METATEX

Ramón Casares

Abstract

METATEX is a set of `plain` TEX and METAFONT macros that you can use to define both the text and the figures in a single source file. Because METATEX sets up two way communication, from TEX to METAFONT and back from METAFONT to TEX, drawing dimensions can be controlled by TEX and labels can be located by METAFONT. Only standard features of TEX and METAFONT are used, but two runs of TEX and one of METAFONT are needed.

Overview

Together, TEX and METAFONT define the page layout to the pixel. This means that nothing more is needed, not even a means of including figures in a TEX document. To prove this is the aim of this paper.

To split the typesetting process in two parts, one to define and draw the characters and the other to arrange the characters in paragraphs and pages, is surely the best way to reduce the complexity of the typesetting task, provided it needs simplification (see Figure 1). But this method makes it difficult, for example, to integrate labels with graphics in figures, because while TEX is best suited to typeset the labels, METAFONT is the appropriate tool to draw the graphics. And, of course, labels should be located in accordance with the graphics.

Therefore, the true successor of TEX has to include in a single program both the capabilities of TEX and METAFONT. Then the typesetting engine would include a powerful graphic tool, a grid to typeset in if required, and it could take into account the shapes of the characters to determine, for example, kernings or italic corrections. The other way around is also possible. It could be seen as a graphic engine with a powerful typesetting tool. From this point of view, the page would be a graphic object that could contain paragraphs of different shapes requested to the typesetting tool.

METATEX, although it does not fulfill the requirements of such a successor, can be seen as an early sign of its possibilities. For the moment, METATEX takes advantage of METAFONT's equation solving capabilities to locate objects, including the labels to be typeset by TEX. The cost of this nice feature is that two TEX passes are required.

During the first TEX pass a METAFONT file is written. As it is TEX itself who writes the METAFONT file, any dimension controlled by TEX can be used and incorporated in METAFONT's calculations. For example, the label sizes, as they will be typeset by TEX, are made known to METAFONT.

Between the two TEX passes, METAFONT draws the graphic figures and writes the label locations in its log file. So it is METAFONT's responsibility to locate the labels. Note that, depending on the style of METAFONT programming, this can be completely determined from TEX. In other words, you can relate the label location to the location and size of other METAFONT objects, or not.

So when TEX executes its second pass, it has to take the graphics from the new font and it has to read the location of labels from the METAFONT log file, but by then everything is complete.

Because labels are just `\hbox`es typeset by TEX, every macro currently defined for text automatically applies also to figures. For example, if a macro `\person` is defined to write its argument in a small caps font and save it to an index file, the same happens whenever it is used inside a figure label.

Methods

METATEX allows the source file to include, in addition to the customary TEX macros to control the text, other commands to generate figures with METAFONT.

Steps. In order to use METATEX the following three steps are to be executed:

1. The METATEX file, suppose it is `filename.ext`, is first processed by `TEX`, with the `plain` format, during which a METAFONT file named `auxiliar.mf` is created. This METAFONT file contains information provided by TEX concerning the size of the labels, so the `MF` program can delete this area from the figure if requested. If the output file `filename.dvi` were typeset now, it would have blanks in place of the figures, but otherwise be the same as the final document.
2. Then `MF`, with the `plain` format, is run on `auxiliar.mf`. As a result, information specifying where to typeset the labels is written in the log file, `auxiliar.log`. In addition, the metric file, `auxiliar.tfm`, and the generic format bitmap font, `auxiliar.329gf`, are created. On my system I have to process this `gf` file to get a `pk` file that my drivers can read,

so I execute the program GFtoPK on it, getting the packed bitmap font auxiliar.329pk. Please note three points. i) The number 329, referring to the resolution, varies according to the METAFONT mode. ii) The tfm and pk files must be in or moved to directories where programs can find them. iii) METATEX sets the METAFONT mode to localfont, thus assuming that localfont is assigned the appropriate name.

3. Lastly, filename.ext is again run through TEX. During this second run, both the font auxiliar containing the figures and the information explaining where to locate the labels are available, so the document is complete.

The figures fill exactly the same area in both the first and second TEX program runs, so references, indices and tables of contents, that need also two passes to be right, can take advantage of the two runs needed by METATEX.

Use. To use METATEX macros, they must be imported by writing in the source file:

```
\input metatex
```

This has to be written after \mag has been given its final value. When metatex.tex is read, METATEX checks whether file auxiliar.mf exists. If it does not exist, then everything is set for the first pass; for example, auxiliar.mf is opened for writing. If it does exist, then things are set for the second pass; for example, auxiliar.log is opened for reading. This means that if file auxiliar.mf is not deleted, then step 3, the second TEX program pass, is executed directly. This saves time when only the text in file filename.ext, but not the figures, were modified.

User macros. METATEX user macros are:

- \MTbeginchar(wd,ht,dp); states that a figure sized as shown, width wd, height ht and depth dp, will be created. These values should be known both by TEX and by METAFONT, so for example 12pt, 6cm, \the\hsize or \the\dimen0, always without #, are all right. During the *first pass*, TEX writes in auxiliar.mf the METAFONT macro beginchar assigning character codes sequentially, and box \MTbox is made empty but sized as specified by the arguments of this macro. During the *second pass*, TEX puts the corresponding character of the font auxiliar in box \MTbox. Box \MTbox size is that specified and it is not affected by the character dimensions.
- \MTendchar; finishes the figure definition. During the *first pass*, TEX writes the METAFONT macro endchar; in file auxiliar.mf. During the *second pass*, box \MTbox contains the complete figure, including labels. Something like \box\MTbox is used to typeset the figure.
- \MTlabel*(s)cc"Text"; adds a label to the current figure. The parameter between quotes, Text in the example, is the label content; it will be put inside an \hbox and therefore could be anything that TEX allows inside an \hbox. The optional asterisk after \MTlabel instructs METATEX to erase the area of the figure already drawn that it is under the label.

  The label will be located at METAFONT point z.s, s being the parameter between parentheses. The reference point is further specified by the optional parameter after the right parenthesis, cc in the example, as follows: it is composed of exactly two letters: the first can be t meaning top, c meaning center or b meaning bottom; and the second letter can be l meaning left, c meaning center or r meaning right. So, for example, tl means that the label reference point is its top left corner. The default value for the reference point is cc, that is, its center.

  \MTlabel should be used between \MTbeginchar and \MTendchar. During the *first pass*, it writes the following three elements in auxiliar.mf: i) the METAFONT macros which in turn cause MF to write the label reference point location to its log file, auxiliar.log; ii) the four label sides, which are by this means made available to the following METAFONT code for the figure, noted as y.s.t the top side, y.s.b the bottom side, x.s.l the left side and x.s.r the right side; and iii) the code to delete, if requested, the figure area already drawn that is under the rectangle occupied by the label. During the *second pass*, it adds the label to the box \MTbox in the place that reads from file auxiliar.log, making no modification to box \MTbox dimensions, even if the label is typeset outside the box.

There are three more macros for passing information to METAFONT, \MT:, \MTcode and \MTline; that is, for writing general text in file auxiliar.mf. This happens only during the first pass; during the second pass, these macros do nothing.

- \MT: writes in file auxiliar.mf everything till the end of line. It writes verbatim except for

the character \, which keeps its normal TEX \catcode of 0. Spaces are *not* ignored after macros. The sequence \\ writes a single \ in file auxiliar.mf.

- \MTcode writes in file auxiliar.mf everything until it finds a line equal (including \catcodes) to the current value of \MTendmark. By default, this is a blank line, thus, \def\MTendmark{}. As with \MT:, it writes verbatim except for \, which still operates as an escape character. The sequence \\ writes a single \ in file auxiliar.mf.
- \MTline{text} writes its parameter to auxiliar.mf, text in the example. It does not change the \catcodes in the argument, so it does not perform verbatim writing. But all plain special characters can be written prefixing them by an escape character \. The plain special characters are (not including the first colon nor the final period): \{}$&#^_~%. For example, \# will result in #.

When defining TEX macros that write to auxiliar.mf, \MTline should be used instead of \MT: or \MTcode because the latter two use the end of line in a special way that is not usually available when TEX is reading a macro.

TEX dimensions can be included using any of these three writing macros. For example, \the\hsize will be expanded to 225.0pt and written as such to the METAFONT file auxiliar.mf. Note that character \ keeps its escape \catcode in all three writing macros. In the case of \MTline, braces {} also keep their \catcodes and therefore macros with parameters can be used normally.

Examples

Diagram. First a typical example of METATEX usage, showing the file formats, programs, and their relationships. The figure width is exactly \hsize, but what is more important is that the same code will adapt itself to any value of the measure. Well, of course, not to *any* width but to any width between, let's say, 8 cm and 25 cm.

Figure 1 is the one column version, and Figure 2 (above the appendix) is the two column version, taken from the same source.

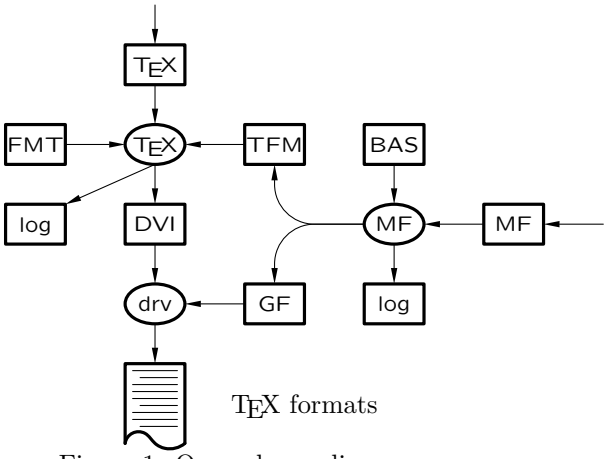


Figure 1: One column diagram

Shadowing. Both TEX and METAFONT are ill suited to creating shadows. In TEX, one straightforward technique is double use of \leaders, but in practice this results in huge dvi files. In METAFONT, drawing lots of tiny points easily exceeds the capacity of the program. The solution is to coordinate the work of both programs.

To create a big rectangular shadow we divide it into an array of $n \times m$ smaller rectangles. The smaller rectangles are all identical, so it is enough that METAFONT draws one shadow character for TEX to type a solid area repeating it.

To make easy the tasks of both TEX and METAFONT, the size of the shadow character has to be similar to that of normal characters, because both programs were designed to work easily with normal sized characters. So a good solution is to make the shadow character as big as possible but never wider nor higher than 16 pt.

For METATEX, each figure is a character. This causes problems with METAFONT when the figure is big and the resolution is high, because it cannot draw areas bigger than 4095×4095 pixels. This is not usually a problem working at 300 dpi. And it is never a problem with METAPOST, see the following section on PostScript. Another advantage of using PostScript is that you get a shadow simply by drawing a grey rule.

Keys. After the following METATEX macros:

```
% KEYS

\MTcode
def keybox =
 pickup pencircle scaled 0.8pt;
 x1 = x3 = 1pt;
 x2 = x4 = w - 1pt;
 x5 = 0; x6 = w;
```

```
 y1 = y2 = -d;
 y3 = y4 = h;
 y5 = y6 = (h - d)/2;
 draw z1 -- z2 .. z6{up} ..
    z4 -- z3 .. z5{down} .. cycle;
 z0 = (x1,0);
enddef;

\def\defkey#1#2{\setbox0=\hbox{\sf#2}%
 \dimen0=\wd0\advance\dimen0 by 2pt
 \dimen2=\ht0\advance\dimen2 by 1pt
 \dimen4=\dp0\advance\dimen4 by 1pt
 \MTbeginchar(\the\dimen0,%
              \the\dimen2,%
              \the\dimen4);%
 \MTline{ keybox;}%
 \MTlabel(0)bl"\sf #2";%
 \MTendchar;%
 \expandafter\newbox
  \csname\string#1box\endcsname
 \expandafter\setbox
  \csname\string#1box\endcsname
  =\vtop{\unvbox\MTbox}%
 \def#1{\expandafter\copy
  \csname\string#1box\endcsname}}

\def\makekey#1{\expandafter\defkey%
 \csname#1\endcsname{#1}}
```

Then, it is enough to declare `\makekey{Alt}` to typeset Alt just writing `\Alt`. It is also possible to declare `\defkey\escape{\tt\char92}` and then `\escape` results in \.

Baroque tables. Baroque periods are the result of new technical achievements providing unexplored possibilities and hence the urgent need to experiment with them, frequently far away from what discretion might recommend. This explains the time of baroque software that we live in, and increases the value of METATEX, because it provides the means to easily draw baroque tables. I am not a baroque man, so my baroque table example is not baroque but, and this is the point, it is not built with straight lines.

This is not a straight table
but it's only an example
and therefore not so ample
of what's METATEX-able!

Ornate paragraphs. Only if you are truly baroque can you get the most from METATEX. If, for example, you like ornate paragraphs, you are in your element. Just put the material in a `\vbox` to get the height and the depth, and pass these dimensions to METAFONT to draw a right sized embellishment. Ah!, but be aware that Computer Modern is a neoclassical font, so it won't mix well with your elaborations.

PostScript

Taking advantage of METAPOST, it is possible to get PostScript versions of the METATEX files. Simply execute `mpost &plain auxiliar.mf` instead of METAFONT and, after TEX's second pass, execute `dvips` (METATEX uses `dvips` specials). This works because file `auxiliar.mf` is valid code for both METAFONT and METAPOST, and because, in the second TEX pass, METATEX checks which one was used and adapts itself to the situation.

And thanks to PDFTEX and the CONTEXT files `supp-mis.tex` and `supp-pdf.tex`, it is also possible to get an Acrobat (`pdf`) version. Just execute PDFTEX twice, instead of TEX, and once METAPOST, instead of METAFONT. In fact, METATEX uses its own macro file `mptopdf.tex` for this, instead of the CONTEXT files. I extracted all that METATEX needs from the CONTEXT files into `mptopdf.tex`.

This works because, if METATEX determines that METAPOST was employed to draw the figures, it then checks which program, TEX or PDFTEX, is executing. If TEX, then it includes the files produced by METAPOST using the `dvips` specials. If PDFTEX, it translates from `ps` to `pdf`.

Therefore, the same METATEX source file generates at will any of the three output formats—`dvi`, `ps`, or `pdf`—just by running the appropriate programs. In the appendix, as an example, there is a DOS batch file that shows how to get the `pdf` version of a file `filename.ext`.

Final remarks

I have been using METATEX for some years. The first version was dated 1994, but it has been used only for personal purposes. For this reason, it is not truly a general end-user tool, as for example LATEX packages should be. It has to be used knowledgeably and with care. And though most tasks can be automated, by chaining TEX and METAFONT errors are even more difficult to pinpoint than in TEX or METAFONT alone.

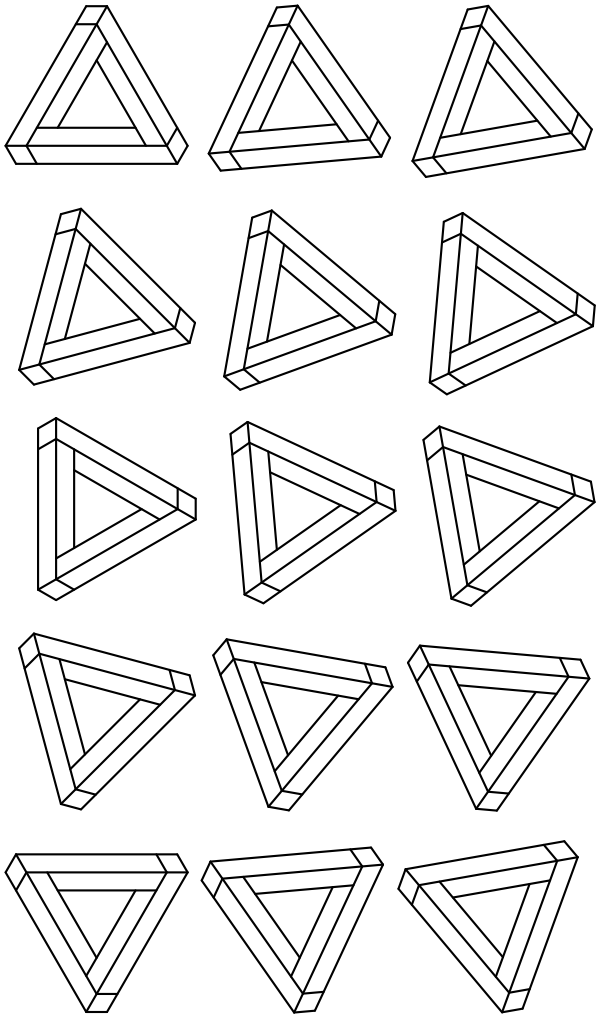
Nevertheless, METATEX serves to validate the feasibility of a closer collaboration between TEX and METAFONT and to appraise the interest of such a collaboration. And, of course, if you dare, you can get lots of fun, and at least an equal amount of frustration, using METATEX. Try it!

The METATEX package is available from CTAN in CTAN:`/macros/plain/contrib/metatex`.

Happy METATEXing!

◇ Ramón Casares
Telefónica de España
`r.casares@computer.org`

Exercise: take three equal bars and build as shown. Ask Roger Penrose if you don't find the solution.



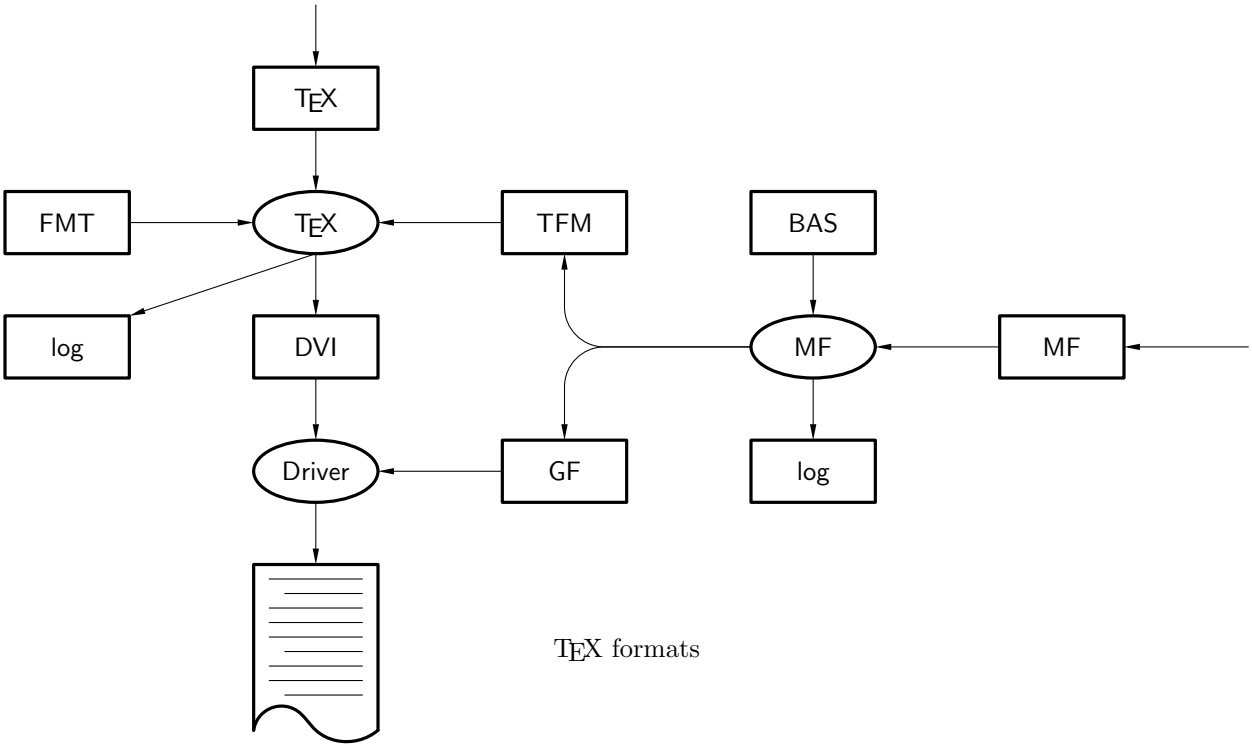


Figure 2: Two-column diagram

Appendix: Pseudo-batch example

This is an example based on DOS batch files that can be adapted for other operating systems. It processes the file `filename.ext`, generating `filename.pdf`. We will comment each line of pseudo-code.

1. We go to the directory where our working files are.
   ```
   cd c:\dir\subdir\mydir
   ```
2. We set environment variables (if necessary). In this case we are using a `web2c` system, so it is enough to set one. In `web2c`, by default, all programs look for files in the current dir, "`.`", and that is enough for us.
   ```
   set TEXMFCNF=c:\tex\texmf.local\web2c;c:\tex\texmf\web2c;d:\texmf\web2c
   ```
3. We tell the operating system where to find the programs.
   ```
   path=$path$;c:\tex\bin\dos
   ```
4. After the settings, we force the first TEX pass.
   ```
   if exist auxiliar.mf del auxiliar.mf
   ```
5. Execute the first TEX pass (in this case, it is PDFTEX).
   ```
   pdftex &plain filename.ext
   ```
6. If METATEX was not used, and no `auxiliar.mf` was written, then we are done.
   ```
   if not exist auxiliar.mf goto end
   ```
7. Otherwise we run METAPOST with its `&plain` memory (format), also known as `&mpost`.
   ```
   mpost &plain auxiliar.mf
   ```
8. Finally, we execute the second TEX pass.
   ```
   pdftex &plain filename.ext
   ```
9. We now have the complete `filename.pdf` file.
   ```
   :end
   ```