What is TEX and Metafont all about?*

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Abstract

A survey of TEX, its flavours, and its twin sister METAFONT, within the context of Electronic Publishing, is given.

Keywords: AMS-TEX, education, electronic publishing, (La)TEX, Metafont, (encapsulated) PostScript, SGML, hypertext.

Contents

Introduction

This work about computer-assisted typesetting by (LA)TEX and METAFONT in context, is aimed at a broad audience. Novice users à la BLU[1] who like to become informed what it is all about, advanced LATEX users who hardly have heard of manmac, and mathematicians and publishers who will find the offerings of the American Mathematical Society interesting.

There have been published many notes, articles and books about TEX. Advanced ones exploring TEX's limits, and also contributions at the survey and introductory level. The latter deal with the macroscopic mark-up features as well as the microscopics of automatic kerning, for example with A and V in AV, the automatic handling of ligatures, the automatic justification and hyphenation supported by hyphenation tables, and the formatting of math, tables and graphics. They also boast of the quality which can be obtained when formatting the typographic teasers: math, tables and graphics.

In the TEXniques series we have the tutorials: A gentle introduction to TEX, by Michael Doob, and First grade TEX, by Arthur Samuel. For LATEX there is: An introduction to LATEX, by Michael Urban, and—for the Dutch speaking community—Publiceren met LATEX, by de Bruin. Also noteworthy is Hoenig's TEX for new users, and the introduction chapter in Salomon's courseware Insights and Hindsights. For METAFONT see Henderson's An introduction to METAFONT, and Knuth's introductory article on the issue in TUGboat. A survey with respect to EP tools (Electronic Publishing) is Document Formatting Systems: Survey, Concepts and Issues, by Furuta and co-authors.

For trying it out and working with it, the user groups distribute PD versions of (La)TEX as well as integrated working environments for PCs, with all kinds of bells-and-whistles added. Ubiquitous is Mattes' PD emTEX, and the working environments. AsTEX (apart from Framework it is in the Public Domain), next to the Dutch 4TEX (which is shareware).

This paper relates TEX and METAFONT to EP, SGML and the like, as a helicopter view, and accounts for the many activities of its users. At the end an annotated bibliography has been supplied.

Conventions and notations. I adhered to the historical development of TEX et cetera, and did not order the tools with respect to perceived importance. The latter is a matter of taste and definitely time-dependent.

The Contents list is not a one-to-one mapping of the section titles. It is used to stress the main items and their treatment within a logical hierarchy. I clustered some section titles and subsection titles, whenever convenient, to enhance readability. The aim was to convey

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[1] BLU is Knuth's nickname for the innocent user, the so-called Ben Lee User of the TEXbook fame, with BLUe its cousin, adopted by me. Nowadays we would say Beginning LATEX User.

the contents and not so much the form, to paraphrase Marvin Minsky.

Because it is a 'helicopter' view I need to refer to other work. This has been done a little loose via the name of the (first) author and the title, or keywords form the title. The reader can easily spot from the supplied list of references which work is hinted at. Just start by the author name and look for the matching title. I also did not bother about traditions which require that book titles are set in italics or so. In my opinion to find out whether it is a book, a report or a journal article follows easily from the ISBN number if provided, respectively the journal name. Hereby I assume that readers are familiar with some journal names, for example TUGboat, the journal of the TEX Users Group.

For common words in the TEX arcana—like TEX, LATEX, American Mathematical Society, et cetera—I adopted the TUGboat typesetting conventions by using their macros for formatting these names. File names are set in the `\tt` font.

1 TEX etc. tools

First of all TEX etc. has been around for some fifteen years, and many of its users have contributed to the components and to the porting to many platforms, with the result that it is not easy to really survey the whole complex.

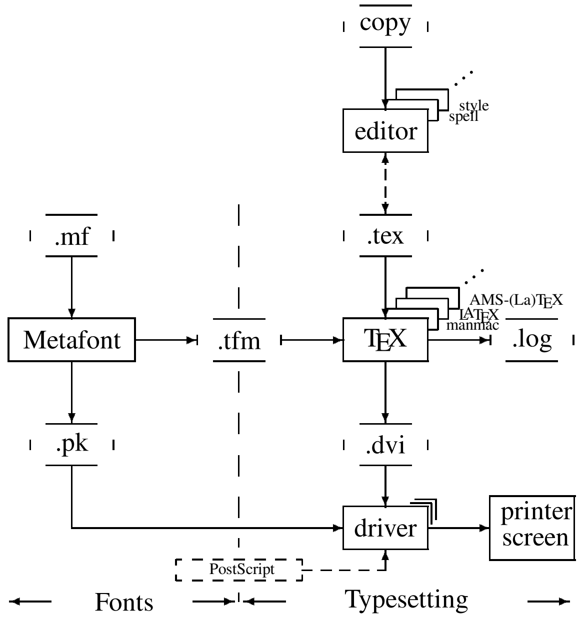
Going back to the roots we can say that TEX is a program for formatting documents, born as a twin with its sister METAFONT, for creating fonts. TEX and METAFONT have been designed to facilitate the high-quality computer-assisted production of books. A more modern way of talking is that TEX is a mark-up language with METAFONT the accompanying tool for designing the needed graphics, starting with the fonts.

A nice survey of the most important components and files when working with TEX is supplied by the accompanying diagram,[2] which illustrates the two main fields: font design and typesetting, with the relations between the components and files, all in one, and abstracting from details.

That is

- the flow from copy to printed results
- where the editor and its associated tools come in
- the location of TEX—its flavours, and add-ons—at the heart
- what is used from METAFONT and where
- the printer independence via various drivers
- at what level PostScript can be included.

The important files are indicated by their extensions and are depicted within ovals. What holds for creating the `.tex` file holds also for the `.mf` file.[3]



1.1 Working environments.

The needed tools are nowadays embedded in computer-assisted (scientific) working environments. At first sight this seems trivial, but it is really handy that the tools are integrated, also with non-formatting applications per se, such as email, database applications and the old running of C or FORTRAN programs. A model of thinking is that, for example, a thesis is prepared and all the simulations and calculations are done as a side-step of the main work: publishing! That is document preparation, formatting, typesetting, and dissemination. The graphics-oriented PCs like Macintosh and Atari paved the way. Nowadays the 486-based PCs with their (graphics) window facilities allow this way of working too.

1.2 Installation.

The products are usually accompanied by their installation documentation. Famous, and top class, are the AMS installation Guides. With the PD PC versions the idea is to supply turn-key scripts so that the installation goes automatically. From those distributed by the TUG/LUGs the only nice one I have seen is the GUTenberg PD PC set and installation guide, prepared by Lavaud. Installation of the working environments is more complicated, because of the many components.

1.3 Lifetime.

The kernel TEX and METAFONT programs have been designed with flexibility and portability in mind. Knuth envisioned that the two could be used a hundred years

[2] Inspired by Salomon's diagram as supplied in his courseware: Insights and Hindsights.

[3] Not mentioned are virTEX and iniTEX. Erik-Jan Vens communicated the following functionalities on the TeX-nl network: 'IniTEX allows preparing and fast loading of `.fmt` files. VirTEX is a program that can accept fast your macros and then do the typesetting job proper.'

from now, just as we do today, with the same input and results![4] In order to make this possible Knuth

- invented the WEB literate programming way of working
- documented the programs (open system) well
- worked hard on making the systems error free
- delivered the twins into the public domain, and
- froze the kernels.

Because of these goodies the user community could port the systems to any conceivable platform, and add layers on top to adjust for users' wishes and demands. All-in-all one can say that the twins are portable in place and time, are powerful, useful, and will serve a lifetime.

The working environments suffer from a much shorter lifetime. Read: need continuous maintenance and that is something, especially in a volunteer-based world. It is always a matter of the right balance: how fast do I need to do the day-to-day work and how often do I wish to upgrade the working environment.

2 Importance

From the computer science point of view TEX and METAFONT are big research achievements in how software engineering should be done, if not for the literate programming way of software design and creation. Top-class algorithms for line-breaking, hyphenation and page make-up have been incorporated. It is designed to be device-independent. That Knuth succeeded so well in his basic research can be witnessed by the many publications which have been built upon his Computer and Typesetting works, and the many honorary degrees he has received.

From the users' point of view TEX etc. is relevant because of the quality which can be obtained when used as a formatter. TEX is an open and freely available system. It has been frozen, and delivered into the public domain to serve for a lifetime. That Knuth succeeded here so well can be distilled from the many organized users of (LA)TEX world-wide, and perhaps the tenfold more who just use the systems.

Its weakness is that TEX proper does *not* have easy user guides. This weakness has been compensated for by efforts like LATEX, AMS-TEX/LATEX, and the styles from publishing houses and their user and installation guides. Perhaps an unexpected side-effect of TEX is that it is so heavily used with alphabets different from Latin, and even with scripts which run from right to left (Hebrew) or scripts which run vertically (Japanese), not to mention specific hyphenation patterns. That TEX allows for these usages might give an idea of its power.

From the publishers' point of view TEX has the potential of being used for producing complex scientific documents cost-effectively. This is the current practice of the American Mathematical Society, and the American Physical Society, APS for short. They supply authors with

- user and installation guides
- fonts
- style files
- templates, and
- support, in general.

The advantages can be summarized as

- high-quality craftsman tool
- lingua franca for exchange of typographically complex documents
- stability (TEX kernel has been frozen)
- open system
- available for nearly all platforms
- in the public domain
- portable, flexible, extensible, ...
- 7.5–10k organized users world-wide
- cost-effective production tool.

Disadvantages are there any? Of course there are. But it is questionable whether one should talk about disadvantages. Perhaps one should talk more in terms of incompleteness.

> What is felt like an omission can be added, because it is an unextensible system.

I for one miss that manmac.sty—Knuth's macros for formatting his books—doesn't take a user guide, nor does plain TEX. Of course there is the TEXbook—the bible for the TEXies—but that does *not* hide the details—it is all there, for the beginner as well as for the advanced macro writer—which is confusing and simply too much for a novice. In summary

- (LA)TEX is not WYSIWYG-like[5]
- unusual macro language[6]
- complex: $\approx$ 1k commands, parameters, ...[7]

So its incompleteness is a challenge to all of us, to fill it up.

It is true, however, that professionals have found some niches which deserve further research and development. Surveys on these items are provided in the E-TEX paper by Mittelbach, and the New Typesetting System efforts initiated by the German-speaking users group DANTE. Also noteworthy is the effort to improve LATEX via the so-called LATEX3 (better known as lxiii) project.

[4] Or better.

[5] Usually commercial.

[6] It is always a matter of education, and after that the *un*usual issues metamorphose into paradigms.

[7] Abstraction, subsetting and user guides—like those of AMS-TEX—are needed. Tools which concentrate on the publishing goal and not so much on understanding and learning the formatting language per se.

One can also argue that delving into these details is sub-optimization, concentrating too much on the mapping onto paper. Bigger issues are related to the multi-media aspects, let us say to represent information in a flexible way such that it can be processed by various technologies, into forms suited for various users, their circumstances and their tastes, limited only by their senses. I like to call this *real* applied information technology: information to be accessed by the masses.

3 TEX's flavours

TEX has gotten its children already, like `manmac`, LATEX, and AMS-TEX/LATEX, to name but a few. As usual with children they live their own lives. For TEX this means that they have the confusing side-effect of not being completely compatible. In spite of this incompatibility reality has it that authors and publishers make their choice—TEX-based, or LATEX-oriented—and therefore the incompatibilities don't hinder most of us.

`manmac.sty` is a set of macros written and used by Knuth to format his magnum opus: The Art of Computer Programming, his Computers and Typesetting series, and so on. For an account see my Manmac BLUes.

LATEX stresses the higher-level approach of descriptive mark-up and hides the formatting details as much as possible from an author. Because of the rigorous way this has been implemented, it is hard to customize the prefab styles.

Leslie Lamport's manual, LATEX, A Document Preparation System, exhibits the functionalities

- prefab styles: article, book, letter, report, slides
- automatic (symbolic) numbering and cross-referencing
- multi-column formatting, with its embedded 1-column occasionally for tables and figures
- automatic generation of ToC, LoT, LoF
- picture environment
- bibliography environment.

AMS-TEX/LATEX are the tools of the pace-setting American Mathematical Society. This publisher adopted and supported the TEX development from the beginning. (See below under TEX and its publishers.)

LAMS-TEX reimplemented in a flexible way the descriptive LATEX approach, next to a general automatic numbering and symbolic referencing scheme, advanced table macros, and sophisticated commutative diagram macros. See my review of Spivak's œuvre for more details about the Joy of TEX and LAMS-TEX—The Synthesis.

In summary

- `manmac.sty`, Knuth's format
- LATEX, descriptive mark-up, and user's guide
- AMS-TEX/LATEX styles and fonts, with support
- LAMS-TEX
- TUGboat styles
- PD software and working environments

4 TEX's drivers

Normally the drivers come with your TEX when you buy it. With the PD versions, users have to be aware of the PD available drivers, for the various PCs and printers, unless your user group provides you with an integrated working environment which contains all. For a survey of the available 'Output device drivers' see Hosek's paper in TUG's resource directory. He details drivers for

- laser xerographic and electron-erosion printers
- impact printers and miscellaneous output devices
- phototypesetters
- screen previewers

and ends up with supplier information. Joachim Schrod reported in TUGboat 13, 1, (early 1992) from the TUG DVI driver standards committee.

Well-known is the PD Beebe driver family. emTEX comes with some drivers for dot matrix printers and the HP LaserJets.

At the TUG '92 meeting the attendees were surprised by Raman's paper 'An audio view of (La)TEX documents.' It has all to do with representing the contents of a publication for the blind.

With respect to PostScript the `dvitops` driver is important. Formerly, I also used `dvitodvi` in order to print out selected pages. Now I use `manmac`'s facility to do that which is essential simpler for that purpose because it ships out only the required pages.

5 TEX and fonts

From the beginning Knuth provided TEX with the computer modern family of fonts. These fonts can be generated, and varied via METAFONT, by adjusting some parameters. Since the introduction of the virtual font concept, in revision '89 better known as TEX version 3, many industrial fonts can be used as well. Via this mechanism, font elements can be combined at the driver level. The need for handling in a flexible way the positioning of diacritical marks was the incentive for adding the virtual font concept, to make it feasible to handle languages with their own special placements of diacritical marks without the need to regenerate complete new fonts. The other way is to generate complete font tables for every language, which is a perfectly acceptible way of doing it, but will entail many font tables and of larger size.[8]

[8] Reality has it that the TEX community standardized on the 256-character DC font tables, to allow for some special characteres, like the use of the ij in Dutch. See Haralambous' paper in TTN 1, 4. An entirely different approach is needed for the Japanese ideograms, that is symbols representing things or ideas. At present there are some 6,353 kanji characters available on various types of computers known as JIS level 1 or 2 (Japanese Industrial Standard is akin to ASCII).

However, since TEX is used for more and more applications the need for more fonts—different shapes, sizes and so on—has emerged. Using standard bitmap technology much computer memory is needed. Reality has it that scaling fonts linearly does not yield pleasing results. To compensate for this the intelligent scalable fonts technology emerged—near-linear and intelligent, that is with some enhancements—as opposed to the classical memory-consuming bitmap fonts, extended by the linear scaling as such.

Also the mark-up for fonts has gotten a new dimension: the linear space of available fonts is seen as a 4-dimensional space governed by the coordinates family, serie, shape, and size. The approach goes with the buzzword NFSS, New Font Selection Scheme (See Goossens, Mittlebach and Samarin).

Which fonts can be used with TEX? The following classes of *text* fonts can be used with TEX

- CM, the native Computer Modern
- 14,000 fonts in industry standard Adobe type 1
- several hundreds in formats such as TrueType.

(Very) few fonts can be used with math, because of the specialities of the font characteristics TEX assumes. However, the following fonts can be used with math

- CM math, the native Computer Modern
- lucida math
- lucida newmath
- mathtimes.

For more details see Horn's Scalable outline fonts paper, and for Japanese Fujiura in TTN 1, 2.

Descriptive mark-up

Since the start of computer-assisted typography attention has been paid to abstraction from details, to the principle of the *separation of concerns*.

Leading in this area is the SGML approach.[9] It is argued that

> authors should concentrate on the contents—and inherently on the structure—of their documents, leaving the details for formatting to the publisher.

Example: (Call for papers, Furuta)

```
\input cfp.tex%contains format and macros
%next copy proper
The aim of this paper...

Paper are solicited on ...
\lstitm Picture editing
\lstitm Text processing
\lstitm Algorithms and software...
Detailed abstracts should not ...
Duration of presentation...
\bye
```

The above example is a mixture of natural input, where blank lines have an intuitive but context-dependent meaning, and of handling trivia automatically behind the scenes. An example of a default is the heading.

For this format the heading is always the same, so there is no need for a user to provide it each time the format is used. It comes along with the format. So do the fonts used and the shortcuts like
`\def\lstitm{\item{--} }.`

My approach looks simpler than Furuta's—in that paper all the low-level formatting details were there—because I applied the principle of the separation of concerns and abstracted from the low-level formatting details. The point I'd like to make is that it is possible to hide formatting details, to account for these separately and at a lower level. I like to call this approach generic, because the mark-up is customized at a lower level to the suited tool.

6 TEX and its author

Don Knuth started the design of TEX in 1978. The first major revison dates back to 1982. The final version is dated 1989, and called TEX version π.[10] It is all a side-step(!) of his magnus opus: The Art of Computer Programming, of which three volumes have appeared of the envisioned seven. Because of the rapid development in computer science volume four consists of three books already.

In designing and developing TEX, Knuth adhered to several software engineering paradigms like: portability, flexibility, robustness, and not to forget correctness and documentation.[11] In order to do this gracefully he coined the words *literate programming*, and provided en-passant tools for practical use! In fact TEX can be seen as a real-life and significant example of literate programming.

In designing TEX he adopted and developed the following

- boxes, glue and penalties as building blocks
- paragraph-wise searching for line-breaks
- page mapping via the OTR,[12] optimizing for least penalties
- device-independent output, to be printed, typeset, or viewed, by independent driver programs
- virtual fonts.

TEX was developed as a side-step. METAFONT can be seen as an off-off-spring.

[9] The relation between SGML and TEX will be discussed later.

[10] Essentially version 3, but because reality has it that even Knuth 'makes errors' he allows for adjusted versions denoted by the decimals of π: 3.1, 3.14, 3.141, et cetera.

[11] The software crises of the seventies suffered much from inadequate documentation.

[12] A buzzword to denote the output routine which performs this task.

7 TEX and its users

It is unknown how many people use (LA)TEX, and for what purposes. We know, however, that it is used all over the world, to typset

- scientific documents, exchange and publish such documents[13]
- documents which require special fonts and layout conventions, like Japanese, Arabic, Hebrew and so on
- transparencies and slides
- material associated with a hobby (bridge, chess, crosswords, go, music, and add yours).

A great virtue of the users' action is

- the porting to various platforms
- to provide macros, fonts and formats
- to maintain LATEX
- to ponder about and develop New Typsetting Systems
- to develop and maintain integrated working environments.

The user groups. We also know that many users have organized themselves into user groups, to start with the original TEX Users Group (TUG), and more recently into so-called LUGs—language-oriented local user groups. The Dutchies are organized since 1988 as the NTG, Nederlandstalige TEX Gebruikersgroep, that is Dutch language-oriented TEX Users' Group. We enjoy some 225 members of whom are 30 institutions.
World-wide some 7.5–10k users are organized.
The benefits of being organized, apart from those which come from cooperation and sharing in general, are

- meetings
- TUGboat, newsletter, casu quo bulletins, 'specials'
- resource directory (information about the (La)TEX working environments of members, their addresses and similar things)
- TUGboat styles
- assistance
  - archives
  - BBS (Bulletin Board Services)
  - digests
  - FAQs (Frequently Asked QuestionS)
- courses
- PD sets (Public Domain)
- distributing point books (tutorials), software.

Moreover, the user groups stimulate and support research and development, such as the projects: TEXHaX, BIBTEX, and more recently LATEX3, and NTS. From the social side we have the TUG bursary fund, to grant attendence for a TUG meeting for those TUG members who can't afford it, next to the Knuth Scholarship award. The latter is a competition which rewards the winner with attending a meeting for free.

Some addresses?

TUG: Balboa Building, Room 307, 735 State Street, Santa Barbara, Ca 93101, USA, `tug@tug.org`

NTG: Postbus 394, 1740 AJ Schagen, `ntg@nic.surfnet.nl`.

For other addresses consult the resource directory of TUG, or your friendly NTG around the corner.
Add-ons have been provided by the user communities. They have also supplied mutual support, and have provided logistic facilities. The latter is not restricted to (LA)TEX proper. It is about the general use of the electronic networks

- exchange via e-mail
- electronic digests and list servers
- the file servers, which store all the macro and style files.

Really, very nice goodies! The proper add-ons concern

- porting the complex to every system, especially the affordable and widespread PCs
- macro and style files[14]
- extra fonts, casu quo font couplings via virtual font scripts
- WYSIWYG user interfaces (commercial)
- TEX-based PD/shareware working environments
- language-specific issues (hyphenation patterns, reserved words, . . .)
- drivers for new printers
- PostScript etc. inclusion at the dvi level.

And the end is not yet in sight.

8 TEX and the publishers

The importance of the American Mathematical Society effort is that the AMS is leading in how (La)TEX can be used cost-effectively as a high-quality tool in a production environment: publishers cooperating with authors.

As I understand it the American Physical Society is following the AMS approach.

At the TUG '91 meeting at Boston, it was estimated that commercial publishers handle some 5 to 10% of their (scientific) production via (La)TEX.

And in the CIS—Commonwealth of Independent States, the former Russia—MIR has adopted the AMS approach as well. And then there is the Ukraine group to be founded offically this fall, and undoubtedly more to follow.

[13] For an impression of published books formatted via TEX see Beebe's bibliography in the TUG resource directory.
[14] A survey of what is provided is contained in the so-called Jones' index, and Beebe's TUGlib.

The American Mathematical Society do their complete production via TeX: ≈100,000 pages/year, and provide authors with

- (generic) styles
- macros, and fonts
- user guides
- support (keyboarding, mark-up, fine-tuning).

The approach can be depicted by the following scheme

author(TeX)	author(LaTeX)
↓	↓
`amsppt.sty`	`amsart.sty`
↓	↓
`amstex.tex`	`amstex.sty` → LaTeX
↓	↓
TeX	TeX

They also supply fonts: Euler, Fraktur, ...
For more details consult the AMS sources or see my AMS BLUes paper on the issue.

The American Physical Society handle some 20% of their production via LaTeX. They cooperate with The Optical Society of America and the American Institute of Physics. Their style is called REVTeX.

MIR publishers Moscow—the driving force behind CyrTUG, the Cyrillic language-oriented TeX users group[15]—translated Spivak's The Joy of TeX into Russian among others. I would not be surprised to hear that they do the production of their scientific documents with TeX too, completely. They have the knowledge and TeXnology. And TeX- and METAFONT-based technology does not require much hard currency for investment.

JTUG? And what is going on in Japan? The JTUG has at least .5k members.[16] They have translated among others the TeXbook and the LaTeX manual into Japanese. Some years ago I received a Japanese newspaper set by JTeX!

9 TeX and other EP tools

Furuta gives a good account of the history and early tools in relation with computer-assisted typesetting. However, since the appearance of that paper

- the laser printer technology has taken off
- many computer-based fonts have emerged
- thinking in structures has gotten more interest (SGML)
- the DTP (Desktop Publishing) credo has come into existence, and
- hardware prices have continued to spiral down.

Everybody can afford a PC, a laser(jet) printer, and some software (especially Word*whatever* or the PD (LA)TeX).

9.1 TeX and intelligent editors.

Keyboarding compuscripts in (La)TeX can be assisted by editors which are (La)TeX intelligent, and next, to use templates as 'fill-in' forms. An example is Beebe's LaTeX-intelligent emacs. This approach can prevent errors like the level 1 or so endings, or non-matching braces and the like. At this level we can also make use of spelling checkers and style assistants.

9.2 Word-whatever and TeX?

It is true that Word-you-name-it, has made the use of computers more popular. They replaced the typewriters, don't forget that. And of course that was a step forward. These are the tools the masses are using because of the sufficient and improved quality which can be obtained. This must be seen in context of course: most of the publications are just in-house reports, memos and the like.

> For high-quality typesetting a TeX-like tool, high-resolution fonts and ipso facto printer, or viewer, are needed.

Because wordprocessors are so widespread and heavily used, it can be anticipated that users start from there and need TeX's formatting capabilities now and then. For that group there exist conversion software: the public domain DRILCON and the commercial K-Talk. Simpler, and better when it concerns complex structured copy, is to

> output in ASCII from Word*whatever* and insert (LA)TeX mark-up.

And, of course, the wordprocessor can always be used as an editor for TeX, with taking advantage of the integrated spelling checker.

9.3 Troff or TeX?

Troff preceded TeX. It comes with UNIX. Both have been in use for the last decade. To begin with Knuth built upon troff, scribe and similar tools. On the other hand the troff add-ons have learned from TeX. So there has been mutual influence.

With respect to the functionality the tools are comparable. Both aim at computer-assisted typography. But there is also a world of difference. Basically the difference is that troff is a program which can be extended by independent preprocessors, and TeX is an extensible language itself, with plain TeX—the kernel program—device independent, that is the mapping on the media has to be done by independent drivers. That the latter was not in troff can be discerned from the subsequent nroff—with accompanying neqn—and finally, di-roff, device-independent roff. Furthermore, remember that TeX is just one of the twins.

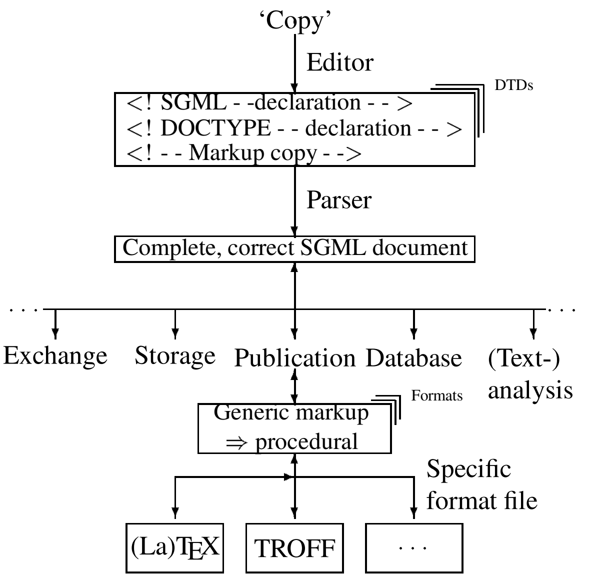
[15] See also 'News about CyrTUG and Russian TeX Users' in TTN 2, 1.
[16] See also 'Update of TeX in Japan' TTN 1, 2.

Rumour has it that interest in troff weakened because the early PCs did not come with UNIX, and that the kernel has remained undocumented (Its author Ossanna died in an accident.) The following table is supplied to indicate roughly the differences.

	(LA)TEX	T/Di-roff
Costs	PD	licensed via UNIX
Availability	all platforms	under UNIX
Documentation	TEXbook (also on-line)	On-line manual
Fonts	Metafont's CM, virtual fonts	?
Design	open system	kernel undocumented
Printers	device independent	di-roff approach
Flexibility	complete	?
Extensibility	macros	preprocessors
Mark-up	formats and styles	ms macros
Coding	uniform in `WEB`	C
Future	kernel frozen, users augment	frozen
Acceptance	users, AMS, APS, . . .	users, ?

9.4 SGML and TEX?

SGML stands for Standardized Generalized Mark-up Language. It is an effort to formalize mark-up, and is defined as a meta-language to define the mark-up language of each publication series into so-called Document Type Definitions, DTDs for short.



SGML is part of a huge standardization effort supported by the US military via the CALS initiative. Other components are: FOSI—Formatted Output Specification Instance[17]—and DSSSL.[18] It is not so much a question of

TEX *or* SGML, but more TEX *and* SGML.

TEX formats can learn a lot from the SGML approach and on the other hand SGML needs a formatter when it is used to print documents. This cooperative approach is known as

SGML the front-end, (LA)TEX the back-end.

A diagram about the SGML-TEX relation is supplied in the accompanying picture.

9.5 SGML and Hypermedia?

The following has been contributed by Gerard van Nes (from SGML FAQs and Personal Computer Word, March 1992)

> 'HyTime—Hypermedia/Time-based Structuring Language (ISO/IEC 10744). HyTime is a standard neutral markup language for representing hypertext, multimedia, hypermedia and time- and space-based documents in terms of their logical structure. Its purpose is to make hyperdocuments interoperable and maintainable over the long term. HyTime can be used to represent documents containing any combination of digital notations. HyTime is parsable as Standard Generalized Markup Language. HyTime was accepted as a full International Standard in spring 1992.
> SGML's hypermedia capabilities have been beefed up in the SGML standard extension HyTime. Although it started out in life as a specific set of standards for representing music, it was soon realised that these could be generalised for multimedia. HyTime provides
>
> - SGML itself
> - Extended Hyperdocument management facilities, including support for various types of hyperlink
> - A Coordinate Addressing Facility which positions and synchronises on-screen events. This allows authors to specify how hypermedia documents are to be rendered
> - Better version-control of comments and activity-tracking policy support.
>
> HyTime has been adapted as the basis for hyperlinking in the US Department of Defense's Interactive Electronic Technical Manual project. HyTime is an extension of SGML, providing a set of syntactic constructs: it doesn't specify a processing system.'

Sounds very promising!

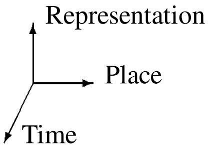
9.6 TEX within the context of EP.

When we think about Electronic Publishing we can't avoid being aware of the life-cycle of publications. This obeys the biological invariant: produce, consume and reuse.

[17] See Dobrowolski's paper.
[18] See Bryan's paper.

Life-cycle: producing.

The production process has all to do with the dimensions



and with the characteristics

- representation of the contents, that is the typesetting proper aspects
- logistics, that is distribution and selling points—the place dimension
- reuse, that is the time aspect, when (parts of) document are reused.

The flow can be depicted via

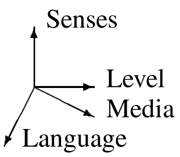
$$\begin{array}{ccccc} \text{Produce} & \rightarrow & \text{Distribute} & \rightarrow & \text{Consume} \\ \uparrow & & \uparrow & & \downarrow \\ \text{reuse} & \leftarrow & \text{retrieve} & \leftarrow & \text{store} \end{array}$$

The big features are the unambiguous mark-up of copy via (LA)TEX and the lifetime of the TEX kernel. Therefore storing documents formatted by TEX, leaves the reuse aspect open. Reality has it that documents formatted via TEX are easily redistributed via the electronic networks, because it is all in ASCII, and TEX is everywhere, so are its drivers.

My day-to-day reuse is transforming reports into articles and these into transparencies. In this work it is the other way round I'm recollecting elements I have set earlier. Similarly with the book I'm working on Publishing with TEX. Actually my first work in the document preparation area, in the early eighties, was called 'Van rapport naar tranparant.'

Life-cycle: consuming.

TEX's drivers have not paid attention to other representations as yet, although an exception is a driver for the blind. Difficulties in formatting languages different from English have been exercised in recent years. Undoubtedly research will be devoted to the aspects hinted at in the diagram given below with the dimensions



Senses :	eyes, ears, tactile
Level :	abridged, full, . . .
Language:	English, Dutch, . . .

and with the characteristics

- choice of consumer language independent of the submitted language, that is automatic translation
- choice of representation, that is for example voice output from written submission.

Of course the above aspects will keep research busy for some time to come. This is the direction multi-media development will go.

10 Trends

Adobe has been the trendsetter of the last decade with respect to new EP technologies. Recently, I heard about their PDF—Portable Document Format—which is at the heart of their Acrobat. Very promising, if not for the tools which come along with this product.

I believe that the multi-media information technology will take off in the next century. Much is known under the buzzword hypertext. See the special issue of the Communications of the ACM for an introductory survey. As a TEXie it is fun to ponder about what niche there will be for TEX. At the various TUG meetings people are concerned about the future of TEX and share their doubts and optimisms. From that the following anthology

- LATEX is the future, forget about TEX
- make (LA)TEX available on low-cost machines
- embed TEX etc. in working environments
- improve TEX, in short keep it alive
- provide WYSIWYG user interfaces
- increase the number of (organized) (LA)TEX users
- get (LA)TEX accepted by publishers (formats, support, fonts, and the like)
- get (LA)TEX accepted by other communities: SGML, scientific societies
- provide user guides and templates
- education is paramount
- keep it simple and small is beautiful.

and so on.

Prophecy. The demand on IT will be that

> people can access cost-effectively, and easily, from their homes the information they need in a representation they wish.

I envision that the following technologies will influence each other in realizing the stated prophecy

- TEX's role? Embedded in a Hypertext approach?
- Increased self-publishing
- Electronic Production & Consumption
  + Photography
  + CD
  + TV/Radio, video
  + PC
  + Phone, fax, email
  + Holography
  + . . .
- Involvement of linguists and behaviourists

with the functionalities

- Various inputs (o.a. voice, photography, . . .)
- Diverse outputs (language, level, media and representation,. . .)

Some years ago I day-dreamed about holographic-based true 3-D 'displays,' as a generalization of computer-assisted interactive TV. Science-fiction? Wait and see, or better hang on and make it happen!

11 Examples

With a publication we have two main issues: macroscopic and microscopic. With the first I mean the aspects which govern the total outer level of a publication, let us say to look upon it as a tree consisting of

- front matter (front pages (title etc.), publication characteristics, foreword, table of contents and the like)
- copy proper (the chapters and their substructures), and
- back matter (appendixes with references, index, and other special items).

These macroscopic aspects are accounted for in so-called formats or style files.

The microscopic aspects deal with formatting in the small within paragraphs, the complex mark-up of math, tables and graphics.

Another basic way to look at the matter is that it has all to do with

> positioning of typographical elements on pages.

The following examples, biased by my own (scientific) needs, are in the main about

- formats, generic and special

and deal in the small with

- special texts like programs
- (displayed) math (formulae, matrices, . . .)
- tables
- graphics
- bibliographies, and
- indexes.

So nothing in here about the use of TEX for non-Latin languages and the design and generation of the needed fonts, simply because I don't speak them. I also refrained from including examples about the hobby use—games—without a serious reason. See NTG's PR set for the latter. See the works of Haralambous with respect to non-Latin languages, and the work of Horak for (math) METAFONT examples.

11.1 Examples: formats.

In this section some detailed formatting examples are provided.

I will consider LATEX as formatter for a rudimentary house-style, followed by a generic approach customized to `manmac` and LATEX's report style.

House-style. LATEX is heavily used for this *as-is*

```
\documentstyle[options]{house}
%preamble
\begin{document}
%front matter
\title{...}
...
\begin{abstract}
...
\end{abstract}
\tableofcontents
\listoffigures
\listoftables
%copy proper
%\section, \subsection structuring with
%paragraphs with (displayed) math, tables
%and graphics.
%back matter
\begin{thebibliography}{xxx}
\bibitem{dek84} Knuth, D.E (1984):...
...
\end{thebibliography}
%Index material (\makeindex tool)
\end{document}
```

Options are, for example, the number of columns,[19] the size of the used fonts, the paper size, and the like.

As style files there are next to report, the styles book, article, letter, and so on.[20]

Generic mark-up. Many users start nowadays via LATEX. Sooner or later the demand for a generic approach pops up. Then the user wishes to abstract from the concrete formatter and use some higher-level mark-up for the global structuring commands, customizable to a concrete formatter of choice.[21]

The idea is that the *user* mark-up at the outer level is as independent as possible from the concrete formatter.

> A generic approach is needed because of the variety of environments we live in and because of their rapid change.

For the generic approach to become realistic, and to handle it gracefully, I assume that

- the opening part is available for the various formats as templates
- the copy proper uses as structuring commands `\head` and the like
- for the detailed formatting plain TEX is used, so that this can be used in (LA)TEX (math, tables, and graphics)

[19] It is not true in general that switching from 1-column into 2-column format can be done without altering the mark-up of displayed math, tables or figures. At least one must change locally back into 1-column format, or one has to scale the document element into smaller size as was done in this paper.

[20] LATEX's SLITEX is a bit different. One can't simply switch from report into slides.

[21] This sounds like SGML, but without its generality and its overhead. I like to call this 'SGML on your mind and TEX in your hands.'

- for the end matter a generic approach for the bibliography—see my BLUe's Bibliography paper—is used
- for index preparation a non-specific tool is used.

With the above a generic approach for a house-style is

```
%Front matter
\opening%To be replaced by template
%Copy proper
% Structured via \head{...} and the like
% with detailed plain mark-up: math, tables,
% line diagrams,...
%Back matter
 \bibliography
 \index
\closing
```

Customization to `manmac`.
`manmac` is flexible, and alas too much overlooked, because it lacks a user guide. Customization of the generic approach to manmac goes along the following lines to give you an impression. (Not tested!)

```
 \input manmac
 \input manmac.cus%manmac customization
 \input man.tem   %manmac template
 \input toc       %table of contents
 \input cover     %see my manmac blues
 %Copy proper
 %Back matter
 \closing
```

with in `manmac.cus`

```
 %Customization of manmac
 %Redefine \beginchapter also non-outer
 \def\beginchapter#1 #2#3.#4\par{%
   \def\hl{\gdef\hl{\issue\hfil\it\rhead}}
   \headline{\hl}
   \def\\{ }\xdef\rhead{#4}
   {\let\\\cr\halign{\line{\titlefont
    \hfil##\hfil}\\#1 #2#3 #4\unskip\\}}
   \bigskip\tenpoint\noindent\ignorespaces}
 \def\endchapter{\vfill\eject}
 %
 \newcnt\chpcnt \newcnt\seccnt
 \def\head#1{\endchapter\beginchapter
     \advance\chpcnt1 \seccnt0
     {} {}\the\chpcnt. #1\endgraf}
 \def\subhead#1{\beginsection\advance\seccnt1
     \the\seccnt. #1\endgraf}
 \def\bibliography{\beginchapter Bibliography
   {}{}.{}\endgraf}
 \def\closing{\bye}
```

and with in `manmac.tem`

```
\def\opening{
 \def\issue{%
 MAPS Special 93.x            %issue
 }\def\title{%
 MAPS Special Template        %title
 }\def\abstract{%
 A template for MAPS Special is provided.
 }\def\keywords{%
 manmac, MAPS, NTG            %keywords
 }
}
```

In my Manmac BLUes paper I have worked out a prototype, directed to customization of `manmac`.

> Actually there it was the other way round: I started from Manmac formatting and abstracted into independent structures.

In Manmac BLUes I also worked out `cover`. Too much detail here.

Customization to LATEX.
The 'title part'-template is inserted instead of `\opening`, edited to suit the publication at hand. In `latex.cus` the macros are supplied to customize the generic mark-up to LATEX.

```
%Begin LaTeX report \opening template
\documentstyle{report}
\input{latex.cus}
\begin{document}
\begin{title}...\end{title}
...
%end LaTeX \opening template
%Copy proper
...
%Back matter
\bibliography
\closing
```

with in `latex.cus`

```
\def\head#1{\chapter{#1}}
\def\subhead#1{\section{#}}
\def\bibliography{\appendix
  \section*{Bibliography}
  \input{lit.dat}
  %\input{lit.tex}
   \frenchspacing
   \def\ls#1{\nul\\#1}%simple
  \input{lit.sel}
}
\def\closing{\end{document}}
```

The above ideas came to mind when working on this paper. They deserve development, because it has all to do with the

> user↔environment interaction,

which has always been important.

11.2 Special texts

are computer programs. First we like that these reflect the structure and different quantities (constants, variables, reserved words, comments etc.) of the program. Second we like that the programs remain correct while formatting them (meaning: humans hands-off!). These kind of texts come at two levels

- the small examples (less than a dozen of lines or so) which are part of courseware, and
- the documentation (and listings) of real-life programs.

Current practice is that for the first it does not really matter what you use. For a survey see the compilation of Van Oostrum. For the second Knuth developed `WEB`, which stimulates a programmer to design and *document* his program from the beginning, by rewarding him with pretty-TEX printing of it all via TANGLE. Actually the hierarchical way of working has been replaced by a relational approach, with the documentation related to the various items of a program. For a survey see Knuth's literal programming article of 1984.

11.3 Examples: math.

The TEXbook has devoted at least 4 chapters to math mark-up: typing math formula, more about math, fine points of math typing, and displayed equations.

See also my Math into BLUes paper for a survey and how to cope with situations which go wrong—not so much that TEX complains, but the results are different from what we expected—by innocent mark-up.

Displayed math via (plain) TEX. A display is marked up by $$ at the beginning and the end. Within a display the following is generally used

- just math mark-up
- `\displaylines`, for multi-liners
- `\(l)eqalign`, for aligned formulas[22]
- `\(l)eqalignno`, similar to the above, but numbering per line.

For numbering there is the primitive `\eqno`.

From a user point of view the following are representative structures

- Labeled 1-line

$$\sin 2x = 2\sin x\, \cos x \qquad \text{(TB186)}$$

- Three lines, second flushed right (relevant for 2-column printing)

$$F(z) = a_0 + \frac{a_1}{z} + \frac{a_2}{z^2} + \cdots + \frac{a_{n-1}}{z^{n-1}} + R_n(z),$$
$$n = 1, 2, \dots ,$$
$$F(z) \sim \sum_{n=0}^{\infty} a_n z^{-n}, \quad z \to \infty \quad \text{(TB ex19.16)}$$

- Two lines aligned, with middle labeling

$$\begin{aligned} \cos 2x &= 2\cos^2 x - 1 \\ &= \cos^2 x - \sin^2 x \end{aligned} \qquad \text{(TB193)}$$

- Two lignes aligned, with labeling per line

$$\cosh 2x = 2\cosh^2 x - 1 \qquad \text{(TB192)}$$
$$= \cosh^2 x + \sinh^2 x$$

obtained via

```
\begin{itemize}
\item Labeled 1-line
$$\sin2x=2\sin x\, \cos x
     \eqno(\hbox{TB186})$$
\item Three lines, second flushed right
(relevant for 2-column printing)
$$\displaylines{F(z)=
a_0+{a_1\over z}+{a_2\over z^2}+\cdots
   +{a_{n-1}\over z^{n-1}}+R_n(z),\cr
          \hfill n=1,2,\dots\,,\cr
\hfill F(z)\sim\sum_{n=0}^\infty a_nz^{-n},
       \quad z\to\infty\qquad\qquad\hfill
       \llap{(TB ex19.16)}\cr}$$
\item Two lines aligned,
      with middle labeling
$$\eqalign{\cos2x&=2\cos^2x-1\cr
                 &=\cos^2x-\sin^2x\cr}
  \eqno(\hbox{TB193})$$
\item Two lignes aligned,
      with labeling per line
$$\eqalignno{
\cosh2x&=2\cosh^2x-1&(\hbox{TB192})\cr
       &=\cosh^2x+\sinh^2x\cr}$$
\end{itemize}
```

Matrices via (plain) TEX. The examples show paradoxically that for practical use we not only need `\matrix`, but

- `\atop`, to stack elements on top of each other
- `\bordermatrix`, for bordered matrices, and this embedded within `\displaylines`
- `\halign`, to handle partitioning, and
- some macros tailored to our situations, like the icon set.

Examples

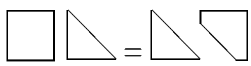
- Hypergeometric function

$$M_n(z) = {}_{n+1}F_n\biggl({k+a_0,\, k+a_1, \dots, k+a_n \atop k+c_1, \dots, k+c_n}; z\biggr)$$

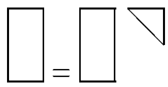
via

```
$$M_n(z)={}_{n+1}F_n\biggl({k+a_0,
   \atop\phantom{kc_1}}
   {k+a_1,\dots,k+a_n
   \atop k+c_1,\dots,k+c_n};z\biggr)$$
```

- Some matrix icons, Wilkinson (1965)



$AL = LH$



$A = QR$

via

```
$$\icmat44\kern\unitlength
  \icllt44=\icllt44\icuh413\qquad AL=LH$$
$$\icmat63=\icmat63\kern
  \unitlength\icurt63\qquad A=QR$$
```

See for the matrix icon macros my paper on the issue.

- Matrix reductions, Wilkinson(1965, p357)

$$\begin{array}{cc} \text{A} & \text{N} \\ \begin{pmatrix} \times & \times & \times \\ \times & \times & \times \\ \times & \times & \times \end{pmatrix} & \begin{pmatrix} 1 & & \\ 0 & 1 & \\ 0 & \times & 1 \end{pmatrix} \end{array}$$

[22] (l) denotes that the numbering appears at the left instead of the default right.

$$
= \begin{array}{c} \mathrm{N} \\ \begin{pmatrix} 1 & & \\ 0 & 1 & \\ 0 & \times & 1 \end{pmatrix} \end{array}
\begin{array}{c} \mathrm{H} \\ \begin{pmatrix} \times & \times & \times \\ \times & \times & \times \\ 0 & \times & \times \end{pmatrix} \end{array}
$$

via

```
$$\displaylines{\indent
\bordermatrix{&      &\rm A &      \cr
              &\times&\times&\times\cr
              &\times&\times&\times\cr
              &\times&\times&\times\cr}
\bordermatrix{& &\rm N & \cr
              &1&      & \cr
              &0&1     & \cr
              &0&\times&1\cr}\hfill\cr
\hfill=
\bordermatrix{& &\rm N & \cr
              &1&      & \cr
              &0&1     & \cr
              &0&\times&1\cr}
\bordermatrix{&      &\rm H &      \cr
              &\times&\times&\times\cr
              &\times&\times&\times\cr
              &0     &\times&\times\cr}
}$$
```

- Partitioning, Wilkinson(1965, p291)

$$
P_r = \left(\begin{array}{c|c} I_{n-r} & 0 \\ \hline 0 & I - 2v_r v_r^T \end{array} \right)
$$

via

```
$$P_r=\left(\vcenter{
    \offinterlineskip\tabskip0pt
    \halign{
      \vrule height3ex depth1ex width 0pt
      \hfil$\enspace#\enspace$\hfil
      \vrule width.1pt\relax
      &\hfil$\enspace#\enspace$\hfil\cr
      I_{n-r}&0\cr
      \noalign{\hrule height.1pt\relax}
      0      &I-2v_rv_r^T\cr}
        }\right)          $$
```

Next some examples without the mark-up, just the results, because they are real teasers.

- Braces and Matrices, Wilkinson(1965, p199)

$$
\begin{array}{c c}
 & \overbrace{\qquad\qquad\qquad\qquad}^{p} \quad \overbrace{\qquad\qquad}^{n-p} \\
\begin{array}{r} p\left\{\begin{array}{c} \\ \\ \\ \end{array}\right. \\ \\ n-p\left\{\begin{array}{c} \\ \\ \\ \end{array}\right. \end{array} &
\begin{pmatrix}
\times & \times & \times & \times & \times & \times & \times \\
0 & \times & \times & \times & \times & \times & \times \\
0 & 0 & \times & \times & \times & \times & \times \\
0 & 0 & 0 & \times & \times & \times & \times \\
0 & 0 & 0 & 0 & \times & \times & \times \\
0 & 0 & 0 & 0 & \times & \times & \times \\
0 & 0 & 0 & 0 & \times & \times & \times
\end{pmatrix}
\end{array}
$$

- Matrices, braces, (dotted) partitioning and icons; space efficient variant

$$
\begin{array}{c c}
 & \overbrace{\qquad\quad}^{p} \;\; \overbrace{\qquad}^{n-p} \\
\begin{array}{r} p\left\{\begin{array}{c} \\ \\ \\ \end{array}\right. \\ n-p\left\{\begin{array}{c} \\ \\ \end{array}\right. \end{array} &
\left(\begin{array}{cccc:ccc}
\times & \times & \times & \times & \times & \times & \times \\
0 & \times & \times & \times & \times & \times & \times \\
0 & 0 & \times & \times & \times & \times & \times \\
0 & 0 & 0 & \times & \times & \times & \times \\
\hdashline
0 & 0 & 0 & 0 & \times & \times & \times \\
0 & 0 & 0 & 0 & \times & \times & \times \\
0 & 0 & 0 & 0 & \times & \times & \times
\end{array}\right) \\
 & \underbrace{\qquad\quad}_{\neg} \;\; \underbrace{\qquad}_{\Box}
\end{array}
$$

- Other interesting two-dimensional structures are commutative diagrams. Consult for those Spivak's LAMS-TEX.[23]
  Interestingly enough, simple commutative diagrams are done by `\matrix`, while I would expect some graphic commands.

11.4 Examples: tables.

For (full) rectangular tables `\halign` or `\valign` is generally used, when they fit on the page. Because of determining automatically the page breaks it might happen that the page builder would like to split a table. Generally this is bad typography, because we like to maintain the summary character of a table all on one page.[24] A table smaller than the page should fit and in order to let that happen we generally allow tables to float, that is they may be shifted around a bit by the page builder. For a survey on the issue see my Table Diversions paper, which also contains a macro for handling bordered tables—the `btable` macro (some 80 lines), and used in this work (see later).

Another important class of tables are the so-called trees. One can argue whether they are tables or belong to graphics. Brüggeman-Klein has provided a package called TreeTEX. The user-interface looks good, although I have not had any personal experience with it myself yet.

Simple tables via (plain) TEX. When I read Furuta a decade ago, I was impressed by the ease of mark-up for tables via the tbl preprocessor of troff.[25] Below I'll show that a similar functionality—and some more, I also abstracted from the kinds of rules, and the positioning of the elements—is provided with respect to tables by my btable macro for the class of bordered tables, where the (possibly complicated) headers are treated separately and independently from the (proper) table data, and the rowstub list.

[23]Within the graphics section I have supplied a simple example, however.

[24]When the latter is not important, for example for tables of values which goes on for pages, we can modify the row separator into a separator which allows line breaks. For tables which don't fit on a page there are special macros, like `supertabular.sty`.

[25]Because of that I was in favour of troff and its preprocessors. Happily a math professor stressed the importance of TEX, and because UNIX was not widely available at the University, I entered TEX-land.

- just framed data

11	12
21	22

- add header and rowstubs

	Header	
1^{st} row	11	12
2^{nd} row	21	22

- add caption and footer, vary via dotted lines

Caption

	Header	
1^{st} row	11	12
2^{nd} row	21	22

Footer

- vary with ruled and framed

Caption

	Header	
1^{st} row	11	12
2^{nd} row	21	22

Footer

via

```
\def\data{11\cs12\rs21\cs22}
\begin{itemize}
\item just framed data
   $$\vcenter{\framed\btable\data}$$
\item add header and rowstubs
  \def\header{\multispan2\hfill
                 Header\hfill}
  \def\rowstblst{{$1^{st}$ row}%
               {{$2^{nd}$ row}}}
  $$\vcenter{\btable\data}$$
\item add caption and footer,
      vary via dotted lines
  \def\caption{Caption}\def\footer{Footer}
  $$\vcenter{\dotruled\btable\data}$$
\item vary with ruled and framed
  $$\vcenter{\ruled\framed\btable\data}$$
\end{itemize}
```

Real-life. AT&T's example from the tbl (troff) documentation, also supplied in TEXbook p.247

AT&T Common Stock

Year	Price	Dividend
1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

* (first quarter only)

The above is obtained via `\btable` as follows

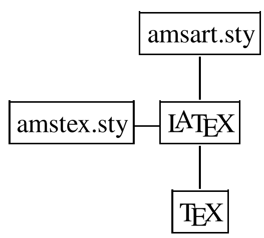
```
\def\caption{AT\&T Common Stock}
\def\header{Year\cs Price\cs Dividend}
\catcode`?=\active \def?{\kern1.1ex}
\def\data{1971\cs41--54\cs\llap{\$}2.60\rs
            2\cs41--54\cs        2.70\rs
            3\cs46--55\cs        2.87\rs
            4\cs40--53\cs        3.24\rs
            5\cs45--52\cs        3.40\rs
            6\cs51--59\cs        ?.95\rlap*}
\def\footer{* (first quarter only)}
$$\vcenter{\vbox{\small
  \framed\ruled\btable\data}}$$
```

11.5 Examples: graphics.

The portable way is via `manmac.sty`, LATEX's picture environment, or PiCTEX. For a survey see Clark's Portable Graphics in TEX paper. TEXtures on the Macintosh by Blue Sky Research is famous for its (non-portable) pic*tures* with TEX. For inclusion of photographs and in general halftones, see the work of Sowa.[26] For drawing on the screen and get (La)TEX code out see GNUplot or TEXCAD, for example.

Many disciplines make use of special graphic diagrams. In this paper for example I won't provide examples of trees, (math) graphs in general, (advanced) commutative diagrams, nor Feynmann diagrams, to name but a few classes known to me.

- simple line diagrams via `manmac.sty`



via

```
$$\hbox{\vbox{%
\element{\fbox{amsppt.sty}}
```

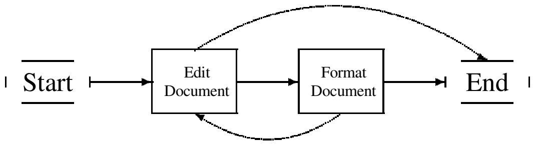
[26]On the Mac one can easily incorporate photos after they having been put onto CD in digitized form. Kodak provides the latter service.

```
\vconnector
\element{\fbox{amstex.tex}}
\vconnector
\element{\fbox{\TeX}}
}\qquad\qquad\qquad\vbox{%
\element{\fbox{amsart.sty}}
\vconnector
\element{\llap{\fbox{amstex.sty}---}
 \fbox{\LaTeX}}
\vconnector
\element{\fbox{\TeX}}
}}$$
```

with the auxiliaries

```
\def\strut{\vrule height2.5ex depth1ex
 width0pt}
\def\fbox#1{\setbox0\hbox{\strut
 $\;$#1$\,$}\leavevmode\rlap{\copy0}%
 \makelightbox}
\def\element#1{\hbox to15ex{\hss#1\hss}}
\def\vconnector{\element{\strut\vrule}} .
```

- flow chart borrowed from Furuta, via LATEX

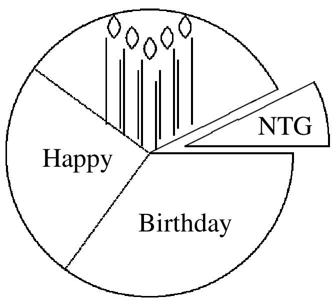


via

```
\setlength{\unitlength}{4ex}
\begin{picture}(14,4)(0,-1)
\put(1, 1){\oval(2, 1)}
\put(1, 1){\makebox(0, 0){Start}}
\put(2, 1){\vector(1, 0){1.5}}
\put(3.5,.25){\framebox(2,1.5){\shortstack
         {\tiny Edit\\\tiny Document}}}
\put(5.5, 1){\vector(1, 0){1.5}}
\put(7,.25){\framebox(2,1.5){\shortstack
       {\tiny Format\\\tiny Document}}}
\put(9, 1){\vector(1, 0){1.5}}
\put(11.5, 1){\oval(2, 1)}
\put(11.5, 1){\makebox(0, 0){End}}
\bezier{75}(4.5,.25)(6.25,-1)(8,.25)
\put(4.5,.25){\vector(-2, 1){0}}
\bezier{150}(4.5,1.75)(8,4)(11.5,1.5)
\put(11.5,1.5){\vector(2,-1){0}}
\end{picture}
```

Although the specification is not as easy as via the pic preprocessor, it is not difficult when we start from a template, like the one above. Cumbersome is the treatment of the arrow heads, but these can be hidden.

- a pie-chart via LATEX



via

```
\setlength{\unitlength}{6ex}
\begin{picture}(6, 5)(-3, -2)
%1st quadrant
%\bezier{100}(2, 0)(2, .54)(1.79, .89)
     % 0  - `30' 2:1-line
\bezier{60}(1.79, .89)(1.46, 1.46)(1, 1.73)
     % `30' - 60
\bezier{60}(1, 1.73)(.54, 2)(0, 2)
     % 60 - 90
%2nd quadrant
\bezier{60}(0, 2)(-.54, 2)(-1, 1.73)
     % 90 - 120
\bezier{60}(-1,1.73)(-1.46,1.46)(-1.73,1)
     %120 - 150
\bezier{60}(-1.73, 1)(-2, .54)(-2, 0)
     %150 - 180
%3rd quadrant
\bezier{60}(-2, 0)(-2, -.54)(-1.73, -1)
     %180 - 210
\bezier{60}(-1.73,-1)(-1.46,-1.46)(-1,-1.73)
     %210 -240
\bezier{60}(-1, -1.73)(-.54, -2)(0, -2)
     %240 - 270
%4th quadrant
\bezier{60}(0, -2)(.54, -2)(1, -1.73)
     %270 - 300
\bezier{60}(1,-1.73)(1.46,-1.46)(1.73,-1)
     %300 - 330
\bezier{60}(1.73, -1)(2, -.54)(2, 0)
     %330 - 360
%division lines
\put(0, 0){\line(1, 0){2}}
\put(0, 0){\line(2, 1){1.79}}
     %1.79 = 2 cos arctg .5
%\put(0, 0){\line(-2, 1){1.79}}
\bezier{75}(0, 0)(-.81, .59)(-1.61, 1.18)
     %-.81 = cos 144; .59 = sin 144
%\put(0, 0){\line(-1, -2){.89}}
     % .89 = 2 sin arctg .5
\bezier{75}(0, 0)(-.59, -.81)(-1.18, -1.62)
     %-.59 = cos -126; -.81 = sin -126
%piece
\bezier{60}(2.5, 0.1)(2.5, .64)(2.29, .99)
     % shift .5, .1
\put(0.5, 0.1){\line(1, 0){2}}
\put(0.5, 0.1){\line(2, 1){1.79}}
%Candles:
\bezier{20}(0,1.31)(-.15,1.45)(0,1.61)
\bezier{20}(0,1.31)(.175,1.45)(0,1.61)
\put(-.1,.1){\line(0,1){1.2}}
\put(.1,.05){\line(0,1){.95}}
\put(.1,1){\line(-2,3){.2}}
%left
\bezier{20}(-.25,1.46)(-.40,1.6)(-.25,1.76)
\bezier{20}(-.25,1.46)(-.075,1.6)(-.25,1.76)
\put(-.35,.25){\line(0,1){1.2}}
\put(-.15,.2){\line(0,1){.95}}
\put(-.15,1.15){\line(-2,3){.2}}
%right
\bezier{20}(.25,1.46)(.40,1.6)(.25,1.76)
\bezier{20}(.25,1.46)(.075,1.6)(.25,1.76)
\put(.35,.25){\line(0,1){1.2}}
\put(.15,.2){\line(0,1){.95}}
\put(.15,1.15){\line(2,3){.2}}
%leftleft
\bezier{20}(-.5,1.61)(-.65,1.75)(-.5,1.91)
\bezier{20}(-.5,1.61)(-.325,1.75)(-.5,1.91)
\put(-.6,.4){\line(0,1){1.2}}
\put(-.4,.35){\line(0,1){.95}}
\put(-.4,1.3){\line(-2,3){.2}}
%rightright
\bezier{20}(.5,1.61)(.65,1.75)(.5,1.91)
\bezier{20}(.5,1.61)(.325,1.75)(.5,1.91)
\put(.6,.4){\line(0,1){1.2}}
\put(.4,.35){\line(0,1){.95}}
\put(.4,1.3){\line(2,3){.2}}
%texts
\put(-1, -.1){\makebox(0, 0){\strut Happy}}
```

```
\put(.5, -1){\makebox(0, 0){\strut Birthday}}
\put(1.9, .35){\makebox(0, 0){\strut NTG}}
\end{picture}
```

The above use of the bezier splines makes the creation of scaling invariant circles easier than the approach by Ramek in the proceedings of TEXeter '88.

- commutative diagrams (LAMS-TEX, ...). As a simple example the calculation flow of the autocorrelation function, a_f, inspired by the TEXBook ex18.46, p.358. $\mathcal{F}$ denotes the Fourier transform and $\mathcal{F}^-$ the inverse Fourier transform

$$\begin{tikzcd} f \arrow[r, "\otimes"] \arrow[d, "\mathcal{F}"] & a_f \\ \mathcal{F}(f) \arrow[r, "\times"] & \bigl(\mathcal{F}(f)\bigr)^2 \arrow[u, "\mathcal{F}^-"'] \end{tikzcd}$$

via

```
$$\matrix{f&\lmapright\otimes&a_f\cr
    \mapdown{{\cal F}}&&\mapup{%
            {\cal F}\strut^{-}}\cr
    \hbox to 0pt{\hss${\cal F}(f)$\hss}
    &\mapright\times\hfil&
    \hbox to 0pt{\hss$\bigl({\cal F}(f)
                     \bigr)^2$\hss}\cr}$$
```

with auxiliaries

```
\def\lllongrightarrow{\relbar\joinrel%
       \relbar\joinrel\relbar\joinrel%
       \relbar\joinrel\rightarrow}
\def\llongrightarrow{\relbar\joinrel%
       \relbar\joinrel\rightarrow}
\def\normalbaselines{%
           \baselineskip20pt
           \lineskip3pt
           \lineskiplimit3pt}
\def\mapright#1{\smash{\mathop{
   \llongrightarrow}\limits^{#1}}}
\def\lmapright#1{\smash{\mathop{
   \lllongrightarrow}\limits^{#1}}}
\def\mapdown#1{\Big\downarrow
      \rlap{$\vcenter{\hbox{$#1$}}$}}
\def\mapup#1{\Big\uparrow
      \rlap{$\vcenter{\hbox{$#1$}}$}}
```

- METAFONT coupled to TEX. Leading in this area is the work of Hoenig, for example see his 'When TEX and METAFONT work together.' He has worked out the printing along curved lines, and the typesetting of paragraphs which flow around arbitrary shapes! Very powerul, but not simple to use for the moment. It looks like going back to the roots, because Knuth's first version of the 'TEXbook' contained it all: 'TEX and METAFONT, New directions in typesetting.'
- (encapsulated) PostScript. Knuth left some niches for handling these kinds of things via the `\special` command. A very nice survey of the possibilities which can be obtained when incorporating PostScript is given in Goossens' 'PostScript en LATEX,' which is also a chapter in the LATEX-companion. A survey of the various user approaches has been compiled by Anita Hoover.
- Screen drawings. An example is GNUplot. Cameron in TEXline characterized these kind of systems as

  '...There are a couple of programs available which take all the calculation out: you draw your picture using the mouse, and it is automagically compiled into LATEX source. But for complicated figures, mathematical insight or computational power may be required.'

An example of figures that require math insight are Hoenig's 'Fractal images with TEX.' We can add to that the reuse aspect, which is hindered by the drawing approach, and the unreadable nature of machine-generated code. But certainly these tools have their niche in the spectrum of tools for EP.

12 Front matter

Much attention is paid to front matter: cover, publication characteristics (source, ISBN or other classification), title etc., abstract, keywords, table of contents and the like if not considered as an appendix, foreword. Basically the style or format can handle these easily. Because of the eye-catching need of a cover a designer is generally involved and the cover, especially the graphics, typeset by different means. The page with publication characteristics can be left to the copy editor. For the others just obey the mark-up characteristics, as demanded by the style file.

13 Back matter

As back matter we have the various appendices. Two kinds are noteworthy: the list of references and the index. Both are complicated because of the *cross-referencing on the fly.*

Bibliography creation. With a publication we have the problem of handling a list of references, to extract them from our literature database, and to format them appropriately. We also like to cross-reference them to the list of references, such that it is adaptable to different journal traditions, with respect to formatting of citations. There are tools available to do that, for example LATEX's BIBTEX with its `thebibliography` environment, and AMS-TEX's `\ref` and `\endref` structures. I designed my own 'little language within TEX' to handle that all in a one-pass job within (LA)TEX. To get the flavour, the bibliography at the end of this paper has been prepared via

```
\section*{References}
\input{lit.dat}%database file
  \def\tubissue#1(#2){{\sl TUGboat\/}
                        {\bf#1} (#2)}
  \def\ls#1{\ea\bibentry#1\endgraf}
\input{lit.sel}%file with names
```

See my BLUe's Bibliography paper for more details, and my solution of the cross-referencing in a one-pass job.

Index preparation. This is complicated because of the dynamic allocation of page numbers and inclusion of these in the index. It is also an art to provide the right entries. Generally (external) sorting needs to be done too, next to the formatting. A complicated job.

> TEXnically there is the tool Makeindex, to cooperate with (La)TEX.

Knuth provided a mark-up mechanism for extracting the index entries and let the OTR add the page numbers. These items are written on a file for further processing, like sorting, and adding comments and the like. I consider that very powerful, but it is not completely automatic. The user, or publisher, has to account for the finishing touch, for the moment. For a survey of the intricacies which come along when writing automatic index generators, see the report of Chen and Harrison about developing Makeindex.

I have exercised index preparation à la Knuth in my Sorting in BLUe paper. Although the approach of doing it all within TEX looks promising, it still needs some polishing for BLU to become useful.

14 Guidelines for Choosing

Given the above-mentioned variety of tools the following questions can be useful

> What facilities does your publisher provide?
> What is the document like?
> What tools are already in use?
> Whom is it aimed at?
> How many authors are involved?
> Is (partial, e.g. bibliographical) reuse also envisaged?
> Is future use, different from formatting, in sight?

First, contact your publisher and agree upon the tools to be used.
Next best, when you are on your own, consider

No structure	it does not matter
(For right-to-left etc.	TEX–XET)
Scientific papers	(LA)TEX
Reuse	(LA)TEX, SGML?
Various authors	(LA)TEX, SGML?
Future (nonformatting) use	(LA)TEX, SGML?

A user sufficiently fluent in di-roff would like me to substitute x-roff for TEX in the table above. Be my guest, I don't have experience with x-roff.

Acknowledgements

This paper has been processed via LATEX because I needed the functionality of the picture environment. The standard formatting of the peculiar TEX-related names have been borrowed from `tugboat.cmn`. I used the `ltugproc.sty`—style for TUG proceedings—because of the nice way the front matter is typeset.

I like to thank Christina Thiele for polishing my English and pointing to the right use of fonts for established names.[27] Gerard van Nes blew his horn once again. Thank you!

Conclusions

For high-quality computer-assisted typography TEX etc. is a flexible and excellent craftsman-like tool, with the following characteristics

- TEX is in the PD, available for all platforms
- flavours of TEX have been added to facilitate its use, next to macro toolboxes
- formats and style files have been added to facilitate the publication process
- TEX can be used with many fonts, and takes its own font generation tool
- drivers, WSYIWYG interfaces are commercially available
- working environments are provided by user groups
- lingua franca for scientific email communication
- publishing houses accept compuscripts marked up by (La)TEX
- users maintain digests, discussion lists and file servers
- some 10k organized users, with many books published via (LA)TEX.

Once mastered TEX is a nice basic tool. However, the way to error-less mark-up is hard and haunting, unless, supported (by a publisher) with generic styles, user's guides, and templates. Using LATEX *as-is* and supported by publishers is much simpler than learning TEX per se.

The TEX arcana is complex. (Professional) Education is paramount! The twins TEX-METAFONT will serve for a lifetime. And above all let us keep it simple!

References

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[27] Although this has its difficulties simply using `\MF` for example goes wrong when we vary size.

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Gebruik en Management van TEX in een Unix omgeving*

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Abstract

Een TEX[1] systeem op een Unix systeem omhelst tegenwoordig veel meer dan alleen het gelijknamige programma. Een goed geïntegreerde werkomgeving is mogelijk voor het produceren van een veelzijdig scala aan documenten. We bespreken de structuur van het TEX systeem, de gangbare hulpmiddelen en pakketten eromheen, zoals printer drivers, previewers, font beheer, grafische pakketten, bibliografiebeheer, index beheer, spelling controle e.d.
Verder besteden we aandacht aan de beheers- en installatie aspecten ervan, zowel voor een stand-alone systeem als voor een client-server omgeving met eventueel heterogene systemen.

1 Inleiding

Het TEX systeem en de afgeleide vormen ervan is in de loop der jaren uitgegroeid van een simpel systeem voor het zetten van tekst met in het bijzonder mathematisch formulewerk tot een werkomgeving voor het produceren van allerlei documenten. In onze vakgroep wordt LATEX gebruikt voor het produceren van praktisch alle drukwerk: brieven, studiegids, wetenschappelijke rapporten, collegedictaten, boeken, tentamenbriefjes en cijferlijsten (beide output van de studentenadministratie), scripties. Diverse uitgeverijen accepteren TEX of LATEX documenten voor hun tijdschriften of boekuitgaven. Belangrijke redenen dat TEX in de universitaire wereld zo'n grote populariteit heeft gekregen zijn m.i.:

- Het is verkrijgbaar voor bijna elk bestaand computersysteem en de meeste implementaties zijn gratis of goedkoop.
- De bestanden hebben een grote mate van uitwisselbaarheid en zijn met de gangbare beheerssystemen te bewerken (bijv. revision control).
- Er is een zeer actieve gebruikersgroep o.a. op Usenet.
- Er zijn diverse hulpprogramma's voor het integreren van bibliografieën, indexen, plaatjes etc.
- Het systeem is uitbreidbaar (programmeerbaar) en er is een grote verzameling TEX oplossingen voor de meest uiteenlopende problemen beschikbaar.

2 De TEX werkomgeving op Unix

In feite bestaat er niet slechts één TEX programma, maar er zijn diverse varianten beschikbaar. Dit komt doordat TEX opgebouwd is uit een kern – de typesetting machinerie met een bijbehorende programmeertaal (macrotaal) – met daaromheen een schil die de kern uitbreidt. Aangezien er verschillende schillen (macropakketten) mogelijk zijn krijgen we verschillende varianten van TEX. De macropakketten vormen de user-interface naar de TEX machinerie. Het aantal mogelijke vormen van TEX is natuurlijk oneindig groot, maar een aantal pakketten is in de loop der tijden populair geworden.

- plain TEX, dit is het 'oorspronkelijke' TEX, zoals het door de auteur D. E. Knuth aangeleverd is. Plain bevat simpele zetcommando's vooral m.b.t. het zetten van formules en tabellen, maar het heeft geen mogelijkheden ingebouwd voor het automatisch bijhouden van tellers (bijv. voor secties), inhoudsopgaven, indexen e.d. Voor zijn eigen boeken heeft Knuth dan ook een schil om deze plain macros heen gebouwd, maar er zijn niet veel mensen die deze gebruiken.
- eplain is een uitbreiding van plain waarbij een aantal van de missende functies van plain toegevoegd zijn, met behoud van de simpliciteit van plain.
- LATEX, het meest populaire pakket heeft uitgebreide voorzieningen voor het structureren van documenten. De filosofie van LATEX is 'logische' opmaak i.p.v. 'visuele' opmaak. De gebruiker specificeert de structuur van de document in termen van hoofdstukken, secties, lijsten e.d. en LATEX maakt de bijbehorende opmaak aan. De specifieke opmaak kan

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[1] TEX wordt uitgesproken als 'tech' met de 'ch' zoals in het Schots, Nederlands, Duits, of een mengsel daarvan. Net als de eerste lettergreep van het woord 'techniek'. In de Angelsaksische wereld wordt meestal de uitspraak 'tek' gebruikt, als in de eerste lettergreep van 'technique', maar 'tech' is officiëel beter. LATEX kan als 'laatech' of 'leetech' uitgesproken worden. Zeg nooit 'teks' of 'lateks'. Ik hoop dat u dezelfde problemen krijgt als ikzelf wanneer u uw muren of plafond wilt gaan schilderen.