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## The T<sub>E</sub>X 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 T<sub>E</sub>X 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 T<sub>E</sub>X 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 T<sub>E</sub>X 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 T<sub>E</sub>X'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.

### T<sub>E</sub>X Version 3.141592653

Let's get down to specifics. The new version of T<sub>E</sub>X differs from the old one in five not-completely-trivial ways, mostly having to do with corrections to T<sub>E</sub>X'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 T<sub>E</sub>X permitted you to get into `\batchmode` while continuing to interact at the terminal(!). Furthermore, he

found that T<sub>E</sub>X's exit-and-edit option—typing ‘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 T<sub>E</sub>X could mysteriously seem to stop dead in its tracks while `\tracingparagraphs` was active. (The reason was that T<sub>E</sub>X had found and reported an error, which went into the transcript file. T<sub>E</sub>X 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, T<sub>E</sub>X 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 T<sub>E</sub>X during the past 35 years or so (although I doubt it): Previous versions of T<sub>E</sub>X have mistakenly allowed the `<replacement text>` of a macro to begin just after, say, `'#\bgroup'`—contrary to a rule that's stated clearly in the fine print of *The T<sub>E</sub>Xbook* [A, bottom of page 275].

Henceforth T<sub>E</sub>X shall rigidly enforce that rule. Anybody who previously had written

```
\def\cs#1#\bgroup hi#1}
```

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

```
\def\cs#1\bgroup{hi#1\bgroup}
```

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 T<sub>E</sub>X.” 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 `<parameter text>`, because #9 is T<sub>E</sub>X's upper limit. However, maybe you're feeling naughty and actually do type ‘#’ improperly; T<sub>E</sub>X will complain:

```
! You already have nine parameters.
```

And its help message used to say

```
I'm going to ignore the # sign you just used.
```

Which was true. But henceforth the help message will state the *new* truth, which is that T<sub>E</sub>X will *also* ignore the next thing that *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 0x\$80.00 (\$327.68) at the Bank of San Serriffe [1], because they exposed serious (although rarely tweaked) deficiencies in T<sub>E</sub>X’s implementation. Besides those, T<sub>E</sub>X 3.141592653 also incorporates a number of other comparatively minor bugfixes. For example, with previous versions you could really screw up the end of your transcript file by saying `\newlinechar='p`.

Plain T<sub>E</sub>X 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 *T<sub>E</sub>X: The Program* [B], which now can be found in PDF form on the webpage [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 always, in the updated master source file `tex.web`. All five of those key files continue to appear online in directory `systems/knuth/dist` of the CTAN archive [7].

The error log of T<sub>E</sub>X 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 literate programming has facilitated everything. This multifaceted program was written 40 years ago, yet I could still get back into T<sub>E</sub>X’s darkest corners without trouble, just by rereading [B] and using its index and mini-indexes! I can’t help but ascribe most of T<sub>E</sub>X’s success to the fact that it has enabled literate programming.

### METAFONT Version 2.71828182

And what about T<sub>E</sub>X’s partner? I almost thought that METAFONT’s version number should stay at 2.7182818, because the outputs of the newly upgraded program don’t differ from what would have been obtained last year except in trivial ways. For example, some of the help messages are now slightly different.

However, the two T<sub>E</sub>X bugs found by Xiaosa Zhang apply also to interaction with METAFONT. Therefore I now believe, in view of [6], that the historic “final bug in METAFONT” was found on 03 July 2020, although he was actually using T<sub>E</sub>X.

### T<sub>E</sub>Xware and METAFONTware

I made minor updates to the master `web` files for more than a dozen other programs, mostly to correct 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 responsible:

name	current version	date
<code>dvitype.web</code>	3.6	December 1995
<code>gftodvi.web</code>	3.0	October 1989
<code>gftopk.web</code>	2.4	January 2014
<code>gftype.web</code>	3.1	March 1991
<code>mf.web</code>	2.71828182	January 2021
<code>mft.web</code>	2.1	January 2021
<code>pltotf.web</code>	3.6	January 2014
<code>pooltype.web</code>	3.0	September 1989
<code>tangle.web</code>	4.6	January 2021
<code>tex.web</code>	3.141592653	January 2021
<code>tftopl.web</code>	3.3	January 2014
<code>vftovp.web</code>	1.4	January 2014
<code>vptovf.web</code>	1.6	January 2014
<code>weave.web</code>	4.5	January 2021

### 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 documentation — which may actually be the hardest thing to get right. Although *The T<sub>E</sub>Xbook* [A] has been under intense scrutiny for almost forty years, readers from around the world have continued to find significant ways to improve it, for instance by amending the answers to some of the more difficult exercises.

The most important new changes to *The T<sub>E</sub>Xbook* involve the way it describes the intricate details of spacing within math formulas. My original 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 T<sub>E</sub>Xbook*’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 T<sub>E</sub>X 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, and D, 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 T<sub>E</sub>X 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 T<sub>E</sub>X 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 T<sub>E</sub>X Tuneup of 2029?!

### **References**

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- [2] Donald E. Knuth, *Digital Typography* (Stanford, California: Center for the Study of Language and Information, 1999), xvi + 685 pages. (CSLI Lecture Notes, no. 78.) The second printing (2012) contains numerous corrections.
- [3] Donald Knuth, “The T<sub>E</sub>X tuneup of 2008,” *TUGboat* **29**:2 (2008), 233–238. [tug.org/TUGboat/tb29-2/tb92knut.pdf](http://tug.org/TUGboat/tb29-2/tb92knut.pdf).
- [4] Donald E. Knuth, “The T<sub>E</sub>X tuneup of 2014,” *TUGboat* **35**:1 (2014), 5–8. [tug.org/TUGboat/tb35-1/tb109knut.pdf](http://tug.org/TUGboat/tb35-1/tb109knut.pdf).
- [5] 潇洒张, <https://tex.stackexchange.com/questions/551313> (27 June 2020).
- [6] 潇洒张, <https://tex.stackexchange.com/questions/552166> (03 July 2020).
- [7] CTAN: Comprehensive T<sub>E</sub>X Archive Network, <https://ctan.org/>.
- [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.)
- [9] *Computers & Typesetting*, <https://www-cs-faculty.stanford.edu/~knuth/abcde.html>.
- [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/tb15knut.pdf](http://tug.org/TUGboat/tb07-2/tb15knut.pdf). (My remarks have also been reprinted, with amendments, as Chapter 28 of [2].)
- [A] Donald E. Knuth, *The T<sub>E</sub>Xbook* (Reading, Mass.: Addison–Wesley, 1984), x + 483 pages. Also published as *Computers & Typesetting*, Volume A. Currently in its 35th printing (paperback, 2017) and 23rd printing (hardcover, 2021).
- [B] Donald E. Knuth, *Computers & Typesetting*, Volume B, *T<sub>E</sub>X: The Program* (Reading, Mass.: Addison–Wesley, 1986), xvi + 594 pages; fifth printing (1994), xvi + 600 pages. Currently in its 11th printing (hardcover, 2021).
- [C] Donald E. Knuth, *The METAFONTbook* (Reading, Mass.: Addison–Wesley, 1986), xii + 361 pages. Also published as *Computers & Typesetting*, Volume C. Currently in its 14th printing (paperback, 2017) and 10th printing (hardcover, 2021).

- [D] Donald E. Knuth, *Computers & Typesetting*,  
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- [E] Donald E. Knuth, *Computers & Typesetting*,  
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- ◇ Donald Knuth  
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