ABSTRACT

Tbl is a document formatting preprocessor for troff or nroff which makes even fairly complex tables easy to specify and enter. Tables are made up of columns which may be independently centered, right-adjusted, left-adjusted, or aligned by decimal points. Headings may be placed over single columns or groups of columns. A table entry may contain equations, or may consist of several rows of text. Horizontal or vertical lines may be drawn as desired in the table, and any table or element may be enclosed in a box. For example:

<table>
<thead>
<tr>
<th>Year</th>
<th>Production all sources</th>
<th>Consumption</th>
<th>Net</th>
</tr>
</thead>
<tbody>
<tr>
<td>1953</td>
<td>36.77</td>
<td>36.27</td>
<td>+0.51</td>
</tr>
<tr>
<td>1958</td>
<td>38.81</td>
<td>40.35</td>
<td>−1.54</td>
</tr>
<tr>
<td>1963</td>
<td>45.85</td>
<td>48.32</td>
<td>−2.47</td>
</tr>
<tr>
<td>1968</td>
<td>56.81</td>
<td>61.00</td>
<td>−4.19</td>
</tr>
<tr>
<td>1973</td>
<td>62.06</td>
<td>74.28</td>
<td>−12.22</td>
</tr>
<tr>
<td>1978</td>
<td>61.01</td>
<td>78.09</td>
<td>−17.08</td>
</tr>
<tr>
<td>1983</td>
<td>61.19</td>
<td>70.05</td>
<td>−8.86</td>
</tr>
<tr>
<td>1987</td>
<td>64.55</td>
<td>76.01</td>
<td>−11.46</td>
</tr>
</tbody>
</table>

1. Introduction.

Tbl turns a simple description of a table into a troff or nroff [3] program (list of commands) that prints the table. It attempts to isolate a portion of a job that it can successfully handle and leave the remainder for other programs. Thus tbl may be used with the equation formatting program eqn [2] or various layout macro packages [1], [5], [6], but does not duplicate their functions.

This memorandum is divided into two parts. First we give the rules for preparing tbl input; then some examples are shown. The description of rules is precise but technical, and the beginning user may prefer to read the examples first, as they show some common table arrangements. A section explaining how to invoke tbl precedes the examples. To avoid repetition, henceforth read troff as ‘‘troff or nroff.’’

The input to tbl is text for a document, with tables preceded by a ‘‘.TS’’ (table start) command and followed by a ‘‘.TE’’ (table end) command. Tbl processes the tables, generating troff formatting commands, and leaves the remainder of the text unchanged. The .TS and .TE lines are copied, too, so that troff page layout macros (such as the memo formatting macros [1]) can use these lines to delimit and place tables as they see fit. In particular, any arguments on the .TS or .TE lines are copied but otherwise ignored, and may be used by document layout macro commands.

The format of the input is as follows:
where the format of each table is as follows:

\texttt{.TS}
\texttt{options ;}
\texttt{format .}
\texttt{data}
\texttt{.TE}

Each table is independent, and must contain formatting information followed by the data to be entered in the table. The formatting information, which describes the individual columns and rows of the table, may be preceded by a few options that affect the entire table. A detailed description of tables is given in the next section.

2. Input commands.

As indicated above, a table contains, first, global options, then a format section describing the layout of the table entries, and then the data to be printed. The format and data are always required, but not the options. The various parts of the table are entered as follows:

2.1. Options

There may be a single line of options affecting the whole table. If present, this line must follow the .TS line immediately and must contain a list of option names separated by spaces, tabs, or commas, and must be terminated by a semicolon. The allowable options are:

- center: center the table (default is left-adjust);
- expand: make the table as wide as the current line length;
- box: enclose the table in a box;
- allbox: enclose each item in the table in a box;
- doublebox: enclose the table in two boxes;
- tab (x): use x instead of tab to separate data items.

linesize(n) set lines or rules (e.g. from box) in n point type;
delim(xy) recognize x and y as the eqn delimiters.

Tbl tries to keep boxed tables on one page by issuing appropriate troff "need" (.ne) commands. These requests are calculated from the number of lines in the tables, and if there are spacing commands embedded in the input, these requests may be inaccurate; use normal troff procedures, such as keep-release macros, in that case. The user who must have a multi-page boxed table should use macros designed for this purpose, as explained below under ‘Usage.’

2.2. Format

The format section of the table specifies the layout of the columns. Each line in this section corresponds to one line of the table (except that the last line corresponds to all following lines up to the next .T&., if any — see below), and each line contains a key-letter for each column of the table. It is good practice to separate the key letters for each column by spaces or tabs. Each key-letter is one of the following:

- L or l: to indicate a left-adjusted column entry;
- R or r: to indicate a right-adjusted column entry;
- C or c: to indicate a centered column entry;
- N or n: to indicate a numerical column entry, to be aligned with other numerical entries so that the units digits of numbers line up;
- A or a: to indicate an alphabetic subcolumn; all corresponding entries are aligned on the left, and positioned so that the widest is centered within the column (see example on page 12);
- S or s: to indicate a spanned heading, i.e. to indicate that the entry from the previous column continues across this column (not allowed for the first column, obviously); or
- ^: to indicate a vertically spanned heading, i.e. to indicate that the entry from the previous row continues down through this row. (Not allowed for the first row of the table, obviously).

When numerical alignment is specified, a location for the decimal point is sought. 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 no alignment is indicated, the item is centered in the column. However, the special non-printing character string \& may be used to override unconditionally dots and digits, or to align alphabetic data; this string lines up where a dot normally would, and then disappears from the final output. In the example below, the items shown at the left will be aligned (in a numerical column) as shown on the right:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>26.4.12</td>
<td>26.4.12</td>
</tr>
<tr>
<td>abc</td>
<td>abc</td>
</tr>
<tr>
<td>abc&amp;</td>
<td>abc</td>
</tr>
<tr>
<td>43&amp;3.22</td>
<td>433.22</td>
</tr>
<tr>
<td>749.12</td>
<td>749.12</td>
</tr>
</tbody>
</table>

**Note:** If numerical data are used in the same column with wider L or r type table entries, the widest number is centered relative to the wider L or r items (L is used instead of \ l for readability; they have the same meaning as key-letters). Alignment within the numerical items is preserved. This is similar to the behavior of a type data, as explained above. However, 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.

**Warning:** the n and a items should not be used in the same column.

For readability, the key-letters describing each column should be separated by spaces. The end of the format section is indicated by a period. The layout of the key-letters in the format section resembles the layout of the actual data in the table. Thus a simple format might appear as:

```
c s s
l n n.
```

which specifies a table of three columns. The first line of the table contains a heading centered across all three columns; each remaining line contains a left-adjusted item in the first column followed by two columns of numerical data. A sample table in this format might be:

<table>
<thead>
<tr>
<th>Overall title</th>
<th>Item-a</th>
<th>34.22</th>
<th>9.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item-b</td>
<td>12.65</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td>Items: c,d,e</td>
<td>23</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>69.87</td>
<td>14.92</td>
<td></td>
</tr>
</tbody>
</table>

There are some additional features of the key-letter system:

**Horizontal lines** — A key-letter may be replaced by _ (underscore) to indicate a horizontal line in place of the corresponding column entry, or by = to indicate a double horizontal line. If an adjacent column contains a horizontal line, or if there are vertical lines adjoining this column, this horizontal line is extended to meet the nearby lines. If any data entry is provided for this column, it is ignored and a warning message is printed.

**Vertical lines** — A vertical bar may be placed between column key-letters. This will cause a vertical line 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, a double vertical line is drawn.

**Space between columns** — A number may follow the key-letter. This indicates the amount of separation between this column and the next column. The number normally specifies the separation in en$. If the ‘‘expand’’ option is used, then these numbers are multiplied by a constant such that the table is as wide as the current line length. The default column separation number is 3. If the separation is changed the worst case (largest space requested) governs.

**Vertical spanning** — Normally, vertically spanned items extending over several rows of the table are centered in their vertical range. If a key-letter is followed by t or T, any corresponding vertically spanned item will begin at the top line of its range.

**Font changes** — A key-letter may be followed by a string containing a font name or number preceded by the letter f or F. This indicates that the corresponding column should be in a different font from the default font (usually Roman). All font names are one or two letters; a one-letter font name should be separated from whatever follows by a space or

* One en is about the width of the letter ‘n’, or more precisely, half the current type size measured in points (1 point = 1/72 inch).
tab. The single letters B, b, I, and i are shorter synonyms for fB and fI and refer to the bold and italic fonts in the current font family. Font change commands given with the table entries override these specifications.

**Point size changes** — A key-letter may be followed by the letter p or P and a number to indicate the point size of the corresponding table entries. The number may be a signed digit, in which case it is taken as an increment or decrement from the current point size. If both a point size and a column separation value are given, one or more blanks must separate them.

**Vertical spacing changes** — A key-letter may be followed by the letter v or V and a number to indicate the vertical line spacing to be used within a multi-line corresponding table entry. The number may be a signed digit, in which case it is taken as an increment or decrement from the current vertical spacing. A column separation value must be separated by blanks or some other specification from a vertical spacing request. This request has no effect unless the corresponding table entry is a text block (see below).

**Column width indication** — A key-letter may be followed by the letter w or W and a width value in parentheses. This width is used as a minimum column width. If the largest element in the column is not as wide as the width value given after the w, the largest element is assumed to be that wide. If the largest element in the column is wider than the specified value, its width is used. The width is also used as a default line length for included text blocks. Normal troff units can be used to scale the width value; if none are used, the default is ens. If the width specification is a unitless integer the parentheses may be omitted. If the width value is changed in a column, the last one given controls.

**Equal width columns** — A key-letter may be followed by the letter e or E to indicate equal width columns. All columns whose key-letters are followed by e or E are made the same width. This permits the user to get a group of regularly spaced columns.

**Staggered columns** — A key-letter may be followed by the letter u or U to indicate that the corresponding entry is to be moved up one half line. This makes it easy, for example, 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 may be followed by the letter z or Z to indicate that the corresponding data item is to be ignored in calculating column widths. This may be useful, for example, in allowing headings to run across adjacent columns where spanned headings would be inappropriate.

**Note:** The order of the above features is immaterial; they need not be separated by spaces, except as indicated above 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
```

**Alternative notation** — Instead of listing the format of successive lines of a table on consecutive lines of the format section, successive line formats may be given on the same line, separated by commas, so that the format for the example above might have been written:

```
c s s, l n n .
```

**Default** — Column descriptors missing from the end of a format line are assumed to be L. The longest line in the format section, however, defines the number of columns in the table; extra columns in the data are ignored silently.

### 2.3. Data

The data for the table are typed after the format. Normally, each table line is typed as one line of data. Very long input lines can be broken: any line whose last character is \ is combined with the following line (and the \ vanishes). The data for different columns (the table entries) are separated by tabs, or by whatever character has been specified with the option tabs. There are a few special cases:

**Troff commands within tables** — An input line beginning with a . followed by anything but a number is assumed to be a command to troff and is passed through unchanged, retaining its position in the table. So, for example, vertical space within a table may be produced by .sp commands in the data.
Full width horizontal lines — An input line containing only _ (underscore) or = (equal sign) is taken to be a single or double line, respectively, extending the full width of the table.

Single column horizontal lines — An input table entry containing only the character _ _ is taken to be a single or double line extending the full width of the column. Such lines are extended to meet horizontal or vertical lines adjoining this column. To obtain these characters explicitly in a column, either precede them by \& or follow them by a space before the usual tab or newline.

Short horizontal lines — An input table entry containing only the string \_ is taken to be a single line as wide as the contents of the column. It is not extended to meet adjoining lines.

Repeated characters — An input table 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 the data in the column. The sequence of x’s is not extended to meet adjoining columns.

Vertically spanned items — An input table entry containing only the character string \^ indicates that the table entry immediately above spans downward over this row. It is equivalent to a table format key-letter of ^.

Text blocks — In order to include a block of text as a table entry, precede it by T{ and follow it by T). Thus the sequence

... T{
   block of
text
T} ...

is the way to enter, as a single entry in the table, something that cannot conveniently be typed as a simple string between tabs. Note that the T) end delimiter must begin a line; additional columns of data may follow after a tab on the same line. See the example on page 44 for an illustration of included text blocks in a table. If more than fifty or so text blocks are used in a table, various limits in the troff program are likely to be exceeded, producing diagnostics such as ‘too many string/macro names’ or ‘too many number registers.’

Text blocks are pulled out from the table, processed separately by troff, and replaced in the table as a solid block. If no line length is specified in the block of text itself, 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 number of columns in the table. The other parameters (point size, font, etc.) used in setting the block of text are those in effect at the beginning of the table (including the effect of the .TS macro) and any table format specifications of size, spacing and font, using the p, v and f modifiers to the column key-letters. Commands within the text block itself are also recognized, of course. However, troff commands within the table data but not within the text block do not affect that block.

Warnings: Although any number of lines may be present in a table, only the first 200 lines are used in calculating the widths of the various columns. A multi-page table, of course, may be arranged as several single-page tables if this proves to be a problem. Other difficulties with formatting may arise because, in the calculation of column widths all table entries are assumed to be in the font and size being used when the .TS command was encountered, except for font and size changes indicated (a) in the table format section and (b) within the table data (as in the entry \(\&s+3\)\fI data\fP \(\&s0\)). Therefore, although arbitrary troff requests may be sprinkled in a table, care must be taken to avoid confusing the width calculations; use requests such as .ps with care.

2.4. Additional Command Lines

If the format of a table must be changed after many similar lines, as with sub-headings or summaries, the .T& (table continue) command can be used to change column parameters. The outline of such a table input is:
.TS
  options ;
format .
data
...
.T&
  format .
data
.T&
  format .
data
.TE

as in the examples on pages 43 and 46. Using this procedure, each table line can be close to its corresponding format line.

Warning: 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 width. Nor is .T& recognized after the first 200 lines of a table.

3. Usage.

On UNIX® systems, tbl can be run on a simple table with the command

tbl input-file | troff

but for more complicated use, where there are several input files, and they contain equations and -ms layout commands as well as tables, the normal command would be

tbl files ... | eqn | troff -ms

and, of course, the usual options may be used on the troff and eqn commands. If any of the file names are – the standard input is read at that point.

For the convenience of users employing line printers without adequate driving tables or post-filters, there is a special –TX command line option to tbl which produces output that does not have fractional line motions in it.

Note that when eqn and tbl are used together on the same file, tbl should be used first. If there are no equations within tables, either order works, but it is usually faster to run tbl first, since eqn normally produces a larger expansion of the input than tbl. However, if there are equations within tables (using the delim mechanism in eqn), tbl must be first or the output will be scrambled. Users must also beware of using equations in n-style columns; this is nearly always wrong, since tbl attempts to split numerical format items into two parts and this is not possible with equations. The user can defend against this by giving the delim(xx) table option; this prevents splitting of numerical columns within the delimiters. For example, if the eqn delimiters are $$, giving delim($) a numerical column such as 1245$+- 16$ will be divided after 1245, not after 16.

Tbl accepts up to about 35 columns, the exact number depending on the availability of number registers. The user must avoid number register names used by tbl, which include two-digit numbers from 31 to 97, and strings of the form 4x, 5x, #x, x+, x|, ^x, and x-, where x is any lower case letter. The names ##, #-, and ^+ are also used in certain circumstances. To conserve number register names, the n and a formats share a register; hence the restriction above that they may not be used in the same column.

For aid in writing layout macros, tbl defines a number register TW which is the table width; it is defined by the time that the .TE macro is invoked and may be used in the expansion of that macro. More importantly, 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 invoked at its end. By use of this macro in the page footer a multi-page table can be boxed. In particular, the –ms macros can be used to 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

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 table; the remaining lines in the table are placed on several pages as required. Note that this is not a feature of tbl, but of the –ms layout macros.

4. Examples.

Here are some examples illustrating features of tbl. The symbol © in the input represents a tab character.
Input:
.TS
box;
c c c
1 1 r.
Fact Location Statistic
Largest state Alaska 591,004 sq. mi.
Smallest state Rhode Island 1,212 sq. mi.
Longest river Mississippi-Missouri 3,710 mi.
Highest mountain Mount McKinley, AK 20,320 ft.
Lowest point Death Valley, CA ±282 ft.
.TE

Output:
<table>
<thead>
<tr>
<th>Fact</th>
<th>Location</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest state</td>
<td>Alaska</td>
<td>591,004 sq. mi.</td>
</tr>
<tr>
<td>Smallest state</td>
<td>Rhode Island</td>
<td>1,212 sq. mi.</td>
</tr>
<tr>
<td>Longest river</td>
<td>Mississippi-Missouri</td>
<td>3,710 mi.</td>
</tr>
<tr>
<td>Highest mountain</td>
<td>Mount McKinley, AK</td>
<td>20,320 ft.</td>
</tr>
<tr>
<td>Lowest point</td>
<td>Death Valley, CA</td>
<td>±282 ft.</td>
</tr>
</tbody>
</table>

Input:
.TS
allbox;
c s s
c c c
n n n.
AT&T Common Stock
Year Price Dividend
1984 15-20 $1.20
5 19-25 1.20
6 21-28 1.20
7 20-36 1.20
8 24-30 1.20
9 29-37 .30*
.TE
* (first quarter only)
### Input:

```plaintext
.TS
box;
c s s
c | c | c
1 | 1 | n.
Major New York Bridges =
Bridge ⊕ Designer ⊕ Length

Brooklyn ⊕ J. A. Roebling ⊕ 1595
Manhattan ⊕ G. Lindenthal ⊕ 1470
Williamsburg ⊕ L. L. Buck ⊕ 1600
Queensborough ⊕ Palmer & Hornbostel ⊕ 1182
Triborough ⊕ O. H. Ammann ⊕ 1380
Bronx Whitestone ⊕ O. H. Ammann ⊕ 2300
Throgs Neck ⊕ O. H. Ammann ⊕ 1800
George Washington ⊕ O. H. Ammann ⊕ 3500
.TE
```

### Output:

**Major New York Bridges**

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Designer</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brooklyn</td>
<td>J. A. Roebling</td>
<td>1595</td>
</tr>
<tr>
<td>Manhattan</td>
<td>G. Lindenthal</td>
<td>1470</td>
</tr>
<tr>
<td>Williamsburg</td>
<td>L. L. Buck</td>
<td>1600</td>
</tr>
<tr>
<td>Queensborough</td>
<td>Palmer &amp; Hornbostel</td>
<td>1182</td>
</tr>
<tr>
<td>Triborough</td>
<td>O. H. Ammann</td>
<td>1380</td>
</tr>
<tr>
<td>Bronx Whitestone</td>
<td>O. H. Ammann</td>
<td>2300</td>
</tr>
<tr>
<td>Throgs Neck</td>
<td>O. H. Ammann</td>
<td>1800</td>
</tr>
<tr>
<td>George Washington</td>
<td>O. H. Ammann</td>
<td>3500</td>
</tr>
</tbody>
</table>

### Input:

```plaintext
.TS
c c
c | c | c np-2 | n | .
⊕ Stack ⊕
⊕ 1 ⊕ 46 ⊕
⊕ 2 ⊕ 23 ⊕
⊕ 3 ⊕ 15 ⊕
⊕ 4 ⊕ 6.5 ⊕
⊕ 5 ⊕ 2.1 ⊕
⊕ .TE
```

### Output:

**Stack**

```
1 46
2 23
3 15
4 6.5
5 2.1
```

---

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Input:

```
.TS
box;
L L L
L L
L L LB
L L
L L L.
january february march
april may
june july Months
august september
october november december
.TE
```

Output:

```
january february march
april may
june july
august september
october november december
```

Input:

```
.FP helvetica
.TS
box;
cf(CW s s s.
Composition of Foods

_.T&
c c s s
c c s s
c c c c c.
Food Percent by Weight
\ "
\ Protein Fat Carbo-
\ hydrate

_.T&
1 | n | n | n.
Apples .4 .5 13.0
Halibut 18.4 5.2 ...
Lima beans 7.5 8.0 22.0
Milk 3.3 4.0 5.0
Mushrooms 3.5 .4 6.0
Rye bread 9.0 .6 52.7
.TE
.FP times
```

Output:

```
<table>
<thead>
<tr>
<th>Food</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protein</td>
</tr>
<tr>
<td></td>
<td>.4</td>
</tr>
<tr>
<td>Apples</td>
<td>13.0</td>
</tr>
<tr>
<td>Halibut</td>
<td>18.4</td>
</tr>
<tr>
<td>Lima beans</td>
<td>22.0</td>
</tr>
<tr>
<td>Milk</td>
<td>5.0</td>
</tr>
<tr>
<td>Mushrooms</td>
<td>6.0</td>
</tr>
<tr>
<td>Rye bread</td>
<td>52.7</td>
</tr>
</tbody>
</table>
```
**Input:**

```
.TS
 allbox;
cfl ss
c cw(1i) cw(1i)
lp9 lp9 lp9.
New York Area Rocks
Era ⊗ Formation ⊗ Age (years)
Precambrian ⊗ Reading Prong ⊗ >1 billion
Paleozoic ⊗ Manhattan Prong ⊗ 400 million
Mesozoic ⊗ Newark Basin, incl. Stockton, Lockatong, and Brunswick formations; also Watchungs and Palisades.
na
Cenozoic ⊗ Coastal Plain ⊗ On Long Island 30,000 years; Cretaceous sediments redeposited by recent glaciation.
.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; also Watchungs and Palisades.</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>
```

**Input:**

```
.EQ
delim $$
.EN

.Name Definition
Gamma \( \Gamma(z) = \int_{0}^{\infty} t^{z-1} e^{-t} dt \)
Sine \( \sin(x) = \frac{1}{2i} (e^ix - e^{-ix}) \)
Error \( \text{erf}(z) = \frac{2}{\sqrt{\pi}} \int_{0}^{z} e^{-t^2} dt \)
Bessel \( J_{0}(z) = \frac{1}{\pi} \int_{0}^{\pi} \cos(z \sin \theta) d\theta \)
Zeta \( \zeta(s) = \sum_{k=1}^{\infty} k^{-s} \quad (\text{Re } s > 1) \)
```

**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>( J_{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} \quad (\text{Re } s &gt; 1) )</td>
</tr>
</tbody>
</table>
```
Input:
.TS
box, tab(:);
cb s s s s
cp-2 s s s s
c | | c | c | c | c
c | | c | c | c | c
r2 | | n2 | n2 | n2 | n.
Readability of Text
Line Width and Leading for 10-Point Type
= Line: Set: 1-Point: 2-Point: 4-Point
Width: Solid: Leading: Leading

9 Pica: \-9.3: \-6.0: \-5.3: \-7.1
14 Pica: \-4.5: \-0.6: \-0.3: \-1.7
19 Pica: \-5.0: \-5.1: 0.0: \-2.0
31 Pica: \-3.7: \-3.8: \-2.4: \-3.6
43 Pica: \-9.1: \-9.0: \-5.9: \-8.8
.TE

Output:

<table>
<thead>
<tr>
<th>Line Width</th>
<th>Set Solid</th>
<th>1-Point Leading</th>
<th>2-Point Leading</th>
<th>4-Point Leading</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 Pica</td>
<td>-9.3</td>
<td>-6.0</td>
<td>-5.3</td>
<td>-7.1</td>
</tr>
<tr>
<td>14 Pica</td>
<td>-4.5</td>
<td>-0.6</td>
<td>-0.3</td>
<td>-1.7</td>
</tr>
<tr>
<td>19 Pica</td>
<td>-5.0</td>
<td>-5.1</td>
<td>0.0</td>
<td>-2.0</td>
</tr>
<tr>
<td>31 Pica</td>
<td>-3.7</td>
<td>-3.8</td>
<td>-2.4</td>
<td>-3.6</td>
</tr>
<tr>
<td>43 Pica</td>
<td>-9.1</td>
<td>-9.0</td>
<td>-5.9</td>
<td>-8.8</td>
</tr>
</tbody>
</table>
### Input:

```
.TS
c s
cip-2 s
l n
a n.
Some London Transport Statistics
(Year 1964)
Railway route miles 244
Tube 66
Sub-surface 22
Surface 156
.sp .5
.T&
l r
.a r.
Passenger traffic ∼ railway
Journeys 674 million
Average length 4.55 miles
Passenger miles 3,066 million
.T&
l r
.a r.
Passenger traffic ∼ road
Journeys 2,252 million
Average length 2.26 miles
Passenger miles 5,094 million
.sp .5
Vehicles 12,521
Railway motor cars 2,905
Railway trailer cars 1,269
Total railway 4,174
Omnibuses 8,347
.sp .5
Staff 73,739
Administrative, etc. 5,582
Civil engineering 5,134
Electrical eng. 1,714
Mech. eng. ∼ railway 4,310
Mech. eng. ∼ road 9,152
Railway operations 8,930
Road operations 35,946
Other 2,971
.TE
```

### Output:

Some London Transport Statistics
(Year 1964)

<table>
<thead>
<tr>
<th>Service</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railway route</td>
<td>244</td>
</tr>
<tr>
<td>Tube</td>
<td>66</td>
</tr>
<tr>
<td>Sub-surface</td>
<td>22</td>
</tr>
<tr>
<td>Surface</td>
<td>156</td>
</tr>
<tr>
<td><strong>Total Railway</strong></td>
<td><strong>4,174</strong></td>
</tr>
<tr>
<td>Journeys</td>
<td>674 million</td>
</tr>
<tr>
<td>Average length</td>
<td>4.55 miles</td>
</tr>
<tr>
<td>Passenger miles</td>
<td>3,066 million</td>
</tr>
<tr>
<td><strong>Total Passenger</strong></td>
<td><strong>5,094 million</strong></td>
</tr>
<tr>
<td>Vehicles</td>
<td>12,521</td>
</tr>
<tr>
<td>Railway motor cars</td>
<td>2,905</td>
</tr>
<tr>
<td>Railway trailer cars</td>
<td>1,269</td>
</tr>
<tr>
<td>Omnibuses</td>
<td>8,347</td>
</tr>
<tr>
<td><strong>Staff</strong></td>
<td><strong>73,739</strong></td>
</tr>
<tr>
<td>Administrative, etc.</td>
<td>5,582</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>5,134</td>
</tr>
<tr>
<td>Electrical eng.</td>
<td>1,714</td>
</tr>
<tr>
<td>Mech. eng. ∼ railway</td>
<td>4,310</td>
</tr>
<tr>
<td>Mech. eng. ∼ road</td>
<td>9,152</td>
</tr>
<tr>
<td>Railway operations</td>
<td>8,930</td>
</tr>
<tr>
<td>Road operations</td>
<td>35,946</td>
</tr>
<tr>
<td>Other</td>
<td>2,971</td>
</tr>
</tbody>
</table>
Input:

.TS
center box;
cBp+2 s s
cB s s
li 1 lb.
Crisis and Emergency Numbers
.sp
24-Hour Hotlines
Abuse Child Abuse Reports 1-800-792-8610
.sp .5
Alcohol Ala-Call 1-800-322-5525
Alcohol Overdose 1-800-962-1253
.sp .5
Drug Drug Hotline 1-800-225-0196
Drug Overdose 1-800-962-1253
Drug Narcotics Anonymous 1-800-992-0401
.sp .5
Poison Poison Hotline 1-800-962-1253
.sp .5
Runaways Hotline 1-800-231-6946
Runaways Covenant House 1-800-999-9999
.sp .5
.T&
cB s s
li 1 lb.
Other Hotlines
AIDS National AIDS Hotline 1-800-342-AIDS
AIDS NJ AIDS Hotline 1-800-624-2377
Drug Cocaine 1-800-COCAINEx
Eating Eating Disorders Hotline 1-800-624-2268
Support Support Group Information 1-800-367-6274
VD VD Information 1-800-227-8922
.sp .5
.sp .5
.sp .5
.TE

Output:

<table>
<thead>
<tr>
<th>Crisis and Emergency Numbers</th>
<th>24-Hour Hotlines</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Abuse Child Abuse Reports</td>
<td>1-800-792-8610</td>
<td></td>
</tr>
<tr>
<td>Alcohol Ala-Call</td>
<td>1-800-322-5525</td>
<td></td>
</tr>
<tr>
<td>Alcohol Overdose</td>
<td>1-800-962-1253</td>
<td></td>
</tr>
<tr>
<td>Drug Drug Hotline</td>
<td>1-800-225-0196</td>
<td></td>
</tr>
<tr>
<td>Drug Overdose</td>
<td>1-800-962-1253</td>
<td></td>
</tr>
<tr>
<td>Drug Narcotics Anonymous</td>
<td>1-800-992-0401</td>
<td></td>
</tr>
<tr>
<td>Poison Poison Hotline</td>
<td>1-800-962-1253</td>
<td></td>
</tr>
<tr>
<td>Runaways Hotline</td>
<td>1-800-231-6946</td>
<td></td>
</tr>
<tr>
<td>Runaways Covenant House</td>
<td>1-800-999-9999</td>
<td></td>
</tr>
</tbody>
</table>

This is a paragraph of normal text placed here only to indicate where the left and right margins are. In this way the reader can judge the appearance of centered tables or expanded tables, and observe how such tables are formatted.
New Jersey Bell Labs Locations

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Area Code</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chester</td>
<td>Chester, NJ 07930</td>
<td>201</td>
<td>879-3400</td>
</tr>
<tr>
<td>Corporate Park III</td>
<td>Somerset, NJ 08873</td>
<td>201</td>
<td>271-2300</td>
</tr>
<tr>
<td>Crawford Hill</td>
<td>Holmdel, NJ 07733</td>
<td>201</td>
<td>888-7000</td>
</tr>
<tr>
<td>ERC</td>
<td>Hopewell Township, NJ 08525</td>
<td>609</td>
<td>639-1234</td>
</tr>
<tr>
<td>Freehold</td>
<td>Freehold, NJ 07728</td>
<td>201</td>
<td>577-5000</td>
</tr>
<tr>
<td>Headquarters Plaza</td>
<td>Morristown, NJ 07960</td>
<td>201</td>
<td>898-6000</td>
</tr>
<tr>
<td>Holmdel</td>
<td>Holmdel, NJ 07733</td>
<td>201</td>
<td>834-1000</td>
</tr>
<tr>
<td>Knightsbridge</td>
<td>Piscataway, NJ 08854</td>
<td>201</td>
<td>457-2000</td>
</tr>
<tr>
<td>Liberty Corner</td>
<td>Warren, NJ 07060</td>
<td>201</td>
<td>580-4000</td>
</tr>
<tr>
<td>Lincroft</td>
<td>Lincroft, NJ 07738</td>
<td>201</td>
<td>576-4000</td>
</tr>
<tr>
<td>MDC</td>
<td>Hopewell Township, NJ 08525</td>
<td>609</td>
<td>639-6100</td>
</tr>
<tr>
<td>Middletown</td>
<td>Middletown, NJ 07748</td>
<td>201</td>
<td>957-2000</td>
</tr>
<tr>
<td>Morris</td>
<td>Morristown, NJ 07960</td>
<td>201</td>
<td>898-1000</td>
</tr>
<tr>
<td>Murray Hill</td>
<td>Murray Hill, NJ 07974</td>
<td>201</td>
<td>582-3000</td>
</tr>
<tr>
<td>Parsippany</td>
<td>Parsippany, NJ 07054</td>
<td>201</td>
<td>581-3000</td>
</tr>
<tr>
<td>Patriots Plaza</td>
<td>Morristown, NJ 07960</td>
<td>201</td>
<td>829-7200</td>
</tr>
<tr>
<td>Red Hill</td>
<td>Middletown, NJ 07748</td>
<td>201</td>
<td>949-3000</td>
</tr>
<tr>
<td>Short Hills</td>
<td>Short Hills, NJ 07078</td>
<td>201</td>
<td>564-2000</td>
</tr>
<tr>
<td>Somerset</td>
<td>Somerset, NJ 08873</td>
<td>201</td>
<td>560-1300</td>
</tr>
<tr>
<td>Summit</td>
<td>Summit, NJ 07901</td>
<td>201</td>
<td>522-6555</td>
</tr>
<tr>
<td>Warren Service Center</td>
<td>Warren, NJ 07060</td>
<td>201</td>
<td>756-1527</td>
</tr>
<tr>
<td>West Long Branch</td>
<td>Morristown, NJ 07764</td>
<td>201</td>
<td>870-7000</td>
</tr>
<tr>
<td>Whippany</td>
<td>Whippany, NJ 07981</td>
<td>201</td>
<td>386-3000</td>
</tr>
<tr>
<td>Woodhollow</td>
<td>Parsippany, NJ 07054</td>
<td>201</td>
<td>581-3000</td>
</tr>
</tbody>
</table>
## Some Interesting Places

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Practical Information</th>
</tr>
</thead>
<tbody>
<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: 10-5:45 M Tu Th, 10-9 W Sat. Sun. Location: Central Park West &amp; 79th St. Admission: Donation: $1.00 asked. Subway: AA to 81st St. Telephone: 212-769-5100</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: 10-5 M-Sat, to 5:30 Sun Location: 185th St. &amp; Southern Blvd, the Bronx. Admission: $3.75/1.50 adult/children; Tu,We,Th donation. Subway: 2, 5 to East Tremont Ave. Telephone: 212-367-1010</td>
</tr>
<tr>
<td>Brooklyn Museum</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: 10-5, closed Tues Location: Eastern Parkway &amp; Washington Ave., Brooklyn. Admission: Free. Subway: 2,3 to Eastern Parkway. Telephone: 212-367-1010</td>
</tr>
<tr>
<td>New-York Historical Society</td>
<td>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.</td>
<td>Hours: Tues-Sun, 10-5 Location: Central Park West &amp; 77th St. Admission: Free. Subway: AA to 81st St. Telephone: 212-873-3400</td>
</tr>
</tbody>
</table>

---

**Research Tenth Edition**
### 5. Acknowledgments.

Many thanks are due to J. C. Blinn, who has done a large amount of testing and assisted with the design of the program. He has also written many of the more intelligible sentences in this document and helped edit all of it. All phototypesetting programs on UNIX are dependent on the work of the late J. F. Ossanna, whose assistance with this program in particular had been most helpful. This program is patterned on a table formatter originally written by J. F. Gimpel. The assistance of T. A. Dolotta, B. W. Kernighan, and J. N. Sturman is gratefully acknowledged.

### 6. References.


### 7. List of Tbl Command Characters and Words

<table>
<thead>
<tr>
<th>Command</th>
<th>Meaning</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>a A</td>
<td>Alphabetic subcolumn</td>
<td>2.2</td>
</tr>
<tr>
<td>allbox</td>
<td>Draw box around all items</td>
<td>2.1</td>
</tr>
<tr>
<td>b B</td>
<td>Boldface item</td>
<td>2.2</td>
</tr>
<tr>
<td>box</td>
<td>Draw box around table</td>
<td>2.1</td>
</tr>
<tr>
<td>c C</td>
<td>Centered column</td>
<td>2.2</td>
</tr>
<tr>
<td>center</td>
<td>Center table in page</td>
<td>2.1</td>
</tr>
<tr>
<td>delim( )</td>
<td>Set <em>eqn</em> delimiters</td>
<td>2.1</td>
</tr>
<tr>
<td>doublebox</td>
<td>Doubled box around table</td>
<td>2.1</td>
</tr>
<tr>
<td>e E</td>
<td>Equal width columns</td>
<td>2.2</td>
</tr>
<tr>
<td>expand</td>
<td>Make table full line width</td>
<td>2.1</td>
</tr>
<tr>
<td>f F</td>
<td>Font change</td>
<td>2.2</td>
</tr>
<tr>
<td>i I</td>
<td>Italic item</td>
<td>2.2</td>
</tr>
<tr>
<td>l L</td>
<td>Left adjusted column</td>
<td>2.2</td>
</tr>
<tr>
<td>linesize( )</td>
<td>Set point size for drawing lines</td>
<td>2.1</td>
</tr>
<tr>
<td>n N</td>
<td>Numerical column</td>
<td>2.2</td>
</tr>
<tr>
<td>nnn</td>
<td>Column separation</td>
<td>2.2</td>
</tr>
<tr>
<td>p P</td>
<td>Point size change</td>
<td>2.2</td>
</tr>
<tr>
<td>r R</td>
<td>Right adjusted column</td>
<td>2.2</td>
</tr>
<tr>
<td>s S</td>
<td>Spanned item</td>
<td>2.2</td>
</tr>
<tr>
<td>t T</td>
<td>Vertical spanning at top</td>
<td>2.2</td>
</tr>
<tr>
<td>tab( )</td>
<td>Change data separator character</td>
<td>2.1</td>
</tr>
<tr>
<td>T( T)</td>
<td>Text block</td>
<td>2.3</td>
</tr>
<tr>
<td>u U</td>
<td>Staggered columns</td>
<td>2.2</td>
</tr>
<tr>
<td>v V</td>
<td>Vertical spacing change</td>
<td>2.2</td>
</tr>
<tr>
<td>w W</td>
<td>Minimum width value</td>
<td>2.2</td>
</tr>
<tr>
<td>z Z</td>
<td>Ignore width of data in this column</td>
<td>2.2</td>
</tr>
<tr>
<td>.xx</td>
<td>Included <em>troff</em> command</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical line</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>^</td>
<td>Vertical span</td>
<td>2.2</td>
</tr>
<tr>
<td>^</td>
<td>Vertical span</td>
<td>2.3</td>
</tr>
<tr>
<td>=</td>
<td>Double horizontal line</td>
<td>2.3</td>
</tr>
<tr>
<td>_</td>
<td>Horizontal line</td>
<td>2.3</td>
</tr>
<tr>
<td>_</td>
<td>Short horizontal line</td>
<td>2.3</td>
</tr>
<tr>
<td>\Rx</td>
<td>Repeat character</td>
<td>2.3</td>
</tr>
</tbody>
</table>