TeX as a Path, a Talk Given at Donald Knuth's 80th Birthday Celebration Symposium

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Donald E. Knuth's 80th birthday celebration on January 10th, 2018, in Piteå (northern Sweden), was organized as a double event: (a) a scientific symposium[1] where colleagues, former students and friends were invited to give presentations in the fields of algorithmics and combinatorics, and (b) the world première of his multimedia work *Fantasia Apocalyptica* for pipe organ and three video tracks.

The symposium was the opportunity to attend talks by renowned scientists, such as, to mention just a few (in alphabetical order): Persi Diaconis (Stanford), Ron Graham (UC San Diego), Dick Karp (UC Berkeley), Bob Sedgewick (Princeton), Bob Tarjan (Princeton), Andrew Yao (Tsinghua University), ... I didn't count the exact number of Turing prizes, but there must have been four or five, at least.

Fantasia Apocalyptica was a stimulating and intense experience: during an hour and a half we listened to Don's "program" music played on one of the best pipe organs in the world, while (1) reading the unabridged text of John's Revelation in Greek and English, (2) reading the score as it was played and (3) looking at specially drawn Duane Bibby drawings ... the whole in perfect synchronization,[2] and in a beautiful wooden concert room: the *Acusticum* of Piteå's Higher School of Music and Dance.

For this unique event, I was invited to give a talk about Don's work in typography. A vast subject, which I had to fit in only 30 minutes. I spent the six months of preparation of this talk constantly alternating between visionary joy ("I will at last be able to express my gratitude and admiration to Don!") and paralyzing anxiety ("will I ever find something to say that Don doesn't know already?!?"). After the symposium, I wanted to share the result with

TUGboat readers, through this paper.[3] What follows is an edited and corrected transcription of my talk, with several additional explanations and references.

1   TEX as a Path

It is a big honor for me to give this talk about TEX and typography in front of Don, because TEX literally changed my life. The main keyword of this talk is 'gratitude', even though the word doesn't appear explicitly in it.

Duane Bibby, the famous creator of the lion and lioness characters, has kindly prepared a drawing especially for this occasion:

In it you can see the lion of TEX together with the lioness of METAFONT and the coffee-drinking happy humanoid computer, walking on a path paved by bits. The path starts from a temple with Don's initials and heads to the setting sun. Our two beloved leonine creatures are dwelling on this path and smiling at us, while we read on a road sign: "Happy 80th birthday Don."

You may be wondering why I chose to talk about paths? Well, a path is, of course (Merriam–Webster) *a trodden way, a track specially constructed for a particular use* — which is also the case of TEX — but also, most importantly, *a way of life, a way of conduct, a way of thought.*

There is this famous poem by Cavafy [4, p. 36]:

Σὰ βγεῖς στὸν πηγαιμὸ γιὰ τὴν Ἰθάκη,
νὰ εὔχεσαι νᾶναι μακρὺς ὁ δρόμος,
γεμᾶτος περιπέτειες, γεμᾶτος γνώσεις.

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[1] I like the word 'symposium' because it stems from the Greek word *symposion*, meaning "drinking together"!

[2] Experiencing *Fantasia Apocalyptica* reminded me of literate programming and specifically of reading volume E of *Computers & Typesetting*: the volume on Computer Modern fonts where you have annotated glyph images, METAFONT code and comments on facing pages. Of course in the case of *Fantasia* the experience was much stronger since the act of reading the Biblical text(s) and the score had to follow the pace of music, while (a different?) part of the brain was cognitively processing the incoming music. It is characteristic of Don to provide the experiencer with many simultaneous levels and modalities of information — so much information, indeed, that selecting a small part of it that your mind can humanly capture and process, is a creative process per se.

[3] The slides are on the symposium's Web site `http://knuth80.elfbrink.se/talks/` and you can also watch the talk on YouTube: `https://youtu.be/P1AxaFQzfT4`.

> *When you set out on the journey to Ithaca,*
> *pray that road be long,*
> *full of adventures, full of knowledge.*

where the "path", the "way of life", is given a name: 'Ithaca'. Don had many Ithacas in his life and he attained them all, but according to Cavafy, what is important is not attaining the destination but rather the journey, a journey full of adventures, full of knowledge.

2 The Outline of the Talk

This is the moment where the speaker traditionally gives the outline of eir[4] talk. This was a difficult task for me because the first idea of an outline that came to my mind was this:

Photo credit: Zabair Khan, CC BY-NC 2.0.

It is the Grand Canyon. I remember somebody saying once that "talking about TeX is like trying to describe the Grand Canyon in a postcard". You may wonder "Why the Grand Canyon?" It happens that when you look at TeX you sometimes feel like contemplating pure beauty:

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[4] I'm using Michael Spivak's gender-neutral pronouns [21, p. xv].

Photo credit: Helari Hellenurm, CC BY-NC-ND 2.0.

and sometimes you feel rather like rafting in a heavy stream:

Photo credit: Andrew Peacock, used by permission.

which is another aspect of the Grand Canyon, and of TeX...

In fact, my real outline is shown in the figure at the bottom of the page, namely a graph whose vertices are the various topics I want to address, and edges represent semantic relatedness above a given threshold between the topics. Once you have

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this semantic graph, a narrative thread can be obtained algorithmically as a shortest Hamiltonian path (Hamiltonian since we want to visit all vertices exactly once, and shortest since we want to keep the talk as coherent as possible). In fact, instead of applying shortest Hamiltonian algorithms I did something easier: I detected communities of vertices (the sections of this talk) and I drew a path joining them in the most sensible way.

3 History

First of all, TeX is a path in time. You may say that it starts in 1942 with a 4-year old Milwaukee boy [18, p. 1] going to the local library to read "Babar the King", and ending up in the local newspaper as the youngest member of the local Book Worm Club. But actually the first real milestone was the first book ever typeset in TeX: "Lena Bernice" [9, 15], typeset in 1978 and printed in 100 copies. And then of course, another important milestone was *The TeXbook* (1984), as the main entrance to TeX for most of us old-timers, and finally, in 1990, Don's decision to freeze TeX [17].

TeX is also a path in the history of typography. We all know that Gutenberg modeled writing by inventing movable metal type-based typography. Don has dematerialized Gutenberg's model using boxes and glue. Also, many people in the Renaissance attempted to mathematically model letter shapes, Pacioli being one of them. Don, once again, has provided a solution to the problem by devising the programming language METAFONT. In a previous talk [20] Martin Ruckert has extensively talked about the letter 'S' and the difficulties this letter caused for Don (see also [14] and [12]). The creative path from Gutenberg and Pacioli to Don is a well-known one, but that's not all. In fact, we can consider that TeX and METAFONT are much more than that since Don's work has introduced two new models: a *model of writing* and a *model of documents*.

4 A Model of Writing

In 1968, in their foundational work "The Sound Pattern of English" [5], Chomsky and Halle describe a language's phonological structure — be it English or any other language — through what they call "sound rules". For them, word forms we use in speech can be obtained from "abstract forms", after some (mostly standard) transformations. For example, the French article <le> /lə/ (note that we use angle brackets for the written word and slashes for pronunciation represented in the IPA) becomes <les> /le/ in the plural, so if we look only at the surface there is /lə/ for the singular and /le/ for the plural. But when

the plural form is followed by a noun starting with a vowel, as in <les ans> /lezã/, a /z/ sound appears out of nowhere (in French this is called *liaison*). Chomsky and Halle say that there is an "abstract sound" /z/ which corresponds to the plural suffix and the sound rule will send it to nothing (= will keep it mute) unless a noun starting with a vowel follows the article.

This will come as no surprise since that "abstract plural suffix" has existed in the French language for many centuries, well before Chomsky and Halle. But it exists not in speech but in the written modality, where it is represented by an <s>.

We can schematize Chomsky and Halle's approach by:

$$\text{abstract sounds} \xrightarrow{\text{sound rules}} \text{pronunciation.}$$

What is of interest to computer scientists is that these "sound rules" are in fact *production rules of a context-sensitive formal grammar* (and this was the very reason why Chomsky introduced the formal grammar concept in the first place).

Richard Sproat [22], inspired by Anneke Nunn [19], has extended this to *graphemes*. Graphemes are the basic elements of writing in the same way that phonemes are the basic elements of spoken language. You can define graphemes by the method of minimal pairs: if two "drawings" in the same context give rise to different semantics, then they are different graphemes. For example, every English reader recognizes the words <hat> and <cat> as having different semantics, therefore <h> and <c> are different English language graphemes. On the other hand, <cɑt> and <cat> represent the same semantics for the average reader of English, so <ɑ> and <a> represent the same grapheme of English language; we call them *allographs*.

Sproat [22] proposes the following diagram:

$$\text{abstract sounds} \xrightarrow{\text{sound rules}} \text{pronunciation}$$
$$\downarrow \text{phoneme to grapheme conversion}$$
$$\text{abstract spelling} \xrightarrow{\text{autonomous spelling rules}} \text{spelling,}$$

where all arrows represent rules that can be described by means of regular languages. In the case of graphemes the regular language is of a special kind; he calls it a *planar* language and it has not one but *five* concatenation operators, corresponding to five relative placements of character pairs: "over" $\overset{\uparrow}{\cdot}$, "under" $\overset{\downarrow}{\cdot}$, "on the left" $\overset{\leftarrow}{\cdot}$, "on the right" $\overset{\rightarrow}{\cdot}$, and "surrounding" $\odot$. So, for example, the Chinese character <鱗> can be described as the formal word <鱼⃗[米·[夕⃗牛]]> if we consider the "components"

appearing in this decomposition as the alphabet of our formal language (notice that we also need brackets since this kind of planar concatenation is not associative).

It is time now to return to TeX. The reader may find a strong similarity between graphemes and Unicode characters. Let's understand well that there is an important difference: the former are language-specific (since they are defined by minimal pairs in a *given* language) and the latter strive for universality. But we can also consider a grapheme as an equivalence class of drawings, and a Unicode character as an equivalence class of glyphs. It is also noteworthy that Sproat's five concatenation operators have their analogs (even though only intended for Chinese Han characters) in Unicode: the *Ideographic description characters* U+2ff0-2ffb, which are not 5 but 12. And still, in my humble opinion, these are not enough: consider for example the Vietnamese acute accent which has to sit *on the right side* of the circumflex accent: this is much subtler than simply saying that the former "lies above" the latter. It should be clear by now that some precise way of describing grapheme/Unicode character interaction is still needed. I claim that

Claim 1. *The ideal tool for describing grapheme interaction is TeX!*

Indeed, our beloved TeX, besides being a program and a programming language, is also an algorithmic transformation from tokens (tokens can represent abstract phonemes or abstract graphemes) into DVI command sequences (which again can represent graphemes, as well as their geometric interactions).

One may argue that to obtain DVI one needs also fonts (or, at least, font metric information). But don't you always need them? When we want to precisely describe the interaction between two graphemes, we need information on their shapes.

And this raises a second issue: when studying a (written) language at some point you need to describe its glyphs/allographs. And since these can vary, while representing the same character/grapheme, you need some *flexible* way of describing them. You need a *meta*-description. I claim that

Claim 2. *METAFONT is the ideal tool for describing glyphs (a.k.a. allographs) and equivalence classes of glyphs (a.k.a. graphemes).*
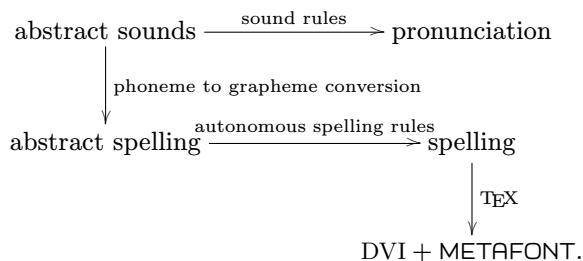
Take for example the description of the Euro symbol as given in [7]. This description uses precise geometrical properties but takes into account neither stroke width variation, nor special techniques for diagonal junction lightening,[5] which are necessary for real-world typography. METAFONT can easily model the precise equations of [7], and still allow for metaness and typographic performance.

To resume, I claim that

Claim 3. *TeX+METAFONT can be considered as a very efficient new model of the written form of (any) language, whether for studying it (as does linguistics) or to produce contents in it.*

And hence I propose an extension of the diagram above to:

$$\begin{array}{ccc} \text{abstract sounds} & \xrightarrow{\text{sound rules}} & \text{pronunciation} \\ \Big\downarrow {\scriptstyle \text{phoneme to grapheme conversion}} & & \\ \text{abstract spelling} & \xrightarrow{\text{autonomous spelling rules}} & \text{spelling} \\ & & \Big\downarrow {\scriptstyle \text{TeX}} \\ & & \text{DVI} + \text{METAFONT.} \end{array}$$

5 A Document Model

Conventional document models, such as XML (with XSL-FO and SVG) or PDF, or the many word processor file formats, contain a mixture of characters and glyphs, the former mostly from the user's input and the latter after processing and applying properties. For example, XML contains only characters, but SVG allows the user to describe glyphs (in a very rudimentary way) and to use them in an XSL-FO context. PDF contains only glyphs, but when the user goes through the GUI for operations such as copying or searching, PDF reader software will either use the font encoding to obtain characters corresponding to glyphs or a special command called `ActualText` [1, §14.9.4] to attach a Unicode string to some part of the document, for example to a sequence of glyphs. A document in one of these formats contains a static textual content, either in glyphs or in characters, or in some weak correspondence between the two.

TeX has introduced a new, infinitely more powerful document model, by providing not only the source and the result but also *the complete process* of document creation. In TeX you know when every transformation is applied and for what reason. Take for example the <fl> ligature and the French <œ> digraph. In the DVI file they are both single glyphs, but if you look at the TeX process you will realize that <œ> was there from the beginning (either as a Unicode character in TeX versions supporting Unicode, or as an `\oe` macro), while <fl> has appeared in the node list when the typesetting process met the

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[5] See the *apex_corr* and *notch_cut* parameters in Computer Modern fonts.

font and got information from it about availability (and necessity) of the ligature in the specific font. And, of course, in a German setting where the letters <f> and <l> belong to different morphemes — such as in the word <Auflage> — the ligature will not be applied.

Accessing the whole process from source to output gives you the five Ws: who, when, why, what and how of every part of your document. To give an analogy, suppose you have to talk about a great (wo)man: you will talk not only about what e left, but about eir entire life. Life is a transformation of projects into memories — take this conference: six months before, it was a project, a dream; then it became an event; six months later, it will become a memory. You don't want to keep only memories, you want to access the whole of it. In our analogy, TeX and METAFONT source is your project, DVI+PK is your memory, what is important is *how* you obtain it. A similar analogy is music: you can have a score (the source) and you can have a recording (the result). But the most important part is neither of them, it is the music making process per se.

For all these reasons I claim that

Claim 4. *TeX and METAFONT can be used to describe the input of a document, its output, as well as the complete process of obtaining the output from the input. This is a new way to model documents, and certainly the most powerful I can imagine.*

6   TeX and Esthetics

When Gutenberg printed his Bible, he actually committed a fraud: he sold Bibles to wealthy monks pretending they were handwritten, and got paid accordingly. Therefore the esthetic of that first printed book was rather the one of manuscripts of its time. But once printing technology emigrated to Italy, immensely talented artists such as Aldus Manutius or Francesco Griffo created a new esthetic for the printed book. This esthetic canon has evolved during centuries but has never really been formalized. There have been manuals and methods, but never a formal specification.

Don has done this formal specification algorithmically and included the algorithm into TeX. When he defined badness, demerits, penalties and the like [16], he was in fact formalizing notions and rules that have existed for centuries as part of a craftsman's skills. And speaking about TeX innards, here is another opportunity to mention a path: the solution to the problem of the most pleasant paragraph is indeed a shortest path in a directed acyclic graph, and TeX managed to be operational in very small systems (as were operating systems in the late sev-

enties) precisely because the algorithm for finding a shortest path in a directed acyclic graph is of no more than linear complexity.

7   Disseminating Scientific Knowledge

After having discussed what a marvelous achievement TeX has been as part of the history of writing, of documents and of typographical esthetics, let us turn to the impact of TeX on humans, be it universally, or individually, or for specific communities.

Firt of all, let us give some figures:

- There are currently 1,344,162 papers on the `arXiv.org` archive, out of which 1,230,793 (that is 92%) are written in TeX[6];
- for those needing help, there are 147,645 brilliantly and multiply *answered questions* on the `tex.stackexchange.com` platform[7];
- for those needing extra power, there are 5,411 LaTeX packages on CTAN written by 2,472 authors[8];
- the collaborative online LaTeX platform Overleaf has 2,169,037 accounts and hosts the astonishing number of 17,256,112 TeX documents[9];
- *all* presentations of the Knuth80 symposium were prepared in TeX![10]

These figures show that, thanks to TeX, nowadays *anyone* with access to a computer can *freely* and *efficiently* produce scientific and scholarly documents with high quality presentation standards.

8   TeX's Impact on Individuals

When you use TeX you become humble, patient, hardened.

Debugging a TeX document is experiencing

δι' ἐλέου καὶ φόβου περαίνουσα
τὴν τῶν τοιούτων παθημάτων κάθαρσιν

*through pity and fear effecting
the proper purgation of such emotions.*

This quote is part of Aristotle's definition of tragedy [3]. TeX users experiencing κάθαρσις (*cathartic emotions*) do it because the result is *worth the pain*. There is beauty emerging from the innards of the

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[6] As of January 5, 2018 (personal communication with Jim Entwood).

[7] As of January 5, 2018 (information available on the Web site).

[8] As of November 1st, 2017 (personal communication with Gerd Neugebauer).

[9] As of January 6, 2018 (personal communication with John Hammersley).

[10] This is notoriously and shamelessly FAKE NEWS as the reader visiting the symposium's Web site can easily verify by downloading the PDF files of the talks. But all other figures in this paragraph are entirely true!

machine. And the important point is that the TEX user can *always* obtain the result e needs, because e has total control on eir tools. This enhances quality of life, and provides confidence, self-esteem and dignity. (And not frustration like other programs, which are fatally bound by limits.)

Besides personal *development* TEX also leads to personal *enhancement*. Take for example the Preface of the *METAFONTbook*, where Don gives a warning:

> WARNING: Type design can be hazardous to your other interests. Once you get hooked, you will develop intense feelings about letterforms; the medium will intrude on the messages that you read. And you will perpetually be thinking of improvements to the fonts that you see everywhere, especially those of your own design.

I.e., if you read that book you will *change*, you will *evolve*. And indeed, being exposed to TEX and META-FONT extensively alters your senses and produces extra sensitivity to *form*. And this extra sensitivity to form enhances understanding of *content* since it is through form that we access content.

Meanwhile, TEXers are easily recognizable by the common symptoms they present:

- facial spasms when witnessing club lines;
- nightmares populated by overfull boxes;
- a smile when discovering other people's typographical blunders, such as mixing up 'ß' and 'β', or 'ς' (number) and 'ς' (letter), or using an ASCII apostrophe '' instead of a typographic apostrophe '' in text, or omitting an 'œ' digraph in French words like 'cœur';
- euphoria when in presence of a beautiful font;
- visionary ecstasy when in front of an Aldine Press volume;
- olfactory excitation when smelling paper and ink;
- a mood of "home sweet home" when unexpectedly recognizing Computer Modern fonts in a library or bookstore.

There are also people using TEX to earn a living and feed themselves and their families *working at it with all their heart* [Col. 3.23]. Again TEX is the ideal tool for this purpose because it gives the professional user total control of eir typesetting activities and document aspects. E don't have to learn it anew on every new version (since there is no new version) but e can capitalize on eir knowledge.

And then, you have communities of people, people who share their experiences and pleasure, but above all, their creativity. In TEX user groups (or {TEX Users}, as Michael Spivak [21, App. H] calls them) there are neither social, nor racial, nor geographic, nor gender-related, nor age-related, nor

computer proficiency-related barriers. TEX-induced friendships last a lifetime.

9 Small Mystery Interlude

TEX may lead you to the encounter of strange creatures like this one:

or this one:

or this one:

These creatures live in tribes:

يجِب أن تكون الآلة التي يذبح بها أطول من عنق رقبة الحيوان المذبوح حتى إذا جربها لا يدخل رأسها فى وسط الذبح لئلا تنكسر في وقت الرد بها على جلد المذبوح ويكون لها عرض وثخن حتى لا تنثني وتضطرب حيث يذبح بها ولا يكون فيها اعوجاج ولا ثلم ولا حروشة جارية على خط مستقيم ماضية حادة في غاية ما يكون. ولا تكون زجاجاً ولا خزقا ولا خشباً ولا عظاً ولا قصبا ولا ظفراً لأن كل هذه الأشياء لا يؤمن تفتيت بعضها وتلتيمها عند الجر بها على الجلد وانها تكون حديداً حتى يكون الذبح مأمونا بها لأن الحديد أقوى

and their tribes sometimes meet:

يجِب أن يكون الضابط للبهيمة غير الذابح كبيرة كانت أو صغيرة ويرمى الذابح يده على عنق المذبوح ويرد الخرزة الكبيرة إلى ما يلي الرأس ويخنق قدامه بالابهام والذى يلى وما بينها وينزل ويذبح ويكون مستقبلا بالمذبوح إلى القبلة القدوسية تمثيلا بالذبائح المقربة كما قال :

וְשָׁחַט אֹתוֹ עַל יֶרֶךְ הַמִּזְבֵּחַ צָפֹנָה לִפְנֵי יוי (ויקרא א:יא) [וְיֶדְבَحُهُ עَלَ جَانِبِ الْمَذْبَحِ إِلَى الشِّمَالِ أَمَامَ الرَّبِّ] (اللاويين ١ الآية ١١)

and when their tribes meet then the *characters become messengers of peace and hope among humans.*

10 TEX in Obfuscation Land

TEX is also the ideal tool for obfuscation. In a previous talk [6], Erik Demaine was referring to songs

with small complexity [13, p. 20]. Here is one of those songs ("On the first day of Christmas, my true love gave me...") written in obfuscated TEX code by David Carlisle [2]:

```
\let~\catcode~`76~`A13~`F1~`j0O~`P2jdefA71F~`7113jdefPALLF
PA''FwPA;;FPAZZFLaLPA//71F71iPAHHFLPAzzFenPASSFthP;A$$FevP
A@@FfPARR717273F737271P;ADDFRgniPAWW71FPATTFvePA**FstRsamP
AGGFRruoPAqq71.72.F717271PAYY7172F727171PA??Fi*LmPA&&71jfi
Fjfi71PAVVFjbigskipRPWGAUU71727374 75,76Fjpar71727375Djifx
:76jelse&U76jfiPLAKK7172F71l7271PAXX71FVLnOSeL71SLRyadR@oL
RrhC?yLRurtKFeLPFovPgaTLtReRomL;PABB71 72,73:Fjif.73.jelse
B73:jfiXF71PU71 72,73:PWs;AMM71F71diPAJJFRdriPAQQFRsreLPAI
I71Fo71dPA!!FRgiePBt'el@ lTLqdrYmu.Q.,Ke;vz vzLqpip.Q.,tz;
;Lql.IrsZ.eap,qn.i. i.eLlMaesLdRcna,;!;h htLqm.MRasZ.ilk,%
s$;z zLqs'.ansZ.Ymi,/sx ;LYegseZRyal,@i;@ TLRlogdLrDsW,@;G
LcYlaDLbJsW,SWXJW ree @rzchLhzsW,;WERcesInW qt.'oL.Rtrul;e
doTsW,Wk;Rri@stW aHAHHFndZPpqar.tridgeLinZpe.LtYer.W,:jbye
```

This is indeed very efficient obfuscation and it works because TEX has a primitive command called `\catcode` which operates in a "transfigurative" way and changes the essence of any character. TEX can follow these transfigurations seamlessly while the human mind is totally unable to read past the first line (at least that is *my* case).

11   TEX's Creator

The path of this talk has allowed us to wander through many aspects of TEX. We left the most important for last: TEX's creator.

C&T, a.k.a. *Computers and Typesetting*, a five-volume book of 2,704 pages, is a *closed universe*. The books have a logical structure, they are produced by programs which have their own logical structure (the two structures being different according to the rules of literate programming). The programs are described by text, which has paragraphs, lines and characters. Characters are also described by programs, which again are described by text.

Take a long breath and think of the complexity of this *œuvre*.

And then consider the fact that even the tiniest character needs the full power of the system. To obtain a humble little comma you need all of META-FONT and TEX, as in oriental theories of the universe [11]:

> *Every atom reflects the whole Universe. How can it be otherwise, since every atom is Primordial Substance?*

Every comma reflects the whole of TEX and METAFONT. So you have a whole universe in front of you, and you can delve inside it. In its center you will encounter its creator.

12   Don's Humor

Don's humor is proverbial, irreverent, unrestrainable and ubiquitous.

Take the following sentences from *The TEXbook*. The first one appears very early, in the Preface:

> *Another noteworthy characteristic of this book is that it doesn't always tell the truth.*

This is hardly expected in a serious book by one of the greatest computer scientists of the 20th century. But it gets even better when the reader arrives at the very last exercise:

> *Final exercise: Find all of the lies in this book, and all of the jokes.*

Then there are Duane Bibby's beautiful, maliciously funny and funnily malicious drawings like this one, from the "Dirty tricks" chapter:

And last, but not least, *The TEXbook* is full of awesome quotations, like the following (one of my favorites):

> *. . . according to legend, an RCA Marketing Manager received a phone call from a disturbed customer. His 301 had just hyphenated "God."* [10]

13   Don's Humanity and Values

When we read Don's books we *learn things*. But we also *learn how to learn*, and by learning how to learn, we *learn how to teach*, how to make the dullest subject interesting and noteworthy, and that, in return, provides us with a feeling of gratifying creativity. Don cares about every single reader whether e is an expert or a novice, and this is a permanent source of inspiration for us.

The following quote is not from Don but is in *The TEXbook* and represents for me the very *essence of teaching*:

> *Pretend that you are explaining the subject to a friend on a long walk in the woods.* [8]

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14 Conclusion

With this "long walk in the woods" (which is yet another path), we arrive at the end of this talk.

Cavafy's *Ithaca* asserts that the voyage is more important than the destination:

Ἡ Ἰθάκη σ᾽ ἔδωσε τὸ ὡραῖο ταξείδι.
Χωρὶς αὐτὴν δὲν θἄβγαινες στὸν δρόμο.

Ithaca gave you the wondrous voyage:
without her you'd never have set out.

Without Don, without his Ithacas, we wouldn't have TEX, we would not have this wondrous voyage, without him we would not have set out.

So on this occasion I would like to wish Don a Happy Eightieth Birthday, and solemnly tell him, in the name of all TEX users, past, present and yet to come,

> *Thank you Don, from the bottom of our hearts!*

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