Footnotes in a Multi-Column Layout*

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1 Introduction

The placement of footnotes in a multi-column layout always bothered me. The approach taken by LaTeX (i.e., placing the footnotes separately under each column) might be all right if nearly no footnotes are present. But it looks clumsy when both columns contain footnotes, especially when they occupy different amounts of space.

In the multi-column style option [5], I used page-wide footnotes at the bottom of the page, but again the result doesn't look very pleasant since short footnotes produce undesirable gaps of white space. Of course, the main goal of this style option was a balancing algorithm for columns which would allow switching between different numbers of columns on the same page. With this feature, the natural place for footnotes seems to be the bottom of the page,[1] but looking at some of the results it seems best to avoid footnotes in such a layout entirely.

Another possibility is to turn footnotes into endnotes, i.e., printing them at the end of every chapter or the end of the entire document. But I assume everyone who has ever read a book using such a layout will agree with me that it is a pain to search back and forth, so that the reader is tempted to ignore the endnotes entirely.

When I wrote the article about future extensions of TeX [6], I was again dissatisfied with the outcome of the footnotes, and since that article was to show certain aspects of high quality typesetting, I decided to give the footnote problem a try and modified the LaTeX output routine for this purpose. The layout I used was inspired by the yearbook of the Gutenberg Gesellschaft Mainz [1]. Later on, I found that it is also recommended by Jan White [9]. On the layout of footnotes I also consulted books by Jan Tschichbold [8] and Manfred Simoneit [7], books I would recommend to everyone able to read German texts.

1.1 Description of the new layout

The result of this effort is presented in this paper and the reader can judge for himself whether it was successful or not.[2] The main idea for this layout is to assemble the footnotes of all columns on a page and place them all together at the bottom of the right column. Allowing for enough space between footnotes and text, and, in addition, setting the footnotes in smaller type,[3] I decided that one could omit the footnote separator rule which is used in most publications prepared with TeX.[4] Furthermore, I decided to place the footnote markers[5] at the baseline instead of raising them as superscripts.[6]

All in all, I think this generates a neat layout, and surprisingly enough, the necessary changes to the LaTeX output routine are nevertheless astonishingly simple.

1.2 The use of the style option

This style option might be used together with any other style option for LaTeX which does not change the three internals changed by ftnright.sty.[7] In most cases, it is best to use this style option as the very last option in the \documentstyle command to make sure that its settings are not overwritten by other options.[8]

It is unfortunate that the current LaTeX has no provisions to make such changes without overwriting the internal routines. In the new LaTeX implementation, we will certainly add some hooks that will make such changes more easy.

The ftnright option makes use of the values of \textheight and \skip\footins (the space between text and footnotes). The values used are the ones current when ftnright.sty is read in. If the user wants to change either of them in the preamble of his document he should call the macro

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*. The LaTeX style option ftnright which is described in this article has the version number v1.0c dated 90/08/24. The documentation was last revised on 90/10/01.

1. You cannot use column footnotes at the bottom, since the number of columns can differ on one page.

2. Please note that this option only changed the placement of footnotes. Since this article also makes use of the doc option [4] that assigns tiny numbers to code lines sprinkled throughout the text, the resulting design is not perfect.

3. The standard layout in *TUGboat* uses the same size for footnotes and text, giving the footnotes, in my opinion, much too much prominence.

4. People who prefer the rule can add it by redefining the command \footnoterule [2, p. 156]. Please note that this command should occupy no space, so that a negative space should be used to compensate for the width of the rule used.

5. The tiny numbers or symbols appearing with the footnote text; e.g., the '5' in front of this footnote.

6. Of course, this is only done for the mark preceeding the footnote text and not the one used within the main text where a raised number or symbol set in smaller type will help to keep the flow of thoughts uninterrupted.

7. These are the macros \@startcolumn, \@makecol and \@outputdblcol as we will see below. Of course, the option will only take effect with a document style using a twocolumn layout (like ltugboat) or when the user additionally specifies twocolumn as a document style option in the \documentstyle command.

8. The ltugboat option (which is currently set up as a style option instead of a document style option which it actually is) will overwrite the size used in footnotes if it follows the ftnright option.

`\preparefootins` afterwards to reinitialize the footnote algorithm, e.g.,

```
\setlength{\skip\footins}{8pt plus 3pt}
\addtolength{\textheight}{1in}
\preparefootins
```

This is necessary because the current LaTeX version contains no hook at the `\begin{document}` command where we could force an execution of `\preparefootins` internally.

2 The Implementation

As usual, we start by identifying the current version of this style file in the transcript file.[9]

```
1 \wlog{Style Option: '\filename'
2    \fileversion\space <\filedate> (FMi)}
3 \wlog{English Documentation
4    \@spaces\@spaces\space <\docdate> (FMi)}
```

To implement the layout described above, we have to distinguish between the left and the right column on a page. For this purpose LaTeX maintains the switch `\if@firstcolumn`. When assembling material for the left (i.e., the first) column, footnotes should take up no space, since they are held over for the second column. In the second column these footnotes are combined with the ones found there and placed a suitable distance from the main text at the bottom of this column.

This means that we have to change certain parameters for the insertion `\footins` when we construct the second column. The right place to do this is in the LaTeX macro `\@outputdblcol` which we are going to change later on. What settings for the insertion parameters are appropriate? For setting the first column, `\count\footins` and `\skip\footins` should both be zero since footnotes are held over, while for the second column `\count\footins` should be[10] 1000 and the `\skip\footins` has to be set to the desired separation between main text and footnotes.

We will allow one column of footnotes (i.e., the right column) at most, so that `\dimen\footins` has to equal `\textheight`. In principle, it would be possible to allow for even more footnotes, but this would complicate matters enormously.[11]

Since a document usually starts with a left column, we have to set `\count` and `\skip\footins` on top-level to zero. For this purpose, we define a macro `\preparefootins` which will first save the current value of `\skip\footins` in a safe place. This saved value will be used later for the second column. In this way, it is possible for the user or a designer of a document style to adjust this parameter without fiddling with the code of this style file.

```
5 \def\preparefootins{%
6    \global\rcol@footinsskip\skip\footins
7    \global\skip\footins\z@
8    \global\count\footins\z@
```

We will also assign `\textheight` to `\dimen\footins` to allow the user to change this parameter in the preamble.

```
9    \global\dimen\footins\textheight}
```

It is necessary to make the assignments above `\global` because we are going to use this macro in the output routine which has an implicit grouping level to keep the changes made by it local.

Of course, we have to allocate the skip register that we used above:

```
10 \newskip\rcol@footinsskip
```

Now we have all the necessary tools available to tackle `\@outputdblcol`. We have to remember that when `\if@firstcolumn` equals `\iftrue`, we are currently starting to build the second column, i.e., that the first column is already assembled. Therefore, the macro will start with the following code:

```
11 \def\@outputdblcol{\if@firstcolumn
12    \global\@firstcolumnfalse
```

After changing the switch, we save the first column (which was placed by preceeding macros in `\@outputbox`) in the box register `\@leftcolumn`. Since we are inside the output routine, all those assignments have to be `\global` to take any effect.

```
13    \global\setbox\@leftcolumn\box\@outputbox
```

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9. Nico Poppelier suggested omitting the `\typeout` statements in the production version of the files to avoid showing all that unnecessary information to the user. While I accept his criticism as valid, I decided that this information should at least be placed into the transcript file to make it easier to detect problems arising from the use of older versions. The command `\wlog` is a PLAIN TeX command that will write its argument to the transcript file.

10. A value of 1000 means that there is a one-to-one relationship between the real size of the footnote and the size finally occupied by the footnote on the current page.

11. If one likes to allow that the footnote text might start in the first column occupying also the whole second column, it is not possible to simply make `\dimen\footins` larger than `\textheight` directly, because this would result in a full left column (with text) and more than one column of footnotes which will not fit on the current page. Instead, one has to make footnotes visible to the page generation algorithm again at the moment when a full column of footnotes is assembled, but we still have some space left in the first column. It is a nice enhancement, and, I suppose, it is of some value for preparing publications in certain disciplines, so here is the challenge ...

exact. If we have a full column of footnotes, it will be too high, but this does not matter since we need it only for an upper bound on the free space available for floats.

```
37      \ftn@amount\ht\footins
38      \advance\ftn@amount\dp\footins
39      \advance\ftn@amount\skip\footins
40    \fi
```

We then reduce the `\@colht` by this amount and again assign `\@colroom` the value of `\@colht`. If no footnotes are present, we substract zero, so there is no harm in doing this operation all the time.

```
41      \global\advance\@colht-\ftn@amount
42      \global\@colroom\@colht
```

Now, we call another internal LATEX macro that will try to contribute floats to the next column. It will use the register `\@colht` when trying to build up a float column, which is the reason for reducing this register. If it succeeds, it will set the switch `\if@fcolmade` to `true`, otherwise, to `false`. If no float column is possible, it will try to place some or all of the deferred floats to the top or the bottom of the next column, thereby, using and reducing the value of the register `\@colroom`.

```
43    \@xstartcol
```

Afterwards, we have to restore the correct values for `\@colht` and `\@colroom` again, but this time, they may differ, so that we have to `\advance` both registers separately by `\ftn@amount`.

```
44      \global\advance\@colht\ftn@amount
45      \global\advance\@colroom\ftn@amount
46  \fi
```

Now, after doing the things depending on the status of the `\@deferlist`, we have to incorporate the left over footnotes in the new column. First we check whether a float column was produced by `\@xstartcol` or not.

```
47  \if@fcolmade
```

If so, we do something awful. To make use of the `\@makecol` macro, which attaches footnotes to `\box255` and places the result in the box register `\@outputbox`, we have to assign `\@outputbox` (i.e., the result of `\@xstartcol`) to `\box255`.[13]

```
48    \setbox\@cclv\box\@outputbox
49    \@makecol
50  \else
```

If no float column was produced, we reinsert the held over footnotes so that they can be reconsidered by the page generation algorithm of TeX. But it is necessary to ensure that this operation is done only when footnotes are actually present.[14]

```
51    \ifvoid\footins\else
```

```
52      \insert\footins{\unvbox\footins}\fi
53  \fi}
```

Of course, we also have to allocate the dimen register. It will be automatically initialized to zero.

```
54 \newdimen\ftn@amount
```

The other internal macro that we have to change is `\@makecol`, a macro that is called whenever one column of material is assembled and column floats and footnotes have to be added. Again, we have to distinguish between actions for the first and the second column.

```
55 \def\@makecol{\if@firstcolumn
```

For the first column, we leave the footnotes in their box and simply save the contents of `\box255` in the `\box` register `\@outputbox`.

```
56    \setbox\@outputbox\box\@cclv
```

But if the user erroneously forgot to specify a twocolumn layout, we will always typeset the first column, so that the footnotes are never printed. Therefore we better check for this special case and output the footnotes on a separate page in an emergency.[15]

```
57    \if@twocolumn \else
58      \ifvoid\footins \else
59        \@latexerr
60    {ftnright option used in one-column mode}%
61    {I shipped out the the footnotes on an
62      extra page.}%
63        \shipout\box\footins \fi\fi
64  \else
```

When we construct the second column, we must first check whether footnotes are actually present. If not, we perform the same actions as before.

```
65    \ifvoid\footins
66      \setbox\@outputbox\box\@cclv
67    \else
```

But, if footnotes are present, it may be possible that the whole column consists of footnotes, i.e., `\box255` is empty. In this case, there is no use in placing

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13. In German, we call this "from the back through the chest into the eyes".

14. Otherwise, we might get an undesired extra vertical space coming from `\skip\footins`, even if there are no footnotes on the page.

15. Otherwise, the footnotes are held over forever, preventing TeX from finishing the document successfully. Instead, TeX will produce infinitely many empty pages at the end of the document, trying in vain to output the held over footnotes. This problem was found by Rainer Schöpf when we prepared the paper for the Cork conference.

Then, we make the footnotes visible to the page generation algorithm by setting `\count\footins` to 1000 (`\@m` is an abbreviation for this number) and `\skip\footins` to its saved value (i.e., `\rcol@footinsskip`).

```
14    \global\count\footins\@m
15    \global\skip\footins\rcol@footinsskip
```

We also have to reinsert all footnotes left over from the first column to make sure that they are reconsidered by the page generation algorithm of TeX using the new values for `\count` and `\skip\footins`. But this will be done later in the macro `\@startcolumn`.

If we have just finished the right column, i.e., when `\if@firstcolumn` equals `\iffalse`, we will reset the `\footins` parameters as explained above using the utility macro `\preparefootins`.

```
16    \else \preparefootins
```

Then, we compose both columns in `\@outputbox`, combine them with all page-wide floats for this page (`\@combinedblfloats`), attach header and footer, and ship out the result (`\@outputpage`). Finally we look to see whether it is possible to generate following pages consisting only of page-wide floats.[12]

```
17    \global\@firstcolumntrue
18    \setbox\@outputbox\vbox{\hbox to\textwidth
19      {\hbox to\columnwidth
20                   {\box\@leftcolumn\hss}%
21       \hfil\vrule\@width\columnseprule\hfil
22       \hbox to\columnwidth
23                   {\box\@outputbox\hss}}}%
24    \@combinedblfloats\@outputpage
25    \begingroup
26      \@dblfloatplacement\@startdblcolumn
27      \@whilesw\if@fcolmade\fi
28      {\@outputpage\@startdblcolumn}%
29    \endgroup
30  \fi}
```

There is a fundamental flaw in LaTeX's output routine for float columns and float pages: split footnotes, i.e., footnotes which are only partly typeset on the preceding page are not resolved. They are held over until LaTeX starts a page (or column) containing text besides floats again. For our current layout, this would mean, that if LaTeX decided to make the right column of a page a float column, footnotes from the left column would appear on a later page. A real cure for this problem would be to rewrite two-thirds of LaTeX's output routine, so I am leaving this open for the interested reader.

But the problem shows up even if only one float is contributed to the right column since LaTeX assumes that the whole column is usable, whereas some of it might actually be already devoted to footnotes from the left column. So we have to change the output

routine at least in the part that contributes floats to the next column. The macro involved is called `\@startcolumn`. The first thing we do is to check whether any deferred floats exists.

```
31 \def\@startcolumn{%
32   \ifx\@deferlist\@empty
```

If not, we set the switch `\if@fcolmade` to false which says that we did not succeed in making a float column. Then, we set `\@colroom` to `\@colht`. The register `\@colht` holds the amount of space that is available for floats, text, and footnotes in one column, i.e., it equals `\textheight` minus the space devoted to page-wide floats. `\@colroom` is a similar register which holds the value `\@colht` minus space for column floats that are already contributed to the current column. Of course, both values should be equal when we start a new column.

```
33     \global\@fcolmadefalse
34     \global\@colroom\@colht
35   \else
```

If there are floats waiting for a change to be processed, the situation is more difficult. In this case, we have to reduce both `\@colht` and `\@colroom` by the amount of space that will be needed for the footnotes from the left column. So we must check whether such footnotes are present. As we have not reinserted them in `\@outputdblcol`, we can check the `\footins` box.

```
36     \ifvoid\footins\else
```

If there are some, we measure the space that will be occupied by them. This measurement is not really

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12. This part is copied directly from the original LaTeX macro. Details about the macros used, their interfaces and meanings can be found in the LaTeX source code [3].

Puzzle:

Given a simple TeX document containing only straight text, is it possible for the editor, after deleting one sentence, to end up with a document producing an extra page?

We assume that the deleted text contains no TeX macros and that the document was prepared with a standard macro package like the one used for *TUGboat* production.

The answer will be given in the next issue.

any glue (\skip\footins) in front,[16] so we have to check for this possibility.

```
68      \setbox\@outputbox\vbox
69        {\ifvoid\@cclv \else
70          \unvbox\@cclv
71          \vskip\skip\footins\fi
```

But in any case, we place the \footnoterule in front of the footnotes even if this macro is not used by this style option.[17] This ends the if-statement testing whether footnotes are present or not. It also ends the code which differs depending on the column number.

```
72          \footnoterule\unvbox\footins}\fi
73    \fi
```

Now the column floats are added at the top and the bottom, and the \@outputbox is adjusted to the full column height so that the glue inside will stretch in certain situations.[18] Again, this code is copied verbatim from the original source, so I won't dwell on details.[19]

```
74    \xdef\@freelist{\@freelist\@midlist}%
75    \gdef\@midlist{}\@combinefloats
76    \setbox\@outputbox\vbox to\@colht
77        {\boxmaxdepth\maxdepth
78        \@texttop
79        \@tempdima\dp\@outputbox
80        \unvbox\@outputbox
81        \vskip-\@tempdima
82        \@textbottom}%
83    \global\maxdepth\@maxdepth}
```

Now we can tackle the remaining small changes to the standard layout. I decided to use a smaller size for footnotes but with a slightly larger leading than usual.[20] This means that we have to redefine the \footnotesize macro which depends on options like 11pt, etc. Fortunately, there is a simple way to find out the main size of the document: the macro \@ptsize contains 0, 1, or 2 standing for 10, 11, or 12 points document text size.

```
84 \ifcase \@ptsize
85 \def\footnotesize{\@setsize\footnotesize
86    {9.9pt}\viiipt\@viiipt}
87 \or
88 \def\footnotesize{\@setsize\footnotesize
89    {11.1pt}\ixpt\@vixpt}
90 \or
91 \def\footnotesize{\@setsize\footnotesize
92    {12.3pt}\xpt\@xpt}
93 \fi
```

Setting footnotes in smaller type and separating them with sufficient space from the main text allow us to omit the \footnoterule normally used.

```
94 \let\footnoterule\@empty
```

Individual footnotes are separated from each other by approximately a \baselineskip of the text size. This can be specified with the following code:

```
95 {\normalsize
96 \global\footnotesep\ht\strutbox}
```

Braces and \global were used to keep the switch to \normalsize local, just in case some weird layout starts out with a different text size for some reason.

And finally, a small but nice change, to the mark at the beginning of the footnote text. We will place it at the baseline instead of raising it as a superscript. Additionally, it will get a dot as punctuation.

```
97 \long\def\@makefntext#1{\parindent 1em
98    \noindent\hbox to 2em{}%
99    \llap{$\@thefnmark.\;\;$}#1}
```

3   Initialisation

We defined the macro \preparefootins above, but we also have to use it to prepare typesetting the first column. As a default for the separation of footnotes and text on the second column, we use the following:

```
100 \skip\footins 10pt plus 5pt minus 3pt
101 \preparefootins
```

Of course, this value can be changed later on by the user as described in the introduction.

16. In fact, it would be a mistake since this glue was not taken into account when the footnotes where assembled, so it would produce an overfull box.

17. This decision is certainly open to criticism, since there is nothing to separate. On the other hand, a rule or some other ornament in front of the footnotes is part of the design which should be used consistently throughout a document. As a last argument in favor of the rule, consider the situation where LaTeX decided to place only floats and footnotes into the right hand column. In this case a separator again seems adequate. In this situation one can even argue that it is necessary to put in the \skip\footins.

18. It is an interesting question as to whether the current layout works well with bottom floats or not. Actually, I would prefer to place the footnotes below the bottom floats instead of above, as it is done here. At least when the floats are part of the document and not puzzles thrown in. But I was too lazy to implement it because I seldom use floats. If somebody implements this layout (some parts of this macro have to be changed) I would be interested in seeing the code and some sample results.

19. I only changed \dimen128 into \@tempdima which is, besides being faster and shorter, only a cosmetic change. The use of this hardwired dimen register seems to indicate that this part of LaTeX was written very early and left unchanged since then: an interesting fact for software archeologists.

20. The sizes used are suitable for high resolution printers but should be perhaps enlarged for resolutions of 300dpi or less. On such output devices footnotes of 8pt size are difficult to read and look too small.

References

[1] Hans-Joachim Koppitz, editor. *Gutenberg Jahrbuch*. Gutenberg-Gesellschaft, Mainz.

[2] Leslie Lamport. *IATEX: A Document Preparation System*. Addison-Wesley, Reading, Massachusetts, 1986.

[3] Leslie Lamport. *latex.tex*, February 1990. IATEX source version 2.09.

[4] Frank Mittelbach. The doc-option. *TUGboat*, 10(2):245–273, July 1989.

[5] Frank Mittelbach. An environment for multi-column output. *TUGboat*, 10(3):407–415, November 1989.

[6] Frank Mittelbach. E-TEX: Guidelines to future TEX extensions. In Lincoln K. Durst, editor, *TUGboat*, 11(3): *1990 TUG Annual Meeting Proceedings*, pages 337–345, September 1990.

[7] Manfred Siemoneit. *Typographisches Gestalten*. Polygraph Verlag, Frankfurt am Main, second edition, 1989.

[8] Jan Tschichbold. *Ausgewählte Aufsätze über Fragen der Gestalt des Buches*. Birkhäuser Verlag, Basel, 1987. Second printing.

[9] Jan White. *Graphic Design for the Electronic Age*. Watson Guptill, Xerox Press, New York, 1988.

4 Index

All numbers denote code lines where the corresponding entry is used, underlined entries point to the definition.

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