This is a list of all substantial corrections made to *Computers & Typesetting* since the publication of the second “Millennium Edition” at the close of the year 2001. (More precisely, it lists errors corrected since the 16th printing of Volume A, the 7th printing of Volume B, the 6th printing of Volume C, the 4th printing of Volume D, and the 5th printing of Volume E.) Corrections made to the softcover version of *The \TeX\book*, beginning with its 32nd printing, are the same as corrections to Volume A. Corrections to the softcover version of *The METAFONTbook*, beginning with its 11th printing, are the same as corrections to Volume C. Changes to the mini-indexes and master indexes of Volumes B, D, and E are not shown here unless they are not obviously derivable from what has been shown. Some (or all) of these errors have been corrected in the most recent printings.

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**Page A7, line 4 from the bottom**

(01/15/04)

since control sequences of the second kind always have exactly one symbol after

**Page A123, line 7 from the bottom**

(02/27/08)

that it won’t make the natural height-plus-depth of \texttt{\box n} surpass \texttt{\dimen n}, when it is

**Page A124, lines 12 and 13**

(02/27/08)

means that \TeX\ has tried to split an \texttt{\insert 254} to height 180.2 pt; the natural height-
plus-depth of the best such split is 175.3 pt, and the penalty for breaking there is 100.)

**Page A153, line 7**

(01/03/14)

of three fonts: one for text size, one for script size, and one for scriptscript size. The

**Page A206, lines 12-17**

(05/21/07)

or alignment template is also considered to be \texttt{\outer} in this sense; for example, a file
shouldn’t end in the middle of a definition. If you are designing a format for others to use, you can help them detect errors before too much harm is done, by using \texttt{\outer} with all control sequences that should appear only at “quiet times” within a document. For example, Appendix B defines \texttt{\proclaim} to be \texttt{\outer}, since a user shouldn’t be stating a theorem as part of a definition or argument or preamble.

**Page A216, line 3 from the bottom**

(12/20/07)

\texttt{\openin(number)=(file \name)}

**Page A290, lines 25–26**

(02/24/08)

- \texttt{\leaders/\box or rule/\horizontal skip}. Here \texttt{\horizontal skip} refers to one of the first five glue-appending commands just mentioned; the formal syntax for \texttt{\leaders}

**Page A292, line 15**

(12/02/02)

are defined as in the second alternative of a \texttt{\math field}, are recorded in a “choice
\def\appendroman#1#2#3{\expandafter\def\expandafter#1\expandafter{\csname expandafter\gobble\string#2\romannumeral#3\endsname}}

\def\if\space\next\ % assume that \next is unexpandable

\leavevmode\copy0\kern-\wd0\makelightbox

15.13. Yes, in severe circumstances. (1) Previous footnotes might have left no room for any more footnotes on the page. (2) If \vadjust{\eject} occurs on the same line

\def\loggingall\{\tracingcommands=2 \tracingstats=2
  \tracingpages=1 \tracingoutput=1 \tracinglostchars=1
  \tracingmacros=2 \tracingparagraphs=1 \tracingrestores=1
  \showboxbreadth=\maxdimen \showboxdepth=\maxdimen\}
\def\tracingall\{\tracingonline=1 \loggingall\}

\def\fmtversion{3.141592653} % identifies the current format

And here's another solution (which may be faster, because token list registers can be expanded more quickly than macros on some implementations, using \the):

\loop \ifnum\m>0 \t=\expandafter{\the\t}\advance\m-1 \repeat
Finally, the reformatting of \footnotes can be achieved easily with an elegant technique suggested by David Kastup, using the following \TeX code within the \output routine:

\def\makemakefootnoteparagraph{\unvbox\footnotes \baselineskip=\footnotebaselineskip \removehboxes \def\removehboxes{\unskip\setbox0=\lastbox \ifhbox0{\removehboxes}\unhbox0 \else\noindent \fi}

The key idea here is \removehboxes, a macro that has the magical ability to take a vertical box such as \`\vbox{\box1\box2\box3\removehboxes}' and transform it into \`\vbox{\noindent\unhbox1\unhbox2\unhbox3}', if \box1, \box2, and \box3 are \hboxes. Notice how \removehboxes introduces braces so that \TeX's save stack will hold all of the \hboxes before they are unboxed. Each level of recursion in this routine uses one cell of input stack space and three cells of save stack space; thus, it is generally safe to do more than 100 footnotes without exceeding \TeX's capacity.

In our application there is no interline glue within \footnotes, so the \unskip command could be deleted from \removehboxes.

Incidentally, the \unskip and \lastbox operations have running times of the approximate form \( a + mb \), where \( m \) is the number of items efficiency on the list preceding the glue or box that is removed. Hence \removehboxes has a running time of order \( n^2 \) when it removes \( n \) boxes. But the constant \( b \) is so small that for practical purposes it is possible to think of \unskip and \lastbox as almost instantaneous.

---

Page A416, lines 18–22

\begin{verbatim}
\def\leftheadline{\hbox to \pagewidth{\spaceskip=0pt \\
vbox to 10pt}{% strut to position the baseline \\
lap[\tenbf{\folio}{kermlp}]{\% folio to left of text \\
\tenit{head}{\hfill} }{\% running head flush left \\
\def\rightheadline{\hbox to \pagewidth{\spaceskip=0pt\vbox to 10pt}{}}}
\end{verbatim}

---

Page A418, line 8 from the bottom

\begin{verbatim}
\def\{3\} \advance\hsize by -18mm
\end{verbatim}

---

Page A418, line 3 from the bottom

\begin{verbatim}
\halign{line{\titlefont{hss#}}\{}\{4\}unskip\}}
\end{verbatim}

---

Page A442, lines 7 and 8 from the bottom

3. If the current item is a style change, set C to the specified style and move on to the next item.
Page A450, lines 14–16 from the bottom (12/19/02)

\texttt{static \_exp x3p pi3a 21a i2al 2id 1do 1ci 2io ou2 2us}

(\texttt{where subscripts that aren't shown are zero}), and this yields

\texttt{.080u1p0\sigma r1c0\alpha l1i0f0r0\alpha g1\i0l4i0s1t2i0c1e0x3p2i3a0l2i1d001c2i02ou2s0.}

Page A458, left column (01/11/07)
\texttt{\backslash, 38, 356, 378, 418.}

Page A459, left column (03/17/06)
\texttt{angle brackets (\textit{\textbackslash} \textbackslash \textit{\textbackslash}), 59, 146–147, 150, 156,}
\texttt{265, 420, 437; see also \textit{\textbackslash angle}, \textit{\textbackslash angle}.}

Page A461, left column (02/24/08)
\texttt{\texttt{\backslash boxit}, 223, 331.}

Page A468, right column (02/26/08)
\texttt{interline glue, 78–79, 90, 104, 105, 125, 221,}
\texttt{245, 263, 281–282, 335, 352, 399, 409.}

Page A469, left column (02/26/08)
Kastrup, David Friedrich, 399.

Page A470, left column (01/21/03)
\texttt{\texttt{\backslash logging11, 361.}}

Page A477, right column (06/08/07)
\texttt{*\texttt{\backslash spaceskip}, 76, 274, 317, 356, 416, 429.}

Page A479, right column (09/11/07)
\texttt{\texttt{\backslash undefined}, 350, 384.}

Page A483, line 5 from the bottom (11/18/03)

\texttt{--- HIERONYMUS HORN SCHUCH, Οὐρσπηνοροφίας (1608)}

Page Bv, page number change (12/27/11)
\texttt{[For consistency with Volumes A, C, and E, the preface now begins on page v instead of page vii. This change was first made in the ninth printing.]}

Page Bv (formerly Bvi), bottom two lines (01/06/14)
\texttt{all of those changes. I now believe that the final bug was discovered on 14 September 2008}
\texttt{and removed in version 3.14159265. The finder's fee has converged to $27.68.}
Page Bxiii (formerly Bxv), line −7  
Format specs have no effect on the corresponding Pascal program, but they do influence

Page B2, line 10 from the bottom  
\[ \text{define} \ \text{banner} \equiv \text{"This is your \TeX \ Version \ 3.14159265"} \quad \{ \text{printed when \TeX \ starts} \} \]

Page B3, new paragraph to follow line 9  
Incidentally, Pascal's standard \textit{round} function can be problematical, because it disagrees with the IEEE floating-point standard. Many implementors have therefore chosen to substitute their own home-grown rounding procedure.

Page B21, lines 33 and 34  
\[
\begin{align*}
\{41 \ldots 46', 60 \ldots 71', 136, 141 \ldots 146', 160 \ldots 171\} \text{ must be printable. Thus, at least 81 printable characters are needed.}
\end{align*}
\]

Page B109, line 16  
\begin{verbatim}
begin print_esc("csname"); print_esc("endsname"); print_char(" "); end
\end{verbatim}

Page B114, line 25  
\begin{verbatim}
\text{define} \ \text{saw_index}(\#) \equiv \text{saw_stack[\#].hh} \quad \{ \text{eqib location or token or saw_stack location} \}
\end{verbatim}

Page B139, line 20  
\begin{verbatim}
begin while \text{(state = token_list) \land (loc = null) \land (token_type \neq v\_template)} \ do
\text{end token_list; \{ conserve stack space} \end{verbatim}

Page B144, line 14  
\begin{verbatim}
\text{cat: 0 .. max_char_code; \{ cat_code(cur_char), usually} \end{verbatim}

Page B153, lines 2 and 3  
In fact, these three procedures account for almost every use of \textit{get\_next}.

Page B161, line 19  
\begin{verbatim}
while \text{(state = token_list) \land (loc = null) \land (token_type \neq v\_template)} \ do
\text{end token_list; \{ conserve stack space} \end{verbatim}

Page B163, line 20  
\begin{verbatim}
long_state \leftarrow \text{call}; \text{cur_fok} \leftarrow \text{par_token}; \text{ins_error; goto continue;} \end{verbatim}
else if \( m = \text{vmode} \) then \( \text{scanned\_result} (\text{prev\_depth})(\text{dimen\_val}) \)

\[
\text{cur\_val} \leftarrow 0; \quad \text{cur\_val\_level} \leftarrow \text{int\_val}; \quad \text{radix} \leftarrow 0; \quad \text{cur\_order} \leftarrow \text{normal};
\]

and denominator sum to 32768 or less. According to the definitions here, 2660dd \( \approx 1000.33297 \) mm;

used input files like \texttt{webmac.tex}.

The following procedures don’t allow spaces to be part of file names; but some users seem to like names that are spaced-out. System-dependent changes to allow such things should probably be made with reluctance, and only when an entire file name that includes spaces is “quoted” somehow.

if \((nw = 0) \lor (nh = 0) \lor (nd = 0) \lor (ni = 0)\) then abort;
Page B260, line 21

\[
\text{else begin } \text{lz} \leftarrow \text{lr \text{ div} (lq + 1);}
\]

Page B261, line 9

\[
\begin{align*}
cur_{\text{glue}} & \text{ real; } \{ \text{glue seen so far} \} \\
cur_{\text{g}} & \text{ scaled; } \{ \text{rounded equivalent of } cur_{\text{glue}} \times \text{the glue ratio} \}
\end{align*}
\begin{align*}
\text{begin} & \quad \text{cur}_{\text{g}} \leftarrow 0; \quad \text{cur}_{\text{glue}} \leftarrow \text{float}_{\text{constant}}(0); \\
& \quad \text{this}_{\text{box}} \leftarrow \text{temp}_{\text{ptr}}; \quad \text{gorder} \leftarrow \text{glue}_{\text{order}}(\text{this}_{\text{box}}); \quad \text{gsign} \leftarrow \text{glue}_{\text{sign}}(\text{this}_{\text{box}});
\end{align*}
\]

Page B262, line 10 from the bottom

\[
\begin{align*}
\text{begin} & \quad g \leftarrow \text{glue}_{\text{ptr}}(p); \quad \text{rule}_{\text{ht}} \leftarrow \text{width}(g) - \text{cur}_{\text{g}};
\end{align*}
\]

Page B262, line 6 from the bottom

\[
\begin{align*}
\text{begin} & \quad \text{cur}_{\text{glue}} \leftarrow \text{cur}_{\text{glue}} + \text{stretch}(g); \quad \text{vet}_{\text{glue}}(\text{float}(\text{glue}_{\text{set}}(\text{this}_{\text{box}})) \times \text{cur}_{\text{glue}});
\end{align*}
\begin{align*}
& \quad \text{cur}_{\text{g}} \leftarrow \text{round}(\text{glue}_{\text{temp}});
\end{align*}
\]

Page B262, line 2 from the bottom

\[
\begin{align*}
\text{begin} & \quad \text{cur}_{\text{glue}} \leftarrow \text{cur}_{\text{glue}} - \text{shrink}(g); \quad \text{vet}_{\text{glue}}(\text{float}(\text{glue}_{\text{set}}(\text{this}_{\text{box}})) \times \text{cur}_{\text{glue}});
\end{align*}
\begin{align*}
& \quad \text{cur}_{\text{g}} \leftarrow \text{round}(\text{glue}_{\text{temp}});
\end{align*}
\]

Page B263, new line to precede old line 2

\[
\text{rule}_{\text{ht}} \leftarrow \text{rule}_{\text{ht}} + \text{cur}_{\text{g}};
\]

Page B264, line 10

\[
\begin{align*}
\text{else begin} & \quad \text{lx} \leftarrow \text{lr \text{ div} (lq + 1);}
\end{align*}
\]

Page B266, line 29

\[
\text{total}_{\text{pages}} \geq 65536, \text{the DVI file will lie. And if } \text{max}_{\text{push}} \geq 65536, \text{the user deserves whatever chaos might ensue.}
\]

Page B279, line 19

\[
\begin{align*}
p & \text{ pointer; } \{ \text{a new glue node} \}
\end{align*}
\]

Page B288, lines 18–20

\[
\begin{align*}
\text{left}_{\text{node}} & \text{ begin } \text{print}_{\text{esc}}(\text{"left"); } \text{print}_{\text{delimiter}}(\text{delimiter}(p)); \\
& \text{ end;}
\end{align*}
\begin{align*}
\text{right}_{\text{node}} & \text{ begin } \text{print}_{\text{esc}}(\text{"right"); } \text{print}_{\text{delimiter}}(\text{delimiter}(p));
\end{align*}
\]

Page B290, line 12

\[
\begin{align*}
\text{begin if } s = \text{text}_{\text{size}} \text{ then } \text{print}_{\text{esc}}(\text{"textfont");}
\end{align*}
\]
Page B299, line 9 (12/20/02)

\[
\text{if } \text{type}(r) = \text{kern}_{-}\text{node} \text{ then} \quad \{ \text{unneeded italic correction} \}
\]

Page B332, line 6 (12/19/02)

is being scanned, or when no alignment preamble is active.

Page B332, line 8 (12/19/02)

\[
\text{begin if } (\text{scanner}_{-}\text{status} = \text{aligning}) \lor (\text{cur}_{-}\text{align} = \text{null}) \text{ then}
\]

Page B336, line 11 from the bottom (10/13/03)

\[ j - i + \text{min}_{-}\text{quarterword} \] in their link fields. The values of \( w_{ii} \) were initialized to \text{null}_{-}\text{flag}.

Page B342, lines 5 and 6 (09/11/07)

In restricted horizontal mode, the \text{clang} part of aux is undefined; an over-cautious Pascal runtime system may complain about this.

Page B416, line 22 (02/29/08)

\[
\text{if } \text{count}(t) = 1000 \text{ then } t \leftarrow \text{height}(r) \\
\text{else } t \leftarrow \text{over}_{-}\text{un}(\text{height}(r), 1000) \ast \text{count}(t); \\
\text{print}_{-}\text{scaled}(t)
\]

Page B438, lines 1–3 (09/11/07)

\textbf{1035.} If \text{link}(\text{cur}_{-}\text{q}) is nonnull when \text{wrapup} is invoked, \text{cur}_{-}\text{q} points to the list of characters that were consumed while building the ligature character \text{cur}_{-}\text{q}.

Page B438, lines 19 and 20 (09/11/07)

\[
\text{begin if } \text{link}(\text{cur}_{-}\text{q}) > \text{null} \text{ then} \\
\text{if } \text{character}(\text{tail}) = q(\text{hyphen}_{-}\text{char}[\text{main}_{-}\text{f}]) \text{ then } \text{ins}_{-}\text{disc} \leftarrow \text{true};
\]

Page B438, line 4 from the bottom (09/11/07)

\text{link}(\text{tail}) \leftarrow \text{lig}_{-}\text{stack}; \text{tail} \leftarrow \text{lig}_{-}\text{stack} \quad \{ \text{main}_{-}\text{loop}_{-}\text{lookahead} \text{ is next} \}

Page B439, line 3 (09/11/07)

\text{if } \text{main}_{-}\text{p} > \text{null} \text{ then } \text{tail}_{-}\text{append}(\text{main}_{-}\text{p}); \quad \{ \text{append a single character} \}

Page B440, new line to follow line 9 (09/11/07)

\text{if } \text{cur}_{-}\text{r} = \text{non}_{-}\text{char} \text{ then } \text{goto } \text{main}_{-}\text{loop}_{-}\text{wmpad};

Page B452, line 18 (28/03/11)

\textit{lmode}, where the latter two are used to denote \texttt{vbox} and \texttt{hbox}, respectively.
if \( ((\text{cmd} = \text{hskip}) \land (\text{abs} = \text{mode} \neq \text{vmode})) \lor ((\text{cmd} = \text{vskip}) \land (\text{abs} = \text{mode} = \text{vmode})) \) then

A devious user might force an \texttt{endv} command to occur just about anywhere; we must defeat such hacks.

begin base_ptr ← input_ptr; input_stack[base_ptr] ← cur_input; while \((\text{input\_stack}[\text{base\_ptr}], \text{index\_field} \neq \text{v\_template}) \land (\text{input\_stack}[\text{base\_ptr}], \text{loc\_field} = \text{null}) \land (\text{input\_stack}[\text{base\_ptr}], \text{state\_field} = \text{token\_list})\) do decr(base_ptr); if \((\text{input\_stack}[\text{base\_ptr}], \text{index\_field} \neq \text{v\_template}) \lor (\text{input\_stack}[\text{base\_ptr}], \text{loc\_field} \neq \text{null}) \lor (\text{input\_stack}[\text{base\_ptr}], \text{state\_field} \neq \text{token\_list})\) then fatal_error(\(\text{‘(interwoven\_alignment\_preambles\_i\_are\_not\_allowed)’}\)); if cur_group = align\_group then

("since the result is out of range."); if \(p \geq \text{glue\_val}\) then delete\_glue\_ref(cur\_val); error; return;

1237. Here we use the fact that the consecutive codes \texttt{int\_val .. mu\_val} and \texttt{assign\_int ..}

says, for example, ‘\texttt{(preloaded\_format=plain 1982.11.19)}’, showing the year, month, and day

if last\_glue = max\_halfword then delete\_glue\_ref(last\_glue);

the area below the bar to the area above it equal to \((\sqrt{5} + 1)/2 \approx 1.61803\), the
Page C29, illustration for exercise 4.11 (09/09/01)
[points 2 and 5 should not be labeled twice]

Page C32, line 5 from the bottom (01/04/14)

\[ \text{penpos}1(\text{stem}, 15); \text{penpos}2(.9\text{stem}, 12); \text{penpos}3(\text{stem}, 10); \]

Page C36, line 5 from the bottom (01/05/14)
line 12, where it says ‘x11’, not ‘x11’ or ‘x11’); be sure to distinguish between

Page C55, lines 5 and 6 (01/05/14)
suffixed or subscripted. Thus, the syntax rule for \{variable\} should actually be replaced
by a slightly more complicated pair of rules:

Page C129, line 16 (02/21/08)

\( \langle \text{path subexpression} \rangle \rightarrow \langle \text{path expression not ending with direction specifier} \rangle \)

Page C130, lines 13-15 from the bottom (09/13/03)
point but not after it, the nonempty one is duplicated in a similar way. A basic path
join ‘.. controls \( u \) and \( v \).’ specifies explicit control points that override any direction
specifiers that may immediately surround it.

Page C137, lines 5-7 from the bottom (02/21/08)

\( \hat{\gamma} \) Let’s conclude this chapter by applying what we’ve learned about paths to a
real-life example. The Journal of Algorithms was published for many years
by Academic Press, and its cover page carried the following logo, which was designed

Page C137, bottom two lines (02/21/08)
A METAFONT program to produce this logo made it possible for the editors of the
journal to use it on letterheads in their correspondence. Here is one way to do that job,

Page C156, line 15 from the bottom (09/09/01)
be the values they had upon entry to the group.)

Page C159, lines 12-15 (12/01/06)

\begin{verbatim}
def --- = ..tension infinity.. enddef;
\end{verbatim}

it makes ‘\( z_1 --- z_2 \)’ become ‘\( z_1 . . \text{tension infinity} . . z_2 \)’. The replacement text
can be any sequence of tokens not including ‘enddef’; or it can include entire
subdefinitions like ‘\def ... enddef\’; according to certain rules that we shall
explain later.
Page C171, line 16 from the bottom (06/18/02)

(loop) \rightarrow (loop header): (loop text) \texttt{endfor}

Page C179, line 7 from the bottom (09/09/01)

next time METAFONT gets to the end of an input line, it will stop reading from the

digits should be a file name that works in essentially the same way on all installations
of METAFONT. Uppercase letters are considered to be distinct from their lowercase
counterparts, on many systems.

Page C180, lines 14-16 (04/25/03)

- When METAFONT is reading the symbolic tokens to be saved by \texttt{save}.

Page C203, line 12 from the bottom (04/25/03)

point 3 at the right of the triangle might digitize into a

Page C213, line 26 (02/21/08)

(path subexpression) \rightarrow (path expression not ending with direction specifier)

Page C226, line 23 (02/21/08)

following nineteen things will be mentioned:

Page C226, new line to be second from the bottom (02/21/08)

\texttt{independent variables} \quad (distinct numeric variables)

Page C236, line 7 from the bottom (01/05/14)

7.4. False. After `newinternal x;' you can’t say `x(tag)' in a \texttt{(suffix list)}.

Page C246, line 12 (02/21/08)

is performed whenever METAFONT uses the last two alternatives in the definition

Page C250, lines 13 and 14 (02/19/08)

19.3. Yes, if and only if \( n - \frac{1}{2} \) is a nonnegative even integer. (Because ambiguous
values are rounded upwards.)

Page C250, line 12 from the bottom (04/25/03)

following (boolean primary).)
problem; it would simply have put ENDFOR into the replacement text of \texttt{ast}s, because

\begin{verbatim}
if if pair x: x>(0,0) else: false fi: A else: B fi.
\end{verbatim}

be known by saying ‘if known \(p - q\): \(p = q\) else: \texttt{false fi}; transforms could be handled

given angle \(\phi\). We can consider the common angle \(\theta\) of \(z_{1r} - z_{1t}\) and \(z_{0r} - z_{0t}\) to be

‘b’ was shipped out.) The second letter, ’o’, is placed in a second little box adjacent

\textit{— CAROLUS LINNAEUS, Philosophia Botanica (1751)}

(The proofsheet resolution will be 50 pixels per inch, because cheapo has 200 pixels per


\texttt{angle}, 29, 67, 72, 107, 135, 211, 238.

arccosine, arcsine, arctangent, see \texttt{angle}.

independent variables, 81–83, 88, 224, 226.

Linné, Carl von [= Linnaeus, Carolus], 325.

Page Dv, page number change  
(12/27/11)

[For consistency with Volumes A, C, and E, the preface now begins on page v instead of page vii. This change was first made in the sixth printing.]

Page Dv (formerly Dvii), bottom two lines  
(01/06/14)

corporates all of those changes. I now believe that the final bug was discovered on 03 June 2008, and removed in version 2.7182818. The finder’s fee has converged to $327.68.

Page Dxi (formerly Dxv), line -7  
(12/27/11)

Format specs have no effect on the corresponding Pascal program, but they do influence

Page D2, line -17  
(01/03/14)

define banner \"This is META\n-Version 2.7182818\" \{ printed when META starts \}

Page D2, lines 4 and 5 from the bottom  
(12/23/02)

types; there are no \texttt{var} parameters, except in the case of files or in the system-dependent \texttt{paint_row} procedure; there are no tag fields on variant records; there are no \texttt{real} variables; no procedures are declared local to other procedures.)

Page D16, new paragraph to follow line 26  
(06/25/04)

The first line is special also because it may be read before META has input a base file. In such cases, normal error messages cannot yet be given. The following code uses concepts that will be explained later. (If the Pascal compiler does not support non-local \texttt{goto}, the statement \texttt{goto final_end} should be replaced by something that quietly terminates the program.)

Page D22, line 26  
(09/11/07)

ASCII codes [‘60 . . 71, ‘136, ‘141 . . ‘146] must be printable.

Page D31, line 29  
(06/25/04)

This is the only nontrivial \texttt{goto} statement in the whole program. It is used when there is no

Page D42, replacement for lines 8–13  
(12/23/02)

Notice that if 64-bit integer arithmetic were available, we could simply compute \((2^{29} * p + q)\) \texttt{div} (2 * q). But when we are restricted to Pascal’s 32-bit arithmetic we must either resort to multiple-precision maneuvering or use a simple but slow iteration. The multiple-precision technique would be about three times faster than the code adopted here, but it would be comparatively long and tricky, involving a number of multiplication and divisions.

Page D43, line 20  
(12/23/02)

language or 64-bit substitute is advisable.
Page D44, lines 24–26

Once again it is a good idea to use 64-bit arithmetic if possible; otherwise take_scaled will use more than 2% of the running time when the Computer Modern fonts are being generated.

Page D58, line 16 from the bottom

\begin{verbatim}
if j_random = 0 then new_randoms else decr(j_random)
\end{verbatim}

Page D63, line 21

Locations of mem between mem_min and mem_top may be dumped as part of preloaded base

Page D75, line 13

\begin{verbatim}
define fi_or_else = 2  { delimiters for conditionals elseif, else, fi }
\end{verbatim}

Page D76, line 5

\begin{verbatim}
define type_name = 30  { declare a type (numeric, pair, etc.) }
\end{verbatim}

Page D77, line 16

\begin{verbatim}
define big_kern_token = \kern  { the operators 'kern' and '='; and '=':1', etc. }
\end{verbatim}

Page D98, bottom two lines

They consist of zero or more parameter tokens followed by a code for the type of macro.

Page D101, line 3

METAFONT user assigns a type to a variable like \texttt{x2oa.b} by saying, for example, \texttt{‘boolean x[] a.b’}.

Page D102, lines 10–16

variable that is relevant when no attributes are attached to the parent. The \emph{attr_head} node has the fields of either a value node, a subscript node, or an attribute node, depending on what the parent would be if it were not structured; but the subscript and attribute fields are ignored, so it effectively contains only the data of a value node. The \emph{link} field in this special node points to an attribute node whose \emph{attr_loc} field is zero; the latter node represents a collective subscript \texttt{[\ ]} attached to the parent, and its \emph{link} field points to the first non-special attribute node (or to \texttt{end_attr} if there are none).

Page D102, lines 7 and 8 from the bottom

\begin{verbatim}
subscr_head(ql) = qq1; qq is a three-word “attribute-as-value” node with type(qq) = numeric_type (assuming that x5 is numeric, because qq represents ‘x[]’ with no further attributes), name_type(qq) = structured_root, attr_loc(qq) = 0, parent(qq) = p,
\end{verbatim}
The value of variable x20b appears in node qqq2 = link (qqq1), as you can well imagine. Similarly, the value of 'x.a.' appears in node q2 = link(q1), where attr_joc(q2) = h(a) and parent(q2) = p.

Such save stack entries are generated by &save commands.

If \( \theta_0 \) is supposed to have a given value \( E_0 \), we simply define \( C_0 = 1 \), \( D_0 = 0 \), and \( R_0 = E_0 \).

for the bisected interval are \( z'_0 = z_0 \) and \( z''_0 = z_0 + (Z'_1 + Z'_2 + \cdots + Z'_n)/2^{k+1} \).

out to hold if and only if \( x_0 \leq x_1 \) and \( x_2 \leq x_3 \), and either \( x_1 \leq x_2 \) or \( (x_1-x_2)^2 \leq (x_1-x_0)(x_3-x_2) \).

For example, if we start with \((x_1 - x_0, x_2 - x_1, x_3 - x_2) = (X_1, X_2, X_3) = (7, -16, 39)\), the

monotonic cubic, then \( B(x_0, x_1, x_2, x_3; \frac{1}{2}) \) is always between \( .06[x_0, x_3] \) and \( .94[x_0, x_3] \); and it is impossible for \( \hat{x} \) to be within \( \epsilon \) of such a number. Contradiction! (The constant \( .06 \) is actually \( 2 - \sqrt{3} \)/4; the worst case occurs for polynomials like \( B(0, 2 - \sqrt{3}, 1 - \sqrt{3}, 3; t) \).)

\[\text{cur_x, cur_y: scaled: \{} \text{ outputs of skew, unskew, and a few other routines } \}\]

399. If the segment numbers on the cycle are \( t_1, t_2, \ldots, t_m \), and if \( m \leq \text{max quarterwont} \), we have \( t_{k-1} \leq t_k \) except for at most one value of \( k \). If there are no exceptions, \( f \) will point to \( t_1 \); otherwise it will point to the exceptional \( t_k \).

\[\text{chopped: integer: \{} \text{ positive if data truncated, negative if data dangerously large } \}\]
Page D184, line 25  
\[
\text{if } (\text{internal}[\text{autorounding}] > 0) \land (\text{chopped} = 0) \text{ then } \text{xy\_round};
\]

Page D184, line 27  
\[
\text{if } (\text{internal}[\text{autorounding}] > \text{unity}) \land (\text{chopped} = 0) \text{ then } \text{diag\_round};
\]

Page D184, line 32  
\[
\text{if } (\text{internal}[\text{autorounding}] \leq 0) \lor (\text{chopped} \neq 0) \text{ then } \text{print\_spec(\text{"\_after\_subdivision"})}
\]

Page D185, lines 15–19  
\[
\text{define } \text{procrustes}(\#) \equiv \text{if } \text{abs}(\#) \geq \text{dmax} \text{ then}
\]
\[
\text{if } \text{abs}(\#) > \text{max\_allowed} \text{ then}
\]
\[
\text{begin chopped } \leftarrow 1;
\]
\[
\text{if } \# > 0 \text{ then } \# \leftarrow \text{max\_allowed} \text{ else } \# \leftarrow -\text{max\_allowed};
\]
\[
\text{end}
\]
\[
\text{else if chopped } = 0 \text{ then chopped } \leftarrow -1
\]

Page D185, old line 22  
\[
p \leftarrow \text{cur\_spec}; k \leftarrow 1; \text{chopped} \leftarrow 0; \text{dmax} \leftarrow \text{half}(\text{max\_allowed});
\]

Page D185, old line 28  
\[
\text{if chopped} > 0 \text{ then}
\]

Page D196, lines 3–8  
\[
The \text{first job is to fix things so that } x(t) \text{ plus the horizontal pen offset is an integer multiple of the current \text{"granularity\" when the derivative } x'(t) \text{ crosses through zero. The given cyclic path contains regions where } x'(t) \geq 0 \text{ and regions where } x'(t) \leq 0. The } \text{quadrant\_subdivide} \text{ routine is called into action before any of the path coordinates have been skewed, but some of them may have been negated. In regions where } x'(t) \geq 0 \text{ we have } \text{right\_type} = \text{first\_octant} \text{ or } \text{right\_type} = \text{eighth\_octant}; \text{ in regions where } x'(t) \leq 0, \text{ we have } \text{right\_type} = \text{fifth\_octant} \text{ or } \text{right\_type} = \text{fourth\_octant.}
\]

Page D196, lines 15 and 16  
\[
\text{current pen might be unsymmetric in such a way that } x \text{ coordinates should round differently in different parts of the curve. These considerations imply that round}(x_0)
\]

Page D200, line 4  
\[
\text{and that there are similar ways to address other important offsets.}
\]
\[
\text{[Also delete the definitions of } \text{north\_south\_edge, etc., on lines 11–15; those definitions are never used.]}\]
at \((x_0, y_0)\) and ends at \((x_1, y_1)\), it’s possible to prove (by induction on the length of the truncated

we list it twice (with coordinates interchanged, so as to make the second octant look like

\[
w_2 \ w_2 \ w_2 \mapsto (\ -5,6 \ -5,6 \ -5,6)\]

as the list of transformed and skewed offsets to use when curves that travel in the second octant. Similarly, we will have

\[
\begin{align*}
w_2 \ w_2 \ w_2 &\mapsto (7, -6) \ (7, -6) \ (7, -6) & \text{in the third;} \\
w_2 \ w_2 \ w_3 &\mapsto (-7, 1) \ (-7, 1) \ (-3, 2) \ (-3, 2) & \text{in the fourth;} \\
w_3 \ w_3 \ w_3 &\mapsto (3, -2) \ (3, -2) \ (3, -2) & \text{in the fifth;} \\
w_3 \ w_3 \ w_0 \w_0 &\mapsto (-3, 1) \ (-3, 1) \ (1, 0) \ (1, 0) & \text{in the sixth;} \\
w_0 \ w_0 \ w_0 &\mapsto (1, 0) \ (1, 0) \ (1, 0) & \text{in the seventh;} \\
w_0 \ w_0 \ w_0 &\mapsto (-1, 1) \ (-1, 1) \ (-1, 1) & \text{in the eighth.}
\end{align*}
\]

count followed by pointers to the eight offset lists, followed by an indication of the pen’s range

The \textit{link} field of a pen header node should be \textit{null} if and only if the pen is a single point.

\textit{endpoint}. The cubics all have monotone-nondecreasing \(x(t)\) and \(y(t)\).

In odd-numbered octants, the numerator and denominator of this fraction will be nonnegative; in even-numbered octants they will both be nonpositive. Furthermore we always have \(0 = s_0 \leq s_1 \leq \cdots \leq s_n = \infty\). The goal of \textit{offset_prep} is to find an offset index \(k\) to associate with each cubic, such that the slope \(s(t)\) of the cubic satisfies

\[
\text{if } \textit{abs}(du) \geq \textit{abs}(dv) \text{ then } \{ s_{k-1} \leq 1 \ \text{or} \ \ s_k \leq 1 \}
\]

and return towards \(s_{k-1}\) or \(s_k\), respectively, yielding another solution of (*).
dinate fields. Hence, for example, the point 
\((x_{\text{coord}}(p) - \text{left}_{\text{w}}(q), y_{\text{coord}}(p) + \text{right}_{\text{w}}(p))\) also

the \(x\)-axis at the point \(((a^2 - \xi^2)\sin\theta\cos\theta/p) + ip\), where \(p = \sqrt{(a\sin\theta)^2 + (b\cos\theta)^2}\). It reaches furthest to the right of the \(y\)-axis at the point \(\sigma + i(a^2 - b^2)\sin\theta\cos\theta/\sigma\), where \(\sigma = \)

\[\text{else begin beta} \leftarrow \text{minor_axis}; \text{gamma} \leftarrow \text{major_axis}; \text{theta} \leftarrow 0;\]

536. Only the coordinates need to be copied, not the class numbers and other stuff. At this point either \(\text{link}(p)\) or \(\text{link(link}(p))\) is \text{null}.

done: if (\text{link}(p) \neq \text{null}) then 
\text{free_node(} \text{link}\text{)}(p), \text{knot_node}\text{);}
\text{link}(p) \leftarrow s; \text{beta} \leftarrow -y_{\text{coord}}(h);\]

we have \(2^\delta u_{\text{min}} = 2^\delta u_0 + U_{\text{min}}, \text{etc.; the condition for overlap reduces to}\)

tol: integer; \{ bound on the uncertainty in the overlap test \}

\(\text{uu} \leftarrow \text{uu} + \text{int}_{\text{packets}}; \{ \text{switch from } L_{\text{packets}} \text{ to } R_{\text{packets}} \}\)
\text{decr(cur}_{\text{p}}); \text{xy} \leftarrow \text{xy} - \text{int}_{\text{packets}}; \{ \text{switch from } R_{\text{packets}} \text{ to } L_{\text{packets}} \}

\(\text{xy} \leftarrow \text{xy} + \text{int}_{\text{packets}}; \{ \text{switch from } L_{\text{packets}} \text{ to } R_{\text{packets}} \}\)

\text{begin if serial}_{\text{no}} > e_{\text{Longo}} - s_{\text{scale}} \text{ then }
\text{overflow("independent}_{\text{u}} \text{ variables", serial}_{\text{no}} \text{ div } s_{\text{scale}}\};
\text{type}(\#) \leftarrow \text{independent}; \text{serial}_{\text{no}} \leftarrow \text{serial}_{\text{no}} + s_{\text{scale}}; \text{value}(\#) \leftarrow \text{serial}_{\text{no}};\]

\text{670. We go to restart instead of to switch, because we might enter } token_{\text{state}} \text{ after the error
728. A suffix or text parameter will have been scanned as a token list pointed to by \texttt{cur.exp},

\texttt{cur.type = unknown boolean} means that \texttt{cur.exp} points to a capsule node that is in a ring of equivalent booleans whose value has not yet been defined.

\texttt{cur.type = unknown string} means that \texttt{cur.exp} points to a capsule node that is in a ring of equivalent strings whose value has not yet been defined.

\texttt{cur.type = unknown pen} means that \texttt{cur.exp} points to a capsule node that is in a ring of equivalent pens whose value has not yet been defined.

\texttt{cur.type = unknown path} means that \texttt{cur.exp} points to a capsule node that is in a ring of equivalent paths whose value has not yet been defined.

\texttt{cur.type = unknown picture} means that \texttt{cur.exp} points to a capsule node that is in a ring of equivalent pictures whose value has not yet been defined.

\texttt{cur.type = token list} means that \texttt{cur.exp} points to a linked list of tokens.

\texttt{cur.type = capsule}, and their type field is one of the possibilities for \texttt{cur.type} listed above. Also \texttt{link} \leq \texttt{void} in capsules that aren’t part of a token list.

\texttt{my.var.flag: 0..max.command_code; \{ initial value of var.flag \}}

\texttt{begin cur.type \leftarrow known; cur.exp \leftarrow 0; free.node(g, dep.node.size);}
begin \textit{type}(r) \leftarrow \textit{known}; \textit{value}(r) \leftarrow 0; \textit{free\_node}(p, \textit{dep\_node\_size});

by a previous operation. We must maintain the value of \textit{right\_type}(q) in cases such as ‘...\{(cur12)z\{0,0\}...’.

\textbf{996.} And \textit{do\_assignment} is similar to \textit{do\_equation}:

\textbf{Page D439, line 10 becomes two lines}

\begin{verbatim}
begin \textit{nonlinear\_eq}(v, \textit{cur\_exp}, \textit{false}); \textit{cur\_type} \leftarrow t; \textit{goto} \textit{done};
\end{verbatim}

\textbf{Page D443, line 11}

\begin{verbatim}
done: if \textit{eq\_type}(x) \textit{mod} \textit{outer\_tag} \neq \textit{tag\_token} then \textit{clear\_symbol}(x, \textit{false});
\end{verbatim}

\textbf{Page D452, line 9}

though they don’t necessarily correspond to primitive tokens.

\textbf{Page D476, line 12 from the bottom}

\begin{verbatim}
if \textit{nl} \leftarrow \textit{skip\_table}[c] > 128 then
\end{verbatim}

\textbf{Page D483, line 7}

\begin{verbatim}
\textit{max\_fm\_dimen} \leftarrow 16 \times \textit{internal}[\textit{design\_size}] \leftarrow 1 \times \textit{internal}[\textit{design\_size}] \div 100000000;
\end{verbatim}

\textbf{Page D483, lines 15-17}

\begin{verbatim}
if \textit{x} > 0 then \textit{x} \leftarrow \textit{max\_fm\_dimen} else \textit{x} \leftarrow -\textit{max\_fm\_dimen};
end;
\end{verbatim}

\textbf{Page D496, line 2}

\begin{verbatim}
\textit{x} \leftarrow \textit{make\_scaled}(\textit{x} \times 16, \textit{internal}[\textit{design\_size}]);
\end{verbatim}

\textbf{Page D496, line 2}
a pointer to an edge structure. Its mission is to describe the positive pixels in GF form,

\textbf{Page D500, line 16}

\begin{verbatim}
\textit{selector} \leftarrow \textit{old\_setting}; \textit{gf\_out}(\textit{cur\_length}); \textit{gf\_string}(0, \textit{make\_string}); \textit{decr}(%pstr);
\end{verbatim}

\textbf{Page D506, lines 8-10}

\texttt{METAFONT} it says, for example, ‘(preloaded base=plain 1984.2.29)’, showing the year, month, and day that the base file was created. We have \textit{base\_ident} = 0 before METAFONT’s tables are loaded.
cmmf, should also be provided for commonly used bases such as cmbase.

Zillions of alphabets can be generated by the programs in this book. All

square dots tells whether dots should be square, not rounded;

hefty tells whether weight-reducing strategies should be used;

monospace tells whether the characters should all be forced to have the same

width;

hair, vair, stem, curve, ess, flare, dot_size, bar, slab,

crisp, tiny, fine;

and thin_join should not be less than fine.

cap_notch_cut  46/36  31/36  25/36  24/36  22/36  25/36

extra_endchar ← extra_endchar & "charcode:=charcode+code_offset;";

numeric mid_thickness; mid_thickness = Vround 1/3[wair, stem];

top y1 = top yb = b; z2 = .5[z3, z1] + bend;

draw z1 - flourish\change {up} + (0, 1.5asc_height) {up}

… {right}(z1+(2u,0)) --- z6 … {down}z7;

% upper bar

[The labels on the new illustrations of beta, omega, and spadesuit are too large, and the resolution of the shapes is too small.]
Page E147, line 11 from the bottom (04/23/04)

\[ x_0 = x_1 = x_0; \ y^t x_{cr} = \text{hround}(1.5u - \cdot 5\text{hair}); \ x_2 = x_4 = x_6 = x_8 = .5w - .25u; \]

Page E147, line 8 from the bottom (04/23/04)

\[ y_t = .5[y_t, y_0]; \ top y_{cr} = \text{stem} + \text{eps}; \ bot y_{cr} = -\infty; \ y_t = y_0 = .5[y_0, y_0]; \]

Page E149, line 8 from the bottom (04/23/04)

\[ y_t + \cdot x_{\text{height}} = y_t = .5[y_t, y_0]; \ bot y_{cr} = -\infty; \]

Page E157, line 11 (02/29/08)

\textit{filldraw} \ z_{\text{cr}} = z_{\text{cr}} \ldots (x_3, y_{23}) \ldots z = z_{1r} \ldots \text{cycle; } \%

\textit{stem}

Page E161, line 7 from the bottom (04/23/04)

\[ \text{top } y_{cr} = x_{\text{height}} + \infty; \ y_t = y_1 = .5[y_1, y_3]; \ bot y_{cr} = -\infty; \]

Page E209, line 3 (12/29/04)

\% This lowercase italic alphabet was prepared by D. E. Knuth in December, 1979.

Page E377, lines 3 and 4 from the bottom (12/22/02)

\begin{verbatim}
path \textit{p}: p_1 = z_{\text{cr}} \ldots \text{darkness} [z_{\text{cr}}, .5[z_{\text{cr}}, z_{\text{cr}}]] \ldots z_{\text{cr}}
\ldots = z_{\text{cr}} \ldots = z_{\text{cr}} \ldots = z_{\text{cr}} \ldots = \text{cycle;}
\text{if } (y_{\text{cr}} > y_{0r}) \neq (\text{ypart} \text{ precontrol} 1 \text{ of } p_1 > \text{ypart postcontrol} 1 \text{ of } p_1):
\textit{p} = z_{\text{cr}} [z_{\text{cr}}, .5[z_{\text{cr}}, z_{\text{cr}}]]
\ldots = z_{\text{cr}} \ldots = z_{\text{cr}} \ldots = \text{cycle; } \%
filldraw \textit{p}, \%
\end{verbatim}

\textit{arm and beak}

Page E379, lines 17 and 18 become one line (01/06/14)

\textit{else: } rt \ x_{cr} = \text{hround}(w - 1.5u); y_t = y_{cr} + \text{eps; } \%

Page E379, bottom line of the program (01/06/14)

\textit{math_fit(0, ic # 2.5, u # ); penlabels(0, 1, 2, 3, 4, 5, 6, 7); endchar;}

Page E489, bottom line (06/25/04)

\textit{labels(1, 2, 3, 4, 5, 6); endchar;}

[Labels '5' and '6' should also be added to the lower illustration on page E488.]

Page E545, line 11 from the bottom (12/29/04)

The most important general routine in \textit{cmbase} is probably the \textit{pos}
quantities needed in the calu programs are also established at this time.

Page E577, right column  (12/23/02)
\textit{p}. 305, 377.

Page E578, left column  (12/23/02)
\textbf{postcontrol}, 347, 377.
\textbf{precontrol}, 347, 377.