

Modifications to the *nroff/troff User's Manual*

January 27, 2019 with updates February 22, 2019

This document describes changes made to the *User's Manual* to add descriptions for the new paragraphing requests and to revise or correct other anomalies that were apparent when proofreading it. A repository of the document source, including all changes, pre-built PDFs, and a copy of this document can be found at <http://github.com/reffort/troffmanual>. There are more changes than I anticipated, so there are two PDFs of the manual:

1. `troffdoc-20190127.pdf` was made directly from the source file and represents what the document actually looks like;
2. `troffdoc-20190127-mk-an.pdf` was marked up by `gdifmk` and modified by hand to show the location of the changes. Paragraph adjustment was turned off because the `.mc` margin character request is not very compatible with paragraph adjustment; consequently, line and page breaks differ from those of `troffdoc.pdf`. Change codes in the margin indicate:
 - A Added content.
 - C Changed content.
 - M Change to document markup, PDF link, etc. These changes are not marked if there is no visible counterpart.
 - N Note or comment. Generally an item that is described but not implemented.
 - B Program bug described in the Bugs section.

Material related to the new requests was added to pages 7, 9, 12, 15, 16, 17, 27–28, 30–35, and 51. The request cross reference, page 12, and Table II, pages 75–76, do not have change marks. All page numbers apply to document 1. The changed items are now highlighted so they are easier to find.

For the predefined number registers, pages 15–17, the new entries do not have links in the section and description columns. Those links are redundant and they make the descriptions hard to read on-screen. Each of the existing entries has a link for the section number, register name, and description; with a few exceptions, all three point to the same location. The list of requests on pages 6–11, for example, does not have links in the explanation column. The redundant links can probably be removed with a `sed` script.

Some non-printing demo code and debugging markup were removed. They were originally part of a demo document I made to verify that the paragraphing extensions would build the *User's Manual* successfully. The debugging markup was introduced to isolate a problem where some lines protruded into the right margin, but because it was in a demo document I didn't bother to remove it. It somehow wound up in the *User's Manual*. The location of these edits is not marked. (The problem turned out to be a `troff` bug and is described in the Bugs section.)

I also made several other (mostly minor) changes to other parts of the document, as listed on the following pages. Most of them are trivial, relating to typos or document markup; most of the errors date from 1976 or before. Some of the changes update old pre-PostScript nomenclature that is wrong or misleading today. Some changes that don't affect content are not described. All of them should be viewed as proposals.

Several edits are intended to remove ambiguity from the document's coding and improve its searchability. If the reader searches for a particular escape sequence, the document must be coded with that sequence (not something that looks kind of similar) or it will not be found.

Items identified with a check mark have been applied; unmarked items have not.

Introduction

PAGE

- ✓ 1, 2, 3 Remove unnecessary emphasis from words like *Heirloom* and other capitalized names.
- ✓ 2 Change the definition of the `\[ecircumflexacute]` character `é` to `.char \[e^']` instead of the string `.ds U+1EBF`. The *Termes* fonts have a glyph for `é` but the default Times fonts do not, so define an alternate composite character for them.
- ✓ 2 Change “rastering” to “rasterizing”.
- ✓ 3 Add direct PDF links for the list of escape sequences and predefined number registers. They are separated from the Request Summary by several pages and are already listed separately in the text.
- ✓ 3 Add the year of first publication to the acknowledgements to provide perspective and eliminate the need to keep up with elapsed time. For Gunnar’s acknowledgements (2006), the only change is to revert “45” years back to the original “30” years.

Kernighan’s “Acknowledgements for the Second Edition” are from Plan 9 v4 (c. 2000), but they appear almost verbatim in the 10th Edition UNIX version of CSTR-54 (c. 1990). The differences are trivial: in the first paragraph, “more than twenty” years reads “fifteen” years; and in the second paragraph, “Recent versions” reads “The current version”. The only source file for the 10th Edition document I could find has an internal note that it was “Revised November, 1992”. I’ve dated Kernighan’s acknowledgements as 1990 based on the date of the Preface to Volume 2 of the Tenth Edition *Programmer’s Manual*, but if there is a more accurate date, it would be worth while to use it.

The “Background for the Second Edition” on page 2 is also from Plan 9 v4 and practically verbatim from the 10th Edition version of CSTR-54. The differences are also trivial: in the fourth paragraph, “In the newer language” was “Most notably”; and in the fifth paragraph, the sentence after “quadratic B-splines” was separated by a semicolon.

- ✓ 3 The web links for references [1], [6], and [12] are no longer online. Add some links that are live (at least for now).

Usage

PAGE

- ✓ 4 “An argument consisting of a single minus (–)”, where the minus sign coded in the document is the arithmetic minus sign `\-` (which won’t work on the command line) but the symbol displayed is the en dash `\(en` (which won’t work, either). The terminology and symbols need to be updated and made consistent, and the correct output character needs to be used. The term *minus* refers, of course, to the ASCII “hyphen-minus” character, not the arithmetic minus sign, not the en dash. The reader is somehow expected to make sense of this. Change command line options from `\-` to `-` globally.

The 10th Edition and Plan 9 v4 versions also use the term *minus*, but both document sources are coded with ASCII hyphens (the 10th Edition version is shown here):

```
An argument consisting of a single minus
.CW - ' `
is taken to be
```

and the arguments shown in the table of options are also ASCII hyphens:

```
-N      T{
Run as \*(NR; default is \*(TR.
T}
-m@name@      T{
Read the macro file
```

The command line example also uses hyphens:

```
Each option is a separate argument;
for example,
.P1
troff -Tpost -ms -o4,6,8-10 @file1 ~ file2@
.P2
```

A PDF built from the *ditroff* output file included with the 10th Edition source produces the ASCII hyphen, U+002D. The PDF supplied with Plan 9 v4 shows the arithmetic minus sign, U+2212; the hyphen is remapped in the CW font file, but remains a hyphen in the R font.

The pre-PostScript 7th Edition document (1976) uses the current-font minus character \-:

```
An argument consisting of a single minus (\fB\-\fR) is taken to be
...
\fB\-\n\fIN\fR    Number first generated page \fIN\fR.
...
Each option is invoked as a separate argument;
for example,
.x1
\fBnroff \-o\fI4,8\-\10 \fB\-\T\fI300S \fB\-\m\fIabc file1 file2\fR
.x2
```

A formatted document is not supplied with the 7th Edition files, but published versions of the *User's Manual* from the 1980s uniformly show the arithmetic minus sign. See the entry for page 4 in the Bugs section and the Addendum for more on the mapping of dashes.

- ✓ 4 Fix the odd acronyms (DASI-450, etc.).

Reference Manual

PAGE

- ✓ 6, 7, 10, 13, 14
Change random italics to roman.
- ✓ 7, 14, 15, 25, 29, 30, 32, 43, 64, 65
Change “base line” and “base-line” to “baseline” (global).
- ✓ 9 Change the default .c2 control character from ´ to '.
- ✓ 14 Add \w to denote the *width* function.
- ✓ 18 The default no-break control character is not the acute accent (´) (which won't work) but the ASCII single quote \[quotesingle] ('). Global. The term “acute accent” can be found in the v7 version of the *User's Manual*, but in v10 and Plan 9 v4 the no-break control character is called the “single quote”. (The ASCII apostrophe, close quote, and acute accent are the same character ('). When PostScript was released in 1984, it renamed the apostrophe/close quote character to \[quotesingle] and the acute accent became a separate character, \[acute].)

- ✓ 18 Clarify wording for 2-character and long names.
- ✓ 19 In the table, center “Meaning” and “Number of basic units”. Add PDF link.
- ✓ 19, 64, 67
Fix italic curly quotes used as delimiters in a bold context.
- ✓ 20 In the table, change “acute accent” to “single quote” and show the correct character. Sequence open quote before close quote. The third line adds nothing but confusion, so it was deleted. (The ASCII minus sign and the ASCII hyphen are the same character, so no translation is done. The graphics shown are the *math* minus sign and the en dash, both of which are wrong.) *troff* correctly maps the math minus sign `\(mi` to the math minus sign, but it maps the current font minus sign `\-` to the en dash; this is an error except perhaps in a fallback situation.
- ✓ 20 §2.1: Clarify wording, fix typos, errant capitalization, etc.
- 20 “Characters for which no name is known are replaced by spaces.”: Current best practice is to print the `.notdef` character ☐. The rationale for leaving a space was probably so the missing graphic could be written in by hand on the printout.
- ✓ 20, 39, 46, 47, 71
Change straight quotes to curly quotes when the context is not source code or literal. (Global.)
- ✓ 22 `.bd`: The amount of emboldening shown, 3, was used as an example for the CAT at 432 dpi and the legacy `-Tpost` driver at 720 dpi. An emboldening of 3 is not likely to be visible on the default high-resolution driver at 72 000 dpi; a corresponding value would be around 300.
- ✓ 25 §4.1: (1) Change “a output text line” to “an output text line”; (2) Use an `\[asciitilde]` (`~`) for the non-breaking adjustable space character instead of the math symbol `\(ap` (`~`).
- ✓ 26 Spring the footnote using an output-line trap.
- ✓ 27 Change “copying of a input line” to “copying of an input line”.
- ✓ 27 Change “substack” to “subtract”, “french” to “French”, and “\.” to “\&”.
- ✓ 28 Fix punctuation, add links for `b1m` and `lsm`.
- ✓ 35 Change “can not” to “cannot”.
- ✓ 41 Add a link and live page number reference to the predefined number register section.
- ✓ 42 In the table, center the third “none”. Vertically center “Sequence”.
- ✓ 42 Change “lower-case” and “upper-case” to non-hyphenated.
- ✓ 44 Change “`e_backspace`” to “`backspace`”.
- ✓ 44 Add a link to the escape summary.
- ✓ 44 “The escape character `\` can be output by using the special character `\(rs`.” This sentence is confusing because `\(rs` does not output the escape character. The source is coded:

The escape character `\fB\e\fR` can be output by using the special character `\A'e_esc'\fB\e(rs\fR`.

which is even more confusing. Additionally, the anchor is the reference point for the delayed escape sequence “`\\`”, not the special character “`\(rs`”. The intent is probably something like:

`\A'e_esc'\fB\e\e\fR` delays interpretation of the escape character.
A backslash character `\fB\(rs\fR` can be output by using the special character `\fB\e(rs\fR` (reverse solidus).

which will be output as:

\\ delays interpretation of the escape character. A backslash character \ can be output by using the special character \rs (reverse solidus).

- ✓ 45 Change “charaters” to “characters”.
- ✓ 45 Change “line-drawing” to “line drawing”.
- ✓ 46 Change instances of no-break control character from the acute accent to the single quote.
- ✓ 46 Change “(not copy mode)” to “(not copy) mode”.
- ✓ 47 Change “imbed” to “embed” and “imbedded” to “embedded” (wrong globally).
- ✓ 48 Change “characters in *string* overprinted” to “characters in *string* are overprinted”. Change \ to \’ to differentiate escape sequence from delimiters.
- ✓ 49 Remove hyphen from “over-lapping”. Also p.50.
- ✓ 50 \D' ~ should use \[asciitilde] (~) instead of \(\ap (~).
- ✓ 50 “a small list of exception words”: Delete the word “small”.
- ✓ 50 “words that contain hyphens (minus) . . . are *always* subject to splitting”. The minus signs (\-, \mi, and U+2212) do not break at the end of a line. Change “(minus)” to “(-)”.
- ✓ 50 Change “explicit hyphenation points specified” to “hyphenation points explicitly specified”.
- ✓ 51 .breakchar and .nhychar: add a little space between the hyphen and em dash.
- ✓ 51 Remove hyphen from “lower-case”.
- ✓ 52 Make “title-length”, “line-length”, “page-number”, and “page-offsets” two words.
- ✓ 53 “in multi-line case use \{ *anything* \}.” The braces are literals, use bold roman: “\{ *anything* \}.”
- 53 “If expression $N \leq 0$ [sic]”: The “[sic]” is unnecessary and confusing, and should be deleted.
- ✓ 54 In the table, vertically center “True if”.
- ✓ 54 In the code example, fix the no-break control character.
- ✓ 54 Change “nobreak” to “no-break” (global).
- ✓ 55 Change /PUT pdfmark\’ to /PUT pdfmark´.
- ✓ 57 Change random italic usage to roman.
- ✓ 59 Romanize random italics: DeviceGray.
- ✓ 60 Change “in relation regard to” and “in relation to” to “relative to”.
- ✓ 62 Change “It the bookmark” to “If the bookmark”.
- ✓ 63 Fix quotation marks in the web link example at top of page, add example of what the reader would see (“The Heirloom Documentation Tools”). Make all quotation marks \(\aq.
- ✓ 63 Change “an 1 point” to “a 1 point”.
- ✓ 63 Fix italics (“red, green, and blue”).
- 63 (1) /BS pdfmark, SetULinkColor, SetULinkBorder, and SetUBorderStyle are not described in the *User's Manual*. (2) In the examples, the meaning of /S/U/W is not defined. (3) Combine fragments.

- ✓ 63 Place reference outside punctuation.
- ✓ 63 Change “different to” to “different from”.
- ✓ 63 Fix italics (“*groff*’s”).
- ✓ 64 Change “recommend” to “recommended”.
- ✓ 64 Change “containes” to “contains”.
- ✓ 64 Remove thin space from between “*groff*” and “’s” so inter-font kerning can work.
- ✓ 64 Change “1’ to “1”.
- ✓ 65 Fix the T_EX logo.
- ✓ 66 “D~”: Change the math symbol “\(\ap” to “[asciitilde]”: “D~”.
- ✓ 67 Change “a output device” to “an output device”; delete extraneous comma.

Tutorial

PAGE

- ✓ 70–73
 - (1) Change no-break control characters from ‘ to ’; (2) Change arithmetic minus signs \- to the ASCII – required for macros.
- ✓ 72 Remove the three links for the word *diversion* in the macro examples and two more from the adjacent paragraph (too many links to one thing).

Font Style Examples

PAGE

- ✓ 74 Add a comma after “font-dependent”.
- 74 (Bug) Note that the “minus sign” shown for the roman, italic, and bold fonts is actually an en dash, which does not match the + sign. The document source is correct, but *troff* outputs an en dash instead of a minus sign for the input character \-.

Table II: Input Naming Conventions

PAGE








- ✓ 75 The character name for the em dash is “em dash”, not “3/4 Em dash”. The 3/4-em dash is named \[threequartersem dash] and has the Unicode value U+F6DE. (“3/4 Em dash” can be found in the 7th Edition document, but not the 10th or Plan 9.)
- ✓ 75 The Input Name for the hyphen is coded in the table as \-, but it should be -. This causes the wrong character to be output. The Input Name for the “current font minus” character is coded in the table as \- instead of \-, causing the wrong character to be shown for the input. The wrong character is also shown for the output because the minus sign \- is mapped to the en dash \[endash] . The en dash \ (en is missing from the table. (Note: the various dash forms are not well differentiated in the default Courier font.)
- ✓ 76 Add missing charlib/ symbols for \ (bx ■, \ (ob ○, and \ (S1 ℓ.

Available characters from *groff_char(7)*

Several of the PostScript names in the *groff_char(7)* list are incorrect. I do not know what the overlap is with *groff*, nor what use *groff* makes of them, but the characters, names, and Unicode values should be as defined in the Adobe Glyph List Specification [\[1\]](#). Some of the names, such as `\[a12]` and `\[a19]`, are specific to the Zapf Dingbats font, ZD, and will not work with standard fonts. `\(ci`, `\(sq`, `\(lh`, and `\(rh` are *charlib/* symbols and do not map to fonts, even if the font has corresponding graphics. Most of the errors are traceable to the *groff_char(7)* manpage. The only changes were to correct the obvious. This list is not intended to be complete.

PAGE

- ✓ 77 (Typo) Character `\[cedilla]` : “cedilly accent” should be “cedilla accent”.
- ✓ 81 Special character `\(hy` is a non-breaking version of `-`. It produces the same output character, PostScript name `\[hyphen]`, which maps to the ASCII “hyphen-minus” at U+002D, not the Unicode character HYPHEN at U+2010. Many fonts do not have a glyph for U+2010, while U+002D can be assumed to exist in all fonts intended for text applications. (U+2010 is named `\[hyphentwo]` in the AGL, but is usually given the alternate name `\[uni2010]`.)
- 81, 83, 84

The input characters for `\(+-` and others that use a “minus” sign are coded in the table to display the minus sign in the math font, `\(mi`, instead of the ASCII “-”. If the reader tries to build the input character `\(+\ \(mi` or searches the PDF, it won’t work.
- ✓ 82 (Typo) `\(rs` : Change “revers” slash to “reverse” slash.
- 82 The graphics for `\(ci`  and `\(sq`  are *charlib/* symbols even if the current font has them.
- 82 `\[a14]` is the Zapf Dingbat symbol for a “writing” hand  (U+270D), not a hand pointing right. There are two pointing-right hands:  `\[a11]` (U+261B) and  `\[a12]` (U+261E). (The graphics for `\(rh`  and `\(lh`  are actually *charlib/* symbols.)
- 82 `\[a19]` is the name for the check mark in the ZD font. It will not work with standard fonts. The AGL name for the check mark is `\[checkmark]`. Both are U+2713.
- ✓ 82 “AT&T Bell Labs logo” should read “AT&T Bell System logo”.
- 82, 83

Notes that read “text variant of *[symbol]*” are confusing and possibly misleading (they are not really variants). The notes might be changed to read something like “*[symbol]* in the current font” or “current font *[symbol]*” to be consistent with the rest of the document. The note for math symbols could read “*[symbol]* in the math [or special] font”:

Output	Input	PostScript Name	Unicode	Notes
×	<code>\(mu</code>	<code>\[multiply]</code>	<code>\U'00D7'</code>	multiply sign in the math font
×	<code>\[tmu]*</code>	<code>\[multiply]</code>	<code>\U'00D7'</code>	multiply sign in the current font
±	<code>\(+-</code>	<code>\[plusminus]</code>	<code>\U'00B1'</code>	plus-minus in the math font
±	<code>\[t+-]*</code>	<code>\[plusminus]</code>	<code>\U'00B1'</code>	plus-minus in the current font

The PostScript names and Unicode values are the same in both cases; the difference is the automatic font change for math symbols. Because the math font can be remapped from the default Special font to any other mounted font, listing the PostScript name and Unicode value is relevant for that case.

Bugs

PAGE

- The non-breaking adjustable space character `\~` does not shrink if global paragraph adjustment `.padj` is not in effect when the input line is read. This causes affected lines to protrude into the right margin. When `.padj` is not in effect, `\~` is mapped to the `STRETCH` token, which must be processed as a special case everywhere it is used. I suspect there is an instance in the the output code where this special case has been overlooked when a minimum space size has been defined with `.minss`. (When global paragraph adjustment is in effect, `\~` is mapped to a normal word space with an infinitive break penalty, which requires no special processing.)
- 1 The em dash always allows a line break after it, but this is incorrect. If an em dash is followed by a punctuation character (including another em dash), the line should not break after the em dash, but after the following punctuation character(s). The flagged line was coded with `"\(\em\j'1000',"` to prevent a break between the em dash and the comma; this works in paragraph adjust mode, but `\j` has no effect in single line mode.
- 4 `troff` erroneously outputs the minus sign `\-` as an en dash “–” instead of a minus sign “-”. The dash forms should be mapped as shown below:

Input	Output ^a	AGL Name	Unicode	Description
-	-	<code>\[hyphen]</code>	U+002D	hyphen-minus (breaking)
<code>\(hy</code>	-	<code>\[hyphen]</code>	U+002D	hyphen-minus (non-breaking)
<code>\(en</code>	—	<code>\[endash]</code>	U+2013	en dash
<code>\(em</code>	—	<code>\[emdash]</code>	U+2014	em dash
<code>\-</code>	-	<code>\[minus]</code>	U+2212	minus sign in the current font
<code>\(mi</code>	-	<code>\[minus]</code>	U+2212	minus sign in the math font
-	-	<code>\[hyphentwo]</code>	U+2010	Unicode hyphen ^b
-	-	<code>\[uni2011]</code>	U+2011	Unicode non-breaking hyphen ^c

TABLE NOTES

- a. With the exception of `\(mi` and U+2011, the graphics in the Output column are from Adobe Caslon Pro, which implements the traditional size relationships and can be distinguished from the math font. The `\(mi` output graphic is from the default (Times) math font, and the U+2011 graphic is from Libertinus Serif.
- b. Adobe Caslon Pro has a glyph for U+2010, but it is not shown because `troff` remaps it to the ASCII hyphen-minus, U+002D.
- c. If the font has a glyph for U+2011, `dpost` remaps it to U+2010, as shown here; otherwise, `dpost` remaps it to the ASCII hyphen-minus U+002D.

By default, `nroff -Tlp` maps the input characters `-`, `\(hy`, `\-`, `\(en`, and `\(mi` to the ASCII hyphen U+002D, and `\(em` to `--` (two ASCII hyphens); this is reasonable given the limited character set, and it is consistent with the historical documentation (see the Addendum).

`nroff -Tlp` also outputs the Unicode input characters U+2010 `HYPHEN` and U+2011 `NON-BREAKING HYPHEN` as themselves. `troff` remaps the input character U+2010 to U+002D and `dpost` remaps U+2011 to U+2010, even when specified with `\U`. Mapping U+2010 to U+002D is usually acceptable for output graphics, especially if the font does not have a glyph for U+2010, but mapping U+2011 to U+2010 at the same time makes no sense at all.

`nroff -Tlocale` inexplicably maps the ASCII hyphen to the Unicode `HYPHEN`, something that should never be done arbitrarily; there is a workaround that reverts this behavior under

certain conditions. In addition, the `nterm/tab.utf8` file inexplicably maps `\(hy` to `U+2010`. The treatment of dash forms seems to have been inspired by the old Abbott and Costello “Who’s on First?” routine.

- 21 “if N=0, the height is restored to the current point size.”: Restoring the character height with `\H'0'` works correctly only if the original point size is an integer value. For non-integer point sizes, the “restored” size becomes the new fixed height—`.ps` and `\s` affect only the width:

Here is 11 point text \H'12' stretched to 12 points high\H'0' and restored. This is the default size, this is 8 point and **this is 16 point.**

Here is 10.5 point text \H'12'stretched to 12 points high\H'0' and “restored.” This is the default size, this is 8 point and **this is 16 point.**

Here is 11 point text again, except it is now only 10.5 points high, thanks to the previous example. \H' 12' stretched to 12 points high \H' 0' and restored. It now has the correct proportions again, 11 x 11, this is 8 point and this is 16 point.

- 50 `\D'~`: The form coded in the document is `\D'\(\ap(\D'~)`, which does resemble the correct output. However, `\D'~` causes `dpost` to give up with a not-overly-helpful error message:

unknown drawing function i (line 23140) (page 8)

The function is not *i*, the line number applies to the `ditroff` file (which is probably pipelined), and the page number is off by one. According to the *User's Manual*, “A `\D` with an unknown *c* is processed and copied through to the output for unspecified interpretation”, and on page 66, in a description of the output language, “`\D z a b c d . . .` for any other *z* is uninterpreted”, so it would not seem too unreasonable for `dpost` to handle this condition a bit less incoherently.

- 53 “all of the forms for `if` above are valid.” The string forms do not work with the `while` request.

- 56 The `.lpfx` paragraph demonstrates two bugs:

1. There is an extra left quote (“) to the far left of the first line in paragraph adjust mode, but not in single line mode. (. 1pfx re-creates an obsolete quotation style, so it is probably used infrequently.)
2. The hyphenation “start-ed,” (note the comma) is incorrect because bringing down the last two letters has been prohibited by .hy 4. The algorithm is including trailing punctuation in its count of the “last two.” The description for .hy reads “For N=4 and 8, the last and first two characters respectively of a word are not split off.” Although trailing punctuation is included in the “word” for line breaking purposes, counting characters that are not part of the actual word is incorrect for hyphenation purposes. Other examples are “print-ed,” on page 37, “dynamical-ly,” on page 43 and “ze-ro.” on page 51.

- 63 “The actual link is built using two `\T` escape sequences”: An unmatched `\T` causes `troff` to lock up.

- 68 “*troff* usually reads font metrics directly from Type 1, OpenType, or TrueType font files”:
Monospaced OpenType fonts are assigned incorrect horizontal metrics:

For example: This is standard TeX Gyre Cursor 012B produces incorrect results. spaced font.

It should act like this: This is a modified TeX Gyre Cursor 012345-+@#;
it does not identify itself as monospaced and works as expected.

Changes in the February 22, 2019 version

`troffdoc.pdf` [↗](#) was formatted directly from the source file; `troffdoc-20190222-an.pdf` [↗](#) has been annotated to highlight the changes from the January 27 version.

PAGE

- ✓ 13–17 Remove redundant PDF links.
- ✓ 13 Change `\(space)` to `\space` for the unpaddable space character. The parentheses can be a bit misleading because `\(` introduces a special character. (The same change was also made in the 10th Edition manual.)
- ✓ 14, 37, 47 “10.7 `\(newline)`”: Change to “10.8 `\newline`” for the same reason as `\(space)`. Pages 37 and 47 do not use the section number.
- ✓ 14 “In `\x'...` and other functions”: Insert this sentence. Moved from top of page 36 (section 5.2) to page 14 so it will be in a place where the reader is more likely to look for it.
- ✓ 22 `.bd`: Change example to use `.bd R 300` to reflect use of the high-resolution driver.
- ✓ 24 `$T2.`: Move period to follow the ending `\T` tag so a sentence space results.
- ✓ 35 Add range of “Awful tight” bins *f* through *a* to the table.
- ✓ 36 Move the sentence at the top of page (previously part of section 5.2) to page 14.
- ✓ 49 `\Z'string'`: Change function delimiters from curly quotes to acute accents.
- ✓ 54 “by `\J.`”: Insert a tie `\~` to keep together.
- ✓ 62 (Code sample): Change function delimiters from acute accents to single quotes.
- ✓ 63 `SetBorderStyle` and `SetUBorderStyle`: Change thickness of the underline from 0.1 to 0.5. Thicknesses less than 0.5 are not displayed by some widely used PDF viewers, notably Adobe Acrobat and the Adobe Reader.
- ✓ 74 Change “¼ em” to “¼-em”.

Addendum

Dashes, Minus Signs, and Hyphens

The **troff** formatter has distinct graphics for a dash, a minus sign, and a hyphen; the **nroff** formatter does not.

- Users who intend to use the **nroff** formatter may use only the minus sign (–) for the minus, hyphen, and dash. *
- Users who plan to use the **troff** formatter primarily should follow **troff** escape conventions.
- Users who plan to use both formatters must take care during input text file preparation. Unfortunately, these graphic characters cannot be represented in a way that is both compatible and convenient for both formatters.

The following approach is suggested:













































Dash	Type “*(EM” for each text dash for both nroff and troff formatters. This string generates an em dash in the troff formatter and two dashes (--) in the nroff formatter. Dash list (.DL) macros {5.1.1.3} automatically generate the em dash for each list item.	
Hyphen	Type “-” and use as is for both formatters. The nroff formatter will print it as is. The troff formatter will print - (a true hyphen).	†
Minus	Type “\” for a true minus sign regardless of formatter. The nroff formatter will ignore the \. The troff formatter will print a true minus sign.	†

From the *Documenters Workbench Macro Package Reference*, Western Electric, 1983, p. 2-20; the *Unix Programmer's Manual, Volume 4: Document Preparation*, CBS College Publishing, 1986, p. 245; and with slightly different wording, the *UNIX System V Documentor's Workbench User's Guide*, Prentice Hall, 1989, p. 4-7. The excerpt is from the section describing the `-mm` macros, but the behaviors are those of **nroff** and **troff**.

* This probably means that **nroff** outputs only the “minus” sign (an ASCII hyphen-minus) for all three input characters.



















































† “True” hyphen and “true” minus probably mean the “distinct graphics.”








Characters in the Zapf Dingbats (ZD) Font

Output	Input	Unicode	Description
	\[a1]	\U'2701'	UPPER BLADE SCISSORS
	\[a2]	\U'2702'	BLACK SCISSORS
	\[a202]	\U'2703'	LOWER BLADE SCISSORS
	\[a3]	\U'2704'	WHITE SCISSORS
	\[a4]	\U'260E'	BLACK TELEPHONE
	\[a5]	\U'2706'	TELEPHONE LOCATION SIGN
	\[a119]	\U'2707'	TAPE DRIVE
	\[a118]	\U'2708'	AIRPLANE
	\[a117]	\U'2709'	ENVELOPE
	\[a11]	\U'261B'	BLACK RIGHT POINTING INDEX
	\[a12]	\U'261E'	WHITE RIGHT POINTING INDEX
	\[a13]	\U'270C'	VICTORY HAND
	\[a14]	\U'270D'	WRITING HAND
	\[a15]	\U'270E'	LOWER RIGHT PENCIL
	\[a16]	\U'270F'	PENCIL
	\[a105]	\U'2710'	UPPER RIGHT PENCIL
	\[a17]	\U'2711'	WHITE NIB
	\[a18]	\U'2712'	BLACK NIB
	\[a19]	\U'2713'	CHECK MARK
	\[a20]	\U'2714'	HEAVY CHECK MARK
	\[a21]	\U'2715'	MULTIPLICATION X
	\[a22]	\U'2716'	HEAVY MULTIPLICATION X
	\[a23]	\U'2717'	BALLOT X
	\[a24]	\U'2718'	HEAVY BALLOT X
	\[a25]	\U'2719'	OUTLINED GREEK CROSS
	\[a26]	\U'271A'	HEAVY GREEK CROSS
	\[a27]	\U'271B'	OPEN CENTRE CROSS
	\[a28]	\U'271C'	HEAVY OPEN CENTRE CROSS
	\[a6]	\U'271D'	LATIN CROSS
	\[a7]	\U'271E'	SHADOWED WHITE LATIN CROSS
	\[a8]	\U'271F'	OUTLINED LATIN CROSS
	\[a9]	\U'2720'	MALTESE CROSS
	\[a10]	\U'2721'	STAR OF DAVID
	\[a29]	\U'2722'	FOUR TEARDROP-SPOKED ASTERISK
	\[a30]	\U'2723'	FOUR BALLOON-SPOKED ASTERISK
	\[a31]	\U'2724'	HEAVY FOUR BALLOON-SPOKED ASTERISK
	\[a32]	\U'2725'	FOUR CLUB-SPOKED ASTERISK
	\[a33]	\U'2726'	BLACK FOUR POINTED STAR
	\[a34]	\U'2727'	WHITE FOUR POINTED STAR
	\[a35]	\U'2605'	BLACK STAR
	\[a36]	\U'2729'	STRESS OUTLINED WHITE STAR
	\[a37]	\U'272A'	CIRCLED WHITE STAR
	\[a38]	\U'272B'	OPEN CENTRE BLACK STAR
	\[a39]	\U'272C'	BLACK CENTRE WHITE STAR

★	\[a40]	\U'272D'	OUTLINED BLACK STAR
☆	\[a41]	\U'272E'	HEAVY OUTLINED BLACK STAR
☆	\[a42]	\U'272F'	PINWHEEL STAR
☆	\[a43]	\U'2730'	SHADOWED WHITE STAR
✱	\[a44]	\U'2731'	HEAVY ASTERISK
✱	\[a45]	\U'2732'	OPEN CENTRE ASTERISK
✱	\[a46]	\U'2733'	EIGHT SPOKED ASTERISK
✱	\[a47]	\U'2734'	EIGHT POINTED BLACK STAR
✱	\[a48]	\U'2735'	EIGHT POINTED PINWHEEL STAR
✱	\[a49]	\U'2736'	SIX POINTED BLACK STAR
✱	\[a50]	\U'2737'	EIGHT POINTED RECTILINEAR BLACK STAR
✱	\[a51]	\U'2738'	HEAVY EIGHT POINTED RECTILINEAR BLACK STAR
✱	\[a52]	\U'2739'	TWELVE POINTED BLACK STAR
✱	\[a53]	\U'273A'	SIXTEEN POINTED ASTERISK
✱	\[a54]	\U'273B'	TEARDROP-SPOKED ASTERISK
✱	\[a55]	\U'273C'	OPEN CENTRE TEARDROP-SPOKED ASTERISK
✱	\[a56]	\U'273D'	HEAVY TEARDROP-SPOKED ASTERISK
✱	\[a57]	\U'273E'	SIX PETALLED BLACK AND WHITE FLORETTE
✱	\[a58]	\U'273F'	BLACK FLORETTE
✱	\[a59]	\U'2740'	WHITE FLORETTE
✱	\[a60]	\U'2741'	EIGHT PETALLED OUTLINED BLACK FLORETTE
✱	\[a61]	\U'2742'	CIRCLED OPEN CENTRE EIGHT POINTED STAR
✱	\[a62]	\U'2743'	HEAVY TEARDROP-SPOKED PINWHEEL ASTERISK
✱	\[a63]	\U'2744'	SNOWFLAKE
✱	\[a64]	\U'2745'	TIGHT TRIFOLIATE SNOWFLAKE
✱	\[a65]	\U'2746'	HEAVY CHEVRON SNOWFLAKE
✱	\[a66]	\U'2747'	SPARKLE
✱	\[a67]	\U'2748'	HEAVY SPARKLE
✱	\[a68]	\U'2749'	BALLOON-SPOKED ASTERISK
✱	\[a69]	\U'274A'	EIGHT TEARDROP-SPOKED PROPELLER ASTERISK
✱	\[a70]	\U'274B'	HEAVY EIGHT TEARDROP-SPOKED PROPELLER ASTERISK
●	\[a71]	\U'25CF'	BLACK CIRCLE
○	\[a72]	\U'274D'	SHADOWED WHITE CIRCLE
■	\[a73]	\U'25A0'	BLACK SQUARE
▣	\[a74]	\U'274F'	LOWER RIGHT DROP-SHADOWED WHITE SQUARE
▤	\[a203]	\U'2750'	UPPER RIGHT DROP-SHADOWED WHITE SQUARE
▥	\[a75]	\U'2751'	LOWER RIGHT SHADOWED WHITE SQUARE
▦	\[a204]	\U'2752'	UPPER RIGHT SHADOWED WHITE SQUARE
▲	\[a76]	\U'25B2'	BLACK UP-POINTING TRIANGLE
▼	\[a77]	\U'25BC'	BLACK DOWN-POINTING TRIANGLE
◆	\[a78]	\U'25C6'	BLACK DIAMOND
◇	\[a79]	\U'2756'	BLACK DIAMOND MINUS WHITE X
◐	\[a81]	\U'25D7'	RIGHT HALF BLACK CIRCLE
|	\\[a82]	\U'2758'	LIGHT VERTICAL BAR
|	\\[a83]	\U'2759'	MEDIUM VERTICAL BAR
|	\\[a84]	\U'275A'	HEAVY VERTICAL BAR
‘	\[a97]	\U'275B'	HEAVY SINGLE TURNED COMMA QUOTATION MARK ORNAMENT
’	\[a98]	\U'275C'	HEAVY SINGLE COMMA QUOTATION MARK ORNAMENT
“	\[a99]	\U'275D'	HEAVY DOUBLE TURNED COMMA QUOTATION MARK ORNAMENT
”	\[a100]	\U'275E'	HEAVY DOUBLE COMMA QUOTATION MARK ORNAMENT

(	\\[a89]	\U'2768'	MEDIUM LEFT PARENTHESIS ORNAMENT
)	\[a90]	\U'2769'	MEDIUM RIGHT PARENTHESIS ORNAMENT
(	\\[a93]	\U'276A'	MEDIUM FLATTENED LEFT PARENTHESIS ORNAMENT
)	\[a94]	\U'276B'	MEDIUM FLATTENED RIGHT PARENTHESIS ORNAMENT
(	\\[a91]	\U'276C'	MEDIUM LEFT-POINTING ANGLE BRACKET ORNAMENT
)	\[a92]	\U'276D'	MEDIUM RIGHT-POINTING ANGLE BRACKET ORNAMENT
<	\[a205]	\U'276E'	HEAVY LEFT-POINTING ANGLE QUOTATION MARK ORNAMENT
>	\[a85]	\U'276F'	HEAVY LEFT-POINTING ANGLE QUOTATION MARK ORNAMENT
⌈	\[a206]	\U'2770'	HEAVY LEFT-POINTING ANGLE BRACK ORNAMENT
⌋	\[a86]	\U'2771'	HEAVY LEFT-POINTING ANGLE BRACK ORNAMENT
\[	\\[a87]	\U'2772'	LIGHT LEFT TORTOISE SHELL BRACKET ORNAMENT
]	\[a88]	\U'2773'	LIGHT RIGHT TORTOISE SHELL BRACKET ORNAMENT
{	\[a95]	\U'2774'	MEDIUM LEFT CURLY BRACKET ORNAMENT
}	\[a96]	\U'2775'	MEDIUM LEFT CURLY BRACKET ORNAMENT
¶	\[a101]	\U'2761'	CURVED STEM PARAGRAPH SIGN ORNAMENT
!	\[a102]	\U'2762'	HEAVY EXCLAMATION MARK ORNAMENT
♥	\[a103]	\U'2763'	HEAVY HEART EXCLAMATION MARK ORNAMENT
♥	\[a104]	\U'2764'	HEAVY BLACK HEART
♣	\[a106]	\U'2765'	ROTATED HEAVY BLACK HEART BULLET
♣	\[a107]	\U'2766'	FLORAL HEART
♣	\[a108]	\U'2767'	ROTATED FLORAL HEART BULLET
♣	\[a112]	\U'2663'	BLACK CLUB SUIT
♦	\[a111]	\U'2666'	BLACK DIAMOND SUIT
♥	\[a110]	\U'2665'	BLACK HEART SUIT
♠	\[a109]	\U'2660'	BLACK SPADE SUIT
①	\[a120]	\U'2460'	CIRCLED DIGIT ONE
②	\[a121]	\U'2461'	CIRCLED DIGIT TWO
③	\[a122]	\U'2462'	CIRCLED DIGIT THREE
④	\[a123]	\U'2463'	CIRCLED DIGIT FOUR
⑤	\[a124]	\U'2464'	CIRCLED DIGIT FIVE
⑥	\[a125]	\U'2465'	CIRCLED DIGIT SIX
⑦	\[a126]	\U'2466'	CIRCLED DIGIT SEVEN
⑧	\[a127]	\U'2467'	CIRCLED DIGIT EIGHT
⑨	\[a128]	\U'2468'	CIRCLED DIGIT NINE
⑩	\[a129]	\U'2469'	CIRCLED NUMBER TEN
❶	\[a130]	\U'2776'	DINGBAT NEGATIVE CIRCLED DIGIT ONE
❷	\[a131]	\U'2777'	DINGBAT NEGATIVE CIRCLED DIGIT TWO
❸	\[a132]	\U'2778'	DINGBAT NEGATIVE CIRCLED DIGIT THREE
❹	\[a133]	\U'2779'	DINGBAT NEGATIVE CIRCLED DIGIT FOUR
❺	\[a134]	\U'277A'	DINGBAT NEGATIVE CIRCLED DIGIT FIVE
❻	\[a135]	\U'277B'	DINGBAT NEGATIVE CIRCLED DIGIT SIX
❼	\[a136]	\U'277C'	DINGBAT NEGATIVE CIRCLED DIGIT SEVEN
❽	\[a137]	\U'277D'	DINGBAT NEGATIVE CIRCLED DIGIT EIGHT
❾	\[a138]	\U'277E'	DINGBAT NEGATIVE CIRCLED DIGIT NINE
❿	\[a139]	\U'277F'	DINGBAT NEGATIVE CIRCLED NUMBER TEN
①	\[a140]	\U'2780'	DINGBAT CIRCLED SANS-SERIF DIGIT ONE
②	\[a141]	\U'2781'	DINGBAT CIRCLED SANS-SERIF DIGIT TWO
③	\[a142]	\U'2782'	DINGBAT CIRCLED SANS-SERIF DIGIT THREE
④	\[a143]	\U'2783'	DINGBAT CIRCLED SANS-SERIF DIGIT FOUR
⑤	\[a144]	\U'2784'	DINGBAT CIRCLED SANS-SERIF DIGIT FIVE

	<code>\[a145]</code>	<code>\U'2785'</code>	DINGBAT CIRCLED SANS-SERIF DIGIT SIX
	<code>\[a146]</code>	<code>\U'2786'</code>	DINGBAT CIRCLED SANS-SERIF DIGIT SEVEN
	<code>\[a147]</code>	<code>\U'2787'</code>	DINGBAT CIRCLED SANS-SERIF DIGIT EIGHT
	<code>\[a148]</code>	<code>\U'2788'</code>	DINGBAT CIRCLED SANS-SERIF DIGIT NINE
	<code>\[a149]</code>	<code>\U'2789'</code>	DINGBAT CIRCLED SANS-SERIF NUMBER TEN
	<code>\[a150]</code>	<code>\U'278A'</code>	DINGBAT NEGATIVE CIRCLED SANS-SERIF DIGIT ONE
	<code>\[a151]</code>	<code>\U'278B'</code>	DINGBAT NEGATIVE CIRCLED SANS-SERIF DIGIT TWO
	<code>\[a152]</code>	<code>\U'278C'</code>	DINGBAT NEGATIVE CIRCLED SANS-SERIF DIGIT THREE
	<code>\[a153]</code>	<code>\U'278D'</code>	DINGBAT NEGATIVE CIRCLED SANS-SERIF DIGIT FOUR
	<code>\[a154]</code>	<code>\U'278E'</code>	DINGBAT NEGATIVE CIRCLED SANS-SERIF DIGIT FIVE
	<code>\[a155]</code>	<code>\U'278F'</code>	DINGBAT NEGATIVE CIRCLED SANS-SERIF DIGIT SIX
	<code>\[a156]</code>	<code>\U'2790'</code>	DINGBAT NEGATIVE CIRCLED SANS-SERIF DIGIT SEVEN
	<code>\[a157]</code>	<code>\U'2791'</code>	DINGBAT NEGATIVE CIRCLED SANS-SERIF DIGIT EIGHT
	<code>\[a158]</code>	<code>\U'2792'</code>	DINGBAT NEGATIVE CIRCLED SANS-SERIF DIGIT NINE
	<code>\[a159]</code>	<code>\U'2793'</code>	DINGBAT NEGATIVE CIRCLED SANS-SERIF NUMBER TEN
	<code>\[a160]</code>	<code>\U'2794'</code>	HEAVY WIDE-HEADED RIGHTWARDS ARROW
	<code>\[a161]</code>	<code>\U'2192'</code>	RIGHTWARDS ARROW
	<code>\[a163]</code>	<code>\U'2194'</code>	LEFT RIGHT ARROW
	<code>\[a164]</code>	<code>\U'2195'</code>	UP DOWN ARROW
	<code>\[a196]</code>	<code>\U'2798'</code>	HEAVY SOUTH EAST ARROW
	<code>\[a165]</code>	<code>\U'2799'</code>	HEAVY RIGHTWARDS ARROW
	<code>\[a192]</code>	<code>\U'279A'</code>	HEAVY NORTH EAST ARROW
	<code>\[a166]</code>	<code>\U'279B'</code>	DRAFTING POINT RIGHTWARDS ARROW
	<code>\[a167]</code>	<code>\U'279C'</code>	HEAVY ROUND-TIPPED RIGHTWARDS ARROW
	<code>\[a168]</code>	<code>\U'279D'</code>	TRIANGLE-HEADED RIGHTWARDS ARROW
	<code>\[a169]</code>	<code>\U'279E'</code>	HEAVY TRIANGLE-HEADED RIGHTWARDS ARROW
	<code>\[a170]</code>	<code>\U'279F'</code>	DASHED TRIANGLE-HEADED RIGHTWARDS ARROW
	<code>\[a171]</code>	<code>\U'27A0'</code>	HEAVY DASHED TRIANGLE-HEADED RIGHTWARDS ARROW
	<code>\[a172]</code>	<code>\U'27A1'</code>	BLACK RIGHTWARDS ARROW
	<code>\[a173]</code>	<code>\U'27A2'</code>	THREE-D TOP-LIGHTED RIGHTWARDS ARROWHEAD
	<code>\[a162]</code>	<code>\U'27A3'</code>	THREE-D BOTTOM-LIGHTED RIGHTWARDS ARROWHEAD
	<code>\[a174]</code>	<code>\U'27A4'</code>	BLACK RIGHTWARDS ARROWHEAD
	<code>\[a175]</code>	<code>\U'27A5'</code>	HEAVY BLACK CURVED DOWNWARDS AND RIGHTWARDS ARROW
	<code>\[a176]</code>	<code>\U'27A6'</code>	HEAVY BLACK CURVED UPWARDS AND RIGHTWARDS ARROW
	<code>\[a177]</code>	<code>\U'27A7'</code>	SQUAT BLACK RIGHTWARDS ARROW
	<code>\[a178]</code>	<code>\U'27A8'</code>	HEAVY CONCAVE-POINTED BLACK RIGHTWARDS ARROW
	<code>\[a179]</code>	<code>\U'27A9'</code>	RIGHT-SHADED WHITE RIGHTWARDS ARROW
	<code>\[a193]</code>	<code>\U'27AA'</code>	LEFT-SHADED WHITE RIGHTWARDS ARROW
	<code>\[a180]</code>	<code>\U'27AB'</code>	BACK-TILTED SHADOWED WHITE RIGHTWARDS ARROW
	<code>\[a199]</code>	<code>\U'27AC'</code>	FRONT-TILTED SHADOWED WHITE RIGHTWARDS ARROW
	<code>\[a181]</code>	<code>\U'27AD'</code>	HEAVY LOWER RIGHT-SHADOWED WHITE RIGHTWARDS ARROW
	<code>\[a200]</code>	<code>\U'27AE'</code>	HEAVY UPPER RIGHT-SHADOWED WHITE RIGHTWARDS ARROW
	<code>\[a182]</code>	<code>\U'27AF'</code>	NOTCHED LOWER RIGHT-SHADOWED WHITE RIGHTWARDS ARROW
	<code>\[a201]</code>	<code>\U'27B1'</code>	NOTCHED UPPER RIGHT-SHADOWED WHITE RIGHTWARDS ARROW
	<code>\[a183]</code>	<code>\U'27B2'</code>	CIRCLED HEAVY WHITE RIGHTWARDS ARROW
	<code>\[a184]</code>	<code>\U'27B3'</code>	WHITE-FEATHERED RIGHTWARDS ARROW
	<code>\[a197]</code>	<code>\U'27B4'</code>	BLACK-FEATHERED SOUTH EAST ARROW
	<code>\[a185]</code>	<code>\U'27B5'</code>	BLACK-FEATHERED RIGHTWARDS ARROW
	<code>\[a194]</code>	<code>\U'27B6'</code>	BLACK-FEATHERED NORTH EAST ARROW
	<code>\[a198]</code>	<code>\U'27B7'</code>	HEAVY BLACK-FEATHERED SOUTH EAST ARROW

	<code>\[a186]</code>	<code>\U'27B8'</code>	HEAVY BLACK-FEATHERED RIGHTWARDS ARROW
	<code>\[a195]</code>	<code>\U'27B9'</code>	HEAVY BLACK-FEATHERED NORTH EAST ARROW
	<code>\[a187]</code>	<code>\U'27BA'</code>	TEARDROP-BARBED RIGHTWARDS ARROW
	<code>\[a188]</code>	<code>\U'27BB'</code>	HEAVY TEARDROP-SHANKED RIGHTWARDS ARROW
	<code>\[a189]</code>	<code>\U'27BC'</code>	WEDGE-TAILED RIGHTWARDS ARROW
	<code>\[a190]</code>	<code>\U'27BD'</code>	HEAVY WEDGE-TAILED RIGHTWARDS ARROW
	<code>\[a191]</code>	<code>\U'27BE'</code>	OPEN-OUTLINED RIGHTWARDS ARROW