UNIX® System V
DOCUMENTOR’S WORKBENCH™
User’s Guide
UNIX® System V
DOCUMENTOR’S WORKBENCH™
User's Guide
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Product Overview
User's Guide
Handbook for New Users
UNIX™ System V
DOCUMENTER'S WORKBENCH™
Software Release 2.0

Product Overview
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Introduction

The DOCUMENTER'S WORKBENCH Software is a set of computer programs developed at AT&T Bell Laboratories to run under the UNIX operating system. These programs help you format any type of document. The DOCUMENTER'S WORKBENCH Software supports a range of output devices from typewriter-like printers to phototypesetting equipment.
Description

The DOCUMENTER'S WORKBENCH Software is a powerful and sophisticated set of text formatting tools that helps you produce a wide variety of documents, including letters, research papers, memoranda, reports, and books. You can use the DOCUMENTER'S WORKBENCH Software to create documents that contain tables, mathematical equations, line drawings, and plots of data.

With the DOCUMENTER'S WORKBENCH Software you can dramatically diminish the time you need to plan and prepare the following features of your document.

- margins
- titles
- lists and displays
- footnotes
- page headers and footers
- page numbering
- table of contents
- glossary
- index

Anyone can run the DOCUMENTER'S WORKBENCH programs—a clerk, a secretary, the writer or editor—you need only a basic familiarity with the UNIX operating system. Using any UNIX system text editor, you type in your text and intersperse formatting instructions (such as .P for paragraph), that state precisely how you want your document to look when it is printed. Then you choose the appropriate preprocessors and formatter to process your file for printing.
Programs

The DOCUMENTER’S WORKBENCH programs can be grouped into the following general categories:

Formatters  
nroff and troff are text-formatting programming languages for typewriter-like printers and phototypesetters, respectively. These "super word processors" are at the heart of the DOCUMENTER’S WORKBENCH Software. The macro packages and preprocessors (see below) create instructions that the formatters use to produce a formatted document.

Macro  
There are four macro packages available with the DOCUMENTER’S WORKBENCH Software: mm, mv, man, and mptx. The mm, or Memorandum Macros, package allows you to produce memoranda and letters easily. The mv package allows you to make high quality typeset transparencies in a variety of sizes. The man macro package allows you to format UNIX system manual pages, and mptx allows you to format a permuted index.

Preprocessors  
Four preprocessors are included with the DOCUMENTER’S WORKBENCH Software: tbl, eqn, pic, and grap. tbl helps you make tables: large or small, simple or complex. eqn enables you to present mathematical notation easily. pic enables you to draw a wide variety of forms and line pictures, and grap, a "language" for describing plots of data, automatically scales and labels axes. Preprocessors are used in conjunction with the text formatters nroff or troff to produce your final formatted file.

Programs to Create an Index  
subj scans your document to collect a list of keywords. ndx creates an index from the keyword list subj makes.

Programs for Comparing and Checking Documents  
checkmm checks input files and tells you if you have made any syntax errors in the DOCUMENTER’S WORKBENCH formatting instructions. diffmk
Programs

compares two versions of a document and produces a third version that highlights the differences between the two original files. **macref** produces a cross-reference of the requests, macros, number registers, and strings that you use in a file. It is helpful for those who want to develop new sets of macros.

Postprocessors

**daps** translates **troff** output for an Autologic APS-5 phototypesetter. **di10** translates output from **troff** for an Imagen IMPRINT-10 laser printer. **tc** turns **troff** output into code that a TEKTRONIX 4015 typesetter can use.
Obsolete Programs

Several programs that were included with Release 1.0 of the DOCUMENTER'S WORKBENCH Software are not in Release 2.0.

checkcw is used with ocw, the preprocessor for otroff. It checks whether left and right delimiters and .CW/.CN pairs are properly balanced. Because otroff is not distributed with DOCUMENTER'S WORKBENCH Software 2.0, there is no longer a need for checkcw.

checkeq is used with eqn. checkeq is not included in DOCUMENTER'S WORKBENCH Release 2.0 because the command checkmm provides more extensive checking of proper equation formatting.

dx9700 prepares troff documents for the Xerox 9700 printer. The Xerox 9700 is no longer a supported device, and so the command is not distributed with DOCUMENTER'S WORKBENCH Release 2.0.

mmlint is a sroff/mm—nroff/mm document compatibility checker. Because sroff/mm is not distributed with DOCUMENTER'S WORKBENCH Release 2.0, there is no longer a need for mmlint.

non-btl.sh reinstalls mm macros without AT&T Bell Laboratories specific features. This command is not included with DOCUMENTER'S WORKBENCH Release 2.0 because AT&T Bell Laboratories specific strings have been moved to an external file called /usr/pub/strings.mm. The system administrator can edit this external file to meet local needs.

ocw is a preprocessor for otroff. Because otroff is not distributed with DOCUMENTER'S WORKBENCH Release 2.0, there is no longer a need for ocw.

osdd The osdd adapter macro package is a tool used with the mm macro package to prepare Operations Systems Deliverable Documentation. The command is not distributed with DOCUMENTER'S WORKBENCH Release 2.0.
obsolete programs

**otc** is a postprocessor for **otroff**. Because **otroff** is not distributed with DOCUMENTER'S WORKBENCH Release 2.0, there is no longer a need for **otc**.

**otroff**

The **otroff** text formatter is an early version of **troff** that formats text for only one device, the C/A/T phototypesetter. **otroff** is not distributed with DOCUMENTER'S WORKBENCH Release 2.0.

**sroff**

**sroff** formats text for printing on typewriter-like devices and line printers, including the Xerox 9700 printer. The Xerox 9700 is no longer a supported device; therefore, **sroff** is not distributed with DOCUMENTER'S WORKBENCH Release 2.0.

**x9700** prepares **nroff** documents for the Xerox 9700 printer. The Xerox 9700 is no longer a supported device; therefore, the command **x9700** is not distributed with DOCUMENTER'S WORKBENCH Release 2.0.
Documentation

The following documents are available for Release 2.0 of the DOCUMENTER'S WORKBENCH Software system:

- **UNIX System V DOCUMENTER'S WORKBENCH Software User's Guide** (Select Code 310-004): The User's Guide contains three sections: 1) the "Sampler," which shows files before and after formatting, 2) a preface, and 3) tutorials. The first two sections familiarize the novice with the software in general, and the tutorials cover its use in detail.

- **UNIX System V DOCUMENTER'S WORKBENCH Software Technical Discussion and Reference Manual** (Select Code 310-005): Organized to suit the more experienced user, this technical explanation of the software is presented according to patterns of customary use. The components of the software are discussed in detail, and manual pages are also provided.

- **UNIX System V DOCUMENTER'S WORKBENCH Software Handbook** (Select Code 310-008): The Handbook is a memory jogger for accomplished users who want a more technical understanding of the software.

- **UNIX System V DOCUMENTER'S WORKBENCH Software Handbook for New Users** (Select Code 310-009): This handbook is aimed at new users. It is task-oriented, and it incorporates aspects of the "Sampler" from the User's Guide.

- **UNIX System V DOCUMENTER'S WORKBENCH Software Product Overview** (Select Code 310-006): This document provides a summary of the software and its features, a list of available documents, and a brief technical description for those who might be asked to evaluate the software.

- **UNIX System V DOCUMENTER'S WORKBENCH Software Release Notes** (Select Code 310-007): The Release Notes, written for system administrators, includes the software installation procedures for all processors that support the DOCUMENTER'S WORKBENCH Software. In addition, it gives transition information for owners of earlier product releases.
You may get copies of the documents in this list from AT&T. When placing orders, refer to the Select Code for the document that you want (for example 310-004 for the User's Guide).

write to: AT&T Customer Information Center
          P.O.Box 19901
          Indianapolis, Indiana 46219

or call: 1-800-432-6600 within the continental United States

To order the DOCUMENTER'S WORKBENCH Software Release 2.0 call

  1-800-828-UNIX  for the source product
  1-800-247-1212  for the binary product
Overview of Technical Information

Supported Hardware

The following list identifies the hardware on which DOCUMENTER'S WORKBENCH Release 2.0 is supported for UNIX System V Release 2.0 as of April 1985:

- AT&T 3B2/300,400 Computers
- AT&T 3B5 Computer
- AT&T 3B20S/A Computers
- VAX 750

The UNIX operating system and components of the DOCUMENTER'S WORKBENCH Software have been run on various other computers, including DEC PDP-11/45, PDP-11/70, and VAX-11/780 mini-computers.

Specifications for the 3B20 Computer and the VAX

For the AT&T 3B20 Computer and the DEC VAX-11/780 and VAX-11/750 computers, the source code for the DOCUMENTER'S WORKBENCH Software Release 2.0 is distributed on a single magnetic tape containing two files in cpio format, written at 1600 bpi. Only a system administrator with root privileges may access this tape. Installing the object code of DOCUMENTER'S WORKBENCH Software Release 2.0 also requires root userid privileges. The Release Notes (310-007) presents complete installation instructions.

Specifications for the 3B5 Computer

For the 3B5 Computer, source code is distributed on either a Lark II disk cartridge or a nine-track magnetic tape, and contains two files in cpio format. (The binary version of the DOCUMENTER'S WORKBENCH is only available on nine-track magnetic tape.) Again, it is written at 1600 bpi, and root userid privileges are required. The Release Notes (310-007) presents complete installation instructions.
Specifications for the 3B2 Computer

Installing the DOCUMENTER'S WORKBENCH Software on the 3B2 Computer requires four floppy disks. Each floppy disk contains "install" and "uninstall" scripts for the installation and removal of the files contained on it. The required disk space for this product is 5500 blocks in the /usr file system.

The first floppy disk contains all files that you need to use troff, grap, mmt, mvt, pic, eqn and tc plus a driver (for the Autologic APS-5 typesetter) and the font tables for this driver. The files on this first disk require 1100 blocks (512 bytes/block) of free space in the /usr file system.

The second floppy disk contains all the files you need to use nroff, neqn, mm, and man. The files on this disk require 750 blocks of free space in the /usr file system.

The third floppy disk contains files used by both nroff and troff. This disk requires 1300 blocks of free space in the /usr file system.

The fourth floppy disk contains the driver, font tables and raster tables for the Imagen IMPRINT-10 laser printer. The files on this disk require 2350 blocks of free space in the /usr file system.

You can find a detailed list of the files on each floppy together with complete instructions for installation in the Release Notes.

Terminal Dependencies

You can display text processed by nroff, tbl, neqn and mm on a typewriter-like printer or on a terminal without graphics capabilities. Text processed by troff, the mv macro package, eqn, pic, and grap must be sent to a terminal or a printer that supports typesetting (for example, a Teletype 5620 terminal).

Software Dependencies

AT&T supports the DOCUMENTER'S WORKBENCH Software Release 2.0 only on UNIX System V Release 2.0 and subsequent releases. AT&T does not support DOCUMENTER'S WORKBENCH Software Release 2.0 on any other
version of the UNIX system. All the software that the DOCUMENTER’S WORKBENCH Software needs for installation and execution is part of UNIX System V Release 2.0 and subsequent releases.

On AT&T 3B2 Computers, the following utilities packages must be installed before the DOCUMENTER’S WORKBENCH Software can be installed:

- Directory and File Management Utilities Package
- Terminal Filter Utilities Package (must be purchased separately)

The installation script checks that these packages are installed on your 3B2 Computer and will prevent you from installing the DOCUMENTER’S WORKBENCH Software if they are not installed.
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**tbl**: Technical Discussion

**nroff/troff**: Technical Discussion

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| ptx(1)      |
| subj(1)     |
| tbl(1)      |
| tc(1)       |
| troff(1)    |
| troff(5)    |
Introduction

The DOCUMENTER'S WORKBENCH Software provides a family of programs for typesetting materials containing equations, tables, and diagrams, as well as standard text. The base upon which these interrelated programs rest is a text formatter called troff, a generic term for nroff/troff, developed by Joseph P. Ossanna around 1973. By itself, troff, with its many requests and escape sequences, provides a highly detailed level of text processing, performing few high-level formatting operations beyond line filling and justification. It accepts input from other, more specialized programs. In particular, page layout is controlled by the mm macro package, so-called because troff is a macro processor.

Several DOCUMENTER'S WORKBENCH Software programs deal with specific areas of document preparation. eqn, for example, is a language for typesetting mathematical expressions. It acts as a preprocessor for troff. That is, the high-level instructions you give eqn are compiled into the lower-level troff code that will actually plot the desired mathematical notation. The other DOCUMENTER'S WORKBENCH Software preprocessors are eqn, tbl, pic, and grap.

grap, actually, is a "pre-preprocessor." This language, which you use to make graphs of numerical data, accepts English-oriented input and directs its output to pic, which in turn feeds troff.

Finally, troff's output, however produced, can be directed to any of a large number of devices, ranging from conventional typesetters to laser printers and bitmap terminals.

The figure shown below gives an overview of this input-output activity:

```
graph --> tbl
    |   pic
    |   troff
    |   output
    |   devices
    |
    |
    |
    |
    |
    |
```

In addition, the figure suggests the characteristic usage of DOCUMENTER'S WORKBENCH tools. Rather than one program doing all of the work, several specialized programs accomplish a wide variety of diverse functions. This
Introduction

approach enables each component to use an individually tailored language particularly suited to its own purposes. That is, DOCUMENTER'S WORKBENCH Software is not top-heavy with a single, lowest-common-denominator language that must address a multitude of different demands. Rather, each program's "dialect" is dedicated, relatively stream-lined, and easy to use.
troff

troff traces its origins back to a group of formatters that developed from RUNOFF by J. E. Saltzer at MIT during the 1960s. (The name roff actually derives from a primitive formatter that Brian Kernighan wrote for his own use as a graduate student.) troff's name was coined to express typesetter run-off. It uses formatting commands, called requests, that are interspersed through the text to govern processing. A report title, for example, might be formed with the following two lines of requests:

```
.ce 1
.ft B
```

which would place the next line of text in a centered position and change the font to bold. troff provides eighty-five such requests, which are in turn effectively multiplied by their respective numerical and alphabetical arguments.

In addition, troff uses about forty in-line commands for changing character size and typeface, placing special characters, invoking previously defined characters or words, and dictating a variety of movements about the page, to name a random assortment. For example, \i changes all succeeding text to italic, \(co gives the encircled copyright symbol, and \h'numeric argument' moves text a distance indicated by a simple numeric argument, arithmetic expression, register evaluation, or a combination of these. Arguments concerning physical dimensions may specify inches, centimeters, picas, ems, ens, points, and machine units.

troff, unlike most of its its related components, does not have individual requests or escape sequences for automatically providing running titles at the top of the page, setting up a table of contents, or making concordances. In contrast to say, the mm macro package, it is intended to permit the user a detailed access to the inner workings of DOCUMENTER'S WORKBENCH Software.

troff is programmable; it has variables, arithmetic arguments, and conditional tests of many things, including the dimensions of processed text. It allows you to define macros that encapsulate a sequence of operations or that receive and store processed text. It also permits you to set traps (marked page positions) that pass control to macros you have set up for this purpose.
While this advanced level of detailed access can be indispensable, it is not always desirable. Higher-level components, such as mm macros, should be used for most text formatting. troff should be thought of as the instrument for fine-tuning that enables you to accomplish the non-standard processing that more generalized components do not offer. Furthermore, troff should be understood as a language especially designed for text programming. It is capable of sophisticated manipulation of typography, evaluation of accumulated text (or "diversions"), placement of graphical elements contingent upon diversion evaluation, and detailed page control.
Macro Packages

DOCUMENTER’S WORKBENCH Software uses a number of macro packages that enable the user to think in terms of text—title, page headings, footnotes—rather than in terms of typography. Each of these packages is designed to accomplish specialized tasks ranging from memorandum and report preparation to compiling indexes.

The mm macro package is by far the most powerful and varied of these. Formed as a library of troff request and string combinations, these macros also allow for limited programmable features. mm provides the tools you would need for most text processing: static or floating displays, seven levels of numbered page headings, one- or two-column formatting, table-of-contents formatter (collected automatically from numbered headings), to name a few features. Many of these standard features can be altered to suit individual tastes.

DOCUMENTER’S WORKBENCH Software also includes the mptx macro package, used to make permuted indices and the mv macro package for making view graphs and projection slides. DOCUMENTER’S WORKBENCH Software’s indexing tools are mptx, ndx, ptx, and subj.
Preprocessors

eqn defines a simple language for representing mathematical expressions. People trained in mathematics can usually learn it in a few minutes; people without such training can normally use the language effectively in an hour or so. For example:

\[ \frac{a+b}{c+d+e} = -b^{\frac{2}{\pi}} \]

generates this:

\[
\frac{a+b}{c+d+e} = -\frac{b^2}{\pi}
\]

Because eqn runs as a preprocessor, the entire document that contains the equation is passed through it before reaching troff, which accepts eqn’s output as input. eqn does not, however, influence non-mathematical parts of the text. It looks for language native to eqn (usually placed between the macros .EQ and .EN) and ignores the rest.

tbl is troff’s preprocessor for making tables. It uses a language altogether different from the other preprocessors, which are more oriented toward spoken English. It is, nonetheless, a simple language to learn and can usually be mastered after one session. The following input lines are an example:
Preprocessors

```
.TS
center, doublebox;
cfB s s
c c c
^ c c
lp8 n n.
```

Program Sizes

<table>
<thead>
<tr>
<th>Name</th>
<th>Source</th>
<th>Object bytes (text+data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>troff</td>
<td>8681</td>
<td>73136</td>
</tr>
<tr>
<td>eqn</td>
<td>1821</td>
<td>34164</td>
</tr>
<tr>
<td>tbl</td>
<td>2581</td>
<td>39936</td>
</tr>
<tr>
<td>pic</td>
<td>3760</td>
<td>83968</td>
</tr>
<tr>
<td>grap</td>
<td>2791</td>
<td>58368</td>
</tr>
</tbody>
</table>

(The columns of listed data items are separated by tabs.)

The output looks like this:

<table>
<thead>
<tr>
<th>Name</th>
<th>Program Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Source</td>
</tr>
<tr>
<td></td>
<td>Lines</td>
</tr>
<tr>
<td>troff</td>
<td>8681</td>
</tr>
<tr>
<td>eqn</td>
<td>1821</td>
</tr>
<tr>
<td>tbl</td>
<td>2581</td>
</tr>
<tr>
<td>pic</td>
<td>3760</td>
</tr>
<tr>
<td>grap</td>
<td>2791</td>
</tr>
</tbody>
</table>

pic is the facility for drawing figures and diagrams. It places forms (boxes, circles, lines, and splines) at absolute positions (using Cartesian coordinates) or at specified positions relative to already placed objects. The following is an example of pic input:
and it will produce the following illustration:

You may follow each object with attributes that control its size and position and associated text strings. You may, in addition, plot forms other than the ones that pic already supplies. A macro facility allows common operations to be encapsulated, and these macros will accept arguments, enabling you to build a library of pic drawings which, furthermore, can be modified at each usage.

grap provides a language for describing graphs. Its output is pic input. pic in turn feeds requests and strings to troff. By default grap plots input numbers as a scatter plot, with automatically computed tick marks. Other commands provide control over labels, scaling, logarithmic coordinates, and the like. The following is a grap graph:
Olympic 400 Meter Run: Winning Times

which was produced by the following input:

```
.G1
frame top invis right invis
label left "Time" "(in seconds)"
label bot "Olympic 400 Meter Run: Winning Times"
draw solid
1896 54.2
1900 49.4
1904 49.2
1908 50.0
....
1980 44.60
arrow from 1924,51 to 1924,49
" "Chariots of Fire"" ljust at 1924,51
.G2
```

graph, like its near-relative pic, has a macro facility and control-flow features.
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1. Introduction

This is a technical discussion of the mm (Memorandum Macro) package, a collection of macros that you use to format documents such as letters, reports, memoranda, papers, manuals, and books. Macros are formatting commands that combine the functions of one or more nroff or troff requests.

Read this technical discussion if you have experience using the mm package. If you have never used mm before, you first might want to read "The Macro Package mm: a Tutorial" in the User's Guide. Once you decide what macros you want to use, refer to this discussion for details about how to use them.

1.1. How this Technical Discussion is Organized

This first chapter offers definitions of terms that are basic to text processing, specifies conventions that this technical discussion uses, and describes formatting concepts relevant to your use of mm. It is provided to enrich and clarify the discussion of each facility of mm that follows.

Assume that a document that you format with mm consists of four segments: a parameter setting segment, a beginning, a body, and an end. "Chapter 2" discusses these segments, which provide the organizing principle for the rest of this technical discussion. "Chapter 3" presents macros relevant to formatting the body of a document. In "Chapter 4," macros for formatting the beginning of a document are described. "Chapter 5" explains end macros. Finally, "Chapter 6" covers miscellaneous macros. In each of these chapters, a macro's default formatting action is described followed by ways to change this default behavior. For the most part, macros are described starting with the simplest usage and progressing to more advanced cases. It might be best to read a section in detail only to the point where you have enough information to obtain the result that you want and then to skim the rest.

After covering all mm macros, this technical discussion tells you about troubleshooting and error messages in "Chapter 7." "Chapter 8" gives a full account of using the mm command line to process the files you create. Appendices are presented in "Chapter 9."
1.2. Definitions

"Formatter" refers to either the nroff or the troff text-formatting program. These programs have their own tutorials in the User's Guide and their own technical discussion in this book. Unless a functional distinction requires otherwise, "the formatter" refers to both nroff and troff.

Requests are built-in commands recognized by the formatter. Although you seldom need to use these requests directly when you use mm, this section contains references to some requests. For example, the request .sp inserts a blank line in the output at the place that the request occurs in the input file. Request names consist of two lower-case letters. For an introduction to nroff/troff, see "The Formatter nroff," or "The Formatter troff" in the User's Guide. For details, refer to the "nroff/troff Technical Discussion" in this book.

Macros are named collections of requests. That is, each macro is an abbreviation for a collection of requests that are used repeatedly in the same combination. Rather than typing them each time they are needed, you simply type the macro that calls them. Sometimes, macros are composed of strings and number registers, which are described below.

The mm package supplies many macros, and you can define additional ones. The names of mm macros consist of one or two upper-case letters, so if you create your own formatting macros, name them with a lower-case and upper-case letter, for example, .pD, to prevent usurping the function of an mm macro. Appendix A, the "mm Macro Name Summary," gives a complete listing of mm macros.

Strings are character variables, each of which names a string of alphanumeric characters. Page headers, page footers, and lists often contain strings. You give a string a value with the .ds (define string) request, and you obtain its value by typing its name, preceded by \\* (for 1-character names) or "\*" (for 2-character names). For instance, the string DT in mm normally contains the current date, thus the input line

\[\text{Today is } \text{DT}.\]

results in output such as this:

\[\text{Today is February 24, 1986.}\]
You can replace the current date by redefining the contents of this string, for example,

```
.dsn DT 06/04/85
```

or by invoking a macro designed for that purpose {4.1.3}. Appendix B provides the "mm String Name Summary."

Number registers, which are similar to integer variables, store the value of various text parameters, such as the number of spaces between paragraphs (register Ps). The formatter program uses these registers for flags, for arithmetic, and for automatic numbering. You can give certain registers a value using the .nr request, and you can reference them by preceding their names by \n (for 1-character names) or \n (for 2-character names, for example, \n(Ps).

The following line creates a new number register d, and sets its value to one more than that of another new register dd: .nr d 1+\nth(dd. Some number registers are read-only. That is, you can reference them, but you cannot change their value. An "mm Number Register Summary" appears as Appendix C to this technical discussion.

1.3. Conventions

Numbers enclosed in curly braces ({} ) refer to section numbers. For example, this is section {1.3}.

In the synopses of macro calls, square brackets ([ ]) surrounding an argument show that it is optional. An argument in italics means that you are to substitute a legal value for that argument. Ellipses (...) show that the preceding argument may appear more than once.

In cases where the behavior of the two formatters nroff and troff is obviously different, the nroff formatter output is described first with the troff formatter output following in parentheses. For instance,

```
The title is underlined (italic).
```

means that the title is underlined by the nroff formatter and italicized by the troff formatter.
1.4. Formatting Concepts

1.4.1. Basic Terms

A formatter normally fills output lines from one or more input lines. You may justify output lines so that both the left and right margins are aligned. As you fill lines, you may also hyphenate words as necessary. It is possible to turn any of these modes on and off (use .SA {6.2}, Hy {1.4.4}, and the .nf and .fi formatter requests). Turning off line filling also turns off justification and hyphenation.

Certain requests and macros cease line filling, print the input line (of whatever length), and begin a new output line after the printed text. This printing of a partially filled output line is known as a line break. A few formatter requests and most of the mm macros cause a line break.

You can use formatter requests {1.4.10} with mm, but there are consequences and side effects that each such request might have. Generally, you should use mm macros alone because

- They are much easier to use, to control, and later to change the overall style of the document.
- You obtain complex features (such as footnotes or tables of contents) with ease.
- You are freed from having to define many page control functions in the nroff or troff languages.

1.4.2. Arguments and Double Quotes

For any macro call, a null argument is an argument whose width is zero. The preferred form for a null argument, which often has a special meaning, is ".". Omitting an argument is not the same as supplying a null argument (for example, see the .MT macro {4.1.1}). You can omit arguments only at the end of an macro argument list, but you can place null arguments anywhere in the list.
Enclose any macro argument containing ordinary (paddable) spaces in double quotes, or \texttt{mm} will interpret the spaces as argument delimiters. A double quote ("") is a single character that must not be confused with two apostrophes (""'), two acute accents (""'), or two grave accents (""').

You may not use double quotes as part of the value of a macro argument or of a string that you use as a macro argument. If you must have double quotes in a macro argument value, use two grave accents (""') or two acute accents (""') instead. This restriction is necessary because many macro arguments are processed a variable number of times.

1.4.3. Unpaddable Spaces

When the formatter justifies output lines to give an even right margin, it may append additional spaces to existing spaces in a line. This may distort the desired alignment of text. To avoid this distortion, you must specify a space that cannot be expanded during justification. There are two ways to accomplish this:

- You may type a backslash followed by a space (\ ). These characters directly generate an unpaddable space.
- You may use some seldom-used character to be translated into a space on output.

Because this translation occurs after justification, you may use the chosen character anywhere an unpaddable space is desired. The tilde (\texttt{\textasciitilde}) is often used with the translation request for this purpose. To use the tilde in this way, put the following request at the beginning of your document: \texttt{.tr \textasciitilde}, where the tilde is followed by a space. If you must put a tilde in the output, you can temporarily "recover" it by inserting \texttt{.tr \textasciitilde} before the place where you need it. Repeating the \texttt{.tr \textasciitilde} restores its usage as a space after a line break or after the line containing the tilde has been flushed from the line buffer.

You should not translate the tilde character into a space when you use it within the \texttt{.EQ} and \texttt{.EN} macros or assigned eqn delimiters.
1.4.4. Hyphenation

Formatters do not hyphenate unless you request it. You can turn on hyphenation in the body of the text by typing the following request at the beginning of the input file: .nr Hy 1. Section 3.3.1 describes hyphenation used within footnotes and across page boundaries.

If you request hyphenation, the formatters will automatically hyphenate words as necessary. However, you may specify hyphenation points for a specific occurrence of any word with a special character known as a hyphenation indicator, or you may specify hyphenation points for a small list of words (about 128 characters). If the hyphenation indicator (initially, the 2-character sequence "\%") appears at the beginning of a word, the word is not hyphenated. Alternatively, you can use the indicator to show legal hyphenation points inside a word. All occurrences of the hyphenation indicator disappear on output.

You may specify a different hyphenation indicator. The circumflex (\`) is often used for this purpose by inserting the following macro at the beginning of a document input text file: .HC \`. Any word containing hyphens or dashes (also known as em dashes) is hyphenated immediately after a hyphen or dash if hyphenation is necessary, even if the hyphenation function is turned off.

You may supply (via the exception word .hw request) a small list of words with the proper hyphenation points shown. For example, to show the proper hyphenation of the word "printout," you may specify .hw print-out.

1.4.5. Tabs

The macros .MT {4.1.1}, .TC {5.4}, and .CS {5.6} use the formatter tabs .ta request to set tab stops. The default values of tab settings are every eight characters in the nroff formatter, and every \( \frac{1}{2} \) inch in the troff formatter. You may set tabs to other values.

For the nroff formatter, default tab setting values are 8, 16, 24, 32, 40, ..., 160 characters for a total of 20 tab stops. That is, the default tab settings correspond to the following example:

.\ta 8 16 24 32 40 48 56 64 72 . . 160
You may separate tab settings with commas, spaces, or any other non-numeric character. You may set tab stops in any horizontally oriented scale.

The formatter interprets a tab character with respect to its position on the input line rather than its position on the output line. In general, you should only put tab characters on lines after you turn off line filling (.nf) (1.4.10). The tbl program (3.7) changes tab stops but does not restore default tab settings.

1.4.6. Bullets

The troff formatter provides the bullet character (•). For compatibility with troff, mm also provides a bullet string: \* (BU). The bullet list (.BL) macro (3.2.5) uses this string to generate automatically the bullets for bullet listed items.

1.4.7. Dashes, Minus Signs, and Hyphens

The troff formatter distinguishes among the dash, the minus sign, and the hyphen, but the nroff formatter does not.

- If you intend to use nroff, you may only use the minus sign (-) for the minus, hyphen, and dash.
- If you plan to use troff primarily, you should follow troff escape conventions.
- If you plan to use both formatters, 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 (3.2.5) 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).
Introduction

Minus Type "\-" for a true minus sign regardless of formatter. The \texttt{nroff} formatter will ignore the \. The \texttt{troff} formatter will print \texttt{-} (a true minus sign).

1.4.8. Trademark String

A trademark string \texttt{\^*(Tm} is available with \texttt{mm}. This places the letters "TM" one-half line above the text that it follows. For example,

\begin{verbatim}
The
.I
UNIX\^*\{Tm
System V User's Guide
.R
is available from the library.
\end{verbatim}

yields

\begin{verbatim}
The
UNIX\textsuperscript{TM}
System V User's Guide
is available from the library.
\end{verbatim}

1.4.9. BEL Character

Many macros use the non-printing character BEL as a delimiter to compute the width of an argument or to delimit arbitrary text in page headers and footers (3.4), headings (3.5), and lists (3.2). This is to decrease the possibility that an argument might contain a character identical to one delimiting it, which would produce undesirable results.

1.4.10. Use of Formatter Requests

You need not use most formatter requests with \texttt{mm} since it provides the corresponding formatting functions in a more straightforward fashion. The following requests can be useful with \texttt{mm}:
Introduction

.af Assign format
.br Break
.ce Center
.de Define macro
.ds Define string
.fi Fill output lines
.ft Change font
.hw Exception word
.ls Line spacing
.nf No filling of output lines
.nr Define and set number register
.nx Go to next file (does not return)
.rm Remove macro or string
.rr Remove register
.rs Restore horizontal spacing
.so Switch to source file and return
.sp Space
.ta Tab stop settings
.ti Temporary indent
.tl Title
.tr Translate
.sy Issue command(s) to UNIX system

The .fp, .lg, and .ss requests are sometimes useful for the troff formatter. In general, it is best not to use too many troff requests in conjunction with mm.
2. The Structure of a Document

A document that you format with mm consists of four segments, any of which you may omit. If you include any of these segments, you must put them in the following order:

- The parameter setting segment sets the general style and appearance of a document. Here, you control page length and width, margin justification, numbering styles for heading and lists, page headers and footers, proprietary markings, among other properties of the document. Also, you can add macros or redefine existing ones. You can omit this segment entirely if you are satisfied with mm's default values; the segment produces no output but performs only the formatter setup for the rest of the document. Here is an example of a parameter setting segment:

```
.nr Ls 0   specifies that no spacing occurs between any list items
.nr Cl 4   saves up to 4th level section headings for table of contents
.nr Pi 7   sets paragraph indentation to 7 spaces
.nr Hs 4   specifies a line of space between text and section headings up to 4th level
```

- The beginning consists of those items that occur only once at the start of a document: a memorandum title, names, the date, and so on. Here is the beginning of a formal memorandum:

```
.PM PM3   specifies a proprietary marking of "SEE PROPRIETARY NOTICE ON COVER PAGE"
.TL   specifies that line following the macros, "Work Report," is the title
.AU "J. Smith" JS  formats information about the author, "J. Smith"
```
The Structure of a Document

.MT sets the formal memorandum type

Here is the beginning of a business letter:

.WA signals the beginning of the writer’s address

.WE signals the end of the writer’s address

.IA signals the beginning of the addressee’s address

.IE signals the end of the addressee’s address

.LO SA "Dear Jane,"

sets the letter's salutation to "Dear Jane,"

.LT BL specifies a Blocked type business letter

- The body of a document is the text itself. It may be as little text as a single paragraph or as much as hundreds of pages. It may have a hierarchy of section headings up to seven levels deep (3.5), and you may automatically number section headings and save them to generate the table of contents. mm provides five additional levels of subordination by a set of list macros for automatic numbering, alphabetic sequencing, and "marking" of list items (3.2.1). You can put various types of displays (3.6), tables (3.7), figures (3.9), equations (3.8), references (5.7), and footnotes (3.3) in the body.

- The end contains items that usually occur at the close of a document. Included are signature(s), and lists of notations (for example, 'Copy to' lists) (5.3), which may occur at the beginning of the document (4.2.1). You may call certain macros at the end to print information that is wholly or partially derived from the rest of the document such as the table of contents or the cover sheet (5.6).

For example,

.FC prints the formal closing, "Yours very truly,"

.SG prints the name(s) specified with .AU

.NS begins a "Copy to" list
The Structure of a Document

.NE signals the end of the "Copy to" list
.TC generates a table of contents

The existence and size of these four segments varies widely among different document styles. Although a specific item of a segment (such as date, title, author names, and so on) may differ depending on the document, there is a uniform way of typing it into an input text file. To make it easy to edit or revise input file text at a later time:

- Keep input lines short.
- Break lines at the end of clauses.
- Begin each new sentence on a new line.
3. Formatting the Body of a Document

3.1. Formatting Paragraphs (.P)

To use .P, which stands for paragraph, your input would look like this:

```
.P [type]
Text
```

.P without an argument forces left justification (the first line begins at the left margin), as does .P 0. .P 1 indents the first line five spaces unless you specify another amount of indentation by changing the value contained in the number register Pi. For example, to indent particular paragraphs ten spaces, type the following line once at the top of your file: .nr Pi 10 and then use .P 1 before every paragraph that you want indented.

3.1.1. Paragraph Type (Pt)

Suppose that you want all paragraphs indented. Rather than type .P 1, you can set the Pt number register, which controls the paragraph type. The initial value of Pt is 0, which provides left-justified paragraphs. Force every paragraph in your output to be indented by inserting the following line at the beginning of the document input file: .nr Pt 1. You may specify the amount of indentation by setting Pi as before if you do not want to use the default.

Indent all paragraphs except after headings, lists, and displays (discussed below) by entering the following at the beginning of your document input file: .nr Pt 2.

Both the Pi and Pt register values must be greater than zero to indent paragraphs. Values that you use to specify indentation must be unscaled and are treated as character positions (ens). nroff understands an en to be equal to the width of a character. troff understands an en to be the number of points (1 point = 1/72 of an inch) equal to half the current point size.

Regardless of the value of Pt, .P 1 causes indentation by the amount specified by the register Pi. If .P occurs inside a list, the indent (if any) of the paragraph is added to the current list indent [3.2.1].
3.1.2. Numbered Paragraphs (Np)

Produce numbered paragraphs by setting the Np register to 1, which numbers paragraphs within first level headings. Use the .nP macro rather than the .P macro to produce paragraphs that are numbered within second level headings.

- \H 1 "FIRST HEADING"
- \H 2 "Second Heading"
- .nP

These numbered paragraphs contain a "double-line indent," in which the text of the second line aligns with the text of the first line, so that the number stands out. The third and following lines of a numbered paragraph return to the left margin.

produces

- 1 -

1. FIRST_HEADING

1.1 Second_Heading

1.01 These numbered paragraphs contain a "double-line indent," in which the text of the second line aligns with the text of the first line, so that the number stands out. The third and following lines of a numbered paragraph return to the left margin.

3.1.3. Spacing Between Paragraphs (Ps)

The Ps number register controls the amount of spacing between paragraphs. By default, the formatter sets Ps to 1, yielding one blank space (one-half vertical space). Giving Ps a value of 0 yields no space between paragraphs.
3.2. Formatting Lists

3.2.1. General Characteristics of Lists

\texttt{mm} provides a convenient way to create lists automatically. All lists are composed of three basic parts:

- A list-initialization macro determines the line spacing, indentation, marking with special symbols, and numbering or alphabetizing of list items. Available list-initialization macros are

  \begin{itemize}
  \item \texttt{.AL} Automatically Incremented List
  \item \texttt{.ML} Marked List
  \item \texttt{.VL} Variable-Item List
  \item \texttt{.BL} Bullet List
  \item \texttt{.DL} Dash List
  \item \texttt{.RL} Reference List
  \end{itemize}

If you do not provide arguments to the list-initialization macro, text will be indented by a default number of spaces from the indent currently in force. This default varies as a function of what type of list you call. Change the indentation value by placing the desired indentation into the number register \texttt{Li}.

- One or more list-item macros (.LI) identifies each item in your list. List-item macros are followed by the text of the corresponding list item:

  \texttt{.LI [mark [1]]}
  \begin{verbatim}
  Text
  \end{verbatim}

Use the .LI macro with all list types and for each list item. .LI normally causes output of a single blank line before its list item although you may suppress this feature by setting the \texttt{Ls} (list space) register. \texttt{Ls} is set to the innermost list level in nested lists for which spacing is done. For example, \texttt{.nr Ls 0} specifies that no spacing will occur around any list items. The default value for \texttt{Ls} is 6 (which is the maximum list nesting level).
You may supply arguments to .LI.

- If you give .LI no arguments, it labels the item with the *mark* specified by the most recent list-initialization macro (for example, .BL sets the mark to be a bullet).
- If you give .LI a single argument, that argument is output instead of the current *mark*.
- If you give .LI two arguments, the first argument becomes a prefix to the current *mark*, allowing you to emphasize one or more items in a list.

For example,

```
.BL
.LI
This is a bullet item.
.LI +
This replaces the bullet with a "plus."
.LI + 1
This uses a "plus" as prefix to the bullet.
.LE
```

when formatted yields

```
- 1 -

- This is a bullet item.
+ This replaces the bullet with a "plus."
+ - This uses a "plus" as prefix to the bullet.
```

Do not put ordinary (paddable) spaces into the *mark* because the alignment of items is lost if you justify the right margin [1.4.3].

If the current mark in the current list is a null string, and the first argument of .LI is omitted or null, the resulting effect is that of a hanging indent. That is, the first line of the following text is "outdented," starting at the same place where the mark would have started [3.2.4]. The list-end macro (.LE) ends the list: .LE [1]. If you specify an argument to .LE, it outputs a blank line.
The list-initialization macro saves the previous list status (indentation marking style, and so on), and changes the status to that of the new initialization macro. The list-end macro restores the status of the previous list unless there is no previous list. In that case, the list-end macro restores the status to that existing before the list-initialization macro call. This information about list status is important to remember when you format nested lists, which are described below.

3.2.2. Automatically Incremented Lists (.AL)

.AL stands for automatically incremented list. The general syntax of the macro is as follows: .AL [type [text-indent [1] ]].

If you do not specify arguments, the list is numbered, and text is indented the value of Li, initially six (five) spaces from the indent in force when the .AL is called, leaving room for a space, two digits, a period, and two spaces before the text.

Do not scale values that specify indentation. These values are scaled in terms of "character positions" (ens).

Specifying a type produces a different type of sequencing. The value of type in the table below shows the first element in the sequence desired.

<table>
<thead>
<tr>
<th>Argument</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arabic (default for all levels)</td>
</tr>
<tr>
<td>A</td>
<td>Upper-case alphabetic</td>
</tr>
<tr>
<td>a</td>
<td>Lower-case alphabetic</td>
</tr>
<tr>
<td>I</td>
<td>Upper-case roman</td>
</tr>
<tr>
<td>i</td>
<td>Lower-case roman</td>
</tr>
</tbody>
</table>

Figure 1: Arguments to the .AL Macro

If you specify a text-indent argument, the formatter uses it as the number of spaces from the current indent to the text of the list items. This value overrides that in Li for the list where you use the argument.
If you give a third argument, a blank line will not separate items in the list. However, a blank line will occur before the first item.

### 3.2.3. Marked Lists (.ML)

The .ML macro expects you to specify an arbitrary mark that may consist of one or more characters: \texttt{.ML mark [text-indent [1]]}. Text is indented \texttt{text-indent} spaces if the second argument is not null; otherwise, the text is indented one more space than the width of \texttt{mark}. If the third argument is specified, no blank lines will separate items in the list.

Do not put ordinary (paddable) spaces into the \texttt{mark} because the alignment of items is lost if you justify the right margin. Here’s a file containing a marked list before formatting:

\texttt{.ML $ .LI Sales are up. .LI Profits are up. .LE}

Here’s that same list after formatting:

\texttt{- 1 -}

\texttt{$ Sales are up. $ Profits are up.}

### 3.2.4. Variable-Item Lists (.VL)

Another version of the marked list is the "variable-item" list that you call with the .VL macro: \texttt{.VL text-indent [mark-indent [1]]}. When you begin a list with a .VL macro, there is effectively no current \texttt{mark}; you provide each .LI its own mark. This form is typically used to display definitions of terms or phrases.
.tr
.VL 1.0
.LI requests
are the most elementary text-formatting command available with
DOCUMENTER'S WORKBENCH Software.
.LI macros
are collections of simple formatting commands called by a
single name.
.LI demonstration of a long mark:
This item shows the effect of a long mark; one space
separates the mark from the beginning of the text.
.LI
This item effectively has no mark because the tilde
is translated into a space.
.LE

when formatted yields

- 1 -

No hyphenation. Automatic hyphenation is turned off. Words
containing hyphens (for example, mother-in-law) may still
be split across lines.

Hyphenate. Automatic hyphenation is turned on.

Hyphenation indicator character is set to "c" or removed.
During text processing, the indicator is suppressed and
will not appear in the output. Prepending the indicator to
a word has the effect of preventing hyphenation of that
word.

As with the other list types, text-indent provides the distance from
current indent to beginning of the text. Mark indent produces the number
of spaces from current indent to beginning of the mark, and it defaults to 0
if omitted or null. If you specify a third argument, no blank lines will
separate items in the list. Again, do not put ordinary (paddable) spaces into
the mark because the alignment of items is lost if you justify the right mar-
gin.
3.2.5. Bullet, Dash, and Reference Lists (.BL, .DL, .RL)

To initialize any of these lists, type: .BL or .DL or .RL [text-indent [1]]

A bullet (+) followed by one space marks each list item. As always, if you specify a text-indent argument, it overrides the default indentation. In the default case, the text of a bullet list lines up with the first line of indented paragraphs (set with the number register Pi {3.1}).

With each of these list types, no blank lines will separate items in the list if you specify a second argument. A dash (—) followed by one space marks each list item of a dash-list. Here's an example of input:

```
.DL
.LI
Prepare documents and tables
.LI
Develop new macro commands
.LE

- 1 -
```

- Prepare documents and tables
- Develop new macro commands

An .RL macro call begins an automatically numbered list that encloses the numbers in square brackets ([[]]).

Here's the input:

```
.RL 8 1
.LI
DOCUMENTER'S WORKBENCH User's Guide
.LI
DOCUMENTER'S WORKBENCH Technical Discussion and Reference Manual
.LI
DOCUMENTER'S WORKBENCH Handbook
.LE
```

The output is as follows:

```
20 TECHNICAL DISCUSSION
```
3.2.6. Nested Lists

Lists may be nested up to six levels. Here is an example of nested lists:

- AL
  - LI
  Develop methods for producing
documentation
  - LI
  Perform duties resulting from the development of these methods.
  For example,
  - BL
  - LI
  Use text processing to:
  - DL
  - LI
  Prepare documents and tables
  - LI
  Develop new macro commands
  - LE
  - LI
  Serve as a point of contact with printers and distributors.
  - LE
  - LI
  If the job holder’s interests and writing skills match the
  needs of the Technical Writing Staff,
  write documents.
  - LE

Here’s how that same list looks after it has been formatted.
1. Develop methods for producing documentation

2. Perform duties resulting from the development of these methods. For example:

   - Use text processing to:
     - Prepare documents and tables
     - Develop new macro commands
   - Serve as a point of contact with printers and distributors.

3. If the job holder's interests and writing skills matched the needs of the Technical Writing Staff, there might be an opportunity to write documents.

   In this example, the first list-initialization macro that occurs is .AL. Since you specify no argument for .AL, the formatter numbers list items in sequence with Arabic numerals. Before the list-end macro associated with .AL occurs, another list-initialization macro appears, .BL. Now, a bullet marks each list item. Finally, .DL marks list items with dashes. When the .LE associated with .DL occurs, a bullet marks list items again, since .BL was the list-initialization macro active before the dash list. When .LE ends the bullet list, list items are numbered until .LE occurs again.

   Every time a new list-initialization macro occurs, the list status (indentation, marking style, and so on) changes. .LE restores the status generated by the immediately preceding list-initialization macro.

### 3.2.7. List-Begin Macro and Customized Lists

List-initialization macros described above suffice for almost all cases. However, you may obtain more control over the layout of lists by using the basic list-begin macro (.LB). The syntax is as follows:

```
.LB text-indent mark-indent pad type [mark [LI-space [LB-space ] ] ]
```

The other list-initialization macros use .LB. Its arguments are as follows:
The *text-indent* argument that provides the number of spaces that text indents from the current indent. Normally, this value is taken from the Li register (for automatic lists) or from the Pi register (for bullet and dash lists).

The combination of *mark-indent* and *pad* arguments determines the placement of the mark. The mark is placed within an area (called *mark area*) that starts *mark-indent* spaces to the right of the current indent and ends where the text begins (that is, ends *text-indent* spaces to the right of the current indent). The *mark-indent* argument is typically 0.

Within the *mark area*, the mark is left justified if the *pad* argument is 0. If *pad* is a number \( n \) (greater than 0), then \( n \) blanks append to the mark; the *mark-indent* value is ignored. The resulting string immediately precedes the text. The mark is effectively right justified \( pad \) spaces immediately to the left of text.

The arguments *type* and *mark* interact to control the type of marking used. If *type* is 0, simple marking is performed using the mark character(s) found in the *mark* argument. If *type* is greater than 0, automatic numbering or alphabetizing is done; and *mark* is then interpreted as the first item in the sequence to be used for numbering or alphabetizing. That is, it is chosen from the set \( \{ 1, A, a, I, i \} \) \{3.5.2.6\}. This is summarized below:

<table>
<thead>
<tr>
<th>Type</th>
<th>Mark</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>omitted</td>
<td>hanging indent</td>
</tr>
<tr>
<td>0</td>
<td>string</td>
<td><em>string</em> is the mark</td>
</tr>
<tr>
<td>&gt;0</td>
<td>omitted</td>
<td>Arabic numbering</td>
</tr>
<tr>
<td>&gt;0</td>
<td>1, A, a, I, i</td>
<td>automatic numbering or alphabetic sequencing</td>
</tr>
</tbody>
</table>

Figure 2: Type and Mark for .LB

Each non-zero value of *type* from one to six selects a different way of displaying the marks. The following table shows the output appearance for each value of *type*, where \( x \) is the generated number.
Formatting the Body of a Document

or letter:

<table>
<thead>
<tr>
<th>Value</th>
<th>Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>x.</td>
</tr>
<tr>
<td>2</td>
<td>x)</td>
</tr>
<tr>
<td>3</td>
<td>(x)</td>
</tr>
<tr>
<td>4</td>
<td>[x]</td>
</tr>
<tr>
<td>5</td>
<td>&lt;x&gt;</td>
</tr>
<tr>
<td>6</td>
<td>{x}</td>
</tr>
</tbody>
</table>

Figure 3: Appearance for Values of .LB Type

- Do not put ordinary (paddable) spaces in the mark.
- The \textit{LI-space} argument gives the number of blank lines (each one-half of the current vertical spacing) that should be output by each \texttt{.LI} macro in the list. If omitted, \textit{LI-space} defaults to 1; use the value 0 to obtain compact lists. If \textit{LI-space} is greater than 0, the \texttt{.LI} macro issues a \texttt{.ne} request for two lines just before printing the mark.

- The \textit{LB-space} argument is the number of blank lines (each one-half the vertical spacing) to be output by \texttt{.LB} itself. If omitted \textit{LB-space} defaults to 0.

There are three combinations of \textit{LI-space} and \textit{LB-space}:

- The normal case is to set \textit{LI-space} to 1 and \textit{LB-space} to 0 yielding one blank line before each item in the list; such a list is usually ended with a \texttt{.LE 1} macro to end the list with a blank line.

- For a more compact list, \textit{LI-space} is set to 0, \textit{LB-space} is set to 1, and the \texttt{.LE} macro is used at the end of the list. The result is a list with one blank line before and after it.

- If both \textit{LI-space} and \textit{LB-space} are set to 0 and the \texttt{.LE} macro is used to end the list, a list without any blank lines will result.
3.2.8. Defining List Structures

This section is intended only for people who write formatter macros. If you have not written macros, or if you are content with the lists that mm provides by default, you may skip this section. To learn about writing macros, check the "User's Guide" for "The Formatter nroff," "The Formatter troff," and check this book for the "nroff/troff Technical Discussion."

If a large document requires complex list structures, it is useful to be able to define the appearance for each list level only once instead of having to define it at the beginning of each list. For example, you might define a generalized list-initialization macro in such a way that causes each list-nesting level to behave differently from its predecessor or successor. Suppose you want levels 1 through 5 of lists to have the following appearance:

- 1 -

A.  

[ 1 ]

*  

a)  

*  

The following code defines a macro (.aL) that always begins a new list and determines the type of list according to the current list level. As the example demonstrates, the mm list macros use the number register :g to determine the current list level; it is 0 if there is no currently active list. Each call to a list-initialization macro increments :g, and each .LE call decrements it.


register \( g \) is used as a local temporary to save \( \hat{g} \) before it is changed below

\[ g \]

\[ g \]

\[ g \]

Now, you can use this macro (with .LI and .LE) instead of .AL, .RL, .BL, .LB, and .ML. For example, the following input:

\[ \text{.aL} \]
\[ \text{.LI} \]
first line.
\[ \text{.aL} \]
\[ \text{.LI} \]
second line.
\[ \text{.LE} \]
\[ \text{.LI} \]
third line.
\[ \text{.LE} \]

will yield

- 1 -

A. first line.


B. third line.

You could take another approach to lists that is similar to the .H mechanism. The list-initialization as well as the .LI and the .LE macros are all included in a single macro. That macro (called .BL below) requires an argument to tell it what level of item is required; it adjusts the list level by either beginning a new list or setting the list level back to a previous value, and then it issues a .LI macro call to produce the item:

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.de BL
\" if argument, that is the level
.ie \n{.* .nr g \$1
\" if no argument, use current level
.el .nr g \n{(g
.if (\ng-\n{(g)>1 .)D " *ILLEGAL SKIPPING OF LEVEL "
.\" increasing level by more than 1
.\" if g > :g, begin new list
.\" and reset g to current level (.AL changes g)
.if \ng>\n{(g) {.AL \ng-1
 nr g \n{(g)}
.\" if :g > g, prune back to correct level
.if \n{(g)>\ng .LC \ng
.\" if :g = g, stay within current list
.LI \" always, get out an item
.

Calling .BL without arguments causes it to stay at the current list level.
The .LC macro (List Clear) removes list descriptions until the level is less
than or equal to that of its argument. For example, the .H macro includes
the ".LC 0" call. If you want to resume text at the end of a list, insert the
call ".LC 0" to clear out the lists completely. The example below illustrates
the small amount of input needed by this approach. The input text

The quick brown fox jumped over the lazy dog's back.
.BL 1
first line.
.BL 2
second line.
.BL 1
third line.
.BL
fourth line.
.LC 0
fifth line.

yields
The quick brown fox jumped over the lazy dog's back.

A. first line.
B. third line.
C. fourth line.
fifth line.

3.3. Footnotes (.FS, .FE)

There are two macros that delimit the text of a footnote. The .FS (footnote start) macro marks the beginning of the text of a footnote, and the .FE (footnote end) macro marks the end:

```
.FS [label]
Footnote text
.FE
```

These macros form a macro pair; you cannot use one macro without the other. Mark the footnoted line of your paper or memo with "\*F" or with the optional label. If you mark your footnoted line with "\*F," do not supply a label with .FS; footnotes will be numbered automatically. If you use a footnote label, follow .FS with the label you have chosen (.FS label).

The footnote text (enclosed within the macro pair) should immediately follow the word that you footnote in the input text, so that "\*F" or label occurs at the end of a line of input and the next line is the .FS macro call. Consider the following examples. The first is input for a numbered footnote:

```
This is the line containing the word\*F
.FS
This is the text of the footnote.
.FE
to be footnoted.
```
Next is a labeled footnote:

This is a labeled
.FS *
The footnote is labeled with an asterisk.
.FE
footnote.

Appendix F shows "Sample Footnotes."

Your memo or paper may contain both user-labeled and automatically numbered footnotes. Another .FS, a .DS (static display [3.6.1]), or a .DF (a floating display [3.6.2]) are not permitted between .FS and .FE macros. If you do not end the text of a footnote with .FE, you will probably cause a formatter error. If you require footnotes in the title, the abstract or in a table, note that only labeled footnotes appear properly. Everywhere else, automatically numbered footnotes work fine.

3.3.1. Changing the Format of Footnote Text (.FD)

Use .FD to control the hyphenation, right margin justification, and indentation of footnote text, and to control left or right justification of the footnote label when you indent footnote text: .FD [arg [1]].

The leftmost column of the following table shows the legal arguments to .FD [arg]. The remaining four columns show the hyphenation, justification and indentation that you obtain with each value of [arg]. For additional information concerning the .ad, .na, .hy, and .nh requests (which stand for adjust, no adjust, hyphenation, and no hyphenation, respectively), see the "nroff/troff Technical Discussion" in this book.
## Formatting the Body of a Document

<table>
<thead>
<tr>
<th>Argument</th>
<th>Hyphenation</th>
<th>Adjust</th>
<th>Text Indent</th>
<th>Label Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>0*</td>
<td>.nh</td>
<td>.ad</td>
<td>yes</td>
<td>left</td>
</tr>
<tr>
<td>1</td>
<td>.hy</td>
<td>.ad</td>
<td>yes</td>
<td>left</td>
</tr>
<tr>
<td>2</td>
<td>.nh</td>
<td>.na</td>
<td>yes</td>
<td>left</td>
</tr>
<tr>
<td>3</td>
<td>.hy</td>
<td>.na</td>
<td>yes</td>
<td>left</td>
</tr>
<tr>
<td>4</td>
<td>.nh</td>
<td>.ad</td>
<td>no</td>
<td>left</td>
</tr>
<tr>
<td>5</td>
<td>.hy</td>
<td>.ad</td>
<td>no</td>
<td>left</td>
</tr>
<tr>
<td>6</td>
<td>.nh</td>
<td>.na</td>
<td>no</td>
<td>left</td>
</tr>
<tr>
<td>7</td>
<td>.hy</td>
<td>.na</td>
<td>no</td>
<td>left</td>
</tr>
<tr>
<td>8</td>
<td>.nh</td>
<td>.ad</td>
<td>yes</td>
<td>right</td>
</tr>
<tr>
<td>9</td>
<td>.hy</td>
<td>.ad</td>
<td>yes</td>
<td>right</td>
</tr>
<tr>
<td>10**</td>
<td>.nh</td>
<td>.na</td>
<td>yes</td>
<td>right</td>
</tr>
<tr>
<td>11</td>
<td>.hy</td>
<td>.na</td>
<td>yes</td>
<td>right</td>
</tr>
</tbody>
</table>

* default for the mmt command line  
** default for mm command line

Figure 4: Arguments to the .FD Macro
An argument of 11 or greater is equivalent to .FD 0. The effect of a null or omitted argument varies according to the command line you use to process your file. If you use the mm command, a null or omitted argument is equivalent to .FD 10; if you use the mmt command, a null or omitted argument is equivalent to .FD 0.

If you specify the second argument, automatically numbered footnotes begin again with 1 when a first-level heading is encountered. This is most useful with the "section-page" page numbering scheme. As an example, the input line .FD "" 1 maintains the default formatting style and causes footnotes to be numbered afresh after each first-level heading in a document.

Hyphenation across pages is inhibited by mm except for long footnotes that continue to the following page. If you permit hyphenation, it is possible for the last word on the last line on the current page footnote to be hyphenated. To avoid this, you may specify an even .FD argument.

Footnotes are separated from the body of the text by a short line rule. Those that continue to the next page are separated from the body of the text by a full-width rule. In the troff formatter, footnotes are set in type two points smaller than the point size used in the body of text.

3.3.2. Spacing Between Footnote Entries (Fs)

Normally, one blank line (a 3-point vertical space) separates footnotes when more than one occurs on a page. To change this spacing, set the Fs number register to the desired value. For example, .nr Fs 2 will cause two blank lines (a 6-point vertical space) to occur between footnotes.

3.4. Page Headers and Footers

A page header (or header) is text that occurs at the top of pages, while a page footer (or footer) occurs at the bottom of pages. By default, the mm macro package centers the page number surrounded by dashes at the top of every page (except the first page of a formal memorandum) and does not print a page footer.

Change this default by using a mm page header macro or a page footer macro. Usually, you change a header or footer once at the beginning of the document, but you may change the header or footer as many times as you wish. You may specify a line on every page, a line on the even page only, and a line on the odd page only; thus, the header and footer may contain as
many as two lines of text: the line printed at the top of every page and the line for the even- or odd-numbered page.

3.4.1. Page Headers (.PH)

Use the .PH macro to specify a header for the top of every page: .PH [arg]. The initial value of [arg] for .PH is the centered page number surrounded by dashes.

For all header and footer macros (.PH, .EH, .OH, .PF, .EF, and .OF) the argument [arg] is of the form:

"'left-part'center-part'right-part'"

The formatter left justifies the left-part, centers the center-part, and right justifies the right-part of the header or footer argument that you provide. For example,

```
.PH " 'John Smith' 'Technical Writing Staff' "
```

produces

John Smith Technical Writing Staff

at the top of every page of the document (after you call .PH). In the example above, the center part of the header is left unspecified. If it is inconvenient to use apostrophe (') as the delimiter because an apostrophe occurs within one part, you may uniformly replace the apostrophe with any other character. For example,

"*Let's put this left•This center•Let's put this right•"

3.4.2. Even-Page Header and Odd-Page Header (.EH, .OH)

The .EH macro supplies a line to be printed at the top of each even-numbered page immediately following the page header: .EH [arg]

The .OH macro is the same as the .EH except that it applies to odd-numbered pages: .OH [arg]. The initial value of [arg] for both .EH and .OH is a blank line.

3.4.3. Page Footer (.PF)

The .PF macro specifies the line that is to appear at the bottom of every page: .PF [arg]. The initial value of the page footer is a blank line.
3.4.4. Even-Page Footer, Odd-Page Footer, and First-Page Footer (.EF, .OF)

The .EF macro supplies a line to be printed at the bottom of each even-numbered page immediately preceding the page footer: .EF [arg]. The .OF macro supplies a line to be printed at the bottom of each odd-numbered page immediately preceding the footer: .OF [arg]. The initial value of these footers is a blank line.

3.4.5. Headers and Footers for the Memorandum and Released Paper Style

In a memorandum or a released-paper style document, the page header on the first page is automatically suppressed provided a break does not occur before the .MT macro is called. Macros and text in the following categories do not cause a break and are permitted before the memorandum types (.MT) macro:

- Memorandum and released-paper style document macros (.TL, .AU, .AT, .TM, .AS, .AE, .OK, .ND, .AF, .NS, and .NE)
- Page headers and footers macros (.PH, .EH, .OH, .PF, .EF, and .OF)
- The .nr and .ds requests.

3.4.6. Strings and Registers in Header and Footer Macros

String and register names may be placed in arguments to header and footer macros. If the value of the string or register is to be computed when the respective header or footer is printed, invocation must be escaped by four backslashes. This is because string or register invocation is processed three times:

1. As the argument to the header or footer macro
2. In a formatting request within the header or footer macro
3. In a .tl request during header or footer processing.

In paragraphs, you only need one backslash (for example, \nP). In a page header, you need four; in a static display, you need two, and so on.
For example, the *mm* page number register *P* must be escaped with four backslashes to specify a header in which the page number is to be printed at the right margin, for example: \texttt{.PH \"Page \ \nP\"} creates a right-justified header containing the word "Page" followed by the page number. Similarly, to specify a footer with the "section-page" style, you specify \texttt{.PF \"\n(H1-\nP \"}.

If you make the string \(a\) contain the current section heading that is to be printed at the bottom of each page, the \texttt{.PF} macro call is \texttt{.PF \"\n\n(a\"}.

If you use only one or two backslashes, the footer would print a constant value for \(a\), namely, its value when \texttt{.PF} appeared in the input text.

### 3.4.7. Top and Bottom (Vertical) Margins (.VM)

The \texttt{.VM} (vertical margin) macro allows you to specify additional space at the top and bottom of the page: \texttt{.VM [top] [bottom]}. This space precedes the page header and follows the page footer. A null \texttt{top} or \texttt{bottom} argument or an argument of 0 puts no additional space before the header or after the footer.

\texttt{top} and \texttt{bottom} are two unscaled arguments that are treated as \texttt{v's} (default vertical line spaces: see the "nroff/troff Technical Discussion"). For example, \texttt{.VM 10 15} adds 10 blank lines to the default top of page margin and 15 blank lines to the default bottom of page margin. Both arguments must be positive (you may decrease default spacing at the top of the page by redefining \texttt{.TP} (3.4.9)).

### 3.4.8. Private Documents (Pv)

The word "PRIVATE" may be printed, centered, and underlined on the second line of a document (preceding the page header). This is done by setting the \texttt{Pv} register value: \texttt{.nr Pv value}. Possible values are as follows:

<table>
<thead>
<tr>
<th>Value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>do not print PRIVATE (default)</td>
</tr>
<tr>
<td>1</td>
<td>PRIVATE on first page only</td>
</tr>
<tr>
<td>2</td>
<td>PRIVATE on all pages</td>
</tr>
</tbody>
</table>

Figure 5: Values for the \texttt{Pv} Number Register
If value is 2, the user definable .TP macro may not be used because mm uses the .TP macro to print "PRIVATE" on all pages except the first page of a memorandum on which .TP is not invoked.

3.4.9. Generalized Top-of-Page Processing

This section is intended only for people who write formatter macros. If you have not written macros, or if you are content the way that mm handles top-of-page processing by default, you may skip this section.

During header processing, mm invokes two user-definable macros:

- The .TP (top of page) macro is invoked in the environment (refer to .ev request) of the header.
- The .PX is a page header user-exit macro that is invoked (without arguments) when the normal environment has been restored and with the "no-space" mode already in effect.

The effective initial definition of .TP (after the first page of a document) is

```
.de TP
.sp 3
.tl \*{ }t
.if e 'tl \*{ }e
.if o 'tl \*{ }o
.sp 2
```

The string ]t contains the header, the string ]e contains the even-page header, and the string ]o contains the odd-page header as you define them with the .PH, .EH, and .OH macros, respectively. To obtain more specialized page titles, you may redefine the .TP macro (3.5). Formatting done within the .TP macro is processed in an environment different from that of the body. For example, to obtain a page header that includes three centered lines of data (document number, issue date, and revision date) you could define the .TP as follows:
3.5. Section Headings (.H)

_mm_ provides two types of section headings: numbered and unnumbered. To create a numbered section heading, type

```
.H level [heading-text [heading-suffix] ]
```

The _level_ argument provides the numbered heading level. There are seven heading levels; level 1 is the highest, level 7 is the lowest. The _heading-text_ argument is the text of the heading. For example,

```
.H 1 "FIRST-LEVEL HEADING"
.H 2 "Second-level heading"
.H 3 "Third-level heading"
.H 1 "ANOTHER FIRST-LEVEL HEADING"
.H 2 "Another second-level heading"
.H 3 "Another third-level heading"
.H 4 "Fourth-level heading"
.H 3 "Still another third-level heading"
.H 5 "Fifth-level heading"
```
produces output like this:

1. FIRST-LEVEL HEADING
   1.1 Second-level heading
   1.1.1 Third-level heading

2. ANOTHER FIRST-LEVEL HEADING
   2.1 Another second-level heading
   2.1.1 Another third-level heading
   2.1.1.1 Fourth-level heading
   2.1.2 Still another third-level heading
   2.1.2.0.1 Fifth-level heading

Enclose the argument in double quotes if the heading contains more than one word or contains spaces. One word of heading-text does not require quotes.

In the example above, using a fifth-level heading immediately after a third-level heading makes the value of level 4 become zero. Unless you conform to the hierarchy of headings (using a second-level heading after a first-level heading, and so on), you might obtain results that you do not want.

The heading-suffix argument may be used for footnote marks that should not appear with heading text in the table of contents (5.4). For example,

```
.H 1 "THE UNIX OPERATING SYSTEM" *
.FS *
Trademark of AT&T Bell Laboratories.
.FE
```

Do not use \*F as the heading suffix. If you do, a number does not appear in the heading as you expect (the string \*F will) and the footnote numbering goes awry.
There is no need for a .P macro (3.1) immediately after .H (or .HU, see below) because the .H macro performs the spacing and indentation functions of the .P macro. If you do use .P after .H, mm ignores it. However, it is good practice to start every paragraph of a document with a .P macro. Later, if you take headings out of your file, paragraphs remain intact.

The effect of .H on line spacing and the font of the heading-text varies according to the level argument. Here is the default effect of each level.

.H 1 heading-text

Produces an underlined (italicized) font heading followed by a single blank line. The text after the heading-text begins on a new line and indents according to the current paragraph type.

.H n heading-text

Produces an underlined (italicized) heading followed by two spaces (3 ≤ n ≤ 7). The following text begins on the same line, that is, these are run-in headings.

Appropriate numbering and spacing occur even if you omit the heading-text argument from a .H macro call.

3.5.1. Unnumbered Section Headings (.HU)

To produce an unnumbered heading, type .HU heading-text. The .HU macro is a special case of .H; it acts the same way as .H except that no heading mark is printed. To preserve the hierarchical structure of headings when you intermix .H and .HU calls, .HU produces headings at level 2 by default. You may change this default value by changing the value of a the number register Hu. Whatever value you give Hu becomes the heading level for .HU. Thus, in the normal case, the only difference between

.HU "An unnumbered heading"

and

.H 2 "A second-level heading"

is that the latter prints the heading mark:
An unnumbered heading

2.2 A second-level heading

By default, both macros have the effect of incrementing the numbering counter for level 2 and resetting to zero the counters for levels 3 through 7. For example,

1. This is a first-level heading

1.1 A second-level heading

1.1.1 A third-level heading

An unnumbered heading

1.2.1 A third-level heading (note that level 2 has incremented)

3.5.2. Altering the Appearance of Section Headings

You can change the appearance of headings easily by setting certain registers and strings at the beginning of the document input text file. This permits quick alteration of a document’s style because this style-control information is concentrated in a few lines rather than being distributed throughout the document.

3.5.2.1. Prespacing and Page Ejection

A first-level heading, produced by .H 1, normally has two blank lines (one vertical space) preceding it. One blank line (one-half vertical space) precedes all other headings. You may force every first-level heading to the top of a new page by inserting .nr Ej 1 at the beginning of the document input text file. Make long documents more manageable by starting each section on a new page. Setting the Ej register to a higher value causes the same effect for headings up to that level, that is, a page eject occurs if the heading level is less than or equal to the Ej value.
3.5.2.2. Spacing after Section Headings

Three registers control the appearance of text immediately following a .H call. The registers are Hb (heading break level), Hs (heading space level), and Hi (post-heading indent).

- If the heading level is less than or equal to Hb, a line break occurs after the heading.
- If the heading level is less than or equal to Hs, mm inserts a blank line (one-half vertical space) after the heading.
- If a heading level is greater than Hb and also greater than Hs, then the heading (if any) is immediately followed by text on the same line.

These registers permit you to separate headings from the text in a consistent way throughout a document and allow you to alter easily white space and heading emphasis. The default value for Hb and Hs is 2.

For any stand-alone heading (a heading on a line by itself) the Hi number register controls alignment of the next line of output.

- If Hi is 0, text is left-justified.
- If Hi is 1 (the default value), mm indents text according to the paragraph type as specified by the Pt register.
- If Hi is 2, mm indents text to line up with the first word of the heading itself so that the heading number stands out more clearly.

To cause a blank line (one-half vertical space) to appear after the first three heading levels, to have no run-in headings, and to force the text following all headings to be left-justified (regardless of the value of Pt), you should put the following line in the parameter setting segment:

```
.nr Hs 3
.nr Hb 7
.nr Hi 0
```
3.5.2.3. Centered Section Headings (Hc)

Use the Hc register to obtain centered headings. A heading is centered if its level argument is less than or equal to Hc and if it is also a stand-alone heading (3.5.2.2). For example,

.nr Hc 1  
.H 1 UNIX  
.H 2 "Application Packages"  
.H 2 Languages

produces

1. UNIX

1.1 Application Packages

1.2 Languages

The Hc register is initially set to 0 (no centered headings).

3.5.2.4. Bold, Italic, and Underlined Headings

3.5.2.4.1. Control by Level.

Any heading that is underlined by the nroff formatter is italicized by the troff formatter. The string HF (heading font) contains seven codes that specify fonts for heading levels 1 through 7. Legal codes, code interpretations, and defaults for HF codes are shown below:

<table>
<thead>
<tr>
<th>Formatter</th>
<th>HF</th>
<th>Default HF</th>
</tr>
</thead>
<tbody>
<tr>
<td>nroff</td>
<td>1: no underline</td>
<td>2 2 2 2 2 2 2</td>
</tr>
<tr>
<td></td>
<td>2: underline</td>
<td>2 2 2 2 2 2 2</td>
</tr>
<tr>
<td></td>
<td>3: bold</td>
<td>2 2 2 2 2 2 2</td>
</tr>
<tr>
<td>troff</td>
<td>1: roman</td>
<td>2 2 2 2 2 2 2</td>
</tr>
<tr>
<td></td>
<td>2: italic</td>
<td>2 2 2 2 2 2 2</td>
</tr>
<tr>
<td></td>
<td>3: bold</td>
<td>2 2 2 2 2 2 2</td>
</tr>
</tbody>
</table>

Figure 6: The HF String

Thus, all levels are underlined by the nroff formatter and italicized by the troff formatter. You may reset HF as desired. Any value omitted from the right end of the list is assumed to be a 1. The following request would result in five bold levels and two underlined (italic) levels:
3.5.2.4.2. nroff Underlining Style.

The nroff formatter underlines in either of two styles:

- The normal style (.ul request) is to underline only letters and digits.
- The continuous style (.cu request) underlines all characters including spaces.

By default, mm attempts to use the continuous style on any heading that is to be underlined and is short enough to fit on a single line. If a heading is to be underlined but is longer than a single line, the heading is underlined in the normal style.

All underlining of headings can be forced to the normal style by using the -rU1 flag when invoking the nroff formatter [8.4].

3.5.2.5. Section Heading Point Sizes (HP)

You may specify the desired point size for each heading level with the HP string (for use with the troff formatter only).

.ds HP [ps1] [ps2] [ps3] [ps4] [ps5] [ps6] [ps7]

By default, mm prints the text of headings (.H and .HU) in the same point size as the body except that bold stand-alone headings are printed in a size one point smaller than the body. You can specify the string HP, which is similar to the string HF, to contain up to seven values, corresponding to the seven levels of headings. For example,

.ds HP 12 12 10 10 10 10 10

specifies that the first and second level headings are to be printed in 12-point type with the remainder printed in 10-point. Specified values may also be relative point-size changes, for example,

.ds HP +2 +2 -1 -1
If you specify absolute point sizes, then absolute sizes are used regardless of the point size of the body of the document. If relative point sizes are specified, then point sizes for headings are relative to the point size of the body even if the latter is changed.

Null or zero values imply that the default size is used for the corresponding heading level. Only the point size of the headings is affected. Specifying a large point size without providing increased vertical spacing (via .HX and/or .HZ [3.5.4]) may cause overprinting.

3.5.2.6. Marking Styles Numerals and Concatenation (.HM)

The registers named H1 through H7 are used as counters for the seven levels of headings. Register values are normally printed using Arabic numerals. The .HM macro (heading mark style) allows this choice to be overridden thus providing "outline" and other document styles:

```
.HM [arg1] ... [arg7]
```

This macro can have up to seven arguments; each argument is a string indicating the type of marking to be used. Legal arguments and their meanings are

<table>
<thead>
<tr>
<th>Argument</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arabic (default for all levels)</td>
</tr>
<tr>
<td>0001</td>
<td>Arabic with enough leading zeroes to get the specified number of digits</td>
</tr>
<tr>
<td>A</td>
<td>Upper-case alphabetic</td>
</tr>
<tr>
<td>a</td>
<td>Lower-case alphabetic</td>
</tr>
<tr>
<td>I</td>
<td>Upper-case roman</td>
</tr>
<tr>
<td>i</td>
<td>Lower-case roman</td>
</tr>
<tr>
<td>omitted</td>
<td>Interpreted as 1 (Arabic)</td>
</tr>
<tr>
<td>illegal</td>
<td>No effect</td>
</tr>
</tbody>
</table>

By default, the complete heading mark for a given level is built by concatenating the mark for that level to the right of all marks for all levels of higher value. To inhibit the concatenation of heading level marks, that is, to obtain just the current level mark followed by a period, the heading mark type register (Ht) is set to 1. For example, a commonly used "outline" style is obtained by:
3.5.3. Headings and Table of Contents (CI)

Automatically collect the text of headings and their corresponding page numbers for a table of contents by doing the following:

- Specify in the contents level register, CI, what level headings you want to save
- Call the .TC macro (5.4) at the end of the document.

\textit{mm} saves any heading whose level is less than or equal to the value of the CI register and later displays it in the table of contents. The first two levels of headings are saved if you use .TC without putting a value in CI (that is, CI by default contains the value 2).

Because of the way headings are saved, it is possible to exceed the formatter's storage capacity, particularly when saving many levels of many headings, while also processing displays (3.6) and footnotes (3.3). If this happens, the "Out of temp file space" formatter error message appears (see Appendix D); the only remedy is to save fewer levels and/or to have fewer words in the heading text.

3.5.4. Section Headings and User Exit Macros

The .HX, .HY, and .HZ macros are the means by which you obtain a final level of control over the section heading mechanism:

\begin{verbatim}
.HX dlevel rlevel heading-text
 HY dlevel rlevel heading-text
.HZ dlevel rlevel heading-text
\end{verbatim}

These macros are not defined by \textit{mm}; they are intended to be defined by you. The .H macro call invokes .HX shortly before it prints the heading text; it calls .HZ as its last action. After .HX is invoked, the size of the heading is calculated. This processing causes certain features that may have been included in .HX, such as .ti for temporary indent, to be lost. After the size calculation, .HY is called so that you may redefine these features. All default actions occur if these macros are not defined. If .HX, .HY, or .HZ are defined by you, user-supplied definition is interpreted at the appropriate
point. These macros can therefore influence handling of all headings because the .HU macro is actually a special case of the .H macro.

If you originally invoked the .H macro, then the derived level argument (dlevel) and the real level argument (rlevel) are both equal to the level given in the .H invocation. If you originally invoked the .HU macro \[3.5.1\], dlevel is equal to the contents of register Hu, and rlevel is 0. In both cases, \textit{heading-text} is the text of the original invocation.

By the time .H calls .HX, it has already incremented the heading counter of the specified level \[3.5.2.6\], produced blank lines (vertical spaces) to precede the heading \[3.5.2.1\], and accumulated the "heading mark," that is, the string of digits, letters, and periods needed for a numbered heading.

When .H calls .HX, you may reference all \texttt{mm} registers and strings, as well as the following:

\begin{itemize}
  \item \texttt{string }\texttt{0} If you make \texttt{rlevel} non-zero, this string contains the "heading mark." Two unpaddable spaces (to separate the \textit{mark} from the \textit{heading}) have been appended to this string.
  \item \texttt{register }\texttt{0} This register shows the type of spacing that is to follow the heading \[3.5.2.2\].
    \begin{itemize}
      \item A value of 0 means that the heading is run-in. A value of 1 means a break (but no blank line) is to follow the heading. A value of 2 means that a blank line (one-half vertical space) is to follow the heading.
    \end{itemize}
  \item \texttt{string }\texttt{2} If "\texttt{register }\texttt{0}" is 0, this string contains two unpaddable spaces that will be used to separate the (run-in) heading from the following text.
    \begin{itemize}
      \item If "\texttt{register }\texttt{0}" is non-zero, this string is null.
    \end{itemize}
  \item \texttt{register }\texttt{3} This register contains an adjustment factor for a \texttt{.ne} request issued before the heading is actually printed. On entry to \texttt{.HX}, it has the value 3 if \texttt{dlevel} equals 1, and 1 otherwise. The \texttt{.ne} request is for the following number of lines: the contents of the "\texttt{register }\texttt{0}" taken as blank lines (halves of vertical space) plus the contents of "\texttt{register }\texttt{3}" as blank
\end{itemize}
Formatting the Body of a Document

You may alter the values of \$0, \$2, and \$3 within .HX. The following are examples of actions that might be performed by defining .HX to include the lines shown:

- Change first-level heading mark from format n. to n.0:
  .if \$1=1 .ds }0 \n(H1.0\<sp>\<sp>
  (where <sp> stands for a space)

- Separate run-in heading from the text with a period and two unpaddable spaces:
  .if \n(;0=0 .ds }2 .\<sp>\<sp>

- Ensure that at least 15 lines are left on the page before printing a first-level heading:
  .if \$1=1 .nr ;3 (15-\n(;0

- Add three additional blank lines before each first-level heading:
  .if \$1=1 .sp 3

- Indent level 3 run-in headings by five spaces:
  .if \$1=3 .ti 5n

If temporary strings or macros are used within .HX, their names should be chosen with care (6.10.1).

When .H calls the .HY macro after the .ne is issued, certain features requested in .HX must be repeated. For example,

.de HY
 .if \$1=3 .ti 5n

The .HZ macro is called at the end of .H to control actions after the heading is produced. In a large document, sections may correspond to chapters of a book, and you may want to change a page header or footer, for example:

.de HZ
 .if \$1=1 .PF "Section \$3"

46  TECHNICAL DISCUSSION
3.6. Displays

Displays are blocks of text that you want kept together, not split across pages. mm provides two styles of displays: static and floating.

A static display appears in the same relative position in the output text as it does in the input text. This may result in extra white space at the bottom of the page if the display is too big to fit there.

A floating display "floats" through the input text to the top of the next page if there is not enough room for it on the current page. Input text that follows a floating display may precede it in the output text.

By default, a display is processed with line-filling turned off, with single-spacing, and not indented from the exiting margins. Do not nest displays and footnotes, in any combination. Do not put headings within displays or footnotes.

3.6.1. Static Displays (.DS, .DE)

A static display is delimited by the .DS and .DE macro pair.

```
.DS [format [fill [rindent] ] ]
Text
.DE
```

With no arguments, .DS accepts lines of text exactly as typed (line-filling off) and will not indent lines from the prevailing left margin or from the right margin.

The format argument is an integer or letter you use to control the indentation and centering of displays. The fill argument is an integer or letter. These arguments can have the following meanings:
### Formatting the Body of a Document

<table>
<thead>
<tr>
<th>Format</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;&quot;</td>
<td>no indent</td>
</tr>
<tr>
<td>0 or L</td>
<td>no indent</td>
</tr>
<tr>
<td>1 or I</td>
<td>indent by standard amount</td>
</tr>
<tr>
<td>2 or C</td>
<td>center each line</td>
</tr>
<tr>
<td>3 or CB</td>
<td>center as a block</td>
</tr>
<tr>
<td>none</td>
<td>no indent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fill</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;&quot;</td>
<td>line-filling off</td>
</tr>
<tr>
<td>0 or N</td>
<td>line-filling off</td>
</tr>
<tr>
<td>1 or F</td>
<td>line-filling on</td>
</tr>
<tr>
<td>none</td>
<td>line-filling off</td>
</tr>
</tbody>
</table>

**Figure 7: Arguments to the .DS Macro**

The *rindent* argument is the number of characters that the line length should be decreased, that is, an indentation from the right margin.

The default static display indentation with `.DS 1` or `.DS I` is five spaces, but you can change it by changing the value in the number register `Si`. By default, then, text of an indented display aligns with the first line of indented paragraphs, unless you also change the value contained in `Pi [3.1]`. These two number registers are independent of one another.

The display *format* argument value 3 (or `CB`) centers (horizontally) the entire display as a block (as opposed to `.DS 2` and `.DF 2` that center each line individually). All collected lines are left justified, and the display is centered based on width of the longest line. By default, a blank line is placed before and after static and floating displays. You can prevent this by setting the number register `Ds` to 0.

The following example shows usage of all three arguments for static displays. The input
.DS IND 5
We the people of the United States,
in order to form a more perfect union,
establish justice, ensure domestic tranquility,
provide for the common defense,
and secure the blessings of liberty to
ourselves and our posterity,
do ordain and establish this Constitution to the
United States of America.
.DE

produces

We the people of the United States, in order to form a more perfect union, establish justice, ensure domestic tranquility, provide for the common defense, and secure the blessings of liberty to ourselves and our posterity, do ordain and establish this Constitution to the United States of America.

This block of text is indented five ems from the current left margin, filled, and indented five spaces from the right margin.

3.6.2. Floating Displays (.DF, .DE)

Delimit a floating display with the macro pair .DF and .DE.

.DE [format [fill [rindent]] ]
Text
.DE

Arguments to .DF have the same meanings as they do to .DS except when they concern format. With floating displays, the formatter calculates indentation and centering with respect to the initial left margin because the prevailing indent may change between the time when the formatter first reads the floating display and when the display is printed. One blank line occurs before and after a floating display.

When the formatter encounters a floating display, it processes and places the display onto a queue waiting to be output. The formatter removes displays from the queue and prints them in the order entered, which is the order they appeared in the input file. If a new floating display is encountered and the queue of displays is empty, the new display is a candidate for immediate output on the current page.
As long as the display queue contains one or more displays, the formatter automatically enters new displays there, rather than putting them out. When the formatter puts out a display, it also removes it from the queue.

When the formatter reaches the end of a section (using section-page numbering) or the end of a document, it automatically removes all displays from the queue, putting them out. This occurs before the formatter processes an `.SG` macro (5.1).

A display will fit on the current page if there is enough room to contain the entire display or if the display is longer than one page in length and less than half of the current page has been used.

You may exercise precise control over the positioning of floating displays on output with two number registers, De and Df (see below). Immediate output of the display queue is governed by size of display and the setting of the Df register code. The De register code controls whether text will appear on the current page after a floating display has been produced.

The De and Df number register code settings and actions are as follows:

**De register:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No special action occurs (also the default condition).</td>
</tr>
<tr>
<td>1</td>
<td>A page eject always follows the output of each floating display, so only one floating display appears on a page and no text follows it.</td>
</tr>
</tbody>
</table>

For any other code, the action performed is the same as for code 1.

**Df register:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Floating displays are not output until end of section (when section-page numbering) or end of document.</td>
</tr>
<tr>
<td>1</td>
<td>Output new floating display on current page if there is space; otherwise, hold it until end of section or document.</td>
</tr>
</tbody>
</table>
2 Output exactly one floating display from queue to the top of a new page or column (when in 2-column mode).

3 Output one floating display on current page if there is space; otherwise, output to the top of a new page or column.

4 Output as many displays as will fit (at least one) starting at the top of a new page or column. If De is set to 1, each display is followed by a page eject, causing a new top of page to be reached where at least one more display is output.

5 Output a new floating display on the current page if there is room (default condition). Output as many displays (but at least one) as will fit on the page starting at the top of a new page or column. If De is set to 1, each display is followed by a page eject causing a new top of page to be reached where at least one more display is output.

For any code greater than 5, the action performed is the same as for code 5.

You may also use the .WC macro \{6.7\} to control handling of displays in double-column mode and to control the break in text before floating displays.

### 3.7. Tables (using tbl)

```
.TS [H]
global options;
format section.
title lines
[.TH [N]]
Data
.TE
```

The macro pair .TS (table start) and .TE (table end) delimits text to be examined by tbl and sets proper spacing around the table. The display function (.DS and .DE) and the tbl delimiting function are independent. To keep together blocks that contain any mixture of tables, equations, filled text, unfilled text, and caption lines, enclose the .TS/.TE block within a display (.DS/.DE) if the table is less than a page long. You may enclose floating tables inside floating displays (.DF/.DE).
mm formats headings for tables that extend over several pages. If a table heading is needed for each page of a multi-page table, the H argument should be specified to the .TS macro as above. Following the options and format information, table title is typed on as many lines as required and is followed by the .TH macro. The .TH macro must occur when .TS H is used for a multi-page table. This is not a feature of tbl but of the definitions provided by the mm macro package.

The .TH (table header) macro may take as an argument the letter N. This argument causes the table header to be printed only if it is the first table header on the page. Use this option when it is necessary to build long tables from smaller .TS H/.TE segments. For example,

```
.TS H
Global options;
Format section.
Title lines
.TH
Data
.TE
.TS H
Global options;
Format section.
Title lines
.TH N
Data
.TE
```

causes the table heading to appear at the top of the first table segment and no heading to appear at the top of the second segment when both appear on the same page. However, the heading still appears at the top of each page that the table continues onto. Use this feature when a single table must be broken into segments because of table complexity (for example, too many blocks of filled text). If each segment had its own .TS H/.TH sequence, it would have its own header. However, if each table segment after the first uses .TS H/.TH N, the table header will appear only at the beginning of the table and the top of each new page or column that the table continues onto.
For the nroff formatter, you may use the -e option [-E for mm {8.1}] for terminals that are capable of finer printing resolution. This causes better alignment of features such as the lines forming the corner of a box. The -e option is not effective with col.

3.8. Equations (using eqn)

```nroff
.DS
.EQ [label]
Equation(s) input
.EN
.DE
```

The programs neqn and eqn expect to use the .EQ (equation start) and .EN (equation end) macros as delimiters in the same way that tbl uses .TS and .TE; however, .EQ and .EN must occur inside a .DS/.DE pair. There is an exception to this rule — if .EQ and .EN are used to specify only the delimiters for in-line equations or to specify eqn/neqn defines, the .DS and .DE macros must not be used; otherwise, extra blank lines will appear in the output.

The .EQ macro takes an argument that will be used as a label for the equation. By default, the label will appear at the right margin in the "vertical center" of the general equation. The Eq register may be set to 1 to change labeling to the left margin.

The equation will be centered for centered displays; otherwise, the equation will be adjusted to the opposite margin from the label.

3.9. Figure, Table, Equation, and Exhibit Titles (.FG, .TB, .EC, .EX)

You may use the .FG (figure title), .TB (table title), .EC (equation caption), and .EX (exhibit caption) macros inside .DS/.DE pairs to number figures, tables, and equations automatically, and give them titles.
These macros use registers Fg, Tb, Ec, and Ex, respectively (see section 8.4 on \(-rN5\) to reset counters in sections). For example,

```
.FG "This is a Figure Title"
```

yields

**Figure 1. This is a Figure Title**

The .TB macro replaces "Figure" with "TABLE," the .EC macro replaces "Figure" with "Equation," and the .EX macro replaces "Figure" with "Exhibit." The output title is centered if it can fit on a single line; otherwise, all lines but the first are indented to line up with the first character of the title.

Change the format of the numbers using the .af request of the formatter.

By setting the Of register to 1, you may change the format of the caption from

```
Figure 1. Title
```

to

```
Figure 1 – Title
```

Use the override argument to change normal numbering. If you omit the flag argument or use an argument of 0, override is used as a prefix to the number; if the flag argument is 1, override becomes a suffix; and if the flag argument is 2, override replaces the number. If \(-rN5\) \([8.4]\) is given, "section-figure" numbering is set automatically and user-specified override argument is ignored.

As a matter of formatting style, you might want to place table headings above the text of tables, and put figure, equation, and exhibit titles below corresponding figures and equations.

You obtain a List of Figures, List of Tables, List of Exhibits, and List of Equations after \(mm\) prints the Table of Contents if the number registers Lf, Lt, Lx and Le (respectively) are set to 1. By default, all but Le are set to 1 by default. You can change the titles of these lists by redefining the following strings, which are presented here with their default values:
4. Formatting the Beginning of a Document

Two specific styles of documents are available with mm: formal memorandum style, which includes formats for memoranda, released papers and external letters, and business letter style.

4.1. Formal Memorandum Style

The mm formal memorandum style allows three document types: the memorandum, the released paper and the external letter. Commonly, people who write formal memoranda put certain information at the beginning of the document (the date, title, case numbers, authors, and so on) or at the end of the document (the signature line and a list of the document's recipients), and put it nowhere else. You specify these beginning and end items the same way for each formal memorandum type. Their formatted appearance depends on which type you choose with the .MT macro. (See "Appendix G" for an example of a formal memorandum.)

4.1.1. Choosing a Formal Memorandum Type (.MT)

This is how you use .MT:

```
.MT [argument [addressee]]
```

An argument specifies a particular formal memorandum type. Legal values for the argument are as follows:
### Formatting the Beginning of a Document

<table>
<thead>
<tr>
<th>Argument</th>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>memorandum</td>
<td>no memorandum type printed</td>
</tr>
<tr>
<td>none</td>
<td>memorandum</td>
<td>no memorandum type printed</td>
</tr>
<tr>
<td>1</td>
<td>memorandum</td>
<td>MEMORANDUM FOR FILE</td>
</tr>
<tr>
<td>2</td>
<td>memorandum</td>
<td>PROGRAMMER'S NOTES</td>
</tr>
<tr>
<td>3</td>
<td>memorandum</td>
<td>ENGINEER'S NOTES</td>
</tr>
<tr>
<td>4</td>
<td>released-paper</td>
<td>released-paper style</td>
</tr>
<tr>
<td>5</td>
<td>external-letter</td>
<td>external-letter style</td>
</tr>
<tr>
<td>&quot;string&quot;</td>
<td>memorandum</td>
<td>string (enclosed in quotes)</td>
</tr>
</tbody>
</table>

Figure 8: Arguments to the .MT Macro

The formal memorandum style produces a standard mast at the top of the first page of your document. The following input lines produce the next mast (and those that follow it). Put these lines immediately after the parameter setting segment of your document:

```
  .ND "September 28, 1984"
  .TL
  Document Production Coordinator
  .AU "John Smith" JS XF 5414 6398 7-123
  .AF "Business Computer Systems, Inc."
  .MT n (where n is a legal argument to .MT)
```

First, consider the memorandum type (here, .MT).

Business Computer Systems, Inc.

subject: Document Production Coordinator  

date: September 28, 1984

from: John Smith  
    XF 5414  
    x6398 7-123

If you give .MT any argument other than 4 or 5, you obtain, a few lines after the last line of author information, the value of value in the preceding table.
There are two alternatives to the memorandum type. To obtain the released-paper style, use .MT 4, which produces a different mast:

Document Production Coordinator

John Smith

Business Computer Systems, Inc.

With the external-letter style (.MT 5), mm prints only the title (without the word "subject:" ) and the date in the opposite left and right corners, respectively, of the top of the first page.

Document Production Coordinator

September 28, 1984

Specify the addressee of a memo, released paper or letter with the second argument to .MT. This argument may be any words you choose. Providing the addressee causes the name you've specified and the page number to replace the normal page header (page headers will be discussed below) on the second and succeeding pages of a memo.

\texttt{.MT 1 "Michael Smith"}

You may not use the addressee argument when the .MT type equals 4. If you try, output will cease after the first page.

4.1.2. TM Numbers

If the memorandum is an AT&T technical memorandum, TM numbers are supplied via the .TM macro.

\texttt{.TM \{number\} ...}

Up to nine numbers may be specified. For example,

\texttt{.TM 7654321 77777777}

mm ignores this macro call in the released-paper and external-letter styles \cite{4.4.1}.
4.1.3. Changing the Date (.ND)

By default, the current date appears in the "date" part of a memorandum or in the right corner of an external letter. You may override the current date using the .ND macro.

\[.ND \text{ new date}\]

4.1.4. Giving the Memorandum a Title (.TL)

The .TL macro gives your formatted document a title. To use .TL, type:

\[.TL [\text{charging-case number(s)}] [\text{filing-case number(s)}] ] \]
\[\text{Text}\]
\[.AU \text{(or another macro)}\]

AT&T Bell Laboratories uses arguments to the .TL macro to specify the charging-case number(s) and filing-case number(s).

- The charging-case number stands for an account to which a person's time is charged. Enter multiple charging-case numbers as "subarguments" by separating each from the previous with a comma and a space, and enclosing the entire argument within double quotes (see example below).

- The filing-case number describes where the memorandum is to be filed. Enter multiple filing-case numbers the same way you enter charging-case numbers (see example below).

Here is an example of specifying more than one charging-case number and filing-case number:

\[.TL "12345, 67890" "987654321, 987654322"\]
\[\text{Document Production Coordinator}\]

Those numbers will appear after the title like this (except for released paper style, when they do not appear at all):

\[\text{Document Production Coordinator}\]
\[\text{Charge Case 12345, 67890}\]
\[\text{File Case 987654321, 987654322}\]
The title of the memorandum follows the .TL macro. You may use the .br request to break the title into several lines

```
.TL 12345
Document Production
.br
Coordinator for the
.br
Technical Writing Staff
```

4.1.5. Specifying the Author (.AU)

Use .AU to specify the author of your memo or paper:

```
.AU name [initials [loc [dept [ext [room [arg [arg [arg]]]]]]]]
.TL 12345
Document Production
.br
Coordinator for the
.br
Technical Writing Staff
```

In the "from:" portion of a formatted memorandum, location and department number follows the author’s name on one line and room number and extension number follow it on the next line. The "x" for the extension is added automatically:

```
from: John Smith
XF 5414
7-123 x6398
machine_5ljj
```

For the memorandum type, you type information that describes an author after the .AU macro as arguments. This information includes:

- name (for example, John Smith)
- initials (for example, JJS)
- location (XF)
• department (5414)
• telephone extension (6398)
• room (7-123)
• one, two or three additional arguments (for example, machine_5jj)

The first six arguments must appear in the order given, that is, the author’s name must be typed before the initials, which must be typed before the location, and so on. By default, these arguments are ignored for the released paper style and the external letter style. If you want to leave any of these arguments blank, put a null argument at the appropriate place.

If you want to suppress printing the location, department number, extension number, room number and later arguments, set the number register Au to 0; the default value is 1.

If a memorandum has more than one author, use a separate .AU macro for each author, for example,

```
.AU "John Smith" JJS XF 5414 6398 7-123 machine_5jj
.AU "John Foley" JFF XF 5415 6666 7-321 machine_6jj
```

produces

```
from: John Smith
XF 5414
7-123 x6398
machine_5jj

John Foley
XF 5415
7-321 x6666
machine_6jj
```

4.1.6. Specifying the Author’s Title (.AT)

Specify the author’s title with the .AT macro.

```
.AT title ...
```
.AT must immediately follow .AU for the given author. For example,

```
.AU "John Smith" JJS XF 5414 6398 7-123
.AT Supervisor "Technical Writing Staff"
```

produces the following output at the signature block:

```
John Smith
Supervisor
Technical Writing Staff
```

You may give .AT up to nine arguments. Each argument will appear in the signature block (at the end of the memorandum, which is discussed below) on a separate line following the signer's name. If you need a long title, surround phrases in double quotes, turning several words into single arguments.

### 4.1.7. Specifying the Author's Firm (.AF)

Supply the name of your firm with .AF.

```
.AF "name of the firm"
```

Use .AF before .AU to avoid a formatting error. If you use .MT 4, your firm name appears after the author's name. For example,

```
.AF "Business Computer Systems, Inc."
```


If you do not supply a name with .AF, "AT&T Bell Laboratories" appears as the name of your firm unless your system administrator edits strings.mm (5.5).
4.1.8. Calling Beginning Formal Memorandum Macros in the Correct Order

If you use the macros described thus far, you must call them in the following order to avoid a formatting error:

- .ND new date
- .TL [charging-case number(s) [filing-case number(s)]]
- Text
- .AF "name of the firm"
- .AU Name [initials [loc [dept [ext [room [arg [arg [arg]]]]]]]]
- .MT [type [addressee]]
- .AF "Business Computer Systems, Inc."

The only required macros for a memorandum, released paper or external letter are .TL, .AU, and .MT.

4.2. Other Beginning Macros

4.2.1. Abstract (.AS, .AE)

If a formal memorandum has an abstract, delimit the text of the abstract with the .AS (abstract start) and .AE (abstract end) macro pair.

- .AS [arg [indent]]
  
  Text of abstract
  
  .AE

Abstracts are printed on page one of a document and/or on its cover sheet. There are three types of cover sheets:

- Released paper
- Memorandum
- Memorandum for file (also used for engineer’s notes, memoranda for record, and so on)

Cover sheets for released papers and memoranda are obtained by invoking the .CS macro.
Formatting the Beginning of a Document

With the released-paper type (argument to the .MT macro is 4) and with the memorandum type, if the first argument of .AS is

0 — Abstract prints on page 1 and on the cover sheet (if any).
1 — Abstract appears only on the cover sheet (if any).

With the memorandum for file type and in all other documents (other than external letters) if the first argument of .AS is:

0 — Abstract appears on page 1 and no cover sheet prints.
2 — Abstract appears only on the cover sheet that will be produced automatically (that is, without invoking the .CS macro).

It is not possible to get either an abstract or a cover sheet with an external letter (first argument of the .MT macro is 5).

Notations such as a "Copy to" list are allowed on memorandum for file cover sheets; the .NS and .NE macros must appear after the .AS 2 and .AE macros. Headings and displays are not permitted within an abstract.

The abstract is printed with ordinary text margins; an indentation to be used for both margins can be specified as the second argument of .AS. Values that specify indentation must be unscaled and are treated as "character positions," that is, as the number of ens.

4.2.2. Other Keywords (.OK)

.OK keyword [...]

Topical keywords should be specified on a technical memorandum cover sheet. You may specify up to nine such keywords or keyword phrases as arguments to the .OK macro; if any keyword contains spaces, you must enclose them in double quotes.

4.2.3. Bottom Block (.BS, .BE)

Specify lines of text to be printed at the bottom of each page after the footnotes (if any) but before the page footer with the bottom block macro pair .BS/.BE.
 Formatting the Beginning of a Document

\textbf{4.3. Proprietary Marking Macro (.PM)}

The \texttt{.PM} (proprietary marking) macro appends to the page footer a proprietary disclaimer.

\begin{verbatim}
 .PM [code]
\end{verbatim}

The argument is selected from among the following (note that arguments formerly used with DOCUMENTER’S WORKBENCH Software 1.0 are included):
## Formatting the Beginning of a Document

<table>
<thead>
<tr>
<th>Current Arg</th>
<th>Former Arg</th>
<th>Disclaimer Message</th>
</tr>
</thead>
</table>
| PM1         | BP, N, P, PN | AT&T BELL LABORATORIES - PROPRIETARY  
Use pursuant to G.E.I. 2.2 |
| PM2 CA      | none       | THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF  
AT&T AND IS NOT TO BE DISCLOSED OR USED EXCEPT IN  
ACCORDANCE WITH APPLICABLE CONTRACTS OR AGREEMENTS. |
| PM3 CP      | none       | SEE PROPRIETARY NOTICE ON COVER PAGE |
| PM4         | BPP, BR    | AT&T BELL LABORATORIES - PROPRIETARY (RESTRICTED)  
Solely for authorized persons having a need to know  
pursuant to G.E.I. 2.2 |
| PM5         | ILL        | THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF  
AT&T BELL LABORATORIES AND IS NOT TO BE DISCLOSED,  
REPRODUCED, OR PUBLISHED WITHOUT WRITTEN CONSENT.  
THIS DOCUMENT MUST BE RENDERED ILLEGIBLE WHEN BEING DISCARDED. |
| PM6         | CI-II      | CI-II  
Not for disclosure to AT&T Information Systems.  
Subject to FCC separation requirements under Computer Inquiry II |

Figure 9: Arguments to .PM (Proprietary Markings)

Use .PM at the beginning of your document, before you use footnotes [3.3]  
or macros that define the memorandum style [4.1.4]. Otherwise, an interaction between this macro and another that redefines the appearance of the bottom of the page may cause you problems.
These disclaimers are in a form approved for use by the AT&T. Markings are underlined. (They are italic in troff.) You may use the CI-II marking with any other message by two separate .PM requests. For example,

```
.PM CI-II
.PM N
```

produces a CI-II and NOTICE mark.

These proprietary markings are specified in the define file. System administrators can change the contents of this define file, strings.mm, to match your needs. This file is described in the next section. In cases where the disclaimer message for a code argument has been removed the argument issues a currently approved disclaimer message. Since the code argument may produce a different disclaimer message (a shorter or longer message), the page formatting of the document may be affected.

4.4. Define File Information

The define file contains pre-defined strings for the .MT and .PM macros. Appendix E presents the contents of the file. The file /usr/lib/macros/strings.mm contains the define file. Only system administrators may change specific string and font information, since only they have write permissions for the define file.

4.5. Business Letter Style

An alternative to the formal memorandum style is the business letter style, which produces four types of business letters: blocked, semiblocked, full-blocked, and simplified. (See Appendix H for an example of an mm business letter.)

4.5.1. Letter-Type Macro (.LT)

The letter-type macro .LT formats a letter in one of four business styles:

```
.LT [arg]
```
.LT accepts one (optional) argument. Arguments and corresponding format are as follows:

<table>
<thead>
<tr>
<th>Argument</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>blocked</td>
</tr>
<tr>
<td>BL</td>
<td>blocked</td>
</tr>
<tr>
<td>SB</td>
<td>semiblocked</td>
</tr>
<tr>
<td>FB</td>
<td>full-blocked</td>
</tr>
<tr>
<td>SP</td>
<td>simplified</td>
</tr>
</tbody>
</table>

.LT controls the placement on the page of the output of the subordinate macro .LO and the subordinate macro pairs (.IA and .IE, .WA and .WE) which differs according to each of the four business letter formats.

Business letter and formal memorandum macros (.LT and .MT) are mutually exclusive. If you specify both .LT and .MT specific macros in a single document, nroff/troff attempts to process the file according to the first formatting specific macro it encounters. mm ignores .MT-specific macros (.2C, .AF, .AS, .AT, .AU, .AV, .CS, .OK, .TC, .TL, .TM) and .MT-specific command line parameters (–rAn, –rEn, –rN4) if you use them with .LT; conversely, if you use .LT-specific macros (.WA, .WE, .IA, .IE, .LO) with .MT, mm ignores them.

If you use these business letter macros, the macro pairs, .WA-.WE and .IA-.IE, and the page formatting macro .LT are required, all other business letter macros are optional.

The .LT macro arguments control paragraph indentation for each of the four letter types. If you redefine the Pt and Pi registers, the user specified indentations will override. Specification of the Pt and Pi registers must occur after specification of the .LT macro.

- In the blocked format all lines of text begin at the left margin except the date line, return address, closing, and writer's identification. These begin at the center of the line. (The center of the line is not a fixed point, it is calculated for the current line length.)
The semiblocked format is the same as the blocked format; except, the first line of each paragraph is indented five spaces.

In full-blocked format all lines begin at the left margin. There are no exceptions.

The simplified format is the same as the full-blocked format; except, the salutation is replaced by an all-capital subject line and is followed by an additional blank line, the closing is omitted, and the writer's identification is in all-capital letters on one line.

Table 1 presents a synopsis of the placement of business letter components for the four .LT letter formats and lists the macros (which are explained in detail below) that you use to format those components.
There are two possible error conditions for the .LT macro:

- If you omit the .LT macro, file processing aborts and an appropriate error message prints.

---

**Figure 10: Arguments to the .LT Macro and their Functions**

<table>
<thead>
<tr>
<th>Macro &amp; Function</th>
<th>Placement on Page By .LT Argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>.WA/.WE</td>
<td>Center</td>
</tr>
<tr>
<td>Writer's Address</td>
<td>Center</td>
</tr>
<tr>
<td>LO CN [arg]</td>
<td>Left</td>
</tr>
<tr>
<td>Confidential Notation</td>
<td>Left</td>
</tr>
<tr>
<td>LO RN[arg]</td>
<td>Center</td>
</tr>
<tr>
<td>Reference Notation</td>
<td>Left</td>
</tr>
<tr>
<td>IA/.IE</td>
<td>Left</td>
</tr>
<tr>
<td>Inside Address</td>
<td>Left</td>
</tr>
<tr>
<td>LO AT [arg]</td>
<td>Left</td>
</tr>
<tr>
<td>Attention</td>
<td>Left</td>
</tr>
<tr>
<td>LO SA [arg]</td>
<td>Left</td>
</tr>
<tr>
<td>Salutation</td>
<td>Left</td>
</tr>
<tr>
<td>LO SJ [arg]</td>
<td>Left</td>
</tr>
<tr>
<td>Subject Line</td>
<td>Indented</td>
</tr>
<tr>
<td>.P Paragraphs</td>
<td>Left</td>
</tr>
<tr>
<td>.FC Closing</td>
<td>Center</td>
</tr>
<tr>
<td>.SG Signature</td>
<td>Center</td>
</tr>
<tr>
<td>Copy Notation</td>
<td>Left</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>BL</th>
<th>SB</th>
<th>FB</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>.WA/.WE</td>
<td>Center</td>
<td>Center</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>Writer's Address</td>
<td>Center</td>
<td>Center</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>LO CN [arg]</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>Confidential Notation</td>
<td>Center</td>
<td>Center</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>LO RN[arg]</td>
<td>Center</td>
<td>Center</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>Reference Notation</td>
<td>Center</td>
<td>Center</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>IA/.IE</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>Inside Address</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>LO AT [arg]</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>Attention</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>LO SA [arg]</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>None</td>
</tr>
<tr>
<td>Salutation</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>None</td>
</tr>
<tr>
<td>LO SJ [arg]</td>
<td>Left</td>
<td>Indented</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>Subject Line</td>
<td>Indented</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>.P Paragraphs</td>
<td>Left</td>
<td>Indented</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>.FC Closing</td>
<td>Center</td>
<td>Center</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>.SG Signature</td>
<td>Center</td>
<td>Center</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>Copy Notation</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
<td>Left</td>
</tr>
</tbody>
</table>
• If \texttt{mm} does not recognize an argument to \texttt{.LT}, the file processing aborts and an appropriate error message prints.

\subsection*{4.5.2. Writer's Address Macros (.WA, .WE)}

Use this macro pair to specify the writer (author) of the letter and the writer's return address.

\begin{verbatim}
.WA writer-name [title]
Return address
.WE
\end{verbatim}

For example,

\begin{verbatim}
.WA "James Lorrin, Ph.D." Director
Summit Research Company
38 River Road
Summit, New Jersey 07901
.WE
\end{verbatim}

If a complete return address is not necessary for the letter (for example, if you use printed letterhead stationary) you can specify the writer information alone:

\begin{verbatim}
.WA "James Lorrin, Ph.D." Director
.WE
\end{verbatim}

The return address cannot exceed 14 lines. Lines in the return address that follow line 14 do not appear on the letter.

The two arguments specified for the \texttt{.WA} and \texttt{.WE} macro pair, the \textit{writer-name} and the \textit{title}, provide information used by the \texttt{.SG} macro [5.1]. If you do not specify the \texttt{.SG} macro, the writer's name does not appear on the letter.

For the case of multiple writers on a single letter, you may specify only one writer return address. The specified writer return address must appear with the first writer-name as the first invocation of the \texttt{.WA/.WE} macro pair. Later return address specifications do not appear on the letter, although any number of additional writer names may be specified. For example,
For blocked and semiblocked letter styles the writer return address begins on line 12 from the top of the first page and each line begins at the center of the line. For the full-blocked and simplified letter styles the writer return address begins on line 12 from the top of the page and each line begins at the left margin.

Top of page processing can be controlled directly through nroff. The beginning of the printed page is user-defined. See the requests .wh and .ch in the "nroff/troff Technical Discussion."

If you omit either or both of the .WA and .WE macros, the file processing aborts and an appropriate error message prints.

4.5.3. Inside Address Macros (.IA, .IE)

.IA and .IE are a macro pair you use to specify the addressee and the addressee's address. There are two different ways that you can use this macro pair:

[.IA
Text
.IE]
or

[.IA [addressee-name [title] ]
Text
.IE]

For example,
Formatting the Beginning of a Document

.first { .IA
  Fred Smith, Ph.D.
  Columbia University
  116th Street
  New York, New York 10019
  .IE

or

  .IA "Fred Smith, Ph.D."
  .IE

For all four letter styles of .LT, the inside address prints on the fifth line below the date (if a reference notation or confidential notation appear after the date, the inside address prints three lines below the notation) and each line begins at the left margin.

If you omit either or both of the .IA and .IE macros, the file processing aborts and an appropriate error message prints.

4.5.4. Letter-Options Macro (.LO)

The letter-options macro provides the capability for specifying five common business letter components:

.first { .LO type [arg]

The .LO macro takes care of placement and spacing of these letter components for each .LT letter format. .LO requires one argument to specify a letter component type, and accepts one optional string argument to refine its action.
Formatting the Beginning of a Document

<table>
<thead>
<tr>
<th>Type</th>
<th>Corresponding Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN</td>
<td>confidential notation</td>
</tr>
<tr>
<td>RN</td>
<td>reference notation</td>
</tr>
<tr>
<td>AT</td>
<td>attention</td>
</tr>
<tr>
<td>SA</td>
<td>salutation</td>
</tr>
<tr>
<td>SJ</td>
<td>subject line</td>
</tr>
</tbody>
</table>

Figure 11: Types Given to .LO and their Functions

4.5.4.1. Confidential Notation (CN)

The confidential notation shows that a business letter should be read only by the person to whom it is addressed. The confidential notation appears on the second line below the date line of the letter and begins at the left margin for all letter formats.

If the optional string argument is present the specified string replaces the default. For example,

```
.LO CN "RESTRICTED"
```

The default of CN prints CONFIDENTIAL in upper-case.

4.5.4.2. Reference Notation (RN)

The reference notation supplies specific information to be used by the addressee. For example,

```
.LO RN "Meeting of 1/25"
```

The reference note appears two lines below the date line of the letter (or on the second line below any notation that follows the date) left aligned with the date line for all four letter formats.

RN provides a common format for including a reference note by printing the string In reference to: preceding the optional string argument to .LO. The format string In reference to: cannot be redefined. There is not a default value for the optional argument.
4.5.4.3. Attention (AT)

The attention line directs the letter to the attention of a specific person or department. For example,

```
.LO AT "Dr. Smith"
```

The attention information appears on the second line below the inside address of the letter and begins at the left margin.

AT provides a common format for directing a letter to the attention of a specific person by printing the string "ATTENTION:" preceding the optional string argument to .LO. The format string "ATTENTION:" cannot be redefined. There is not a default value for the optional argument.

4.5.4.4. Salutation (SA)

The salutation specifies the letter's opening greeting. For the blocked, semiblocked, and full-blocked formats the salutation appears on the second line below the inside address (or on the second line below the attention line, if used). In the simplified letter format, the salutation is ignored.

The default of SA prints "To Whom It May Concern:" for the salutation. If the optional string argument is present the specified string will replace the default. For example,

```
.LO SA "Dear Dr. Smith"
```

4.5.4.5. Subject Line (SJ)

The subject line shows what the letter is about. In the blocked and full-blocked letter formats the subject line information appears on the second line below the salutation and begin at the left margin. For the semiblocked format the subject line appears on the second line below the salutation and is indented five spaces. In the simplified letter format the subject line information appears in place of the salutation three lines below the inside address of the attention line; the salutation, if you use it, is ignored.

For the blocked, semiblocked, and full-blocked formats, SJ provides a common format for indicating what the letter is about by printing the string "SUBJECT:" preceding the optional string argument to .LO.

```
.LO SJ "Staff Meeting:"
```

The format string "SUBJECT:" cannot be redefined. There is not a default value for the optional argument.
Formatting the Beginning of a Document

For the simplified letter, the subject line string argument prints on the third line below the inside address or the attention line (a salutation is ignored if used).

If you specify the .LO macro without an argument or the argument you specify is unrecognized, the file processing aborts and an appropriate error message prints.

4.5.5. Multi-page Letters

The .LT macro controls the format for the first page of the letter. The letter macros will not alter the default nroff/troff page processing following the first page of the letter.

4.5.6. Sequence of Beginning Letter Macros

Macros .WA, .WE, .IA, .IE, and .LT must be given in the order listed in the following table. .LO can be specified multiple times with different argument types. The .LO argument types do not have to be in any specific order. All .LO requests must be specified before .LT.
If you put nroff/troff requests and lines of text before .LT, you change how .LT works. For example, if the first line of a file is a line of text, mm processes the file as if you had not specified .LT.
5. Formatting the End of a Document

5.1. Formal Closing and Signature Line (.FC, .SG)

If you like, you may make your formal memorandum more formal with the .FC macro, which prints "Yours very truly," as a formal closing. You may specify an argument to .FC. to present a different closing.

The .SG (for "signature line") macro prints the author's name(s) after the formal closing, otherwise the author's name appears after the last line of the body of the memo. Each printed name begins at the center of the page. Three blank lines are left above each name for an author's signature. Use .FC before .SG or the formal closing will appear after the signature line.

Here's how you use .FC and .SG together. You may use either macro by itself.

```
.FC ["closing argument"]
.SG [arg [1] ]
```

You append a line of reference data including location code (for example, XF), department number (5414) and author's initials (JJS) by typing .SG "" instead of .SG. These data appear after the author's name and before the "Copy to" list (which is described below) and look like this:

```
XF-5414-JJS
```

If you type any other argument after .SG (not ""), that argument is treated as the typist's initials and is appended to the reference data. For example, if you specify:

```
.SG abc
```

the following line appears after the author's signature and before the "Copy to" list:

```
XF-5414-JJS-abc
```

If there are several authors and the second argument is given, reference data is placed on the signature line of the first author. This reference data contains only the location and department number of the first author, even though the other authors' initials are printed. Therefore, if there are authors from different departments and/or from different locations, the
Formatting the End of a Document

reference data should be supplied manually after calling .SG without arguments, like this:

```plaintext
.SG
XF-5414-JJS
XF-5415-SJF
```

This manually supplied information appears on the signature line of the second author.

For business letter style documents, the .SG macro prints the writer’s name(s) after the formal closing, if any. Placement of the writer’s names(s) for the signature block is controlled by the .LT macro specification (for example at the left margin or at the center of the page). The optional arguments accepted by .SG will not alter the processing of the macro when used in conjunction with .LT.

5.2. Approval Line (.AV)

Use the .AV macro after the last notation block to generate automatically a line for the approver’s signature and the date.

```plaintext
.AV approver's-name [1]
```

For example,

```plaintext
.AV "Todd Doe"
```

produces

```
APPROVED:

__________________________  ______________
Todd Doe                 Date
```

Use the optional second argument to prevent the mark "APPROVED:" from appearing above the approval line.

The .SG and .NS macros format signatures of authors and a list of notations, respectively. These macros do not work with released-paper style (.MT 4, 4.1.1).
5.3. "Copy to" and Other Notations (.NS, .NE)

Many types of notations (such as a list of attachments or "Copy to" lists) may follow signature and reference data. Various notations are obtained through the .NS macro, which provides for proper spacing and for breaking notations across pages if necessary. You use .NS like this:

```
.NS [argument [1] ]
Names or other notation
.NE
```

If you use the optional second argument, the first argument will be used as the entire notation string. Codes for argument and the corresponding notations are

<table>
<thead>
<tr>
<th>Argument</th>
<th>Notations</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>Copy to</td>
</tr>
<tr>
<td></td>
<td>Copy to</td>
</tr>
<tr>
<td>0</td>
<td>Copy to</td>
</tr>
<tr>
<td>1</td>
<td>Copy (with att.) to</td>
</tr>
<tr>
<td>2</td>
<td>Copy (without att.) to</td>
</tr>
<tr>
<td>3</td>
<td>Att.</td>
</tr>
<tr>
<td>4</td>
<td>Atts.</td>
</tr>
<tr>
<td>5</td>
<td>Enc.</td>
</tr>
<tr>
<td>6</td>
<td>Encs.</td>
</tr>
<tr>
<td>7</td>
<td>Under Separate Cover</td>
</tr>
<tr>
<td>8</td>
<td>Letter to</td>
</tr>
<tr>
<td>9</td>
<td>Memorandum to</td>
</tr>
<tr>
<td>10</td>
<td>Copy (with atts.) to</td>
</tr>
<tr>
<td>11</td>
<td>Copy (without atts.) to</td>
</tr>
<tr>
<td>12</td>
<td>Abstract Only to</td>
</tr>
<tr>
<td>13</td>
<td>Complete Memorandum to</td>
</tr>
<tr>
<td>&quot;string&quot;</td>
<td>Copy (string) to</td>
</tr>
<tr>
<td>&quot;string&quot;, with 2nd arg</td>
<td>string</td>
</tr>
</tbody>
</table>

Figure 12: Arguments to the .NS Macro
The string, which you may or may not enclose in double quotation marks, is placed within parentheses between the words "Copy" and "to" if it consists of more than two characters; otherwise, it is ignored. For example,

```
.NS "with att. 1 only"
```
generates

```
Copy (with att. 1 only) to
```
as the notation.

You may specify more than one notation before the .NE macro because a .NS macro stops the preceding notation, if any. For example,

```
.NS 4
Attachment 1-List of branch offices and managers
Attachment 2-List of regional offices and managers
.NS 1
Bill Taylor
.NS 2
J. Craven
A. Greenland
.NE
```
produces

```
Atts.
Attachment 1-List of branch offices and managers
Attachment 2-List of regional offices and managers

Copy (with att.) to
Bill Taylor

Copy (without att.) to
J. Craven
A. Greenland
```

If you use a second argument, the first argument becomes the entire notation. For example,

```
.NS "Table of Contents to" 1
```
produces

```
Table of Contents to
```
as the notation.
You may also use .NS and .NE at the beginning of a document following .AS 2 and .AE to place the notation list on the Memorandum for File cover sheet (5.6). If you give notations at the beginning without .AS 2, they will be saved and printed at the end of the document.

5.4. Table of Contents (.TC)

For most documents, the table of contents appears at the beginning, but because you have to call .TC at the end of your unformatted file, this Technical Discussion treats it as a macro for the end of the document. mm produces the table of contents at the end because the entire document must be processed before the table of contents can be generated from gathered section headings.

This macro normally appears once at the end of the document, after the Signature Block (5.1) and Notations (5.3) macros.

The .TC macro generates a table of contents containing heading levels that were saved for the table of contents as determined by the value of the CI register (3.5.3).

.TC [slevel] [spacing] [tlevel] [tab] [h1] [h2] [h3] [h4] [h5]

Arguments to .TC control spacing before each entry, placement of associated page number, and additional text on the first page of the table of contents before the word "CONTENTS."

Spacing before each entry is controlled by the first and second arguments (slevel and spacing). Headings whose levels are less than or equal to slevel will have spacing blank lines (halves of a vertical space) before them. Both slevel and spacing default to 1. This means that first-level headings are preceded by one blank line (one-half a vertical space). The slevel argument does not control what levels of heading have been saved; saving of headings is the function of the CI register.

The third and fourth arguments (tlevel and tab) control placement of the associated page number for each heading. Page numbers can be justified at the right margin with either blanks or dots (called leaders) separating the heading text from the page number, or the page numbers can follow the heading text.
For headings whose level is less than or equal to $tlevel$ (default 2), page numbers are justified at the right margin. Here, the value of $tab$ determines the character used to separate heading text from page number. If $tab$ is 0 (default value), dots (that is, leaders) are used. If $tab$ is greater than 0, spaces are used.

For headings whose level is greater than $tlevel$, page numbers are separated from heading text by two spaces (that is, page numbers are "ragged right," not right justified).

Additional arguments ($h1 \ldots hS$) are horizontally centered on the page and precede the table of contents.

5.5. Changing the Table of Contents (.TX, .TY)

If you call the .TC macro with at most four arguments, mm calls the user-exit macro .TX (without arguments) before the word "CONTENTS" is printed, or calls the user-exit macro .TY, and does not print the word "CONTENTS." By defining .TX or .TY and calling .TC with at most four arguments, you can specify what needs to be done at the top of the first page of the table of contents. For example,

```
.de TX
.ce 2
Special Application
Message Transmission
.sp 2
.in +5n
Approved: \l\’2.5i\’
.in
.sp
.. TC
```

yields the following output when you format the file that contains them:
If you define the .TX macro as .TY, the word "CONTENTS" would be suppressed. Defining .TY as an empty macro suppresses "CONTENTS" with no replacement:

```
.de TY
```

By default, the first level headings appear in the table of contents left justified. Later levels align with the text of headings at the preceding level. You may change these indentations by defining the Ci string that takes a maximum of seven arguments corresponding to the heading levels. You must give at least as many arguments as are set by the Cl register. With these registers, arguments must be scaled. For example, with "Cl = 5":

```
.ds Ci .25i .5i .75i 1i 1i " troff
```

or

```
.ds Ci 0 2n 4n 6n 8n " nroff
```

Two other registers are available to change the format of the table of contents:

- By default, table of contents pages will have lower-case roman numeral page numbering. If the Oc register is set to 1, the .TC macro will not print any page number but will instead reset the P register to 1. It is your responsibility to give an appropriate page footer to specify the placement of the page number. Ordinarily, the same .PF macro (page footer) used in the body of the document is adequate.

- Front matter pages, such as those listing figures and tables, will be produced separately unless Cf is set to 1, which causes these lists to appear on the same page as the table of contents.
5.6. Cover Sheet (.CS)

Like the table of contents macro, you call the cover sheet macro (.CS) at the end of the document, even though you usually put a cover sheet at the beginning. .CS generates a cover sheet in either the released paper or memorandum type of the formal memorandum style.

```
.CS [pages [other [total [figs [tbs [refs] ] ] ]]]
```

All other information for the cover sheet is obtained from data given before the .MT macro call (4.1.1). If you use the memorandum type, the .CS macro generates the "Cover Sheet for Technical Memorandum". The data that appear in the lower left corner of the memorandum cover sheet (counts of: pages of text, other pages, total pages, figures, tables, and references) are generated automatically (0 is used for "other pages"). You may change these values by supplying the corresponding arguments to the .CS macro. If you use the released-paper style, all arguments to .CS are ignored.

5.7. References (.RS, .RF, .RP)

Obtain automatically numbered references by typing `\*(Rf` (invoking the string Rf) immediately after the text you want to reference. This places the next sequential reference number (in a smaller point size) enclosed in brackets one-half line above the text you reference. mm keeps reference count in the Rf number register. mm uses the number register :R to print the reference number for each reference call in the text (`\*(Rf`). You may change the format or value of the :R register to effect the reference marks, without affecting the total count of references.

Use the .RS and .RF macros to delimit text of each reference.

```
Text to be referenced.\*(Rf
.RS
Reference
.RF
```
The `.RS` macro takes an optional argument, a string-name. For example,

```
.RS aA
Reference
.RF
```

The string `aA` is assigned the current reference number. You may use this string later in the document as the string call, `{aA`, to reference text that must be labeled with a prior reference number. The reference is enclosed in brackets one-half line above the text to be referenced. You do not need a `.RS/.RF` pair for subsequent references.

You may use the `.RP` (reference page) macro to produce reference pages anywhere else within a document (that is, after each major section). It is not needed to produce a separate reference page with default spacings at the end of the document.

The `.RP` macro produces the reference page.

```
.RP [arg1 [arg2]]
```

Two arguments may be used with `.RP`. Possibilities for the first argument are as follows:

<table>
<thead>
<tr>
<th>Argument 1</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Reset reference counter (default).</td>
</tr>
<tr>
<td>1</td>
<td>Do not set reference counter.</td>
</tr>
</tbody>
</table>

Possibilities for the second argument are as follows:

<table>
<thead>
<tr>
<th>Argument 2</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Put on separate page (default).</td>
</tr>
<tr>
<td>1</td>
<td>Do not cause a following .SK.</td>
</tr>
<tr>
<td>2</td>
<td>Do not cause a preceding .SK.</td>
</tr>
<tr>
<td>3</td>
<td>Do not cause a preceding or following .SK.</td>
</tr>
</tbody>
</table>

This page contains the reference items (that is, reference text enclosed within `.RS/.RF` pairs). Reference items are separated by a space (one-half a vertical space) unless you set the `Ls` register to 0 to suppress this spacing. You may change the reference page title by defining the `Rp` string:
.ds Rp "New Title"

If no .SK macro is issued by the .RP macro, a single blank line separates the references from the following/preceding text. You may wish to adjust spacing. For example, to produce references at the end of each major section:

.sp 3
.RP 1 2
.H 1 "Next Section"
6. Miscellaneous Macros


mm provides three macros for changing the prevailing font of a document.

```
.B [bold-arg [previous-font-arg] ] ...
.I [italic-arg [previous-font-arg] ] ...
.R
```

When you invoke it without arguments, .B changes the font to bold, and .I changes to underlining (italic). mm uses these fonts until you invoke another font macro, such as the .R macro, which restores roman font. Thus,

```
.I
here is some text.
.R
```

yields underlined text via the nroff and italic text via the troff formatter.

If you invoke the .B or .I macro with one argument, that argument appears in the appropriate font (underlined in the nroff formatter for .I). Then mm restores the previous font (underlining is turned off in the nroff formatter). If you give two or more arguments (maximum six) with a .B or .I macro call, the second argument is concatenated to the first with no intervening space (1/12 space if the first font is italic), but it is printed in the previous font. Remaining pairs of arguments are similarly alternated. For example,

```
.I italic " words of text " right-justified
```

produces

```
italic words of text right-justified
```

The .B and .I macros alternate with the prevailing font at the time the macros are invoked. To alternate specific pairs of fonts, the following macros are available:

```
.IB .BI .IR .RI .RB .BR
```
Each macro takes a maximum of six arguments and alternates arguments between specified fonts.

When you use a terminal that cannot underline, you can insert the following line in the parameter setting segment to eliminate all underlining:

```
.rm ul
.rm cu
```

\textit{mm} handles font changes in headings separately (3.5.2.4).

### 6.2. Justification of Right Margin (.SA)

Use the \texttt{.SA} macro to set right-margin justification for the main body of text.

\texttt{.SA [arg]}

Choose from two justification flags: \textit{current} and \textit{default}. Initially, \textit{mm} sets both flags for no justification in the \texttt{nroff} formatter and for justification in the \texttt{troff} formatter. An argument to \texttt{.SA} causes the following action:

<table>
<thead>
<tr>
<th>Argument</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Sets both flags to no justification. It acts like the \texttt{.na} request.</td>
</tr>
<tr>
<td>1</td>
<td>Sets both flags to cause both right and left justification, the same as the \texttt{.ad} request.</td>
</tr>
<tr>
<td>Omitted</td>
<td>Causes the current flag to be copied from the default flag, thus performing either a \texttt{.na} or \texttt{.ad} depending on the default condition.</td>
</tr>
</tbody>
</table>

Figure 13: Arguments to the \texttt{.SA} Macro
In general, you can use the no adjust request (.na) to ensure that justification is turned off. Use .SA to restore justification, rather than the .ad request. Specify justification or no justification for the remainder of the text by inserting .SA 1 or .SA 0 one time at the parameter setting segment.

6.3. Skipping Pages (.SK)

The .SK macro skips pages but retains the usual header and footer processing.

.SK [pages]

If you omit the pages argument, or make it null or 0, .SK skips to the top of the next page unless it is currently at the top of a page (then it does nothing). .SK n skips n pages. .SK positions text that follows it at the top of a page, while .SK 1 leaves one page blank except for the header and footer.

6.4. Forcing an Odd Page (.OP)

Use the .OP macro to ensure that formatted output text following the macro begins at the top of an odd-numbered page.

.OP

- If currently at the top of an odd-numbered page, text output begins on that page (no motion takes place).
- If currently on an even page, text resumes printing at the top of the next page.
- If currently on an odd page (but not at the top of the page), one blank page is produced, and printing resumes on the next odd-numbered page after that.
6.5. Setting Point Size and Vertical Spacing (.S)

Change the prevailing point size and vertical spacing by invoking the .S macro.

\[ \text{.S [point size [vertical_spacing]]} \]

In the troff formatter, the default point size (obtained from the mm register $S \{8.4\}$) is 10 points, and the vertical spacing is 12 points (six lines per inch). You may use the mnemonics D (default value), C (current value), and P (previous value) for both arguments.

- If an argument is negative, current value is decremented by the specified amount.
- If an argument is positive, current value is incremented by the specified amount.
- If an argument is unsigned, it becomes the new value.
- If there are no arguments, the .S macro defaults to P.
- If you specify the first argument but not the second, then (default) D is used for the vertical spacing.

Default value for vertical spacing is always two points greater than the current point size. Footnotes $\{3.3\}$ are two points smaller than the body with an additional 3-point space between footnotes. A null (""") value for either argument defaults to C (current value). Thus, if $n$ is a numeric value:
### Miscellaneous Macros

<table>
<thead>
<tr>
<th>Macro and Argument</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>.S</td>
<td>.S P P</td>
</tr>
<tr>
<td>.S (n)</td>
<td>.S C (n)</td>
</tr>
<tr>
<td>.S (n)</td>
<td>.S (n) C</td>
</tr>
<tr>
<td>.S (n)</td>
<td>.S (n) D</td>
</tr>
<tr>
<td>.S (n)</td>
<td>.S C D</td>
</tr>
<tr>
<td>.S (n)</td>
<td>.S C C</td>
</tr>
<tr>
<td>.S (n)</td>
<td>.S (n) (n)</td>
</tr>
</tbody>
</table>

Figure 14: Arguments to the .S Macro

P means previous value, D means default value (usually 10 point), and C means current value.

If you make the first argument greater than 99, the default point size (10 points) is restored. If the second argument is greater than 99, mm uses the default vertical spacing (current point size plus two points). For example,

\[ .S \texttt{100} = .S \texttt{10 12} \]
\[ .S \texttt{14 111} = .S \texttt{14 16} \]

The .SM macro allows you to reduce by one point the size of a string.

\[ .S M \texttt{string1} [\texttt{string2}] [\texttt{string3}] \]

If you omit the third argument (\texttt{string3}), the first argument (\texttt{string1}) is made smaller and is concatenated with the second argument (\texttt{string2}), if specified. If all three arguments are present (even if any are null), the second argument is made smaller and all three arguments are concatenated. For example,
### 6.6. Producing Accents

The following example shows that you may use strings to produce accents for letters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grave accent</td>
<td>c*</td>
<td>c</td>
</tr>
<tr>
<td>Acute accent</td>
<td>e*'</td>
<td>é</td>
</tr>
<tr>
<td>Circumflex</td>
<td>o*'</td>
<td>ô</td>
</tr>
<tr>
<td>Tilde</td>
<td>n*~</td>
<td>ñ</td>
</tr>
<tr>
<td>Cedilla</td>
<td>c*</td>
<td>ç</td>
</tr>
<tr>
<td>Lower-case umlaut</td>
<td>u*:</td>
<td>ü</td>
</tr>
<tr>
<td>Upper-case umlaut</td>
<td>U*;</td>
<td>Ü</td>
</tr>
</tbody>
</table>

### 6.7. Two-Column Output (.2C, .1C)

The \texttt{mm} text formatting macro package can format two-columns on a page. The .2C macro begins 2-column processing that continues until a .1C macro (1-column processing) is encountered.
Miscellaneous Macros

.2C  
text and formatting requests (except another .2C)

.1C

In 2-column processing, each physical page is thought of as containing 2-columnar "pages" of equal (but smaller) "page" width. Page headers and footers are not affected by 2-column processing. The .2C macro does not balance 2-column output.

It is possible to have full-page width footnotes and displays when in 2-column mode though footnotes and displays are by default narrow in 2-column mode and wide in 1-column mode. .WC controls footnote and display width, which is specified in arguments. .WC WD FF, for instance, causes all displays to be wide and all footnotes to be the same width. .WC N reinstates the defaults. If you give conflicting settings to .WC, mm selects the last one: a .WC WF -WF command has the effect of a .WC -WF. Arguments to .WC are as follows:

<table>
<thead>
<tr>
<th>Argument</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Default mode (-WF, -FF, -WD, FB).</td>
</tr>
<tr>
<td>WF</td>
<td>Wide footnotes (even in 2-column mode).</td>
</tr>
<tr>
<td>-WF</td>
<td>DEFAULT: Turn off WF. Footnotes follow column mode; wide in 1-column mode (.1C), narrow in 2-column mode (.2C), unless FF is set.</td>
</tr>
<tr>
<td>FF</td>
<td>First footnote. All footnotes have same width as first footnote encountered for that page.</td>
</tr>
<tr>
<td>-FF</td>
<td>DEFAULT: Turn off FF. Footnote style follows settings of WF or -WF.</td>
</tr>
<tr>
<td>WD</td>
<td>Wide displays (even in 2-column mode).</td>
</tr>
<tr>
<td>-WD</td>
<td>DEFAULT: Displays follow the column mode in effect when display is encountered.</td>
</tr>
<tr>
<td>FB</td>
<td>DEFAULT: Floating displays cause a break when output on the current page.</td>
</tr>
<tr>
<td>-FB</td>
<td>Floating displays on current page do not cause a break.</td>
</tr>
</tbody>
</table>
6.8. Inserting Text Interactively (.RD)

The .RD (read insertion) macro allows you to stop the standard output of a document and to read text from the standard input until two consecutive newline characters are found.

```
.RD [prompt [diversion [string] ] ]
```

When newline characters are encountered, normal output is resumed.

- The prompt argument prints at the terminal. If not given, .RD signals you with a BEL on terminal output.
- The diversion argument allows you to save all text typed in after the prompt in a macro whose name is that of the diversion.
- The string argument allows you to save for later reference the first line following the prompt in the named string.

The .RD macro follows the formatting conventions in effect. Thus, the following examples assume that the .RD is invoked with line-filling off (.nf):

```
.RD Name aA bB
```

produces

```
Name: J. Jones   (you type name)
16 Elm Rd.,
Piscataway
```

The diverted macro .aA will contain

```
J. Jones
16 Elm Rd.,
Piscataway
```

The string bB \(\text{*(bB)}\) contains "J. Jones."

A newline character followed by an EOF (user specifiable CONTROL-d) also allows you to resume normal output.
6.9. SCCS Release Identification (RE)

The RE string contains the SCCS release and the mm text formatting macro package current version level. For example,

This is version *(RE of the macros.*

produces

- 1 -

This is version 10.129 of the macros.

This information is useful in analyzing suspected bugs in mm. The easiest way to have the release identification number appear in the output is to specify -rD1 [8.4] on the command line. This causes the RE string to be output as part of the page header [3.4.1].

6.10. Extending and Changing the Macros

6.10.1. Naming Conventions

In this part, the following conventions are used to describe names:

- Digit
- Lower-case letter
- Upper-case letter
- Any alphanumeric character (n, a, or A, that is, letter or digit)
- Any nonalphanumeric character (special character)

Request, macro, and string names are kept by the formatters in a single internal table; therefore, there must be no duplication among such names. Number register names are kept in a separate table.
6.10.1.1. Components Used by Formatters

Requests:  
- **aa** (most common)
- **an** (only one, currently: c2)

Registers:  
- **aa** (normal)
- **.x** (normal)
- **.s** (only one, currently: .$)
- **a.** (only one, currently: c.)

6.10.1.2. Components Used by mm

Macros and Strings:  
- **A, AA, Aa** (accessible to you; for example, macros .P and .HU, strings F, BU, and Lt)
- **nA** (accessible to you; only two, currently: 1C and 2C)
- **aA** (accessible to you; only one, currently: nP)
- **s** (accessible to you; only the seven accents, currently {6.6})

Registers:  
- **An, Aa** (accessible to you; for example, H1, Fg)
- **A** (accessible to you; meant to be set on the command line; for example, C)

6.10.2. Sample Extensions

6.10.2.1. Appendix Headings

The following is a way of generating and numbering appendix headings:
After the above initialization and definition, each call of the form

```
.aH "Title"
```

begins a new page (with the page header changed to "Appendix a–n") and generates an unnumbered heading of title, which, if desired, can be saved for the table of contents. To center appendix titles the Hc register must be set to 1 \[3.5.2.3\].

6.10.2.2. Hanging Indent with Tabs.

The following example uses the hanging indent feature of variable-item lists \[3.2.4\]. A user-defined macro is defined to accept four arguments that make up the mark. In the output, each argument is to be separated from the previous one by a tab; tab settings are defined later. Since the first argument may begin with a period or apostrophe, the \& is used so that the formatter does not interpret such a line as a formatter request or macro call. The 2-character sequence \& is understood by formatters to be a zero-width space. It causes no output characters to appear, but it removes the special meaning of a leading period or apostrophe. The \t is translated by the formatter into a tab. The \c is used to concatenate the input text that follows the macro call to the line built by the macro.
No hyphenation. Automatic hyphenation is turned off. Words containing hyphens (for example, mother-in-law) may still be split across lines.

Hyphenate. Automatic hyphenation is turned on.

Hyphenation indicator character is set to "c" or removed. During text processing, the indicator is suppressed and will not appear in the output. Prepending the indicator to a word has the effect of preventing hyphenation of that word.
6.11. Vertical Spacing (.SP)

There exists several ways of obtaining vertical spacing, all with different effects. The .sp request spaces the number of lines you specify unless you turn off spacing with .ns, then mm ignores the .sp request. You can restore spacing with the .rs request.

Spacing is turned off automatically at the end of a page header to eliminate spacing by a .sp or .bp request that happens to occur at the top of a page.

Use the .SP macro to avoid the accumulation of vertical space by successive macro calls.

.SP [lines]

Several .SP calls in a row will not produce the sum of the arguments but only the maximum argument. For example, the following produces only three blank lines:

.SP 2  
.SP 3  
.SP

Many mm macros use .SP for spacing. For example, if you immediately follow .LE 1 [3.2.1] with .P [3.1], mm produces only a single blank line (one-half vertical space) between the end of the list and the following paragraph. An omitted argument to .SP defaults to one blank line (one vertical space). Negative arguments are not permitted. The argument must be unscaled, but fractional amounts are permitted. The .ns request also inhibits the .SP macro (as well as the .sp request).
7. Troubleshooting and Error Messages

7.1. Error Terminations

When an mm macro detects an error, it performs the following actions:

- It performs a line break.
- It prints the formatter output buffer (which may contain some text) to avoid confusion regarding location of the error.
- It prints a short message giving the name of the macro that detected the error, type of error, and approximate line number in the current input file of the last processed input line. The last section of this chapter explains error messages.
- It stops processing unless register D (8.4) has a positive value. In the latter case, it continues processing even though the output is guaranteed to be garbled from that point on.

The error message outputs directly to your terminal. If you are using an output filter, such as 300, 450, or hp to postprocess the nroff formatter output, this message may be garbled by being intermixed with text that is held in that filter’s output buffer. If you are using any eqn/neqn or tbl material, and if the −olist option of the formatter causes the last page of the document not to be printed, a harmless "broken pipe" message may result.

7.2. Disappearance of Output

Disappearance of output usually occurs because of an unclosed diversion (for example, a missing .DE or .FE macro). Fortunately, macros that use diversions are careful about it, and these macros check to make sure that illegal nestings do not occur. If any error message is issued about a missing .DE or .FE, search backwards from the termination point and look for the corresponding .DF, .DS, or .FS (since you must use these macros in pairs).
The command `grep -n ~EDFRT\[EFNQS\] files ...` prints all the .DF, .DS, .DE, .EQ, .EN, .FS, .FE, .RS, .RF, .TS, and .TE macros found in files ..., each preceded by its file name and the line number in that file. Use this listing to check for illegal nesting and/or omission of these macros. Also, the checkmm programs finds mismatched macro pairs.

7.3. Error Messages

An mm error message has a standard part followed by a variable part. The standard part has the form:

```
ERROR : (file)input line n:
```

Variable parts consist of a descriptive message usually beginning with a macro name. Appendix D lists them in alphabetical order by macro name, each with a more complete explanation.
8. Using the \texttt{mm} Command Line

Use the \texttt{mm} command line to print documents using \texttt{nroff} and the \texttt{mm} macros. Use \texttt{mmt} to format documents with \texttt{troff} and the macros.

8.1. Typical \texttt{mm} Command Lines and Options

These are the typical command lines for \texttt{mm} (\texttt{options} are described below). Pipe results to a printer or phototypesetter as appropriate, or redirect output to a file.

- Text without tables or equations:
  \begin{verbatim}
  mm [options] file ...
  mmt options file ...
  \end{verbatim}

- Text with tables:
  \begin{verbatim}
  mm -t options file ...
  mmt -t options file ...
  \end{verbatim}

- Text with equations:
  \begin{verbatim}
  mm -e options file ...
  mmt -e options file ...
  \end{verbatim}

- Text with line pictures:
  \begin{verbatim}
  mmt -p options file ...
  \end{verbatim}

- Text with graphs:
  \begin{verbatim}
  mmt -g options file ...
  \end{verbatim}
Using the mm Command Line

- Text with both tables and equations:

  `mm -t -e options file ...`

  `mmt -t -e options file ...`

- Text with tables, equations, pictures and graphs:

  `mmt -t -e -p -g options file ...`

You can put `options` in any order you wish, but you must put them before the `file` name(s).

- `e` calls neqn (mm) or eqn (mmt) and causes it to read `/usr/pub/eqnchar`
- `c` calls col(1)
- `t` calls tbl
- `p` calls pic (use this with mmt only)
- `g` calls grap (use this with mmt only)
- `-E` calls the `-e` option of nroff

- `-12` specifies that 12 characters per inch, or 78 characters per normal output line (6 1/2 inches) are output. This specification is called "12-pitch mode." The pitch switch on your printer should be set to 12. By default, 10 characters per inch are output.

- `-Ttty_type`
  specifies to which output device you are sending your output.

When you format a document, prepare the output for a particular type of terminal, because the output may require features that are specific to that terminal. For example, some terminals produce reverse paper motion or half-line paper motion in both directions. A list of the supported terminals you may use with mm appears in the following section. (Check with your system administrator for a list of locally supported devices.)
If you use two-column processing (6.7), you must specify either the \texttt{-c} option to \texttt{mm} \texttt{mm} uses \texttt{col(1)} automatically for many terminal types\] or you must postprocess \texttt{nroff} formatter output with \texttt{col(1)}. In the latter case, you must specify the \texttt{-T37} terminal type to the \texttt{nroff} formatter, take care not to specify the \texttt{-h} option, and process the output of \texttt{col(1)} by the appropriate terminal filter (for example, \texttt{450}); \texttt{mm} with the \texttt{-c} option handles all this automatically.

8.2. Command Line Options for Specifying a Printer

Use one of the following arguments to the \texttt{mm} command line option \texttt{-T} to specify an output device to the formatter. To specify a program that drives the printer, use the \texttt{-T} option. It is a way of telling the formatter to carry out certain operations that your particular printer program can execute. Ask your system administrator what argument to \texttt{-T} is appropriate for your text formatting set-up. A list of all supported arguments (values for \texttt{tty_type}) and the devices they signify are as follows:

\texttt{-Ttty_type}

\begin{tabular}{|c|l|}
\hline
2631 & Hewlett-Packard 2631 printer in regular mode \\
2631-c & Hewlett-Packard 2631 printer in compressed mode \\
2631-e & Hewlett-Packard 2631 printer in expanded mode \\
300 & DASI-300 printer \\
300-12 & DASI-300 terminal set to 12-pitch (12 characters per inch) \\
300s & DASI-300s printer (300S is a synonym) \\
300s-12 & DASI-300s printer set to 12-pitch (12 characters per inch) (300S-12 is a synonym) \\
37 & Teletype Model 37 terminal \\
382 & DTC-382 \\
4000a & Trendata 4000a terminal (4000A is a synonym) \\
450 & DASI-450 (Diablo Hyterm) printer \\
450-12 & DASI-450 terminal set to 12-pitch (12 characters per inch) \\
832 & Anderson Jacobson 832 terminal \\
8510 & C.ITOH printer \\
lp & generic name for printers that can underline \\
\hline
\end{tabular}
and tab. (All text using reverse linefeeds, such as those having tables, that is sent to lp must be processed with \texttt{col}.) lp is the default device for \texttt{mm}.

\begin{tabular}{ll}
\texttt{tn300} & GE Terinet 300 terminal \\
\texttt{X} & printers equipped with TX print train
\end{tabular}

8.3. Giving \texttt{nroff} or \texttt{troff} the \texttt{\textasciitilde mm} Flag

You may also use the \texttt{mm} package by including the \texttt{\textasciitilde mm} flag as an argument to \texttt{nroff} or \texttt{troff}. The \texttt{\textasciitilde mm} flag causes the file /usr/lib/tmac/tmac.m to be read and processed before any other files. This action:

- defines the Memorandum Macros
- sets default values for various parameters
- initializes the formatter to be ready to process input text files

8.4. Setting Number Registers from the Command Line

With \texttt{mm}, you commonly use number registers to hold parameter values that control various aspects of output style. You can change many of these values within the text files with \texttt{.nr} requests. In addition, you can set some of these registers from the command line. This is useful when parameters should not be embedded within the input text. The number register meanings are

\begin{itemize}
\item \texttt{\textasciitilde ra\textasciitilde n} \hfill \texttt{n = 1} has effect of invoking the \texttt{.AF} macro without an argument \cite{4.1.7}.
\item \texttt{\textasciitilde rc\textasciitilde n} \hfill Sets type of copy (for example, DRAFT) to be printed at bottom of each page \cite{3.4.3}.
\texttt{n = 1} for OFFICIAL FILE COPY. \\
\texttt{n = 2} for DATE FILE COPY. \\
\texttt{n = 3} for DRAFT with single spacing and default paragraph style.
\end{itemize}
$n = 4$ for DRAFT with double spacing and 10-space paragraph indent.

`-rD1` Sets *debug* mode. This flag requests formatter to continue processing even if `mm` detects errors that would otherwise cause termination. It also includes some debugging information in the default page header [3.4.1].

`-rEn` Controls font of Subject/Date/From fields.

$n = 0$, fields are bold (default for the `troff` formatter).

$n = 1$, fields are roman font (regular text-default for the `nroff` formatter).

`-rLk` Sets length of physical page to $k$ lines.

For the `nroff` formatter, $k$ is an unscaled number representing lines.

For the `troff` formatter, $k$ must be scaled.

Default value is 66 lines per page.

This flag is used, for example, when directing output to a Versatec printer.

`-rNn` Specifies page numbering style (See Figure 8-1).

$n = 0$ (default), all pages get the prevailing header [3.4.1].

$n = 1$, page header replaces footer on page 1 only.

$n = 2$, page header is omitted from page 1.


$n = 4$, default page header is suppressed; however, a user-specified header is not affected.

$n = 5$, "section-page" and "section-figure" numbering occurs.
### Using the `mm` Command Line

<table>
<thead>
<tr>
<th>( n )</th>
<th>Page 1</th>
<th>Pages 2-end</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>header</td>
<td>header</td>
</tr>
<tr>
<td>1</td>
<td>header replaces footer</td>
<td>header</td>
</tr>
<tr>
<td>2</td>
<td>no header</td>
<td>header</td>
</tr>
<tr>
<td>3</td>
<td>&quot;section-page&quot; as footer</td>
<td>same as page 1</td>
</tr>
<tr>
<td>4</td>
<td>no header</td>
<td>no header unless .PH defined</td>
</tr>
<tr>
<td>5</td>
<td>&quot;section-page&quot; as footer and &quot;section-figure&quot;</td>
<td>same as page 1</td>
</tr>
</tbody>
</table>

Figure 15: Effects of the \( n \) Register on Page Numbering Style

Contents of the prevailing header and footer do not depend on number register \( N \) value; \( N \) controls whether the header (\( N=3 \)) or the footer (\( N=5 \)) is printed, as well as the page numbering style. If header and footer are null \( \{3.4\} \), the value of \( N \) is irrelevant.

\(-rOk\) Offsets output \( k \) spaces to the right.

For the `nroff` formatter, \( k \) is an unscaled number representing lines or character positions.

For the `troff` formatter, \( k \) must be scaled.

This flag is helpful for adjusting output positioning on some terminals. The default offset if this register is not set on the command line is 0.75 inch \((nroff)\) and 0.5 inch \((troff)\).

\(-rPn\) Specifies that pages of the document are to be numbered starting with \( n \).

This register may also be set via a \( .nr \) request in the input text.

\(-rSn\) Sets point size and vertical spacing for the document.

The default \( n \) is 10, that is, 10-point type on 12-point vertical spacing, giving six lines per inch \( \{6.5\} \).

This flag applies to the `troff` formatter only.

\(-rTn\) Provides register settings for certain devices.

If \( n \) is 1, line length and page offset are set to 80 and 3, respectively.

Setting \( n \) to 2 changes the page length to 84 lines per page.
and inhibits underlining; it is meant for output sent to the Versatec printer. This flag applies to the nroff formatter only.

\textbf{-rU1} Controls underlining of section headings. This flag causes only letters and digits to be underlined. Otherwise, all characters (including spaces) are underlined \cite{3.5.2.4.2}. This flag applies to the nroff formatter only.

\textbf{-rWk} Sets page width (line length and title length) to \textit{k}. For the nroff formatter, \textit{k} is an unscaled number representing character positions. For the troff formatter, \textit{k} must be scaled. This flag can be used to change page width from the default value of 6 inches (60 characters in 10 pitch or 72 characters in 12 pitch).
9. Appendices

9.1. Appendix A: mm Macro Name Summary

The following listing shows all the mm macros and their usage. Each item in the list gives a definition of the macro followed by its normal format and arguments. The numbers enclosed in braces {} show the section in this technical discussion where a complete explanation of each macro may be found. You do not call macros marked with an asterisk directly. They are "user exits" that you define, and they are called by the mm macros from inside header, footer, or other macros.

.1C 1-column processing {6.7}
.1C
.2C 2-column processing {6.7}
.2C
.AE Abstract end {4.2.1}
.AE
.AF Alternate format of "subject:/date:/from:" block {4.1.7}
.AF ["name of firm"]
.AL Automatically incremented list start {3.2.2}
.AL [type [text-indent [1]]]
.AS Abstract start {4.2.1}
.AS [arg [indent]]
.AT Author's title {4.1.6}
.AT [title] ...
.AU Author's information {4.1.5}
.AU name [initials [loc [dept [ext [room [arg [arg [arg]]]]]]]]]
.AV Approval signature {5.2}
.AV [name [1]]
.B bold {6.1}
.B [bold-arg [previous-font-arg]] ...
Appendices

.OK Other keywords for the Technical Memorandum cover sheet {4.2.2}
.OK [keyword] ...

.OP Odd page {6.4}
.OP

.P Paragraph {3.1}
.P [type]

.PF Page footer {3.4.3}
.PF [arg]

.PH Page header {3.4.1}
.PH [arg]

.PM Proprietary marking {4.3}
.PM [code]

.PX* Page-header user exit {3.4.9}
.PX

.R Return to regular (roman) font {6.1}
.R

.RB roman/bold {6.1}

.RD Read insertion from terminal {6.8}
.RD [prompt [diversion [string] ] ]

.RF Reference end {5.7}
.RF

.RI roman/italic {6.1}

.RL Reference list start {3.2.5}
.RL [text-indent [1] ]

.RP Produce reference page {5.7}
.RP [arg [arg]

.RS Reference start {5.7}
.RS [string-name]
Set \texttt{troff} formatter point size and vertical spacing \{6.5\}
\texttt{.S [size [spacing] ]}

Set adjustment (right-margin justification) default \{6.2\}
\texttt{.SA [arg]}

Signature line \{5.1\}
\texttt{.SG [arg [1] ]}

Skip pages \{6.3\}
\texttt{.SK [pages]}

Make a string smaller \{6.5\}
\texttt{.SM string1 [string2 [string3] ]}

Space vertically \{6.11\}
\texttt{.SP [lines]}

Table title \{3.9\}
\texttt{.TB [title [override [flag] ] ]}

Table of contents \{5.4\}

Table end \{3.7\}
\texttt{.TE}

Table header \{3.7\}
\texttt{.TH [N]}

Title of memorandum \{4.1.4\}
\texttt{.TL [charging-case [filing-case] ]}

Technical Memorandum number(s) \{4.1.2\}
\texttt{.TM [number] ...}

Top-of-page macro \{3.4.9\}
\texttt{.TP*}

Table start \{3.7\}
\texttt{.TS [H]}

Table of contents user exit \{5.5\}
\texttt{.TX*}

Table of contents user exit (suppresses "CONTENTS") \{5.4.1\}
\texttt{.TY*}
9.2. Appendix B: mm String Name Summary

The following list shows the predefined string names used by the mm macro package. The numbers in braces {} show the section in this technical discussion where more information about the string can be found.

BU  Bullet {1.4.6}
    nroff: @
    troff: *

Ci  Table of contents indent list {5.4.1}
    Up to seven scaled arguments for heading levels

DT  Date {1.2}
    Current date, unless overridden
    Month, day, year (for example, May 31, 1979)

EM  Em dash string {1.4.7}
    Produces an em dash in the troff formatter and a double
    hyphen in nroff
    nroff: \v\n+(:p\d
    troff: \v'.4m\s-3\n+(p\s0\v'.4m'

HF  Heading font list {3.5.2.4.1}
    Up to seven codes for heading levels 1 through 7
    2 2 2 2 2 2 2 (all levels given emphasis)
9.3. Appendix C: mm Number Register Summary

The list that follows contains a description of all the predefined number registers used by mm. Numbers enclosed in braces {} show the section in this technical discussion where more information about the register can be found. After each description is the normal value of the register followed by the range of allowable values, enclosed in brackets [ ]. The lower and upper limit of values are separated by a colon ( : ). An asterisk attached to a register name means that this register can be set only from the command line or before the mm macro definitions are read by the formatter. Section 1.2 has notes on setting and referencing registers. Any register having a single-character name can be set from the command line { 8.4 }. These are marked with a dagger ( † ) in the following list.

A * † Handles preprinted forms and logo
{ 8.4 } 0, [0:2]

Au Inhibits printing of author information
{ 4.1.5 } 1, [0:1]
Appendices

C *†
Copy type (original, DRAFT, and so on)
{8.4} 0 (Original), [0:4]

Cl
Level of headings saved for table of contents
{3.5.3} 2, [0:7]

Cp
Placement of list of figures, and so on
{3.9} 1 (on separate pages), [0:1]

D *†
Debug flag
{8.4} 0, [0:1]

De
Display eject register for floating displays
{3.6.2} 0, [0:1]

Df
Display format register for floating displays
{3.6.2} 5, [0:5]

Ds
Static display pre- and post-space
{3.6.1} 1, [0:1]

E *†
Controls font of the subject:/date:/from: fields
{8.4} 1 (nroff) 0 (troff), [0:1]

Ec
Equation counter, used by .EC macro
{3.9} 0, [0:?]
Incremented by one for each .EC call.

Ej
Page-ejection flag for headings
{3.5.2.1} 0 (no eject), [0:7]

Eq
Equation label placement
{3.8} 0 (right-adjusted), [0:1]

Ex
Exhibit counter, used by .EX macro
{3.9} 0, [0:?]
Incremented by one for each .EX call.

Fg
Figure counter, used by .FG macro
{3.9} 0, [0:?]
Incremented by one for each .FG call.

Fs
Footnote space (that is, spacing between footnotes)
{3.3.2} 1, [0:?]
H1-H7  Heading counters for levels 1 through 7
    {3.5.2.6} 0, [0:?]
    Incremented by the .H macro of corresponding level or the .HU macro if at level given by the Hu register. The H2 through H7 registers are reset to by any .H (.HU) macro at a lower-numbered level.

Hb  Heading break level (after .H and .HU)
    {3.5.2.2} 2, [0:7]

Hc  Heading centering level for .H and .HU
    {3.5.2.3} 0 (no centered headings), [0:7]

Hi  Heading temporary indent (after .H and .HU)
    {3.5.2.2} 1 (indent as paragraph), [0:2]

Hs  Heading space level (after .H and .HU)
    {3.5.2.2} 2 (space only after .H 1 and .H 2), [0:7]

Ht  Heading type (for .H: single or concatenated numbers)
    {3.5.2.6} 0 (concatenated numbers: 1.1.1, and so on), [0:1]

Hu  Heading level for unnumbered heading (.HU)
    {3.5.1} 2 (.HU at the same level as .H 2), [0:7]

Hy  Hyphenation control for body of document
    {1.4.4} 0 (automatic hyphenation off), [0:1]

L * †  Length of page
    {8.4} 66, [20:?]
    (11i, [2i:?] in troff formatter)

Le  List of equations
    {3.9} 0 (list not produced) [0:1]

Lf  List of figures
    {3.9} 1 (list produced) [0:1]

Li  List indent
    {3.2.1} 6 (nroff) 5 (troff), [0:?]

Ls  List spacing between items by level
    {3.2.1} 6 (spacing between all levels) [0:6]

Lt  List of tables
    {3.9} 1 (list produced) [0:1]


Appendices

Lx  List of exhibits
     \{3.9\} 1 (list produced) [0:1]

N  * †  Numbering style
     \{8.4\} 0, [0:5]

Np  Numbering style for paragraphs
     \{3.1.2\} 0 (unnumbered) [0:1]

O  * †  Offset of page
     \{8.4\} .75i, [0:?]
     (0.5i, [0:?] in \texttt{troff} formatter)
     For \texttt{nroff} formatter, these values are unscaled numbers
     representing lines or character positions. For \texttt{troff} formatter,
     these values must be scaled.

Oc  Table of contents page numbering style
     \{5.4.1\} 0 (lower-case roman), [0:1]

Of  Figure caption style
     \{3.9\} 0 (period separator), [0:1]
     P † Page number managed by \texttt{mm}
     \{8.4\} 0, [0:?]

Pi  Paragraph indent
     \{3.1.3\} 5 (\texttt{nroff}) 3 (\texttt{troff}), [0:?]

Ps  Paragraph spacing
     \{3.1.1\} 1 (one blank space between paragraphs), [0:?]

Pt  Paragraph type
     \{3.1.1\} 0 (paragraphs always left justified), [0:2]

Pv  "PRIVATE" header
     \{3.4.9\} 0 (not printed), [0:2]

Rf  Reference counter, used by \texttt{.RS} macro
     \{5.8\} 0, [0:?]
     Incremented by one for each \texttt{.RS} call.

S  * †  The \texttt{troff} formatter default point size
     \{8.4\} 10, [6:36]

Si  Standard indent for displays
     \{3.6.1\} 5 (\texttt{nroff}) 3 (\texttt{troff}), [0:?]


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T * † Type of nroff output device
{8.4} 0, [0:2]

Tb Table counter, used by .TB macro
{3.9} 0, [0:?]
Incremented by one for each .TB call.

U * † Underlining style (nroff) for .H and .HU
{8.4} 0 (continuous underline when possible), [0:1]

W * † Width of page (line and title length)
{8.4} 6i, [10:1365]
(6i, [2i:7.54i] in the troff formatter)

9.4. Appendix D: ERROR MESSAGES

When processing text using the mm macro package, mm will report any errors it can detect. Since the macros are written in the basic formatter primitives, other errors may be found and reported by the formatter.

An mm error message has a standard part followed by a variable part. The standard part has the form:

ERROR:(filename) input line n:

The variable part consists of a descriptive message, usually beginning with a macro name. The variable parts are listed alphabetically by macro name below:

CS:cover sheet too long
Text of the cover sheet is too long to fit on one page. The abstract should be reduced or the indent of the abstract should be decreased.

DE:no DS or DF active
A .DE macro has been encountered, but there has not been a previous .DS or .DF macro to match it.

DF:illegal inside TL or AS
Displays are not allowed in the title or abstract.
DF:missing DE
A .DF macro occurs within a display, that is, a .DE macro has been omitted or mistyped.

DF:missing FE
A display starts inside a footnote. The likely cause is the omission (or misspelling) of a .FE macro to end a previous footnote.

DF:too many displays
More than 26 floating displays are active at once, that is, have been accumulated but not yet output.

DS:illegal inside TL or AS
Displays are not allowed in the title or abstract.

DS:missing DE
A .DS macro occurs within a display, that is, a .DE has been omitted or mistyped.

DS:missing FE
A display starts inside a footnote. The likely cause is the omission (or misspelling) of a .FE to end a previous footnote.

FE:no FS active
A .FE macro has been encountered with no previous .FS to match it.

FS:missing DE
A footnote starts inside a display, that is, a .DS or .DF occurs without a matching .DE.

FS:missing FE
A previous .FS macro was not matched by a closing .FE, that is, an attempt is being made to begin a footnote inside another one.
H:bad arg:value
     The first argument to the .H macro must be a single digit from one
to seven, but value has been supplied instead.

H:missing arg
     The .H macro needs at least one argument.

H:missing DE
     A heading macro (.H or .HU) occurs inside a display.

H:missing FE
     A heading macro (.H or .HU) occurs inside a footnote.

HU:missing arg
     The .HU macro needs one argument.

LB:missing arg(s)
     The .LB macro requires at least four arguments.

LB:too many nested lists
     Another list was started when there were already six active lists.

LE:mismatched
     The .LE macro has occurred without a previous .LB or other list- ini-
tialization macro [3.2]. This is not a fatal error. The message is
issued because there exists some problem in the preceding text.

LI:no lists active
     The .LI macro occurred without a preceding list-initialization macro.
The latter probably has been omitted or entered incorrectly.

LO: Required argument missing
     The .LO macro requires an argument.
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LO: LO argument not recognized
You have provided an argument to .LO that it does not recognize.

LT: LT argument not recognized
You have provided an argument to .LT that it does not recognize.

ML: missing arg
The .ML macro requires at least one argument.

ND: missing arg
The .ND macro requires one argument.

RF: no RS active
The .RF macro has been encountered with no previous .RS to match it.

RP: missing RF
A previous .RS macro was not matched by a closing .RF.

RS: missing RF
A previous .RS macro was not matched by a closing .RF.

S: bad arg: value
The incorrect argument value has been given for the .S macro {6.5}.

SA: bad arg: value
The argument to the .SA macro (if any) must be either 0 or 1. The incorrect argument is shown as value.

SG: missing DE
The .SG macro occurred inside a display.

SG: missing FE
The .SG macro occurred inside a footnote.

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SG: no authors

The .SG macro occurred without any previous .AU macro(s).

Check TL, AU, AS, AE, MT sequence

The correct order of macros at the start of a memorandum is shown in section 4.1.8. Something has disturbed this order.

Check TL, AU, AS, AE, NS, NE, MT sequence

The correct order of macros at the start of a memorandum is shown in section 4.1.8. Something has disturbed this order. (_occurs if the .AS 2 [4.1.9] macro was used.)

VL: missing arg

The .VL macro requires at least one argument.

Check WA, WE, IA, IE, LT sequence

The correct order of these macros is shown in section 4.2.6. Something has disturbed this order.

)W: WA macro missing

If you use .LT, you must specify at least one .WA-.WE pair.

)W: WA or WE macro missing

If you use .WA or .WE, you must specify the other member of the macro pair.

)W: WA, WE, or IE macro missing

You have omitted either or both of the .IA and .IE macros.

WC: unknown option

An incorrect argument has been given to the .WC macro.
9.5. Appendix E: The Define File—
/usr/lib/macros/strings.mm

."" Copyright (c) 1984 AT&T
."" All Rights Reserved
."" THIS IS UNPUBLISHED PROPRIETARY SOURCE CODE OF AT&T
."" The copyright notice above does not evidence any actual
."" or intended publication of such source code.
."" @(#)macros:strings.mm 1.5
."" \"tab\ begins comments.
."" No comments should appear on the same line as the string
."" definition.
.""
."" The following string is used by the macro MT.
."" \"S defined as logo character
.ds }S
."" }Z Company Name
.ds }Z AT&T Bell Laboratories
.""
."" The following strings are used by the macro PM
.""
."" Proprietary marking "PM1" (BP, N, P and BPN) lines 1-4
.ds }M AT&T BELL LABORATORIES - PROPRIETARY
.ds }O Use pursuant to G.E.I. 2.2
.ds }Q
.ds }R
."" Proprietary marking "PM2" (CA) lines 1-4
.ds }A THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF
.ds }F AT&T AND IS NOT TO BE DISCLOSED OR USED EXCEPT IN
.ds }G ACCORDANCE WITH APPLICABLE CONTRACTS OR AGREEMENTS.
.ds }H
."" Proprietary marking "PM3" (CP) lines 1-4
.ds }I SEE PROPRIETARY NOTICE ON COVER PAGE
.ds }J
.ds }K
.ds }L
."" Proprietary marking "PM4" (BPP and BR) lines 1-4
.ds }U AT&T BELL LABORATORIES - PROPRIETARY (RESTRICTED)
Appendices
9.6. Appendix F: Sample Footnotes

Input:

.FD 10
.P
This example illustrates several footnote styles for both labeled and automatically numbered footnotes. First input, then output is shown. With the footnote style set to the default style, the first footnote is processed.

.FS
This is the first footnote text example. This is the default style (F.D 10). The right margin is not justified, hyphenation is not permitted, text is indented, and the automatically generated label is right justified in the text-indent space.

.FE
and followed by a second footnote.*****

.FS *****
This is the second footnote text example. This is also the default style (.FD 10) but with a long footnote label (***** ) provided by the user.

.FE
.FD 1
Footnote style is changed by using the .FD macro to specify hyphenation, right margin justification, indentation, and left justification of the label. This produces the third footnote, F.

.FS
This is the third footnote example (FD 1). The right margin is justified, the footnote text is indented, and the label is left justified in the text-indent space. Although not necessarily illustrated by this example, hyphenation is permitted.

.FE
and then the fourth footnote.
This is the fourth footnote example (.FD 1).
The style is the same as the third footnote.

Footnote style is set again via the .FD macro for no hyphenation,
no right margin justification,
no indentation, and with the label left justified.
This produces the fifth footnote.

This is the fifth footnote example (.FD 6).
The right margin is not justified, hyphenation is not permitted,
footnote text is not indented,
and the label is placed at the beginning of the first line.
This example illustrates several footnote styles for both labeled and automatically numbered footnotes. First input, then output is shown. With the footnote style set to the default style, the first footnote is processed and followed by a second footnote. Footnote style is changed by using the .FD macro to specify hyphenation, right margin justification, indentation, and left justification of the label. This produces the third footnote, then the fourth footnote. Footnote style is set again via the .FD macro for no hyphenation, no right margin justification, no indentation, and with the label left justified. This produces the fifth footnote.

1. This is the first footnote text example. This is the default style (.FD 10). The right margin is not justified, hyphenation is not permitted, text is indented, and the automatically generated label is right justified in the text-indent space.

2. This is the second footnote text example. This is also the default style (.FD 10) but with a long footnote label (••••••) provided by the user.

3. This is the third footnote example (.FD 1). The right margin is justified, the footnote text is indented, and the label is left justified in the text-indent space. Although not necessarily illustrated by this example, hyphenation is permitted.

4. This is the fourth footnote example (.FD 1). The style is the same as the third footnote.

5. This is the fifth footnote example (.FD 6). The right margin is not justified, hyphenation is not permitted, footnote text is not indented, and the label is placed at the beginning of the first line.
9.7. Appendix G: Formal Memorandum

Input:

.ND "September 28, 1984"
.TL
Document Production Coordinator
.AU "John Smith" JJS XF 5414 6398 7-123 machine_5!jjs
.AF "Business Computer Systems, Inc."
.MT 0
.P
Business Computer Systems, Inc. (BCS) has job
openings for people that
can do the following tasks:
.AL
.LI
Develop methods for producing
documentation
.LI
Perform duties resulting from the development of these methods.
For example,
.BL
.LI
Use text processing with UNIX* DOCUMENTER'S WORKBENCH*
.FS *
Trademark of AT&T
.FE
(mm, nroff, tbl) to:
.DL
.LI
Prepare documents and tables
.LI
Develop new macro commands
.LE
.LI
Serve as a point of contact for BCS with printers and
distributors.
.LE
.LI
If the job holder’s interests and writing skills match the needs of the Technical Writing Staff, write documents.

BCS Technical Writing Staff
Business Computer Systems, Inc. (BCS) has job openings for people that can do the following tasks:

1. Develop methods for producing documentation

2. Perform duties resulting from the development of these methods. For example:

   - Use text processing with UNIX* DOCUMENTER'S WORKBENCH* (mm, nroff, tbl) to:
     - Prepare documents and tables
     - Develop new macro commands

   - Serve as a point of contact for BCS with printers and distributors.

3. If the job holder's interests and writing skills match the needs of the Technical Writing Staff, write documents.

John Smith

Copy to
BCS Technical Writing Staff

* Trademark of AT&T
Appendices

9.8. Appendix H: Business Letter

Input:

.OA AT "Personnel"
.OA "Bill Taylor" "Director of Placement Services"
Columbia University
116th Street
New York, NY 10019
.OE
.OA SA "Dear Dr. Smith:"
.OA RN "Career Day"
.OA "Rebecca Smith"
Business Computer Systems, Inc.
190 River Boulevard
Durham, N.C. 27707
.OE
.OE BL
.P

We would be happy to include a representative of your company in our "Career Day" program this spring.
I am forwarding your request to James Blinn, who is organizing the event this year.
.P
Thank you for your interest in our placement programs.
.FC "Sincerely,"
.SG
.NS 5
.NE
.NS
J. Blinn
.NE
Columbia University
116th Street
New York, NY 10019
December 15, 1985

In reference to: Career Day

Rebecca Smith
Business Computer Systems, Inc.
190 River Boulevard
Durham, N.C. 27707

ATTENTION: Personnel

Dear Dr. Smith:

We would be happy to include a representative of your company in our “Career Day” program this spring. I am forwarding your request to James Blinn, who is organizing the event this year.

Thank you for your interest in our placement programs.

Sincerely,

Bill Taylor
Director of Placement Services

JL-der
Enc.
Copy to
J. Blinn
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1. Introduction

This is a technical discussion of tbl, a program that you use to produce simple and complex tables. Read this if you have had some experience with tbl; if you have never used tbl before, you should read the tutorial "The Preprocessor tbl" in the User's Guide.

Tables that you format with tbl consist of columns that you may center, right-adjust, left-adjust, or align according to digit and decimal point. You may place labels over single columns or groups of columns. A table entry may contain equations or consist of several rows of text. You may draw horizontal or vertical lines in the table, and you may enclose any table or element in a box.
2. Table Delimiters (.TS and .TE)

Delimit tables with the macro pair .TS (table start) and .TE (table end). tbl processes certain commands (options, key letters, and commands specifying such details as point size and font control) that it finds between this macro pair, and it generates formatting requests, escape sequences, defined strings, and number registers. The .TS and .TE lines are copied so that nroff/troff formatter layout macros (such as mm formatting macros) can use these lines as delimiters. The general format of a file that you would submit to tbl is

```
text
.TS
table
.TE
.text
.TS
table
.TE
.text
```

The format of each table is

```
.TS
-global options;
-format section.
data
.TE
```
Each table is independent and contains

- Global options that affect the layout of the whole table
- A format section that describes individual columns and rows of the table
- Data that you want printed

Unlike the options section, the format section and data are always required.
3. Global Options

You may specify a single line of options to affect the layout of the whole table. These must be placed immediately after the .TS line. On this line, you must separate options with spaces, tabs, or commas. You must end the options line with a semicolon. Allowable options are

- **center** centers the table (default is left-adjusted)
- **expand** makes the table as wide as current line length
- **box** encapsulates the table in a box
- **allbox** encloses each data entry of the table in a box
- **doublebox** encapsulates the table in two boxes
- **tab (x)** separates data entries by using x instead of tab
- **linesize (n)** sets lines or rules (for example, from box) in \(n\)-point type
- **delim (xx)** recognizes x and \(x\) as eqn delimiters.
4. Format Section

The format section of the table specifies the layout of the columns. Each line in the format section corresponds to one line of table data except the last format line, which corresponds to all following data lines up to any additional .T& command line. (.T& is described below.) Each format line contains a key letter for each column of the table.

4.1. Key Letters

In the format section, you may separate key letters with spaces or tabs to improve readability, but spaces or tabs are not necessary. A dot (.) indicates the end of key letters and should follow the last key letter before data is entered in the lines below. Key letters are

- L or l specifies a left-adjusted column entry
- R or r specifies a right-adjusted column entry
- C or c specifies a centered column entry
- N or n specifies a numerical column entry. Numerical entries are aligned according to digit and decimal point.
- A or a specifies an alphabetic subcolumn. All entries in an alphabetic subcolumn are aligned on the left and positioned so that the widest entry is centered within the column.
- S or s specifies a spanned heading. The entry from the previous column continues across this column. You may not use this key letter for the first column of a table.
- ^ specifies a vertically spanned heading. The entry from the previous row continues down through this row. You may not use this key letter for the first row of a table.

The layout of key letters in the format section resembles the layout of the data in the table. Thus, a simple 3-column format might appear as

css
lmn.
Format Section

The first line of the table contains a heading centered across all three columns. Each remaining line of the table contains a left-adjusted item in the first column followed by two columns of numerical data. A sample table in this format is

CENTERED HEADING
Item-a 34.22 9.1
Item-b 12.65 .02
Item-c 23 5.8
Total 69.87 14.92

Instead of listing the format of successive lines of a table on consecutive lines of the format section, you may give successive line formats on the same line, separated by commas. That is, you can specify the format for the above example like this:

c s s, l n n.

Again, signal the end of the key letter section with a dot (.).

When you specify numerical column alignment (n), tbl seeks a location for the decimal point. The rightmost dot (.) adjacent to a digit is used as a decimal point. If there is no dot adjoining a digit, the rightmost digit is used as a units digit. If you do not specify alignment, the item is centered in the column. However, you may use the escape sequence \& (a zero-width character) to override dots and digits or to align alphabetic data. This aligns the dots, and the \& disappears from the final output. In the following example, the output column shows how items in the input column are aligned in a numerical column.
If you use numerical data in the same column with wider L or r type table entries, tbl centers the widest number relative to the wider L or r items and preserves alignment within the numerical items. This is similar to the behavior of a type data. Alphabetic subcolumns (requested by the a key letter) are always slightly indented relative to L items. If necessary, the column width is increased to force this. This is not true for n type entries. You should not use n and a items in the same column.

### 4.2. Additional Features

Additional features of the key letter system are

**Horizontal lines**

You may replace a key letter by an underscore (_) to specify a horizontal line in place of the column entry, or an equal sign (=) to specify a double horizontal line. If an adjacent column contains a horizontal line or if there are vertical lines adjoining this column, the horizontal line extends to meet nearby lines. If you provide any data entry for a column containing an underscore or an equals sign, tbl ignores the entry and prints a warning message.
Vertical lines

If you place a vertical bar (|) between column key letters, a vertical line appears between the corresponding columns of the table. A vertical bar to the left of the first key letter or to the right of the last one produces a line at the edge of the table. If two vertical bars appear between key letters, `tbl` draws a double vertical line.

Space between columns

You may follow a key letter with a number to show the amount of separation between this column and the next. The number specifies the separation in ens. One en is a relative measure about the width of the letter "n" in the current point size. More precisely, an en is the number of points (1 point = 1/72 inch) equal to half the current type size. If you use the `expand` global option, these numbers are multiplied by a constant so that the table is as wide as the current line length. The default column separation number is 3. If you change the separation number, the largest space requested prevails.

Vertical spanning

Vertically spanning entries extending over several rows of the table are centered in their vertical range. If you follow a key letter with t or T, any corresponding vertically spanned item begins at the top line of its range.

Font changes

You may specify that the corresponding column should be in a different font from the default font (usually roman) by following a key letter with the letter f or F and a character naming the desired font. You should put a space or a tab between a 1-letter font name and whatever follows. The single letters B, b, I, and i are shorter synonyms for `fb` and `fi`. Font-change requests given with the data override these specifications.

Point size changes

You may specify the point size of the corresponding table entries by following a key letter with p or P and a number. If p or P is followed by an arithmetic expression, such as +2, the formatter interprets it as an increment (or decrement in the case of −2) from the current
point size. If you give both a point size and a column separation value, you must separate them with one or more blanks.

Vertical spacing changes
You may specify the vertical line spacing used within a multi-line data entry by following a key letter with v or V and a number. The formatter interprets an arithmetic expression (+2 or −2, for example) as an increment or decrement from the current vertical spacing. You must separate a column separation value by blanks or some other specification from a vertical spacing request. This request has no effect unless the corresponding data entry is a text block.

Column width indication
You may specify minimum column width by following a key letter with w or W and a width value in parentheses (for example, cw(5)). If the largest element in the column is not as wide as this specified width value, the formatter uses the width value to determine column size. If the largest element in the column is wider than the value you specify, the width of the largest element determines column width.

The formatter also uses the width value as a default line length for included text blocks. You can use normal nroff/troff formatter dimensions, such as i, m, n, v, or u to scale the width value. (See the "nroff/troff Technical Discussion".) If you do not specify a scale, the formatter uses ens. If the width value is an unscaled integer, you may omit the parentheses. If you give another width value in a column, the last one you specify controls the width.

Equal-width columns
If you follow a key letter by e or E, you specify equal-width columns. The formatter makes all columns whose key letters are followed by e or E the same width.

Staggered columns
You may specify that the corresponding entry is to be moved up one-half line by following a key letter with u
or U. This makes it easy to have a column of differences between numbers in an adjoining column. The allbox option does not work with staggered columns.

Zero-width item

A key letter followed by z or Z specifies that the corresponding data item is to be ignored in calculating column widths. This may be useful in allowing headings to run across adjacent columns where spanned headings would be inappropriate.

Default

Column descriptors missing from the end of a format line are assumed to be L. That is, if you have more columns of data than descriptors to specify them, the data in the unspecified columns are left-justified. The longest line in the format section defines the number of columns in the table. tbl ignores columns in the data if there are not corresponding key letters in the format section.

As some examples in the "tbl Sampler," the features need not be separated by spaces except to avoid ambiguities involving point size and font changes. Thus, a numerical column entry in italic font and 12-point type with a minimum width of 2.5 inches and separated by 6 ens from the next column could be specified as

np12w(2.5i)fI 6
5. Data

Put table data after the format section, typing each line of the table as one line of data. You may break a long input line into smaller lines by ending each short line, except the last, with a backslash. The resulting output line is as long as the combined parts.

Data to be placed in different columns (data entries) should be separated with tabs or with whatever character you specify in the tab global option. There are a few special cases of data entries:

- **nroff/troff commands within tables**
  - tbl assumes that an input line beginning with a dot is a request to the formatter and interprets it accordingly, retaining its position in the table. For example, a space within a table may be produced with the .sp request in the data.

- **Full width horizontal lines**
  - tbl interprets a data line containing only the _ (underscore) character or = (equal sign) to be a single or double line, respectively, extending the full width of the table.

- **Single column horizontal lines**
  - tbl interprets a data entry containing only the _ character or the = to be a single or double line extending the full width of the column. Such lines extend to meet horizontal or vertical lines adjoining this column. To obtain these characters explicitly in a column, precede them with the escape sequence \&, or follow them with a space before the usual tab or newline character.

- **Short horizontal lines**
  - A data entry containing only the string _ is assumed to be a single line as wide as the contents of the column. It does not extend to meet adjoining lines.

- **Repeated characters**
  - A data entry containing only a string of the form \Rx, where x is any character, is replaced by repetitions of the character x as wide as data in the column. The sequence does not extend to meet adjoining columns.
Vertically spanned entries

A data entry containing only the escape sequence \" specifies that the data entry immediately above it spans downward over the corresponding row. It is equivalent to a table format key letter of \.

Text blocks

To include a block of text as a data entry, precede it by T{ and follow it by T}. Thus, the sequence

... T{
  block of
text
T} ...

is a convenient method for inserting data not easily placed between tabs. You may put T{ (the beginning delimiter) anywhere in the data section. Do not put any character to the immediate right of this delimiter. You must put T} (the end delimiter) at the beginning of a line, and you may follow T} with a tab or tab character. You may follow the tab with additional columns of data on the same line. Table 4 in the "tbl Sampler" shows how to use text blocks.

Text blocks are pulled out from the table, processed separately by the formatter, and replaced in the table as a solid block. Various limits in the nroff/troff program are likely to be exceeded if 30 or more text blocks are used in a table. This produces diagnostic messages such as Too many text block diversions; tbl quits, Too many string/macro names, or Too many number registers.

If no line length is specified in the block of text or in the table format, the default is to use

\[ L \times C / (N + 1) \]

where \( L \) is the current line length, \( C \) is the number of table columns spanned by the text, and \( N \) is the total columns in the table.
Other parameters (point size, font, and so on) that you may use in typesetting the text block are

- those in effect at the beginning of the table (including the effect of the .TS macro)
- any table format specifications of size, spacing, and font using the p, v, and f modifiers to the column key letters
- nroff/troff requests within the text block itself (requests within the data but not within the text block itself do not affect that block).

Although you may put many lines in a table, tbl uses only the first 200 lines to create the table. Similarly, column adjustment is determined for the first 200 lines only. You may arrange a multi-page table as several single-page tables if these limits prove to be a problem.

When calculating column widths, tbl assumes that all data entries are in the font and size being used when the formatter encounters .TS. This is true except for font and size changes specified in the table format section (see Table 7 in the "tbl Sampler" or within the table data (as mentioned in the section "Data"). You may sprinkle nroff/troff requests throughout a table, but take care not to confuse tbl's width calculations.
6. Additional Command Lines

To change the format of a single table, use the .T& (table continue) command. Such a table would look like this:

```
.TS
global options ;
format section .
data
...
.TE
new format section .
data
.TE
newer format section .
data
.TE
```

Using this procedure, each table line can be close to its corresponding format line. It is not possible to change the number of columns, the space between columns, the global options such as box, or the selection of columns to be made equal in width in additional command lines. tbl does not recognize this command after the first 200 lines of a table.
7. Using the tbl Command

As the term "preprocessor" implies, you process a file with tbl before you run nroff or troff. On the UNIX system, the tbl program can process a simple table with the nroff commands

```
tbl -TX file | nroff [option(s)]
```

or

```
mm -t [option(s)] file
```

For troff output you can use

```
tbl file | troff [option(s)]
```

or

```
mmt -t [option(s)] file
```

When there are several input files containing tables, equations, pictures, and mm macro requests, type

```
tbl -TX file1 file1... | neqn | nroff -mm
```

For troff output type

```
tbl -TX file1 file2... | eqn | troff -mm
```

The next section explains the rationale for placing tbl before eqn).

Notice that you may specify options usually used with the nroff formatter. Using nroff/troff is similar to using nroff. If you specify "-" as the file name, tbl reads the standard input at that point.

The special -TX command-line option to tbl produces output without fractional line motions to accommodate line printers without adequate driving tables or postprocessors. That is, this option tells tbl to process data in terms of full line motions.
7.1. Equations in Tables

When both tbl and eqn programs operate on the same file, you should call tbl first. If there are no equations within tables, either sequence works. It is usually faster to execute tbl first because eqn normally produces a larger expansion of the input. However, if you have equations within tables (using eqn's delim statement, see Table 5 in the "tbl Sampler"), you must execute tbl first, or the output will be scrambled. You should avoid use of eqn's equations in n-style (numeric) columns since tbl attempts to split numerical format items into two parts, and the delim (xx) statement prevents splitting numerical columns within delimiters. For example, if the eqn delimiters are $$, a delim ($$) statement causes a numerical column entry such as

1245 $$(- 16$$

to be divided after 1245, not after 16.

7.2. Using Number Registers

The tbl program accepts up to 35 columns of data; this figure may be compromised depending on the availability of nroff/troff formatter number registers. tbl itself must define several macros and number registers. As a result, you must not use the following names for macros that you create: #f, #o, #+, #%, #&, and #. You must also avoid using number registers named by tbl. These include 2-digit numbers from 31 to 99 and strings of the form 4x, 5x, #x, x+, x|, "x, and x–, where x is any lower-case letter. The register names ##, #–, #", #+, #T, and T# are also used by tbl in certain circumstances. To conserve register names, the n and a key letters share a register; hence the restriction that you may not use them in the same column of the format section.

As an aid in writing layout macros, tbl defines the number register TW, which is the table width, by the time that the .TE macro is invoked. You may use the register in the expansion of .TE. More important, to assist in laying out multi-page boxed tables, the macro T# is defined to produce the bottom lines and side lines of a boxed table and then to be invoked at its end.
You can print a multi-page boxed table with a repeated heading by giving the argument H to the .TS macro. If the table start macro is written

```
.TS H
```
then, a line of the form

```
.TH
```
must be given in the table after any table heading (or at the start if none). Material up to the .TH is placed at the top of each page of the table. The remaining lines in the table are placed on several pages as required. This is a feature of the mm macros, not of tbl.
8. tbl Sampler

The following tables illustrate basic concepts of the tbl program. The <TAB> symbol in the input data represents a tab character produced by typing \t or by pressing the tab key. Although each table shows particular options or features, you may glean other information about usage from them.

The following pages contain successive examples of matching input and output to provide models for making a variety of tables. The general format of the "tbl Sampler" is to show the contents of an input file, as read at a terminal, on the left page:

Input:

```
.TS
option option option option ;
key letter descriptor key letter descriptor
key letter descriptor key letter descriptor
key letter descriptor key letter descriptor
key letter descriptor key letter descriptor
key letter descriptor key letter descriptor.

table heading data
optional double or single horizontal line
data entry <TAB> data entry <TAB> data entry
optional double or single horizontal line
data entry <TAB> data entry <TAB> data entry
optional double or single horizontal line
data entry <TAB> data entry <TAB> data entry
.
.TE
```
On the opposite right page, a corresponding example of output appears.

Output:

```
| table heading data |
|---------------------|-----------------|-----------------|
| data entry          | data entry      | data entry      |
| data entry          | data entry      | data entry      |
| data entry          | data entry      | data entry      |
```

The command line used for most of the examples below is as follows:

```
tbl  file  | troff  | phototypesetter
```

Table 5 required

```
tbl  file  | eqn  | troff  | phototypesetter
```

in order to process the equations made with eqn.
Table 1: Using Horizontal Lines in Place of Key Letters

Input:

.TS
box;
L L L
L L
L L L L
L L L
j l
L L L
january <tw> february <tw> march
april <tw> may
june <tw> july <tw> months
august <tw> september
october <tw> november <tw> december
.TE
Output:

<table>
<thead>
<tr>
<th>january</th>
<th>february</th>
<th>march</th>
</tr>
</thead>
<tbody>
<tr>
<td>april</td>
<td>may</td>
<td></td>
</tr>
<tr>
<td>june</td>
<td>july</td>
<td></td>
</tr>
<tr>
<td>august</td>
<td>september</td>
<td></td>
</tr>
<tr>
<td>october</td>
<td>november</td>
<td>december</td>
</tr>
</tbody>
</table>

*Months*
### Table 2: Changing Point Size of One Column

**Input:**

```plaintext
.TS  
c  c  
np=2 i n l .  
<TAB> Stack  
<TAB> -  
1 <TAB> 46  
<TAB> -  
2 <TAB> 23  
<TAB> -  
3 <TAB> 15  
<TAB> -  
4 <TAB> 6.5  
<TAB> -  
5 <TAB> 2.1  
<TAB> -  
.TE  
```
Output:

<table>
<thead>
<tr>
<th>Stack</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>46</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>6.5</td>
</tr>
<tr>
<td>5</td>
<td>2.1</td>
</tr>
</tbody>
</table>
Table 3: Using Additional Command Lines

Input:

```plaintext
.TS
box,center;
cf3 s s s.
Composition of Foods

.TA
cline
c:css
c:css
c:ccc:
Food <TAB> Percent by Weight
\" <TAB>
\" <TAB> Protein <TAB> Fat <TAB> Carbo-
\" <TAB> \" <TAB> \" <TAB> hydrate

:T.

Apples <TAB> .4 <TAB> .5 <TAB> 13.0
Halibut <TAB> 18.4 <TAB> 5.2 <TAB> ...
Lima beans <TAB> 7.5 <TAB> .8 <TAB> 22.0
Milk <TAB> 3.3 <TAB> 4.0 <TAB> 5.0
Mushrooms <TAB> 3.5 <TAB> .4 <TAB> 6.0
Rye bread <TAB> 9.0 <TAB> .6 <TAB> 52.7
```
## Composition of Foods

<table>
<thead>
<tr>
<th>Food</th>
<th>Protein</th>
<th>Fat</th>
<th>Carbohydrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>.4</td>
<td>.5</td>
<td>13.0</td>
</tr>
<tr>
<td>Halibut</td>
<td>18.4</td>
<td>5.2</td>
<td>...</td>
</tr>
<tr>
<td>Lima beans</td>
<td>7.5</td>
<td>.8</td>
<td>22.0</td>
</tr>
<tr>
<td>Milk</td>
<td>3.3</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Mushrooms</td>
<td>3.5</td>
<td>.4</td>
<td>6.0</td>
</tr>
<tr>
<td>Rye bread</td>
<td>9.0</td>
<td>.6</td>
<td>52.7</td>
</tr>
</tbody>
</table>
Table 4: Using Text Blocks and Controlling Column Width

Input:

```
.TS
allbox;
cf2 s s
cw(1i) cw(1.5i) cw(1.5i)
1 1 1.
New York Area Rocks
.sp
Era <TAB> Formation <TAB> Age (years)
Precambrian <TAB> Reading Prong <TAB> >1 billion
Paleozoic <TAB> Manhattan Prong <TAB> 400 million
Mesozoic <TAB> T
Newark Basin, incl.
Stockton, Lockatong,
and Brunswick
formations
T) <TAB> 200 million
Cenozoic <TAB> Coastal Plain <TAB> T
On Long Island
30,000 years;
Cretaceous sediments
redeposited
by recent
 glaciation
T)
.TE
```
Output:

<table>
<thead>
<tr>
<th>Era</th>
<th>Formation</th>
<th>Age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precambrian</td>
<td>Reading Prong</td>
<td>&gt;1 billion</td>
</tr>
<tr>
<td>Paleozoic</td>
<td>Manhattan Prong</td>
<td>400 million</td>
</tr>
<tr>
<td>Mesozoic</td>
<td>Newark Basin, incl., Stockton, Lockatong, and Brunswick formations</td>
<td>200 million</td>
</tr>
<tr>
<td>Cenozoic</td>
<td>Coastal Plain</td>
<td>On Long Island 30,000 years; Cretaceous sediments redeposited by recent glaciation</td>
</tr>
</tbody>
</table>
### Table 5: Including Equations

**Input:**

```
.TE
.delim $$
.EN

.TS
doublebox;
  c c
  1 1.
Name <TAB> Definition
.sp
.vs +2p
Gamma <TAB> $\text{\textsc{Gamma}} (z) = \int_0^\infty t^{z-1} e^{-t} \, dt$
Sine <TAB> $\sin(x) = \frac{1}{2i} (e^{ix} - e^{-ix})$
Error <TAB> $\text{\textsc{error}} (z) = 2 \sqrt{\pi} \int_0^z e^{-t^2} \, dt$
Bessel <TAB> $J_0 (z) = \frac{\cos(z \sin \theta) \, d\theta}{\pi}$
Zeta <TAB> $\zeta (s) = \sum_{k=1}^{\infty} k^{-s} \text{Re}(-s > 1)$
.vs -2p
.sp 2p
.TE
```
Output:

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamma</td>
<td>$\Gamma(z) = \int_0^\infty t^{z-1}e^{-t} dt$</td>
</tr>
<tr>
<td>Sine</td>
<td>$\sin(x) = \frac{1}{2i}(e^{ix} - e^{-ix})$</td>
</tr>
<tr>
<td>Error</td>
<td>$\text{erf}(z) = \frac{2}{\sqrt{\pi}} \int_0^z e^{-t^2} dt$</td>
</tr>
<tr>
<td>Bessel</td>
<td>$I_0(z) = \frac{1}{\pi} \int_0^\pi \cos(z\sin\theta)d\theta$</td>
</tr>
<tr>
<td>Zeta</td>
<td>$\zeta(s) = \sum_{k=1}^{\infty} k^{-s}$ (Re $s &gt; 1$)</td>
</tr>
</tbody>
</table>
Table 6: Using Additional Command Lines and Defining Tab Character

Input:

```
.TS
.tab(<TAB>);
cs
ciss
1n
an.

Some London Transport Statistics
(Year 1964)
Railway route miles <TAB> 244
Tube <TAB> 66
Sub-surface <TAB> 22
Surface <TAB> 156
.sp .5
.TA
1r
1n

Passenger traffic \- railway
Journeys <TAB> 674 million
Average length <TAB> 4.55 miles
Passenger miles <TAB> 3,066 million
.TA
1r
1n

Passenger traffic \- road
Journeys <TAB> 2,252 million
Average length <TAB> 2.26 miles
Passenger miles <TAB> 5,094 million
.TA
1n
an.

.sp .5
Vehicles <TAB> 12,521
Railway motor cars <TAB> 2,905
Railway trailer cars <TAB> 1,269
Total railway <TAB> 4,174
Omnibuses <TAB> 8,347
```
Some London Transport Statistics
(Year 1964)

Railway route miles 244
  Tube 66
  Sub-surface 22
  Surface 156

Passenger traffic – railway
  Journeys 674 million
  Average length 4.55 miles
  Passenger miles 3,066 million

Passenger traffic – road
  Journeys 2,252 million
  Average length 2.26 miles
  Passenger miles 5,094 million

Vehicles 12,521
  Railway motor cars 2,905
  Railway trailer cars 1,269
  Total railway 4,174
  Omnibuses 8,347
Table 7: Using Different Point Sizes and Column Widths

Input:

```plaintext
.TS
box tab( <TAB> );
cbssss
clccss
ltiw(1i)!ltw(1.5i)p8!lp8!lw(1.5i)p8.
Some Interesting Places

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Practical Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Museum of Natural History</td>
<td>The collections fill 11.5 acres (Michelin) or 25 acres (MTA) of exhibition halls on four floors. There is a full-sized replica of a blue whale and the world's largest star sapphire (stolen in 1964).</td>
<td>Hours 10-5, ex. Sun 11-5, Wed. to 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bronx Zoo</td>
<td>About a mile long and .6 mile wide, this is the largest zoo in America. A lion eats 18 pounds of meat a day while a sea lion eats 15 pounds of fish.</td>
<td>Hours</td>
</tr>
</tbody>
</table>
```

32  TECHNICAL DISCUSSION
10-4:30 winter, to 5:00 summer

Brooklyn Museum
Five floors of galleries contain
American and ancient art.
There are American period
rooms and architectural ornaments
saved from wreckers,
such as a classical figure from
Pennsylvania
Station.

New York
Historical Society
All the original paintings for
Audubon's
Birds of America
are here, as are exhibits of American decorative arts, New York history, Hudson River school paintings, carriages, and glass paperweights.

T) <TAB> Hours <TAB> T{
Tues-Fri & Sun, 1-5; Sat 10-5
T}

\^ <TAB> \^ <TAB> Location <TAB> T{
Central Park West & 77th St.
T}

\^ <TAB> \^ <TAB> Admission <TAB> Free
\^ <TAB> \^ <TAB> Subway <TAB> AA to 81st St.
&\^ <TAB> \^ <TAB> Telephone <TAB> 212-873-3400
.TE

TECHNICAL DISCUSSION
## Some Interesting Places

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Practical Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>American Museum of Natural History</strong></td>
<td>The collections fill 11.5 acres (Michelin) or 25 acres (MTA) of exhibition halls on four floors. There is a full-sized replica of a blue whale and the world's largest star sapphire (stolen in 1964).</td>
<td>Hours: 10–5, ex. Sun 11–5, Wed. to 9 Central Park West &amp; 79th St. \  Location: Central Park West &amp; 81st St. \  Donation: $1.00 asked \  Admission: $1.00 asked \  Subway: AA to 81st St. \  Telephone: 212-873-4225</td>
</tr>
<tr>
<td><strong>Bronx Zoo</strong></td>
<td>About a mile long and .6 mile wide, this is the largest zoo in America. A lion eats 18 pounds of meat a day while a sea lion eats 15 pounds of fish.</td>
<td>Hours: 10–4:30 winter, to 5:00 summer \  Location: 185th St. &amp; Southern Blvd, the Bronx. \  Admission: $1.00, but Tu, We, Th free \  Subway: 2, 5 to East Tremont Ave. \  Telephone: 212-933-1759</td>
</tr>
<tr>
<td><strong>Brooklyn Museum</strong></td>
<td>Five floors of galleries contain American and ancient art. There are American period rooms and architectural ornaments saved from wreckers, such as a classical figure from Pennsylvania Station.</td>
<td>Hours: Wed–Sat, 10–5, Sun 12–5 \  Location: Eastern Pkway &amp; Washington Ave. Brooklyn. \  Admission: Free \  Subway: 2, 3 to Eastern Parkway. \  Telephone: 212-638-5000</td>
</tr>
<tr>
<td><strong>New York Historical Society</strong></td>
<td>All the original paintings for Audubon's <em>Birds of America</em> are here, as are exhibits of American decorative arts, New York history, Hudson River school paintings, carriages, and glass paperweights.</td>
<td>Hours: Tues–Fri &amp; Sun, 1–5; Sat 10–5 \  Location: Central Park West &amp; 77th St. \  Admission: Free \  Subway: AA to 81st St. \  Telephone: 212-873-3400</td>
</tr>
</tbody>
</table>
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Introduction

*nroff* and *troff* are text processors provided with the UNIX System V DOCUMENTER'S WORKBENCH Software. They accept lines of text interspersed with lines of format control information and process the text into a printable, paginated document having a user-designed style. *nroff* and *troff* offer unusual freedom in document styling, including the following: arbitrary style headers and footers; arbitrary style footnotes; multiple automatic sequence numbering for paragraphs, sections, and other user-defined blocks of text; multiple column output; dynamic font and point-size control; arbitrary horizontal and vertical local motions; and a group of automatic overstriking, bracket construction, and line drawing functions.

*nroff* and *troff* are highly compatible with each other, and it is almost always possible to prepare input acceptable to both. Conditional input is provided that enables the user to embed input expressly destined for either program. *troff* formats text suitable for phototypesetters and printers capable of producing digital-typographical output.

The general form of invoking *nroff* or *troff* at the UNIX system command level is

```
nroff option(s) file(s) | printer
or
      troff option(s) file(s) | typesetter
```

where *option(s)* represents any of a number of options and option arguments, and *file(s)* represents the file containing the document to be formatted. An argument consisting of a single minus (−) is taken to be a file name corresponding to the standard input. If no *file* is given, input is taken from the standard input. The options, which may appear in any order so long as they appear before the file name(s), are

<table>
<thead>
<tr>
<th>Option</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>−e</td>
<td><em>(nroff only.)</em> Produce equally-spaced words in adjusted lines, using full terminal resolution.</td>
</tr>
<tr>
<td>−h</td>
<td><em>(nroff only.)</em> Use output tabs during horizontal spacing to speed up output as well as to reduce output byte count. Device tab settings are assumed to be every 8</td>
</tr>
</tbody>
</table>
nominal character widths, as are the settings of input (logical) tabs.

-i Read standard input after the input files are exhausted.

-mname Prepend the macro file /usr/lib/tmac.name to the input files. nroff and troff can accept several -m options on the command line causing all macro packages thus named to be read in turn. The possible macro packages (the memorandum macros, the man macros, the viewgraph macros, and the permuted index macros) would be called, with the following options, respectively: -mm, -man, -mv, and -mptx.

-nN Number first generated page N.

-olist Print only pages whose page numbers appear in list. list consists of comma-separated numbers and number ranges. A number range has the form N-M and means pages N through M; an initial -N means from the beginning to page N; and a final N- means from N to the end.

-q Invoke the simultaneous input-output mode of the .rd request.

-raN Set the number register whose (one-character) name is a to N.

-sN Stop every N pages. nroff will halt prior to every N pages (default N=1) to allow paper loading or changing, and will resume upon receipt of a new-line. troff will stop the phototypesetter every N pages, produce a trailer to allow for changing of paper, and will resume after the phototypesetter START button is pressed. In nroff the ASCII BEL character will sound when stopping between pages.
\texttt{-Ttty\_type} \hfill Specifies the name of \texttt{nroff} terminal type, \texttt{tty\_type}.

Currently defined names are

\begin{tabular}{ll}
2631 & Hewlett-Packard 2631 printer in regular mode \\
2631-c & Hewlett-Packard 2631 printer in compressed mode \\
2631-e & Hewlett-Packard 2631 printer in expanded mode \\
300 & DASI-300 printer \\
300-12 & DASI-300 terminal set to 12-pitch (12 characters per inch) \\
300s & DASI-300s printer (300S is a synonym) \\
300s-12 & DASI-300s printer set to 12-pitch (12 characters per inch) (300S-12 is a synonym) \\
37 & Teletype Model 37 terminal (default) \\
382 & DTC-382 \\
4000a & Trendata 4000a terminal (4000A is a synonym) \\
450 & DASI-450 (Diablo Hyterm) printer \\
450-12 & DASI-450 terminal set to 12-pitch (12 characters per inch) \\
832 & Anderson Jacobson 832 terminal \\
8510 & C.ITOH printer \\
lp & generic name for printers that can underline and tab. (All text using reverse linefeeds, such as those having tables, that is sent to lp must be processed with col.) \\
tn300 & GE Terminet 300 terminal \\
X & printers equipped with TX print train
\end{tabular}

(Check with your system administrator for a list of locally supported devices.)

In \texttt{troff}, the \texttt{-T} option may be used to specify the output device. In addition, it is possible to set the environment variable "\texttt{TYPESETTER.}" The output devices presently supported for \texttt{troff} are the Autologic APS-5 (\texttt{-Taps}) and the Imagen Imprint-10 (\texttt{-Ti10})

\texttt{-uN} \hfill (\texttt{nroff} only.) Set the emboldening strike-count (number of character overstrikes) for the bold font (normally
mounted at the third font position) to be $N$. If option is used without $N$, the number of overstrikes is assumed to be zero. Note that it is not possible to turn off the emboldening in nroff if the overstriking is controlled locally by the printing device (e.g., DASI 300s). See the .bd request in Section 2.3 and the .b number register in Section 4 for a fuller treatment of emboldening.

- $z$
  Suppress formatted output. Only diagnostics and messages from .tm requests will occur.

- $a$
  Send a printable ASCII approximation of results to the standard output.

Each option is invoked as a separate argument; for example,

nroff -04,8-10 -T300-12 -mabc file1 file2

requests formatting of pages 4, 8, 9, and 10 of the document contained in files named file1 and file2, specifies the output terminal as a DASI 300 in 12-pitch, and invokes the macro package $abc$.

Various pre- and postprocessors are available for use with nroff and troff. These include the preprocessors for writing equations, neqn and eqn (for nroff and troff respectively); the preprocessor for making tables, tbl; the preprocessor for drawing pictures, pic, and the grap preprocessor for presenting statistics in a graph. A reverse-line postprocessor, col, is available for multiple-column nroff output on terminals without reverse-line ability; col expects the Teletype Model 37 escape sequences that nroff produces by default. troff output can be viewed on the Teletype Model 5620. No special filter is required to postprocess troff’s output for the 5620. The finished version of a document typeset with troff is most frequently sent to a phototypesetter:

grap file(s) | pic | tbl | eqn | troff option(s) | typesetter

The first pipe ($) indicates the redirecting of grap’s output to pic’s input; the second pipe shows pic’s output being redirected to tbl’s input; the third pipe shows tbl’s output flowing into eqn’s input; the fourth indicates the piping of eqn’s output to troff’s input. Finally, the accumulated output from these processes is piped to a postprocessor that interprets troff’s output graphics language for the output device.
tc is a phototypesetter-simulator postprocessor, which enables you to view troff output on a Tektronix 4014 terminal. The syntax for its usage is as follows:

```
grap file(s) | pic | tbl | eqn | troff option(s) | tc
```

The remainder of this manual consists of a "Summary" followed by "A Technical Description of nroff/troff." The numbered sections of the "Summary" correspond to numbered sections of the "Technical Description," in which the individual nroff/troff subcomponents are covered in detail.
Summary

This summary presents abstracts of requests, escape sequences, number registers, and predefined strings. It gives essential information about these subcomponents such as syntax usage, value of arguments, and default scaling of parameters. The following is a key to some of the notation:

Notes:

- **B**: Request normally causes a break.
- **D**: Mode or relevant parameters associated with current diversion level.
- **E**: Relevant parameters are a part of the current environment.
- **O**: Must stay in effect until logical output.
- **P**: Mode must be still or again in effect at the time of physical output.
- **T**: Parameters are typesetter- or printer-dependent.
- **v.p.m.u**: Default scale indicator; if not specified, scale indicators are ignored.
- **;**: Values separated by ";" are for nroff and troff respectively.
- **†**: Requests marked with "†" have no effect in nroff.
- **‡**: Requests marked with "‡" cause a line break, like that caused by .br. Invoking them with the control character "\" (instead of ",") will suppress that break function.

1. General Explanation

(This topic is covered in section 1 of the "Technical Description" below.)

2. Font and Character Size Control

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>\ps ± \n</td>
<td>10 point</td>
<td>previous</td>
<td>E,† Point size; also \s ± \n.</td>
</tr>
<tr>
<td>\ss \n</td>
<td>12/36 em</td>
<td>ignored</td>
<td>E,† Space-character size set to \n/36 em.</td>
</tr>
<tr>
<td>\cs F N M</td>
<td>off</td>
<td>P,†</td>
<td>Constant character space (width) mode (font F).</td>
</tr>
</tbody>
</table>

6 TECHNICAL DISCUSSION
Summary

.\bd F N off - P Embolden font F by N−1 units.
.\bd S F N off - P Embolden Special Font when current font is F.
.\ft F Roman previous E,T Change to font F = x, xx, or 1-N. Also \fx, \f(xx, \fN.
.\fp N F - ignored T Font named F mounted on physical position 1≤N.

3. Page Control

<table>
<thead>
<tr>
<th>Request</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.pl ±N</td>
<td>11 in</td>
<td>11 in</td>
<td>v Page length.</td>
</tr>
<tr>
<td>.bp ±N</td>
<td>N=1</td>
<td>-</td>
<td>B,‡,v Eject current page; next page number N.</td>
</tr>
<tr>
<td>.pn ±N</td>
<td>N=1</td>
<td>ignored</td>
<td>- Next page number N.</td>
</tr>
<tr>
<td>.po ±N</td>
<td>0;26/27 in</td>
<td>previous</td>
<td>v Page offset.</td>
</tr>
<tr>
<td>.ne N</td>
<td>-</td>
<td>N=1V</td>
<td>D,v Need N vertical space (V = vertical spacing).</td>
</tr>
<tr>
<td>.mk R</td>
<td>none</td>
<td>internal</td>
<td>D Mark current vertical place in register R.</td>
</tr>
<tr>
<td>.rt ±N</td>
<td>none</td>
<td>internal</td>
<td>D,v Return (upward only) to marked vertical place.</td>
</tr>
</tbody>
</table>

4. Text Filling, Adjusting, and Centering

<table>
<thead>
<tr>
<th>Request</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.br</td>
<td>-</td>
<td>-</td>
<td>B,‡ Break.</td>
</tr>
<tr>
<td>.fi</td>
<td>fill</td>
<td>-</td>
<td>B,‡,E Fill output lines.</td>
</tr>
<tr>
<td>.nf</td>
<td>fill</td>
<td>-</td>
<td>B,‡,E No filling or adjusting of output lines.</td>
</tr>
<tr>
<td>.ad c</td>
<td>adj,both</td>
<td>adjust</td>
<td>E Adjust output lines with mode c.</td>
</tr>
<tr>
<td>.na</td>
<td>adjust</td>
<td>-</td>
<td>E No output line adjusting.</td>
</tr>
<tr>
<td>.ce N</td>
<td>off</td>
<td>N=1</td>
<td>B,‡,E Center following N input text lines.</td>
</tr>
</tbody>
</table>
5. Vertical Spacing

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.vs N</td>
<td>1/6in;12pts</td>
<td>previous</td>
<td>E,p Vertical base line spacing (V).</td>
</tr>
<tr>
<td>.ls N</td>
<td>N=1</td>
<td>previous</td>
<td>E Output N−1 Vs after each text output line.</td>
</tr>
<tr>
<td>.sp N</td>
<td>-</td>
<td>N=1v</td>
<td>B,‡,v Space vertical distance N in either direction.</td>
</tr>
<tr>
<td>.sv N</td>
<td>-</td>
<td>N=1v</td>
<td>v Save vertical distance N.</td>
</tr>
<tr>
<td>.os</td>
<td>space</td>
<td>-</td>
<td>D Turn no-space mode on.</td>
</tr>
<tr>
<td>.ns</td>
<td>-</td>
<td>-</td>
<td>D Restore spacing; turn no-space mode off.</td>
</tr>
</tbody>
</table>

6. Line Length and Indenting

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.ll ±N</td>
<td>6.5in</td>
<td>previous</td>
<td>E,m Line length.</td>
</tr>
<tr>
<td>.in ±N</td>
<td>N=0</td>
<td>previous</td>
<td>B,‡,E,m Indent.</td>
</tr>
<tr>
<td>.ti ±N</td>
<td>-</td>
<td>ignored</td>
<td>B,‡,E,m Temporary indent.</td>
</tr>
</tbody>
</table>

7. Macros, Strings, Diversion, and Position Traps

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.de xx yy</td>
<td>-</td>
<td>.yy=..</td>
<td>- Define or redefine macro xx; end at call of yy.</td>
</tr>
<tr>
<td>.am xx yy</td>
<td>-</td>
<td>.yy=..</td>
<td>- Append to a macro.</td>
</tr>
<tr>
<td>.ds xx string</td>
<td>-</td>
<td>ignored</td>
<td>- Define a string xx containing string.</td>
</tr>
<tr>
<td>.as xx string</td>
<td>-</td>
<td>ignored</td>
<td>- Append string to string xx.</td>
</tr>
<tr>
<td>.rm xx</td>
<td>-</td>
<td>ignored</td>
<td>- Remove request, macro, or string.</td>
</tr>
</tbody>
</table>
Summary

- **.rn xx yy**: ignored - Rename request, macro, or string `xx` to `yy`.
- **.di xx**: end D - Divert output to macro `xx`.
- **.da xx**: end D - Divert and append to `xx`.
- **.wh N xx**: - v - Set location trap; negative is with respect to page bottom.
- **.ch xx N**: - - v - Change trap location.
- **.dt N xx**: off D,v - Set a diversion trap.
- **.it N xx**: off E - Set an input-line count trap.
- **.em xx**: none none - End macro is `xx`.

8. Number Registers

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.nr R ±N M-</td>
<td>-</td>
<td>u</td>
<td>Define and set number register <code>R</code>; auto-increment by <code>M</code>.</td>
</tr>
<tr>
<td>.af R c</td>
<td>Arabic</td>
<td>-</td>
<td>Assign format to register <code>R</code> (<code>c = 1, i, I, a, A</code>).</td>
</tr>
<tr>
<td>.rr R</td>
<td>-</td>
<td>-</td>
<td>Remove register <code>R</code>.</td>
</tr>
</tbody>
</table>

9. Tabs, Leaders, and Fields

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.ta Nt ...</td>
<td>0.8;0.5in</td>
<td>none E,m</td>
<td>Tab settings; left type, unless <code>t=R</code> (right) or <code>t=C</code> (centered).</td>
</tr>
<tr>
<td>.tc c</td>
<td>none</td>
<td>none E</td>
<td>Tab repetition character.</td>
</tr>
<tr>
<td>.lc c</td>
<td>none</td>
<td>none E</td>
<td>Leader repetition character.</td>
</tr>
<tr>
<td>.fc a b</td>
<td>off</td>
<td>off -</td>
<td>Set field delimiter <code>a</code> and pad character <code>b</code>.</td>
</tr>
</tbody>
</table>
10. Input and Output Conventions and Character Translations

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.ec c</td>
<td>\</td>
<td>\</td>
<td>Set escape character.</td>
</tr>
<tr>
<td>.eo</td>
<td>on</td>
<td>-</td>
<td>Turn off escape character mechanism.</td>
</tr>
<tr>
<td>.lg N</td>
<td>-;on</td>
<td>on</td>
<td>Ligature mode on if N&gt;0.</td>
</tr>
<tr>
<td>.ul N</td>
<td>off</td>
<td>N=1</td>
<td>E Underline (italicize in troff) N input lines.</td>
</tr>
<tr>
<td>.cu N</td>
<td>off</td>
<td>N=1</td>
<td>E Continuous underline in nroff; like .ul in troff.</td>
</tr>
<tr>
<td>.uf F</td>
<td>Italic</td>
<td>Italic</td>
<td>- Underline font set to F (to be switched to by .ul).</td>
</tr>
<tr>
<td>.cc c</td>
<td>;</td>
<td>;</td>
<td>E Set control character to c.</td>
</tr>
<tr>
<td>.c2 c</td>
<td>;</td>
<td>;</td>
<td>E Set no-break control character to c.</td>
</tr>
<tr>
<td>.tr abcd....</td>
<td>none</td>
<td>-</td>
<td>O Translate a to b, etc., on output.</td>
</tr>
</tbody>
</table>

11. Local Horizontal and Vertical Motions, and the Width Function

<table>
<thead>
<tr>
<th>Vertical Motion</th>
<th>Effect in troff</th>
<th>Effect in nroff</th>
<th>Horizontal Motion</th>
<th>Effect in troff</th>
<th>Effect in nroff</th>
</tr>
</thead>
<tbody>
<tr>
<td>\v'N'</td>
<td>Move distance N</td>
<td></td>
<td>\h'N'</td>
<td>Move distance N</td>
<td></td>
</tr>
<tr>
<td>\u</td>
<td>½ em up</td>
<td>½ line up</td>
<td>(space)</td>
<td>Unpaddable space-size space</td>
<td></td>
</tr>
<tr>
<td>\d</td>
<td>½ em down</td>
<td>½ line down</td>
<td>\0</td>
<td>Digit-size space</td>
<td></td>
</tr>
<tr>
<td>\r</td>
<td>1 em up</td>
<td>1 line up</td>
<td>\1</td>
<td>1/6 em space</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>\2</td>
<td>1/12 em space</td>
<td>ignored</td>
</tr>
</tbody>
</table>
12. Overstrike, Bracket, Line-drawing, and Zero-width Functions

<table>
<thead>
<tr>
<th>Escape Sequence</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>\o'string'</td>
<td>Automatically centered overstriking of characters named in string.</td>
</tr>
<tr>
<td>\zc</td>
<td>Zero-width spacing following character c to produce overstruck characters.</td>
</tr>
<tr>
<td>\b'string&quot;</td>
<td>Vertically pile characters named in string.</td>
</tr>
<tr>
<td>\l'Nc'</td>
<td>Horizontal line drawing function. Optional character c may be named to travel to the right a distance N. Travel to the left may be specified with a negative N.</td>
</tr>
<tr>
<td>\L'Nc'</td>
<td>Vertical line drawing function. Optional character c may be specified to travel downward a distance N. Upward distance may be specified with a negative N.</td>
</tr>
</tbody>
</table>

13. Hyphenation

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.nh</td>
<td>no hyphen</td>
<td>-</td>
<td>E</td>
</tr>
<tr>
<td>.hy N</td>
<td>no hyphen</td>
<td>hyphenate</td>
<td>E</td>
</tr>
<tr>
<td>.hc c</td>
<td>%</td>
<td>%</td>
<td>E</td>
</tr>
<tr>
<td>.hw word1 ...</td>
<td>ignored</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

14. Three Part Titles

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.tl 'left' center 'right'</td>
<td>-</td>
<td>-</td>
<td>Three part title.</td>
</tr>
<tr>
<td>.pc c</td>
<td>%</td>
<td>off</td>
<td>E,m</td>
</tr>
<tr>
<td>.lt \pm N</td>
<td>6.5in</td>
<td>previous</td>
<td></td>
</tr>
</tbody>
</table>
### 15. Output Line Numbering

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.nm ±N M S l</td>
<td>off</td>
<td>E</td>
<td>Number mode on or off, set parameters.</td>
</tr>
<tr>
<td>.nn N</td>
<td>-</td>
<td>N=1</td>
<td>Do not number next N lines.</td>
</tr>
</tbody>
</table>

### 16. Conditional Acceptance of Input

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.if c anything-</td>
<td>-</td>
<td></td>
<td>If condition c true, accept anything as input, for multi-line use {anything}.</td>
</tr>
<tr>
<td>.if !c anything</td>
<td>-</td>
<td>-</td>
<td>If condition c false, accept anything.</td>
</tr>
<tr>
<td>.if N anything</td>
<td>-</td>
<td>u</td>
<td>If expression N &gt; 0, accept anything.</td>
</tr>
<tr>
<td>.if !N anything</td>
<td>-</td>
<td>u</td>
<td>If expression N ≤ 0, accept anything.</td>
</tr>
<tr>
<td>.if 'string1' 'string2' anything</td>
<td>-</td>
<td></td>
<td>If string1 identical to string2, accept anything.</td>
</tr>
<tr>
<td>.if !'string1' 'string2' anything</td>
<td>-</td>
<td></td>
<td>If string1 not identical to string2, accept anything.</td>
</tr>
<tr>
<td>.ie c anything</td>
<td>-</td>
<td>u</td>
<td>If portion of if-else; all above forms (like if).</td>
</tr>
<tr>
<td>.el anything</td>
<td>-</td>
<td></td>
<td>Else portion of if-else.</td>
</tr>
</tbody>
</table>
## 17. Environment Switching

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.ev N</td>
<td>N=0</td>
<td>previous</td>
<td>Environment switched (push down).</td>
</tr>
</tbody>
</table>

## 18. Insertions from the Standard Input

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.rd prompt</td>
<td></td>
<td>prompt=BEL</td>
<td>Read insertion.</td>
</tr>
<tr>
<td>.ex</td>
<td></td>
<td></td>
<td>Exit from nroff/troff.</td>
</tr>
</tbody>
</table>

## 19. Input/Output File Switching

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.so file</td>
<td></td>
<td></td>
<td>Switch source file (push down).</td>
</tr>
<tr>
<td>.nx file</td>
<td></td>
<td>end-of-file</td>
<td>Next file.</td>
</tr>
<tr>
<td>.cf file</td>
<td></td>
<td></td>
<td>Copy file.</td>
</tr>
<tr>
<td>.lf N file</td>
<td></td>
<td></td>
<td>change line number and file name.</td>
</tr>
<tr>
<td>.pi program</td>
<td></td>
<td></td>
<td>Pipe output to program.</td>
</tr>
</tbody>
</table>

## 20. Miscellaneous

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.mc c N</td>
<td></td>
<td>off</td>
<td>E,m Set margin character c and separation N.</td>
</tr>
<tr>
<td>.tm string</td>
<td></td>
<td>new-line</td>
<td>Print string on terminal (UNIX standard message output).</td>
</tr>
<tr>
<td>.ig yy</td>
<td></td>
<td>.yy=..</td>
<td>Ignore till call of yy.</td>
</tr>
</tbody>
</table>

nroff/troff: TECHNICAL DISCUSSION 13
Summary

.pm t                       all                       -
  Print macro names and sizes; if t present, print only total of sizes.

.fl                        -                        B;‡
  Flush output buffer.

.ab text                   -                        user abort
  Terminates processing immediately.

.sy cmd args               -                        cmd executed but output not captured.

21. Output and Error Messages

(This topic is covered in section 21 of the "Technical Description," which follows.)

22. Request and Section Number Cross Reference

## 23. Escape Sequences for Characters, Indicators, and Functions

<table>
<thead>
<tr>
<th>Section Reference</th>
<th>Escape Sequence</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td><code>\</code></td>
<td><code>(to prevent or delay the interpretation of \)</code></td>
</tr>
<tr>
<td>10.1</td>
<td><code>\e</code></td>
<td>Printable version of the current escape character.</td>
</tr>
<tr>
<td>2.1</td>
<td><code>\'</code></td>
<td><code>'(acute accent; typographically equivalent to \(aa)</code></td>
</tr>
<tr>
<td>2.1</td>
<td><code>\</code></td>
<td><code>'(grave accent; typographically equivalent to \(ga)</code></td>
</tr>
<tr>
<td>2.1</td>
<td><code>\-</code></td>
<td>– (minus sign in the current font)</td>
</tr>
<tr>
<td>7.2</td>
<td><code>\.</code></td>
<td>. (period or dot; see .de)</td>
</tr>
<tr>
<td>11.1</td>
<td><code>\(space)</code></td>
<td>Unpaddable space-size space character</td>
</tr>
<tr>
<td>11.1</td>
<td><code>\0</code></td>
<td>Digit width space</td>
</tr>
<tr>
<td>11.1</td>
<td><code>\1</code></td>
<td>1/6em narrow space character (zero width in nroff)</td>
</tr>
<tr>
<td>11.1</td>
<td><code>\2</code></td>
<td>1/12em half-narrow space character (zero width in nroff)</td>
</tr>
<tr>
<td>4.1</td>
<td><code>\&amp;</code></td>
<td>Non-printing, zero width character</td>
</tr>
<tr>
<td>10.6</td>
<td><code>\!</code></td>
<td>Transparent line indicator</td>
</tr>
<tr>
<td>10.7</td>
<td><code>\&quot;</code></td>
<td>Beginning of comment</td>
</tr>
<tr>
<td>7.3</td>
<td><code>\$N</code></td>
<td>Interpret argument 1 ≤ N ≤ 9</td>
</tr>
<tr>
<td>13</td>
<td><code>\%</code></td>
<td>Default optional hyphenation character</td>
</tr>
<tr>
<td>2.1</td>
<td><code>\(xx)</code></td>
<td>Character named xx</td>
</tr>
<tr>
<td>7.1</td>
<td><code>\x, \*xx</code></td>
<td>Interpret string x or xx</td>
</tr>
<tr>
<td>9.1</td>
<td><code>\a</code></td>
<td>Non-interpreted leader character</td>
</tr>
<tr>
<td>12.3</td>
<td><code>\b'abc...'</code></td>
<td>Bracket building function</td>
</tr>
<tr>
<td>4.2</td>
<td><code>\c</code></td>
<td>Interrupt text processing</td>
</tr>
<tr>
<td>11.1</td>
<td><code>\d</code></td>
<td>Forward (down) 1/2em vertical motion (1/2 line in nroff)</td>
</tr>
<tr>
<td>12.4</td>
<td><code>\D</code></td>
<td>Line-drawing functions</td>
</tr>
<tr>
<td>2.2</td>
<td><code>\fx, \f(xx), \fN</code></td>
<td>Change to font named x or xx, or position N</td>
</tr>
<tr>
<td>8</td>
<td><code>\gx, \g(xx)</code></td>
<td>Return the format of values stored in general number registers x and xx.</td>
</tr>
<tr>
<td>11.1</td>
<td><code>\h\N</code></td>
<td>Local horizontal motion; move right N (negative left)</td>
</tr>
<tr>
<td>2.3</td>
<td><code>\H\N</code></td>
<td>Height control of characters (does not affect width).</td>
</tr>
</tbody>
</table>
Summary

<table>
<thead>
<tr>
<th>Section</th>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.3</td>
<td>(kx)</td>
<td>Mark horizontal input place in register (x)</td>
</tr>
<tr>
<td>12.4</td>
<td>(l'Nc')</td>
<td>Horizontal line drawing function (optionally with (c))</td>
</tr>
<tr>
<td>12.4</td>
<td>(L'Nc')</td>
<td>Vertical line drawing function (optionally with (c))</td>
</tr>
<tr>
<td>8</td>
<td>(nx), (n(xx))</td>
<td>Evaluate number register (x) or (xx)</td>
</tr>
<tr>
<td>12.1</td>
<td>(o'abc...')</td>
<td>Overstrike characters (a, b, c, ...)</td>
</tr>
<tr>
<td>4.1</td>
<td>(p)</td>
<td>Break and spread output line</td>
</tr>
<tr>
<td>11.1</td>
<td>(r)</td>
<td>Reverse (up) 1 em vertical motion (reverse line in (nroff))</td>
</tr>
<tr>
<td>2.3</td>
<td>(sN, s \pm N)</td>
<td>Point-size change function</td>
</tr>
<tr>
<td>2.3</td>
<td>(S'n')</td>
<td>Slant control of characters.</td>
</tr>
<tr>
<td>9.1</td>
<td>(t)</td>
<td>Non-interpreted horizontal tab</td>
</tr>
<tr>
<td>11.1</td>
<td>(u)</td>
<td>Reverse (up) 1/2 em vertical motion (1/2 line in (nroff))</td>
</tr>
<tr>
<td>11.1</td>
<td>(v'N')</td>
<td>Local vertical motion; move down (N) (negative up)</td>
</tr>
<tr>
<td>11.2</td>
<td>(w'string')</td>
<td>Evaluate and use width of (string)</td>
</tr>
<tr>
<td>5.2</td>
<td>(x'N')</td>
<td>Extra line-space function (negative before, positive after)</td>
</tr>
<tr>
<td>12.2</td>
<td>(zc)</td>
<td>Print (c) with zero width (without spacing)</td>
</tr>
<tr>
<td>16</td>
<td>(</td>
<td>)</td>
</tr>
<tr>
<td>16</td>
<td>(</td>
<td>)</td>
</tr>
<tr>
<td>10.7</td>
<td>(</td>
<td>(new-line))</td>
</tr>
<tr>
<td>()</td>
<td>(</td>
<td>)</td>
</tr>
</tbody>
</table>

The escape sequences \(\|\), \(\_\), \(\^\), \(\$\), \(\_\), \(\a\), \(\n\), \(\t\), and \(|(new-line)\) are interpreted in copy mode.
### 24. Predefined General Number Registers

<table>
<thead>
<tr>
<th>Section Reference</th>
<th>Register Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>%</td>
<td>Current page number.</td>
</tr>
<tr>
<td>2.2</td>
<td>.b</td>
<td>Emboldening factor of current font.</td>
</tr>
<tr>
<td>-</td>
<td>.c</td>
<td>Input line-number in the current input file. (Contains the same value as the read-only .c register.)</td>
</tr>
<tr>
<td>-</td>
<td>.R</td>
<td>Count of number registers that remain available for use.</td>
</tr>
<tr>
<td>11.2</td>
<td>ct</td>
<td>Character type (set by width function).</td>
</tr>
<tr>
<td>7.4</td>
<td>dl</td>
<td>Width (maximum) of last completed diversion.</td>
</tr>
<tr>
<td>7.4</td>
<td>dn</td>
<td>Height (vertical size) of last completed diversion.</td>
</tr>
<tr>
<td>-</td>
<td>dw</td>
<td>Current day of the week (1-7).</td>
</tr>
<tr>
<td>-</td>
<td>dy</td>
<td>Current day of the month (1-31).</td>
</tr>
<tr>
<td>15</td>
<td>ln</td>
<td>Output line number.</td>
</tr>
<tr>
<td>-</td>
<td>mo</td>
<td>Current month (1-12).</td>
</tr>
<tr>
<td>4.1</td>
<td>nl</td>
<td>Vertical position of last printed text base-line.</td>
</tr>
<tr>
<td>11.2</td>
<td>sb</td>
<td>Depth of string below base line (generated by width function).</td>
</tr>
<tr>
<td>11.2</td>
<td>st</td>
<td>Height of string above base line (generated by width function).</td>
</tr>
<tr>
<td>-</td>
<td>yr</td>
<td>Last two digits of current year.</td>
</tr>
</tbody>
</table>

### 25. Predefined Read-only Number Registers

<table>
<thead>
<tr>
<th>Section Reference</th>
<th>Register Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.3</td>
<td>.$</td>
<td>Number of arguments available at the current macro level.</td>
</tr>
<tr>
<td>-</td>
<td>$$</td>
<td>Identification number (process i.d.) for nroff or troff processes.</td>
</tr>
<tr>
<td>-</td>
<td>.A</td>
<td>Set to 1 in troff if -a option used; always 1 in nroff.</td>
</tr>
<tr>
<td>-</td>
<td>.F</td>
<td>String that is the name of the current input file.</td>
</tr>
<tr>
<td>11.1</td>
<td>.H</td>
<td>Available horizontal resolution in basic units.</td>
</tr>
<tr>
<td>-</td>
<td>.L</td>
<td>Current line-spacing parameter (see request, .ls).</td>
</tr>
</tbody>
</table>
Summary

- \.P Set to 1 if the current page is being printed, and zero otherwise.
- \.T Set to 1 if –T option used; otherwise set to 0.
11.1 \.V Available vertical resolution in basic units.
5.2 \.a Post-line extra line-space most recently utilized using \x'N'.
- \.c Number of lines read from current input file.
7.4 \.d Current vertical place in current diversion; equal to \(n_l\), if no diversion.
2.2 \.f Current font as numerical position.
4.1 \.h Text base-line high-water mark on current page or diversion.
6 \.i Current indent.
- \.j Current adjustment mode and type. Can be saved and later given to the .ad request to restore a previous mode.
- \.k Horizontal size of the text portion (without indent) of the current partially collected output line, if any, in the current environment.
6 \.l Current line length.
4.1 \.n Length of text portion on previous output line.
3 \.o Current page offset.
3 \.p Current page length.
2.3 \.s Current point size.
7.5 \.t Distance to the next trap.
4.2 \.u Equal to 1 in fill mode and 0 in no-fill mode.
5.1 \.v Current vertical line spacing.
11.2 \.w Width of previous character.
- \.x Reserved version-dependent register.
- \.y Reserved version-dependent register.
7.4 \.z Name of current diversion.

26. Predefined Strings

- \.T Name of output device.
A Technical Description of nroff/troff

This section explains the subcomponents listed in the summary. The subcomponents can be cross-referenced by section number.

1. General Explanation

1.1. Form of Input

Input consists of text lines, which are destined to be printed, interspersed with control lines, which set parameters or otherwise control subsequent processing. Control lines begin with a control character—normally a period (.), or an acute accent (') followed by a one or two character name that specifies a basic request or the substitution of a user-defined macro in place of the control line. The control character "'" suppresses the break function—the forced output of a partially filled line—caused by certain requests. The control character may be separated from the request or macro name by white space (spaces and/or tabs) for aesthetic reasons. Names must be followed by either space or a new-line. Control lines with unrecognized names are ignored.

Various special functions may be introduced anywhere in the input by means of an escape character, normally \\.

For example, the function \nR invokes the contents of the number register R in place of the function; here R is either a single character name as in \nx, or a left-parenthesis-introduced, two-character name as in \n(xx).

1.2. Formatter and Device Resolution

nroff internally uses 240 units/inch, corresponding to the least common multiple of the horizontal and vertical resolutions of various current typewriter-like output devices. Units in troff are device-dependent. troff rounds horizontal/vertical numerical parameter input to its internal horizontal/vertical resolution. nroff similarly rounds numerical input to the actual resolution of the output device indicated by the -T option (default Teletype Model 37).
1.3. Numerical Parameter Input

Both nroff and troff accept numerical input with the appended scale indicators shown in the following table, where $S$ is the current type size in points, $V$ is the current vertical line spacing in basic units, and $C$ is a nominal character width in basic units.

<table>
<thead>
<tr>
<th>Scale Indicator</th>
<th>Meaning</th>
<th>Number of Basic Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>Inch</td>
<td>troff: 240</td>
</tr>
<tr>
<td>c</td>
<td>Centimeter</td>
<td>troff: $240 \times 50/127$</td>
</tr>
<tr>
<td>P</td>
<td>Pica = 1/6 inch</td>
<td>troff: 240/6</td>
</tr>
<tr>
<td>m</td>
<td>Em = $S$ points</td>
<td>troff: machine-dependent</td>
</tr>
<tr>
<td>n</td>
<td>En = Em/2</td>
<td>troff: C, same as Em</td>
</tr>
<tr>
<td>p</td>
<td>Point = 1/72 inch</td>
<td>240/72</td>
</tr>
<tr>
<td>u</td>
<td>Basic unit</td>
<td>troff: 1</td>
</tr>
<tr>
<td>v</td>
<td>Vertical line space</td>
<td>troff: $V$</td>
</tr>
<tr>
<td>none</td>
<td>Default, see below</td>
<td>troff: $V$</td>
</tr>
</tbody>
</table>

In nroff, both the em and the en are taken to be equal to the $C$, which is output-device dependent; frequent values are 1/10 and 1/12 inch. Actual character widths in nroff need not be all the same, and characters constructed with predefined strings such as \(-\) are often extra wide.

The scaling for horizontally-oriented control characters, vertically-oriented control characters, and the requests .nr, .if, and .ie are as follows:

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Measure by Default</th>
<th>Request or Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>Em (m)</td>
<td>.ll, .in, .ti, .ta, .lt, .po, .mc, \h, \l.</td>
</tr>
<tr>
<td>Vertical</td>
<td>Vertical line space (v)</td>
<td>.pl, .wh, .ch, .dt, .sp, .sv, \ne, \rt, \v, \x, \L.</td>
</tr>
<tr>
<td>Register-oriented or conditional</td>
<td>Basic unit (u)</td>
<td>.nr, .if, .ie.</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Point (p)</td>
<td>.ps, .vs, \H, \s.</td>
</tr>
</tbody>
</table>

All other requests ignore any scale indicators. When a number register containing an already appropriately scaled number is interpreted to provide numerical input, the unit scale indicator $u$ may need to be appended to
prevent an additional inappropriate default scaling. The number, N, may
be specified in decimal-fraction form but the parameter finally stored is
rounded to an integer number of basic units.

The absolute position indicator I may be prepended to a number N to
generate the distance to the vertical or horizontal place N. For vertically­
oriented requests and functions, I\textit{N} becomes the distance in basic units from
the current vertical place on the page or in a diversion to the the vertical
place \textit{N}. (See section 7.4, "Diversions.") For all other requests and func­
tions, I\textit{N} becomes the distance from the current horizontal place on the
input line to the horizontal place \textit{N}. For example,

\texttt{.sp 13.2c}

will space in the required direction to 3.2 centimeters from the top of the
page.

\textbf{1.4. Numerical Expressions}

Wherever numerical input is expected an expression involving
parentheses, the arithmetic operators +, -, /, \textbullet, \%, (mod), and the logical
operators <, >, <=, >=, = (or ==), & (and), and : (or) may be used.
Except where controlled by parentheses, evaluation of expressions is left-to­
right. In the case of certain requests, an initial + or - is stripped and inter­
preted as an increment or decrement indicator respectively. In the presence
of default scaling, the desired scale indicator must be attached to every
number in an expression for which the desired and default scaling differ.
For example, if the number register \textit{x} contains 2 and the current point size
is 10, then

\texttt{.Il (4.25i+\textbackslash nxP\text{+}3)/2u}

will set the line length to 1/2 the sum of 4.25 inches + 2 picas + 3 ems.

\textbf{NOTE}
The use of white space in arithmetic expressions is not permitted. There is
no precedence among arithmetic and logical operators. \texttt{nroff/troff} expres­
sions do not recognize decimal multipliers or divisors; a high level of preci­
sion may be achieved by mixing scales within expressions.
1.5. Notation

Numerical parameters are indicated in this manual in two ways. $\pm N$ means that the argument may take the form $N$, $+N$, or $-N$ and that the corresponding result is to set the affected parameter to $N$, to increment it by $N$, or to decrement it by $N$ respectively. Plain $N$ means that an initial algebraic sign is not an increment indicator, but merely the sign of $N$. Generally, unreasonable numerical input is either ignored or truncated to a reasonable value. For example, most requests expect to set parameters to non-negative values: exceptions are .sp, .wh, .ch, .nr, and .if. The requests .ps, .ft, .po, .vs, .ls, .ll, .in, and .It restore the previous parameter value in the absence of an argument.

Single character arguments are indicated by single lower-case letters and one or two character arguments are indicated by a pair of lower-case letters. Character string arguments are indicated by multi-character mnemonics.

2. Font and Character Size Control

2.1. Character Set

The troff character set consists of the so-called Commercial II character set plus a Special Mathematical Font character set. With three exceptions, these ASCII characters are input as themselves, and non-ASCII characters are input in the form $\backslash xx$ where $xx$ is a two-character name. The three ASCII exceptions are mapped as follows:
The characters ' ', and _ may be input by \', \', and \_ respectively or by their names. (See the Table of Special Characters.) ASCII control characters are discussed in the section, "Input Character Translation."

**nroff** understands the entire **troff** character set, but can in general print only ASCII characters, additional characters as may be available on the output device, such characters as may be able to be constructed by overstriking or other combination, and those that can reasonably be mapped into other printable characters. The exact behavior is determined by a driving table prepared for each device. The characters ' ', and _ print as themselves.

### 2.2. Fonts

Default fonts may differ from device to device. Typically, the fonts will include the following: Times Roman (R), Times Italic (I), Times Bold (B), and the Special Mathematical Font (S). The current font may be changed by use of the .ft request, or by embedding at any desired point either \fx, \fxx, or \fN where x and xx are the name of a mounted font and N is a numerical font position. It is not necessary to change to the Special Font; characters on that font are handled automatically.

A request for a named but not mounted font is translated into a request to mount the font at position 0. This position is reserved for such dynamic requests and is otherwise inaccessible. **troff** can be informed that any particular font is mounted by use of the .fp request. The list of known fonts is device-dependent. In the subsequent discussion of font-related requests, \( F \) represents either a one or a two-character font name. The current font is available (as a numerical position) in the read-only number register .f. **nroff** understands font control and normally underlines italic characters. (See section 10.3, "Backspacing, Underlining, and Overstriking.")
2.3. Character Size

The available character point sizes depend on the individual printing device. The .ps request is used to change or restore the point size. Alternatively, the point size can be changed between any two characters by embedding a \sN at the desired point. (N may represent the desired available size or \s±N may be used to increment or decrement the size by N; double-digit increments or decrements are expressed as \s±NN.) \s0 restores the previous size. Requested point size values that are between two legal sizes will yield the closer legal size. The current size is available in the .s register.

In troff the escape sequence \H'N' sets the height of a character without affecting its width. N can be expressed in absolute values or in relative values of the form ±N.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.ps ±N</td>
<td>10 point</td>
<td>previous</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Point size set to ±N. Alternatively, embed \sN or \s±N. Any positive size value may be requested; if invalid, the nearest valid size will result, with a maximum size to be determined by the individual printing device. A paired sequence +N,−N will work because the previous requested value is also remembered. Ignored in nroff.</td>
</tr>
</tbody>
</table>

| .ss N        | 12/36em       | ignored        | E                 |
|              |               |                | Space-character size is set to N/36ems. This size is the minimum word spacing in adjusted text. Ignored in nroff. |

| .cs FNM      | off           | -              | P                 |
|              |               |                | Constant character space (width) mode is set on for font F (if mounted); the width of every character will be taken to be N/36 ems. If M is absent, the |

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em is that of the character's point size; if $M$ is given, the em is $M$-points. All affected characters are centered in this space, including those with an actual width larger than this space. Special Font characters occurring while the current font is $F$ are also so treated. If $N$ is absent, the mode is turned off. The mode must be still or again in effect when the characters are physically printed. Ignored in nroff.

\texttt{.bd \hspace{1em} F \hspace{1em} N} \hspace{1em} \text{off} \hspace{1em} - \hspace{1em} P

The characters in font $F$ will be artificially emboldened by printing each one three times, separated by $N-1$ basic units. If $N$ is missing the embolden mode is turned off. In nroff the default setting is \texttt{.bd 3 3}, specifying that characters on the font mounted at position 3 (normally bold) are to be overstruck 3 times (i.e., printed in place a total of 4 times).

The column heads above were printed with \texttt{.bd 2 3}. That is, the font stored at font position 2 was emboldened by an offset of 3. The font name itself may be substituted for the font position (e.g., \texttt{.bd I 3}). The \texttt{\textendash u} command line option may be used to change the number of overstrikes using an argument that is functionally identical to \texttt{.bd}'s second argument. (See section 2.3, "Character Size.") The mode
Description

must be still or again in effect when the characters are physically printed. This request may affect the contents of the general number register .b.

Note that it is not possible to turn off the emboldening in nroff if it is being controlled locally by the printing device (e.g., DASI 300s).

`.bd S F N  off - P`

The characters in the Special Font will be emboldened whenever the current font is F. The mode must be still or again in effect when the characters are physically printed.

`.ft F Roman previous E`

Font changed to F. Alternatively, embed \fF. The font name P is reserved to mean the previous font.

`.fp N F file - ignored -`

Font position. This is a statement that a font named F is mounted on position N. It is a fatal error if F is not known. Fonts and the possible range of their numerical positions is device-dependent. .fp accepts a third optional argument, file, which is an alternate version of the font F.

.bd can be used to embolden characters, effectively increasing the number of available fonts. This capability of modifying existing fonts to make new ones is enhanced with the troff escape sequence, \S, used to slant output characters by a number of specified degrees. This escape sequence is stated as \S'N' where N may be any integer, negative or positive. 0 turns slanting off.

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3. Page control

Top and bottom margins are not automatically provided; it is conventional to define two macros and to set traps for them at vertical positions 0 (top) and \(-N\) (\(N\) from the bottom). A pseudo-page transition onto the first page occurs either when the first break occurs or when the first non-diverted text processing occurs. Arrangements for a trap to occur at the top of the first page must be completed before this transition. In the following, references to the current diversion mean that the mechanism being described works during both ordinary and diverted output (the former being considered as the top diversion level). (See section 7.4, "Diversions.")

The physical limitations on nroff and troff output are output-device dependent.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.pl (\pm N)</td>
<td>11 in</td>
<td>11 in</td>
<td>Page length set to (\pm N). The internal limitation is about 75 inches in troff and about 136 inches in nroff. The current page length is available in the .p register.</td>
</tr>
<tr>
<td>.bp (\pm N)</td>
<td>(N=1)</td>
<td></td>
<td>Break page. The current page is ejected and a new page is begun. If (\pm N) is given, the new page number will be (\pm N). Also see request .ns.</td>
</tr>
<tr>
<td>.pn (\pm N)</td>
<td>(N=1)</td>
<td>ignored</td>
<td>Page number. The next page (when it occurs) will have the page number (\pm N). A .pn must occur before the initial pseudo-page transition to affect the page number of the first page. The current page number is in the % register.</td>
</tr>
</tbody>
</table>
\textbf{Description}

\texttt{.po \pm N} \hspace{1em} 0; 1in\dagger \hspace{1em} \texttt{previous} \hspace{1em} v \hspace{1em} Page offset. The current left margin is set to \pm N. The \texttt{troff} initial value provides 1 inch of paper margin. (See section 6, "Line Length and Indenting.") The current page offset is available in the .o register.

\texttt{.ne N} \hspace{1em} \texttt{N=1} \hspace{1em} v \hspace{1em} D,v \hspace{1em} Need N vertical space. If the page space needed (N) is greater than the distance to the next trap (D), then a forward vertical space of size D occurs, which will spring the trap. If there are no remaining traps on the page, D is the distance to the bottom of the page. If the distance to the next trap (D) is less than one vertical line space (v), then another line could still be output before the trap is sprung. In a diversion, D is the distance to the diversion trap, if any, or is very large.

\texttt{.mk R} \hspace{1em} \texttt{none} \hspace{1em} \texttt{internal} \hspace{1em} D \hspace{1em} Mark the current vertical place in an internal register (both associated with the current diversion level), or in register R, if given. See .rt request.

\texttt{.rt \pm N} \hspace{1em} \texttt{none} \hspace{1em} \texttt{internal} \hspace{1em} D,v \hspace{1em} Return upward only to a marked vertical place in the current diversion. If \pm N (relative to the current place) is given, the place is \pm N from the top of the page or diversion or, if N is absent, the place is that marked by a previous .mk. Note that the .sp request may be used in all cases instead of .rt by spacing to the
absolute place stored in a explicit register; e.g., using the sequence .mk R ... .sp \nRu. (See section 5.3, "Blocks of Vertical Space.")

4. Text Filling, Adjusting, and Centering

4.1. Filling and Adjusting

During fill mode, words normally are collected from input text lines and assembled into an output text line until some word doesn't fit. An attempt is then made to hyphenate the word in an effort to assemble a part of it into the output line. In adjust mode the spaces between the words on the output line are then increased to spread out the line to the current line length minus any current indent. A word is any string of characters delimited by the space character, the beginning or end of the input line, or by a combination of these. Any adjacent pair of words that must be kept together (neither split across output lines nor spread apart in the adjustment process) can be tied together by separating them with the unpaddable space character "\ " (backslash-space). The adjusted word spacings are uniform in troff and the minimum interword spacing can be controlled with the .ss request. (See section 2, "Font and Character Size Control.") In nroff, they are normally nonuniform because of quantization to character-size spaces; however, the command-line option -e causes uniform spacing with full output device resolution. Filling, adjustment, and hyphenation can all be prevented or controlled. (See section 13, "Hyphenation.") The text length on the last line output is available in the .n register, and text base-line position on the page for this line is in the nl register. The text base-line high-water mark (lowest place) on the current page is in the .h register.

An input text line ending with ., ?, !, .), ?), or !) is taken to be the end of a sentence, and an additional space character is automatically provided during filling. Multiple inter-word space characters found in the input are retained except for trailing spaces; initial spaces also cause a break.

When filling is in effect, a \p may be embedded or attached to a word to cause a break at the end of the word and have the resulting output line spread out to fill the current line length.
A text input line that happens to begin with a control character can be made to not look like a control line by prefacing it with the non-printing, zero-width filler character \&. Still another way is to specify output translation of a specific character into the control character using .tr. (See section 10.4, "Output Translation.") To suppress the break function of the control character ".", replace it with the single quote, "'.".

4.2. Interrupted Text

The copying of an input line in no-fill (i.e., no line filling) mode can be interrupted by terminating the partial line with a \c. The next encountered input text line will be considered to be a continuation of the same line of input text. Similarly, a word within filled text may be interrupted by terminating the word (and line) with \c; the next encountered text will be taken as a continuation of the interrupted word. If the intervening control lines cause a break, any partial line will be forced out along with any partial word.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.br</td>
<td>-</td>
<td>-</td>
<td>B Break. The filling of the line currently being collected is stopped and the line is output without adjustment. Text lines beginning with space characters and empty text lines (blank lines) also cause a break.</td>
</tr>
<tr>
<td>.fi</td>
<td>fill on</td>
<td>-</td>
<td>B,E Fill subsequent output lines. The register .u is 1 in fill mode and 0 in no-fill mode.</td>
</tr>
<tr>
<td>.nf</td>
<td>fill on</td>
<td>-</td>
<td>B,E No-fill. Subsequent output lines are neither filled nor adjusted. Input text lines are copied directly to output lines without regard for the current line length.</td>
</tr>
</tbody>
</table>
Line adjustment is begun. If fill mode is not on, adjustment will be deferred until fill mode is back on. If the type indicator \( c \) is present, the adjustment type is changed as shown in the following table.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Adjust Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>( l )</td>
<td>adjust left margin only</td>
</tr>
<tr>
<td>( r )</td>
<td>adjust right margin only</td>
</tr>
<tr>
<td>( c )</td>
<td>center</td>
</tr>
<tr>
<td>b or n</td>
<td>adjust both margins</td>
</tr>
<tr>
<td>absent</td>
<td>unchanged</td>
</tr>
</tbody>
</table>

The adjustment type indicator \( c \) may also be a number obtained from the .j register. (See section 25 in the "Summary," "Predefined Read-Only Registers.")

No-adjust. Adjustment is turned off; the right margin will be ragged. The adjustment type for .ad is not changed. Output line filling still occurs if fill mode is on.

Center the next \( N \) input text lines within the current (line-length minus indent). If \( N=0 \), any residual count is cleared. A break occurs after each of the \( N \) input lines. If the input line is too long, it will be left adjusted.
5. **Vertical Spacing**

5.1. **Base-line Spacing**

The vertical spacing \(V\) between the base-lines of successive output lines can be set using the `.vs` request with a resolution that is device-dependent in both `nroff` and `troff`. \(V\) must be large enough to accommodate the character sizes on the affected output lines. For the common type sizes (9-12 points), usual typesetting practice is to set \(V\) to 2 points greater than the point size; `troff` default is 10-point type on a 12-point spacing (as in this document). The current \(V\) is available in the `.v` register. Multiple-\(V\) line separation (e.g., double spacing) may be requested with `.ls`.

5.2. **Extra Line-space**

If a word contains a vertically tall construct requiring the output line containing it to have extra vertical space before and/or after it, the extra-line-space function \(\textbackslash x'N'\) can be embedded in or attached to that word. In this and other functions having a pair of delimiters around their parameter (here `\`), the delimiter choice is arbitrary except that it can't look like the continuation of a number expression for \(N\). If \(N\) is negative, the output line containing the word will be preceded by \(N\) extra vertical space; if \(N\) is positive, the output line containing the word will be followed by \(N\) extra vertical space. If successive requests for extra space apply to the same line, the maximum values are used. The most recently utilized post-line extra line-space is available in the `.a` register.

5.3. **Blocks of Vertical Space**

A block of vertical space is ordinarily requested using `.sp`, which honors the no-space mode and which does not space past a trap. A contiguous block of vertical space may be reserved using `.sv`. 
<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.vs $N$</td>
<td>$1/6\text{in};12\text{pts}$</td>
<td>previous</td>
<td>E.p</td>
</tr>
<tr>
<td>.ls $N$</td>
<td>$N=1$</td>
<td>previous</td>
<td>E</td>
</tr>
<tr>
<td>.sp $N$</td>
<td>-</td>
<td>$N=1V$</td>
<td>B,v</td>
</tr>
<tr>
<td>.sv $N$</td>
<td>-</td>
<td>$N=1V$</td>
<td>v</td>
</tr>
<tr>
<td>.os</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Description

Used to finally output a block of vertical space requested by an earlier .sv request.

/.ns space - D

No-space mode turned on. When on, the no-space mode inhibits .sp requests and .bp requests without a next page number. The no-space mode is turned off when a line of output occurs, or with .rs.

/.rs space - D

Restore spacing. The no-space mode is turned off.

Blank text line

Causes a break and outputs a blank line exactly like .sp 1.

6. Line Length and Indenting

The maximum line length for fill mode may be set with .ll. The indent may be set with .in; an indent applicable to only the next output line may be set with .ti. The line length includes indent space but not page offset space. The line-length minus the indent is the basis for centering with .ce. The effect of .ll, .in, or .ti is delayed, if a partially collected line exists, until after that line is output. In fill mode the length of text on an output line is less than or equal to the line length minus the indent. The current line length and indent are available in registers .l and .i, respectively. The length of three-part titles produced by .tl is independently set by .lt. (See section 14, "Three Part Titles.")

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.ll ±N</td>
<td>6.5in</td>
<td>previous</td>
<td>E,m</td>
<td>Line length is set to ±N. In troff the maximum (line-length)+(page-offset) is device-dependent.</td>
</tr>
<tr>
<td>.in ±N</td>
<td>N=0</td>
<td>previous</td>
<td>B,E,m</td>
<td>Indent is set to ±N. The indent</td>
</tr>
</tbody>
</table>

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is prepended to each output line.

\texttt{.ti \pm N} - ignored \texttt{B,E,m} Temporary indent. The next output text line will be indented a distance \(\pm N\) with respect to the current indent. The resulting total indent may be zero (equal to current page offset) but may not be less than the current page offset. The temporary indent applies only for the one output line following the request; the value of the current indent (that value stored in the \texttt{.i} register) is not changed.

7. Macros, Strings, Diversions, and Position Traps

7.1. Macros and Strings

A macro is a named set of arbitrary lines that may be invoked by name or with a trap. A string is a named string of characters, not including a new-line character, that may be summoned by name at any point. Request, macro, and string names share the same name list. Macro and string names may be one or two characters long and may usurp previously defined request, macro, or string names. Any of these entities may be renamed with \texttt{.rm} or removed with \texttt{.rm}.

Macros are created by \texttt{.de} and \texttt{.di}, and appended to by \texttt{.am} and \texttt{.da}; \texttt{.di} and \texttt{.da} cause normal output to be stored in a macro. Strings are created by \texttt{.ds} and appended to by \texttt{.as}. A macro is invoked in the same way as a request; a control line beginning \texttt{.xx} will execute the contents of macro \texttt{xx} (macro \texttt{xx} may be followed by a maximum of nine arguments): should the macro-define contain requests or escape sequences, these will be executed along with the rest of the defined contents of \texttt{xx}. If the macro is defined to contain text, that text will print. The strings defined as \texttt{x} and \texttt{xx} are inserted at any desired point with \texttt{\textbackslash x} and \texttt{\textbackslash\text{xx}} respectively. String references and macro invocations may be nested.
7.2. Copy Mode Input Interpretation

During the definition and extension of strings and macros (not by diversion) the input is read in copy mode. The input is copied without interpretation except that

- The contents of number registers, indicated by \( n \), are substituted.
- Strings, indicated by \( \ast x \) and \( \ast ( x x , \) are read into the text.
- Arguments indicated by \( \$ \) are replaced by the appropriate values at the current macro level.
- Concealed new-lines indicated by \( \langle n e w \text{-line} \rangle \) are eliminated.
- Comments indicated by \( \langle t \rangle \) are eliminated.
- \( \langle t \) and \( \langle a \) are interpreted as ASCII horizontal tab and SOH respectively. (See section 9, "Tabs, Leaders, and Fields."
- \( \langle \) is interpreted as \( \).\)
- \( \. \) is interpreted as ".".

These interpretations can be suppressed by prepending a \( \langle \). For example, since \( \langle \) maps into a \( \), \( \langle n \) will copy as \( \) which will be interpreted as a number register indicator when the macro or string is reread.

7.3. Arguments

When a macro is invoked by name, the remainder of the line is taken to contain up to nine arguments. The argument separator is the space character, and arguments may be surrounded by double-quotes to permit embedded space characters. Pairs of double-quotes may be embedded in double-quoted arguments to represent a single double-quote. If the desired arguments won’t fit on a line, a concealed new-line may be used to continue on the next line.

When a macro is invoked the input level is pushed down and any arguments available at the previous level become unavailable until the macro is completely read and the previous level is restored. A macro’s own arguments can come into play at any point within the macro with \( \$ N \), which introduces the \( N \)th argument \( ( 1 \leq N \leq 9 ) \) into the macro’s processing activity. If an invoked argument doesn’t exist, a null string results. For example, the
macro \texttt{xx} may be defined by
\begin{verbatim}
   .de xx   "begin definition
   Today is \$1 the \$2.
   ..   "end definition
\end{verbatim}
and called by
\begin{verbatim}
   .xx Monday 14th
\end{verbatim}
to produce the text
\begin{quote}
   Today is Monday the 14th.
\end{quote}
Notice that the $ was concealed in the definition with a prepended \. This
leading backslash protected the argument ($) so that it would be replaced by
the argument of the macro when invoked, and not by the argument in
effect when this one was being defined. The number of currently available
arguments is in the .$ register.

No arguments are available at the top (non-macro) level in this imple­
mentation. Because string referencing is implemented as an input-level
push down, no arguments are available from within a string. No arguments
are available within a trap-invoked macro.

Arguments are copied in copy mode onto a stack where they are avail­
able for reference. The mechanism does not allow an argument to contain a
direct reference to a long string (evaluated at copy time), and it is advisable
to conceal string references (with an extra \) to delay interpretation until
argument reference time.

7.4. Diversions

Processed output may be diverted into a macro for purposes such as
footnote or sidenote processing or determining the horizontal and vertical
size of some text for conditional changing of pages or columns. A single
diversion trap may be set at a specified vertical position. The number regis­
ters \texttt{dn} and \texttt{dl} respectively contain the vertical and horizontal size of the
most recently ended diversion. Processed text that is diverted into a macro
retains the vertical size of each of its lines when reread in no-fill mode
regardless of the current \texttt{V}. Constant-spaced (.cs) or emboldened (.bd) text
that is diverted can be reread correctly only if these modes are again or still
in effect at reread time. One way to do this is to embed in the diversion
the appropriate .cs or .bd requests with the transparent mechanism
described in section 10.6, "Transparent Throughput."
Diversions may be nested and certain parameters and registers are associated with the current diversion level (the top non-diversion level may be thought of as the 0th diversion level). These are the diversion trap and associated macro, no-space mode, the internally-saved marked place (see .mk and .rt), the current vertical place (.d register), the current high-water text base-line (.h register), and the current diversion name (.z register).

7.5. Traps

Three types of trap mechanisms are available—page traps, a diversion trap, and an input-line-count trap. Macro-invocation traps may be planted using .wh at any page position including the top. This trap position may be changed using .ch. Trap positions at or below the bottom of the page have no effect unless or until moved to within the page or rendered effective by an increase in page length.

Two traps may be planted at the same position only by first planting them at different positions and then moving one of the traps; the first planted trap will conceal the second unless and until the first one is moved. If the first one is moved back, it again conceals the second trap.

The macro associated with a page trap is automatically invoked when a line of text is output whose vertical size reaches or sweeps past the trap position. Should several traps be placed so close together that a single output line could spring all of them, all but the first will be ignored. Reaching the bottom of a page springs the top-of-page trap, if any, provided there is a next page. The distance to the next trap position is available in the .t register; if there are no traps between the current position and the bottom of the page, the distance returned is the distance to the page bottom.

A macro-invocation trap effective in the current diversion may be planted using .dt. The .t register works in a diversion; if there is no subsequent trap a large distance is returned.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.de xx yy</td>
<td>-</td>
<td>.yy=..</td>
<td>Define or redefine the macro xx. The contents of the macro begin on the next input line. Input lines are copied in copy mode until the definition is</td>
</tr>
</tbody>
</table>
Description

terminated by a line beginning with \texttt{.yy}, whereupon the macro \texttt{yy} is called. In the absence of \texttt{yy}, the definition is terminated by a line beginning with "\texttt{..}". A macro may contain \texttt{.de} requests provided the terminating macros differ or the contained definition terminator is concealed; "\texttt{..}" can be concealed as "\texttt{\textbackslash..}" which will copy as "\texttt{..}" and be reread as "\texttt{..}".

\texttt{.am xx yy} - \texttt{.yy=} -
\hspace{1cm} Append to macro (append version of \texttt{.de}).

\texttt{.ds xx string} ignored - -
\hspace{1cm} Define a string \texttt{xx} containing \texttt{string}. Any initial double-quote in \texttt{string} is stripped off to permit initial blanks.

\texttt{.as xx string} ignored - -
\hspace{1cm} Append \texttt{string} to string \texttt{xx} (append version of \texttt{.ds}).

\texttt{.rm xx} - ignored -
\hspace{1cm} Remove request, macro, or string. The name \texttt{xx} is removed from the name list and any related storage space is freed. Subsequent references will have no effect.

\texttt{.rn xx yy} - ignored -
\hspace{1cm} Rename request, macro, or string \texttt{xx} to \texttt{yy}. If \texttt{yy} exists, it is first removed.

\texttt{.di xx} - end D
\hspace{1cm} Divert output to macro \texttt{xx}. Normal text processing occurs during diversion except that page offsetting is not done. The diversion ends when the request \texttt{.da} or \texttt{.da} is encountered without
<table>
<thead>
<tr>
<th>Description</th>
<th>Code</th>
<th>Parameters</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>an argument; extraneous requests of this type should not appear when nested diversions are being used.</td>
<td>.da</td>
<td>xx</td>
<td></td>
</tr>
<tr>
<td>Divert, appending to xx (append version of .di).</td>
<td></td>
<td></td>
<td>D</td>
</tr>
<tr>
<td>Install a trap to invoke xx at page position N; a negative N will be interpreted with respect to the page bottom. Any macro previously planted at N is replaced by xx. A zero N refers to the top of a page. In the absence of xx, the first found trap at N, if any, is removed.</td>
<td>.wh</td>
<td>N xx</td>
<td></td>
</tr>
<tr>
<td>Change the trap position for macro xx to be N. In the absence of N, the trap, if any, is removed.</td>
<td>.ch</td>
<td>xx N</td>
<td></td>
</tr>
<tr>
<td>Install a diversion trap at position N in the current diversion to invoke macro xx. Another .dt will redefine the diversion trap. If no arguments are given, the diversion trap is removed.</td>
<td>.dt</td>
<td>N xx</td>
<td></td>
</tr>
<tr>
<td>Set an input-line-count trap to invoke the macro xx after N lines of text input have been read (control or request lines don’t count). The text may be in-line text or either in-line or trap-invoked macros representing text. (See the discussion of the input-line-count .it request in section 7.5, &quot;Traps.&quot;)</td>
<td>.it</td>
<td>N xx</td>
<td></td>
</tr>
</tbody>
</table>

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The macro \em xx will be invoked when all input has ended. The effect is the same as if the contents of \em xx had been at the end of the last file processed.

8. Number Registers

A variety of parameters are available to the user as predefined, named number registers. The user may also define his own named registers. Register names are one or two characters long and do not conflict with request, macro, or string names. Except for certain predefined read-only registers, a number register can be read, written, automatically incremented or decremented, and inserted into the input using a variety of counting methods. Automatically numbered sections and paragraphs are common usages. A number register may be used any time numerical input is expected or desired. (See section 1.4, "Numerical Expressions.")

Number registers are created and modified using \texttt{.nr}, which specifies the name, numerical value, and the auto-increment size. Registers are also modified, if accessed with an auto-incrementing sequence. If the registers \em x and \em xx both contain \em N and have the auto-increment size \em M, the following access sequences have the effect shown:

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Effect on Register</th>
<th>Interpreted Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>\n\em x</td>
<td>none</td>
<td>\em N</td>
</tr>
<tr>
<td>\n\em xx</td>
<td>none</td>
<td>\em N</td>
</tr>
<tr>
<td>\n+\em x</td>
<td>\em x incremented by \em M</td>
<td>\em N+M</td>
</tr>
<tr>
<td>\n-\em x</td>
<td>\em x decremented by \em M</td>
<td>\em N-M</td>
</tr>
<tr>
<td>\n+\em xx</td>
<td>\em xx incremented by \em M</td>
<td>\em N+M</td>
</tr>
<tr>
<td>\n-\em xx</td>
<td>\em xx decremented by \em M</td>
<td>\em N-M</td>
</tr>
</tbody>
</table>

When evaluated, a number register is converted to decimal (default), decimal with leading zeros, lower-case roman, upper-case roman, lower-case alphabetic, or upper-case alphabetic according to the format specified by \texttt{.af}. The escape sequence \texttt{\g xx} or \texttt{\g( xx} gives the format used by the registers \em x or \em xx. This escape sequence will only return a value if the stated register has been set or used; otherwise, it returns 0. The value can also be saved and used as the second argument to \texttt{.af} to restore a previous format.
### Description

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.nr R ±N M-</td>
<td>-</td>
<td>u</td>
<td>The number register R is assigned the value ±N with respect to the previous value, if any. The increment for auto-incrementing is set to M.</td>
</tr>
</tbody>
</table>

| af R c       | Arabic        | -              | Assign format c to register R. The available formats are |

<table>
<thead>
<tr>
<th>Format</th>
<th>Numbering Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0,1,2,3,4,5,...</td>
</tr>
<tr>
<td>001</td>
<td>000,001,002,003,004,005,...</td>
</tr>
<tr>
<td>i</td>
<td>0,i,ii,iii,iv,v,...</td>
</tr>
<tr>
<td>I</td>
<td>0,I,II,III,IV,V,...</td>
</tr>
<tr>
<td>a</td>
<td>0,a,b,c,...,z,aa,ab,...,zz,aaa,...</td>
</tr>
<tr>
<td>A</td>
<td>0,A,B,C,...,Z,AA,AB,...,ZZ,AAA,...</td>
</tr>
</tbody>
</table>

An Arabic format having N digits specifies a field width of N digits. The read-only registers and the width function are always Arabic. (See section 11.2, "Width Function.")

| rr R       | ignored        | Remove register R. If many registers are being created dynamically, it may become necessary to remove unneeded registers to recapture internal storage space for new registers. |
9. Tabs, Leaders, and Fields

9.1. Tabs and Leaders

The ASCII horizontal tab character and the ASCII SOH (hereafter known as the leader character) can both be used to generate either horizontal motion or a string of repeated characters. The length of the generated entity is governed by internal tab stops specifiable with .ta. The default difference is that tabs generate motion and leaders generate a string of periods; .tc and .lc offer the choice of repeated character or motion. There are three types of internal tab stops—left adjusting, right adjusting, and centering. In the following table $D$ is the distance from the current position on the input line (where a tab or leader was found) to the next tab stop; next-string consists of the input characters following the tab (or leader) up to the next tab (or leader) or end of line; and $W$ is the width of next-string.

<table>
<thead>
<tr>
<th>Tab type</th>
<th>Length of motion or repeated characters</th>
<th>Location of next-string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>$D$</td>
<td>Following $D$</td>
</tr>
<tr>
<td>Right</td>
<td>$D-W$</td>
<td>Right adjusted within $D$</td>
</tr>
<tr>
<td>Centered</td>
<td>$D-W/2$</td>
<td>Centered on right end of $D$</td>
</tr>
</tbody>
</table>

The length of generated motion is allowed to be negative, but that of a repeated character string cannot be. Repeated character strings contain an integer number of characters, and any residual distance is prepended as motion. Tabs or leaders found after the last tab stop are ignored, but may be used as next-string terminators.

Tabs and leaders are not interpreted in copy mode. \t and \a always generate a non-interpreted tab and leader respectively, and are equivalent to actual tabs and leaders in copy mode but are ignored during output mode.

9.2. Fields

A field is contained between a pair of field delimiter characters, and consists of sub-strings separated by padding indicator characters. The field length is the distance on the input line from the position where the field
begins to the next tab stop. The difference between the total length of all
the sub-strings and the field length is incorporated as horizontal padding
space that is divided among the indicated padding places. The incorporated
padding is allowed to be negative. For example, if the field delimiter is #
and the padding indicator is ^, #^xxx^right # specifies a right-adjusted string
with the string xxx centered in the remaining space.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.ta Nt ...</td>
<td>8n; 0.5in</td>
<td>none</td>
<td>E,m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>t=R, right adjusting; t=C, centering; t absent, left adjusting. tR tab stops are preset every 0.5in.; nroff every 8 nominal character widths. The stop values are separated by spaces, and a value preceded by + is treated as an increment to the previous stop value.</td>
</tr>
<tr>
<td>.tc c</td>
<td>none</td>
<td>none</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The tab repetition character becomes c, or is removed specifying motion.</td>
</tr>
<tr>
<td>.lc c</td>
<td>.</td>
<td>none</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The leader repetition character becomes c, or is removed specifying motion.</td>
</tr>
<tr>
<td>.fc a b</td>
<td>off</td>
<td>off</td>
<td>.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The field delimiter is set to a; the padding indicator is set to the space character or to b, if given. In the absence of arguments the field mechanism is turned off.</td>
</tr>
</tbody>
</table>
10. Input and Output Conventions and Character Translations

10.1. Input Character Translations

Ways of typing in the graphic character set are discussed in section 2.1 "Character Set." The ASCII control characters SOH and horizontal tab are described in section 9.1, "Tabs and Leaders." The backspace is discussed in section 10.3, "Backspacing, Underlining, and Overstriking." The new-line delimits input lines. In addition, STX, ETX, ENQ, ACK, and BEL may be used as delimiters or translated into a graphic with .tr. (See section 10.5, "Output Translation.") troff normally passes none of these characters to its output; nroff passes the BEL character. All others are ignored.

The escape character \ introduces escape sequences—causes the following character to mean another character, or to indicate some function. A complete list of such sequences is given in the Summary and Index above. \ should not be confused with the ASCII control character ESC of the same name. The escape character \ can be input with the sequence \\,. The escape character can be changed with .ec, and all that has been said about the default \ becomes true for the new escape character. \ can be used to print whatever the current escape character is. If necessary or convenient, the escape mechanism may be turned off with .eo, and restored with .ec.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.ec c</td>
<td>\</td>
<td>\</td>
<td>-</td>
<td>Set escape character to , or to c, if given.</td>
</tr>
<tr>
<td>.eo</td>
<td>on</td>
<td>-</td>
<td>-</td>
<td>Turn escape mechanism off.</td>
</tr>
</tbody>
</table>

10.2. Ligatures

Five ligatures are available in the current troff character set fi, fl, ff, ffi, and ffi. They may be input (even in nroff) by \ff, \ff, \ffi, \ffi, \ffi, and \ffi respectively. The ligature mode is normally on in troff, and automatically invokes ligatures during input.
### 10.3. Backspacing, Underlining, and Overstriking

Unless in copy mode, the ASCII backspace character is replaced by a backward horizontal motion having the width of the space character. Underlining as a form of line-drawing is discussed in section 12.4, "Line Drawing." A generalized overstriking function is described in section 12.1, "Overstriking."

*nroff* automatically underlines characters in the underline font specifiable with `.uf` (normally Times Italic on font position 2.) See section 2.2, "Fonts." In addition to `.ft` and `F`, the underline font is selected by `.ul` and `.cu`. Underlining is restricted to an output-device-dependent subset of reasonable characters.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>.ul N</code></td>
<td>off</td>
<td>N=1</td>
<td>Underline in <em>nroff</em> (italicize in <em>troff</em>) the next N input text lines. Actually, switch to underline font, saving the current font for later restoration; other font changes within the span of a <code>.ul</code> will take effect, but the restoration will undo the last change. Output generated by <code>.tl</code> is affected by the font change, but does not decrement N. (See section 14, &quot;Three Part Titles.&quot;)</td>
</tr>
</tbody>
</table>
If \( N > 1 \), there is the risk that a trap-invoked macro may provide text lines within the span; environment switching can prevent this.

A variant of \texttt{.ul} that causes every character to be underlined and causes no line breaks to occur in the affected input lines. That is, each output space following \texttt{.cu} is like an unpaddable space. \texttt{.cu} is identical to \texttt{.ul} in \texttt{troff}.

Underline font set to \( F \). In nroff, \( F \) may not be on position 1 (initially Times Roman).

### 10.4. Control Characters

Both the control character \texttt{"."} and the no-break control character \texttt{"'"} may be changed, if desired. Changes must be compatible with the design of macros used in the span of the change, especially trap-invoked macros.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes/Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>\texttt{.cc} c</td>
<td>.</td>
<td>.</td>
<td>E</td>
</tr>
<tr>
<td>\texttt{.c2} c</td>
<td>.</td>
<td>.</td>
<td>E</td>
</tr>
</tbody>
</table>

### 10.5. Output Translation

One character can be made a stand-in for another character using \texttt{.tr}. All text processing (e.g., character comparisons) takes place with the input (stand-in) character which appears to have the width of the final character. The graphic translation occurs at the moment of output (including diversions).
10.6. Transparent Throughput

An input line beginning with a `!` is read in copy mode and transparently output (without the initial `!`); the text processor is otherwise unaware of the line's presence. This mechanism may be used to pass control information to a post-processor or to embed control lines in a macro created by a diversion.

10.7. Comments and Concealed New-lines

An awkwardly long input line that must stay one line (e.g., a string definition, or no-filled text) can be split into many physical lines by ending all but the last one with the escape `\`. The sequence `\(new-line)` is always ignored—except in a comment. Comments may be embedded at the end of any line by prefacing them with `\*`. The new-line at the end of a comment cannot be concealed. A line beginning with `\*` will appear as a blank line and behave like `.sp 1`; a comment can be on a line by itself by beginning the line with `\*`.

---

**Description**

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.tr abcd....</td>
<td>none</td>
<td>-</td>
<td>O Translate a into b, c into d, etc. If an odd number of characters is given, the last one will be mapped into the space character. To be consistent, a particular translation must stay in effect from input to output time. To reset .tr, follow request with previous arguments given in duplicate. The example given at the start of this entry, for instance, would be turned off as follows: .tr aacc.</td>
</tr>
</tbody>
</table>
11. Local Horizontal and Vertical Motions, and the Width Function

11.1. Local Motions

The functions $\backslash v'N'$ and $\backslash h'N'$ can be used for local vertical and horizontal motion respectively. The distance $N$ may be negative; the positive directions are rightward and downward. A local motion is one contained within a line. To avoid unexpected vertical dislocations, it is necessary that the net vertical local motion within a word, in filled text, and otherwise within a line, balance to zero. The above and certain other escape sequences providing local motion are summarized in the following table.

<table>
<thead>
<tr>
<th>Vertical Motion</th>
<th>Effect in R</th>
<th>Effect in nroff</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\backslash v'N'$</td>
<td>Move distance $N$</td>
<td>$\backslash h'N'$</td>
</tr>
<tr>
<td>$\backslash u$</td>
<td>$1/2$ em up</td>
<td>$1/2$ line up</td>
</tr>
<tr>
<td>$\backslash d$</td>
<td>$1/2$ em down</td>
<td>$1/2$ line down</td>
</tr>
<tr>
<td>$\backslash r$</td>
<td>$1$ em up</td>
<td>$1$ line up</td>
</tr>
</tbody>
</table>

As an example, $E^2$ could be generated by the sequence $E\backslash s-2\backslash v'-0.4\backslash m'\backslash s+2$; it should be noted in this example that the $0.4$ em vertical motions are at the smaller point size.

11.2. Width Function

The width function $\backslash w'string'$ generates the numerical width of $string$ (in basic units). Size and font changes may be safely embedded in $string$, and will not affect the current environment. For example, $\texttt{.ti -}\backslash w'1'$. $'u$ could be used to temporarily indent leftward a distance equal to the size of the string "1. ".

The width function also sets three number registers. The registers $st$ and $sb$ are set respectively to the highest and lowest extent of $string$ relative to the baseline; then, for example, the total height of the string is $\backslash n(stu-\backslash n(sbu)$. In nroff the number register $ct$ is set to a value between
0 and 3: 0 means that all of the characters in string were short lower case characters without descenders (like "e"); 1 means that at least one character has a descender (like "y"); 2 means that at least one character is tall (like "H"); and 3 means that both tall characters and characters with descenders are present.

11.3. Mark Horizontal Place

The escape sequence \kx will cause the current horizontal position in the input line to be stored in register x. As an example, the construction \kx\h'\nxu+2u'word will embolden word by backing up to almost its beginning and overprinting it, resulting in word.

12. Overstrike, Bracket, Line-drawing, and Zero-width Functions

12.1. Overstriking

Automatically centered overstriking of up to nine characters is provided by the overstrike function \o'string'. The characters in string are overprinted with centers aligned; the total width is that of the widest character. string should not contain local vertical motion. As examples, \o'e'' produces e\o\mo\sl produces .

12.2. Zero-width Characters

The function \zc will output c without spacing over it, and can be used to produce left-aligned overstruck combinations. As examples, \z\ci\pl will produce Θ, and \(br\z\rn\ul\br will produce the smallest possible constructed box □.

12.3. Large Brackets

The Special Mathematical Font contains a number of bracket construction pieces ( ( ) [ ] { } | | | | | ) that can be combined into various bracket styles. The function \b'string' may be used to pile up vertically the characters in string (the first character on top and the last at the bottom); the characters are vertically separated by 1 em and the total pile is centered 1/2 em
above the current baseline (½ line in \text{nroff}). For example,
\b' \l{c}\rf 'E' \b' \r{c}\rf 'x' -0.5m' \x' 0.5m' produces \E'.

12.4. Line Drawing

The function \l'Nc' will draw a string of repeated c's towards the right for a distance \(N\). (\l is \text{lower-case L}). If \(c\) looks like a continuation of an expression for \(N\), it may be insulated from \(N\) with a \&. If \(c\) is not specified, the _ (baseline rule) is used (underline character in \text{nroff}). If \(N\) is negative, a backward horizontal motion of size \(N\) is made before drawing the string. Any space resulting from \(N/(\text{size of } c)\) having a remainder is put at the beginning (left end) of the string. In the case of characters that are designed to be connected such as baseline-rule _, underrule _, and root-en _, the remainder space is covered by overlapping. If \(N\) is less than the width of \(c\), a single \(c\) is centered on a distance \(N\). As an example, a macro to underscore a string can be written

\begin{verbatim}
.de us \$1 \l'0\l'...
\end{verbatim}
or one to draw a box around a string

\begin{verbatim}
.de bx \l'(bx\l' \$1 \l'(bx\l' 1 \l' 0\l'
\end{verbatim}

such that

\begin{verbatim}
.us "underlined words"
\end{verbatim}

and

\begin{verbatim}
.bx "words in a box"
\end{verbatim}
yield underlined words and \text{words in a box}. Notice that the text follows the request on the same input line and that multiple words are enclosed by double quotes. (Compare the \text{mm} font macros \R, \I, \B, \RI, \RB, and so forth.) The output cannot cross line boundaries. One way to ensure this is to use these macros in no-fill mode where input lines and output lines are identical.
The function \L'Nc' will draw a vertical line consisting of the (optional) character c stacked vertically apart 1 em (1 line in nroff), with the first two characters overlapped, if necessary, to form a continuous line. The default character is the box rule | (\(br)); the other suitable character is the bold vertical | (\(bv)). The line is begun without any initial motion relative to the current base line. A positive N specifies a line drawn downward and a negative N specifies a line drawn upward. After the line is drawn no compensating motions are made; the instantaneous baseline is at the end of the line.

The horizontal and vertical line drawing functions may be used in combination to produce large boxes. The zero-width box-rule and the \(1\)-em wide underrule were designed to form corners when using 1-em vertical spacings. For example the macro

```
.de eb
.sp -1 " compensate for next automatic base-line spacing
.nf " avoid possibly overflowing word buffer
\h'-.5n\L' \nau-1'\l'\n(u.lu+1n\ul'\L'-' \nau+1
'\l' \nau-.5n\ul' " draw box
.fi
```

will draw a box around some text whose beginning vertical place was saved in number register a (e.g., using .mk a) as done for this paragraph.

In addition, troff provides drawing functions capable of drawing arcs and splines.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>\D'1 dh dv'</td>
<td>-</td>
<td>-</td>
<td>Draw a line from the current position by dh, dv.</td>
</tr>
<tr>
<td>\D'c d'</td>
<td>-</td>
<td>-</td>
<td>Draw a circle of diameter d with its left side at the current position.</td>
</tr>
<tr>
<td>\D'e d1 d2'</td>
<td>-</td>
<td>-</td>
<td>Draw an ellipse of diameters d1 and d2 with its left side at the current position.</td>
</tr>
</tbody>
</table>

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\D'a \ dhl \ dv1 \ dh2 \ dv2' 

- 
- 

Draw a counterclockwise arc from the current position to \( dh1+dh2, \ dv1+dv2, \) with its center at \( dh1, \ dv1 \) from the current position.

\D'' \ dh1 \ dv1 \ dh2 \ dv2... 

- 
- 

Draw a B-spline from the current position by \( dh1, \ dv1, \) then by \( dh2, \ dv2, \) then ...

The current position after using these drawing functions is at the end of the drawn line, which for circles and ellipses is at the right side.

13. Hyphenation

The automatic hyphenation may be switched off and on. When switched on with \.hy, several variants may be set. A hyphenation indicator character may be embedded in a word to specify desired hyphenation points, or may be prepended to suppress hyphenation. In addition, the user may specify a small exception word list.

Only words that consist of a central alphabetic string surrounded by (usually null) non-alphabetic strings are considered candidates for automatic hyphenation. Words that were input containing hyphens (minus), em-dashes (\em), or hyphenation indicator characters—such as mother-in-law—are always subject to splitting after those characters, whether or not automatic hyphenation is on or off.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.nh</td>
<td>no hyphen.</td>
<td>-</td>
<td>E Automatic hyphenation is turned off.</td>
</tr>
<tr>
<td>.hy ( N )</td>
<td>off, ( N=0 )</td>
<td>on, ( N=1 )</td>
<td>E Automatic hyphenation is turned on for ( N \geq 1 ), or off for</td>
</tr>
</tbody>
</table>
\( N=0 \). If \( N=2 \), last lines (ones that will cause a trap) are not hyphenated. For \( N=4 \) and 8, the last and first two characters respectively of a word are not split off. These values are additive; i.e., \( N=14 \) will invoke all three restrictions.

\[ .hc \ c \ \% \ \% \ E \]

Hyphenation indicator character is set to \( c \) or to the default \( \% \). The indicator does not appear in the output.

\[ .hw \ word1 \ ... \ ignored \]

Specify hyphenation points in words with embedded minus signs. Versions of a word with terminal \( s \) are implied (that is, \( dig-it \) implies \( dig-its \)). This list is examined initially and after each suffix stripping. The space available is small—about 128 characters.

14. Three Part Titles

The titling function \( .tl \) provides for automatic placement of three fields at the left, center, and right of a line with a title-length specifiable with \( .lt \). \( .tl \) may be used anywhere, and is independent of the normal text collecting process. A common use is in header and footer macros.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( .tl \ 'left'center'right' )</td>
<td>-</td>
<td>-</td>
<td>The strings ( left, center, ) and ( right ) are respectively left-adjusted, centered, and right-adjusted in the current title-length. Any of the strings may be empty, and overlapping is permitted. If the</td>
</tr>
</tbody>
</table>
Description

page-number character (initially %) is found within any of the fields it is replaced by the current page number having the format assigned to register %. Any character may be used as the string delimiter.

.pc c  %  off  -

The page number character is set to c, or removed. The page-number register remains %.

.lt ±N  6.5in  previous  E,m

Length of title set to ±N. The line-length and the title-length are independent. Indents do not apply to titles; page-offsets do.
15. Output Line Numbering

Automatic sequence numbering of output lines may be requested with .nm. When in effect, a three-digit, arabic number plus a digit-space is prepended to output text lines. The text lines are thus offset by four digit-spaces, and otherwise retain their line length. A reduction in line length may be desired to keep the right margin aligned with an earlier margin. Blank lines, other vertical spaces, and lines generated by .tl are not numbered. Numbering can be temporarily suspended with .nn, or with an .nm followed by a later .nm +0. In addition, a line number indent $I$, and the number-text separation $S$ may be specified in digit-spaces. Further, it can be specified that only those line numbers that are multiples of some number $M$ are to be printed (the others will appear as blank number fields).

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.nm $\pm N M S I$</td>
<td>off</td>
<td>E</td>
<td>Line number mode. If $\pm N$ is given, line numbering is turned on, and the next output line numbered is numbered $\pm N$. Default values are $M=1$, $S=1$, and $I=0$. Parameters corresponding to missing arguments are unaffected; a non-numeric argument is considered missing. In the absence of all arguments, numbering is turned off; the next line number is preserved for possible further use in number register In.</td>
</tr>
</tbody>
</table>

$\cdot nn$ $N$ $N=1$ $E$ The next $N$ text output lines are not numbered.
As an example, the paragraph portions of this section are numbered with $M=3$: `.nm 1 3` was placed at the beginning; `.nm` was placed at the end of the first paragraph; and `.nm +0` was placed in front of this paragraph; and `.nm` finally placed at the end. Line lengths were also changed (by \w'0000'u) to keep the right side aligned. Another example is `.nm +5 5 x 3` which turns on numbering with the line number of the next line to be 5 greater than the last numbered line, with $M=5$, with spacing $S$ untouched, and with the indent $l$ set to 3.

### 16. Conditional Acceptance of Input

In the following, $c$ is a one-character, built-in condition name, `!` signifies not, $N$ is a numerical expression, `string1` and `string2` are strings delimited by any non-blank, non-numeric character not in the strings, and *anything* represents what is conditionally accepted.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>.if c anything</code></td>
<td>-</td>
<td>-</td>
<td>If condition $c$ true, accept anything as input; in multi-line case use ({\text{anything}}).</td>
</tr>
<tr>
<td><code>.if !c anything</code></td>
<td>-</td>
<td>-</td>
<td>If condition $c$ false, accept anything.</td>
</tr>
<tr>
<td><code>.if N anything</code></td>
<td>-</td>
<td>u</td>
<td>If expression $N &gt; 0$, accept anything.</td>
</tr>
<tr>
<td><code>.if !N anything</code></td>
<td>-</td>
<td>u</td>
<td>If expression $N \leq 0$, accept anything.</td>
</tr>
<tr>
<td><code>.if 'string1''string2' anything</code></td>
<td>-</td>
<td></td>
<td>If <code>string1</code> identical to <code>string2</code>, accept anything.</td>
</tr>
<tr>
<td><code>.if !'string1''string2' anything</code></td>
<td>-</td>
<td></td>
<td>If <code>string1</code> not identical to <code>string2</code>, accept anything.</td>
</tr>
<tr>
<td><code>.ie c anything</code></td>
<td>-</td>
<td>u</td>
<td>If portion of if-else; all above forms (like <code>.if</code>).</td>
</tr>
<tr>
<td><code>.el anything</code></td>
<td>-</td>
<td>-</td>
<td>Else portion of if-else.</td>
</tr>
</tbody>
</table>
The built-in condition names are

<table>
<thead>
<tr>
<th>Condition Name</th>
<th>True If</th>
</tr>
</thead>
<tbody>
<tr>
<td>o</td>
<td>Current page number is odd</td>
</tr>
<tr>
<td>e</td>
<td>Current page number is even</td>
</tr>
<tr>
<td>t</td>
<td>Formatter is troff</td>
</tr>
<tr>
<td>n</td>
<td>Formatter is nroff</td>
</tr>
</tbody>
</table>

If the condition \( c \) is true, or if the number \( N \) is greater than zero, or if the strings compare identically (including motions and character size and font), anything is accepted as input. If a \( ! \) precedes the condition, number, or string comparison, the sense of the acceptance is reversed.

Any spaces between the condition and the beginning of anything are skipped over. The anything can be either a single input line (text, macro, or whatever) or a number of input lines. In the multi-line case, the first line must begin with a left delimiter \( \langle \) and the last line must end with a right delimiter \( \rangle \). The left delimiter must be followed by either a command or text:

```
.if 58>1 \{ `sp 0.5i
```

Following this delimiter with a backslash (\( \backslash \)), escaping the newline, yields an equivalent arrangement.

The request .ie (if-else) is identical to .if except that the acceptance state is remembered. A subsequent and matching .el (else) request then uses the reverse sense of that state. .ie - .el pairs may be nested.

Some examples are

```
.ie \n%>1 \{
 `sp 0.5i
 .tl ` Even Page %'''
```

which outputs a title if the page number is even; and

```
.ie \n%>1 \{
 `sp 0.5i
 .tl ` Page %'''
 `sp 1.2i \}
 .el `sp 1 2.5i
```

which treats page 1 differently from other pages.
17. Environment Switching

A number of the parameters that control the text processing are gathered together into an environment, which can be switched by the user. The environment parameters are those associated with requests noting E in their Notes column; in addition, partially collected lines and words are in the environment. Everything else is global; examples are page-oriented parameters, diversion-oriented parameters, number registers, and macro and string definitions. All environments are initialized with default parameter values.

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.ev N</td>
<td>N=0</td>
<td>previous</td>
<td>Environment switched to environment $0 \leq N \leq 2$. Switching is done in push-down fashion so that restoring a previous environment must be done with .ev rather than specific reference.</td>
</tr>
</tbody>
</table>
18. Insertions from the Standard Input

The input can be temporarily switched to the system standard input with .rd, which will switch back when two new-lines in a row are found (the extra blank line is not used). This mechanism is intended for insertions in form-letter-like documentation. On the UNIX system, the standard input can be the user's keyboard, a pipe, or a file.

<table>
<thead>
<tr>
<th>Request</th>
<th>Initial</th>
<th>If No</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Value</td>
<td>Argument</td>
<td></td>
</tr>
<tr>
<td>.rd prompt</td>
<td>-</td>
<td>prompt=BEL</td>
<td>-</td>
</tr>
</tbody>
</table>

Read insertion from the standard input until two new-lines in a row are found. If the standard input is the user's keyboard, prompt (or a BEL) is written onto the user's terminal. .rd behaves like a macro, and arguments may be placed after prompt.

.ex - - -

Exit from nroff/troff. Text processing is terminated exactly as if all input had ended.

If insertions are to be taken from the terminal keyboard while output is being printed on the terminal, the command-line option -q will turn off the echoing of keyboard input and prompt only with BEL. The regular input and insertion input cannot simultaneously come from the standard input.

As an example, multiple copies of a form letter may be prepared by entering the insertions for all the copies in one file to be used as the standard input, and causing the file containing the letter to reinvoke itself using .nx; the process would ultimately be ended by an .ex in the insertion file.
## 19. Input/Output File Switching

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.so file</td>
<td>-</td>
<td>-</td>
<td>Switch source file. The top input (file reading) level is switched to file. When the new file ends, input is again taken from the original file; .so's may be nested. Note that file should be preprocessed, if necessary, before being called by .so. eqn, tbl, pic, and grap will not reach through .sos to process an object file. Once a .so is encountered, the processing of file is immediate. Processing of the original file (e.g., a macro that is still active) is suspended.</td>
</tr>
<tr>
<td>.nx file</td>
<td>end-of-file</td>
<td>-</td>
<td>Next file is file. The current file is considered ended, and the input is immediately switched to file.</td>
</tr>
<tr>
<td>.cf file</td>
<td>-</td>
<td>-</td>
<td>Copy the contents of file, uninterpreted into troff output file at this point. Havoc ensues unless the motions in the file restore the current horizontal and vertical position.</td>
</tr>
<tr>
<td>.If N file</td>
<td>-</td>
<td>-</td>
<td>Corrects troff's idea of the current line number, N, and the current file, file, for use in error messages.</td>
</tr>
<tr>
<td>.pi program</td>
<td>-</td>
<td>-</td>
<td>Pipe output to program. This</td>
</tr>
</tbody>
</table>
request must occur before any printing occurs. No arguments are transmitted to program.

### 20. Miscellaneous

<table>
<thead>
<tr>
<th>Request Form</th>
<th>Initial Value</th>
<th>If No Argument</th>
<th>Notes Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>.mc c N</code></td>
<td>-</td>
<td>off</td>
<td>E,m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Specifies that a margin character c appear a distance N to the right of the right margin after each non-empty text line (except those produced by .t1). If the output line is too long (as can happen in no-fill mode) the character will be appended to the line. If N is not given, the previous N is used; the initial N is 0.2 inches in nroff and 1 em in troff. The margin character used with this paragraph was a 12-point box-rule.</td>
</tr>
<tr>
<td><code>.tm string</code></td>
<td>-</td>
<td>new-line</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>After skipping initial blanks, string (rest of the line) is read in copy mode and written on the user’s terminal.</td>
</tr>
<tr>
<td><code>.ig yy</code></td>
<td>-</td>
<td>.yy=..</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ignore input lines. .ig behaves exactly like .de except that the input is discarded. (See section 7, &quot;Macros, Strings, Diversions, and Position Traps.&quot;). The input is read in copy mode, and any auto-incremented registers will be affected.</td>
</tr>
</tbody>
</table>
.pm t - all - Print macros. The names and sizes of all of the defined macros and strings are printed on the user's terminal; if t is given, only the total of the sizes is printed. The size is given in blocks of 128 characters.

.fl - - B Flush output buffer.

.ab text - Abort - Prints text on the diagnostic output (normally the terminal) and terminates without further processing. If text is missing, the message "User Abort" is printed. The output buffer is flushed. Used in interactive debugging to force output.

.sy cmd args - - - cmd is executed but its output is not captured at this point. The standard input for cmd is closed. Output for processing must be explicitly saved in an output file.
21. Output and Error Messages

The output from .tm, .pm, and the prompt from .rd, as well as various error messages are written onto the UNIX system's standard error message output. The latter is different from the standard output, where nroff formatted output goes. By default, both are written onto the user's terminal, but they can be independently redirected.

Various error conditions may occur during the operation of nroff and troff. Certain less serious errors having only local impact do not cause processing to terminate. Two examples are "word overflow," caused by a word that is too large to fit into the word buffer (in fill mode), and "line overflow," caused by an output line that grew too large to fit in the line buffer; in both cases, a message is printed, the offending excess is discarded, and the affected word or line is marked at the point of truncation with a • in nroff and a † in troff. The philosophy is to continue processing, if possible, on the grounds that output useful for debugging may be produced. If a serious error occurs, processing terminates, and an appropriate message is printed. Examples are the inability to create, read, or write files, and the exceeding of certain internal limits that make future output unlikely to be useful.
# Special Characters

1. **Input Names for ′, ″, and − and for Non-ASCII Special Characters**

<table>
<thead>
<tr>
<th>Char</th>
<th>Input Name</th>
<th>Character Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;</td>
<td>′</td>
<td>close quote</td>
</tr>
<tr>
<td>&quot;</td>
<td>″</td>
<td>open quote</td>
</tr>
<tr>
<td>′</td>
<td>(fm</td>
<td>foot mark</td>
</tr>
<tr>
<td>″</td>
<td>(ct</td>
<td>cent sign</td>
</tr>
<tr>
<td>−</td>
<td>(em</td>
<td>3/4 em dash</td>
</tr>
<tr>
<td>−</td>
<td>(ru</td>
<td>current font minus</td>
</tr>
<tr>
<td>−</td>
<td>(hy</td>
<td>hyphen</td>
</tr>
<tr>
<td>°</td>
<td>(de</td>
<td>degree</td>
</tr>
<tr>
<td>•</td>
<td>(bu</td>
<td>bullet</td>
</tr>
<tr>
<td>☐</td>
<td>(sq</td>
<td>square</td>
</tr>
<tr>
<td>■</td>
<td>(bx</td>
<td>box</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Char</th>
<th>Input Name</th>
<th>Character Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>fi</td>
<td>(fi</td>
<td>fi ligature</td>
</tr>
<tr>
<td>ff</td>
<td>(ff</td>
<td>ff ligature</td>
</tr>
<tr>
<td>ff</td>
<td>(fl</td>
<td>fl ligature</td>
</tr>
<tr>
<td>ffi</td>
<td>(Fi</td>
<td>ffi ligature</td>
</tr>
<tr>
<td>ffl</td>
<td>(Fl</td>
<td>ffl ligature</td>
</tr>
<tr>
<td>(14</td>
<td>one-fourth</td>
<td></td>
</tr>
<tr>
<td>(12</td>
<td>one half</td>
<td></td>
</tr>
<tr>
<td>(34</td>
<td>three-fourths</td>
<td></td>
</tr>
<tr>
<td>(dg</td>
<td>dagger</td>
<td></td>
</tr>
<tr>
<td>(dd</td>
<td>double dagger</td>
<td></td>
</tr>
<tr>
<td>(rg</td>
<td>registered</td>
<td></td>
</tr>
<tr>
<td>(co</td>
<td>copyright</td>
<td></td>
</tr>
<tr>
<td>(tm</td>
<td>trademark</td>
<td></td>
</tr>
</tbody>
</table>
2. Non-ASCII Characters and Minus on the Standard Fonts

The upper-case Greek letter names followed by † are mapped into upper-case English letters in whatever font is mounted on font position one (default Times Roman). The special math plus, minus, and equals are provided to insulate the appearance of equations from the choice of standard fonts.

<table>
<thead>
<tr>
<th>Char</th>
<th>Input Name</th>
<th>Character</th>
<th>Char</th>
<th>Input Name</th>
<th>Character</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(\text{\textasciitilde A} )</td>
<td>Alpha†</td>
<td>α</td>
<td>\texttt{\textasciitilde a}</td>
<td>alpha</td>
</tr>
<tr>
<td>B</td>
<td>(\text{\textasciitilde B} )</td>
<td>Beta†</td>
<td>β</td>
<td>\texttt{\textasciitilde b}</td>
<td>beta</td>
</tr>
<tr>
<td>Γ</td>
<td>(\text{\textasciitilde G} )</td>
<td>Gamma</td>
<td>γ</td>
<td>\texttt{\textasciitilde g}</td>
<td>gamma</td>
</tr>
<tr>
<td>Δ</td>
<td>(\text{\textasciitilde D} )</td>
<td>Delta</td>
<td>δ</td>
<td>\texttt{\textasciitilde d}</td>
<td>delta</td>
</tr>
<tr>
<td>E</td>
<td>(\text{\textasciitilde E} )</td>
<td>Epsilon†</td>
<td>ε</td>
<td>\texttt{\textasciitilde e}</td>
<td>epsilon</td>
</tr>
<tr>
<td>Z</td>
<td>(\text{\textasciitilde Z} )</td>
<td>Zeta†</td>
<td>ζ</td>
<td>\texttt{\textasciitilde z}</td>
<td>zeta</td>
</tr>
<tr>
<td>H</td>
<td>(\text{\textasciitilde Y} )</td>
<td>Eta†</td>
<td>η</td>
<td>\texttt{\textasciitilde y}</td>
<td>eta</td>
</tr>
<tr>
<td>Θ</td>
<td>(\text{\textasciitilde H} )</td>
<td>Theta</td>
<td>θ</td>
<td>\texttt{\textasciitilde h}</td>
<td>theta</td>
</tr>
<tr>
<td>I</td>
<td>(\text{\textasciitilde I} )</td>
<td>Iota†</td>
<td>ι</td>
<td>\texttt{\textasciitilde i}</td>
<td>iota</td>
</tr>
<tr>
<td>K</td>
<td>(\text{\textasciitilde K} )</td>
<td>Kappa†</td>
<td>κ</td>
<td>\texttt{\textasciitilde k}</td>
<td>kappa</td>
</tr>
<tr>
<td>L</td>
<td>(\text{\textasciitilde L} )</td>
<td>Lambda</td>
<td>λ</td>
<td>\texttt{\textasciitilde l}</td>
<td>lambda</td>
</tr>
<tr>
<td>M</td>
<td>(\text{\textasciitilde M} )</td>
<td>Mu†</td>
<td>μ</td>
<td>\texttt{\textasciitilde m}</td>
<td>mu</td>
</tr>
<tr>
<td>N</td>
<td>(\text{\textasciitilde N} )</td>
<td>Nu†</td>
<td>ν</td>
<td>\texttt{\textasciitilde n}</td>
<td>nu</td>
</tr>
<tr>
<td>Ξ</td>
<td>(\text{\textasciitilde C} )</td>
<td>Xi</td>
<td>ξ</td>
<td>\texttt{\textasciitilde c}</td>
<td>xi</td>
</tr>
<tr>
<td>O</td>
<td>(\text{\textasciitilde O} )</td>
<td>Omicron†</td>
<td>ο</td>
<td>\texttt{\textasciitilde o}</td>
<td>omicron</td>
</tr>
<tr>
<td>Π</td>
<td>(\text{\textasciitilde P} )</td>
<td>Pi</td>
<td>π</td>
<td>\texttt{\textasciitilde p}</td>
<td>pi</td>
</tr>
<tr>
<td>P</td>
<td>(\text{\textasciitilde R} )</td>
<td>Rho†</td>
<td>ρ</td>
<td>\texttt{\textasciitilde r}</td>
<td>rho</td>
</tr>
<tr>
<td>Σ</td>
<td>(\text{\textasciitilde S} )</td>
<td>Sigma</td>
<td>σ</td>
<td>\texttt{\textasciitilde s}</td>
<td>sigma</td>
</tr>
<tr>
<td>T</td>
<td>(\text{\textasciitilde T} )</td>
<td>Tau†</td>
<td>τ</td>
<td>\texttt{\textasciitilde t}</td>
<td>tau</td>
</tr>
<tr>
<td>Υ</td>
<td>(\text{\textasciitilde U} )</td>
<td>Upsilon</td>
<td>υ</td>
<td>\texttt{\textasciitilde u}</td>
<td>upsilon</td>
</tr>
<tr>
<td>Φ</td>
<td>(\text{\textasciitilde F} )</td>
<td>Phi</td>
<td>φ</td>
<td>\texttt{\textasciitilde f}</td>
<td>phi</td>
</tr>
<tr>
<td>Χ</td>
<td>(\text{\textasciitilde X} )</td>
<td>Chi†</td>
<td>χ</td>
<td>\texttt{\textasciitilde x}</td>
<td>chi</td>
</tr>
<tr>
<td>Ψ</td>
<td>(\text{\textasciitilde Q} )</td>
<td>Psi</td>
<td>ψ</td>
<td>\texttt{\textasciitilde q}</td>
<td>psi</td>
</tr>
<tr>
<td>Ω</td>
<td>(\text{\textasciitilde W} )</td>
<td>Omega</td>
<td>ω</td>
<td>\texttt{\textasciitilde w}</td>
<td>omega</td>
</tr>
</tbody>
</table>
### Special Characters

<table>
<thead>
<tr>
<th>Char</th>
<th>Input Name</th>
<th>Character Name</th>
<th>Char</th>
<th>Input Name</th>
<th>Character Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>(pl)</td>
<td>math plus</td>
<td>()</td>
<td>(if)</td>
<td>infinity</td>
</tr>
<tr>
<td>-</td>
<td>(mi)</td>
<td>math minus</td>
<td>()</td>
<td>(pd)</td>
<td>partial derivative</td>
</tr>
<tr>
<td>*</td>
<td>(eq)</td>
<td>math equals</td>
<td>()</td>
<td>(gr)</td>
<td>gradient</td>
</tr>
<tr>
<td></td>
<td>(**)</td>
<td>math star</td>
<td>()</td>
<td>(no)</td>
<td>not</td>
</tr>
<tr>
<td>()</td>
<td>(aa)</td>
<td>acute accent</td>
<td>()</td>
<td>(pt)</td>
<td>proportional to</td>
</tr>
<tr>
<td>()</td>
<td>(ga)</td>
<td>grave accent</td>
<td>()</td>
<td>(es)</td>
<td>empty set</td>
</tr>
<tr>
<td>()</td>
<td>(ul)</td>
<td>underrule</td>
<td>()</td>
<td>(mo)</td>
<td>member of</td>
</tr>
<tr>
<td>()</td>
<td>(sl)</td>
<td>slash</td>
<td>()</td>
<td>(or)</td>
<td>or</td>
</tr>
<tr>
<td>()</td>
<td>(sr)</td>
<td>(matching backlash)</td>
<td>()</td>
<td>(br)</td>
<td>box vertical rule</td>
</tr>
<tr>
<td>()</td>
<td>(rn)</td>
<td>root en extender</td>
<td>()</td>
<td>(rh)</td>
<td>right hand</td>
</tr>
<tr>
<td>()</td>
<td>(&gt;)=)</td>
<td>&gt;=</td>
<td>()</td>
<td>(lh)</td>
<td>left hand</td>
</tr>
<tr>
<td>()</td>
<td>(&lt;=)</td>
<td>&lt;=</td>
<td>()</td>
<td>(ci)</td>
<td>circle</td>
</tr>
<tr>
<td>()</td>
<td>(==)</td>
<td>identically equal</td>
<td>()</td>
<td>(lt)</td>
<td>left top of big curly bracket</td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>approx =</td>
<td>()</td>
<td>(lb)</td>
<td>left bottom</td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>approximates</td>
<td>()</td>
<td>(rt)</td>
<td>right top</td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>not equal</td>
<td>()</td>
<td>(rb)</td>
<td>right bottom</td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>right arrow</td>
<td>()</td>
<td>(lk)</td>
<td>left center of big curly bracket</td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>left arrow</td>
<td>()</td>
<td>(rk)</td>
<td>right center of big curly bracket</td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>up arrow</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>down arrow</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>multiply</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>divide</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>plus-minus</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>cup (union)</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>cap (intersection)</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>subset of</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>superset of</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>improper subset</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>()</td>
<td>improper superset</td>
<td>()</td>
<td>()</td>
<td></td>
</tr>
</tbody>
</table>

nroff/troff: TECHNICAL DISCUSSION 67
NAME
checkmm - checks documents formatted with the mm macros

SYNOPSIS
checkmm [ file(s) ]

DESCRIPTION
checkmm stands for "check memorandum macros." Use checkmm to check
for syntax errors in files that have been prepared for the mm(1) or mmt(1)
command. For example, checkmm checks that you have a .DE (display end
macro) corresponding to every .DS (display start macro).

The output for checkmm is the number of lines checked, and a list of macros
that are unfinished because of missing macros. If you do not include a file
name on the command line, checkmm takes input from standard input.

SEE ALSO
eqn(1), mm(1), mmt(1), mvt(1), neqn(1), tbl(1), and mm(5).

DIAGNOSTICS
"checkmm Cannot open file(s) " if file(s) is unreadable. The remaining output
of the program is diagnostic of the source file.
col reads from the standard input and writes onto the standard output. It performs the line overlays implied by reverse line feeds (ASCII code ESC-7), and by forward and reverse half-line-feeds (ESC-9 and ESC-8). col is particularly useful for filtering multicolumn output made with the .rt command of nroff and output resulting from use of the tbl(1) preprocessor.

If the -b option is given, col assumes that the output device in use is not capable of backspacing. In this case, if two or more characters are to appear in the same place, only the last one read will be output.

Although col accepts half-line motions in its input, it normally does not emit them on output. Instead, text that would appear between lines is moved to the next lower full-line boundary. This treatment can be suppressed by the -f (fine) option; in this case, the output from col may contain forward half-line-feeds (ESC-9), but will still never contain either kind of reverse line motion.

Unless the -x option is given, col will convert white space to tabs on output wherever possible to shorten printing time.

The ASCII control characters SO (\017) and SI (\016) are assumed by col to start and end text in an alternate character set. The character set to which each input character belongs is remembered, and on output SI and SO characters are generated as appropriate to ensure that each character is printed in the correct character set.

On input, the only control characters accepted are space, backspace, tab, return, new-line, SI, SO, VT (\013), and ESC followed by 7, 8, or 9. The VT character is an alternate form of full reverse line-feed, included for compatibility with some earlier programs of this type. All other non-printing characters are ignored.

Normally, col will ignore any escape sequences unknown to it that are found in its input; the -p option may be used to cause col to output these sequences as regular characters, subject to overprinting from reverse line motions. The use of this option is highly discouraged unless the user is fully aware of the textual position of the escape sequences.

SEE ALSO

mm(1), nroff(1), tbl(1).
NOTES

The input format accepted by col matches the output produced by nroff with either the -T37 or -TIp options. Use -T37 (and the -f option of col) if the ultimate disposition of the output of col will be a device that can interpret half-line motions, and -TIp otherwise.

BUGS

Cannot back up more than 128 lines.
Allows at most 800 characters, including backspaces, on a line.
Local vertical motions that would result in backing up over the first line of the document are ignored. As a result, the first line must not have any superscripts.
NAME
daps — postprocessor for the Autologic APS-5 phototypesetter

SYNOPSIS
daps [ option(s) ] [ -- ] [ file(s) ]

DESCRIPTION
daps prints file(s) created by troff(1) on an Autologic APS-5 phototypesetter. If you do not specify a file(s), the standard input is printed. daps understands the following options:

-\( b \) reports whether the typesetter is busy; does not print output
-\( h \) string
  prints string in this job's header. The header appears on a page preceding the output.
-\( o \) list
  prints pages whose numbers are given in a list, containing single numbers \( N_1 \), or ranges \( N_1 \)--\( N_2 \). A missing \( N_1 \) means the lowest-numbered page, a missing \( N_2 \) means the highest.
-\( r \)
  reports the number of 11-inch pages generated by this job. Use this option only after you have checked with the typesetter operations staff.
-\( s \) n
  stops after every n pages of output. daps continues when you push the PROCEED button on the typesetter.
-\( t \)
  directs output to the standard output instead of the typesetter.
-\( w \)
  waits for typesetter to become free, then prints output.

The file(s) that you submit to daps should be prepared under the -Taps option of troff(1).

FILES
/dev/aps APS-5 phototypesetter device
/usr/lib/font/devaps/* font description files for APS-5

SEE ALSO
di10(1), tc(1), troff(1), troff(5), mmt(1), mvt(1).

BUGS
Installations with an Autologic APS-5 phototypesetter should be aware that getting a good match to their Autologic fonts will almost certainly require hand-tuning of the font description files (see FILES above).
NAME
di10 — postprocessor for the Imagen Imprint-10 laser printer

SYNOPSIS
di10 [ option(s) ] [ -- ] [ file(s) ]

DESCRIPTION
di10 prints file(s) created by troff(1) on an Imagen Imprint-10 laser printer. It is a phototypesetter simulator that can handle troff output prepared for any supported typesetter. However, files sent to di10 look best when prepared with the −T10 option of troff.

If you do not specify a file, the standard input is printed. di10 understands the following options:

−o list prints pages whose numbers are given in a list containing single numbers $N_i$ or ranges $N_1$−$N_2$. A missing $N_1$ means the lowest-numbered page, a missing $N_2$ means the highest.

−t directs output to the standard output instead of the typesetter.

−r $n$ resolution of printer is $n$ dots per inch. di10 will adjust its choice of raster files to produce properly scaled output. The default is 240.

FILES
/usr/lib/font/devil0/* font description files for Imagen Imprint-10
/usr/lib/font/devil0/rast10/* raster files for Imprint-10
/tmp/dimp* output of di10 ready for Imagen

SEE ALSO
daps(1), tc(1), troff(1), troff(5), mmt(1), mvt(1).
NAME
diffmk — mark differences between files

SYNOPSIS
diffmk [ -- ] file1 file2 file3

DESCRIPTION
diffmk compares two versions of a file and creates a third file that includes
"change mark" requests (.mc) for nroff or troff(l). file1 and file2 are the old
and new versions of the file. diffmk generates file3, which contains the lines
of file2 plus inserted formatter "change mark" requests. When file3 is format­
ted, changed or inserted text is shown by | at the right margin of each line.
The position of deleted text is shown by a single asterisk: •.

If anyone is so inclined, diffmk can be used to produce listings of C (or
other) programs with changes marked. A typical command line for such use
is

diffmk old.c new.c tmp; .nroff macs tmp | pr

where the file macs contains

.pl 1
.ll 77
.nf
.eo
.ec

The .ll request might specify a different line length, depending on the nature
of the program being printed. The .eo and .nc requests are probably needed
only for C programs.

SEE ALSO
nroff(l), and troff(l).

Where diffmk encounters — it uses the standard input.

BUGS
Aesthetic considerations may dictate manual adjustment of some output. File
differences involving only formatting requests may produce undesirable out­
put, i.e., replacing .sp by .sp 2 will produce a "change mark" on the preceding
or following line of output.
NAME
eqn — format mathematical text for troff

SYNOPSIS
eqn [-d xx] [-p n] [-s n] [-f n] [-Ttty_type] [—] [file(s)]

DESCRIPTION
eqn is a troff(1) preprocessor for typesetting mathematical text on a phototypesetter. Normal usage is:

```
eqn [option(s)] file(s) | troff [option(s)] | [typesetter]
```

If you do not specify files (or if you specify - as the last argument), eqn reads the standard input. eqn prepares output for the typesetter that you name in the -T option. Currently supported devices are -Taps (Autologic APS-5), and -TitO (Imagen Imprint-10). The default is -Taps.

A line beginning with .EQ marks the start of an equation; the end of an equation is marked by a line beginning with .EN. troff does not alter these lines, so they may be defined in macro packages to get centering, numbering, etc. You may also name two characters as delimiters; eqn treats subsequent text between delimiters as input. You may set delimiters to characters x and x with the command line argument -d xx or (more commonly) with delim xx between .EO and .EN. The left and right delimiters may be the same character; the dollar sign is often used as such a delimiter. Turn delimiters off with delim off. eqn touches only text that is between delimiters or between .EO and .EN.

Set apart keywords recognized by eqn with spaces, tabs, new-lines, braces, double quotes, tildes, and circumflexes. Use braces, {}, for grouping; generally speaking, anywhere you can use a single character such as x, you may use a complicated construction enclosed in braces instead. Tilde (\textasciitilde) represents a full space in the output, circumflex (\textasciicircum) half as much.

Subscripts and superscripts are produced with the keywords sub and sup. Fractions are made with over. sqrt makes square roots.

The keywords from and to introduce lower and upper limits. Left and right brackets, braces, etc., of the right height are made with left and right. Legal characters after left and right are braces, brackets, bars, c and f for ceiling and floor, and " for nothing at all (useful for a right-side-only bracket). A left thing need not have a matching right thing, but a right thing must have a matching left thing.

Vertical piles of things are made with pile, lpile, cpile, and rpile. Piles may have arbitrary numbers of elements; lpile left-justifies, pile and cpile center (but with different vertical spacing), and rpile right-justifies. Matrices are made with matrix. In addition, there is rcol for a right-justified column.

Diacritical marks are made with dot, dotdot, hat, tildes, bar, vec, dyad, and \textasciicircum.

You may change point sizes and fonts with size n or size \pm n, roman, italic, bold, and font n. You may change point sizes and fonts globally in a document by gsize n and gfont n, or by the command-line arguments -sn and -fn.
Normally, subscripts and superscripts are reduced by 3 points from the previous size; you may change this with the command-line argument -pn.

You can line up successive display arguments. Place mark before the desired lineup point in the first equation; place lineup at the place that is to line up vertically in subsequent equations.

You may define shorthands or redefine existing keywords with define:

    define thing % replacement %

defines a new token called thing that is replaced by replacement whenever it appears thereafter. The % may be any character that does not occur in replacement.

Keywords such as sum, int, inf, and shorthands such as >=, !=, and -> are recognized. Greek letters are spelled out in the desired case, as in alpha or GAMMA. Mathematical words such as sin, cos, and log are made Roman automatically. troff(1) four-character escapes such as \(dd, which produces the double dagger, may be used anywhere. Strings enclosed in double quotes ("...") are passed through untouched; this permits keywords to be entered as text, and can be used to communicate with troff(1) when all else fails. Full details are given in the REFERENCE cited below.

SEE ALSO

mmt(1), mvt(1), neqn(1), nroff(1), tbl(1), troff(1), eqnchar(5), mm(5), and mv(5).


BUGS

To embolden digits, parentheses, etc., it is necessary to quote them, as in bold "12.3". When you use eqn with the mm macro package, displayed equations must appear only inside displays.

See also BUGS under troff(1).
NAME
eqnchar — special character definitions for eqn and neqn

SYNOPSIS

eqn /usr/pub/eqnchar [ option(s) ] [ - ] [ file(s) ] | troff [ option(s) ]
eqn /usr/pub/cateqnchar [ option(s) ] [ - ] [ file(s) ] | troff [ option(s) ]
neqn /usr/pub/eqnchar [ option(s) ] [ - ] [ file(s) ] | nroff [ option(s) ]
eqn -Taps /usr/pub/apseqnchar [ option(s) ] [ - ] [ file(s) ] |
troff [ option(s) ]

DESCRIPTION

/usr/pub/eqnchar contains the following troff(1) and nroff(1) character
definitions that are not ordinarily available on a phototypesetter or printer.
These definitions are primarily intended for use with eqn(1) and neqn(1).

eqnchar contains definitions for the following characters:

- $\oplus$ ciplus
- $\ominus$ citimes
- $\sim$ wig
- $\simeq$ -wig
- $\triangleright$ >wig
- $\triangleleft$ <wig
- $\ast$ star
- $\star$ bigstar
- $\cdot$ -dot
- $\forall$ orsign
- $\land$ andsign
- $\Delta$ oppA
- $\exists$ oppE
- $\AA$ angstrom
- $\leq$ -<

/usr/pub/apseqnchar is a version of eqnchar tailored for the Autologic APS-5
phototypesetter. If you use apseqnchar, output will not look optimal on other
phototypesetters. cateqnchar is more "device-independent," and should pro-
duce output that looks reasonable on any device supported by troff(1). You
may link /usr/pub/eqnchar to /usr/pub/cateqnchar or to
/usr/pub/apseqnchar. By default, /usr/pub/eqnchar is linked to
/usr/pub/apseqnchar.
SEE ALSO
  eqn(1), neqn(1), nroff(1), troff(1), mm(1), mmt(1), and mvt(1).

FILES
  /usr/pub/eqnchar
  /usr/pub/apseqnchar
  /usr/pub/cateqnchar
NAME
font — description files for troff

SYNOPSIS
troff -Ttty_type ...

DESCRIPTION
For each phototypesetter that troff(1) supports and that is available on your system, there is a directory that contains files describing the phototypesetter and its fonts. This directory is named /usr/lib/font/devtty_type, where tty_type is the name of the phototypesetter. Currently, the supported devices are aps for the Autologic APS-S and i10 for the Imagen Imprint-10 laser printer.

For a particular phototypesetter, tty_type, the ASCII file DESC in the directory devtty_type within the troff source directory describes its characteristics. A binary version of this file (described below) is found in /usr/lib/font/devtty_type/DESC.out. Each line of this ASCII file starts with a word that identifies the characteristic, which is followed by appropriate specifiers. Blank lines and lines beginning with the # character are ignored.

The legal lines for DESC are:

- res num: resolution of device in basic increments per inch
- hor num: smallest unit of horizontal motion
- vert num: smallest unit of vertical motion
- unitwidth num: pointsize in which widths are specified
- sizescale num: scaling for fractional pointsizes
- paperwidth num: width of paper in basic increments
- paperlength num: length of paper in basic increments
- biggestfont num: maximum size of a font
- sizes num num ...: list of pointsizes available on typesetter, terminated by 0
- fonts num name ...: number of initial fonts followed by the names of the fonts. For example:
  fonts 4 R I B S
- charset: this always comes last in the file and is on a line by itself. Following it is the list of special character names for this device. Names are separated by a space or a newline. The list can be as long as necessary. Names not in this list are not allowed in the font description files.

res is the basic resolution of the device in increments per inch. hor and vert describe the relationships between motions in the horizontal and vertical directions. If the device is capable of moving in single basic increments in both directions, both hor and vert would have values of 1. If the vertical motions only take place in multiples of two basic units while the horizontal motions take place in the basic increments, then hor would be 1, while vert...
would be 2. unitwidth is the pointsize in which all width tables in the font description files are given. troff automatically scales the widths from the unitwidth size to the pointsize it is working with. sizescale is not currently used and is 1. paperwidth is the width of the paper in basic increments. The APS-5 is 6120 increments wide. paperlength is the length of a sheet of paper in the basic increments. biggestfont is the maximum number of characters on a font.

For each font supported by the phototypesetter, there is also an ASCII file with the same name as the font (e.g., R, I, CW). The format for a font description file is:

```
name name
internalname name
special
ingatures name ... 0
spacewidth num
charset
```

name is the name of the font, such as R or CW
internalname is the internal name of font
special sets flag indicating that the font is special
lingatures sets flag indicating font has ligatures. The list of ligatures follows and is terminated by a zero. Accepted ligatures are: ff fi fl ffi ffl.
spacewidth specifies width of space if something other than default (1/3 of an em) is desired.
charset The character set must come at the end. Each line following the word charset describes one character in the font. Each line has one of two formats:

```
name width kerning code
name *
```

where name is either a single ASCII character or a special character name from the list found in DESC. The width is in basic increments. The kerning information is 1 if the character descends below the line, 2 if it rises above the letter 'a', and 3 if it both rises and descends. The kerning information for special characters is not used and so may be 0. The code is the number sent to the typesetter to produce the character. The second format is used to show that the character has more than one name. The double quote shows that this name has the same values as the preceding line. The kerning and code fields are not used if the width field is a double quote character. The total number of different characters in this list should not be greater than the value of biggestfont in the DESC file (see above).

In the source version of DOCUMENTER'S WORKBENCH Software, troff and its postprocessors read this information from binary files produced from the ASCII files by makedev, a program distributed with troff source. For those having a source license and need to know, a description of the format of these files follows:
The file DESC.out starts with the dev structure, defined by dev.h:

```c
/*
 * dev.h: characteristics of a typesetter *
 */

struct dev {
    unsigned short filesize; /* number of bytes in file, */
    /* excluding dev part */
    short res; /* basic resolution in goobies/inch */
    short hor; /* goobies horizontally */
    short vert;
    short unitwidth; /* size at which widths are given*/
    short nfonts; /* number fonts physically available */
    short nsizes; /* number of pointsizes */
    short sizescale; /* scaling for fractional pointsizes */
    short paperwidth; /* max line length in units */
    short paperlength; /* max paper length in units */
    short nchtab; /* number of funny names in chtab */
    short lchname; /* length of chname table */
    short biggestfont; /* max # of chars in a font */
    short spare; /* in case of expansion */
};
```

filesize is just the size of everything in DESC.out excluding the dev structure. nfonts is the number of different font positions available. nsizes is the number of different pointsizes supported by this typesetter. nchtab is the number of special character names. lchname is the total number of characters, including nulls, needed to list all the special character names. At the end of the structure is one spare for later expansions.

Immediately following the dev structure are a number of tables. First is the sizes table, which contains nsizes + 1 shorts(a null at the end), describing the pointsizes of text available on this device. The second table is the funny_char_index_table. It contains indices into the table that follows it, the funny_char_strings. The indices point to the beginning of each special character name that is stored in the funny_char_strings table. The funny_char_strings table is lchname characters long, while the funny_char_index_table is nchtab shorts long.

Following the dev structure will occur nfonts {font}.out files, which are used to initialize the font positions. These {font}.out files, which also exist as separate files, begin with a font structure and then are followed by four character arrays:

```c
struct Font { /* characteristics of a font */
    char nwfont; /* number of width entries */
    char specfont; /* 1 == special font */
    char ligfont; /* 1 == ligatures exist on this font */
    char namefont[10]; /* name of this font, e.g., R */
    char intname[10]; /* internal name of font, in ASCII */
};
```
The *font* structure tells how many defined characters there are in the font, whether the font is a "special" font and if it contains ligatures. It also has the ASCII name of the font, which should match the name of the file it appears in, and the internal name of the font on the typesetting device (*intname*). The internal name is independent of the font position and name that troff knows about. For example, you might say mount R in position 4, but when asking the typesetter to actually produce a character from the R font, the postprocessor which instructs the typesetter would use *intname*.

The first three character arrays are specific for the font and run in parallel. The first array, *widths*, contains the width of each character relative to *unitwidth*. *unitwidth* is defined in DESC. The second array, *kerning*, contains kerning information. If a character rises above the letter 'a', 02 is set. If it descends below the line, 01 is set. The third array, *codes*, contains the code that is sent to the typesetter to produce the character.

The fourth array is defined by the device description in DESC. It is the *font_index_table*. This table contains indices into the *width*, *kerning*, and *code* tables for each character. The order that characters appear in these three tables is arbitrary and changes from one font to the next. In order for troff to be able to translate from ASCII and the special character names to these arbitrary tables, the *font_index_table* is created with an order that is constant for each device. The number of entries in this table is 96 plus the number of special character names for this device. The value 96 is 128 - 32, the number of printable characters in the ASCII alphabet. To determine whether a normal ASCII character exists, troff takes the ASCII value of the character, subtracts 32, and looks in the *font_index_table*. If it finds a 0, the character is not defined in this font. If it finds anything else, that is the index into *widths*, *kerning*, and *codes* that describe that character.

To look up a special character name, for example \(\texttt{pl}\), the mathematical plus sign, and determine whether it appears in a particular font or not, the following procedure is followed. A *counter* is set to 0 and an index to a special character name is picked out of the *counter*th position in the *funny_char_index_table*. A string comparison is performed between *funny_char_strings[funny_char_index_table[counter]]* and the special character name, in our example \(\texttt{pl}\), and if it matches, then troff refers to this character as \((96 + \text{counter})\).

When it wants to determine whether a specific font supports this character, it looks in *font_index_table[96+counter]*, (see below), to see whether there is a 0, meaning the character does not appear in this font, or a number, which is the index into the *widths*, *kerning*, and *codes* tables.

Notice that since a value of 0 in the *font_index_table* shows that a character does not exist, the 0th element of the *width*, *kerning*, and *codes* arrays are not used. For this reason the 0th element of the *width* array can be used for a special purpose, defining the width of a space for a font. Normally a space is defined by troff to be 1/3 of the width of the \(\texttt{em}\) character, but if the 0th element of the *width* array is non-zero, then that value is used for the width of a space.

**SEE ALSO**

troff(1), troff(5).
FILES
/usr/lib/font/devtty_type/DESC.out  description file for phototypesetter tty_type
/usr/lib/font/devtty_type/font.out   font description files for phototypesetter tty_type
GRAP(1)

NAME
grap — pic preprocessor for drawing graphs

SYNOPSIS
grap [-Ttty_type] [-l] [--] [file(s)]

OPTIONS
   -T Specifies tty_type as grap's output device. Currently supported devices are aps (Autologic APS-S) and di10 (Imagen Imprint 10). -Taps is default.
   -l Stops grap from looking for a library file of macro defines, /usr/lib/dwb/grap.defines.

DESCRIPTION
grap is a language for typesetting graphs. It is also the name of a preprocessor that feeds input to pic(1). Thus, a typical command line would appear as follows:

   grap file(s) | pic | troff | typesetter

Graphs are surrounded by the troff "commands" .Gt and .G2. Data that is enclosed is scaled and plotted, with tick marks supplied automatically. Commands exist to modify the frame, add labels, override the default ticks, change the plotting style, define coordinate ranges and transformations, and include data from files. In addition, grap provides the same loops, conditionals and macro processing that pic does.

FILES
/usr/lib/dwb/grap.defines: definitions of standard plotting characters, e.g., bullet.

SEE ALSO
   pic(1).

REFERENCE MANUAL 1
NAME
hyphen — find hyphenated words

SYNOPSIS
hyphen [ file(s) ]

DESCRIPTION
hyphen finds all the hyphenated words ending lines in file(s) and prints them on the standard output. If no arguments are given or if hyphen encounters - , it uses the standard input. Thus, hyphen may be used as a filter.

EXAMPLE
You would use the following command-line to proofread nroff’s hyphenation in file(s):

    mm mm_option(s) file(s) | hyphen

SEE ALSO
mm(1), troff(1).

BUGS
hyphen can’t cope with hyphenated italic (or underlined words); it frequently will either miss them altogether or mishandle them. hyphen occasionally gets confused but with no ill effects other than spurious extra output.
NAME
macref — produces cross-reference listing of macro files

SYNOPSIS
macref [-t] [-s] [-n] [- - ] file(s)

DESCRIPTION
macref reads the named file(s) (which are assumed to be nroff(1) or troff(1) input) and produces a cross-reference listing of the symbols in the input.

A -t on the command line causes a macro table of contents to be printed. The option -s causes symbol-use statistics to be printed. The option -n causes one line to be printed for each reference to a symbol. The options may be grouped behind one -. You may use "---" to delimit the end of options. macref does not accept - as standard input.

The default output is a list of the symbols found in the input, each accompanied by a list of all references to that symbol. macref lists the symbols alphabetically in the leftmost column, with the references following to the right. Each reference is given in the form:

```
[(NMname) Mname-] type Inum [#]
```

where the fields have the following meanings:

- **Mname**: the name of the macro within which the reference occurs. This field is missing if the reference occurs outside a macro. Any names listed in the NMname part are macros within which Mname is defined.

- **type**: the type associated, by context, with this occurrence of the symbol. The types may be:
  - r: request
  - m: macro
  - d: diversion
  - s: string
  - n: number register
  - p: parameter (e.g., \$x is a parameter reference to x. Note that parameters are never modified, and that the only valid parameter symbol names are 1, 2, ... 9).

- **Inum**: the line number on which the reference occurred.

- **#**: this reference modifies the value of the symbol.

Generated names are listed under the artificial symbol name ""sym"".

SEE ALSO
nroff(1), troff(1), mm(1), mm(5), mv(5), mmt(1), mvt(1), and man(5).
NAME
man — macros for formatting entries in this manual

SYNOPSIS
nroff -man file(s)
troff -man [ -rs1 ] file(s)

DESCRIPTION
These nroff/troff macros are used to lay out the format of the entries of this manual. The default page size is 8.5"×11", with a 6.5"×10" text area; the -rs1 option reduces these dimensions to 6"×9" and 4.75"×8.375", respectively; this option also reduces the default type size from 10-point to 9-point, and the vertical line spacing from 12-point to 10-point. The -rV2 option may be used to set certain parameters to values appropriate for certain Versatec printers: it sets the line length to 82 characters, the page length to 84 lines, and it inhibits underlining.

Any text argument below may be one to six "words." Double quotes (""") may be used to include blanks in a "word." If text is empty, the special treatment is applied to the next line that contains text to be printed. For example, .I may be used to italicize a whole line, or .SM followed by .B to make small bold text. By default, hyphenation is turned off for nroff(1), but remains on for troff(1).

Type font and size are reset to default values before each paragraph and after processing font- and size-setting macros, for example, .I, .RB, .SM. Tab stops are neither used nor set by any macro except .DT and .TH.

Default units for indents in are ens. When in is omitted, the previous indent is used. This remembered indent is set to its default value (7.2 ens in troff(1), 5 ens in nroff(1)) by .TH, .P, and .RS, and restored by .RE.

.TH t s c n Set the title and entry heading; t is the title, s is the section number, c is extra commentary, e.g., "local", n is new manual name. Invokes .DT (see below).

.SH text Place subhead text, for example, SYNOPSIS, here.
.SS text Place sub-subhead text, for example, Options, here.
.B text Make text bold.
.I text Make text italic.
.SM text Make text 1 point smaller than default point size.
.RI a b Concatenate roman a with italic b, and alternate these two fonts for up to six arguments. Similar macros alternate between any two of roman, italic, and bold:

.IR .RB .BR .IB .BI

.P Begin a paragraph with normal font, point size, and indent. .PP is a synonym for the mm(5) macro .P.

.HP in Begin paragraph with hanging indent.
.TP in Begin indented paragraph with hanging tag. The next line that contains text to be printed is taken as the tag. If the tag does not fit, it is printed on a separate line.
.IP t in Same as .TP in with tag t; often used to get an indented paragraph without a tag.
Increase relative indent (initially zero). Indent all output an extra in units from the current left margin.

Return to the kth relative indent level (initially, $k=1$; $k=0$ is equivalent to $k=1$); if $k$ is omitted, return to the most recent lower indent level.

Produces proprietary markings see REFERENCE to mm(l) below.

Restore default tab settings (every 7.2 ens in troff(l), 5 ens in nroff(l)).

Set the interparagraph distance to $v$ vertical spaces. If $v$ is omitted, set the interparagraph distance to the default value (0.4$v$ in troff(l), 1$v$ in nroff(l)).

The following strings are defined:

\*R  * in troff(l), (Reg.) in nroff.
\*S  Change to default type size.
\*(Tm  Trademark indicator.

The following number registers are given default values by .TH:

IN  Left margin indent relative to subheads (default is 7.2 ens in troff(l), 5 ens in nroff(l)).
LL  Line length including IN.
PD  Current interparagraph distance.

EXAMPLES

The man macros are provided to process manual pages already on-line at a given location and to enable users to make their own manual pages. The preceding section demonstrated the usage of the macros themselves; the following section provides examples of command lines typically used to process the completed files.

man macros are designed to run with either nroff or troff. The first command line will process file(s) using only macros and nroff requests:

```
nroff -Tlp -man file(s) | lp
```

File(s) is piped to the local line printer, lp.

The next command line will process file(s) containing tables as well as macros and nroff requests:

```
tbl file(s) | nroff -Tlp -man | col | lp
```

Notice that before it is sent to the line printer, the output is first filtered through col, to process the reverse line feeds used by tbl.

The final example is a command line that processes an unusual manual page, one using pic and grap. If the manual pages created with man are intended for an on-line facility, components requiring troff, such as grap or pic, should be avoided since the average installation of terminals will not be able to process typeset documents.

```
grap file(s) | pic | tbl | troff -Taps -man | typesetter
```

2 REференц MANуал
grap precedes pic because it is a preprocessor to pic; the reverse order will not format correctly. File(s) contains one or more tables, requiring tbl, but col is no longer necessary because typeset documents do not use reverse line feeds with which to make tables. The -T option for specifying the output device (Terminal type) takes the argument aps here, readying the document for processing on the APS-5 phototypesetter.

SEE ALSO
eqn(1), man(1), neqn(1), nroff(1), tbl(1), tc(1), troff(1).
The "mm: Technical Discussion"

FILES
/usr/lib/tmac/tmac.an
/usr/lib/macros/an
/usr/man/[uap]_man/man0/skeleton

CAVEATS
Special macros, strings, and number registers exist, internal to man, in addition to those mentioned above. Except for names predefined by troff(1) and number registers d, m, and y, all such internal names are of the form XA, where X is one of ), [ and ], and A stands for any alphanumeric character. User defined macros should avoid these naming conventions.

The programs that prepare the Table of Contents and the Permuted Index for this manual assume the NAME section of each entry consists of a single line of input that has the following format:

name \- explanatory text

The macro package increases the inter-word spaces (to eliminate ambiguity) in the SYNOPSIS section of each entry.

The macro package itself uses only the roman font (so that one can replace, for example, the bold font by the constant-width font (CW). Of course, if the input text of an entry contains requests for other fonts (for example, I, .RB, \fil), the corresponding fonts must be mounted.

BUGS
If the argument to .TH contains any blanks and is not enclosed by double quotes (""), there will be strange irregular dots on the output.
NAME

`mm` - prints documents formatted with the `mm` macros

SYNOPSIS

```
mm [ option(s) ] [ file(s) ]
```

DESCRIPTION

Use `mm` to format documents using `nroff` and the `mm` text-formatting macro package. `mm` has options to specify preprocessing by `tbl(1)` and/or `neqn(1)`, and postprocessing by various terminal-oriented output filters. The proper pipelines and the required arguments and flags for `nroff` and `mm` are generated, depending on the options that you select.

Options for `mm` are given below. Any other arguments or flags (e.g., `-rC3`) are passed to `nroff` as appropriate. You may use such options in any order, but you must put them before the `file(s)` arguments. If you do not specify arguments, `mm` prints a list of its options.

`-Ttty_type`

specifies the type of output terminal.

Here is a list of recognized values for `tty_type`.

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2631</td>
<td>Hewlett-Packard 2631 printer in regular mode</td>
</tr>
<tr>
<td>2631-c</td>
<td>Hewlett-Packard 2631 printer in compressed mode</td>
</tr>
<tr>
<td>2631-e</td>
<td>Hewlett-Packard 2631 printer in expanded mode</td>
</tr>
<tr>
<td>300</td>
<td>DASI-300 printer</td>
</tr>
<tr>
<td>300-12</td>
<td>DASI-300 terminal set to 12-pitch (12 characters per inch)</td>
</tr>
<tr>
<td>300s</td>
<td>DASI-300s printer (300S is a synonym)</td>
</tr>
<tr>
<td>300s-12</td>
<td>DASI-300s printer set to 12-pitch (12 characters per inch) (300S-12 is a synonym)</td>
</tr>
<tr>
<td>37</td>
<td>Teletype Model 37 terminal</td>
</tr>
<tr>
<td>382</td>
<td>DTC-382</td>
</tr>
<tr>
<td>4000a</td>
<td>Trendata 4000a terminal (4000A is a synonym)</td>
</tr>
<tr>
<td>450</td>
<td>DASI-450 (Diablo Hyterm) printer</td>
</tr>
<tr>
<td>450-12</td>
<td>DASI-450 terminal set to 12-pitch (12 characters per inch)</td>
</tr>
<tr>
<td>832</td>
<td>Anderson Jacobson 832 terminal</td>
</tr>
<tr>
<td>8510</td>
<td>C.ITOH printer</td>
</tr>
<tr>
<td>tn300</td>
<td>GE Terminet 300 terminal</td>
</tr>
<tr>
<td>X</td>
<td>printers equipped with TX print train</td>
</tr>
<tr>
<td>lp</td>
<td>generic name for printers that can underline and tab. <code>lp</code> is the default device for <code>mm</code>. All text sent to <code>lp</code> requiring reverse linefeeds, such as those having tables, must be processed with <code>col</code>, invoked with <code>mm</code>'s <code>--c</code> option. If you do not use this option, <code>mm</code> uses the value of the shellvariable <code>TERM</code> from the environment (see <code>profile(4)</code> and <code>environ(5)</code>) as the value of <code>tty_type</code> if <code>TERM</code> is set; otherwise, <code>mm</code> uses 450 as the value of <code>tty_type</code>. If you specify several terminal types, the last one takes precedence.</td>
</tr>
</tbody>
</table>
(Check with your system administrator for a list of locally supported devices.)

-12 indicates that the document is to be produced in 12-pitch. You may use this option when $TERM is set to one of 300, 300s, and 450. (You must manually set the pitch switch on the DASI 300 and 300s terminals to 12 if you use this option.)

-c causes mm to invoke col(1); note that col(1) is invoked automatically by mm unless tty_type is one of 300, 300s, 450, 37, 4000a, 382, and X.

-e causes mm to invoke neqn; also causes neqn to read the /usr/pub/eqnchar file (see eqnchar(5)).

-t causes mm to invoke tbl(1).

-E invokes the -e option of nroff.

As an example, assume that the shell variable $TERM is set in the environment to 450. The two command lines below are then equivalent:

```
mm -t -rc3 -12 file(s)
tbl file(s) | nroff -mm -T450-12 -h -rc3
```

mm reads the standard input when you specify - instead of any file(s). (Mentioning other files together with - leads to undesired results.) This option allows you to use mm as a filter, for example:

```
cat file(s) | mm -
```

HINTS

1. mm invokes nroff with the -h flag. With this flag, nroff assumes that the terminal has tabs set every 8 character positions.

2. Use the -olist option of nroff to specify ranges of pages to be output. Note, however, that if you invoke mm with one or more of the -e, -t, and - options, together with the -olist option of nroff, you may cause a harmless "broken pipe" diagnostic if you do not specify the last page of the document in list.

3. If you use the -s option of nroff (to stop between pages of output), use line-feed (rather than return or new-line) to restart the output. The -s option of nroff does not work with the -c option of mm, or if mm automatically invokes col(1) (see -c option above).

4. If you lie to mm about the kind of terminal its output will be printed on, you will get (often subtle) garbage; however, if you are redirecting output into a file, use the -T37 option, and then use the appropriate terminal filter when you actually print that file.

FILES

/usr/pub/terminals list of supported terminals
SEE ALSO

checkmm(1), col(1), env(1), eqn(1), greek(1), mmt(1), mvt(1), neqn(1),
nroff(1), tbl(1), profile(4), mm(5), and term(5).
The "mm: Technical Discussion"
"The Macro Package mm" in the User's Guide.
NAME

mm — the mm macro package for formatting documents

SYNOPSIS

```
mm [ option(s) ] [ file(s) ]
nroff [ option(s) ] -mm [ file(s) ]
mmt [ option(s) ] [ file(s) ]
troff [ option(s) ] -mm [ file(s) ]
```

DESCRIPTION

This package provides a formatting capability for a very wide variety of docu-
ments. The manner in which you type and edit a document is essentially
independent of whether the document is to be eventually formatted at a ter-
minal or is to be phototypeset.

FILES

```
/usr/lib/tmac/tmac.m       pointer to the mm package
/usr/lib/macros/mm[nt]    the mm package
```

SEE ALSO

mm(1), mmt(1), nroff(1), and troff(1).
"mm: Technical Discussion."
"The Macro Package mm" in the User's Guide.
NAME
mmt — typeset documents

SYNOPSIS
mmt [ option(s) ] [ file(s) ]

DESCRIPTION
This command is similar to mm(1), except that it typesets its input via troff(1),
as opposed to formatting it via nroff(1); mmt uses the mm macro package.
There are options to specify preprocessing by tbl(1) and/or pic(1) and/or
eqn(1) and/or grap(1). The proper pipelines and the required arguments and
flags for troff(1) and for the macro package are generated, depending on the
options selected.

Option(s) specific to mmt are given below. Any other arguments or flags (e.g.,
-rC3) that you give mmt are passed to troff(1). You can put options in any
order, but they must appear before any file(s). If you give no arguments or
files, mmt prints a list of its options.

-e invokes eqn(1); also causes eqn to read the
/usr/pub/eqnchar file (see eqnchar(5)).
-t invokes tbl(1).
-p invokes pic(1).
-g invokes grap(1), which in turn calls pic(1).
-Ttty_type creates output for troff device tty_type (see troff(1)). The
output is sent through the appropriate postprocessor (see
daps(1)).
-Ddest directs the output to device dest. Supported values for
dest are: 4014 (TEKTRONIX 4014 terminal via the tc(1)
filter); and i10 (Imagen Imprint-10 laser printer via
di10(1) filter).
-z invokes no output filter to process or redirect the output
of troff(1).

mmt reads the standard input when you specify - instead of any files.

HINT
Use the -olist option of troff(1) to specify ranges of pages to be output. Note,
however, that if you call mmt with one or more of the -e, -t, -p, -g, and -
options together with the -olist option of troff(1), you may cause a harmless
"broken pipe" diagnostic if the last page of the document is not specified in
list.

SEE ALSO
daps(1), di10(1), eqn(1), grap(1), mm(1), mvt(1), pic(1), tbl(1), tc(1), troff(1),
eqnchar(5), mm(5).
**NAME**
mptx — the macro package for formatting a permuted index

**SYNOPSIS**
- `nroff -mptx [ option(s) ] file(s) | printer`
- `troff -mptx [ option(s) ] file(s) | typesetter`

**DESCRIPTION**
This package provides a definition for the .xx macro used for formatting a permuted index as produced by ptx(1). This package does not provide any other formatting capabilities such as headers and footers. If these or other capabilities are required, the mptx macro package may be used in conjunction with the mm macro package. In this case, the -mptx option must be invoked after the -mm call. For example,

```
nroff -mm -mptx file(s) | printer
```

or

```
mmt -mptx file(s) | typesetter
```

**FILES**
- `/usr/lib/tmac/tmac.ptx` pointer to the macro package
- `/usr/lib/macros/ptx*` macro package

**SEE ALSO**
mmp(1), nroff(1), ptx(1), troff(1), mm(5).
NAME

mv – a troff macro package for typesetting view graphs and slides

SYNOPSIS

mvt [-a ] [ option(s) ] [ file(s) ]
troff [-a ] [ -rX1 ] -mv [ option(s) ] [ file(s) ]

DESCRIPTION

This package makes it easy to typeset view graphs and projection slides in a variety of sizes. A few macros (briefly described below) accomplish most of the formatting tasks needed in making transparencies. All of the facilities of troff(l), eqn(l), tbl(l), pic(l), and grap(l) are available for more difficult tasks.

The output can be previewed on most terminals, and, in particular, on the TEKTRONIX 4014. For this device, specify the -rX1 option (this option is automatically specified by the mvt command when that command is invoked with the -D40t4 option). To preview output on other terminals, specify the -a option.

The available macros are:

.VS [n] [i] [d] Foil-start macro; foil size is to be 7" × 7"; n is the foil number, i is the foil identification, d is the date; the foil-start macro resets all parameters (indent, point size, etc.) to initial default values, except for the values of i and d arguments inherited from a previous foil-start macro; it also invokes the .A macro (see below).

The naming convention for this and the following eight macros is that the first character of the name (V or S) distinguishes between view graphs and slides, respectively, while the second character indicates whether the foil is square (S), small wide (w), small high (h), big wide (W), or big high (H). Slides are “skinnier” than the corresponding view graphs: the ratio of the longer dimension to the shorter one is larger for slides than for view graphs. As a result, slide foils can be used for view graphs, but not vice versa; on the other hand, view graphs can accommodate a bit more text.

.VW [n] [i] [d] Same as .VS, except that foil size is 7" wide × 5" high.
.Vh [n] [i] [d] Same as .VS, except that foil size is 5" × 7".
.VW [n] [i] [d] Same as .VS, except that foil size is 7" × 5.4".
.VH [n] [i] [d] Same as .VS, except that foil size is 7" × 9".
.Sw [n] [i] [d] Same as .VS, except that foil size is 5" × 5".
.Sh [n] [i] [d] Same as .VS, except that foil size is 5" × 7".
.SW [n] [i] [d] Same as .VS, except that foil size is 7" × 5.4".
.SH [n] [i] [d] Same as .VS, except that foil size is 7" × 9".
.A [x] Place text that follows at the first indentation level (left margin); the presence of x suppresses the ½ line spacing from the preceding text.
.B [m [s ]] Place text that follows at the second indentation level; text is preceded by a mark; m is the mark (default is a large bullet); s is the increment or decrement to the point size of the
mark with respect to the prevailing point size (default is 0); if s is 100, it causes the point size of the mark to be the same as that of the default mark.

.C \[m [s] \] Same as .B, but for the third indentation level; default mark is a dash.

.D \[m [s] \] Same as .B, but for the fourth indentation level; default mark is a small bullet.

.T \[string\] String is printed as an over-size, centered title.

.I \[in] [a [x] \] Change the current text indent (does not affect titles); in is the indent (in inches unless dimensioned, default is 0); if in is signed, it is an increment or decrement; the presence of a invokes the .A macro (see below) and passes x (if any) to it.

.S \[p \] [l] Set the point size and line length; p is the point size (default is "previous"); if p is 100, the point size reverts to the initial default for the current foil-start macro; if p is signed, it is an increment or decrement (default is 18 for .VS, .VH, and .SH, and 14 for the other foil-start macros); l is the line length (in inches unless dimensioned; default is 4.2" for .Vh, 3.8" for .Sh, 5" for .SH, and 6" for the other foil-start macros).

.DF \[n f \] \[n f \ldots\] Define font positions; may not appear within a foil's input text (i.e., it may only appear after all the input text for a foil, but before the next foil-start macro); n is the position of font f; up to four "n f" pairs may be specified; the first font named becomes the prevailing font; the initial setting is (H is a synonym for G):

.DF 1 H 2 I 3 B 4 S

.DV \[a\] \[b\] \[c\] \[d\] Alter the vertical spacing between indentation levels; a is the spacing for .A, b is for .B, c is for .C, and d is for .D; all non-null arguments must be dimensioned; null arguments leave the corresponding spacing unaffected; initial setting is:

.DV .5v .5v .5v 0v

.U \[str1 \] \[str2\] Underline str1 and concatenate str2 (if any) to it.

The last four macros in the above list do not cause a break; the .I macro causes a break only if it is invoked with more than one argument; all the other macros cause a break.

The macro package also recognizes the following upper-case synonyms for the corresponding lower-case troff requests:

.AD .BR .CE .FI .HY .NA .NF .NH .NX .SO .SP .TA .TI

The Tm string produces the trademark symbol.

See the reference cited below for further details.

FILES
/usr/lib/tmac/tmac.v
/usr/lib/macros/vmca

2 REFERENCE MANUAL
SEE ALSO

eqn(1), grap(1), mvt(1), pic(1), tbl(1), troff(1).

BUGS

The .VW and .SW foils are meant to be 9" wide by 7" high, but because the typesetter paper is generally only 8" wide, they are printed 7" wide by 5.4" high and have to be enlarged by a factor of 9/7 before use as view graphs; this makes them less than totally useful.
NAME
mvt — typeset view graphs and slides

SYNOPSIS
mvt [ option(s) ] [ file(s) ]

DESCRIPTION
This command is similar to mmt(1), except that it typesets its input with the
mv macro package for view graphs and slides. mvt has options to specify
preprocessing by tbl(1) and/or pic(1) and/or eqn(1) and/or grap(1). The
proper pipelines and the required arguments and flags for troff(1) and for the
macro package are generated, depending on the options selected.

Option(s) specific to mvt are given below. Any other arguments or flags that
you give mvt are passed to troff(1). Options can occur in any order, but they
must appear before any file(s). If you give no arguments or file(s), mvt prints
a list of its options.

-e invokes eqn(1); also causes eqn to read the
/usr/pub/eqnchar file (see eqnchar(5)).
-t invokes tbl(1).
-p invokes pic(1).
-g invokes grap(1), which in turn calls pic(1).
-Ttty_type creates output for troff device tty_type (see troff(1)). The
output is sent through the appropriate postprocessor (see
daps(1)).
-Ddest directs the output to device dest. Supported values for
dest are: 4014 (TEKTRONIX 4014 terminal via the tc(1)
filter); and i10 (Imagen Imprint-10 laser printer via
di10(1) filter.)
-z invokes no output filter to process or redirect the output
of troff(1).

mvt reads the standard input when you specify - instead of any
file(s).

HINT
Use the -olist option of troff(1) to specify ranges of pages to be output. Note,
however, that if you invoke mvt with one or more of the -e, -t, -p, -g, and
-o options together with the -olist option of troff(1), you may cause a harm­
less "broken pipe" diagnostic if the you do not specify the last page of the
document in list.

SEE ALSO
daps(1), di10(1), eqn(1), grap(1), mmt(1), pic(1), tbl(1), tc(1), troff(1),
eqnchar(5), mv(5).
NAME
ndx - create a subject-page index for a document

SYNOPSIS
ndx [subfile] "formatter command line"

DESCRIPTION
ndx, given a list of subjects (subfile), searches a specified document and writes
a subject-page index to the standard output.

subfile is the list of subjects to be included in the index. Each subject must
begin on a new line and have the following format:

word1 [word2 ...] [, wordk ...]

For example,

printed circuit boards
arrays
arrays, dynamic storage
Smith, W. P.
printed circuit boards, channel-oriented multi-layer
Aranoff
University of Illinois
PL/1

The subject must start in column 1.

The syntax for the formatter command line is

formatter [ option(s) ] file(s)

It is the command that will be used to create the final form of the document.
The following are examples of valid formatter command lines:

\texttt{mm -Tlp file(s)}
\texttt{nroff -mm -Tlp -rW60 file(s)}
\texttt{troff -rB2 -Taps -r01.5i file(s)}

For more information on the formatter command line, see, \texttt{mm(1)}, \texttt{mmt(1)},
\texttt{nroff(1)} and \texttt{troff(1)}.

The document must include formatting commands for \texttt{mm}, \texttt{nroff}, or \texttt{troff}.
The formatter command line tells ndx whether \texttt{troff}, \texttt{nroff}, \texttt{mm} or \texttt{mmt}
would be used to produce the final version of the document.

\texttt{troff or mmt}
\hspace{1cm} specifies \texttt{troff} as the formatting program.

\texttt{nroff or mm}
\hspace{1cm} specifies \texttt{nroff} as the formatting program.
The \texttt{option(s)} are those that would be given to the \texttt{troff}, \texttt{nroff}, \texttt{mm} or
\texttt{mmt} command in printing the final form of the document, and are
necessary to determine the correct page numbers for subjects as they
are located in the document. \texttt{ndx} does not actually cause the final version of the document to be printed. The author must create the document separately. The indexer, of course, should not be used until the document is complete and no further changes are expected.

**EXAMPLES**

The command

\begin{verbatim}
ndx subjfile "nroff -mm -rW70 file(s)" > indexfile
\end{verbatim}

would produce a subject-page index for the document \texttt{file(s)} and take its subjects from the list, \texttt{subjfile}. The page numbers would correspond to the document produced by

\begin{verbatim}
nroff -mm -rW70 file(s)
\end{verbatim}

The command

\begin{verbatim}
ndx subjfile "mm -rW60 -rN2 -rO0 ch1 ch2 ch3" > indexfile
\end{verbatim}

would produce a subject-page index for the documents \texttt{ch1}, \texttt{ch2}, and \texttt{ch3}. The page numbers would correspond to the documents produced by

\begin{verbatim}
mm -rW60 -rN2 -rO0 ch1 ch2 ch3
\end{verbatim}

The command

\begin{verbatim}
ndx subjfile "troff -rB2 -rW5i -rO1.5i -mm file(s)" > indexfile
\end{verbatim}

would produce a subject-page index for the document \texttt{file(s)}, and the page numbers would correspond to the document produced by

\begin{verbatim}
troff -rB2 -rW5i -rO1.5i -mm file(s)
\end{verbatim}

SEE ALSO

\begin{verbatim}
mm(1), mmt(1), nroff(1), subj(1), troff(1).
\end{verbatim}
NAME
neqn - format mathematical text for nroff

SYNOPSIS
neqn [ -d xx ] [ -p n ] [ -s n ] [ -f n ] [ -- ] [ file(s) ]

DESCRIPTION
neqn is a preprocessor for formatting mathematical text with nroff on typewriter-like terminals. Normal usage is:

    neqn [option(s)] file(s) | nroff [option(s)] | [printer]

If you do not specify files (or if you specify - as the last argument), neqn reads the standard input.

SEE ALSO
eqn(1), mm(1), nroff(1), tbl(1), eqnchar(5), and mm(5).
NAME
nroff — text formatting language

SYNOPSIS
nroff [ option(s) ] [ file(s) ] | printer

DESCRIPTION
nroff formats text contained in file(s) (standard input by default) for printing on typewriter-like devices and line printers.

An argument consisting of a minus (−) is taken to be a file name corresponding to the standard input. The option(s), which may appear in any order, but must appear before the file(s), are,

-olist  Print only pages whose page numbers appear in the list of numbers and ranges, separated by commas. A range N–M means pages N through M; an initial −N means from the beginning to page N; and a final N− means from N to the end. (See Bugs below.)

-nN    Number first generated page N.

-sN    Stop every N pages. nroff will halt after every N pages (default N=1) to allow paper loading or changing, and will resume upon receipt of a line-feed or new-line (new-lines do not work in pipelines, e.g., with mm(I)). This option does not work if the output of nroff is piped through col(I). When nroff halts between pages, an ASCII BEL is sent to the terminal.

-raN   Set register a (which must have a one-character name) to N.

-i     Read standard input after file(s) are exhausted.

-q     Invoke the simultaneous input-output mode of the .rd request.

-z     Print only messages generated by .tm (terminal message) requests.

-mname Prepend to the input file(s) the macro file /usr/lib/tmac/tmac.name.

-Ttty_type Prepare output for specified terminal. Known tty_type(s) are

2631    Hewlett-Packard 2631 printer in regular mode
2631-c  Hewlett-Packard 2631 printer in compressed mode
2631-e  Hewlett-Packard 2631 printer in expanded mode
300     DASI-300 printer
300-12  DASI-300 terminal set to 12-pitch
         (12 characters per inch)
300s    DASI-300s printer (300S is a synonym)
300s-12 DASI-300s printer set to 12-pitch
         (12 characters per inch)
         (300S-12 is a synonym)
37      Teletype Model 37 terminal (default)
382     DTC-382
4000a   Trendata 4000a terminal (4000A is a synonym)
450     DASI-450 (Diablo Hyterm) printer
450-12  DASI-450 terminal set to 12-pitch
         (12 characters per inch)
832     Anderson Jacobson 832 terminal
8510    C.I.TOH printer
lp      generic name for printers that can
underline and tab (All text using reverse line feeds, such as those having tables, that is sent to \texttt{lp} must be processed with \texttt{col}.)

\begin{itemize}
\item \texttt{tn300} GE Terminet 300 terminal
\item \texttt{X} printers equipped with TX print train
\end{itemize}

\begin{itemize}
\item \texttt{e} Produce equally-spaced words in adjusted lines, using the full resolution of the particular terminal.
\item \texttt{h} Use output tabs during horizontal spacing to speed output and reduce output character count. Tab settings are assumed to be every 8 nominal character widths.
\item \texttt{un} Set the emboldening factor (number of character overstrikes) for the third font position (bold) to \texttt{n}, or to zero if \texttt{n} is missing.
\end{itemize}

\textbf{FILES}

\begin{itemize}
\item /usr/lib/tmac/tmac.* pointers to standard macro files
\item /usr/lib/macros/* standard macro files
\item /usr/lib/nterm/* terminal driving tables for \texttt{nroff}
\item /usr/pub/terminals list of supported terminals
\end{itemize}

\textbf{SEE ALSO}

\texttt{col}(1), \texttt{neqn}(1), \texttt{greek}(1), \texttt{mm}(1), \texttt{mm}(5), \texttt{tbl}(1).

The "\texttt{nroff/troff: Technical Discussion}.

"The Formatter \texttt{nroff}" in the \textit{User’s Guide}.

\textbf{BUGS}

\texttt{nroff} believes in Eastern Standard Time; as a result, depending on the time of the year and on your local time zone, the date that \texttt{nroff} generates may be off by one day from your idea of what the date is.

When \texttt{nroff} is used with the \texttt{--olist} option inside a pipeline (e.g., with one or more of \texttt{eqn}(1), and \texttt{tbl}(1)), it may cause a harmless "broken pipe" diagnostic if the last page of the document is not specified in \texttt{list}.
NAME
nterm — terminal driving tables for nroff

DESCRIPTION
nroff(1) uses driving tables to customize its output for various types of output
devices, such as printing terminals, special word-processing terminals (such as
Diablo, Qume, or NEC Spinwriter mechanisms), or special output filter pro­
grams. These driving tables are written as ASCII files, and are installed in
/usr/lib/nterm/tab.name, where name is the name for that terminal type as
given in term(5).

The first line of a driving table should contain the name of the terminal: sim­
ply a string with no embedded white space. “White space” means any combi­
nation of spaces, tabs and new-lines. The next part of the driver table is
structured as follows:

bset [integer] (not supported in all versions of nroff)
breset [integer] (not supported in all versions of nroff)
Hor [integer]
Vert [integer]
Newline [integer]
Char [integer]
Em [integer]
Halfline [integer]
Adj [integer]
twinit [character string]
twrest [character string]
wlnl [character string]
hlr [character string]
hlf [character string]
fir [character string]
bdon [character string]
bdoff [character string]
iton [character string]
itoff [character string]
ploton [character string]
plotoff [character string]
up [character string]
down [character string]
right [character string]
left [character string]

The meanings of these fields are as follows:
bset bits to set in the c_oflag field of the termio structure before output.
breset bits to reset in the c_oflag field of the termio structure before out­
put.
Hor horizontal resolution in units of 1/240 of an inch.
Vert vertical resolution in units of 1/240 of an inch.
Newline space moved by a newline (linefeed) character in units of 1/240 of
an inch.
Char quantum of character sizes, in units of 1/240 of an inch. (i.e., a character is a multiple of Char units wide)

Em size of an em in units of 1/240 of an inch.

Halfline space moved by a half-linefeed (or half-reverse-linefeed) character in units in 1/240 of an inch.

Adj quantum of white space, in 1/240 of an inch. (i.e., white spaces are a multiple of Adj units wide)

Note: if this is less than the size of the space character, nroff will output fractional spaces using plot mode. Also, if the -e switch to nroff is used, Adj is set equal to Hor by nroff.

twinit sequence of characters used to initialize the terminal in a mode suitable for nroff.

twrest sequence of characters used to restore the terminal to normal mode.

twnl sequence of characters used to move down one line.

hlr sequence of characters used to move up one-half line.

hlf sequence of characters used to move down one-half line.

flr sequence of characters used to move up one line.

bdon sequence of characters used to turn on hardware boldface mode, if any.

bdoff sequence of characters used to turn off hardware boldface mode, if any.

iton sequence of characters used to turn on hardware italics mode, if any.

itoff sequence of characters used to turn off hardware italics mode, if any.

ploton sequence of characters used to turn on hardware plot mode (for Diablo type mechanisms), if any.

plotoff sequence of characters used to turn off hardware plot mode (for Diablo type mechanisms), if any.

up sequence of characters used to move up one resolution unit (Vert) in plot mode, if any.

down sequence of characters used to move down one resolution unit (Vert) in plot mode, if any.

right sequence of characters used to move right one resolution unit (Hor) in plot mode, if any.

left sequence of characters used to move left one resolution unit (Hor) in plot mode, if any.

This part of the driving table is fixed format, and you cannot change the order of entries. You should put entries on separate lines, and these lines should contain exactly two fields (no comments allowed) separated by white space. For example,
and so on.

Follow this first part of the driving table with a line containing the word "charset," and then specify a table of special characters that you want to include. That is, specify all the non-ASCII characters that nroff(1) knows by two character names, such as \(hy\). If nroff does not find the word "charset" where it expects to, it will abort with an error message.

Each definition in the part after "charset" occupies one line, and has the following format:

```
chname width output
```

where "chname" is the (two letter) name of the special character, "width" is its width in ems, and "output" is the string of characters and escape sequences to send to the terminal to produce the special character.

If any field in the "charset" part of the driving table does not pertain to the output device, you may give that particular sequence as a null string, or leave out the entry. Special characters that do not have a definition in this file are ignored on output by nroff(1).

You may put the "charset" definitions in any order, so it is possible to speed up nroff by putting the most used characters first. For example,

```
charset
  em 1 -
  hy 1 -
  \- 1 -
  bu 1 +\bo
```

and so on.

The best way to create a terminal table for a new device is to take an existing terminal table and edit it to suit your needs. Once you create such a file, put it in the directory /usr/lib/nterm, and give it the name tab.xyz where xz is the name of the terminal and the name that you pass nroff via the -T option (for example, nroff -Txyz).

**FILES**

```
/usr/lib/nterm/tab.name       terminal files
```

**SEE ALSO**

nroff(1).
NAME
    pic – troff preprocessor for drawing pictures

SYNOPSIS
    pic [ -Ttty_type ] [ -- ] [ file(s) ]

DESCRIPTION
    pic is a troff(1) preprocessor for drawing simple figures on a typesetter. The
    basic objects are box, circle, ellipse, line, spline, arrow, arc and text.

    The optional argument -Ttty_type specifies device tty_type; currently sup-
    ported devices are aps (Autologic APS-5) and i10 (Imagen Imprint-10). Default is -Taps.

SEE ALSO
    grap(1), troff(1).
NAME
ptx — make permuted index

SYNOPSIS
ptx [ option(s) ] [ input [output] ]

DESCRIPTION
ptx generates the file output that can be processed with a text formatter (nroff or troff) to produce a permuted index of file input. Standard input (-) and standard output are default. It has three phases: the first does the permutation, generating one line for each keyword in an input line. The keyword is rotated to the front. The permuted file is then sorted. Finally, the sorted lines are rotated, so the keyword comes at the middle of each line. ptx output is in the following form:

.xx "" ""before keyword" "keyword" "after keyword"

where .xx is assumed to be an nroff(1) or troff(1) macro provided by the user or provided by ptx(1). The -mptx macro package provides the .xx macro definition. The before keyword and after keyword fields incorporate as much of the line as will fit around the keyword when it is printed. The first field and last field, at least one of which is always the empty string, are wrapped-around to fit in the unused space at the opposite end of the line.

The following option(s) can be applied:

- f  Fold upper- and lower-case letters for sorting.
- t  Prepare the output for the phototypesetter.
- w n  Use the next argument, n, as the length of the output line. The default line length is 72 characters for nroff and 100 for troff.
- g n  Use the next argument, n, as the number of characters that ptx will reserve in its calculations for each gap among the four parts of the line as finally printed. The default gap is 3.
- o only  Use as keywords any words given in the only file.
- i ignore  Do not use as keywords any words given the ignore file. If the -i and -o options are missing, use /usr/lib/eign as the ignore file.
- b break  Use the characters in the break file to separate words. Tab, new-line, and space characters are always used as break characters.
- r  Take any leading non-blank characters of each input line to be a reference identifier (as to a page or chapter), separate from the text of the line. Attach that identifier as a 5th field on each output line.
FILES

/bin/sort
/usr/lib/eign
/usr/lib/tmac/tmac.ptx

SEE ALSO

nroff(2), troff(1), mm(5), mptx(5).

BUGS

Line length counts do not account for overstriking or proportional spacing. Lines that contain tildes (\~) are botched because ptx uses that character internally. ptx does not discard non-alphanumeric characters.
NAME
subj — generate a list of subjects from a document

SYNOPSIS
subj file(s)

DESCRIPTION
subj searches file(s) for subjects that might be appropriate in a subject-page index and prints the list of subjects on the standard output. The document should contain formatting commands (from nroff, troff, and mm among others) to make the best use of subj.

SEE ALSO
ndx(1), troff(1), mm(1), nroff(1).

WARNINGS
subj selects sequences of capitalized words as subjects except the first word in each sentence. Thus, if a sentence begins with a proper noun, the capitalization rule will not select this word as a subject. On the other hand, since each sentence is expected to begin on a newline, the first word of a sentence that begins in the middle of a line may be erroneously selected.

The output of subj may not be appropriate for your needs and should be edited accordingly.

BUGS
subj also selects as subjects modifier-noun sequences from the abstract, headings, and topic sentences (the first sentence in each paragraph), and occasionally a word is incorrectly categorized as a noun or adjective.
NAME
tbl – prepare tables for nroff or troff

SYNOPSIS
tbl [ -T x ] [ -- ] [ file(s) ] [ - ]

DESCRIPTION
tbl is a preprocessor that prepares tables for nroff(1) or troff(1). tbl assumes
that lines between the .TS and .TE command lines describe tables, thus they
are re-formatted; lines outside these command lines are copied to the standard
output. (tbl does not alter the .TS and .TE command lines.

Follow .TS with global options. The available global options are:

center centers the table (default is left-adjust);
expand makes the table as wide as the current line length;
box encloses the table in a box;
doublebox encloses the table in a double box;
allbox encloses each item of the table in a box;
tab (x) uses the character x instead of a tab to separate items
in a line of input data.
linesize (n) sets line or rules (e.g., from box) in n-point type;

End the global options, if any, with a semi-colon (;).

After global options come lines describing the format of each line of the table.
Each such format line describes one line of the table itself, except that the last
format line (which you must end with a period) describes all remaining lines
of the table. A single key letter describes each column of each line of the

The available key-letters are:
c centers item within the column;
r right-adjusts item within the column;
l left-adjusts item within the column;
n numerically adjusts item in the column: units positions of
numbers are aligned vertically;
s spans previous item on the left into this column;
a centers longest line in this column and then left-adjust all
other lines in this column with respect to that centered line;
^ spans down previous entry in this column;
- replaces this entry with a horizontal line;
= replaces this entry with a double horizontal line.

The characters B and I stand for the bold and italic fonts, respectively; the
character | indicates a vertical line between columns.

The format lines are followed by lines containing the actual data for the table,
followed finally by .TE. Within such data lines, data items are normally
separated by tab characters.

If a data line consists of only _ or =, a single or double line, respectively, is
drawn across the table at that point; if a single item in a data line consists of
only _ or =, then that item is replaced by a single or double line. Some printers do not have the vertical resolution to produce double lines. Full details of all these and other features of tbl are given in the tutorial and technical discussion cited below.

The -TX option forces tbl to use only full vertical line motions, making the output more suitable for devices that cannot generate partial vertical line motions (for example, line printers).

If you give no file(s) as arguments, or if you specify - as file(s), tbl reads the standard input, so it may be used as a filter. When you use it with eqn(1) or neqn(1), put tbl first to minimize the volume of data passed through pipes.

EXAMPLE

If we let = represent a tab (which should be typed as a genuine tab), then the input:

```
.TS
center box ;
cB s s
c1 | c1 s
^ | c c
l | n n
Household Population

Town Households
Number Size

= Bedminster=789=3.26
Bernards Twp.=3087=3.74
Bernardsville=2018=3.30
Bound Brook=3425=3.04
Bridgewater=7897=3.81
Far Hills=240=3.19
.TE
```

yields:

```
<table>
<thead>
<tr>
<th>Household Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Town</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Bedminster</td>
</tr>
<tr>
<td>Bernards Twp.</td>
</tr>
<tr>
<td>Bernardsville</td>
</tr>
<tr>
<td>Bound Brook</td>
</tr>
<tr>
<td>Bridgewater</td>
</tr>
<tr>
<td>Far Hills</td>
</tr>
</tbody>
</table>
```
SEE ALSO

eqn(1), mm(1), mmt(1), mvt(1), neqn(1), nroff(1), troff(1), mm(5), and mv(5).
The "tbl: Technical Discussion."

BUGS

See BUGS under nroff(1).
NAME

tc — troff output interpreter

SYNOPSIS

tc [ -t ] [ -o list ] [ -a n ] [ -e ] [ file(s) ]

DESCRIPTION

tc interprets its input (standard input default) as output from troff(1). The
standard output of tc is intended for a TEKTRONIX 4015 (a 4014 terminal with
ASCII and APL character sets). The various typesetter sizes are mapped into
the 4014's four sizes; the entire troff character set is drawn using the 4014's
character generator, using overstruck combinations where necessary, produc-
ing an altogether displeasing effect. Typical usage:

    troff troff_option(s) file(s) | tc

At the end of each page tc waits for a new-line (empty line) from the key-
board before continuing on to the next page. In this wait state, the following
commands are recognized:

!cmd      Send cmd to the shell.
e      inverts state of the screen erase

- n      skip backward n pages.

an      sets the aspect ratio to n.

?      prints list of available options.

The command line options are:

- t      does not wait between pages (for directing output into a file).

- o list prints only the pages enumerated in list. The list consists of pages
and page ranges (e.g., 5-17) separated by commas. The range n- goes
from n to the end; the range -n goes from the beginning to and
including page n.

- a n      sets the aspect ratio to n; default is 1.5.

- e      does not erase before each page.

SEE ALSO

4014(1), nroff(1), tplot(1G), and troff(1).

BUGS

Font distinctions are lost.
It needs a -w option to wait for input to arrive.
NAME
troff — text formatting and typesetting language

SYNOPSIS
troff [ option(s) ] [ -- ] [ file(s) ] | typesetter

DESCRIPTION
troff formats text in the named file for printing on a phototypesetter or comparable device.
If no file(s) argument is present, the standard input is read. An argument consisting of a single minus (−) is taken to be a file name corresponding to the standard input. The options, which may appear in any order so long as they appear before the files, are

-olist
Print only pages whose page numbers appear in the comma-separated list of numbers and ranges. A range N—M means pages N through M; an initial −N means from the beginning to page N; and a final N— means from N to the end. (See BUGS below.)

-nN
Number first generated page N.

-sN
Generate output to make typesetter to stop every N pages.

-mname
Prepend the macro file /usr/lib/tmac/tmac.name to the input, file(s).

-raN
Set register a (one character name) to N.

-i
Read standard input after the input files are exhausted.

-q
Invoke the simultaneous input-output mode of the .rd request.

-z
Print only messages generated by .tm requests.

-a
Send a printable ASCII approximation of the results to the standard output.

-Ttty_type
Prepare output for typesetter or laser printer tty_type. Supported devices are aps (Autologic APS-5 typesetter) i10 (Imagen Imprint_10). Alternatively, the environment variable "TYPESETTER" may be set.

FILES
/usr/lib/tmac/tmac.* pointers to standard macro files
/usr/lib/macros/* standard macro files
/usr/lib/font/-dev/* font width tables
/usr/tmp/trtmp* temporary file

SEE ALSO
daps(1), di10(1), eqn(1), grap(1), mmt(1), nroff(1), pic(1), tbl(1), tc(1);
The "nroff/troff Technical Discussion"

BUGS
The .tl request may not be used before the first break-producing request in the input to troff.
troff believes in Eastern Standard Time; as a result, depending on the time of the year and on your local time zone, the date that troff generates may be off by one day from your idea of what the date is.

When troff is used with the -olist option inside a pipeline (e.g., with one or more of pic(1), eqn(1), and tbl(1)), it may cause a harmless "broken pipe" diagnostic if the last page of the document is not specified in list.
NAME
troff — description of output language

DESCRIPTION
The device-independent troff outputs a pure ASCII description of a typeset document. The description specifies the typesetting device, the fonts, and the point sizes of characters to be used as well as the position of each character on the page. A list of all the legal commands follows. Most numbers are denoted as n and are ASCII strings. Strings inside of [ ] are optional. troff may produce them, but they are not required for the specification of the language. The character \n has the standard meaning of "newline" character. Between commands white space has no meaning. White space characters are spaces and newlines.

sn
The point size of the characters to be generated.

fn
The font mounted in the specified position is to be used. The number ranges from 0 to the highest font presently mounted. 0 is a special position, invoked by troff, but not directly accessible to the troff user. Normally fonts are mounted starting at position 1.

cx
Generate the character x at the current location on the page; x is a single ASCII character.

Cxyz
Generate the special character xyz. The name of the character is delimited by white space. The name will be one of the special characters legal for the typesetting device as specified by the device specification found in the file DESC. This file resides in a directory specific for the typesetting device. (See font(5) and /usr/lib/font/dev.*)

Hn
Change the horizontal position on the page to the number specified. The number is in basic units of motions as specified by DESC. This is an absolute "goto".

hn
Add the number specified to the current horizontal position. This is a relative "goto".

Vn
Change the vertical position on the page to the number specified (down is positive).

vn
Add the number specified to the current vertical position.

nnx
This is a two-digit number followed by an ASCII character. The meaning is a combination of hnn followed by cx. The two digits nn are added to the current horizontal position and then the ASCII character, x, is produced. This is the most common form of character specification.

nb a
This command indicates that the end of a line has been reached. No action is required, though by convention the horizontal position is set to 0. troff will specify a resetting of the x,y coordinates on the page before
requesting that more characters be printed. The first number, \( b \), is the amount of space before the line and the second number, \( a \), the amount of space after the line. The second number is delimited by white space.

w

A \texttt{w} appears between words of the input document. No action is required. It is included so that one device can be emulated more easily on another device.

\texttt{pn}

Begin a new page. The new page number is included in this command. The vertical position on the page should be set to 0.

\texttt{# .... \n}

A line beginning with a pound sign is a comment.

\texttt{Dl \ x \ y}

Draw a line from the current location to \( x, y \).

\texttt{Dc \ d\n}

Draw a circle of diameter \( d \) with the leftmost edge being at the current location \( (x, y) \). The current location after drawing the circle will be \( x+d,y \), the rightmost edge of the circle.

\texttt{De \ dx \ dy\n}

Draw an ellipse with the specified axes. \( dx \) is the axis in the \( x \) direction and \( dy \) is the axis in the \( y \) direction. The leftmost edge of the ellipse will be at the current location. After drawing the ellipse the current location will be \( x+dx,y \).

\texttt{Da \ dh1 \ dv1 \ dh2 \ dv2\n}

Draw a counterclockwise arc from the current position to \( dh1+dh2, dv1+dv2 \) whose center is \( dh1, dv1 \) from the current position. The current location after drawing the arc will be at its end.

\texttt{D= \ x \ y \ x \ y \ ...
}

Draw a spline curve (wiggly line) between each of the \( x,y \) coordinate pairs starting at the current location. The final location will be the final \( x,y \) pair of the list.

\texttt{x \ \texttt{init}\n}

Initialize the typesetting device. The actions required are dependent on the device. An \texttt{init} command will always occur before any output generation is attempted.

\texttt{x \ T \ device\n}

The name of the typesetter is \texttt{device}. This is the same as the argument to the \(-T\) option. The information about the typesetter will be found in the directory \\
/usr/lib/font/devdevice.

\texttt{x \ \{res\} \ n \ h \ v\n}

The resolution of the typesetting device in increments per inch is \( n \). Motion in the horizontal direction can take place in units of \( h \) basic increments. Motion in the vertical direction can take place in units of \( v \) basic increments. For example, the APS-5 typesetter has a basic resolution of 723 increments per inch and can move in either direction in 723rds of an inch. Its specification is:

\texttt{x \ res \ 723 \ 1 \ 1}
Pause. Cause the current page to finish but do not relinquish the typesetter.

Stop. Cause the current page to finish and then relinquish the typesetter. Perform any shutdown and bookkeeping procedures required.

Generate a trailer. On some devices no operation is performed.

Load the font name into position n.

Set the character height to n points. This causes the letters to be elongated or shortened. It does not affect the width of a letter. Not all typesetters can do this.

Set the slant to n degrees. Only some typesetters can do this and not all angles are supported.
UNIX™ System V
DOCUMENTER'S WORKBENCH™
Software Release 2.0
Handbook for New Users
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Introduction

If you have limited experience using the DOCUMENTER'S WORKBENCH Software, this reference handbook is designed for you. It shows various files before and after formatting and explains the role of each request or macro in the "input" file.

You should not use this handbook to learn how to use DOCUMENTER'S WORKBENCH Software tools; the DOCUMENTER'S WORKBENCH Software User's Guide (310-004) is the authoritative primer. Annotated, concrete examples for nroff, mm, tbl, neqn/eqn, troff, and pic are provided here to jog your memory after you use the User's Guide.

Two other documents are available for the more experienced DOCUMENTER'S WORKBENCH Software user. The DOCUMENTER'S WORKBENCH Software Technical Discussion and Reference Manual (310-005) is the source for technical details, and the DOCUMENTER'S WORKBENCH Software Handbook (310-008) is a memory jogger for people with technical expertise.

How to Read this Handbook

1. First, this handbook presents an input, or source, file in unformatted form (input). The source files presented here also appear wholly or partially in the "Sampler" of the User's Guide, and they are available for you to copy (see the Preface to the "Sampler").

2. Next, each macro or request in the input file is explained.

3. This handbook next suggests where in the User's Guide or in the Technical Discussion and Reference Manual to find more information about the DOCUMENTER'S WORKBENCH Software components used in the example.

4. Command lines for formatting the file are presented next. These command lines show you how to store the formatted output in a file and how to send the formatted output to a printer or, where appropriate, to a phototypesetter.

5. Finally, this handbook shows the formatted file (input.out).
This handbook observes the following rules:

[] specifies an optional argument

*Italic text* shows where you may substitute appropriate values

**Bold text** shows where you must type exactly what is specified

Check with your system administrator for locally available output devices (printer or phototypesetter).
.in +0.5i
October 14, 1984
.sp 2
.nf
John Smith
Business Computer Systems, Inc.
190 River Boulevard
Durham, NC 27707
.sp 2
Dear Mr. Smith:
.sp 2
.fi
I would like to be considered for the position of Document Production Coordinator
with Business Computer Systems, Inc.
I have a B.A. in English and have finished course work for a Masters in English.
Currently, I am assisting Steve Foley, Production Editor with Techno-Publishing
in Jonesville.
My duties consist of proofreading documents and coordinating graphics production.
.sp
While I enjoy my position here, I know I am ready for more challenging work and
greater responsibility.
Our shop uses a computer running UNIX System V.
I am confident in my potential for growth with the Technical Writing Staff
at Business Computer Systems.
I have enclosed my resume and two letters of recommendation.
Please feel free to contact my present supervisor with any questions you may have.
I am available for an interview at any time, and I look forward to hearing from
you.
.sp 2
.nf
Sincerely yours,
.sp 5
John Jones
41 Stanford Drive
Bridgewater, NJ 08807
.sp 2
Enclosures: 3
nroff

Explanation

.in +0.5i indents all text one-half inch from the left margin
.sp 2 places two lines of space between the lines it separates
.nf turns off line filling
.fi turns on line filling
.sp 5 places five lines of space between the lines of text it separates

"The Formatter nroff: a Tutorial" in the User's Guide teaches you how to control attributes of your formatted document, including the margins, indentation, hyphenation, number of characters per line, and lines per page. It also discusses number registers and strings. The chapter titled "nroff/troff Technical Discussion" in the Technical Discussion and Reference Manual comprehensively discusses nroff and provides the nroff(1) manual page.

Command Lines

nroff [options] input > input.out
or
nroff [options] input | printer
October 14, 1984

John Smith
Business Computer Systems, Inc.
190 River Boulevard
Durham, NC 27707

Dear Mr. Smith:

I would like to be considered for the position of Document Production Coordinator with Business Computer Systems, Inc. I have a B.A. in English and have finished course work for a Masters in English. Currently, I am assisting Steve Foley, Production Editor with Techno-Publishing in Jonesville. My duties consist of proofreading documents and coordinating graphics production.

While I enjoy my position here, I know I am ready for more challenging work and greater responsibility. Our shop uses a computer running UNIX System V. I am confident in my potential for growth with the Technical Writing Staff at Business Computer Systems. I have enclosed my resume and two letters of recommendation. Please feel free to contact my present supervisor with any questions you may have. I am available for an interview at any time, and I look forward to hearing from you.

Sincerely yours,

John Jones
41 Stanford Drive
Bridgewater, NJ 08807

Enclosures: 3
input:

I started work with the Technical Writing Staff on April 16. My writing assignments are:

- Documentation for the BCS Fortran compiler
- I collected materials relevant to implementing programming languages on the UNIX* system.
- Documentation for the Distributed Transaction Processing System (DTPS) 2.0
- I reviewed DTPS requirements, outstanding complaints about DTPS, and users' suggestions for improving DTPS documentation.

Explanation

.TL   formats the lines that follow it (until the next macro) as the title of a formal memorandum
.AF   formats the name of the firm, "Business Computer Systems, Inc."
.AU   formats information about the author
.MT   chooses a formal memorandum type
.HU   formats an unnumbered heading
.P    begins a new paragraph
.BL   initializes a bullet list
.LI   specifies that the text that follows is a list item
.DL   initializes a dash list
.FS   signals the beginning of footnote text
.FE   signals the end of footnote text
.LE   signals the end of a list
.SG   prints the signature line

"The mm Macro Package: a Tutorial" in the User's Guide teaches you how to format documents with mm using its defaults and, for some macros, teaches you how to refine the way they work. The chapter titled "mm Technical Discussion" in the Technical Discussion and Reference Manual comprehensively discusses this package. It also provides manual pages for the mm and mmt commands (mm(1), mmt(1)) and the mm macro package (mm(5)).
Command Lines

\texttt{mm [options] input > input.out}
or
\texttt{mm [options] input | printer}
or
\texttt{mmt [options] input | phototypesetter}
Writing Assignments

I started work with the Technical Writing Staff on April 16. My writing assignments are:

- Documentation for the BCS Fortran compiler
  - I collected materials relevant to implementing programming languages on the UNIX* system.

- Documentation for the Distributed Transaction Processing System (DTPS) 2.0
  - I reviewed DTPS requirements, outstanding complaints about DTPS, and users' suggestions for improving DTPS documentation.

Other Activities


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* Trademark of AT&T
tbl

<TAB> means to press the TAB key.

input:

.TS
box, center;
c c c 
1 1 1.
Language<TAB>Authors<TAB>Primary Use
.sp

APL<TAB>IBM<TAB>Mathematics, Applications
Basic<TAB>Dartmouth<TAB>Teaching, Applications
C<TAB>HTL<TAB>Systems, Applications
COBOL<TAB>Many<TAB>Business Applications
Fortran<TAB>Many<TAB>Scientific Applications
LISP<TAB>M.I.T.<TAB>Artificial Intelligence
Pascal<TAB>Stanford<TAB>Teaching, Systems
PL/I<TAB>IBM<TAB>Applications
SNBOL4<TAB>AT&T<TAB>Applications
.TE

Explanation

.TS signals the beginning of a table
box, center; tells tbl to center the output and enclose the entire table
in a box. The comma between the two words delimits each instruction. The character ";" ends global options,
telling tbl that what follows is the format section.
makes up the format section, and tells tbl that there are three columns in the table. In the first row, each column should be centered, and in the second and following rows, each column should be flush left. The character "." ends the format section, telling tbl that what follows is text to be put in the table.

.places one line of space between the lines of text that it separates

-draws a line the width of the table between the text lines that it separates

.signals the end of a table


Command Lines

```
tbl -TX input | nroff -mm -TIp [options] | col > input.out
or
tbl -TX input | nroff -mm -TIp [options] | col | printer
or
mm -t -Tlp [options] input > input.out
or
mm -t -Tlp [options] input | printer
or
tbl input | troff -mm -Ttty_type [options] | phototypesetter
or
mmt -t -Ttty_type [options] input | phototypesetter
```
<table>
<thead>
<tr>
<th>Language</th>
<th>Authors</th>
<th>Primary Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>APL</td>
<td>IBM</td>
<td>Mathematics, Applications</td>
</tr>
<tr>
<td>Basic</td>
<td>Dartmouth</td>
<td>Teaching, Applications</td>
</tr>
<tr>
<td>C</td>
<td>BTL</td>
<td>Systems, Applications</td>
</tr>
<tr>
<td>COBOL</td>
<td>Many</td>
<td>Business Applications</td>
</tr>
<tr>
<td>Fortran</td>
<td>Many</td>
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</tr>
<tr>
<td>LISP</td>
<td>M.I.T.</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>Pascal</td>
<td>Stanford</td>
<td>Teaching, Systems</td>
</tr>
<tr>
<td>PL/1</td>
<td>IBM</td>
<td>Applications</td>
</tr>
<tr>
<td>SNOBOL4</td>
<td>AT&amp;T</td>
<td>Applications</td>
</tr>
</tbody>
</table>
neqn/eqn

neqn prepares equations for the nroff formatter. eqn prepares them for troff.

input:

.P
The mean is the arithmetic average for a set of scores.
The formula for computing a mean (M) is
.sp 2
.DS
.EQ
M = \frac{\sum_{i=1}^{n} x_i}{n}
.EN
.DE

Explanation

.P
(an mm macro) begins a new paragraph
.sp 2
(an nroff request) places two lines of space between the text it separates
.DS
(an mm macro) starts a static display. When you put an equation in a document formatted with mm macros, you must put it inside a static display (shown here) or a floating display.
.EQ
tells neqn/eqn that what follows, here

M = \frac{\sum_{i=1}^{n} x_i}{n}

is a displayed equation to be formatted. sum, from, to, sub, and over are eqn instructions. The character "-" translates into a space.

**Command Lines**

```
neqn input | nroff [options] > input.out
or
neqn input | nroff [options] | printer
or
eqn input | troff [options] > input.out
or
eqn input | troff [options] | phototypesetter
```

**input.out:**

The mean is the arithmetic average for a set of scores. The formula for computing a mean (M) is

\[
M = \frac{\sum_{i=1}^{n} x_i}{n}
\]
troff

input:

.rs
.sp 4
.ps 14
.vs 16
.ls 2
.P
However sophisticated your printer is, \fI{troff}\fR can probably handle your font control.

By placing .ft on a line by itself before the line of text you want to change or \fI{f before the word or words you want to change}, you can modify your typography.

.ft I
This is a line of italic made with .ft I (italic).

.ft B
If you prefer a heavier emphasis, use bold roman type made with .ft B (bold).

.ft H
For the clean appearance of a sans serif type, use .ft H (Helvetica).

.ft R
Roman is the most popular, of course.

The \f allows for a finer level of control:
The individual \fI{Italic}\fR, \fB{Bold}\fR, or \fH{Helvetica}\fR word can be done in-line.

All printers were not made equal, so consult your systems manager to find what is available.

.ps 10
.vs 12
.ls 1
Explanation

.rs        turns no-space mode off
.sp 4      places four lines of space between the lines it separates
.ps 14     sets the point size to 14 (ignored by nroff)
.vs 16     sets vertical spacing between output lines to 16 points
.ls 2      sets line-spacing to 2, that is, one line of space is placed between each pair of output lines.
.P         (an mm macro) begins a new paragraph
.ft I      changes the font to italics
.br        forces a line break
.ft B      changes the font to bold
.ft H      changes the font to Helvetica
.ft R      changes the font to roman
\f         changes font in the middle of a line, e.g., \f1 changes font to roman wherever it appears in the text
.ps 10     changes point size to 10
.vs 12     changes vertical spacing to 12
.ls 1      Sets line spacing to 1, which is the default

The tutorial titled "The Formatter troff: a Tutorial" in the User's Guide teaches you about local motion, font and point size changes, basic graphics, as well as the programming capabilities of troff. The chapter "nroff/troff Technical Discussion" in the Technical Discussion and Reference Manual comprehensively discusses troff. It also provides a manual page for troff(1).
Command Lines

\texttt{troff -mm [options] input | phototypesetter}

or

\texttt{mmt [options] input | phototypesetter}
However sophisticated your printer is, *troff* can probably handle your font control. By placing \ft on a line by itself before the line of text you want to change or \f before the word or words you want to change, you can modify your typography. *This is a line of italic made with \ft I (italic).*

If you prefer a heavier emphasis, use bold roman type made with \ft B (bold).

For the clean appearance of a sans serif type, use \ft H (Helvetica).

Roman is the most popular, of course.

The \f allows for a finer level of control: The individual *italic, bold*, or Helvetica word can be done in-line.

All printers were not created equal, so consult your systems manager to find what is available.
The forms that `pic` provides are

```
Circle "circle"; move; box "box"; move; arrow "arrow" above
```

```
Ellipse "ellipse"; move; line "line" above; move; arc "arc"
```

\`pic\`'s language is intuitive, so making your own forms is not hard. For instance, you can talk to `pic` as you would to someone drawing shapes with a pencil:

```
Ellipse; line right; arc; arc; line down 1i; circle; arrow right; box dashed line right; line dotted right; arc; arrow dashed; box "There."
```

Since you can store these instructions in special commands, you are able to compile a personal library of shapes, naming them whatever you like:

```
input output
molecular_struct
solar_system
```

And these you can even tailor later to suit your particular needs in any document. For instance, the following example might be used to demonstrate the concept of processing:

```
Box "input"; arrow; ellipse "processing"; arrow; box "output"
```

```
input +0.75i
```
Explanation

.P  (an mm macro) begins a new paragraph
.sp 2  (a troff request) puts two lines of space between the lines of text it separates
.in +1i  indents one inch all text that follows. Other instances of .in in this example indent text various distances.
.PS  tells pic that what follows should be interpreted as instructions to draw a picture. In this example, the basic shapes that pic offers are drawn, labeled by their names; for example, circle "circle" instructs pic to put a circle around the word "circle." circle, move, box, arrow, and above are keywords for pic. More elaborate pictures are drawn after these shapes are labeled.
.PE  ends a picture for pic
.DS I  (an mm macro) starts an indented static display
.DE  (an mm macro) ends the static display


Command Lines

pic input | troff -mm [options] | phototypesetter
or
mmt -p [options] input | phototypesetter
input.out:

The forms that *pic* provides are

```
circle  box  arrow

ellipse  line  arc
```

*pic*’s language is intuitive, so making your own forms is not hard. For instance, you can talk to *pic* as you would to someone drawing shapes with a pencil:

```
 видеонаблюдение
```

Since you can store these instructions in special commands, you are able to compile a personal library of shapes, naming them whatever you like:

```
input_output
molecular_struct
solar_system
```

And these you can even tailor later to suit your particular needs in any document. For instance, the following example might be used to demonstrate the concept of processing:
Other books in the Prentice-Hall C and UNIX® Systems Library

- The C Programmer's Handbook  Bell Labs/M. I. Bolshy
- The UNIX System User's Handbook  Bell Labs/M. I. Bolshy
- The Vi User's Handbook  Bell Labs/M. I. Bolshy
- UNIX System Software Readings  AT&T UNIX PACIFIC
- UNIX System Readings and Applications, Volume I  Bell Labs
- UNIX System Readings and Applications, Volume II  Bell Labs
- UNIX System V Utilities Release Notes  AT&T
- UNIX System V Streams Primer  AT&T
- UNIX System V User's Reference Manual  AT&T
- UNIX System V Programmer's Reference Manual  AT&T
- UNIX System V Streams Programmer's Guide  AT&T
- UNIX System V Network Programmer's Guide  AT&T
- UNIX System V Programmer's Guide  AT&T
- UNIX System V Documentor's Workbench User's Guide  AT&T
- UNIX System V Documentor's Workbench Reference Manual  AT&T