The \TeX\ tuneup of 2021

Donald Knuth

This is the promised sequel to previous reports from 2008 [3] and 2014 [4]. Once again I’m immensely grateful to everybody who contributed potential errata to the “core” of \TeX\ and \METAFONT\, and to the wonderful team of experts — led this time by Karl Berry — who checked their input carefully and filtered it down to a list of issues that definitely demanded attention. According to our longstanding plan, I received that list on 31 December 2020.

Karl will write separately about his role as a meta-filter. Let me just remark that, when I did the previous round of maintenance seven years ago, I had to deal with “more than two dozen potentially troublesome topics” [4]. This time the number was more than 250(!).

As in 2008 and 2014, both \TeX\ and \METAFONT\ have changed slightly and gained new digits in their version numbers. But again there’s good news, because the changes are essentially invisible. I can’t resist quoting once more from [3], because it reflects my unwavering philosophy (see [2]):

The index to Digital Typography lists eleven pages where the importance of stability is stressed, and I urge all maintainers of \TeX\ and \METAFONT\ to read them again every few years. Any object of nontrivial complexity is non-optimum, in the sense that it can be improved in some way (while still remaining non-optimum); therefore there’s always a reason to change anything that isn’t trivial. But one of \TeX\’s principal advantages is the fact that it does not change — except for serious flaws whose correction is unlikely to affect more than a very tiny number of archival documents.

Users can rest assured that I haven’t “broken” anything in this round of improvements. Everyone can upgrade or not, at their convenience.

\TeX\ Version 3.141592653

Let’s get down to specifics. The new version of \TeX\ differs from the old one in five not-completely-trivial ways, mostly having to do with corrections to \TeX\’s attempts at recovering from errors.

The first two of these anomalies were found by Xiaosa Zhang and reported last summer on tex.stackexchange [5, 6]. He discovered a sneaky combination of keystrokes with which last year’s \TeX\ permitted you to get into \texttt{\textbackslash batchmode} while continuing to interact at the terminal(!). Furthermore, he found that \TeX\’s exit-and-edit option — typing \texttt{\textbackslash E} in response to an error prompt — was sometimes offered when it shouldn’t have been, at times when an input file wasn’t actively being read.

Both of those bugs could crash the system. So those two doors are now closed.

Another strange interaction had been noticed in 2017 by Udo Wermuth, who found that \TeX\ could mysteriously seem to stop dead in its tracks while \texttt{\textbackslash tracingparagraphs} was active. (The reason was that \TeX\ had found and reported an error, which went into the transcript file. \TeX\ was silently waiting for Udo to respond to that message, not realizing that messages are not echoed to the user’s terminal while paragraphs are being traced.) In the future, \TeX\ will not remain silent; the user will see the error message and be asked to respond.

Late last year Udo was bitten by quite a different sort of bug. This one has nothing to do with interaction, and it might possibly have occurred to others in some “real” runs of \TeX\ during the past 35 years or so (although I doubt it): Previous versions of \TeX\ have mistakenly allowed the \texttt{\langle replacement text} of a macro to begin just after say, \texttt{\textbackslash \#\textbackslash group} — contrary to a rule that’s stated clearly in the fine print of The \TeX\book [A, bottom of page 275].

Henceforth \TeX\ shall rigidly enforce that rule. Anybody who previously had written

\begin{verbatim}
\def\cs#1\bgroup{hi#1\bgroup}
\end{verbatim}

will now get an error message. And they should now write

\begin{verbatim}
\def\cs#1\bgroup{hi#1\bgroup}
\end{verbatim}

if they want to reproduce the former behavior.

Finally, on 22 October 2020, Bruno Le Floch reported what might well turn out to be the historic “final bug in \TeX.” Again it’s about macros. Suppose you’ve asked for nine parameters, specifying them one by one as \#1 through \#9. Then you’re not supposed to say \# again until finishing off the \langle parameter text\rangle, because \#9 is \TeX\’s upper limit. However, maybe you’re feeling naughty and actually do type \# improperly; \TeX\ will complain:

\begin{verbatim}
! You already have nine parameters.
\end{verbatim}

And its help message used to say

\begin{verbatim}
I’m going to ignore the # sign you just used.
\end{verbatim}

Which was true. But henceforth the help message will state the new truth, which is that \TeX\ will also ignore the next thing that \texttt{\ follows} the bad \#. From now on, bad stuff won’t be able to get through and foul things up.
All five of the bugs mentioned above are big
ticket items, worth \$$80.00 (\$327.68) at the Bank
of San Serriffe [1], because they exposed serious (al-
though rarely tweaked) deficiencies in \TeX's imple-
mentation. Besides those, \TeX 3.141592653 also in-
corporates a number of other comparatively minor
bugfixes. For example, with previous versions you
could readily screw up the end of your transcript file
by saying `\newlinechar'p.'

Plain \TeX has also changed in a minor way, for
consistency: It now ensures that `\muskip255 and
\toks255 are available as "scratch registers" (never
allocated by `\newmuskip or `\newtoks). The new
incarnation defines `\fmtversion as 3.1415926535.

The least trivial of these additional changes
are noted in updates to \TeX: The Program [B],
which now can be found in PDF form on the web-
page [9] and in a file called `errata.tex. They
appear also in files called `errorlog.tex, tex82.bug,
and `plain.tex. But the full truth resides, as al-
ways, in the updated master source file `tex.web.
All five of those key files continue to appear on-
line in directory systems/knuth/dist of the CTAN
archive [7].

The error log of \TeX began in 1978, and its first
14 years are documented in [8, Chapters 10 and 11].
The next several years are covered in [2, Chapter 34],
ending with bug #933, dated 10 March 1995 and
found by Peter Breitenlohner. And hey, who knows,
the log may at last have gained its final entry —
which is #957.

While I was preparing this round of updates, I
was overjoyed to see how well the philosophy of lit-
erate programming has facilitated everything. This
multifaceted program was written 40 years ago, yet I
could still get back into \TeX's darkest corners with-
out trouble, just by rereading [B] and using its index
and mini-indexes! I can't help but ascribe most of
\TeX's success to the fact that it has enabled literate
programming.

**\TeXware and METAfontware**

I made minor updates to the master `web files for
more than a dozen other programs, mostly to cor-
rect spelling errors, to add Oxford commas, and to
make them more consistent with each other. Doug
McKenna and David Fuchs found two obscure bugs
in TANGLE and WEAVE that hadn't been noticed
since the early 80s(!). Here is a current list of all the
`web files for which I have traditionally been respon-
able:

```plaintext
<table>
<thead>
<tr>
<th>name</th>
<th>current version</th>
<th>date</th>
</tr>
</thead>
<tbody>
<tr>
<td>dvitype.web</td>
<td>3.6</td>
<td>December 1995</td>
</tr>
<tr>
<td>gftodvi.web</td>
<td>3.0</td>
<td>October 1989</td>
</tr>
<tr>
<td>gftopk.web</td>
<td>2.4</td>
<td>January 2014</td>
</tr>
<tr>
<td>gftype.web</td>
<td>3.1</td>
<td>March 1991</td>
</tr>
<tr>
<td>mf.web</td>
<td>2.71828182</td>
<td>January 2021</td>
</tr>
<tr>
<td>mft.web</td>
<td>2.1</td>
<td>January 2021</td>
</tr>
<tr>
<td>plotf.web</td>
<td>3.6</td>
<td>January 2014</td>
</tr>
<tr>
<td>pooltype.web</td>
<td>3.0</td>
<td>September 1989</td>
</tr>
<tr>
<td>tangle.web</td>
<td>4.6</td>
<td>January 2021</td>
</tr>
<tr>
<td>tex.web</td>
<td>3.141592653</td>
<td>January 2021</td>
</tr>
<tr>
<td>tftopl.web</td>
<td>3.3</td>
<td>January 2014</td>
</tr>
<tr>
<td>vftovf.web</td>
<td>1.4</td>
<td>January 2014</td>
</tr>
<tr>
<td>vftovp.web</td>
<td>1.6</td>
<td>January 2014</td>
</tr>
<tr>
<td>weave.web</td>
<td>4.5</td>
<td>January 2021</td>
</tr>
</tbody>
</table>
```

**Typographic errors and other blunders**

So far I've only been discussing anomalies that were
detected in the software. But of course people have
also reported problematic aspects of the documen-
tation — which may actually be the hardest thing to
get right. Although The \TeXbook has been un-
der intense scrutiny for almost forty years, readers
from around the world have continued to find signif-
ificant ways to improve it, for instance by amending
the answers to some of the more difficult exercises.

The most important new changes to The \TeXbook
involve the way it describes the intricate de-
tails of spacing within math formulas. My origi-
nal discussion of “Inner atoms” was unfortunately
quite wrong; yet apparently nobody noticed those
mistakes until December 2018, when Sophie Alpert
identified some key inconsistencies in Appendix G.
Several pages of fine print needed to change, and
of course I'm happy to have the true story finally
nailed down.

Other significant amendments include more
precise syntax regarding things like discretionaries,
hyphens, and patterns. Many enhancements have
also been made to the index. Altogether, it has
turned out that at least 93 of The \TeXbook's 483
pages have been improved in some way (about 19%).

And The METAfontbook has improved even more — on 128 of its 361 pages (35%). A typo was
even found in its Table of Contents! Two of the leading contributors to this bug hunt, Hu Yajie and Udo Wermuth, must surely rank among the absolutely top proofreaders of the world, possibly of all time. In particular, Yajie not only suggested many mutually orthogonal ways to apply spit and polish to this multidisciplinary book, but also helped me to straighten out the formal syntax of METAFONT’s expressions.

Computers & Typesetting Jubilee

One of the highlights of my life took place on 21 May 1986, when Addison–Wesley arranged for an all-day event [10] at Boston’s Computer Museum, to celebrate the completion of TeX and METAFONT. It was the first time I’d gotten a glimpse of the books [A, B, C, D, E], which were literally “hot off the press.” And my fondest recollection from that day was the beaming face of A–W’s cofounder, Mel Cummings, as he held those five volumes in his hands with obvious pride and satisfaction. He had spent his life in the printing industry, and devoted it to producing technical books of the finest quality; so I was delighted to see his delight.

Having just looked again at each of the 2668 pages in those volumes, I can’t help but feel a reflected glow of pride from being associated with this extraordinary collaborative undertaking, especially now that it has reached a new peak of perfection. It seems fair to say that these books represent a significant milestone in the history of typography, as they self-describe every detail of the computations that went into their own composition. “If copies of these books were sent to Mars, the Martians would be able to use them to recreate the patterns of 0s and 1s that were used in the typesetting.”[10]

Therefore I’m extremely pleased to announce that Addison–Wesley has just published brand new printings of Volumes A, B, C, D, and E, dated February 2021, a “35th Jubilee Edition” that contains all of the refinements that were introduced during this tuneup. At last the i’s have all been really properly dotted and the t’s have all been really properly crossed! (The 2017 printing of Volume E remains up to date.)

Conclusion

The TeX family of programs seems to be nice and healthy as it continues to approach perfection. Chances are nil that any documents produced by previous versions of TeX or METAFONT will be affected by the changes in the new versions. Volunteers have been stalwart contributors to this success in optimum ways.

Stay tuned for The TeX Tuneup of 2029?!

References

[8] Donald E. Knuth, Literate Programming (Stanford, California: Center for the Study of Language and Information, 1992), xvi + 368 pages. (CSLI Lecture Notes, no. 27.)
[10] Barbara Beeton, Peter Gordon, and Donald Knuth, “Computers & Typesetting coming out party,” TUGboat 7:2 (June 1986), 93–98. tug.org/TUGboat/tb07-2/tb15knu.pdf. (My remarks have also been reprinted, with amendments, as Chapter 28 of [2].)


* Donald Knuth
  *www-cs-faculty.stanford.edu/~knuth*