to work on

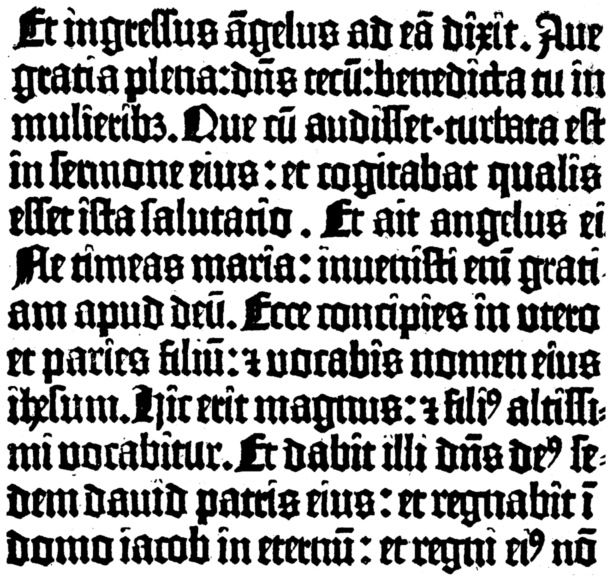
Et ingressus āgelus ad eā dixit. Aue
gratia plena: dñs tecū: benedicta tu in
mulieribȝ. Que cū audisset·turbata est
in sermone eius: et cogitabat qualis
esset ista salutatio. Et ait angelus ei.
Ne timeas maria: inuenisti enī grati
am apud deū. Ecce concipies in utero
et paries filiū: ⁊ uocabis nomen eius
ihesum. Hic erit magnus: ⁊ filiꝰ altissi
mi uocabitur. Et dabit illi dñs deꝰ se
dem dauid patris eius: et regnabit ī
domo iacob in eternū: et regni eiꝰ nō

Figure 3: From the 42-line bible.

Implementation

Fonts: When trying to find how to initiate the idea of varying-width characters, the problems with fonts is of the main importance. Essentially, there are two approaches: a) extend the typesetting with width variants of certain group of characters, or b) generate the necessary typeface on the fly, according to the requests from the typesetting system. The first solution, supposedly used in the hz-system, has both some drawbacks (limited flexibility that comes from the fixed set of available characters) and advantages: the set of characters will (should) be prepared by experianced designer, which will prevent possible excesses, that could appear during automatic generation; the disk usage is lower as well. The second solution requires very good cooperation of the typesetting system with the program generating the fonts. Also the number of fonts used in document will be enormous.[5] The need to change the shape of the characters and yet to keep all the main characteristics of the font (especially the stem width) implies the use of METAFONT.[6]

Line breaking: You barely get sparse typesetting with *optimum fit* algorithm. That was the thought during the first years of experience with TEX. The reality is slightly different. People are too lazy to aid the hyphenation algorithm or rewrite the text to get better line breaks. On the other hand, *optimum fit* and the box-glue-penalty paradigm itself is still a very strong concept.

Probably not very hard extension of it by *gluish box*, that would merge some features of both boxes and glues, would allow such a change of the line-breaking algorithm that would reflect the fact that even the material in the box has got some width variability. The badness of lines today is computed using the formula $b = |r|^3 \times 100$. If we could stretch or shrink both spaces and characters, the adjustment ratio r would come out as something like

$$\alpha \times \text{change of spaces} + \beta \times \text{change of characters}$$

Fine-tuning the balance between α and β, the user could express if they prefer loose lines or lines containing "deformed" font. By proper setting of these parameters, one could even get the backward compatibility with TEX.

How to simulate this approach in TEX

Let's stop theorizing and see what we can do in the current TEX, to finally understand how this inovatory typesetting looks like; how it works and what effect it has on readers. After considering various approaches (prototype system as a TEX change file, typesetting system independent on TEX, other ways) we opted for the method of postprocessing of DVI and a cooperation of Perl, TEX and METAFONT.

Method: When preparing such a system, several groups of problems needed to be solved. In the present solution line breaking that considers the flexible gluish boxes is simulated using existing TEXdata type: glue. Optimum fit in TEX considers the content of the `\rightskip` register (it contains the glue that should be placed on the right margin of the line). If one breaks a paragraph into lines with the setting

```
\rightskip=0pt plus 0.052\hsize minus 0.047\hsize
```

(`\hsize` holds the width of the page) we get the same result as if we allowed all objects on the line to stretch/shrink by 5 per cent. These broken lines will be wrapped (using suitable macro) with marks,

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it. Its hz-system is, however, a typical commercial product: the information vacuum is impenetrable, and no test or any other version is available on the market. Yet the suspected existence of the hz-system was a source of inspiration and hope for us, hope that it would make sense to explore the

VLW approach. We did concentrate on the cooperation with the TEX typesetting system, the tools that would allow anybody to test the utility and limits of this method; hopefully one day somebody will implement it in a really systematic way.

[5] This disadvangate could be eliminated by different font management, similar to font servers that generate only characters needed, not the whole fonts.

[6] Even if we can see some future in a Multiple Master system that could bring the needed metaness to the Postscript world.

showing the beginning and the end of each line. For this, we can use the `\special` primitive that allows to write out arbitrary marks into the DVI file.

Proper positioning of the material on a broken line is the phase when we leave TEX and the subsequent work is done on the output DVI file that is analyzed using a Perl program. It is kept intact up to a place marked with the `\special`s, showing the line boundaries. The distance between these marks defines the space that should contain the objects and minimize the variance from the required grayness. The Perl script computes the widths of the characters; it uses heuristics to decide if the skips in the DVI file come from spaces or kernings (kernings are kept intact, spaces will be used for modifications). It figures out by how much it needs to vary the font and re-sets the line using the new font. If the necessary metrics is not available, it waits for another script to generate it.

The preparation of the variant-width fonts consists of automatic generation of the source texts in METAFONT. We base our procedure on the DC family of fonts. The Perl script takes as a parametr the font name, which defines which typeface it is derived from and how much it differs (for example dcr8+3w.mf is an 8 pt font extended by 3 per cent). We modify the source code of the original font accordingly (the value of its width parametr `\u#`, to be exact) and using METAFONT we generate new metric and bitmap files. The implicit attempt is to prepare 10 width variants with the width differences from the original font being $\langle -5, -4, \ldots 4, 5\rangle$ per cent. The actual typesetting is then done using the font that is closest to the one requested. To have a special exact font for each line of the document wouldn't be feasible from the computational point of view. In special cases, but only on request, we can generate exact width-variant.[7]

Equivalence of the proper and implemented solutions: The solution presented is in many respects only an approximation of systematic approach. The most visible simplifications include:

The fact that $x\%$ of the width of the line is not equal to the sum of $x\%$ of widths of the flexible boxes that built it. The equality holds only if we can vary the width of *all* objects involved. The first goal was to get the document that has all the spaces identical, so the fact that we consider the modification of spaces in not a benefit. On the other hand, a method that changes letters but not spaces, smells too artifical. More problematic is the fact that the line can contain parts that must not be modified at all. The user has to have a tool to specify that certain hand-tuned typographical construction should not be changed even by a micron. To improve the result in the rest of the paragraph, we recommed to the user to enclose these dangerous parts by a couple of `\special` marks that will inform the justifying algorithm that this material should be typeset without any change. We however encounter one nuisance: the assumption about modifying the material in the line by x per cent fails, if there is some unchangeable part that occupies substantial width of the line.

There is only one way how to check the badness of the created line. In this solution, we simulate the flexibility of the boxes by adding a glue to the `\rightskip` variable. The only possibility is to compute the badness using the standing formula $|r|^3 \times 100$, not distinguishing the white space and deformed characters. For the same reason, when searching for the optimum line-breaks in a whole paragraph, we are not able to consider some variant of `\adjdemerits` that would penalize adjaced lines with stretched and shrinked characters.

We do not analyze the content of the `\hbox`es. The `\hbox` in the DVI file is usually represented by another stack level. Because the presence of such a construct often marks something untypical (the difference of the actual and declared width of objects, explicit shifts of the reference point back and forth, complicated objects build by the user), we keep these parts of the page intact.

Results of æsthetic experiments

The individual examples are provided with comments and numeric characteristics, but we strongly encourage the reader to do some æsthetic observation before taking author's prejudice into account. The empirical findings show that the perception of microtypographical effects differs extremely for different individuals; we would probably need to make great series of psychological and ergonomic tests to get any objective valuation.[8]

In an attempt to quantify results of the work by some algorithmic way, we have chosen following metrics:

Badness: is shown with some examples that compare the result with the result produced by TEX.

[7] For example for my favorite task to "typeset the headline to exactly fit the specified width".

[8] All remarks of kind readers about bad headaches encountered as a result of endless excitation of visual nerves that try to seize the alphabet the same way they have known it (i.e. with constant width of letters), are greatly appreciated.

Unfortunately, vast majority of narrow columns shown bellow fall through into the third pass of the line-breaking algorithm (where the stretchability of the line is extended by `\emergencystretch`). In this pass, TEX doesn't considers this added glue in its final compilation log. Badness, as measure of quality of the paragraph, is therefore insufficient. That is why we show another metrics.

Percentage difference from the ideal width of the space: Negative value means shrinking for example white spaces in *overfull boxes* have the width of −33 per cent. The paragraphs after iterated line-breaking, include the following:

Percentage difference of the width of the font used: The positive values mean that we have used a font wider than the original, negative denotes shrinking. By looking at adjaced fonts that differ by a great amount (for example +5% and −4%), we can review the critical spots of this way of typesetting, because here the eye of the reader encounters the biggest difference in the shape of the letters.

The following examples are prepared with the standard settings of the plain format (especially `\pretolerance100`, `\tolerance200`, `\hfuzz0.1pt`, `\adjdemerits10000`).

The first example: shows that TEX has substantial problems when breaking lines into really narrow columns. The allowed tolerance limit of 200 is relatively tough; on the other hand, this is not a mathematical text with many unbreakable formulas, nor a technical text where terms not typical for the Czech language could confuse the hyphenation algorithm. The line-breaking is so hard that even after the third pass there are some `overfull boxes` left. The amount by which dere the white spaces were stretched out in the solution with variable width font (second columns at the bottom right) indicates that even typesetting with five per cent ragged-right margin did not prevent the third pass or `\emergencystretch`. The fonts used here have, nevertheless, made it possible to decrease the stretch of the white spaces by an order of magnitude. When we compare the sixth lines (bottom right and left) we notice that the same material typeset with extended spaces (34%) changes into a line where they are shrunk just a little (−1%). This paradox solution was chosen because the choice of the best of 11 possible width variants has left us with less white space than would be needed in the optimum case. By increasing the number of variants in a font, it would be possible to decrease the scale of these non-optimal spaces.

The sixth and seventh lines show adjacent fonts that differ by nine per cent, truly one of the critical places on the page. Careful inspection of m's reveals that the differences are very noticeable.

When we compare the last thirds of the paragraphs, the new system evidently wins. Not even inherent scepticism can keep the author from appreciating the regular grayness and more compact ending with the more reasonable length of the broken lines (see Figure 4).

The second example: brings 6 lines with *badness* 10000. The ragged-right version shows that the opening lines of a paragraph can be broken only very short. And really, even after iteration, the spaces on the second line are still very wide (124%). The left side brings little comfort because TEX itself was unable to typeset this paragraph at all.

The last part of the paragraph offers two different variants of italics for comparison. Even a glimpse suggests that this typeface makes the modifications more visible than roman. The sixth and seventh lines of the text differ by eight per cent, but this is far less perceptible than those with italics. Individual typefaces obviously have different limits of painless modification (see Figure 5).

The third example: shows a typical way of using the system: TEX could typeset the paragraph using `\emergencystretch` but the possible ways to do so were so few that even the freedom added by allowing a ragged-right margin did not change the solution chosen. Using the variant-width fonts we only adjust the spaces — we actually try to relax very loose lines. Because of the upper limit of the font modification (5 per cent) the widths of spaces still remain "unacceptable" (to compare this, see the ideal spaces in the ragged-right example). The advantage of this solution is the fact that most of the lines have undergone a similar type of modification — a rather stretched font. We do not see the compatibility problems as in other cases (see Figure 6).

The fourth example: shows that when TEX encounters a truly unfeasible situation, as with very long words (and at the beginning of a paragraph, words shorter than 2`\hsize` are enough), even a big value for `\emergencystretch` does not help. The glue added in the third pass is considered and typeset at the right margin of the text (see second line at the bottom left). Even words that are theoretically reasonably long can cause extreme problems — see the 206 per cent spaces on the third line.

We can find faults in the iterated solution but it comes very well from the comparison. The difficult

5	18%	Norská runová jména
1	11%	jsou pozdější, z doby, kdy
8	−14%	bylo ve Skandinávii použí-
10000	−33%	váno už pouze 16 run, takže
10000	−33%	kompletní seznam jmen run
20	29%	této oblasti nemáme. Ná-
2	−9%	zvy, které runám daly jiné
10000	−33%	germánské národy, neznáme
10000	−33%	vůbec (ačkoliv některá pís-
9	−14%	mena gótské abecedy mají
10000	−33%	k jménům run jistý vztah).
7	20%	Ze 16 *přeživších* norských
15	26%	run jich většina odpovídá
10000	−33%	jejich anglosaským protějškům;
28	32%	a tuto podmnožinu pova-
87	47%	žujeme za runy nejstarší,
8	−14%	pocházející z dávných ger-
–	8%	mánských dob.

Norská runová jména
jsou pozdější, z doby, kdy
bylo ve Skandinávii pou-
žíváno už pouze 16 run,
takže kompletní seznam
jmen run této oblasti ne-
máme. Názvy, které runám
daly jiné germánské ná-
rody, neznáme vůbec (ač-
koliv některá písmena gót-
ské abecedy mají k jmé-
nům run jistý vztah). Ze
16 *přeživších* norských run
jich většina odpovídá jejich
anglosaským protějškům;
a tuto podmnožinu pova-
žujeme za runy nejstarší,
pocházející z dávných ger-
mánských dob.

5	18%	Norská runová jména
1	11%	jsou pozdější, z doby, kdy
154	57%	bylo ve Skandinávii pou-
329	74%	žíváno už pouze 16 run,
2005	135%	takže kompletní seznam
32	34%	jmen run této oblasti ne-
10000	−33%	máme. Názvy, které runám
768	98%	daly jiné germánské ná-
5	18%	rody, neznáme vůbec (ač-
35	−23%	koliv některá písmena gót-
169	98%	ské abecedy mají k jmé-
72	44%	nům run jistý vztah). Ze
10000	238%	16 *přeživších* norských
4391	176%	run jich většina odpo-
3029	155%	vídá jejich anglosaským
536	87%	protějškům; a tuto pod-
2884	153%	množinu považujeme za
0	0%	runy nejstarší, pocházející
2591	147%	z dávných germánských
–	–	dob.

+1	5%	Norská runová jména
+1	4%	jsou pozdější, z doby, kdy
+5	8%	bylo ve Skandinávii pou-
+5	40%	žíváno už pouze 16 run,
+5	62%	takže kompletní seznam
+5	−1%	jmen run této oblasti ne-
−4	−3%	máme. Názvy, které runám
+5	52%	daly jiné germánské ná-
+2	−1%	rody, neznáme vůbec (ač-
−2	−1%	koliv některá písmena gót-
+5	25%	ské abecedy mají k jmé-
+5	9%	nům run jistý vztah). Ze
−2	−2%	16 *přeživších* norských run
−4	−9%	jich většina odpovídá jejich
+3	13%	anglosaským protějškům;
+3	3%	a tuto podmnožinu pova-
+5	−1%	žujeme za runy nejstarší,
−1	−3%	pocházející z dávných ger-
0	0%	mánských dob.

Figure 4: The first example. Top left: format plain. Bottom left: with additional `\emergencystretch1em`. Top right: ragged-right lines (ideal spaces, `\rightskip` plus minus 5%). Bottom right: ragged-right lines adjusted with modified fonts.

10000	−33%	Ani při návodu nemůžeme od-
10000	−33%	dělovat to, co je správné, od toho,
12	−16%	co je pouze zdánlivě správné, po-
10000	−33%	něvadž právě to není sporným stra-
14	−17%	nám nikdy předem známo. Proto
29	33%	zde uvádím **úskoky** bez ohledu
10000	−33%	na objektivní pravdu či nepravdu,
9	−14%	neboť to člověk sám nemůže bez-
15	26%	pečně vědět. Teprve sporem má
143	56%	být pravda zjištěna. A pak při
86	47%	každé debatě nebo argumentaci
10000	−33%	vůbec se musíme shodnout na ně-
175	60%	čem, odkud – jakožto od prin-
0	1%	cipu – hodláme otázku, o kterou
111	51%	jde, zkoumat: *Contra negantem*
190	64%	*principia non est disputandum.*
0	1%	(Nechť se nediskutuje s tím, kdo
10000	−33%	popírá platnost základních pojmů
–	0%	a vět.)

Ani při návodu nemůžeme
oddělovat to, co je správné,
od toho, co je pouze zdánlivě
správné, poněvadž právě to není
sporným stranám nikdy pře-
dem známo. Proto zde uvádím
úskoky bez ohledu na objektivní
pravdu či nepravdu, neboť to člo-
věk sám nemůže bezpečně vědět.
Teprve sporem má být pravda
zjištěna. A pak při každé debatě
nebo argumentaci vůbec se mu-
síme shodnout na něčem, odkud
– jakožto od principu – hodláme
otázku, o kterou jde, zkoumat:
Contra negantem principia non
est disputandum. (Nechť se nedis-
kutuje s tím, kdo popírá platnost
základních pojmů a vět.)

273	69%	Ani při návodu nemůžeme
80	46%	oddělovat to, co je správné, od
10000	−33%	toho, co je pouze zdánlivě správné,
0	−4%	poněvadž právě to není sporným
552	88%	stranám nikdy předem známo.
219	65%	Proto zde uvádím **úskoky** bez
145	56%	ohledu na objektivní pravdu či
175	60%	nepravdu, neboť to člověk sám
72	44%	nemůže bezpečně vědět. Teprve
14	26%	sporem má být pravda zjištěna.
725	96%	A pak při každé debatě nebo
1248	116%	argumentaci vůbec se musíme
1342	118%	shodnout na něčem, odkud –
218	64%	jakožto od principu – hodláme
179	60%	otázku, o kterou jde, zkoumat:
133	57%	*Contra negantem principia non*
124	56%	*est disputandum.* (Nechť se ne-
0	−3%	diskutuje s tím, kdo popírá plat-
–	0%	nost základních pojmů a vět.)

+5	17%	Ani při návodu nemůžeme
+5	124%	oddělovat to, co je správné,
+5	56%	od toho, co je pouze zdánlivě
+1	−3%	správné, poněvadž právě to není
+5	114%	sporným stranám nikdy pře-
+5	19%	dem známo. Proto zde uvádím
−3	−12%	**úskoky** bez ohledu na objektivní
−3	−4%	pravdu či nepravdu, neboť to člo-
−1	2%	věk sám nemůže bezpečně vědět.
+5	27%	Teprve sporem má být pravda
+1	0%	zjištěna. A pak při každé debatě
+3	0%	nebo argumentaci vůbec se mu-
+1	1%	síme shodnout na něčem, odkud
+0	2%	– jakožto od principu – hodláme
+5	15%	otázku, o kterou jde, zkoumat:
+5	−11%	*Contra negantem principia non*
−3	−13%	*est disputandum.* (Nechť se nedis-
−2	−4%	kutuje s tím, kdo popírá platnost
0	0%	základních pojmů a vět.)

Figure 5: The second example. Top left: format plain. Bottom left: with additional `\emergencystretch1em`. Top right: ragged-right lines (ideal spaces, `\rightskip` plus minus 5%). Bottom right: ragged-right lines adjusted with modified fonts.

25	−20%	Eristická dialektika je umění
9	−15%	diskutovat, a sice tak diskutovat,
10000	−33%	aby člověk vždy získal pravdu, tedy
0	6%	*per fas et nefas.* Lze totiž mít ve
87	47%	věci samé pravdu objektivně, a
10000	−33%	přece se člověk v očích posluchačů,
143	56%	ba leckdy i ve svých vlastních,
10000	−33%	ocitne v neprávu – tehdy, vyvrátí-
147	56%	li odpůrce můj důkaz a platí-li
26	31%	toto vyvrácení již také jako vy-
19	−19%	vrácení tvrzení samého, jež přece
0	−4%	lze dokazovat ještě jinak; v tako-
1	−7%	vém případě je ovšem poměr pro
1	10%	odpůrce opačný: získá vrch, jak-
5	−12%	koli je objektivně v neprávu. Jak
–	0%	je to možné?

Eristická dialektika je umění
diskutovat, a sice tak diskutovat,
aby člověk vždy získal pravdu,
tedy *per fas et nefas.* Lze totiž
mít ve věci samé pravdu objek-
tivně, a přece se člověk v očích
posluchačů, ba leckdy i ve svých
vlastních, ocitne v neprávu –
tehdy, vyvrátí-li odpůrce můj
důkaz a platí-li toto vyvrácení
již také jako vyvrácení tvrzení
samého, jež přece lze dokazovat
ještě jinak; v takovém případě
je ovšem poměr pro odpůrce
opačný: získá vrch, jakkoli je
objektivně v neprávu. Jak je to
možné?

25	−20%	Eristická dialektika je umění
9	−15%	diskutovat, a sice tak diskutovat,
259	68%	aby člověk vždy získal pravdu,
66	43%	tedy *per fas et nefas.* Lze totiž
21	29%	mít ve věci samé pravdu objek-
37	36%	tivně, a přece se člověk v očích
0	3%	posluchačů, ba leckdy i ve svých
1199	114%	vlastních, ocitne v neprávu –
2150	139%	tehdy, vyvrátí-li odpůrce můj
341	75%	důkaz a platí-li toto vyvrácení
338	75%	již také jako vyvrácení tvrzení
29	33%	samého, jež přece lze dokazovat
364	77%	ještě jinak; v takovém případě
1960	134%	je ovšem poměr pro odpůrce
1478	122%	opačný: získá vrch, jakkoli je
17	27%	objektivně v neprávu. Jak je to
–	–	možné?

−2	2%	Eristická dialektika je umění
−1	−4%	diskutovat, a sice tak diskutovat,
+5	23%	aby člověk vždy získal pravdu,
+5	17%	tedy *per fas et nefas.* Lze totiž
+4	1%	mít ve věci samé pravdu objek-
+5	7%	tivně, a přece se člověk v očích
+0	3%	posluchačů, ba leckdy i ve svých
+5	72%	vlastních, ocitne v neprávu –
+5	79%	tehdy, vyvrátí-li odpůrce můj
+5	31%	důkaz a platí-li toto vyvrácení
+5	30%	již také jako vyvrácení tvrzení
+3	5%	samého, jež přece lze dokazovat
+5	32%	ještě jinak; v takovém případě
+5	93%	je ovšem poměr pro odpůrce
+5	80%	opačný: získá vrch, jakkoli je
+3	6%	objektivně v neprávu. Jak je to
0	0	možné?

Figure 6: The third example. Top left: format plain. Bottom left: with additional `\emergencystretch1em`. Top right: ragged-right lines (ideal spaces, `\rightskip` plus minus 5%). Bottom right: ragged-right lines adjusted with modified fonts.

second line is solved using a font with a customized width. Here it even came out greater than the five per cent limit — when examining the relevant line and lines around it we find to our surprise that adjacent lines that differ by 7.52% do not cause a big problem (see Figure 7).

The variant width of the fonts can be used not only for improving narrow columns but for many other typographic purposes. This example shows an attempt to typeset a paragraph of reasonable width longer by one line (let's say we need it to achieve some higher visual goal). TEX will find such a solution but the price is an increased tolerance from 200 to 1635. Amazing rivers are one of its side effects.

Our solution reduces these annoying consequences. With a similar approach we can use variant-width fonts to improve paragraphs that need to be typeset with specific `\parfillskip` values. When typesetting such texts the loose lines can usually be seen, even in rather wide lines.

The task of typesetting a headline with given wording and size at a given width sometimes brings problems as well. To alter the font by several per cent is sometimes the smartest solution (see Figure 8).

Now that we have gone through the above series of examples, let us consider some thoughts and conclusions. Adjacent lines with big differences in the type of font modification are the most problematic ones. However, such narrow and short paragraphs cannot be broken in too many ways, so it's hard to select a solution with more compatible adjacent lines — by increasing the value of `\adjdemerits` we only increase the total demerits of paragraphs but we do not get a clear improvement. Much better results can be achieved, in this respect, with paragraphs that were stretched by force (positive `\looseness`, lower `\parfillskip`), where this method just "shrinks the white spaces" and in most places where the stretched fonts are used.

One note about the æsthetic evaluations of the examples: ordinary people usually "do not see anything" (but this result might be ambiguous, of course). On the other hand, people with some experience with micro-typographical effects only support the feeling that the readers' notions can differ significantly.

And in the end...

First, let me apologize for the many motivation notes in the first part of this text. This article is the final word to a successfully completed thesis which nobody will ever re-open! So, the purpose was to make expert TEX-programmers feel that variant-width fonts are an interesting tool that would be nice to have. Anybody who wants to do their own experiments, both for inspiration when polishing difficult documents or searching for ideas for programming projects, can make use of scripts and macros available at `http://www.fi.muni.cz/~imladris/vlw`. Any modifications, improvements or even complex solutions to ideas presented here will certainly be appreciated by those TEXists who (like me) enjoy the never-ending playing with typography.

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10000	−33%	Tvůj příklad Llanfairpwllgwyn-
10000	–	gyllgogerychwyrndrobwllllantysil-
157	58%	iogogogoch (čili Llanfairu P.G.,
200	63%	jak se prý běžně zkracuje toto
1	−7%	město ve Walesu) je přece jenom
84	47%	okrajový. Němčina taky nestojí
10	23%	a nepadá s tím, že se v ní ‚pro-
85	47%	středí pro vývoj aplikací‘ řekne
10000	–	‚Anwendungsentwicklungsumgebung‘.

Tvůj příklad Llanfairpwll-
gwyngyllgogerychwyrndrobwll-
llantysiliogogogoch (čili Llanfairu
P.G., jak se prý běžně zkracuje
toto město ve Walesu) je přece
jenom okrajový. Němčina taky
nestojí a nepadá s tím, že se v ní
‚prostředí pro vývoj aplikací‘
řekne ‚Anwendungsentwicklungs-
umgebung‘.

1342	118%	Tvůj příklad Llanfairpwll-
10000	–	gwyngyllgogerychwyrndrobwll-
7030	206%	llantysiliogogogoch (čili Llan-
1831	131%	fairu P.G., jak se prý běžně
40	37%	zkracuje toto město ve Walesu)
159	58%	je přece jenom okrajový. Něm-
3	−9%	čina taky nestojí a nepadá s tím,
132	54%	že se v ní ‚prostředí pro vývoj
1	12%	aplikací‘ řekne ‚Anwendungsent-
–	–	wicklungsumgebung‘.

+5	38%	Tvůj příklad Llanfairpwll-
+5.52	0%	gwyngyllgogerychwyrndrobwll-
−2	−5%	llantysiliogogogoch (čili Llanfairu
+5	1%	P.G., jak se prý běžně zkracuje
+5	9%	toto město ve Walesu) je přece
+5	13%	jenom okrajový. Němčina taky
−2	0%	nestojí a nepadá s tím, že se v ní
+5	102%	‚prostředí pro vývoj aplikací‘
−2	17%	řekne ‚Anwendungsentwicklungs-
0	0%	umgebung‘.

Figure 7: The fourth example. Top left: format plain. Bottom left: with additional `\emergencystretch1em`. Top right: ragged-right lines (ideal spaces, `\rightskip` plus minus 5%). Bottom right: ragged-right lines adjusted with modified fonts.

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Figure 8: The fifth example. First four solutions: TeX. The fifth: headline shrunk by using the narrower font.