10 Mar 1978

1. Rename a few external variables to make their first six letters unique.

2. Initialize escape_char to −1, not 0 [it will be set to the first character input].

3. Fix bug: The test ‘id < 200’ was supposed to distinguish one-letter identifiers from longer (packed) ones, but negative values of id also pass this test.

4. Fix bug: I wrote ‘while α ∧ (β ∨ γ)’ when I meant ‘while (α ∧ β) ∨ γ’.

5. Initialize the input routines in INITEX [at this time a short, separate program not under user control], in case errors occur.

6. Don’t initialize mem in INITEX, it wastes time.

7. Change ‘new_line’ [which denotes a lexical scanning state] to ‘next_line’ [which denotes carriage return and line feed] in print commands.

8. Include additional test ‘mem[p] ≠ 0 ∧’ in check_mem.

9. Fix inconsistency between the eq_level conventions of macro_def and eq_define.

10. About six hours of debugging time today.

11 Mar 1978

10. Insert space before ‘(’ on terminal when opening a new file.

11. Put ‘p ← link(p)’ into the loop of show_token_list, so that it doesn’t loop forever.

12. Shift the last item found by scan_toks into the info field. [With SAIL all packing of fields was done by arithmetic operations, not by the compiler.]

13. Fix the previous bugfix: I shifted by the wrong amount.

14. Add a feature that prints a warning when the end of a file page occurs within a macro definition or call. [System dependent.]

15. Add the forgotten case ‘set_font:’ to eq_destroy.

16. Change \require to \input.

17. Add code for the case cur_cmd = 0 [later known as the case ‘t ≥ cs_token_flag’] when scanning a tokenlist.

18. Introduce a ‘d’ option in the error routine, to facilitate debugging.

19. Assign a floating-point constant ignore_depth to prev_depth, instead of assigning the integer constant flag [since prev_depth is type real in \TeX78].

20. Improve the readability and spacing of show_node_list output.

21. Set the variable v before using the case construction in show_node_list, because there’s one case where v didn’t receive a value [as part of the field unpacking].

22. Insert debug_help into succumb, giving a chance to look at memory before the system dies.

23. Use eq_destroy wherever necessary in unsave.
24 Change ‘t ← (t − 1) mod 8’ to ‘t ← (t − 1) land 7’ in id_name, since \$hil has −1 mod 8 = −1. [At this time, id_name is a routine that unpacks control sequence names, according to a scheme that will become obsolete after change #422.]

25 Remove the space that appears at end of paragraph. (I hadn’t anticipated that.) §816 S

26 Throw away unwanted line_feed after getting a carriage_return in response to in_chr_w [a system routine for input from the terminal]. §83 L

27 Delete spurious call to flush_list in end_token_list. §324 B

- Why did I make such a silly mistake?

28 Fix bug in get_x_token: I forgot to say ‘macro_call’ (which is the main point of that routine)! §380 F

- While tracking that bug down, I found out incidentally that kerning is okay.

- Also \TeX correctly caught an error op for opt.

29 Fix bug in scan_spec (while instead of repeat). §404 L

30 Make the table entries for \hfill and \hskip consistent with the program conventions. §1058 M

31 Disable unforeseen coercion: When scan_spec put hsize on save_stack, the value changed from real to integer. §645 L

32 Use ‘*’ instead of ‘-1.0’ for running dimensions of rules in show_node_list. §176 I

33 Clear mem[head] to null in push_nest [in \TeX82, this will be done by get_avail]. §216 D

- A rule link got clobbered because I forgot to do this.

34 Translate ASCII control codes to special form when displaying them. §48, 68 I

- Ligatures work, but show_node_list showed them funny.

35 Remember to clear parameters off save_stack in package routine. §1086 F

- About eight hours today.

13 Mar 1978

36 Introduce a new variable hang_first [later the sign of hang_after]. §849 D

37 Simplify the new code, realizing that if hang_indent = 0 then hang_first is irrelevant. §848 E

- Time sharing is very slow today, so I’m mostly reading technical reports while waiting three hours for compiler, editor, and loading routine.

- I’m not counting this as debugging time!

- (Come back in the evening.)

38 Spruce up the comments in the line_break routine, which appears to be almost working. §813 P

39 Rethink the setting of best_line; it’s 1 too high in many cases. [The final line of a paragraph was handled in a treacherous way.] §874 D

40 Compute proper initialization for prev_depth when beginning an \hbox with a paragraph inside. [This refers to a special ‘paragraph box’ construction, used when an hbox of specified size becomes overfull; \TeX78 doesn’t have the concept of internal vertical mode.] §1083 D

41 Also initialize tail in that case. §1083 D

42 Also put the result of line-breaking into the correct list. §1083 D

43 Fix a typo in the free_node routine (‘link’ not ‘llink’); by strange chance it had been harmless until today. §130 T

44 Fix bug: post_line_break forgot to set adjust_tail. §889 F

45 Update act_width properly when looking for end of word while line breaking. §866 D

46 Repair the “tricky” part of get_node: I used the info field when I meant to say link.

- Now the \corners macro of acphdr works! [See \setcornerrules in The \TeXbook, page 417.]
47 Reset contrib_tail properly in build_page. §995 D
48 Fix typo (− for +) in computation of page_total. §1004 T
49 Change the page-breaking logic: \TeX{} reached fire_up with best_page_break = null in one case, since the badness was too bad. §1005 S
50 Perform the operation delete_token_ref(top_mark) only when top_mark ≠ 0. §1012 M
51 Make scan_toks omit the initial \{ of an \output routine. §473 F
52 Insert a comma to make memory usage statistics look better. §639 I

14 Mar 1978
• (Came in evening after sleeping most of day, to get computer at better time.)
• (Some day we will have personal computers and will live more normally.)
• 8:30pm, began to enter corrections to yesterday’s problems.
53 Issue an error message for non-character in filename or in font name. §771 I
54 Display ‘\ldots’ for omitted stuff in show_context routine. §643 I
55 Watch out for the SAIL syntax ‘\alpha + \beta \ lsh \gamma’; it doesn’t shift \alpha + \beta left (only \beta). §464 L
• That error was very hard to track down; it created a spurious link field and sent hash[0] = \beta to the scanner!
• I could have found this bug an hour sooner if I had looked at the correct stack entries for name and token_type.
56 Show the correct page number when tracing pages before output is shipped. §638 D
57 Remember to nullify a box after using it. §1079 F
58 Issue an error message if \box255 isn’t consumed by the output routine. §1015 I
• I’m having trouble with the \BAIL debugger; it makes an illegal memory reference and dies, when single-stepping past the entry to recursive procedures hlist_out and vlist_out. So I have to reload and be careful to go thru these procedures at high speed.
59 Fix bug in comment (memory parameter description said ≥ not ≤). §11 P
60 Fix typo in definition of rule output (said x,y not x0,y0). [This part of the code went away when DVI files were introduced.] B
61 Correct the embarrassing bug in shellsort, where I said ‘\le str[k]’ not ‘\le t’. [The first \TeX{} had to sort all output by vertical position on page.] B
62 Make start_input set up job_name in the form needed by shipout; it uses obsolete conventions. §532, 537 M
63 Insert ( and ) into the SAIL macro definition of new_string. [This macro was for pre-DVI output.] L
64 Unscramble the parameters of out_rule: The declaration was (x0, y0, x1, y1) while the call was (x0, x1, y0, y1). M
• 4:30am, \TeX{}’s first page is successfully output!
• It was ‘\titlepage\setcpage1\corners\eject\end’.
15 Mar 1978
• 10:30pm. Today I’m instrumenting the line-breaking routine and putting it through a bunch of tests.
• (The inserted instrumentation had bugs that won’t be mentioned here.)
65 Don’t abort the job when eq_destroy redefines a \TeX{} control sequence. §275 C
66 Fix the typo in line_break that spoils the test for ‘letters in the same font’. §896 T
• The effect of that typo was to suppress all hyphenation attempts.
67 Replace the space at paragraph end by fillglue, not by zero. §816 B
68 Pack the hyphen character properly into its node. §582 L
69 Fix a typo (‘−’ for ‘+’) in the computation of break_width. §838 T
70 Change the \texttt{end} maneuver; the present code doesn’t end the job, since I forgot that \texttt{back_input} uses \texttt{cur_tok}. §1054 M

71 Add a parameter to \texttt{try_break}, since the width is different at a discretionary hyphen. [This problem will be solved differently in \TeX82, when discretionary becomes much more general.] §840 A

72 Bypass kern nodes in pre-hyphenation. §896 F

73 Supply code for the forgotten case ‘< “a”’ in pre-hyphenation. [This case was later generalized to a test of \texttt{lc_code}.] §897 F

74 Change \texttt{mem[q]} to \texttt{prev_break(q)} in the reverse-linking loop. §878 B

75 Introduce special logic for \texttt{eject_penalty}; I was wrong to think that forced ejection was exactly like an infinitely negative penalty. §851 A

76 Use \((1 + b)^2 − p^2\) when computing demerits with \(p < 0\). §859 A

• 9pm. The plan for tonight is to test page breaking and more paragraphing. §1001 G

77 Insert \texttt{\topskip} glue at beginning of page. §363 I

78 Add \texttt{\pausing} feature. §668 M

79 Fix discrepancy: In \texttt{make_accent} I called \texttt{vpackage} with a pointer to the first list item, but \texttt{vpackage} itself assumes that the parameter is a pointer to that pointer. [The \texttt{vpackage} of \TeX82 will be different.] §669 F

• I checked for other lapses like that. Result: 14 calls OK, 12 NG. §1014 M

80 Combine the page lists before pruning off glue in \texttt{fire_up}; otherwise the pruning doesn’t go far enough. §1017 F

25 → 83 Fix typo where line-breaking starts: ‘\texttt{fill_glue}’ should be ‘\texttt{new_glue(fill_glue)}’. §816 B

84 Add \texttt{/q} to \texttt{xspool} command (cosmetic change). [This changes a system command that causes \TeX output to be printed on the Xerox Graphics Printer (XGP), the progenitor of future laser printers; the \texttt{/q} option says that the queue of printing requests should be displayed on the user’s terminal.] §642 I

85 Don’t write a form feed after the last page of output. §642 E

• To fix this, I reorganized \texttt{ship_out}, and it became simpler. §622 T

86 Correct a typo (‘+’ for ‘*’) in the \texttt{vlist_node} case within \texttt{hlist_out}. [The output routines were quite different at this time, because output went directly to the XGP.] §638 I

87 Change the message ‘\texttt{completed page}’ to ‘Completed for page’. §1004 B

48 → 88 Fix yet another typo in the computation of \texttt{page_total}: My original code said \texttt{stretch(p)} instead of \texttt{stretch(q)} (terrible). §1016 P

89 Document the dirty trick about \texttt{bot_mark}’s reference count. [That trick is, fortunately, no longer useful.] §1016 P

90 Rethink the algorithm for contributing an insertion: The original code tests for a page break after incrementing the totals but before the \texttt{contrib_list} is updated. [\TeX78 handles insertions in a hardwired manner that will be greatly generalized in \TeX82.] A
Fix \texttt{get_node} again: After the variable memory overflows, control falls through to \texttt{found} instead of going to the \texttt{overflow} call. §125

- I spent several hours tracking down that data structure bug!

Amend the line-breaking algorithm: \texttt{\textbackslash break} in paragraph doesn’t work with really bad breaks. §851

- A problem to be diagnosed tomorrow: Each time I run the test program, the amount of memory in use grows by 13 cells not returned.
- Seven hours tonight.

\textbf{17 Mar 1978}

Introduce \texttt{dead_cycles} to keep \texttt{end} active until \texttt{ship_out} occurs. §1054

Don’t call \texttt{line_break} with an empty list. §1096

Take proper account of the (infinite) fillglue when computing the width of a paragraph line preceding a display. §1146

Add a new parameter to \texttt{hpack} so that \texttt{line_break} won’t be called at the wrong time. [This is for the soon-to-be-obsolete feature described in \#40.] M

Give a warning message if there’s an \texttt{\textbackslash hfill} in the middle of a paragraph; fillglue upsets the line breaker, because floating-point calculations don’t have sufficient accuracy.

- I spent an hour looking for another bug in \TeX, but the following one was in METAFONT: The \texttt{xgp} height data in fonts had been supplied wrong.
- It took two hours to recompile 32 fonts with proto-METAFONT.

Make \texttt{show_node_list} and \texttt{show_token_list} more robust in the presence of software bugs. §182

\textbf{18 Mar 1978}

- 3:30pm. (Saturday)

Add a parameter to \texttt{check_mem} (to suppress display unless needed). §167

Introduce a user-settable parameter \texttt{\maxdepth}, and pass it as a parameter to \texttt{vpackage}. §668

- I realized the need for \texttt{\maxdepth} while fixing insertions (see \#90).

Introduce a user-settable parameter for \texttt{line_break}: The constant 2.0 in my original algorithm becomes \texttt{\par} [later \texttt{\tolerance}], to be set like \texttt{\tracing}. §828

Reclaim the \texttt{eject_penalty} nodes removed during line-breaking.

- Those were the 13 extra nodes reported on Thursday.
- The \texttt{init_align} procedure worked right the first time!
- Also \texttt{init_row}, \texttt{init_col}. But then…

Rethink the command codes: \texttt{ende} in a token list has too high a code for the assumptions of \texttt{get_next}.

Add a \texttt{prev_cmd} variable for processing delimited macro parameters; the original algorithm loses track of braces. [The rules will change slightly in \TeX82, and \texttt{rbrace_ptr} will take on a similar function.] §400

Make the \texttt{get_next} routine intercept \& and \texttt{\textbackslash cr} tokens.

- I’d thought I could just put \& and \texttt{\textbackslash cr} into \texttt{big_switch} [i.e., in the stomach of \TeX, not the eyes]; that was a great big mistake.

Make more error checks on \texttt{ende}; e.g., it must not occur in a macro definition or call. §780
108 → 110 No, rethink alignments again; the new program still fails! §768 S

- For the first time I can glimpse the hairiness of alignment in general (e.g., `\halign{u\&v\&...}` when \& and \v are defined to include \&'s and possible alignments themselves).
- I think there's a "simple" solution, by considering only whether an alignment is currently active [in §342].
- 11:30pm. Went to bed.

19 Mar 1978

- Woke up with "better" idea on how to handle \& and \cr.
- (Namely, to consider a special kind of `\def` whose parameters don't interrupt on \&'s and \cr's.)
- But replaced this by a much better idea (to introduce `align_state`).
- 11pm. Began to use computer.Performed major surgery (inserting `align_state` and updating the associated routines and documentation).

111 Pop the alignment stacks in `fin_align`. §800 D

110 → 112 Fix a (newly inserted) typo in `show_context`. §314 T

110 → 113 Set `align_state` false when a live \& or \cr is found. [Originally `align_state` was of type `boolean`.] §789 D

114 Insert \cr when '{' occurs prematurely in an alignment. §1132 I

115 Remember to record `glue_stretch` when packaging an unset node. §796 M

- I had a mistake in `acphdr` definition of `quoteformat`; also extra spaces.
- My first test programs, used before today, were contrived to test macro expansion, line-breaking, and page layout.
- Next I'm using a test program based on Volume 2.

116 Make carriage-return, space, and tab equivalent for macro matching. §348 C

117 Omit the reference count node when displaying a mark. §176 F

118 Correct a silly slip: I wrote `type_displacement` instead of `value_displacement` when packing data in a penalty node. §158 B

119 Don't go to `build_page` after seeing `\noindent`; `\TeX` isn't ready for that. [In the original program, this was an instance of a bad `goto`.] §1091 M

- I had undesired spaces coming thru the scanner in my macro definitions of `\tenpoint` [see The \TeXbook, page 414].
- 4am. `\TeX` now knows enough to typeset page 1 of Volume 2!
- Also it did its first "math formula" (namely `$X$") without crucial error.
- (Except that the italic correction was missing for some reason.)

120 Remember to decrement `cur_level` in `fin_align`. [The routines will eventually become more general and use `unsave` here.] §800 D

121 Remember to increment `cur_level` in error corrections by `handle_right_brace`. [A better procedure will be adopted later.] §1069 D

122 Fix a typo: ("C instead of "Y") in error message for `mmode + math_shift`. §1065 T

99 → 123 Make `show_node_list` more robust and more like the new `show_node_list`. [The routines will be combined in \TeX82.] §690 R

124 Fix a typo in `char_box`: should say `font_info_real`. [In \TeX78 a single array is used for both `real` and `integer`; in \TeX82 things will be `scaled`.] §554 L

125 Fix typos in the definitions of `default_rule_thickness` and `big_op_spacing`; they shouldn't start at `mathex`(7). §701 B

126 Reverse the `before` and `after` conventions in math nodes.

- I had them backwards; this turned hyphenation on just before math, and off just after it!
- Seven and a half hours debugging today. Got through the test program a little more. But `\TeX` blew up on `\$Y+1\$`; tomorrow I hope to find out why.
20 Mar 1978

- 8pm. I decided to work next on a super-hairy formula.

127 Change `\ascii' to `\cc' (character code). [This name will change again later, to `\char'.] §265 C

128 Don't bother to store a penalty node at the beginning of $$ when the paragraph-so-far fits on a single line, since such a penalty has already been stored. [These conventions will change later, and the \predisplaypenalty will always be stored.] §1203 E

129 Avoid reference to tail in build_page, if nest_ptr > 0. §995 S

130 Correct a silly slip in math_comp (the exact opposite of what I did in #118). §1158 B

131 Rectify my mental lapse in make_fraction; I said nucleus instead of thickness. §743 B

132 Mask off the math class when scanning delimiters. §1160 F

133 Allow an optional space after \def{...}. [This decision will be retracted later.] §473 C

- My test example is so complicated it causes the semantic stacks to overflow!

134 Don't test for no pages output by looking at the channel status. §642 L

135 Fix typo in definition of \mathop (open_noad not op_noad). §1156 T

136 Rewrite \fin_ml, because `\left(...\above...\right)' doesn't parse correctly; the \left goes into the numerator, the \right into the denominator. §1184 A

137 Correct the use of depth_threshold in print_subsidiary_data: Simple fields get shown while others look empty. §692 B

78 → 138 Return the carriage before showing the first line of a new file when pausing. §538 I

139 Fix bug: The call show_noad_list(mem[...]) should be show_noad_list(., in the incompleat_noad case of show_activities. §219 M

- 3am. The whole messy formula has been parsed correctly into a tree.

- The easy part is done, now comes the harder part.

140 Don't shift single characters down in make_op. §749 F

141 Make clean_box return a box (as its name implies), not an hlist.

- Font info still isn't quite right, it has the wrong value of quad. §720 D

142 Retain the italic correction when doing rebox; can make glue_set ≠ 0 a flag for this. [A better solution will be adopted later.] §715 A

143 Fix the bug that makes rebox bomb out: value(p) should be value(mem[p]). §715 B

- 6am; ten hours today. \TeX didn't do $\pi/\over2$ correctly, but was close.

- I found that the rebox problem (#142) went away when I fixed the clean_box problem (#141); but I will leave the extra stuff about glue_set ≠ 0 in the program anyway, just for weird cases.

144 Omit extra levels of boxing when possible in clean_box. §721 E

- (To do this, I need to face the rebox problem anyway.)

21 Mar 1978

- 10pm. The computer is rather heavily loaded tonight.

145 Don’t forget thickness when making a square-root sign (see #131). [The rule thickness will later be derived from the character height.] §737 F

146 Define p local to the make_fraction routine. §743 L

- Unwittingly using the global p was a disaster.

147 Don’t show the amount of glue_set when it’s zero. §186 I

142 → 148 Make glue_set nonzero in the result of var_delimiter. §706 D

149 Fix bug: The math_glue function didn’t return any result. §716 F

150 Fix typo in char_box (c not w); this caused a subscripted P to come out the same width as an unsubscripted P. [Later changes in the rules will move this computation to §755.] §709 T

144 → 151 Revise clean_box to do operations that are needed often because of the rebox change. §720 P

152 Use the new clean_box to avoid a bug in \sqrt{\raise...}. §737 D
153 Change the definition of \not so that it’s a relation (which will butt against the following relation). [All math symbols and Greek letters are defined in \INITEX at this time, not in a changeable format definition.]

154 Give error message ‘Large delimiter must be in \mtext font’, instead of calling confusion, since the error can occur. [This particular error is impossible in \TeX82.]

155 Change the use of \var in \var_delimiter; it isn’t always set when I say \go to found. §706 I

- Another font problem now surfaced: The \mtext meta-font didn’t compute \TeX info in a machine-independent way. (It took two hours to correct this.)

156 Don’t forget to set \type(b) in all relevant cases of \var_delimiter. §708 D

157 Use the correct sign convention for \shift_amount in \hpackage. §653 B

158 Always kern by \delta when there’s no superscript. §755 F

159 Declare \space_table to be [0...6,0...6] not [0...7,0...7]; otherwise its entries are preloaded into the wrong positions. [The \space_table in \TeX78 is 7 x 7; it will become 8 x 8 in \TeX82, represented as a string called \math_spacing.]

160 Use a negative value, not zero, to represent a null delimiter. [Actually zero will come back again later.] §685 C

127 → 161 Change \cc to \char. §265 C

162 Don’t use tricky subtraction on packed data when changing \var_to an \ord_noad in \mlist_to_hlist; subtraction isn’t always safe. §729 L

163 Fix two typos in the \space_table (\* for 0). §764 L

164 Initialize \cur_size everywhere (I forgot it in two places). §703 F

165 Reset \op_noad before resetting \bin_noad. §728 A

166 Treat \display_style + \cramped the same as \display_style inside \make_op. §749 F

167 Shift the character correctly in the non-\displaystyle case of \make_op. §749 B

- Still another font problem: The italic corrections are wrong because the corresponding array was declared real in proto-\METAFONT (and italic corrections were used in nonstandard way in \mtext).

168 Use \depth instead of \height in \var_delimiter. [Later, both were used.] §714 B

169 Skew the accents according to the font \slant. [Soon retracted.] §741 Q

- At this point I think nearly all the \mtext routines have been exercised.
- Tomorrow they should work!
- Eight hours debugging today.

22 Mar 1978

- (Wednesday, but actually Thursday: I began at midnight because I was proof-reading a paper.)
- I checked out the font access tables, slowly (i.e., all the \mathcode and special-character name entries were catalogued).

169 → 170 Do not consider slants after all in the \mtext accent routine, since slanted \mtext letters are put differently into fonts. §741 Q

171 Don’t use \var for two different things simultaneously in \make_mathAccent. §738 B

172 Fix bug in \compact_list (I forgot to advance the loop variable). [This procedure became unnecessary in \TeX82.] F

173 Avoid conflict between \var_delimiter and \mlist_to_hlist, which want to use \temp_head simultaneously. §713 M

174 Fix bad typo in \overbar routine (b for p). §705 T

- Finally \TeX got to after_math after dealing with that hairy formula...

175 Fix another bad typo: p for b this time. §1199 T

176 Insert more parentheses (twice) because of ‘\lsh’ precedence in \SAIL §1199 L

36 → 177 Use the new hanging-indentation conventions when formatting displayed equations. §1199 M

178 Recompute penalties so that break is allowed after \punct_noads. §761 Q
179 Center the large delimiters vertically. §749 F
180 Round all rule sizes (up) before drawing them. §589 Q
181 Provide more space over $x$ in $\sqrt{x}$, and more space atop vincula. §705, 737 Q
182 Make large delimiters large enough to cover formula height (important for subscripts, superscripts). §762 Q
183 Insert /ntn=33 on XGP prompt message so that complex math won’t blow the device driver. [See #84.] I

23 Mar 1978

• Six hours today.

25 Mar 1978

• 2am Saturday. (Might as well drop Friday.)
Note to myself: I knew it would be cleaner to define `get_next` so that it sets `cur_cs` to zero every time it begins [i.e., in §341, where this change will in fact be made in TeX82]. But I had avoided this on grounds of efficiency in the inner loop. Well, now I have earned this tiny bit of efficiency.

Prohibit the first word of an unavailable node from becoming negative. [The storage allocator of TeX78 uses a negative value to signify a node that is available, just as `-0` = `max_halfword` will signal availability in TeX82.]

That was another bad one, it’s not my night.

At least I’m developing more subtle diagnostic techniques.

Remember to un-negate the top `save_stack` entry when `handle_right_brace` finishes an `insert_group`. [This routine was completely revised in TeX82.]

Don’t let `vpackage` lose the top insert. (It fails when the very first item is a `topinsert`.)

And when that stupid code is corrected, make it handle insertions first-in-first-out.

Seven hours today.

**26 Mar 1978**

Easter Sunday, will work till sunrise.

Add an ‘i’ feature to the `error` recovery routine.

Include a prompt.

Ignore space after `\noalign{...}`.

Otherwise, things are going well tonight; I’m finding more bugs in my test program than in TeX.

The ‘i’ feature is proving to be very helpful.

I increased the size of `mem` (now `lo_mem_max` = 3500, `mem_max` = 10000).

In fact I just needed to increase it again (now `lo_mem_max` = 4500, `mem_max` = 11000).

Calculate the size of delimiters by considering the enclosed formula’s distance from the axis, not from the baseline.

I’m having trouble with a SAIL compiler bug; I must rearrange the program, more or less at random, until it compiles correctly. I hope the bug isn’t more severe than it appears.

Don’t put a new group on `save_stack` if a null mark is expanded. [TeX82 will remove the ‘)’ from the mark text.] I had to redo the typewriter-style font since its width tables were wrong.

And I increased low-memory size again to 5500, then 6500.

Finally the entire test program was TeXed. Happy Easter! Six hours today.

**27 Mar 1978**

Beginning at 2:30am.

Move `\vcenter` processing to the first pass of `mlist_to_hlist`; otherwise the height, depth, subscripts, etc., are way off.

Omit space after closing `\$`.

Spacing is wrong in the formula $Y_1 + \cdots + Y_k$; I have to rethink the use of three dots.
221 Make conditional thin space available to user as \(\leq\). [Later will retract this.] §226 G
222 Introduce \texttt{\textbackslash dispaskip} and \texttt{\textbackslash dispbskip} [later called \texttt{\textbackslash abovedisplayshortskip} and \texttt{\textbackslash belowedisplayshortskip}]. §226 Q

- Reminder: I need to test line-breaking with embedded math formulas.

223 Make sure that interaction ≠ error_stop_node in the ‘whoa’ error \([\texttt{\textbackslash fatal\_error}]\). §93 I
224 Fix a big mistake in the \texttt{\textbackslash style\_node} routine (which points to a glue spec, not to glue itself); somehow this didn’t cause trouble yesterday. [In \TeX78, style nodes double as placeholders for math glue like thin spaces.] §732 B

225 Make \texttt{\textbackslash fntfam} obey group structure. \([\TeX78’s \texttt{\textbackslash fntfam} operation is a combination of \TeX82’s \texttt{\textbackslash textfont}, \texttt{\textbackslash scriptfont}, and \texttt{\textbackslash scriptscriptfont}.]\) §1234 C

- At this point the test routine for Volume 2 works perfectly.
- But I will change the page width in order to check harder cases.

227 Represent italic corrections as boxes, not glue, so that they won’t be broken.

- Eight hours today.

228 Fix a bug that just clobbered the memory: Call \texttt{\textbackslash free\_avail}, not \texttt{\textbackslash free\_node}, in the \texttt{\textbackslash ins\_node} case of \texttt{vpackage}. [This logic will change completely in \TeX82.] §1019 B

29 Mar 1978

- (Wednesday) Again beginning at 2:30am.

229 Put still more space above and below fraction lines in displayed formulas. §746 Q

189 → 230 Install an infinite penalty feature, which positively suppresses breaks; use it in displayed formulas whose \texttt{\textbackslash eqno} doesn’t fit. §1205 G

231 Call \texttt{\textbackslash build\_page} after finishing a display; and don’t go to the \texttt{\textbackslash noindent} routine because of the next remark. §1200 F

232 Put \texttt{\textbackslash parskip} glue just before a paragraph, not just after (since it interferes with a penalty after). §1091 S

- Although the test program gives correct output, it generates 46 locations of variable-size memory and 280 of one-word memory that are not freed.

233 Fix a bug when deleting space at end of paragraph: \texttt{\textbackslash delete\_glue\_ref} \texttt{(\textbackslash cur\_node)} not \texttt{\textbackslash delete\_glue\_ref} \texttt{(value(\textbackslash cur\_node))}. §816 M

- There’s also a more mysterious type of uncollected garbage, a \texttt{\textbackslash fraction\_noad} corresponding to \$p\texttt{\textbackslash choose} k\$, an \texttt{incompleat\_noad} not completed.

- Couldn’t find that one, so I recompiled with #233 and #234 corrected.

- Now it gains just 10 locations of variable-size memory and 7 of the other kind.

235 Extend \texttt{\textbackslash search\_mem} to search \texttt{eqtb} also. §255 I

236 Recycle the ulists and vlists in \texttt{\textbackslash fin\_align}. §801 F

25 → 234 Fix bug when deleting space at end of paragraph: \texttt{\textbackslash delete\_glue\_ref} \texttt{(\textbackslash cur\_node)} not \texttt{\textbackslash delete\_glue\_ref} \texttt{(value(\textbackslash cur\_node))}. §816 M

- The seven one-word nodes were generated by this bug; \texttt{\textbackslash rebox} put them onto a linked list starting with \texttt{\textbackslash mem}[0], growing at the far end!

237 Remember to complete each \texttt{incompleat\_noad}. §1184 D

- This solved the other mystery. I had never noticed that my test output was actually wrong: \$p\texttt{\textbackslash choose} k\$ came out as ‘k’.

- After these corrections, the test routine worked... I feel that \TeX{} is now pretty well debugged (except perhaps for error recovery)—it’s time to celebrate!

I feel that \TeX{} is now pretty well debugged (except perhaps for error recovery)—it’s time to celebrate!

1 Apr 1978

238 Don’t quit after file lookup fails. §530 I

2 Apr 1978

239 Add \texttt{\textbackslash T\textbackslash eX\_font\_area}, so that it’s easier to change the default library area associated with a device. §514 P
3 Apr 1978
240 Insert parentheses again, to cope with the precedence of lsh when packing data. (See #55 and #176.) §1114 L
241 Remember that back_error requires cur_tok to be set. (Problem can arise during error recovery on parameter \n with n out of range.) §476 M

4 Apr 1978
242 Add a deletion feature to the error routine. §88 I

5 Apr 1978
243 Reset space_factor after / [this was later rescinded] and after math in text. §1196 Q

10 Apr 1978
104 → 244 Replace \jpar and \tracing by a new primitive \chpar for parameters. It allows a user to change those quantities as well as the penalties for hyphens, relations, binary ops, widows. §209 G

11 Apr 1978
• Beginning to typeset a real book (Volume 2, second edition), not just a test.

14 May 1978
245 Make math in text end with spacing as if it were followed by punctuation. [This rule will soon be rescinded.] §760 Q

17 May 1978
248 Fix a silly bug that hasn't been tweaked until today: \halign to size' [obsolete in \TeX 82] used vsize instead of hsize. §645 B

19 May 1978
249 Add a \topbaseline feature [later called \topskip]. §1001 G

20 May 1978
256 Fix the spurious value of prev_depth inside alignments. §775 A
257 Consider (and defeat) the following scenario: The u and v lists are built in init_align using temp_head; then while scanning \tabskip 2pt\rt{...}' the macro \rt is expanded, clobbering temp_head. §779 S

22 May 1978
260 Change \$ to \$ and introduce \$ as the negative of \$. [Later obsolete.] §226 C
261 Fix the display of negative penalty nodes; \textit{show_node_list} is confused when a negative value has been packed into the middle of a word.

- Memory overflow just occurred with $lo\_mem\_max = 7500$ and $mem\_max = 16384$. So I have to go to 15-bit pointers. (A problem on 32-bit machines?)

23 May 1978

262 Add a new parameter \texttt{big_op_spacing5}, for extra space above and below limits of big displayed operators.

263 Initialize \texttt{incompleat_noad} in \texttt{\halign{...}}.

- That was another heretofore-untested operation. How much of the code has not yet been exercised?

26 May 1978

264 Close the file when doing lookup-failure recovery.

265 Improve the error recovery for ‘Extra \&’.

266 The top piece must be calculated mod 128 in \texttt{var_delimiter}, to guarantee a valid subscript range. [Obsoleted in \TeX82.]

267 Fix a blunder in new \texttt{missing_brace} code.

268 Fix a blunder in new code for limits on display operators.

26 May 1978

269 Don’t insert a new penalty after an explicit penalty in math mode.

- The hash table overflowed; I ought to make it much bigger.

110 \mapsto 270 Avoid possible bad memory references in alignment when there is erroneous input after \texttt{\cr}. [Instead of \texttt{extra_info}, the value of \texttt{cur_align} in \TeX78 is negated, because we need only distinguish \texttt{\cr} from \&.]

271 Make the dimension parameters like \texttt{\hsize} all global, so that they can be set in the \texttt{\output} routine.

- This led to major simplifications, also to major surgery.

- [But it was a kludgy decision, overruled in \TeX82.]

94 \mapsto 272 Don’t forget to set the type of the new null box in the \texttt{\end} routine.

27 May 1978

- The data overflowed memory again, both low and high, doing Section 3.3.2.

184 \mapsto 273 Mask off extra bits of \texttt{\char} in math mode, to avoid bad memory references. \§1151 R

274 Zero out the negative \texttt{\medmuskip} in script styles. \§732 B

29 May 1978

275 Be prepared to handle an undefined control sequence during \texttt{get_c_token}. (Can fix this by brute force, using \texttt{get_token} instead of \texttt{get_next}.)

276 Correct the superscript shift when a single character is raised.

184 \mapsto 277 Mask off all but 7 bits in \texttt{\char} routine, to avoid space-factor index out of range.

- More memory capacity overflows.

22 \mapsto 278 Fix \TeX’s overflow stop so that I don’t have to wait for loading of the \texttt{BAIL} debug routines. [System dependent.]

279 Remember to adjust the page number when a file page ends in mid-macro. [System dependent.]

5 Jun 1978

280 Make sure that the arguments of positioning commands don’t overflow their field size.

281 Report the excess amount when giving an overfull box warning. \§666, 677 I

7 Jun 1978

282 Use $\geq$ instead of $>$ as termination criterion in \texttt{var_delimiter}.

283 Disallow \texttt{\eject} in math mode. [In \TeX82, \texttt{\eject} is distinct from \texttt{\break}; in horizontal mode it includes \TeX82’s ‘\vadjust{\break}’.]
Don’t put too much clearance above $\sqrt{}$ in text style. \hfill §737 Q

Make align state an integer variable, not boolean, so that \eqalign can be within another \eqalign. \hfill §309 G

A \mark should expand its input. \hfill §1101 C

Provide for preloading of fonts. \hfill §1320 E

Close the output file before switching to edit the input file with the ‘e’ option. \hfill §84 L

Return adjustments found by hpack to free storage if they’re not used. [Later, hpack will detach them only when they’re used.] \hfill §655 E

Strive for consistency between make_under and make_over. \hfill §735 Q

Fix a serious error in rebox (‘b’ instead of ‘list_ptr(b)’). \hfill §715 B

Strange that such a bug would now surface for the first time! \hfill C

Add an extra hyphenation penalty for two hyphenated lines in a row. \hfill §859 Q

Introduce the ‘no_new_control_sequence’ switch. Among other things, this will prevent an undefined control sequence following scan_math from clobbering the save stack. \hfill §259 S

Change the badness test ‘glue ≤ 0.0’ to ‘glue ≤ 0.0001’. [TpX82 will avoid such problems by calculating badness without floating point arithmetic.] \hfill §99 L

Force badness to be at most 10\(^{19}\). \hfill §108 R

Add end_template for better error recovery in alignments. \hfill §375 I

Make INITEX more like the real TpX; my simple scheme for font preloading was no good because it left thousands of ‘dead’ words in memory. \hfill §8 E

Econimize disk space by using internal arrays in load modules that aren’t being reinitialized. [System dependent.] \hfill E

Move the declaration of mem to the semantics module, so that the object code will be more efficient. [System dependent. The code of TpX78 was divided into separately compiled modules for syntax, semantics, output, extensions, and general organization.] \hfill E

Today I’m working on the user manual. \hfill §239 S

Disallow \input except in vertical mode. [I will change this in TpX82, treating \input as a case of expansion.] \hfill §378 C

Add error recovery for endv and par_end occurring in math mode. \hfill §1047 I

Generalize \ifT to \if T. \hfill §506 G

Preload the \bullet [later done by plain.tex]. \hfill F

Get the correct prev_depth at the beginning of an alignment. \hfill §775 D

Change \eject so that it ejects only once. \hfill §1000 C

Look in standard area if a file isn’t found in the user’s area. \hfill §537 I

Echo all online inputs in the transcript file. \hfill §71 I

Equalize spacing when only one of numerator/denominator is big. \hfill §745 Q

Prevent subscript from getting too high above baseline. \hfill §757 Q
311 Avoid infinite loop when stack overflows: \texttt{push\_input} should say \texttt{if input\_ptr \geq stack\_size \land interaction = error\_stop\_mode}. §321 R

22 Jul 1978

312 Make \texttt{\quad} meaningful outside math mode. (All fonts must be generated again!) §558 C

313 Show the nesting level at the end of \texttt{show\_activities}. [But I decided not to do this in \TeX82.] §218 I

314 Put in \texttt{\>} [namely, \texttt{\mskip\medmuskip}; \TeX78 already has \texttt{\<}, \texttt{\leq}, as well as the negative amounts \texttt{\>}, \texttt{\leq}]. Change the name of vector accent from \texttt{\>} to \texttt{\b}. [Math spacing operators will become much more general in \TeX82.] §716 C

25 Jul 1978

94 \mapsto 315 Give the correct \texttt{\hsize} and \texttt{\vsize} to the null boxes created at \texttt{\end}. §1054 Q

94 \mapsto 316 And don’t “append” them. [Later this was changed, so that it would work better with generalized output routines.] §1054 A

297 \mapsto 317 Remove the control sequence \texttt{\endv}, since error recovery is now better. §375 I

318 Define another mode of tracing: It says ‘OK’ and stops after \texttt{\showlists}. §1298 I

244 \mapsto 319 Give better defaults to parameters. [Later done by \texttt{\plain.tex}.] §209 Q

320 Allow more bits in the packed representation of \texttt{\showboxdepth}. §238 I

321 Scan past delimiters and/or dimensions when recovering from ambiguous fractions. §1183 I

322 Reduce accent numbers modulo 128 or 512, depending on the mode. §1165 R

323 Include a warning, ‘(\texttt{\end} occurred on level . . .)’. §1335 I

28 Jul 1978

• (I’m writing Chapter 27 of the manual: ‘Recovery From Errors’.)

324 Improve the error message in \texttt{scan\_digit}. [This procedure will change its name to \texttt{scan\_eight\_bit\_int}, when the number of registers increases from 10 to 256.] §433 I

325 Don’t report overfull boxes if they’re less than .1 point over. §666, 677 I

326 Give the user extra chances to define the font, if \texttt{\read\_font\_info} is unsuccessful. §560 I

327 Change default recovery for bad parameter number from \texttt{\#1} to \texttt{\##}, since \texttt{\#1} won’t always work and since \texttt{\##} is probably intended. §479 I

328 Omit the “Negative?” message on things like \texttt{scan\_char\_num}. §435 I

329 Improve error recovery when a large delimiter isn’t in family 3. [Obsolet.] I

330 Give a more appropriate error message when the input is \texttt{\$\right}. §1192 I

• Currently \TeX says ‘Missing $’! §435 I

331 Call \texttt{\back\_input} before the error message in \texttt{\back\_error}, not afterwards. §327 I

1 Aug 1978

332 Give an appropriate warning when there’s no input file and the user types ‘e’. §84 I

333 Increase the system pushdownlist size so that the manual will compile. [Procedures \texttt{\hlist\_out} and \texttt{\vlist\_out} can recurse deeply.] L

• Yesterday I distributed 45 preliminary copies of the manual; today I took out the “debugging hooks” and put \TeX up as a system program.

2 Aug 1978

• I’m typing Volume 2 again (currently in Section 4.2.2). Culture shock!

334 Introduce a \texttt{\ragged} parameter, to indicate a degree of raggedness. [Previously, ragged-right setting was performed when the \texttt{\tolerance}/100 was odd! Eventually a better approach, with \texttt{\rightskip} and such things, will be discovered.] §886 G

335 Omit the ‘widow penalty’ in one-line paragraphs. §890 Q
5 Aug 1978
336 Generalize \pageno
to \count\{digit\}.
§236 G

285 ⥈ 337 Update align_state when recovering from ‘Missing {’ and ‘Extra }’ errors.
§1069, 1127 D

338 Show “runaway” tokens, making it easier to pinpoint an error.
§306 I

22 Aug 1978
339 Add \predisdisplaypenalty.
§1203 G

340 Clarify error messages; they should indicate when something has been inserted, etc.
§1064 I

23 Aug 1978
114 ⥈ 341 Substitute ‘Extra }’ for the losing ‘Missing \cr’ error message.
§1069 I
213 ⥈ 342 Go past online insertions in show_context.
§311 I

343 Exact no penalty for breaking one line before a display.
§1145 Q

338 ⥈ 344 Check for runaways at end of file.
§362 I

345 Give error message when a macro argument begins with }.
§395 I

24 Aug 1978
213 ⥈ 346 Remove extra line-feed in show_context after printing insertions. [System dependent.]
§318 L

25 Aug 1978
347 Leave no glue at top of page, even after \eject.
§997 Q

27 Aug 1978
348 Adopt Guy Steele’s new version of the \TeX source files. [He has recently made a copy and modified it by introducing compile-time switches for MIT conventions as an alternative to SUAI. This is the first time that \TeX is being ported to another site; additional switches for PARC, TENEX, TOPS10, and TOPS20 will be added later, using the Steele style.] P

1 Sep 1978
349 Don’t pass over leader nodes in the try_break background computation. [At this time, leaders have not yet been unified with glue.]
§837 Q

82 ⥈ 350 Prune away all penalties at the top of a page.
§997 Q

4 Sep 1978
338 ⥈ 351 Include ‘\’ in error message about a runaway argument.
§306 I

8 Sep 1978
• I just remade all the fonts, with increased ligature field size.

350 ⥈ 352 Insert a necessary goto statement in the first branch of the new penalty routine within build_page.
§997 B

30 Sep 1978
338 ⥈ 353 Make the token list for runaway arguments meaningful outside of \macro_call.
(I just had a runaway argument ending with ‘\lcm’, which turned out to be the control sequence in hashtable location 0.)
§371 M

354 Avoid infinite loop when recovering from $\$\$ in restricted horizontal mode.
§1138 R

355 Fix two hyphenation bugs related to -ages, -ers. [A completely new algorithm for hyphenation will go into \TeX82.]
L

356 Add -est to hyphenation routine; also disable puzzled and rattled, etc.
Q

4 Oct 1978
357 Add new primitive \vtop.
§1087 G

358 Treat implicit kerns properly after discretionary hyphens have been inserted.
§914 Q
4 Nov 1978
359 Forget the half quad originally required at left and right when centering displayed equations without equation numbers. §1202 Q

11 Nov 1978
360 Don’t let the postamble come out empty. [This could occur if no fonts were selected.] §642 R

15 Nov 1978
361 Allow optional space after digit in scan_int routine. §444 C

17 Nov 1978
362 Make the check_mem procedure slightly more robust. §167 R

20 Nov 1978
363 Make the \par in a \def match the \par that comes automatically with a blank line. (Suggested by Terry Winograd.) §351 C
364 Add new parameter \mathsurround for spacing before and after math in text. §1196 G
365 Extend \advance to allow increase by other than unity. [At this time it applies only to the ten \count registers, and it is called \advcount.] §1238 G

25 Nov 1978
366 Add a new primitive: \unskip. §1105 G
367 Add new primitives \uppercase and \lowercase. §1288 G

28 Nov 1978
368 Don’t let \mark and macro_call interfere with each other’s scanner_status. §306 M
369 Omit extra } after show_node_list shows a \mark, since the right brace is already there. (See #210.) §176 M
370 Add a new primitive suggested by Terry Winograd: \xdef. §1218 G

29 Nov 1978
371 Delete a space following \else{...} also in the false case. [\TeX uses braces, not \fi, for conditionals.] S

6 Dec 1978
376 Change the file opening statement to allow lines up to 150 characters long. [System dependent.] L

16 Jan 1979
365 Initialize negative properly in the \advance routine with a \count as argument. §440 F

20 Jan 1979
378 Try to keep complex, buggy preambles of alignments from crashing the program. §789 R

17 Feb 1979
376 → 379 Give more detailed information when warning about a long line being broken. [System dependent; the buffer size in \TeX is very limited.] I

380 Declare p local to try_break, for the “rare” case code. [My original program included the following comment: “This case can arise only in weird circumstances due to changing line lengths, and the code may in fact never be executed.” Later Michael Plass will discover that variable line lengths require an entirely different algorithm, using last_special_line.] §847 L
334 \rightarrow 381 \text{Don't omit the raggedness correction when the last line of paragraph has to shrink. [Obsolete in \TeX82.]} \quad F

**22 Feb 1979**

363 \rightarrow 382 \text{Don't forget to return from \texttt{get_x_token} after finding \texttt{\par}.} \quad \S 351 \quad F

383 \text{Add a new parameter: \texttt{lineskiplimit}.} \quad \S 679 \quad Q

384 \text{Change the syntactic sugar: `\hbox par' replaces `\hjust to ...{overfull}'.} \quad [This vastly improves on the old idea (see \#40), but there still is no internal vertical mode.] \quad C

385 \text{Introduce new names \texttt{\hbox} and \texttt{\vbox} for \texttt{\hjust} and \texttt{\vjust}.} \quad \S 1071 \quad C

386 \text{Add a new condition: \texttt{\ifpos}. [It will later be generalized to \texttt{\ifnum} and \texttt{\ifdim}.]} \quad \S 513 \quad G

387 \text{Add \texttt{\vu} and \texttt{\varunit}. [\TeX82 will eventually allow arbitrary internal dimensions as units of measure.]} \quad \S 453 \quad G

312 \rightarrow 388 \text{Add an \texttt{em} unit.} \quad \S 455 \quad G

389 \text{Legalize \texttt{\hbox spread} (negative dimension) [since \texttt{scan_spec} no longer uses the sign as a flag].} \quad \S 645 \quad C

**10 Mar 1979**

370 \rightarrow 390 \text{Make \texttt{scan_toks} expand \texttt{\count} during \texttt{\xdef}. [This will change later when \texttt{\the} and \texttt{\number} are introduced.]} \quad \S 367 \quad C

**23 Mar 1979**

391 \text{Put only 100000 pt stretch at the end of a paragraph instead of 10000000000 pt.} \quad [In \TeX78, “infinite” glue is actually finite but large; in the language of \TeX82 we would say that \texttt{\parfillskip}, which is not yet user-settable, is being changed to be like \texttt{\hfil} instead of like \texttt{\hfill}.] \quad \S 816 \quad Q

392 \text{Treat the last line of a paragraph more consistently with the other lines (e.g., when \texttt{\hfil} appears in mid-paragraph), by effectively inserting inf_penalty at the end.} \quad \S 816 \quad Q

**31 Mar 1979**

393 \text{Ensure that penalty nodes aren’t wiped out, in weird cases where breaks occur at penalties that normally disappear.} \quad \S 879 \quad S

**27 Apr 1979**

394 \text{Correct the page number count when files begin with an empty page. [System dependent.]} \quad A

395 \text{Allow the \texttt{math_code} table to be changeable via \texttt{\chcode}. [In \TeX82, \texttt{\chcode} will split into \texttt{\mathcode} and \texttt{\catcode}.]} \quad \S 1232 \quad G

332 \rightarrow 396 \text{Don’t accept ‘e’ after an error message if not inputting from a file.} \quad \S 84 \quad I

**29 May 1979**

397 \text{Don’t call \texttt{end_file_reading} if you haven’t already invoked \texttt{begin_file_reading}; this could happen when trying to recover from an error in \texttt{start_input}.} \quad \S 537 \quad F

**7 Jun 1979**

306 \rightarrow 398 \text{Be sure to eject two pages, when \texttt{\eject} comes just at the time another break is preferable (e.g., when the page has just become too full).} \quad \S 1005 \quad A

**27 Jun 1979**

354 \rightarrow 399 \text{Don’t say ‘You can’t do that in math mode’ when the user says ‘$$’ in restricted horizontal mode!} \quad \S 1138 \quad I

**30 Jun 1979**

400 \text{Add \texttt{\wd}, \texttt{\dp}, \texttt{\ht} dimension units.} \quad \S 455 \quad G

307 \rightarrow 401 \text{Don’t try the system area for file names whose area is explicitly indicated.} \quad \S 537 \quad I
1 Jul 1979
402 Allow letters as (ASCII) numbers [without the ‘ marker introduced later]. §442 G

2 Jul 1979
403 Fix a \gdef bug: If the control sequence was never defined before [this later became the restore_zero option], don’t remove it at group end. §282 F

16 Jul 1979
320 → 404 Update show_node_list to be like show_node_list. [The two routines, originally separate, will be merged in \TeX82.] §238 I

18 Jul 1979
405 Extend capacity from 32 fonts to 64 fonts if desired. §134 G
406 Add new extra_space parameter to all text fonts (requested by Frances Yao). §558 Q
407 Make each node_noad print properly in show_node_list. §183 F
408 Make \jpar allow any break if it is 1000000 or more. [In \TeX82, a \tolerance of 10000 or more allows any break.] §851 Q

23 Jul 1979
409 Introduce new primitives \hfil, \vfil, \hfilneg, \vfilneg. §1058 E
410 Add \ifmmode. §501 G
411 Add \firstmark. §1012, 1016 G
412 Allow break at leaders (horizontal mode only). §149 C

25 Jul 1979
213 → 413 Revise error so that online insertions work properly after end-of-file errors. §336 I
411 → 414 Change ‘if first_mark \neq 0’ to ‘if first_mark \geq 0’ [because \texttt{-1} is used to indicate ‘not yet given a value’]. §1012 B

28 Jul 1979
370 → 415 Stop \xdef from expanding control sequences after \def’s. [This decision will be rescinded later, after several more years of experience with macro expansion will suggest better ways to cure the problem.] §366 C
416 Change symbolic printout for control symbols. [System dependent.] §49 I
308 → 417 Avoid linefeeds in the transcript file. [System dependent.] L
370 → 418 Expand \topmark, etc., in \xdef. §366 C

4 Aug 1979
413 → 419 Fix an error introduced recently: \par was suddenly omitted at end of page. [System dependent.] B

11 Aug 1979
420 Change error messages that use SAIL characters not in standard ASCII. §360 P

28 Aug 1979
411 → 421 Move the command ‘first_mark \leftarrow -1’ from vpackage to fire_up. §1012 D
403 → 422 Correct a serious \gdef bug: Control sequences don’t obey a last-in-first-out discipline, so \TeX loses things from the hash table when deleting a control sequence.

• To fix this, I either need to restrict \TeX (so that \gdef can be used inside a group only for control sequences already defined on the outer level) or need to change the hash table algorithm. Although all applications of \TeX known to me will agree to the former restriction, I’ve chosen the latter alternative, because it gives me a chance to improve the language: Control sequences of arbitrary length will now be recognized.

423 Make sure that unsave cannot call eq_destroy with a value from the upper part of eqtb. §282 D
• I noticed this long-standing bug while fixing #422. It had very low probability of causing damage (e.g., it required a certain field of a floating-point number to have a certain value), but it would have been devastating on the day it first showed up!

29 Aug 1979

424 Call \texttt{eq\_destroy} when a control sequence is \texttt{\def}ed after being \texttt{\def}ed. §283 F
418 \rightarrow 425 Treat the first token consistently when \texttt{\topmark} and its cousins are expanded in \texttt{scan\_toks}. §477 F

• Now I’ve checked things pretty carefully and I think \TeX is “fully debugged.”

25 Jan 1980

338 \rightarrow 426 Display runaway alignment preambles. §306 I
427 Introduce active characters (one-stroke control sequences). [I don’t yet go all the way: The meanings of ‘x’ and ‘\x’ have to be identical.] §344 G

7 Feb 1980

314 \rightarrow 428 Fix a glaring omission: Op space \texttt{\textgreater} was never implemented in math mode! §716 F

25 Feb 1980

429 Add a new dimension ‘ex’ (for units of \texttt{xheight}). §455 G

3 Mar 1980

427 \rightarrow 430 Allow the control sequence \texttt{:} to be redefined [it was the ‘select font’ operator]; this allows the character : to be active. [Obsolete.]

23 Mar 1980

• An extend-\TeX-for-the-eighties party:
431 Add a new \texttt{\copy} feature. §204 G
432 Add a new \texttt{\unbox} feature. §1110 G
433 Add a new \texttt{\open} feature [later \texttt{\openout}]. §1351 G
434 Add a new \texttt{\send} feature [later \texttt{\write}]. §1352 G
435 Add a new \texttt{\leqno} feature, requested by MDS. §1204 G
436 Add a new \texttt{\ifdimen} feature [ later \texttt{\ifdim}]. §513 G
437 Make \langle \texttt{space} \rangle in vertical mode begin a paragraph. §1090 C
438 Add a new \texttt{\font} feature [replacing the silly previous convention that a font must be defined when it is first selected]. §1256 G
439 Add new \texttt{\parval} and \texttt{\codeval} features [later \texttt{\the} (whatever)]. §413 G
427 \rightarrow 440 Don’t let active characters gobble the following space. §344 C
208 \rightarrow 441 Add a new parameter to govern amount of token list dumped. [Obsolete.] §295 G
442 Add a new \texttt{\linebreak} feature [later replaced by \texttt{\break}]. §831 G

25 Mar 1980

• (Still working on the above, also thought of more.)
443 Add a new \texttt{\skip} feature. §716 G
444 Add a new \texttt{\newname} feature (soon changed to \texttt{\let}). §1221 G
430 \rightarrow 445 Allow any control sequence to be redefined. §275 G
446 Send the output to the user’s current file area, even when input comes from elsewhere. §532 I

27 Mar 1980

447 Compute the xheight for accents in math mode from family 1, not family 3. [Obsolete.] Q

28 Mar 1980

448 Increase minimum clearance between subscript and superscript. §759 Q

29 Mar 1980

222 \rightarrow 449 When a display follows a display, the second should have the ‘shortskip’ glue. §1146 Q
4 Apr 1980
445 ↔ 450 Look at current token meanings when trying to recognize \tabskip in alignment preambles. §782 A

23 Apr 1980
451 Estimate the length of printed output, for the new priority feature on our XGP device driver. [System dependent.]
434 ↔ 452 Break long \send lines into pieces so that the file can be read in again. [System dependent.]

19 May 1980
182 ↔ 453 Don’t make \left and \right delimiters too large; they need to be only 90% of the enclosed size. [This eventually became \delimiterfactor.] §762 Q

21 May 1980
454 Add a new \pagebreak feature [later \vadjust{\break}]. §655 G

13 Jun 1980
• Today I’m beginning to overhaul the line-breaking routine, and I’ll also install miscellaneous goodies.
455 Allow a radical sign to be in different font positions. §737 G
456 Clear empty tokenlists off input stacks to allow deeper recursions (suggested by Jim Boyce’s macros for chess positions). §325 E
457 Make \spaceskip and \parfillskip changeable. §1228 G
458 Add a new parameter \fudge (per request of Zippel) [later \mag]. §288 G
459 Add a new parameter \loose [later \looseness]; now parameters are allowed to take negative values. §875 G
460 Remove the variable just_par. [Obsolete; it was the real equivalent of an integer]. E

14 Jun 1980
461 Install new line-breaking routines, including \parshape. (These major changes are introduced as Michael Plass and I write our article.) §813 Q
462 Add a new parameter \exhyf [later \exhyphenpenalty]. §869 G

16 Jun 1980
444 ↔ 463 Change conventions in eqtb so that glue is distinguishable from other equivalents. §275 S
444 ↔ 464 Don’t expand \b in \xdef{\d\b{...}} after \let\d=\def. [Obsolete.] A
444 ↔ 465 Avoid creating dead storage when doing \unsave in certain regions. §275 D

17 Jun 1980
466 Allow negative dimensions in rules. §138 C

19 Jun 1980
463 ↔ 467 Make the new test for glue at the outer level of show_eqtb. §252 B

27 Jun 1980
453 ↔ 468 Don’t let \left and \right become too small for big matrices. [This eventually became \delimitershortfall.] §762 Q

3 Aug 1980
469 Don’t move extra-wide, numbered equations flush left unless they begin with glue. §1202 Q

15 Sep 1980
461 ↔ 470 Say ‘≥ fz’ instead of ‘> fz’ in the pre-hyphenation routine; I’d forgotten my definition of fz [a variable used to test for a sequence of lowercase letters in the same font]. §897 M
395 ↔ 471 Check the range of the index in \chcode before saving the old value. §1232 R
18 Sep 1980

457 → 472  Don’t forget to increase the reference count to \parfillskip, or it will mysteriously vanish. §816 D

19 Sep 1980

412 → 473  Make leaders break like glue in both horizontal and vertical modes. §149 C

364 → 474  Make \mathsurround break properly at left and right end of lines. §879 Q

13 Oct 1980

461 → 475  Remove spurious overfull boxes generated when the looseness criterion fails. [Obsolete.]

461 → 476  Redesign the iteration for looseness; breakpoints were not chosen optimally. §875 A

461 → 477  Avoid storing a lot of breakpoints when they are dominated by others. §836 E

366 → 478  Don’t say ‘cur_node’ when you mean ‘mem[cur_node]’. §1105 B

461 → 479  Prefer the oldest break to the youngest break when two break nodes have the same total demerits. §836 Q

461 → 480  Don’t make badness too big for floating-point calculations, when forced to make an overfull box. [Obsolete.]

10 Dec 1980

481  Make it impossible to get unmatched ‘}’ in a delimited macro argument. §392 R

482  Add new \topsep and \botsep features. [These are TeX78’s way to put space at the edge of inserts, replaced in TeX82 by the \skip register corresponding to an \insert class.] §1009 G

6 Jan 1981

483  Install new routines for reading the font metrics, using Ramshaw’s TFM files instead of TFX files. §539 P

484  Abort after reporting 100 errors, if not pausing on errors. §82 I

485  Add new \spacefactor and \specsip and \skip primitives. [At this time we write ‘\specsip3=10pt’ and ‘\skip3’ for what will become ‘\skip3=10pt’ and ‘\skip\skip3’ in TeX82.] §1060 G

366 → 486  \unskip is now allowed in internal vertical mode. §1105 G

26 Jan 1981

482 → 487  Don’t say ‘mem[q]’ when you mean ‘q’. (See #143 and #478.) §1009 B

27 Feb 1981

417 → 488  Put some linefeeds back into the transcript file, in order to prevent overprinting in listings. [System dependent.]

489  Add a new \penalty feature [later \postdisplaypenalty]. §1205 G

490  Add the dimension cc for European users. §458 G

491  Make scan_keyword match uppercase letters as alternatives to lowercase ones (suggested by Barbara Beeton’s experiments with \uppercase). §407 C

492  Add nonstop mode so that overnight batch processing is possible. §73 I

2 Mar 1981

422 → 493  Fix a still more serious \gdef bug: The generality of \gdef almost makes it a crime to forget any control sequence names, ever! (The previous bug was only the tip of an iceberg.)

494  Issue warning message at the end of a file page if nesting level isn’t zero. [System dependent.] §259 S

5 Mar 1981

495  Keep track of maximum memory usage, for statistical reporting. [Obsolete.] §125 I

350 → 496  Prune away glue and penalties at top of page after marks, sends, inserts. §1000 Q

497  Allow \mark in horizontal mode. [Later it will be \vadjust{\mark...}]. §655 G
498 Allow optional space before a required left brace, e.g., `\if AA {...}'. [See #251.] §403 C

499 Issue an incomplete `\if' error, to help catch a bad `\if'. §336 I

17 Mar 1981

494 → 500 Omit the warning message at end of a file page unless the nesting level has changed on that page. [System dependent.] I

310 → 501 Fix the spacing when there is a very tall subscript with a superscript. §759 Q

20 Mar 1981

371 → 502 Make space-eating after `\else' fully consistent between the true and false cases. [Obsolete.] S

24 Mar 1981

496 → 503 Change `glue_spec_size' to `ins_spec_size' in `vpackage' where insertions are done. [Obsolete.] B

5 Apr 1981

501 → 504 Fix a typo (`+' instead of `−') in the new subscript code; this shifted certain subscripts down instead of up. §759 B

18 Apr 1981

505 Make leaders with rules of specified size act like variable rules. §626, 635 G

29 Apr 1981

461 → 506 Don’t consider `badness > threshold' at a line `\break' except in an emergency. §854 A

13 Jul 1981

402 → 507 Allow other characters as numbers. §442 C

294 → 508 Avoid dead storage if a `no_new_control_sequence' error occurs. [Obsolete.] §259 R

509 Add a new `\ifx' feature. §507 G

510 Add new features `\xleaders' and `\cleaders'. §626, 635 G

14 Jul 1981

507 → 511 Amend the new code for constants; the `.’ in `.5' is thought to mean `056?' §442 S

507 → 512 And fix an egregious blunder in that code; New commands at the end of a procedure are ignored when earlier statements exit via `return'. §442 L

4 Aug 1981

513 Accept alphabetic codes for all online error recovery options, instead of insisting on control codes like line feed or form feed. [The original error-recovery codes were suggested by the conventions of the SAIL compiler.] §84 P

514 Add a new `\thebox' feature [later `\lastbox']. §1079 G

7 Aug 1981

515 Add `fil', `fill', and `filll' as units for glue stretching or shrinking. §454 G

516 Suppress the overfull box error when shrinkage amount is negative. §664 I

9 Aug 1981

517 Let unset boxes inherit the size of their parent in alignments. §810 Q

12 Apr 1982

518 Make `INITEX' dump out the `font_dsize' array needed by the new DVI output module. §1322 F

1 May 1982

151 → 519 Fix `clean_box' so that `mlist_to_hlist' cannot make `link(q) = 0' and `type(q) = glue_node'. §720 S

• [That was the historic final change to \TeX78. All subsequent entries in this log refer to \TeX82.]
15 Jul 1982

- Finished draft of test program and began debugging about 1430 [2:30 pm].
  Taking my time.

X1 Change \texttt{eqth[\texttt{cur_font}]} to \texttt{eqth[\texttt{cur_font}\_loc]}.

- Not logging changes to the exposition.
- Compile time is about 2 minutes CPU, times 5 for time-sharing; add another half minute for linking and loading.
- Hash table and \texttt{get\_next} seem to be working, with no changes needed!
- Time out 1630–1815 for Jill’s birthday party.

X2 Insert \texttt{begin \ldots end} around \texttt{dump\_int} macro.

- \texttt{The TRIP test should preload more fonts.}

X3 Print two blank spaces before date in \texttt{open\_log\_file}.

- \texttt{Don’t forget to increase \texttt{k}.

X4 Update \texttt{x} and \texttt{cur\_used} outside the \texttt{for} loop.

- \texttt{Set} \texttt{\textit{TRIP}}

X5 Change \texttt{if = to if \# as loop exit condition.}

- \texttt{Make sure \texttt{eqtb} seems to be working, with no changes needed!}

X6 Insert \texttt{begin \ldots end} around statistics output.

- \texttt{Print the word \textit{mode} in \texttt{print\_mode}.}

X7 Must \texttt{get\_x\_token} when scanning a number.

- \texttt{Remember to return a value in \texttt{new\_font}.}

X8 Interactive \texttt{debug\_help} needs to print a newline.

- \texttt{Making \texttt{new\_char} the default category for ASCII control codes too.}

X9 Include \texttt{ignore\_spaces} and \texttt{math\_accent} in \texttt{print\_cmd\_char} cases.

- \texttt{Don’t call \texttt{confusion} when \texttt{print\_cmd\_char} sees unknown code.}

X10 Don’t call \texttt{confusion} when \texttt{print\_cmd\_char} sees unknown code.

- \texttt{Compiler bug causes stack overflow. Retiring for the night at 2145.}

16 Jul 1982

- Starting at 0700; DRF has fixed the compiler.

X11 Allow arbitrary integer parameters in diagnostic print routines.

- \texttt{Starting at 0700; DRF has fixed the compiler.}

X12 Say \texttt{cur\_tok}, not \texttt{cur\_val}, when you mean \texttt{cur\_tok}.

- \texttt{Say \texttt{\textit{TRIP}}}.

X13 Make \texttt{\textit{PAUSE}} effective also on first line of a file.

- \texttt{Adjust \textit{limit} properly after line changed when pausing.}

X14 Show context after online deletion.

- \texttt{Remember to return a value in \texttt{new\_spec} and \texttt{new\_penalty}.}

X15 Bypass reference count when \texttt{debug\_help} shows a token list.

- \texttt{Now stepping through line\_break in simple case.}

X16 Change \texttt{\texttt{case p} to \texttt{\textit{case type}(p)}.}

- \texttt{Don’t prune unwanted nodes if \texttt{cur\_p} = \texttt{null}.}

X17 Fix timing of \texttt{print\_ln} when scrolling help messages.

- \texttt{Use \texttt{last}, not \texttt{limit}, in \texttt{term\_input}; else error prompt causes trouble when \texttt{state} = \texttt{token\_list}.}

X18 Make \texttt{other\_char} the default category for ASCII control codes too.

- \texttt{Make sure \texttt{set\_trick\_count} is always performed.}

X19 Use special scanning method for font number in \texttt{new\_font}.

17 Jul 1982

X20 Don’t forget to increase \texttt{k} in the \texttt{while} loop.

- \texttt{Don’t forget to increase \texttt{k} in the \texttt{while} loop.}

X21 Adjust \texttt{limit} properly after line changed when pausing.

- \texttt{Adjust \texttt{limit} properly after line changed when pausing.}

X22 Remember to return a value in \texttt{new\_spec} and \texttt{new\_penalty}.

- \texttt{Remember to return a value in \texttt{new\_spec} and \texttt{new\_penalty}.}

X23 Don’t prune unwanted nodes if \texttt{cur\_p} = \texttt{null}.

- \texttt{Now stepping through line\_break in simple case.}

X24 Print a closing parenthesis when displaying glue nodes.

- \texttt{Use \texttt{last}, not \texttt{limit}, in \texttt{term\_input}; else error prompt causes trouble when \texttt{state} = \texttt{token\_list}.}

X25 Use \texttt{last}, not \texttt{limit}, in \texttt{term\_input}; else error prompt causes trouble when \texttt{state} = \texttt{token\_list}.

- \texttt{Use \texttt{last}, not \texttt{limit}, in \texttt{term\_input}; else error prompt causes trouble when \texttt{state} = \texttt{token\_list}.}

X26 Set \texttt{first} ← \texttt{limit} + 1 after \texttt{init\_terminal}.

- \texttt{Set \texttt{first} ← \texttt{limit} + 1 after \texttt{init\_terminal}.}

X27 Make sure \texttt{set\_trick\_count} is always performed.

- \texttt{Make sure \texttt{set\_trick\_count} is always performed.}

X28 Add new diagnostic feature \texttt{\textbackslash tracing\_commands}.

- \texttt{Add new diagnostic feature \texttt{\textbackslash tracing\_commands}.}

X29 Initialize \texttt{\textit{passive} ← \texttt{null}.}

- \texttt{Debugging of system-dependent code not shown in this log.}

X30 Fix pseudo-printing when the line is empty.

- \texttt{Tangling \TeX now takes 1.75 minutes; about 75K bytes, 108K tokens.}

X31 Merge adjacent free areas of dynamic memory before dumping.

- \texttt{Merge adjacent free areas of dynamic memory before dumping.}

X32 Print the word \texttt{node} in \texttt{print\_mode}.

- \texttt{Print the word \texttt{node} in \texttt{print\_mode}.}
X33 Improve message and help in case of weird error. §415 I
X34 Allow optional space after `def` and similar constructions. §473 G
X35 Declare `alpha` to be integer in `read_font_info`. §560 M
X36 Fix timing of `back_input` in `scan_dimen`. §448 A
X37 Back up after missing number error. §446 I
X38 Show the `at` size that is considered improper. §1259 I
X39 Streamline the dialog in `debug_help`. §1338 I
X40 Take output of `the_toks` from the advertised place. §467, 1297 M
X41 Say `true_fix(q)`, not `true_fix(p)`. §959 T
X42 Decrease low limit of `error_count` to $-1$. §76 S

18 Jul 1982

X43 Clear initial reference count of macro definitions. §473 F
X44 Fix timing of `back_input` in `scan_glue`. §461 A
X45 Use `cur_val_level`, not `cur_val`, when checking levels. §461 B
X46 Multiply `fil` units by $2^{16}$ for correct scaling. §454 B
X47 Don’t confuse `glue_base` with `skip_base`. §1237 B
X48 Fix `print_scaled` so that 0.01 doesn’t come out 0.1. §103 A
X28 → X49 Show mode changes when tracing commands. §299 I
X50 Don’t say if $(n = 0) \lor (\ldots \text{div}\ n)$ in Pascal. §105 L
X51 Don’t confuse `box_flag` with `box_code`. §1075 B
X52 Reset offset on `print_in` even in no_print mode. §57 S
X53 Fix restarting of interrupts after `big_switch`. §1031 S
X54 Don’t loop for $k \leftarrow a$ to $b - 1$ when $b = 0$ if $k$ is declared nonnegative. L
X55 Put `=` sign into the `format_ident`. §1328 I
X56 Allow $r$ to be any integer in `get_node`. §125 S
X57 Don’t put the output of `print_file_name` in quotes. §518 I
X58 Say `dumped` after dumping. §1311 I
X59 Eliminate unnecessary initialization code. §1332 E
X60 Get the file reading started right when beginning to undump. §1308 L
X61 Give forlorn message if format file can’t be loaded. §1303 I
X62 Assign value to `cur_val` after glue arithmetic. §1239, 1240 F

19 Jul 1982

X63 Don’t say if $p > \max \lor \text{free}[p]$ in Pascal. §169 L
X64 Fix memory-undump logic; loops are out of phase with input. §1312 A
X65 Undump `hyph_word[j]`, not `hyph_word[k]`. §1235 B

* At last `trip_fat` loads without bombing out.
X66 Remove assignment of array to array, not allowed by IBM Pascal (Susan Plass). §167 P
X67 Simplify an expression that’s too big for IBM Pascal (Susan Plass). §1009 P
X68 Go to `contribute`, not `done`, after insertions. §1000 A
X69 Decrease `depth_threshold` if there’s not enough string space. §198 I
X70 Show rules as `{}` in short displays. §175 S
X71 Don’t show null glue in short displays. §175 I
X72 Set `job_name` ← 0 as part of output initialization. §528 S
X73 Don’t complain of infinite shrinkage on `opt minus 0fil`. §825, 976, 1009 S
X74 Use different prompt at beginning when accepting a file name. §37 I
X75 Reset `last_glue` on nonglue nodes. §996 F
X76 Remember to call `error` after printing `OK`. §1293 B
X77 Insert `begin` … `end` around program text of section. §1025 L
X78 Define the `\shipout` primitive. §1071, 1073 F
X79 Introduce `write_loc` analogous to `par_loc`. §1344, 1371 A
X80 Dump and undump `par_loc` and `write_loc`. §1313, 1314 F
X81 Allow the in scan_the [later scan_something_internal].
X82 Interchange command codes the := number [later convert].
X83 Don’t confuse breadth with depth.
X84 Add string printing feature to debug_help.
X85 Set state ← mid_line in begin_file_reading.
   • Time out 2105–2200 to pick up Jenny from driving lesson.
X86 Keep c ≤ 127 when deleting 99 tokens.
X87 Don’t check for str_room error when selector = new_string.

21 Jul 1982

X88 Gather more statistics: String usage, font info, hyphen exceptions, stacks.
X79 → X89 Initialize write_loc from cur_ptr, not from cs_ptr.
X90 Remember to pack file name for \open.
X34 → X91 Defuse \outer test before scanning optional space after ‘}’.
X92 Don’t allow prepare_mag to cause errors after jump_out.
   • The first page of DVI output is perfect! Pause to play piano.
X93 Don’t confuse dimen_base with scaled_base.
X94 Initialize link(page_head) ← null when beginning a page.
X95 Correct cur_height more often, since max_depth might be negative.
X96 Calculate page dimensions properly after vertical kerns.
X97 Install new page_contents logic to handle interaction between insertions and \topskip.
X98 Allow top_skip glue to be a valid breakpoint.
X99 Don’t forget to count dyn_used in inner loop [erroneous analysis retracted later].

22 Jul 1982

X100 Set p ← q after migration step.
X101 Clear prev_graf to zero at start of paragraph.
X102 Put parens into negated leader_flag macro.
   • Time out 1720–1920 for John’s birthday dinner.
X103 Scale best_height when adjusting page_goal.
X104 Simplify logic of split insertions; three states become two.
X105 Don’t omit first character when showing a macro argument.
X106 Prevent clobberage if macros have too many parameters.

X107 Tell how many DVI bytes were output.
X88 → X108 Adjust for singular or plural statistics.
X98 → X109 Consider page_head a glue node, to inhibit unwanted break.
X110 Introduce new_skip_param to keep reference counts updated.
X111 Record the correct size of new insertion after it’s split.
X112 Use free_node, not flush_node_list, when recycling insertion nodes.
X113 Make online insertions work after get_next is interrupted.
X114 Print newline on interruption stop.
X34 → X115 Put space before end_write_token.
X116 Don’t confuse glue_order with stretch_order.
X117 Set max_dimen ← 7777777777, not 7777777777.
X118 Make \global\textfont legal.
X119 Fetch \the\textfont with equiv, not fam_font.
X120 Call new_ligature(f,l,...) not (f,c,...).
X121 Make show_box work on random garbage.
X122 Count reference to zero_glue from cond_math_glue.
THE ERRORS OF TeX

23 Jul 1982

X123  Allow avail = null when undumping.  §1312 R
X110 -> X124  Set width(glue_ptr(p)), not width(p).  §679 B
X125  Put begin_file_reading inside the start_input loop.  §537 A
X116 -> X126  Don’t confuse glue_stretch with stretch_order [the previous fix went only half-
way].  §838 B
X127  Negate x when calculating badness of shrinkage.  §667, 678 B
X121 -> X128  Remove dangling else that parses wrong.  §174 L
X28 -> X129  Print newline before {, not after }, when tracing commands.  §299 I
X130  Remove colon from overfull box messages.  §663, 675 I
X97 -> X131  Compute page_goal properly when the first box arrives after inserts.  §1001 D
X132  Don’t confuse page_size [now page_goal] with best_size.  §1017 B
X133  Put heldover insertions at front of contribution list.  §1023 A
X88 -> X134  Output stats before closing DVI file, since the latter decreases font_ptr.  §1333 S
X135  Don’t call a vbox an hbox.  §674 T
X136  Fix misplaced end caused by editing error.  §675 T

24 Jul 1982

X137  Don’t eq_destroy any paragraph shape when par_shape is null.  §275 D
X138  Omit blank before \message at the beginning of a line.  §1280 I
X104 -> X139  Don’t try to split an insertion when best_node isn’t the split one.  §1021 A
X140  Correct another case of ‘if x \& y’ misunderstood by Pascal.  §1021 L
X141  Provide diagnostic info about insertions via \showlists.  §986 I
X142  Add ‘inside a group’ to clarify a warning message.  §1335 I
X143  Report prev_depth on a separate line in \showlists.  §219 I
X144  Back up input to avoid unexpected clobberage of cur_tok.  §1090 S
  * Wow what a bug; new_graf calls build_page, which invokes the output routine,
  after which ‘goto reswitch’ is a disaster.
X145  Add insertion glue to page_so_far instead of subtracting it from the goal.  §1009 D
X146  Put extra blank line before overfull box warning.  §660 I
X147  Define break at kern consistently between horizontal and vertical lists.  §973, 1000 C
X148  Renumber so that math nodes are nondiscardable.  §147 D
X149  Correct the char_kern macro: #, not f.  §557 T
X150  Decrease t after reconstituting discretionary break.  §916 F
X151  Simplify the hyphen routine, knowing that link(s) = null.  §918 E
X152  Initialize r ← q in discretionary destruction routine.  §883 F

25 Jul 1982

X153  Don’t add interline penalty after last line of paragraph.  §890 A
X154  Adjust spacing in diagnostic messages.  §245 I
X155  Avoid simultaneous use of temp_head by prune_page_top and the page builder.  §1017 D
X156  Clear the post_break field of simple discretionary.  §916 F
X157  Split offset into independent variables term_offset, file_offset.  §54, 57, 58 A
  * Am freezing current program as version = 0.25; a week of TUG lectures begins
tomorrow.

5 Aug 1982

X158  The ‘.err’ file should be ‘.log’ instead.  §534 I
X159  Allow \special strings to contain more than 256 bytes.  §585, 1368 G
X99 -> X160  Undo “correction” to a non-bug.  §1034 M
X161  Suggest \& in help message for unexpected &.  §1128 I
X162  Make ‘E’ a standard option for exiting.  §84 G
X163  Restore the use of dead cycles à la TeX78.  §1024, 1054 G
  * The previous six changes were suggested during discussions with TeX82 class.
X164 Fix global variable conflict between open_log_file and new_font. §1257 S
X165 Allow optional ‘w’ when assign to font parameter. §1253 C
X166 Set cur_val after increasing the number of font parameters. §580 F
X167 Set hash_brace when matching ‘c’. §476 D
X88 ↔ X168 Clarify meaning of statistics printed. §1334 I
X169 Change DVI format to include design size. §602,1260 G
X170 Introduce def_rej for runaway messages. §306 D
X171 Restore cur_es before calling scan_toks. §1226 M
X157 ↔ X172 Update print_at to dual offset conventions. §62 A
X163 ↔ X173 Move endgame logic inside main_control, because the output routine becomes active. §1054 A

6 Aug 1982

X174 Allow INITEX to load format files. §1337 C
X175 Conserve input stack space by deleting finished token lists. §325 E
X74 ↔ X176 Print the opening ‘**’ in the transcript file. §534 I
  • Now ready to try breaking new ground in TRIP.
X177 Preserve align_state from tokens deleted online. §88 S
X178 Set i in all branches of scan_toks. §473 D
X179 Change ‘cur_end ≤ right_brace’ to ‘cur_tok ≤ right_brace_limit’; otherwise \relax gets through. §477 S
X180 Allow optional * when setting \spacefactor; disallow zero. §1243 C
X181 Change vpackage(head) to vpackage(link(head)). §796 B
  • Shades of 1978!
X182 Insert missing begin . . . end. §798 L

7 Aug 1982

X183 Keep trie_max declared in non-\HTEX [later rescinded]. §950 L
X184 Watch out for empty token list when copying. §466 D
X185 Free unused reference count slot when defining \everypar. §1226 D
X163 ↔ X186 Introduce \maxdeadcycles
  • I believe the line_break routine has passed its test perfectly.
X187 Don’t put discretionary after – inside a discretionary. §1039 S
X188 Change ‘\minus’ to ‘\minus the’ [this feature retracted later]. §413 C
X189 Change cur_p to r (three places). §875 B
X190 Increase range of hc to halfword; otherwise end-of-word mark might match a vacant entry in the trie. §892 A
X191 Initialize b in shift_case routine. §1288 F
X192 Don’t back up if a space follows a decimal fraction. §452 E
X193 Don’t confuse glue_base with dimen_base. §1145 B
X194 Guard against anomalous floating-point values in glue display. §186 L

8 Aug 1982

X195 Avoid infinite loop when \outer leads to runaways. §339 S
  • I worked on that problem about two hours before fixing it.
X196 Move final debug help to succumb, except in batch mode. §93 I
X197 Insert kern after spanned box, to defeat access to floating point. §808 R

9 Aug 1982

X198 Include \leftskip and \rightskip in displayed equations [rescinded later]. §1199 C
X199 Trace line-break computations if tracing_stats > 2. §846, 856 I
X200 Keep prev_p up to date when passing a string. §867 D
  • Now stepping through math stuff; a lot is working.
X201 Set link(p) ← z when making a fraction. §747 D
X202 Don’t reset space factor when beginning \align. §775 C
X203 Don’t show glue setting if glue_sign = normal. §186 I
X204 Clear glue_stretch and glue_shrink when creating an unset box. §801 D
X205 Do _pack in hmode and vice versa when aligning. §804 B
X206 Remove fallacious call to _confusion after alignment in display. §1206 A
X207 Don’t test _mode = vmode in display, test _nest_ptr = 1. §1145 A
X208 Show an _inner_node as well as the other types. §690, 696 F
X209 Renumber mu_glue and cond_math_glue so that the glue display logic works. §149 D
X210 Don’t confuse cur_size with cur_style. §703 B
X211 Advance _p ← _q during second pass over _mlist. §761 F
X212 Add helpful hint about \tracingoneline=1. §1293 I
X213 Delete spurious statement left from sloppy editing. §710 T
X214 Change the subtype when _mskip becomes _hskip. §732 D
X215 Don’t forget to use the remainder when computing math glue. §716 F
X199 → X216 Improve paragraph diagnostics using _short_display. §857 I
X199 → X217 Introduce artificial_badness for better diagnostics. §854, 856 I

11 Aug 1982

X218 Introduce _char_box subroutine so that _var_delimiter adds italic correction. §709 A
X219 Save font and char in local variables of _make_mathAccent, since it can be recursive. §738 S
X220 Call _error after decrying an invalid character. §346 F

12 Aug 1982

X199 → X221 Install new format for showing break nodes. §846 I

• I have been testing _line_break and I think it’s working _fine.

X222 Change _q to _p, in order to catch empty alignments. §812, 1206 B
X223 Disallow third part of discretionary in math mode. §1120 S
X224 Don’t change _tail if discretionary third part is empty. §1120 D
X225 Say _nonscript, not _non_script. §189 I
X226 Inhibit math if _scriptfont3 is improper. §1195 S
X199 → X227 Introduce _@firstpass and _@secondpass comments. §863 I
X228 Change _p to _r when you mean _r. §1204 T
X108 → X229 Say _page, not _pages, if there’s only 1. §642 I
X230 Insert space before [ ] on truncated _showlists. §182 I

28 Aug 1982

• Back from vacation after having looked at hardcopy listing of _TRIP test.

X231 Allow _dm as a unit [later .5_dm1 will be .5\dimen1]. §455 G
X108 → X232 Singularize _prevgrafl 1 lines. §219 I
X233 Omit trailing zero count registers when showing completed page numbers. §638 I
X234 Avoid clobbering _a by introducing a new local variable _t. §986 L
X216 → X235 Fix diagnostic printing of discretionaries. §858 D
X236 Don’t show unset stretch/shrink that’s zero. §185 I
X198 → X237 Make \halign in displays consistent with other displays. (Namely, ignore _leftskip and _rightskip in nonaligned displays; respect the paragraph shape in aligned displays.) §800, 1199 C
X238 Parenthesize ’_If you’re confused ...’’. §403 I
X239 Say ’_fraction’, not ’_xabove’._. §697 I
X240 Remember to _return when you should. §1153 F
X241 Use absolute value to make sure _div is unambiguous. §737 P
X218 → X242 Don’t confuse depth with height. §709 B
X243 Use _delta – _height, not _height – _delta. §736 B
X244 Increase _shift_down to increase the clearance. §745 B
X245 Don’t back up after improper use of _the. §428 I
X246 Do\textemdash \textbf{not} give \texttt{0pt} as the default result when looking for \texttt{tok_eal}.

§428 I

X247 Initialize \texttt{second-indent} in the easy case.

§848 F

X248 Package the equation number.

§1204 F

X249 Don\textemdash \textbf{t} resort to \texttt{v \leftarrow max_dimen} when glue doesn\textemdash \textbf{t} stretch or shrink.

§1148 Q

X250 Insert newline before showing current \texttt{\botmark}.

\texttt{I}

X251 Call \texttt{error} after giving error message.

§784 F

X252 Change implementation of \texttt{\number}; it should \texttt{scan_int}, not something internal.

§471 A

X253 Introduce symbolic constants like \texttt{format_area_length}.

§524 P

X254 Change \texttt{quit} to \texttt{jump_out}, since some compilers treat \texttt{quit} as a reserved word.

§81 P

X255 Add more parentheses to get proper parsing.

§1260 L

X256 Say \texttt{please} in order to be friendly (or at least polite).

§360 I

X257 Don\textemdash \textbf{t} confuse \texttt{cur_vcmd} with \texttt{cur_chr}.

§508 B

X258 Use \texttt{\&} instead of \texttt{!} to specify a preloaded format.

§1337 I

X177 \rightarrow X259 Correct \texttt{s3} to \texttt{s4}.

§88 T

X260 Introduce new primitive \texttt{\mathchardef}, to save space and time.

§1224 G

X261 Use the \texttt{\{} convention for noads as well as nodes.

§692 C

X262 Correct spelling in call to \texttt{primitive: \textbackslash xatopx} should be \texttt{xoverx} [later renamed, thank goodness].

§1178 T

\textbf{30 Aug 1982}

X263 Don\textemdash \textbf{t} fetch \texttt{link(null)} in malformed list.

§175 R

X264 Initialize \texttt{align_state} at a better time so that \texttt{align_peek} doesn\textemdash \textbf{t} see \texttt{&} or \texttt{\span}.

§785, 791 S

X265 Outlaw preamble interfering with \texttt{align_state} = 0.

§789 S

X266 Add level of grouping to alignment to tabskip locality.

§774 C

X267 Check \texttt{align_state} when scanning \texttt{\langle u_j \rangle}.

§783 F

X268 Move \texttt{unsav}e; \texttt{\textbackslash new\_save\_level} from \texttt{main\_control} into \texttt{fin\_col}.

§791, 1131 A

X180 \rightarrow X269 Remember \texttt{cur_chr} when you\textemdash \texttt{\textbackslash u} re looking for optional \texttt{\textbackslash u}.

§1243 S

X270 Change \texttt{q} to \texttt{r} [\texttt{in code now obsolete}].

§804 T

X271 Disable interrupts during \texttt{back_error} so that help messages aren\textemdash \textbf{t} clobbered.

§327 I

X272 Introduce \texttt{slow_print} for printing control sequences.

§60 S

X273 Initialize \texttt{\textbackslash del\_code(" .") \leftarrow 0} for error recovery.

§240 I

X274 Call \texttt{end\_file\_reading} before calling \texttt{check\_outer\_validity}.

§362 S

X275 Don\textemdash \textbf{t} delete an extra \texttt{\textbackslash u} when \texttt{\textbackslash par} will help find a runaway.

§395 I

\textbf{31 Aug 1982}

X276 Don\textemdash \textbf{t} confuse \texttt{\textbackslash thin\_muskip} with \texttt{\textbackslash thin\_muskip\_code}.

§413 B

X266 \rightarrow X277 Recover from error if new \texttt{align\_group} ends abnormally.

§1132 F

X278 Recover from error if \texttt{\textbackslash par} occurs when \texttt{align\_state < 0}.

§1094 I

X279 Make \texttt{\textbackslash hskip\textbackslash the\textbackslash thin\textbackslash muskip} and \texttt{\textbackslash \textbackslash \textbackslash baselineskip} erroneous.

§413 C

X280 Add \texttt{\textbackslash muskip} and \texttt{\textbackslash set\textbackslash muskip} analogs to \texttt{\textbackslash skip} and \texttt{\textbackslash set\textbackslash skip}.

§413, 1228 G

X281 Don\textemdash \textbf{t} output \texttt{pop} right after \texttt{\textbackslash push}.

§601 E

\begin{itemize}
  \item \textit{The TRIP test looks right; now to test for wasted memory.}
  \item When memory should be empty \texttt{I} find \texttt{dyn\_used} = 18, \texttt{var\_used} = 267.
\end{itemize}

\textbf{1 Sep 1982}

\begin{itemize}
  \item \textit{Made special MEMTEX program, designed to track all memory allocation.}
  \item \textit{Delete reference to \texttt{last\_glue} when a page is packaged.}
  \item \texttt{\textbackslash save\_stack} in the \texttt{search\_mem} debugging routine.
  \item \texttt{\textbackslash vfill} in restricted horizontal mode.
\end{itemize}

\begin{itemize}
  \item Most of the memory locations I thought were wasted were actually in good use.
  \item Total 192 hours (approx) debugging time so far since July 15.
\end{itemize}
2 Sep 1982

- Now looking at all zero counts in profile and extending TRIP.

X285 Simplify the creation of vtop boxes. §1087 E
X286 Set space_factor ← 1000 after \hbox. §1076 C
X287 Introduce preamble into DVI format. §617 P
X288 Give special chr_code to \relax. §265 S
X289 Don’t show ‘(null)’ when token list is null, just show nothing. §295 I
X290 Delete the procedure write_name_string, which is never used. E
X291 Rename \xbabelx to \abovevdelim; do the same for \xatopx and \xoverx. §1178 C
X292 Improve clean_box so that it recognizes cleanliness better. §720 Q
X293 Report a Missing delimiter more meaningfully. §1161 I
X294 Give endv_token a chr code of 128 so that it will end a file name. §289 R
X295 Test present of math fonts after parsing an mlist, not before. §1138, 1195 R
X296 Omit ‘recent contributions’ and/or ‘current page’ when they are empty. §218, 986 I
X297 Display what \TeX\ has deleted after improper discretionary list has arisen. §1121 I
X298 Show what math character was undefined. §723 I
X299 Improve the Incompatible magnification error; break it into two lines. §288 I
X300 Put new cases into flush_node_list, to recycle mlist noads. §698 D

6 Sep 1982

X300 → X301 Insert a necessary \texttt{goto done} in that new material. §698 F
- It took two hours to diagnose that \texttt{goto} problem.

X295 → X302 Change ‘2’ to ‘3’ in help message for extension fonts. §1195 T
X303 Add a special note if material is being held over for the next output. §986 I
X304 Divide before multiplying in make_left_right, to avoid overflow. §762 R
X305 Introduce the box_error routine. §992 I
X306 Clear arith_error after overflow has been reported. §460 F
X249 → X307 Don’t confuse stretch with glue_stretch. §1148 B
X308 Set glue_sign ← normal when packaging with glue ratio zero. §558, 664 D
X309 Test for overflow before attaching the sign. §448 A
- That all worked! Now trying min_quarterword negative.

X310 Take absolute value before applying mod in new_trie_op. §944 L
X311 Say qi(c), not c, when testing TFM flags [now obsolete]. §573 L
X312 Initialize token_ref_count(def_ref) to null, not zero. §473 L
X313 Change the type of split parameter n from quarterword to eight_bits. §977 L
X314 Initialize null_delimiter different form null_character. §685 L
X315 Insert qi twice in scan_delimiter. §1160 L
X316 Insert qi in scan_math. §1151 F
X317 Insert qo in fetch. §722, 723 F
X318 Insert qi in set_math_char. §1155 F
X319 Insert qi in math_ac. §1165 F
X320 Insert qo in mlist_to_list. §755 F
X321 Use brackets around 8-bit characters in print_ASCI. §68 I
X322 Include hyph_list in the search_mem debugging routine. §933 I
- Now compiling non-\TRIP\ to try an industrial-strength version.

X323 Add return to final_cleanup, because some Pascal compilers insist that each label be used. §1335 L
X324 Compute partoken when undumping. §1314 D
X325  Emit newline before file name, if near end of line.  §537 I
X326  Define \ifx for arbitrary tokens.  §507 C

11 Sep 1982
X327  Don’t ask users to type x twice before exiting.  §84 I
X328  Install new features \openin, \read, \ifeof, \closein; rename existing \open,
\send, \close to be \openout, \write, \closeout.  §209, 313, 1275 G
X329  Install new feature \expandafter.  §368 G
X330  Change the default file area from ‘<TeX>’ to ‘TeXinputs:’.  §574 P

12 Sep 1982
X331  Install new feature \string.  §472 G
X332  Remove spurious space printed by sprint_cx.  §263 A
  • All tests passed now! But when I played with the system I found another bug
  (undetected by TRIP);
X333  Set r ← s after matching macro parameter tokens.  §397 F

13 Sep 1982
X334  Introduce serial numbers in line-break records, improving readability and
independence.  §846 I
X335  Don’t abort when file_name_size is exceeded.  §519 I

17 Sep 1982
X336  Remove unwanted period from font capacity message.  §567 I

18 Sep 1982
X337  Make \expandafter more powerful by moving it from semantics to syntax [i.e.,
from stomach to mouth].  §368 G

19 Sep 1982
X338  Improve error recovery for ‘Missing number’.  §415 I

22 Sep 1982
X339  Suppress italic correction between letters in math mode except in math fonts.  §752 Q

24 Sep 1982
X340  Define \null = mem_bot, not min_halfword, because there’s a reference to
link(null) in try_break.  §115 P
X341  Initialize str_start[0] ← 0.  §47 D
X342  Avoid blank space at beginning of line.  §638 I
X343  Set type of new box in math mode to ord_noad, not inner_noad.  §1076 D

28 Sep 1982
• Here are the first changes made to the preliminary listing of TeX82 that was
published by the TeX project earlier this month.
X344  Insert the missing cases letter and other_char after x_token looks ahead.  §1038 F
X345  Change ‘\pause’ to ‘\pausing’.  §236 C
X346  Reset overfull_rule when determining tabskip glue.  §804 D
X347  Fix the logic for scanning \ifcase [in obsolete syntax—everything is still done
with braces since \fi’ doesn’t exist yet].  §509 A

30 Sep 1982
X348  Change "0.0" to "?.?" (suggested by DRF).  §186 I

2 Oct 1982
X349  Use conditional thin spacing next to ‘Inner’ noads.  §764 Q
X350  Make thick spaces conditional.  §766 Q
4 Oct 1982
527 Increase trie_size from 7000 to 8000, because of Frank Liang’s improved (but longer) hyphenation patterns.

6 Oct 1982
X330 → 528 Change the string lengths to match the new \TeX\_format_default. §520 F

8 Oct 1982
529 Fix a blunder: I decreased h mod a quarterword when it should have been decreased mod trie_op_hash_size (HWT). §944 B

9 Oct 1982
X258 → 530 Fix a typo (‘!’ not ‘&’) in the \WEB documentation. §524 P

12 Oct 1982
532 Add the ‘\immediate’ feature, by popular request. §1375 G

13 Oct 1982
533 Introduce new \WEB macros so that glue_ratio is more easily changed. §109 P

14 Oct 1982
534 Change the type of hd to eight_bits; it’s not a quarterword (HWT). §649 B

15 Oct 1982
535 Revise the optimization of DVI commands: It’s not always safe to eliminate pop when the preceding byte is push, since DVI commands have variable length! (Embarrassing oversight caught by DRF.) §601 S

16 Oct 1982
536 Test ‘\prev_depth > ignore_depth’, not ‘\neq’. §679 C

21 Oct 1982
X145 → 539 Subtract width(q) from page_goal, don’t add it to page_so_far[1]. §1009 A

22 Oct 1982
540 Increase the amount of lower (variable-size) memory from 12000 to 13000, since the \TeX program listing now needs about 11500. [At this time there still is a fixed boundary between upper and lower memory.] §12 P

26 Oct 1982
542 Fix an off-by-one error caught by Gabi Kuper and HWT. (I forgot ‘+1’). §1317 B

543 Fix the spacing of displayed control sequences: print ces should base its decision on cat_code(p − single_base), not cat_code(p). §262 B

27 Oct 1982
544 Set math_type before saying fetch(nucleus(q)), since fetching can have a side effect. §752 S
28 Oct 1982

**545** Install a major change: Fonts now have identifiers instead of code letters. Eliminate the ‘:\’ primitive, and give corresponding new features to ‘\the’.

- Actually I began making these changes on October 26, but I needed two days to debug them and to put Humpty Dumpty together again.
- At this time I’m also drafting macros for typesetting The \TeXbook.
- The above changes have been incorporated into Version 0.6.

30 Oct 1982

- After years of searching, I’ve finally found a definitive definition of the printer’s point; and (unfortunately) my previous conjecture was wrong. The truth is that 83 pc = 35 cm, exactly; so I am changing \TeX to conform.

**546** Revise unit definitions for the ‘real’ printer’s point.

- Version 0.7 incorporates the above.

1 Nov 1982

- Oops! Retract error #546, and retract \TeX Version 0.7; the source of my information about points was flaky after all. My original suppositions were correct, as confirmed by NBS Circular 570.

4 Nov 1982

**547** Revise the definition of \texttt{dd}, conforming to the definitive value shown me by Chuck Bigelow.

**548** Introduce “frozen” copies of font identifiers, to be returned by \texttt{\the\font}, so that font manipulation is more robust.

5 Nov 1982

**549** Reset \texttt{looseness} and paragraph shape when beginning a \texttt{\vbox}.

6 Nov 1982

**550** De-update \texttt{align_state} when braces are in constants.

**551** Improve error recovery for bad alignments.

**552** Give more power to \texttt{\let}: the right-hand side needn’t be a control sequence.

**553** Amend \texttt{show_context} to say ‘(base_ptr = input_ptr) ∨ ’; otherwise undefined control sequences can be invisible in unusual cases (John Hobby).

**554** Compute demerits more suitably by adding a penalty squared, instead of adding penalties before squaring.

- Previously a slightly loose hyphenated line followed by a decent line was considered worse than a decent hyphenated line followed by a quite loose line.

8 Nov 1982

**555** Save a bit of buffer space by declaring \texttt{pool_file} only in \texttt{INITEX}.

11 Nov 1982

**556** Introduce a new context indicator to clarify \TeX’s scanning state: A special type called \texttt{backed_up} is distinguished from other kinds of \texttt{inserted} lists; it is called ‘recently read’ or ‘to be read again’, while others are called ‘inserted’.

**557** Append a comment, ‘\texttt{treated as zero}’, to the missing-number message.

**558** Ignore the settings of \texttt{\hfuzz} or \texttt{\vfuzz} if \texttt{\hbadness} or \texttt{\vbadness} is less than 100.

13 Nov 1982

- Major surgery on the program is planned for today, because of new ideas suggested by correspondence with MDS and other macro writers.

**559** Introduce a new \texttt{\tokens} register; this will be useful and easy to add, since \TeX already can handle \texttt{\everypar} and \texttt{\output}.
X34 → 560 Change \get_x_token to \get_token when scanning an optional space; then a construction like \def\foo{...}\foo won’t complain that \foo is undefined. §443 C

- This change was retracted when it was being debugged, because it could cause \endv to abort the job. Then it was re-established again when I found that \endv needed to be more robust anyway. [But it was eventually rescinded again.]

561 Make \span mean ‘expand’ in a preamble. §782 G

562 Use three separate if tests instead of ‘\&’ in the inner loop of \get_next, to gain efficiency. §342 E

563 Introduce \get_r_token so that assignments have uniform error messages and so that frozen equivalents cannot be changed. §1215 R

- I gave a few variables more mnemonic names as I made these changes.

564 Move conditional statements from the semantics (‘stomach’) part of \TeX to the syntax (‘mouth’) part, by introducing ‘\fi’. Also introduce \csname and \endcsname. §372, 489–500 C

- This makes macros much more predictable and logical, but it is by far the most drastic change ever made to \TeX. The program began to come back to life only after three days of solid hacking.

- Several other things were cleaned up as part of this change because it is now more natural to handle them differently. For example, a null control sequence has now become more logical.

- The result of all this is called Version 0.8.

18 Nov 1982

- Today I resumed writing Chapter 8. Tomorrow I’m 2¹⁴ days old!

21 Nov 1982

565 Declare c as a local variable for hyphenation (DRF). §912 F

566 Omit the “first pass” and try hyphenations immediately, if \pretolerance is negative (suggested by DRF). §863 E

567 Don’t ship out huge pages; they might foul up DVI files. §641 R

2 Dec 1982

568 Add new features \everymath and \everydisplay. §1139, 1145 G

569 Add a new feature \futurelet. §1221 G

- The changes above have been incorporated into Version 0.9 of \TeX.

7 Dec 1982

570 Add a new \endinput primitive (suggested by FY). §362, 378 G

8 Dec 1982

571 Try off\save, if \par occurs in restricted horizontal mode. (This avoids embarrassment if \TeX says ‘type a command or say \end’, then when you type \end it says you can’t!) [However, I soon retracted this change.]

21 Dec 1982

572 Redefine \relax so that its chr field exceeds 127. (This facilitates the test for end in scan_file_name.) §265 A

566 → 573 Call \begin_diagnostic when omitting the first pass of line breaking. §863 F

574 Fix the logic of glue scanning: In \hskip-1pt plus2pt the minus should apply only to the 1pt. §461 A

23 Dec 1982

575 Renumber the decimal codes in paragraph statistics for loose and tight lines; they were ordered backwards. §817 I

576 Treat a paragraph that ends with leaders like a paragraph that ends with glue. §816 C

577 Allow commas as alternates to radix points, for Europeans. §438 C
578 Change \hangindent to a normal dimension parameter. [It had been a combination of \hangindent and \hangafter, with special syntax.] §247 C
579 Make \prevgraf accessible to users. §422, 1244 G
580 Split \clubpenalty off from \widowpenalty. §890 G
  * I’m typing Chapter 14 while making these changes.

24 Dec 1982
581 Use back_input instead of goto reswitch when inserting \par may have changed. §1095 S
582 Don’t prompt for a new file name if \openin doesn’t find a file. §1275 I
583 Add a new \jobname primitive. §472 G
584 Give the user a way to delete the dollar sign, when \TeX decides to insert one. §1047 I
585 Allow optional equals after \parshape, and implement \the\parshape. §423, 1248 C

26 Dec 1982
586 Add an if_line field to the condition stack entries, so that more informative error messages can be given. §489 I
549 → 587 Introduce a normal_paragraph procedure, since initialization is needed also within \insert, \vadjust, \valign, \output. §1070 D

27 Dec 1982
588 Give users access to \pagetotal and \pagegoal. (Analogous to #679 and #585, but simpler.) §1245 G
X199 → 589 Introduce \tracingpages, allowing users to see page-optimization calculations. Also split \tracingparagraphs off from \tracingstats. §987, 1005, 1011 I
  * The changes above have been incorporated into Version 0.91 of \TeX.

31 Dec 1982
590 Break the \buildpage procedure into two parts, by extracting the section now called fire_up. [This is necessary because some Pascal compilers, notably for IBM mainframes, cannot deal with large procedures.] §1012 P
564 → 591 Make \ifodd\else legal by introducing if_code. §489 S
592 Improve alignments when columns don’t occur: Don’t append null boxes for columns missing before \cr, and zero out the tabskip glue after nonpresent columns. §802 Q
593 Make the error message about overfull alignment more intelligible. §801, 804 I
  * The changes above have been incorporated into Version 0.92 of \TeX82, which was the last version of 1982, completed at 11:59pm on December 31.

3 Jan 1983
  * Today I’m beginning to write Chapter 15, and planning the \output routine of plain.tex.
X186 → 594 Change the logic of its_all_over; use max_dead_cycles here too, instead of the fixed constant 100. §1054 C
X34 → 595 Don’t forget to pop_nest when an insert is empty. Also disallow optional space after \insert n {...}. §1100 F

4 Jan 1983
541 → 596 Use the \boxmaxdepth that’s declared inside a \vbox when packaging it. §1086 C
597 Rename \groupbegin and \groupend as \begingroup and \endgroup. §265 C
598 Make \deadcycles accessible to users. §1246 G
599 Base the split insertions on natural height plus depth, not on delta. §1010 Q
  * The changes above have been incorporated into Version 0.93.
6 Jan 1983

600 Add push_math to handle a case where I forgot to clear incompleat_node. (This long-standing bug was unearthed today by Phyllis Winkler.) §1136 D

588 → 601 Add \pageshrink, etc., too. §1245 G

602 Introduce new parameters \floatingpenalty, \insertpenalties. Also adopt a new internal representation of insertion nodes, so that \floatingpenalty, \splittopskip and \splitmaxdepth can be stored with each insertion. §140, 1008 G

7 Jan 1983

603 Improve the rules for entering new_line, in particular when the end-of-line character is active. §343 Q

9 Jan 1983

604 Distinguish between implicit and explicit kerns. §155, 896 Q

605 Change the name \ignorespace to \ignorespaces. §265 C

560 → 606 Don’t omit a blank space after \def, \message, \mark, etc.; the previous hodgepodge of rules is impossible to learn. §473 C

• The above changes appear in Version 0.94.

12 Jan 1983

• Beginning to write the chapters on math today.

607 Add a new feature: active characters in math mode. §1151 G

15 Jan 1983

608 Fix a surprise bug: ‘$1-$’ treated the – as binary. §729 A

609 Initialize space_factor inside discretionaries. §1117 D

16 Jan 1983

610 Fix an incredibly embarrassing bug: I forgot to update spotless in the error routine!

• While fixing this, I decided to change spotless to a more general history variable, as suggested by IBMers who want a return code. §76, 82, 1335

611 Replace two calls of confusion by attempts at error recovery, in places where ‘This can’t happen’ could actually happen. §1027, 1372 I

18 Jan 1983

612 Introduce the normalize selector routine to protect against startup anomalies when the transcript file isn’t open. Also make open_log_file terminate in some cases. §92, 535 R

591 → 613 Insert \relax, not a blank space, to cure infinite loop like \ifeof\fi (LL). §510 R

614 Change the old \limitswitch to \limits, \nolimits, and \displaylimits. Incidentally, this fixes a bug in the former positioning of integral signs. §682, 749 G

615 Give a \char in math mode its inherited \mathcode. §1151 C

525 → 616 Make underline, overline, radical, vcenter, accent noads and {...} all revert to type Ord instead of type Inner. Introduce a new primitive \mathinner. (This fixes the spacing, which got worse in some ways after change #525.) §761 Q

• I’m working on Appendix G today.

19 Jan 1983

617 Introduce a \mathchoice primitive. §1174 G

618 Move \input from the stomach to the mouth. §378 C

X260 → 619 Introduce \chardef, analogous to \mathchardef. §1038, 1224 C

620 Change \unbox to \unbox and \unvbox; also add \unhcopy. §1110 G

621 Consider \spacefactor, \pagetotal, etc., as part of prefixed_command, even though they are always global. §1211 C
20 Jan 1983
622 Switch modes when \hrule occurs in horizontal mode or \vrule in vertical.

623 Add a new \globaldefs feature.

21 Jan 1983
624 Optimize the code, in places where it’s important (based on frequency counts
of \TeX usage accumulated during the past week): Introduce \fast_get_avail
and \fast_store_new_token; reduce procedure-call overhead in begin_token_list,
end_token_list, back_input, flush_node_list; change some tests from ‘if a \& b’
to ‘if a then if b’.

22 Jan 1983
625 Save space in math lists: Don’t insert penalties within restricted horizontal
mode; simplify trivial boxes.

626 Fix a surprising oversight in the rebox routine: Ensure that b isn’t a vbox.

545 \rightarrow 627 Make \nullfont a primitive, so that \carfont always has a value. (This is a
dramatic improvement over \TeX78, where a missing font was a fatal error
called ‘Whoa’!)

24 Jan 1983
586 \rightarrow 628 List all incomplete \if’s when the job ends.

29 Jan 1983
552 \rightarrow 629 Change initialization of align_state so that \halign\bgroup works.

30 Jan 1983
625 \rightarrow 630 Be sure to test ‘is_char_node(q)’ when checking for a trivial box.

* By extraordinary coincidence, this bug was caught when somebody used font
number 11 (= kern_node) in the second character of a list of length 2!

X168 \rightarrow 631 Improve format for stats at end of run, as suggested by DRF.

632 Don’t ignore the space after a control symbol (except ‘\’).

633 Remove all trailing spaces at the right of input lines, so that there’s perfect
compatibility with IBM systems that extend short lines with spaces.

3 Feb 1983
634 Assume that a \math_accent was intended, after giving an error message in the
case \if mmode + accent.

635 Add new primitives \iftrue and \iffalse.

6 Feb 1983
X304 \rightarrow 636 Improve the accuracy of fixed-point arithmetic when calculating sizes for \left
and \right. (I had started by dividing \delimiter_factor, not \delta, by 500.) 762 A

12 Feb 1983
637 Change the name \delimiterlimit to \delimitershortfall.

638 Make \abovewithdelims.. equivalent to \above; change the order of operands
so that delimiters precede the dimension.

607 \rightarrow 639 Remove the kludgy math codes introduced earlier; make \fam a normal integer
parameter and allow \mathcode to equal 2^{15}.

640 Don’t let \spacefactor become more than 2^{15}.

* I finished drafting Chapter 17 today.

14 Feb 1983
639 \rightarrow 641 Replace octal output (print_octal) by hexadecimal (print_hex) so that math
codes are clearer.

619 \rightarrow 642 Don’t forget char_given in the math_accent routine.
17 Feb 1983

622 → 643 Switch modes when `\halign` occurs in horizontal mode, or `\valign` in vertical mode. §1090, 1094 C

18 Feb 1983

644 Add a new feature `\tracingrestores`. This requires a new procedure called `show_eqtb`, whose code can be interspersed with the `eqtb` definitions. §252 I

25 Feb 1983

622 → 645 Suggest using `\leaders` when the user tries a horizontal rule in restricted horizontal mode. §1095 I

27 Feb 1983

646 Specify the range of source lines, when giving warning messages for underfull or overfull boxes in alignments.

• Why did it take me all day to type the middle part of Chapter 18?

4 Mar 1983

647 Introduce a new feature `\xcr` (suggested by LL). [Changed later to `\crcr`] §785 G

631 → 648 Subtract out `\TeX`'s own string requirements from the stats. §1334 I

6 Mar 1983

649 Add new features `\everyhbox` and `\everyvbox`. §1083, 1167 G

9 Mar 1983

X295 → 650 Avoid accessing `math_quad` when the symbol fonts aren't known to be present. §1199 R

533 → 651 Introduce `float` and `unfloat` macros to aid portability (HWT). §109 P

652 Introduce new names `\abovedisplayskip` and `\belowdisplayskip` for the old `\dispkip`; also `\abovedisplayshortskip` and `\belowdisplayshortskip` for the old `\dispshortkip` and `\dispshortskip`. §226 C

10 Mar 1983

653 Unbundle `\romannumeral` from `\number` (suggested by FY). §468 C

12 Mar 1983

654 Ignore leading spaces in `scan_keyword`. §407 C

14 Mar 1983

631 → 655 Use `write` and `write\ln` directly when printing stats. §1334 E

16 Mar 1983

602 → 656 Refine the page-break cost function (introducing ‘deplorable’, which is not quite ‘awful_bad’), after suggestion by LL. §974, 1005 Q

• The changes above have been incorporated into Version 0.96.

18 Mar 1983

657 Add a new feature `\everyjob` suggested by FY. §1030 G

19 Mar 1983

658 Don’t treat left braces specially when showing macros. §294 I

659 Ignore blanks that would otherwise become undelimited arguments. §393 C

21 Mar 1983

X280 → 660 Make `\lastskip` handle `\mu\text{glue}` as well as ordinary glue. §424 F

561 → 661 Expand only one level in a preamble `\span`. §782 C

22 Mar 1983

662 Let a single `#` suffice in `\tokens`, `\message`, etc. (The previous rule, in which `##` was always required as in macros, was a loser especially in `\write` where you had to say `####\)`) §477 C
X328 $\rightarrow$ 663 Require the keyword ‘to’ in \read. (This will avoid the common error of an incomplete constant when no space appears before the \cs.) Also allow terminal I/O as a default when a stream number is out of range. §482, 1225, 1370 C

26 Mar 1983

664 Replace \ifeven(countnumber) by \ifodd(number), for better consistency of language. §504 C

564 $\rightarrow$ 665 Introduce the change_if_limit, to overcome a big surprise bug relating to \if\if aabc\fi.

- Such examples show that cur_if might not be current, in my original implementation.

28 Mar 1983

X326 $\rightarrow$ 666 Tolerate non-characters as arguments to \if and \ifcat. §506 G

667 Change ‘absent’ to ‘void’, a better word. §487 C

668 Clear the shift_amount in \lastbox, since I don’t want to figure out what it means in all cases. §1081 C

29 Mar 1983

669 Wake up the terminal before giving an error message. (This means a special print_err procedure is introduced.) (Suggested by DRF.) §34, 73 I

1 Apr 1983

- Today I finished Chapter 21 (boxes) and began to draft Chapter 22 (alignments).

670 Allow periodic preambles in alignments. §793 G

671 Make \leaders line up according to the smallest enclosing box. §627, 636 C

672 Allow hyphenation after whatsis (e.g., after items for an index). §896 Q

2 Apr 1983

673 Call build_page when \par occurs in vertical mode. §1094 Q

674 Clear aux in inst_row, for tidyness. §786 C

4 Apr 1983

675 Let digits switch families in math mode. §232 C

7 Apr 1983

602 $\rightarrow$ 676 Refine the test for not splitting an insertion. §1008 Q

8 Apr 1983

647 $\rightarrow$ 677 Rename \xcr as \crcr, at LL’s request. §780 C

9 Apr 1983

- Took a day off and had a chance to help print a sample page on a 150-year-old letterpress in Murphys, California.

11 Apr 1983

678 Recover more sensibly after a runaway preamble. §339 I

12 Apr 1983

X328 $\rightarrow$ 679 Make \read span several input lines, if necessary to get balanced braces. §482 C

14 Apr 1983

680 Fix a subtle bug found by JS: $\S882$ can make q a char_node, so we need to test ‘if $\neg$is_char_node(q)’. [Actually I discovered much later that the real bug was to omit ‘else’ at this point.] $\S881$ S

15 Apr 1983

681 Make \uppercase and \lowercase apply to all characters, regardless of category. §1289 C
THE ERRORS OF \TeX

- 7:30am. After working all night, I completed a draft of the manual thru Chapter 22, for distribution to volunteer readers.
- 5pm. The changes above have been incorporated into Version 0.97.

17 Apr 1983

682 Change ‘small
umber’ to ‘0...65’ in the hyphenation routine (DRF).

683 Flush patterns in the input when the user tries \patterns outside of INITEX
(suggested by DRF).

- Tomorrow I fly to England, where I’ll lecture and write a paper about ‘Literate Programming’ [Comp. J. 27 (1984), 97–111].

14 May 1983

663\rightarrow 684 Improve the behavior of \read from terminal (suggested by Todd Allen at Yale). [I’d forgotten to implement the extended stream numbers in #663. Also, the prompt is now omitted if n < 0.]

18 May 1983

685 Restrict \write n to the transcript file only, if n < 0.

X188\rightarrow 686 Unify the syntax for registers and internal quantities. (Remove primitives called \insthe and \minusthe; rename scan_the to scan_something_internal, and change its interface accordingly; clean up command codes generally.) §209, 413 C

687 Introduce new parameters \hoffset, \voffset.

24 May 1983

688 Introduce a new parameter \everycr (suggested by MDS).

- Many macro writers and preliminary-manual readers have been requesting new features; I’ll try to keep the language as concise and consistent as possible.

25 May 1983

689 Introduce \countdef, \dimendef, etc. (suggested by DRF long ago, easy now in view of #686).

690 Introduce \advance, \multiply, \divide (suggested by FY).

691 Introduce \hyphenchar: this requires a new command assign_font_int, plus minor changes to about 15 modules.

692 Introduce \skewchar (easy because of #691).

693 Introduce \noexpand. (I had difficulty thinking of how to implement this one!)

694 Introduce \meaning.

X231\rightarrow 695 Remove ‘dm’ and ‘vu’; allow the more general ‘.5\hsize’.

696 Change ‘\texinfo f n’ to ‘\fontdimen n f’.

27 May 1983

697 Add a new feature \afterassignment (suggested by ARK).

619\rightarrow 698 Adjust the timing so that commands like \chardef xx=5\xx behave sensibly.

28 May 1983

699 Ignore ‘\relax’ as if it were a space, in math mode and in a few other places where \relax would otherwise be erroneous.

700 Improve \mathaccent spacing with respect to subscripts and superscripts (suggested by HWT).

30 May 1983

598\rightarrow 701 Terminate a job only when dead_cycles = 0.

- The changes above constitute Version 0.98.

3 Jun 1983

- I finished the draft of Chapter 23 (output routines) today.
Allow \mark and \insert and \vadjust in restricted horizontal mode, and also in math mode. (This is a comparatively big change, triggered by the fact that \mark in a display presently causes \TeX to crash with ‘This can’t happen’!) The global variable adjust_tail is introduced. §796, 888, 1085

6 Jun 1983

695 \rightarrow 703 Replace (and generalize) the previous uses of \ht, \wd, and \dp in dimensions by introducing the new control sequences \\ht, \\wd, and \\dp. §1247

704 Display sub-parts of noads with the symbols ‘ and _ instead of ( and [. §696

694 \rightarrow 705 Allow A..F in hex constants to be other char as well as letter. §445

7 Jun 1983

654 \rightarrow 706 Remove an instance of ⟨Scan optional space⟩, since it’s now redundant. §457

707 Legalize \makern\thimnuskip and \makern5\thimnuskip. §456

708 Clean up the treatment of optional spaces in numerical specifications. §455

• A construction like 2.5\space\space\dimen0 was previously valid after ‘plus’ or ‘minus’ only!

• I’m obviously working on Chapter 24 today.

545 \rightarrow 709 Allow ‘\font’ as a ⟨font identifier⟩ for the current font. §577

623 \rightarrow 710 Don’t make \gdef global when global_defs < 0. §1218

711 Produce zero_glue as the outcome of \advance\spaceskip by \-\spaceskip. §1229

712 Make \show do something appropriate for every possible token. §1294

559 \rightarrow 713 Replace the (single) \tokens parameter by an array of 256 token registers. §230

714 Allow \indent in math mode; also make \valign in math mode produce the ‘Missing $’ error. §1046, 1093

715 Remove redundant code: There’s no need to check \cur_group or call \offsave when starting alignments or equation numbers in displays. §1130, 1142

8 Jun 1983

716 Disallow \openout-1 and \closeout-1. §1350

717 Disallow \lastbox in math mode. §1080

9 Jun 1983

718 Call back_error, not error, when \leaders aren’t followed by proper glue. §1078

719 Initialize for a possible paragraph, after \noalign in a \valign. §785

10 Jun 1983

708 \rightarrow 720 Expand the optional space after an ASCII constant. §442

12 Jun 1983

721 Set space_factor ← 1000 after a rule or a constructed accent. §1056, 1123

14 Jun 1983

722 Correct a serious blunder: Set disc_width ← 0 before testing if s is null (caught by JS). §869

• This is a real bug that existed since the beginning! It showed up on page 37 of the Version 0 \TRIP manual, but I didn’t notice the problem.

708 \rightarrow 723 Make optional spaces after \dimen like those after \number. §448

568 \rightarrow 724 Insert every_display before calling \build_page. §1145

648 \rightarrow 725 Report \TeX’s capacity on overflow errors in a way that’s fully consistent with other statistical reports. §42

17 Jun 1983

726 Make all \tracing decisions on the basis of ≥ versus <, not ≠ versus =. §581

• Today I finished the draft of Chapter 27 (the last chapter)!

• The changes above were released as Version 0.99 on June 19, 1983.
20 Jun 1983

727 Set \catcode`\%=14 in INITEX. §232 C

587 \rightarrow 728 Call normal_paragraph when \par occurs in vertical mode. §1094 C
  • Once again I’m retiring about 8am and awaking about 4pm.

21 Jun 1983

558 \rightarrow 729 Don’t append an overfull rule solely because of \hbadness. §666 C

730 Don’t allow the glue-ratio of shrinking to be less than −1. §810, 811 R

22 Jun 1983

653 \rightarrow 731 Declare the parameter to print_roman_int to be of type integer, instead of nonnegative_integer (found by Debby Clark). §69 B

690 \rightarrow 732 Make the keyword ‘by’ optional (suggested by LL). §1236 C

24 Jun 1983

733 Say ‘preloaded’ when announcing format_ident. §1328 I

25 Jun 1983

734 Add extra boxes and glue to the output of alignment. [This thwarts possible attempts at trickery by which system-dependent glue set values computed by \span could have gotten into T\TeX’s registers by things like \align and \vsplit. It also has the advantage of perfect accuracy in alignment of vertical rules.] §809 R

735 Make leaders affect the height or width of the enclosing boxes. §656, 671 C
  • Today I’m mainly installing a much-improved format for change files in WEB programs (suggested by DRF).

28 Jun 1983

736 Permit \unskip in vertical mode when we know that it does nothing. §1106 C

1 Jul 1983

700 \rightarrow 737 Avoid redundant boxes when things like ‘\bf A’ occur in math. §1186 E

738 Add a ‘scaled’ feature to \font input. §1258 G

700 \rightarrow 739 Remember to correct delta when an accented box changes. §742 D

2 Jul 1983

740 Introduce bypass_colon, to remove anomalous behavior on input files of length 1. (Suggested by DRF after the problem was discovered by LL). §31 R

4 Jul 1983

741 Allow codes like ^\b as well as ^\B. §352, 355 G

742 Introduce new parameters \escapechar, \endlinechar, \defaulthyphenchar, and \defaultskewchar, to make T\TeX less dependent on the character set. (This affects many modules, since a lot of error messages must be broken up so that they use print_esc.) G

7 Jul 1983

743 Use a system-dependent function erstat when opening or closing files (suggested by DRF). §27 P

11 Jul 1983

• The computer is back up after more than 50 hours down time (due to air conditioning failure).

744 Show total glue in the output of \tracingpages. §985 I

745 Guard against insertion into an hbox. §993 R

746 Legalize the assignment {tokenvar}=⟨tokenvar⟩. §1227 C

747 Introduce a new parameter \errhelp. §1283 I

623 \rightarrow 748 Don’t forget to check global_defs when \tabskip is changed. §782 F
12 Jul 1983

749 Allow an \outer macro to appear after \string, \noexpand, and \meaning
(Todd Allen). §369, 471 C

750 Make ‘the’ an expandable control sequence (i.e., move it from the stomach to
the throat); this cleans up several annoying glitches. §367 C

620 → 751 Allow \unhbox and \unhcopy in math mode if the box is void. §1110 C

13 Jul 1983

• I lectured for four hours at the TUG meeting today after very little sleep!

16 Jul 1983

• The following were suggested by TUG meeting discussions.

752 Round the value of default_rule more properly: It should be 26215. §463 L

700 → 753 Fix \mathaccent again; it’s still not right! The final height should be the
maximum of the height of accented letter without superscript and the height
of unaccented letter with superscript. §742 Q

754 Add a new feature \newlinechar. §59 G

755 Allow boxes and rules in discretionaries (suggested by somebody from Hewlett-
Packard). §1121 G

756 Show all token expansions, not just macros, when \tracingcommands. §367 I

757 Allow \char in a \hyphenation list. §935 C

758 Introduce a new feature \aftergroup; it can be implemented with \save_stack. §326 G

759 Run the running dimensions to alignment boundaries (suggested by ARK). §806 C

17 Jul 1983

760 Zero out hyf values at the edges, so that weird pattern data cannot lead to
Pascal range checks. §965 R

X28 → 761 Decrease the hc codes for hyphenation, so that code 127 cannot possibly be
matched. §937, 962 R

672 → 762 Allow whatsit after hyphenatable words. §899 C

604 → 763 Represent an italic correction as an explicit kern. §1113 C

18 Jul 1983

764 Allow lowercase letters in file names. §519 C

765 Change the message ‘No output file’ to: ‘No pages of output’. §642 I

766 Confirm that a quiet mode is being entered, when error interaction ends with
Q, R, or S (suggested by ARK). §86 I

• Version 0.999 was finally installed today; a new program listing has been
printed.

• From now on, I plan to keep all section numbers unchanged.

• I’m done writing Appendix H; beginning to revise Chapter 20.

25 Jul 1983

663 → 767 Allow space after ‘to’ in the \read command (FY). §1215 C

• To bed at 1pm today.

27 Jul 1983

665 → 768 Stack the current type of \if; this precaution is necessary in general (FY). §498 S

• To bed at 2pm today.

29 Jul 1983

769 Avoid putting a control sequence in the hash table when it occurs after \ifx.
Requested by Math Reviews people.) §507 E

• Finished a version of The \TeXbook lacking only Appendices D, E, and I, for
distribution to interested readers.

• To bed at 10:30pm, planning to arise regularly at 6am for a change.
31 Jul 1983
766 → 770 Call `update_terminal` when going quiet (HWT). §86 I

1 Aug 1983
771 Don’t put an empty line at the end of an `\input` file! (This simplifies the rules and the program, and also gets around a bug that occurred at the end of files with `end_line_char < 0`.) §362 C

* The changes above went into Version 0.9999, which was widely distributed.

16 Aug 1983
665 → 772 Rectify a ridiculous gaffe: I initialized `q` every time the loop of `change_if_limit` was performed! (Found by FY.) §497 B

648 → 773 Distinguish `string` from `strings` when reporting statistics. §1334 I

774 Introduce `lx`, to correct a bug in `\xleader` computations (found by FY). §627 A

20 Aug 1983
775 Don’t forget to apply `/` to ligatures. §1113 F

* Today I began to read all previous issues of TUGboat, in preparation for Appendix D.

27 Aug 1983
776 Add debugging hack number 16, to help catch subtle data structure bugs. §1339 I

777 Remove redundant setting and resetting of `name_in_progress`. §531 E

618 → 778 Suppress `\input` during a font size spec; otherwise `cur_name` is clobbered (found by MDS). §1258 S

779 Introduce new conditionals `\ifhbox` and `\ifvbox`. §505 G

29 Aug 1983
780 Test for an empty list, if emptiness will mess up the data structure. (Found by Todd Allen.) §478 D

624 → 781 Use `fast_store_new_token` in another place for efficiency. §466 E

782 Say `has only` instead of `has`.

* These changes yield Version 0.99999, used only at Stanford.

30 Aug 1983
783 Make funny blank spaces showable. §298 C

31 Aug 1983
754 → 784 Make `\newlinechar` affect `print_char`, not just `print`. §58 C

4 Sep 1983
785 Add new features `\lastkern`, `\lastpenalty`, `\unkern`, `\unpenalty`. §424, 996, 1105 G

* OK, Appendix D is finished!!

* The above changes have been installed in Version 0.999999.

17 Sep 1983
548 → 786 Don’t bother making duplicate font identifiers; that was overkill, not really needed. §1258 P

* Will this be the historic last change to \TeX?

18 Sep 1983
787 Correct a minor inconsistency, `display` not `displayed`. §211 I

20 Sep 1983
604 → 788 Treat the kerns inserted for accents as explicit kerns. §1125 C

26 Sep 1983
789 Change `log` to `transcript` in several messages. §535, 1335 I

* The index was finished today; I mailed the entire \TeX{}book to Massachusetts for final proofreading before publication.
1 Oct 1983

790 Prevent uninitialized trie positions in case of overflow (found by Bernd Schulze). §944 D

7 Oct 1983

• Henceforth our weekly ‘\TeX{} lunch’ meetings will be called ‘\METAFONT{} lunch’.
• \METAFONT{} begins to produce The \TeX{}book on our APS phototypesetter.

14 Oct 1983

633 → 791 Ignore spaces at the ends of lines also in \TEX{} POOL (found by DRF). §52 P
610 → 792 Initialize the \texttt{history} variable at \texttt{start} here (DRF). §1332 D

18 Oct 1983

793 Extend runaway to catch runaway text (suggested by FY). §306 I
794 Reset \texttt{cur} cs after \texttt{back} input, not after scanning the ‘\texttt{=’} (found by FY). §1226 D

24 Oct 1983

638 → 795 Change the error recovery for bad delimiters, in accordance with the changed syntax. (Found by Barry Smith.) §1183 I

9 Nov 1983

796 Optimize the code a bit more, based on empirical frequency data gathered during September and October: In §45, use the fact that the result is almost always true. In §380, delete ‘while true do’ since many compilers implement that badly. Rewrite §852 to avoid calling \texttt{badness} in the most common case. §45, 380, 852 E

3 Dec 1983

797 Don’t forget to call \texttt{error} after the message has been given (noticed by Gabi Kuper).
• Version 1.0 released today incorporates all of the above. §500 F
• Dinner party with 36 guests to celebrate \TeX{}’s coming of age.

9 Dec 1983

798 Reinstall \font precautions that I thought were unnecessary. I overlooked many problematic possibilities, like ‘\texttt{\font\a=x \global\a} \the\font’ and ‘\texttt{\font\a=x \font\b=x \let\b=\undefined \the\a}’, etc. (Found by Mike Urban.) The new remedy involves removal of the \texttt{font_ident} array and putting the identifiers into a frozen part of the hash table; so there’s a sprinkling of corrections in lots of modules. But basically the change is quite conservative, so it shouldn’t spawn any new bugs (it says here). §222, 267, 1257 S

2 Feb 1984

799 Remove the possibility of double interrupt, in a scenario found by Clint Cuzzo. §1031 S

12 Feb 1984

800 Improve spacing in a formula like $(A,<)$. §764 Q

13 Feb 1984

801 Avoid a bad \texttt{goto}, as diagnosed by Clint Cuzzo and George O’Connor. (Must not go directly to \texttt{switch}.) §346 A
802 Conserve string pool space by not storing file name in two guises (suggested by DRF). §537 E

26 Feb 1984

803 Make scaled output look cleaner by printing fewer decimals whenever this involves no loss of accuracy. (Suggested by \METAFONT{} development.) §103 I
2 Mar 1984
804 Maintain 17-digit accuracy, not 16; now constants like ‘.00000762939453126pt’ will round correctly. §452 R

16 Mar 1984
805 Plug a loophole that permitted recursion in get_next, by disallowing deletions in check_outer_validity. §336 R

24 Mar 1984
806 Open the terminal before trying to wake it up, when the program starts bad. §1332 I

27 Mar 1984
807 Check that \( k < 63 \), to avoid the \texttt{\patterns{xxx...xxdxxxdxxx}} anomaly found by Jacques Désarménien. §962 R

11 Apr 1984
808 Supply code for the missing case adjust_node in copy_node_list. §206 F

11 Jun 1984
627 \( \mapsto \) 809 Initialize char_base, etc., for \texttt{null_font}. (Found by Nick Briggs.) §552 D
810 Clear the buffer array initially (Briggs). §331 R

21 Jun 1984
811 Look ahead for ligature or kern after a \texttt{\chardef}'d item (Désarménien). §1038 C

4 Jul 1984
812 Make the quarterword constraint explicit with a new ‘bad’ case (19). §111 R

7 Jul 1984
813 Optimize firm_up_the_line slightly, to be consistent with the METAFONT program. §363 E

8 Jul 1984
814 Give additional diagnostics when \texttt{\tracingmacros}>1. §323 I

27 Jul 1984
815 Say ‘see the transcript file’ after handling offline \texttt{\show} commands. (Suggested by METAFONT.) §1298 I

20 Oct 1984
816 Allow ‘0’ in response to error prompts. §84 I

25 Nov 1984
817 Don’t forget to check for \texttt{null} before looking at subfields of a node. (This was “dirty Pascal,” with two quarterword 0’s read as a halfword.) §846 R
818 Ditto in another place! §939 R
819 Remove the fixed-at-compile-time partition between lower and upper memory. §116, 125, 162 E

20 Dec 1984
820 Keep the node_size field from overflowing if the lower part of memory is too large. §125 R

5 Jan 1985
821 Improve the missing-format-file error (DRF). §524 I
7 Jan 1985

822 Update the terminal right away so that the welcoming message will appear as soon as possible (DRF). §61 I

23 Jan 1985

823 Convey more uncertainty in the help message at times of confusion. §95 I

610 → 824 Improve the history logic in the warning_issued case. §245 I

18 Feb 1985

810 → 825 Stick to standard Pascal: Don’t use first in a for loop. [Some procedures “threaten” it globally, according to British Standard 6192, section 6.8.3.9.] (Pointed out by CET.) §331 P

11 Apr 1985

826 Prevent nonexistent characters from being output by unusual combinations of ligatures and hyphenation. §915 S

15 Apr 1985

819 → 827 Compute memory usage correctly in INITEX; the previous number was wrong because of a WEB text macro without parentheses (DRF). §164 L

16 Apr 1985

828 Speed up flush_list by not calling free_avail (DRF). §123 E

17 Apr 1985

788 → 829 Introduce a special kind of kern for accent positioning; it must not disappear after a line break. §837, 879, 1125 A

18 Apr 1985

755 → 830 Prevent \lastbox and \unkern from removing discretionary replacements. §1081, 1105 R

• That completes Version 1.4.

26 Apr 1985

831 Don’t try TeX_area if a nonstandard file area has been specified (DRF). §537 C

• That was #401 in TeX78: I never learn!

30 Apr 1985

754 → 832 Eliminate the limitation on \write length; the reason for it has disappeared (Nancy Tuma). §1370 C

8 May 1985

819 → 833 Allocate two words for the head of the active list (CET). §162 D

11 May 1985

834 Change uterm to uterm_in after a bad beginning (Bill Gropp). §1332 I

806 → 835 Don’t open the terminal twice (CET). §1332 E

22 May 1985

836 Test for batch_mode after trying to open the transcript file, not before (DRF). §92 R

837 Be prepared for string pool overflow while reading the command line! (This bug was first found in METAFONT, when it could occur more easily.) §525 R

7 Aug 1985

838 Fix a bug in \edef{foo}{\iffalse\fi\the\toks0}: TeX should stay in the loop when expanding non-\the. (Found by Dan Brotsky.) §478 A

• The above changes were incorporated in Version 1.5.

27 Nov 1985

764 → 839 Make ‘plain’ a lowercase name, for consistency with the manual. §521 C

669 → 840 Wake up the terminal for \show commands. §1294, 1297 I
• The above changes were incorporated in Version 2.0, which was published as Volume B of the Computers & Typesetting series.

15 Dec 1986

841 Punctuate the Poirot help message more carefully. §1283 I

28 Jan 1987

842 Make sure that \maxinopen doesn’t exceed 127 (DRF). §14 R

843 Don’t allow a \kern to be clobbered at the end of a pre-break list when a discretionary break is taken. (A missing ‘\else’ was the source of the error, diagnosed incorrectly before.) §881 D

844 Take account of discarded nodes when computing the background width after a discretionary. §840 D

• That was the first really serious bug detected for more than 17 months! I found it while experimenting with right-to-left extensions.

• Version 2.1 was released on January 26, 1987.

5 Feb 1987

845 Remove cases in shorthand_def that cannot occur (found by Pat Monardo). §1224 E

14 Apr 1987

846 Improve robustness of data structure display when debugging (Ronaldo Amá). §174, 182 R

21 Apr 1987

847 Make the storage allocation algorithm more elegant and efficient. §127 E

22 Apr 1987

848 Calculate the empty-line condition properly when \endlinechar is absent. §360 A

• The previous three changes were found while I was teaching a class based on Volume B; they led to Version 2.2.

28 Apr 1987

849 Avoid closing a file when \TeX knows that it isn’t open (JS). §560 E

3 Aug 1987

850 Clean up unfinished output if it’s necessary to \jump_out (Klaus Guntermann). §642 S

• That makes Version 2.3; subsequent version numbers won’t be logged here.

19 Aug 1987

851 Indent rules properly in cases like \hangindent=1pt $$\halign {...\cr \noalign{\hrule}}$$.$ §806 A

20 Aug 1987

852 Introduce \code{co_backup} because of cases like \hskip 0pt plus 1fil\ifdim (Alan Guth). §366 S

9 Nov 1987

853 Change the calculation for number of leader boxes, so that it won’t be too sensitive to roundoff error near exact multiples (M. F. Bridgland). §626 S

17 Nov 1987

854 Replace my stupid algorithm for fixed-point multiplication of negatives (WGS). §572 A

12 Dec 1987

855 Fix a typo in the initialization of hyphenation tables (PB). §952 B

• That error was almost completely harmless, thus undetectable, except if some \lccode is 1 and no \patterns are given.

23 Dec 1987

564 ↔ 856 Be more cautious when “relaxing” a previously undefined \csname; you might be inside a group (CET). §372 S
20 Apr 1988
857 Make sure temp_head is well-formed whenever it can be printed in a “runaway”
message: Consider constructions like \outer\def\a0{}\a\a (Silvio Levy). §391 S

24 Apr 1988
618 \rightarrow 858 Avoid conflicting use of the string pool in constructions like \def\#1{}\input
a\\z (Robert Messer). §260 S

10 May 1988
859 Amend the \patterns data structure when trie_min = 0 (PB). §951, 953 R

25 May 1988
860 Guarantee that trie_pointer cannot be out of range. §923 R
618 \rightarrow 861 Avoid additional bugs like #858 in constructions like \input a\romanumeral1,
etc. §464, 465, 470 S
618 \rightarrow 862 Prevent similar string pool confusion that could occur during the processing of
**\input\roman numeral6. §525 R

19 Jun 1988
819 \rightarrow 863 Prevent a negative dividend from rounding upward, causing a loop (CET). §126 S
819 \rightarrow 864 Adopt a smoother allocation strategy when memory is nearly gone (CET). §126 E

20 Jun 1988
852 \rightarrow 865 Initialize cur_order, now that it’s being backed up (Tsunetoshi Hayashi). §439 D

6 Nov 1988
612 \rightarrow 866 Disable fatal_error in prompt_input, so that open_log_file can use it safely (Tim
Morgan). §71 S
836 \rightarrow 867 Force terminal output whenever open_log_file fails. §535 S

14 Dec 1988
866 \rightarrow 868 Restore fatal_error in prompt_input, but don’t let it be unsafe for open_log_file. §92, 534 P

23 Jan 1989
869 Give q a legal value when recovering from “infinite shrinkage” error. §976, 1004 D

17 Feb 1989
758 \rightarrow 870 Avoid spurious error message for \aftergroup\relax\dump by avoiding inac-
cessible \aftergroup tokens (FM and Rainer Schöpf). §280 D

20 Mar 1989
871 Don’t refer to link(null) even when it “can’t happen” (PB). §791 R

7 Jun 1989
872 Avoid confusion from $\begingroup\halign{#\cr}$ (FM). §1130 S

20 Jun 1989
873 Put fraction digits into dynamic memory, not the global dig array, because of
constructions like .5\ifdim.6 (FM). §452 S

17 Jul 1989
874 Prevent embarrassing attempts to report errors before the string mechanism
has been fully initialized, for example when the command line exceeds the
buffer size (WGS). §31 S

16 Aug 1989
875 Allow integer products to be 31 bits long (FM). §105 M

31 Aug 1989
441 \rightarrow 876 Increase the number of tokens shown by token_show (J. Lavagnino). §295 C
877 Avoid confusion from $\begingroup\eqno$ (FM). §1140 S
The recent TUG meeting turned out to be an extend-TeX-for-the-nineties party! I agreed that some extensions for non-English languages ought to be made while I still knew how to do them. (In other words, I broke my firm commitment to keeping TeX completely stable; but in this case nobody objected.) The following eleven changes were coded during the month of September.

<table>
<thead>
<tr>
<th>Date</th>
<th>Change Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 Sep 1989</td>
<td>Install major change allowing general 8-bit code input.</td>
<td>§38, 352 G</td>
</tr>
<tr>
<td></td>
<td>Install major change allowing multiple hyphenation tables (M. Ferguson).</td>
<td>§923 G</td>
</tr>
<tr>
<td></td>
<td>Introduce new parameters <code>\lefthyphenmin</code> and <code>\righthyphenmin</code>.</td>
<td>§923 G</td>
</tr>
<tr>
<td></td>
<td>Introduce major new ligature capabilities including implicit boundary characters.</td>
<td>§908, 1037G</td>
</tr>
<tr>
<td></td>
<td>Install new <code>\inputlineno</code> feature suggested by MDS.</td>
<td>§424 G</td>
</tr>
<tr>
<td></td>
<td>Install new <code>\holdinginserts</code> feature suggested by FM.</td>
<td>§1014 G</td>
</tr>
<tr>
<td></td>
<td>Install new <code>\badness</code> feature.</td>
<td>§424, 664G</td>
</tr>
<tr>
<td></td>
<td>Install new <code>\emergencyystretch</code> feature.</td>
<td>§863 G</td>
</tr>
<tr>
<td></td>
<td>Install new <code>\errorcontextlines</code> feature suggested by FM.</td>
<td>§311 G</td>
</tr>
<tr>
<td></td>
<td>Recover from anomaly when hyphenation <code>char_warning</code> clobbers <code>old_setting</code>.</td>
<td>§863 S</td>
</tr>
<tr>
<td></td>
<td>Make it easier to change the format extension (Don Hosek).</td>
<td>§520, 1328P</td>
</tr>
<tr>
<td>16 Oct 1989</td>
<td>Avoid range check in null font with <code>bc=256</code> (PB).</td>
<td>§565 R</td>
</tr>
<tr>
<td>22 Nov 1989</td>
<td>Prevent <code>save_stack</code> conflicts in <code>{\hbox\expandafter{\csname\endcsname}}</code> and similar constructions (WGS).</td>
<td>§645, 1117 S</td>
</tr>
<tr>
<td>3 Dec 1989</td>
<td>Allow different hyphenmins in the same paragraph (M. Ferguson).</td>
<td>§1376 G</td>
</tr>
<tr>
<td></td>
<td>Distinguish <code>\par</code> from characters on <code>\if</code> tests. (MVL).</td>
<td>§334 S</td>
</tr>
<tr>
<td></td>
<td>Alignments need to be more robust against malicious attacks (MVL).</td>
<td>§782 S</td>
</tr>
<tr>
<td></td>
<td>Don’t let kerns in discretionary disappear at breaks (MVL).</td>
<td>§869 C</td>
</tr>
<tr>
<td></td>
<td>Make the new hyphenation reconstruction procedure less cautious, so that it doesn’t lose hyphens found by the old method.</td>
<td>§914 Q</td>
</tr>
<tr>
<td>11 Dec 1989</td>
<td>Make an undumped trie dumpable again (PB).</td>
<td>§1325 D</td>
</tr>
<tr>
<td>18 Dec 1989</td>
<td>Allow access to page totals in <code>\output</code> routines (FM and Chris Rowley).</td>
<td>§421 G</td>
</tr>
<tr>
<td>22 Jan 1990</td>
<td>Recognize more cases of unbalanced <code>\output</code> (CET).</td>
<td>§1026 R</td>
</tr>
<tr>
<td>29 Jan 1990</td>
<td>Make <code>\aftergroup</code> work properly after <code>\eqno</code> (Michael Downes).</td>
<td>§1194 S</td>
</tr>
<tr>
<td>1 Feb 1990</td>
<td>Fix one more case of <code>end_line_char_inactive</code> (WGS).</td>
<td>§360 S</td>
</tr>
<tr>
<td>22 Feb 1990</td>
<td>Don’t lose the last active node when total demerits are very high (FM).</td>
<td>§836, 854 R</td>
</tr>
<tr>
<td>13 Mar 1990</td>
<td>Doublecheck math fonts after making equation number (MVL).</td>
<td>§1194 D</td>
</tr>
<tr>
<td></td>
<td>Don’t forget to rule out charnodes before testing <code>type</code> (MVL).</td>
<td>§805, 1202D</td>
</tr>
</tbody>
</table>
23 Mar 1990

881 → 905 Don’t change the font of punctuation preceding a hyphenated word (Scott C. Allendorf). §903 F

906 Balance the parentheses shown on the terminal during normal runs. §1335 I

907 Optimize \ifx p \q after \let p \q (MVL). §508 E

908 Treat migration properly in displays (MVL). §1199,1205 S

• We’re now up to Version 3.0; I sincerely hope all bugs have been found.

11 May 1990

881 → 909 Initialize \nullfont ligature parameters (Lance Carnes). §552 F

22 July 1990

579 → 910 Treat \prevgraf as zero within \write (Boguslaw Jackowski). §422 S

26 July 1990

911 Report ‘1.1’ when first line of file overflows buffer (George Russell). §538 S

5 December 1990

878 → 912 Translate unprintable characters in font identifiers (WGS). §63 S

28 December 1990

913 Avoid range check when there are 65536 or more pages (Eberhard Mattes). §642 R

20 September 1991

878 → 914 Improve error message for \mathchar out of range. §436 I

878 → 915 Retain unprintable internal strings in 8-bit form (FM). §59 S

881 → 916 Retain right punctuation context for ligature reconstruction (problem found by Brian Hamilton Kelly). §903 S

10 January 1992

881 → 917 Also avoid producing a double kern at boundary (CET). §897 S

918 Disallow \setbox where it doesn’t work (Robert Hunt). §1241,1270 S

919 Robustify \mskip and \mkern in presence of negative quad (WGS). §716,717 S

679 → 920 Defend against ‘Y’ in \read (Michael Downes). §483 S

798 → 921 Save string memory if font occurs repeatedly (Boguslaw Jackowski). §1260 E

784 → 922 Don’t let \newline interrupt unprintable expansion (Bernd Raichle). §59,60 S

7 February 1992

881 → 923 Restore cur_l properly when boundary character doesn’t exist (Eberhard Mattes and Bernd Raichle). §1036 D

17 July 1992

892 → 924 Use current language at beginning of horizontal mode (Rainer Schöpf and CET). §1091,1200 C

17 December 1992

879 → 925 Avoid (harmless) range errors (Philip Taylor and CET). §934,960 R

25 February 1993

881 → 926 Protect kerns inserted by boundary characters (William Baxter). §837,866 C

917 → 927 Don’t let boundary kern disappear after hyphenation. §897 S

26 June 1993

668 → 928 Avoid potential future bug (Peter Breitenloher). §628,637 R

17 December 1993

881 → 929 Boundary character representation shouldn’t depend on the font memory size (Berthold Horn). §549,1323 S

10 March 1994

930 Huge font parameter number may exceed array bound (CET). §549 R
4 September 1994
926 → 931 Math kerns are explicit (Walter Carlip). §717 F
932 Avoid overflow on huge real-to-integer conversion. §625, 634 R

19 March 1995
933 Avoid spurious reference counts in format files (PB). §1335 R

23 November 1998
934 Make sure that \TeX is certifiably Y2K-safe. §1328 R

12 July 1999
255 → 935 \leaders often drops the final box (Hiroshi Nakashima). §627, 636 A

30 August 2001
936 Don’t allow a million unbalanced braces followed by \cr outside of any alignment (Ralf Roth). §789 R
937 Don’t allow end-template except at end of template (Roth). §325, 1131 R

30 September 2002
938 Improve rounding of glue during output (M. F. Bridgland). §625, 634 Q

18 March 2008
939 Forgot to goto the proper error recovery (DRF). §395 F
940 Avoid a case of dirty Pascal and speed up inner loop. §1035 E
941 Forget reference to last glue in format file (DRF). §1335 R
942 Glue reference not updated after overflow error (DRF). §1236 R
943 Mglue in \leaders was wrong units; now disallowed (DRF). §1078 B
944 Speedup of ligatures and kerns at end of a word (DRF). §1039 E
945 Another sanity check of TFM files for security (DRF). §565 R
946 Give better size data for unmagnified insertions. §986 I

6 January 2014
947 Space after \csname\endcsname to match other spaces. (Oleg Bulatov) §262 C

15 January 2021
948 Don’t pause on errors when tracing paragraphs (Udo Wermuth). §826 I
949 Don’t try to interact when in \batchmode (Xiaosa Zhang). §83 S
950 Don’t try to edit when no file is active (Xiaosa Zhang). §84 S
951 Take date and time sometimes from system, not user (Udo Wermuth). §241, 536 R
952 Don’t allow implicit left brace after # (Udo Wermuth). §476 B
953 After nine parameters, must delete offending tokens (Bruno Le Floch). §476 R
954 Garbage visible in buffer after file ends prematurely (DRF). §486 D
955 Force nonexistent characters to have null specs (DRF). §722 R
956 Don’t mark fraction noads as temporarily Inner (DRF). §761 C
957 Reset \newlinechar before logging the stats (Udo Wermuth). §1333, 1335 Q

List of abbreviated names:
DRF: David Fuchs
HWT: Howard Trickey
FY: Frank Yellin
LL: Leslie Lamport
JS: Jim Sterken
ARK: Arthur Keller
CET: Chris Thompson
FM: Frank Mittelbach
PB: Peter Breitenlohner
WGS: Wayne G. Sullivan
MVL: Marc van Leeuwen
MDS: Michael D. Spivak