



Special joint user group publication of the Euro \TeX 2005 proceedings

DANTE Deutschsprachige Anwendervereinigung \TeX e.V.
Die \TeX nische Komödie
18. Jahrgang Heft 2/2006 April 2006
ISSN 1434-5897

Cervan \TeX Grupo de Usuarios de \TeX Hispanohablantes

GUST Grupa Użytkowników Systemu \TeX

GUT Groupe francophone des utilisateurs de \TeX

NTG Nederlandstalige \TeX Gebruikersgroep

TUG \TeX Users Group

UKTUG UK \TeX Users' Group

Editor Volker RW Schaa

Printed by Konrad Triltsch Print und digitale Medien GmbH
D-97199 Ochsenfurt-Hohestadt
Germany

Paper coated paper Allegro, 80 g/m²

Cover coated paper Allegro, 250 g/m²

Printed copies 5000

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Let's T_EX together – EuroT_EX 2005 Proceedings

Klaus Höppner

Fabrice Popineau

April 2006

EuroT_EX 2005 was a special conference, celebrating the 16th anniversary of both DANTE and GUTenberg, with the theme “Let's T_EX together”. It took place from March 7 to March 11, 2005, in the French-German border region at the Abbaye des Prémontrés, in Pont-à-Mousson.

This proceedings aim to give you an impression of the T_EXnical contents of the conference. Though it's death is sometimes predicted, T_EX and related typesetting tools are still alive. We are sure the following articles are a good evidence for it. On the other hand, the T_EX community is a big family grown over decades. So please enjoy many color photos taken on the conference during the sessions, coffee breaks, meals and the banquet.

When DANTE and GUTenberg started to think about a place for the conference we were inspired by conferences like EuroT_EX 2001 in Kerkrade, Netherlands, or BachoT_EX in Poland. A conference with all participants at one place looked promising. Though the organization of accommodation for 128 persons wasn't easy and the versions of the Excel sheet with the occupations of rooms are uncounted, it was a success after all. The abbaye was a nice place—at least the renovated part—and the hotels where quite a lot of participants had to stay were nearby. France is famous for its food, and so even the daily meals were some kind of celebration.

We are glad that it was one of the largest and most fruitful T_EX conference in the last years. We are thankful for contributions from user groups that made special conference rates and support for participants from Eastern Europe possible, namely TUG and GuIT for financial aid and NTG and GUST for organizing the bus from Poland to France.

Special renowned guests were Donald E. Knuth and Hermann Zapf. They volunteered to participate in a moderated panel discussion of about two hours. We thank Taco Hoekwater who supplied his notes of the session—unfortunately the reader has to imagine the visual part where Hermann Zapf drew several samples of glyphs on the blackboard, e. g. showing the improvements of Optima Nova against Optima.

Unforgotten is the social highlight of the conference, the banquet taking place in the old church of the abbey. After a gala dinner, surrounded by some speeches

of user groups representatives and house made music—a Polish chorus and David Kastrup's guitar play—it ended with two big cakes, with ornaments added by Hermann Zapf and served by Donald E. Knuth.

The content of the conference was equally wide-ranging, with research papers on multilingual typesetting and other areas, reports on current developments in the T_EX world, and examinations of the T_EX system in practice. Many well-known T_EX luminaries contributed, and we were especially glad to welcome many relative newcomers as well.

Since the conference was special, we wanted the publication to also be special. Thus, this proceedings mark the first occasion of a single volume being simultaneously published by many of T_EX user groups and distributed as a benefit for their respective memberships. This proceedings act both as issue 2/2006 of DANTE's journal *Die T_EXnische Komödie* and issue 1/2006 of the TUGboat and are distributed by the following user groups: CervanT_EX, GUST, GUTenberg, NTG and UKTUG.

We are all very happy to collaborate in this endeavor, and hope it will be the first of many. So while the title of the conference was «Let's T_EX together», for this proceedings it should be read as:

Let's publish together!

The proceedings has been organized and edited by Volker RW Schaa of DANTE. Physically, it contains about 25 papers (some in slide form), and a large number of color pages. The logistics were considerable! The cover was prepared by Hans Hagen, who made valuable contributions to this proceedings.

We hope you find this special joint user group publication of the EuroT_EX 2005 proceedings enjoyable and valuable.

We thank Karl Berry for help preparing these introductory remarks and for corrections.

With best regards

Klaus Höppner

Fabrice Popineau

main organizers of the EuroT_EX 2005 conference

Let's publish together! – EuroT_EX 2005 Proceedings

Volker RW Schaa

April 2006

I have chosen Karl Berry's motto as a title for my annotations and acknowledgements. A successful conference and as a result these proceedings are the result of long preparation work by many people. I want to thank the program committee members who invested their time in many email exchanges and sometimes even in direct communications with authors and presenters.

Programme Committee

Volker RW Schaa
Fabrice Popineau
Jacques André
Giuseppe Bilotta
Włodzimierz Bzyl
Daniel Flipo
Steve Grathwohl
Hans Hagen
Bogusław Jackowski
Bernd Raichle
Petr Sojka

The other team was the organizing committee, which assured all logistics questions of the event. It started by finding the perfect place for the conference, arranging the accommodations, organizing all the important bits and pieces: from technical equipment over order of the menu for the gala diner to T_EXnical goodies for the participants. I like to name two people who spent an enormous amount of time to make this conference such a success: Fabrice Popineau and Klaus Höppner.

Organizing Committee

Volker RW Schaa
Fabrice Popineau
Klaus Höppner
Sarah Grimaud
Hans Hagen
Michèle Jouhet
Maurice Laugier
Jerzy Ludwиковski
Gilles Pérez-Lambert

The inclusion of so many conference pictures was only possible by people providing their 'shots'. I was lucky to have more than 750 pictures to choose from, provided by Hartmut Henkel, Harald König, Bernd Reichle, Volker RW Schaa, Petr Sojka, Ulrik Vieth, and

Zofia Walczak. I hope you like the selection, which tries to cover the place, the people, the exceptional food, the atmosphere, and a bit of the T_EX talks and presentations.

For EuroT_EX 2005 we had several special lion drawings by Duane Bibby, the main one is shown in color on the first page. Two drawings were dedicated to Hermann Zapf and Donald Knuth.



On the left you see a lion juggling with pens, brushes, ink pots, and other requisites of the typographic art, even Hermann's special black ink is mentioned as »Noir Zapf«. On the right there is a lion juggling with Zeros and Ones, each carrying Don's initials (DEK).

A special thank you goes to Hans Hagen, who made valuable contributions to the conference, the abstract booklet and this proceedings. He also designed the cover. The background has the blue color of the European flag, the 128 stars represent the participants, with two golden stars (in yellow) for our special guests Hermann Zapf and Donald Knuth.

Last but not least I like to thank all participants who gave a talk or tutorial. I'm happy that we got with one exception all presented papers or slides for this proceedings. Several audio recordings were made during the panel discussion "With a little help from the wizards" with Hermann Zapf and Donald Knuth. Maybe a transcription will be printed in a future edition of a joint user group publication like this.

With best regards

Volker RW Schaa

Monday, March 7

09:00	Welcome
09:15	MOT01 Javier Bezos Mem. A Multilingual Environment for \LaTeX with Aleph
09:45	MOT02 Yannis Haralambous, Gábor Bella Omega Becomes a Sign Processor
10:30 – 11:00	Coffee Break
11:00	MOT03 Joachim Schrod, Chris Rowley, Christine Detig A Taxonomy of Automated Typesetting Systems
11:45	MOT04 David Kastrup Designing an Implementation Language for a \TeX Successor
12:30 – 14:00	Lunch
14:00	MOT05 Jim Hefferon CTAN Plans
14:30	MOT06 Denis Roegel MP2GL: prototyping 3D objects with Metapost
15:00	MOT07 Taco Hoekwater Metapost Developments
15:30 – 16:00	Coffee Break
16:00	MOT08 Péter Szabó Verbatim Phrases and Listings in \LaTeX
16:30	MOT09 Stephan Lehmké, Arne Jans, Andre Dierker From RTF to XML to \LaTeX
17:00	MOT10 Jonathan Fine \TeX Forever!
17:30	DANTE e.V. General Meeting GUTenberg General Meeting
20:30	Diner
22:00 – 23:00	BoF sessions

Tuesday, March 8

09:00	TUT01 The TEI/ \TeX Interface Sebastian Rahtz
09:45	TUT02 Frank Mittelbach, Chris Rowley \LaTeX 3 News
10:30 – 11:00	Coffee Break
11:00	TUT03 Hans Hagen The 16 Faces of a Dutch Math Journal
11:45	TUT04 Adam Twardoch Typographic Perfection with OpenType?
12:30 – 14:00	Lunch

14:00	TUT05	Gerd Neugebauer Namespaces for $\epsilon\chi\text{T}_{\text{E}}\text{X}$
14:30	TUT06	Patrick Gundlach contextgarden.net: The ConT E Xt Wiki
15:00	TUT07	Thành Hàn Thế Experiences with Micro-Typographic Extensions of pdfT E X in Practice
15:30 – 16:00		Coffee Break
16:00	TUT08	Johannes Küster NewMath and Unicode
16:30	TUT09	Bogusław Jackowski, Janusz M. Nowacki Latin Modern fonts: how less means more
17:00 – 19:00	TUT10	Panel discussion with Hermann Zapf and Donald Knuth 'With a little help from the wizards'
20:00		Gala Diner

Wednesday, March 9

8:30	WET01	Thomas Feuerstack ProT E Xt, a new T E X-Collection for Beginners
9:00	WET02	Jean-Michel Hufflen Bibliography Styles Easier with MIBibT E X
9:30	WET03	Antoine Lejay La machine à formulaires (The Forms' Machine)
10:00	WET04	Frank-René Schäfer ŞäferT E X: Source Code Esthetics for Automated Typesetters
10:30 – 11:00		Coffee Break
11:00	WET05	Jérôme Laurens The T E X Wrapper Structure: A Basic T E X Document Model Implemented in iT E XMac
11:30	WET06	Stephan Lehmke Case Study of T E X in Commercial Data Based Publishing: Completely Automatic Typesetting of a Large Product Catalogue
12:00	WET07	David Kastrup The Bigfoot Bundle for Critical Editions
12:30 – 14:00		Lunch
14:00		Excursion
19:30		Lunch
22:00 – 23:00		BoF sessions

Thursday, March 10

09:00 – 12:30	THT01	Sebastian Rahtz, Hans Hagen XML to PDF, where does \TeX fit in
09:00 – 10:30	THT02	Stephan Lehmké \TeX Power – Dynamic Presentations with \LaTeX
10:30 – 11:00		Coffee Break
11:00 – 12:30	THT03	Gerd Neugebauer, Michael Niedermair $\epsilon\chi\TeX$ – Under the Hood
12:30 – 14:00		Lunch
14:00 – 17:30	THT04	Denis Roegel Metapost
14:00 – 15:30	THT05	Staszek Wawrykiewicz \TeX Live 2004 Windows Installer
15:30 – 16:00		Coffee Break
16:00 – 17:30	THT06	David Kastrup Installing and using Emacs, AUCTeX , RefTeX , preview-latex
19:30		Diner
22:00 – 23:00		BoF sessions

Friday, March 11

09:00 – 10:30	FRT01	Hans Hagen ConTeXt
09:00 – 10:30	FRT02	N.N. Advanced \LaTeX
10:30 – 11:00		Coffee Break
11:00 – 12:30	FRT01 FRT02	<i>continuing</i>
12:30 – 14:00		Lunch
14:00		Farewell









*Un foie gras en marbré de figues, pain
d'épices maison, compote du fruit en cuillère*

↓

*Rissolé croustillant de St jacques aux
légumes mêlés d'écrevisses au jus,
américaine corsée*

↓

*'Charlotte' de veau en chemise de jambon
cuit, chantilly de girolles*

↓

*Croûte de Rocamadour au sésame,
Un mesclun au sirop d'amande*

↓

*Mandarine entière flambée, tartelette
Cianola, croustillant d'orange,
réduction de Cointreau*

↓

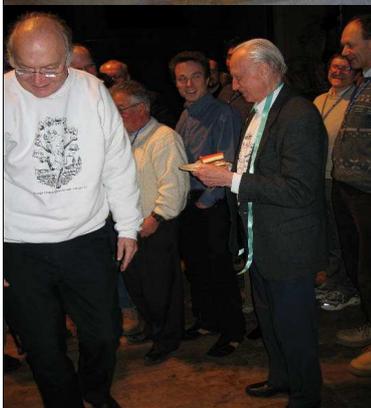
*Sauvignon blanc
Coteaux d'Aix St Louis
Minérale plate et gèzeuse
Café*

↓

Mignardises

↓

Surprise











Not Another Project
The Guts: Formatting Model
The Border: Document Representations
Shiny Stuff: Visuals
The Brain: Styles

A Taxonomy of Automated Typesetting Systems

Joachim Schrod Christopher A. Rowley Christine Detig

EuroTeX 2005 Pont-à-Mousson, France

Not Another Project
The Guts: Formatting Model
The Border: Document Representations
Shiny Stuff: Visuals
The Brain: Styles
Vision
Strategy
Tactics
High-Level Classification

Joachim Schrod, Christopher A. Rowley, Christine Detig
Typesetting Systems' Taxonomy

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Tactics
High-Level Classification

Strategy

What

- First steps—work in progress!
- Informal but precise description of existing document formats
- Focus on text typesetting
- Describe capabilities of formatters

What not

- Multimedia, multi-channel publishing
- Word processing
- Authoring environments, e.g., spell checkers
- Graphics manipulation
- Calligraphy
- Font design

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Not Another Project

Vision

- Formal model of document formatting
- Emphasis on text typesetting
- Investigate and document, what is automated typesetting?
- Restore automated (high-quality) typesetting to be a vigorous topic of research and development

Why

- Counterpoint to the hype of hypertext
- There is more than online publishing
- Literature is old: hence no description of current systems
- Previous work is empirical: no systematic generalisation

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Short Term Goals

- Find a vocabulary
- Find categories
- Classify systems
- Find common ground for reasoning
- Discuss current and future system capabilities
- Built up some abstractions
- Present results independent of software artefacts

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Vision Strategy
Tactics
High-Level Classification

Tactics

Don't describe and focus on the functionality of 7th sub-sub-menu of 3rd subsystem's dialog —
Intention of the creator is what counts!

- Identify underlying models
- Aim of classification demands decision criteria
- Find discriminators

Real Danger: How many angels can be on a 1sp rule?

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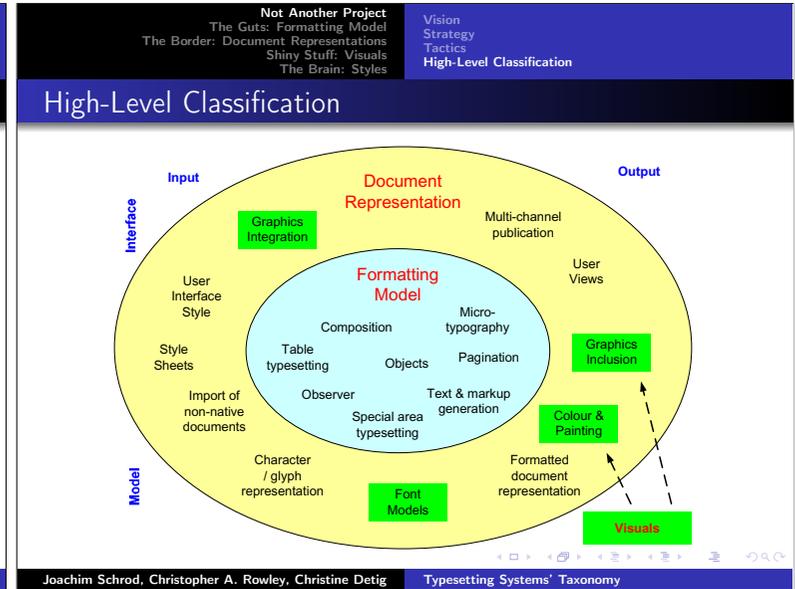
Vision Strategy
Tactics
High-Level Classification

The Guts: Formatting Model

Categories for formatting model

- Formatting objects
- Composition
- Pagination
- Micro-typography
- Text & markup generation
- Table typesetting
- Special purpose typesetting
- Observers

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Examples: Formatting Objects

"Lines" – New term needed
Abstraction: Sequence of characters along one direction

"Paragraphs" – There's more to a term
E.g.: \TeX with its simple paragraph abstraction cannot handle

- Medieval scripts (inline paragraphs separated by ¶)
- First fit (word-processor style paragraphs)

"Grids / Glue" – Intention of creator

- Systems can often be coerced to do both
- Creator had a clear intent—and we want to capture that
- Examples: QuarkXPress, \TeX

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Formatting Model Categories
Examples

Examples: Micro-Typography, Observers

Micro-typography: separation of concerns

- Punctuation
- Text input methods (alphabetic, syllabic, sinographemes)
- Segmentation (words, sub-words, ...)
- Oft' forgotten: text symbols

Observers: missing abstractions

- Observers in current systems are not systematic, most are very limited —
 e.g., page number of current text position, but no line number
- Missing: object model, with an observer interface

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The Border: Document Representations

Categories for document representations

Interfaces to the outside:

- User interface style
- Character / glyph representation
- User views of the document
- Representation of the formatted document
- Import of non-native material

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Overview
 Graphics Integration

Shiny Stuff: Visuals

Graphics Inclusion

Graphics Integration

Colour and Painting

Font Usage

Joachim Schrod, Christopher A. Rowley, Christine Detig Typesetting Systems' Taxonomy

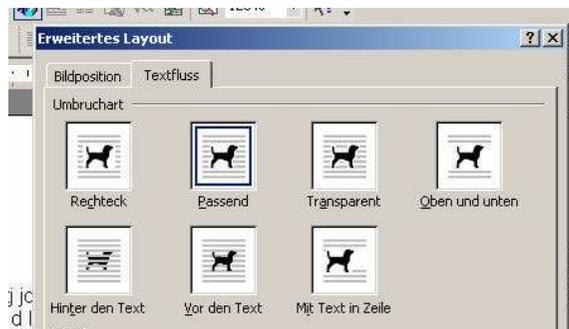
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Overview
 Graphics Integration

Example: Problems with Graphics Integration

Joachim Schrod, Christopher A. Rowley, Christine Detig Typesetting Systems' Taxonomy

Example: Text Flow and Graphics



What have we learnt?

- Far bigger than Joachim thought!
- Far more interesting than Chris thought!
- Far less current literature than Christine thought!

The Brain: Style Sheets

Design interface

- Vocabulary: what is a style sheet
- Integration: relation of style sheets to documents
- Examples: Word — \LaTeX — XSLT/FOP

What Have You Learnt?

Wrap Up

- Classification is possible and sensible
- Classification has many different facets
- More than one way to format a document
- More than one way to model the formatting of a document
- New names are needed for old ideas
- New ideas are needed for old names
- Clarification of vocabulary is important
- Much work needed on classification and formalisation
- Much work needed on investigating current systems

MP2GL: prototyping 3D objects with METAPOST and OpenGL

Denis Roegel
LORIA, Nancy (France)

7 March 2005

Abstract

METAPOST was created with 2D graphics in mind, and in spite of various extensions added during the last few years, it doesn't seem well adapted for 3D technical graphics. However, there are cases where simple but realistic 3D graphics are needed, for instance for inclusion in an article, and there are also cases where 3D objects are mere 2D objects with added depth. In such cases, an approach combining METAPOST with an OpenGL environment proves very useful and allows for interesting applications, in particular the prototyping of 3D objects for use independently from METAPOST. Such an approach is also a smooth way to get introduced to OpenGL. MP2GL is our first attempt towards this direction.

1 Introduction

METAPOST is a language aimed at the description of technical drawings, and is adapted from METAFONT [8, 7]. With METAPOST, one describes a two-dimensional drawing with primitive objects such as points and paths connecting these points. The language of METAPOST is very rich and a number of extensions have been written, in particular for handling graphs, or objects.

1.1 Limitations of METAPOST

However, METAPOST is not a 3D engine. 3D objects can be defined in the language, but doing so is tedious. Moreover, the representation of a 3-dimensional scene requires an algorithm for hidden faces removal, which is time-consuming. Currently, the few existing 3D extensions to METAPOST only handle special cases. For instance, our own `3d` extension was able to handle convex polyhedra, but not always when they were overlapping [11]. But even if a general hidden faces removal algorithm were implemented, it wouldn't be the end of the story. METAPOST has known numerical limitations and such an algorithm, as well as other features like shading, would stretch it to its limits.

It appears therefore desirable, either to extend the core METAPOST and include native 3D support, or to use an external processor for the 3D computations. With the first approach, one is led to rebuild all the 3D algorithms which are already available elsewhere. It may be a sound approach, and it may provide inherent advantages, but there is a long way to go.

With the second approach, on the contrary, an existing 3D engine is used and combined with METAPOST. This may lead to some inefficiencies, for instance when the 3D engine doesn't know about internal METAPOST parameters, but the advantages seem to far outweigh the limitations, at least for the time being.

The second approach, however, leads us to a crucial question: if we use METAPOST with a 3D engine, do we need METAPOST at all? In other words, why would we want to use METAPOST for 3D drawings? We come to the motivations of our work.

1.2 Motivations of this work

Among the main reasons for using 2D-METAPOST in a T_EX environment are that:

- it is a natural partner of T_EX;
- it can produce high-quality and accurate technical drawings;

- it produces vector graphics;
- it has a nice declarative approach, where equations can be used to specify points;
- it has nice types, especially the `path` type;
- and it is fun to use!

The main reasons for using 3D-METAPOST should at least include the previous ones. In particular, we are looking for a way to produce 3D vector graphics, while at the same time retaining the declarative approach and the ability to use types such as paths.

But we also want more. With 3D come more needs. Consider first a planar drawing. The coordinates of the origin of such a drawing are actually irrelevant. Whether a square is drawn with its lower left corner at $(0, 0)$ or at $(1, 1)$ doesn't make a difference, as long as the bounding box of the visible part of the drawing is used for insertion.

With 3D, we have a camera (or an observer), and its location determines the point of view. But with 3D, there is also the legitimate desire to have motion, or animations. Such was actually the motivation of the `3d` METAPOST package we wrote in 1997 [11]. With it, small GIF animations could be produced.

But these animations were not interactive. Now, we want interaction, so that a 3D scene created with METAPOST can be animated, and the best point of view chosen, something that is often best done interactively. Once the point of view is found, a vector snapshot should be produced.

Since 3D vector graphics can be obtained by other tools than METAPOST, the answer to our question on the need of 3D-METAPOST at all is therefore that it is only needed if we want to retain an homogeneous framework common with 2D-METAPOST, and if we want to be able to have a smooth integration with T_EX.

2 MP2GL

MP2GL is the bridge we have developed between METAPOST on one side, and OpenGL on the other. Such a bridge is interesting not only for producing 3D figures for inclusion in articles, but also for 3D objects independent of articles. We will see that linking METAPOST to OpenGL isn't that catastrophic in terms of loss of critical information, because METAPOST could reuse later outputs.

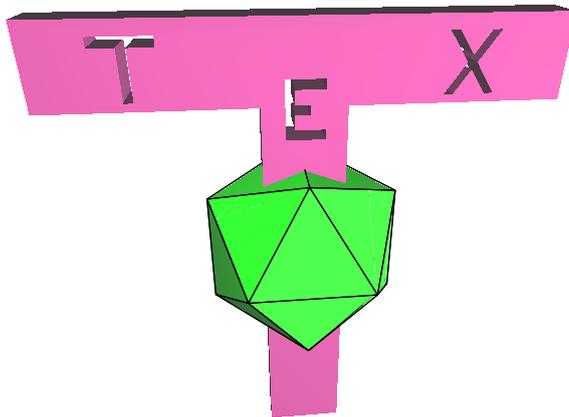


Figure 1: A T_EX logo produced with MP2GL. This scene combines an object built from METAPOST paths (the 'T' with the three holes) and a predefined OpenGL icosahedron in solid output, to which a slightly larger wire frame icosahedron was superimposed.

2.1 OpenGL

OpenGL is an API for 3D graphics, which has become a standard in the industry [18]. There are OpenGL libraries for many languages and many applications are using such a library for their advanced graphics. Various games (for instance *Quake*) also use OpenGL.

OpenGL provides functions for the rendering of 3D scenes, and these can include lights, shading, and various other effects. The scene is drawn on a screen and adapted to its resolution. An OpenGL frame is a *bitmap*. OpenGL uses the *z*-buffer algorithm for hidden parts removal and this is done seamlessly.

We can therefore envision producing 3D bitmaps, but fortunately there are also ways to save a 3D scene, not as a bitmap, but as a vector graphics, which is independent of the screen size. This is made possible by the GL2PS library [2] (figure 2) ¹.

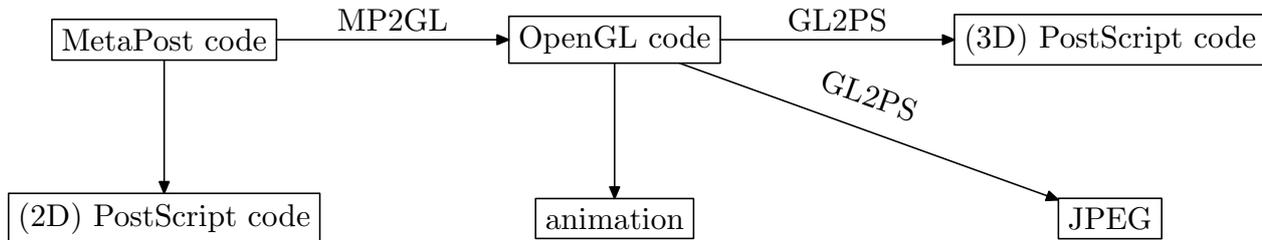


Figure 2: From METAPOST to 3D-PostScript.

2.2 Overview and scope of MP2GL

MP2GL currently provides a limited interface to OpenGL, and tries to be faithful to the motivations given above ².

Our aim so far has been to show the feasibility of this approach, and we have therefore only coded a few representative features. It is hoped that this approach will be extended if it proves useful.

More specifically, it occurred to us that most 3D objects that one wants to build are:

- either geometrically very simple (for instance a cube, a sphere, ...),
- or obtained simply from 2D objects (a cube, a prism, ...),
- or composed of simpler 3D objects.

In other words, we think that the greatest amount of time when building 3D objects will normally be spent on adding depth to 2D shapes. The reason behind this observation lies of course in either the manufacturing process of the objects we want to reconstruct, or in the way they function. For instance, almost every moving object is actually moving in translation or around an axis (consider a car, a steering wheel, etc.), and this usually is reflected in the shape of the object.

MP2GL is not limited to such objects, but it has facilities for handling them. In particular, MP2GL makes it possible to use paths for specifying shapes used in 3D objects.

The main features of MP2GL (in this experimental version) are:

- METAPOST input language;
- structures for points and homogeneous coordinates;
- interface to OpenGL objects (for instance polyhedra);
- ability to build low-level objects made of faces;
- ability to use METAPOST paths as a basis for prisms, including non-convex prisms with holes;
- equations can be used for positioning objects in space;

¹However, GL2PS has several limitations, and this will have as a consequence that there are 3D scenes which are constructible with MP2GL, but which cannot be saved in PostScript.

²MP2GL has only been tested on linux, but should be easy to adapt to other platforms, provided GL2PS is ported there.

- C code using the OpenGL library is produced, with a minimal animation interface;
- from a given point of view, either a bitmap or a PS output can be produced;
- T_EX labels can be added and adjusted after the PS production;
- the C output can be edited and extended;
- the objects created with MP2GL can be used without METAPOST;
- objects can also be created in OpenGL for use by MP2GL.

The animation produced by MP2GL provides a standard set of lights and a standard position for the observer. These can easily be changed, but not yet from MP2GL in this preliminary version ³.

For some of the objects, the METAPOST interface is very simple. This is, for instance, the case for the regular polyhedra. Other objects require more work.

The reasons why an object should be coded in METAPOST or in OpenGL have to do with the need to use a METAPOST structure (for instance a **path** value), or with a greater familiarity of the user with one of these two languages. MP2GL should actually be seen as a gateway from METAPOST to OpenGL, both for the code which is translated in OpenGL, and for the user who can seamlessly learn about OpenGL and try to make changes to the produced code.

3 Elements of OpenGL

3.1 Objects

The scene itself is made of objects, which are themselves made of faces. For instance, a cube is made of six faces. Objects or faces are built using points in a given referential. OpenGL provides means to change the referential. The basic transformations in OpenGL are:

- translation: `glTranslatef(x,y,z)`
- rotation: `glRotatef(α,x,y,z)`
- scaling: `glScalef(x,y,z)`
- saving a position: `glPushMatrix()`
- restoring a position: `glPopMatrix()`

Building an object amounts to moving to where the object should be set, and then calling the appropriate function. For instance, building a tetrahedron at coordinates $(-4.1, 5, 12.3)$ is done as follows:

```
glTranslatef(-4.1,5,12.3);
glutSolidTetrahedron();
```

Building a square face at coordinates $(0, 0, 0)$, $(1, 0, 0)$, $(1, 1, 0)$ and $(0, 1, 0)$ is done as follows:

```
glBegin(GL_POLYGON);
  glNormal3f(0,0,1);
  glVertex3f(0,0,0);
  glVertex3f(1,0,0);
  glVertex3f(1,1,0);
  glVertex3f(0,1,0);
glEnd();
```

The `glVertex3f` calls specify the vertices and the `glNormal3f` call specifies a normal to the face, which is necessary for correct shading with lights.

Such a square can be put anywhere in space by the appropriate use of transformations before `glBegin`.

³It should be stressed that many features are very easy to add, since they are a mere interface to OpenGL. The main difficulty is to get the file organization right.

3.2 Projections

The main OpenGL projections are the perspective and orthographic projections. In both cases a frustum is defined and all elements outside the frustum are not drawn. In the perspective projection, a camera has to be defined.

4 The MP2GL interface to OpenGL

MP2GL can be used either to create 3D objects using the high-level OpenGL objects library, or it can create objects by a low-level approach.

We distinguish therefore an OpenGL objects library (OL) and a METAPOST objects library (ML).

In either case, objects can be set anywhere in space, and the handling of coordinates is done by mimicking the OpenGL operations. Although in many cases we do not really need to know where we are, but only how we came there, we provide means to obtain an exact location from relative motions (translations and rotations).

4.1 Coordinates and coordinate transformations

Coordinates are seen as triples, but are actually manipulated as vectors in a 4-dimensional space. Nevertheless, we use a 3-dimensional structure to store points, namely the `color` structure, renamed `Point`.

```
def Point = color enddef;
def Xpart = redpart enddef;
def Ypart = greenpart enddef;
def Zpart = bluepart enddef;
```

Internal transformations involve 4×4 matrices which are stored as 2-dimensional arrays of numerics.

The user need not care about matrices, even less in METAPOST than in OpenGL. The only transformations needed are the following:

- `ResetPosition`: return to the origin.
- `ResetLocalPosition`: return to the *local* origin.
- `PushPosition`: save the current position.
- `PopPosition`: restore the formerly saved position (if there was one).
- `Translate(x,y,z)`: move by (x, y, z)
- `TranslateV(v)`: move by (v_x, v_y, v_z)
- `RotateX(a)`: rotate a around the X axis
- `RotateY(a)`: rotate a around the Y axis
- `RotateZ(a)`: rotate a around the Z axis
- `Scale(sx,sy,sz)`: scale coordinate X by s_x , Y by s_y , Z by s_z . (a scale with one negative value does a reflection)
- `CurrentPosition`: returns the absolute position of the origin of the current referential.

We also have functions to compute the usual vector operations, and in particular the normal of a surface given three points.

4.2 Basic objects

The current version of MP2GL provides only a few basic objects, among them the regular polyhedra, the sphere, the cylinder, etc. All these objects either exist in OpenGL, or can easily be constructed. Although these objects seem to be special cases, they can actually be transformed. For instance, a sphere can be used to obtain an ellipsoid, by changing the scales of the axes.

A number of basic objects are provided in two versions (solid and wire frame):

- Regular tetrahedron: `solid_tetrahedron`, `wire_tetrahedron`; in addition, there is a `new_tetrahedron` macro building a solid tetrahedron from four points;
- Cube: `solid_cube(size)`, `wire_cube(size)`;
- Octahedron: `solid_octahedron`, `wire_octahedron`;
- Dodecahedron: `solid_dodecahedron`, `wire_dodecahedron`;
- Icosahedron: `solid_icosahedron`, `wire_icosahedron`;
- Sphere: `solid_sphere(radius,slices,stacks)`,
`wire_sphere(radius,slices,stacks)`;
- Cone: `solid_cone(radius,height,slices,stacks)`,
`wire_cone(radius,height,slices,stacks)`;
- Torus: `solid_torus(r,R,nsides,rings)`, `wire_torus(r,R,nsides,rings)`;
- Teapot: `solid_teapot(size)`, `wire_teapot(size)`.

The dimensions will be the METAPOST dimensions interpreted as OpenGL dimensions. So, if the object `solid_cube(1cm)` is drawn, it will actually be a cube of edge $\frac{72}{2.54}$ OpenGL units, because METAPOST uses PostScript points and 2.54cm corresponds to 72 PostScript points. How big OpenGL units are is irrelevant, since it all depends on the position of the camera.

The first example in figure 3 was obtained with the following commands:

```
begin_scene;
  disable_lighting;
  setwirecolor(0,0,0); % black
  setlinewidth(0.5);
  wire_tetrahedron;
end_scene;
```

and the second is a mere call to `solid_tetrahedron` with no other settings.

The following objects are based on quadrics and there is only one version of each:

- Disk: `disk(name,r,R,slices,rings)`;
- Partial disk: `partialdisk(name,r,R,slices,rings,startangle,sweepangle)`
- Sphere: `sphere(name,r,slices,stacks)`
- Cylinder: `cylinder(name,rbase,rtop,height,slices,stacks)`

4.3 Objects constructed from paths

Paths are a very convenient structure in METAPOST. Although METAPOST paths are limited in 2D, we can readily build 3D objects using them.

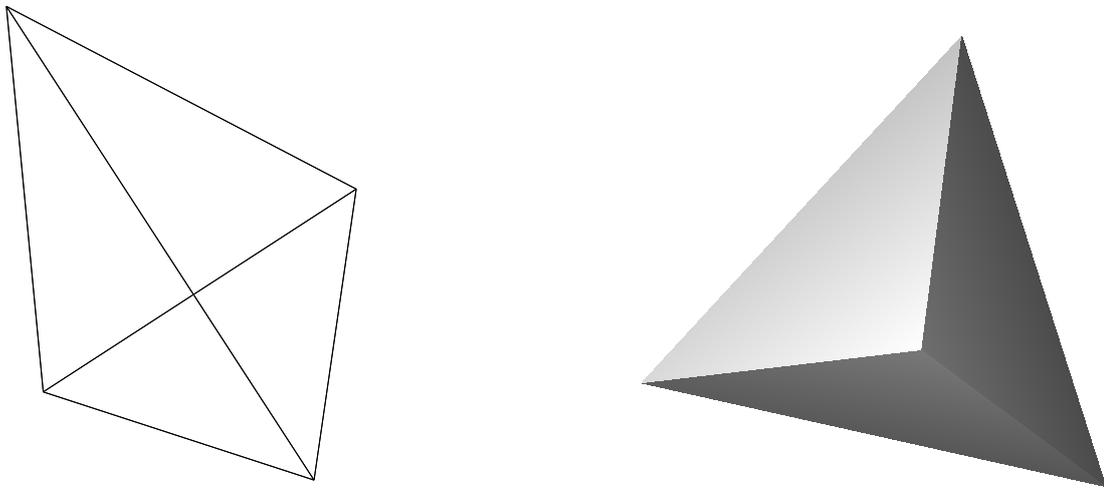


Figure 3: A regular tetrahedron in wire frame and another in solid mode.

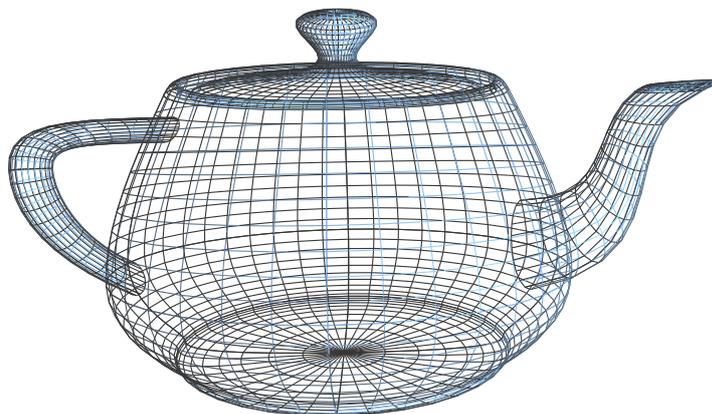


Figure 4: The standard teapot in wireframe.

4.3.1 Simple cyclic paths

The first step is to evaluate a path and store it in a way appropriate for OpenGL. Currently, we merely store the points used to build the path, not the control points. In other words, only three points are used in a path such as `z1..z2..z3`. Future versions may offer options to save control points in order to take advantage of NURBS. Possibly, the computation of control points could also be added to the OpenGL library, mimicking the METAFONT/METAPOST construction of control points.

```
path p;
p=.....--cycle;
storepath(p,"Path_P");
```

Once the path is stored (which saves its points in a C array), an object built on path p will use the name "Path_P" of the path. For instance, a prism can be built as follows ⁴:

```
new_prism("Prism1","Path_P",3cm);
```

The last parameter is the height of the prism.

MP2GL functions prefixed with "new_" create new C functions representing the objects. Calls to these functions can be produced within METAPOST with `use_object`. For example, the scene involving the previous object can be constructed as follows:

```
begin_scene;
  use_object("Prism1");
end_scene;
```

The 2D elements involved in the construction can be examined in the same METAPOST run, by the help of an ordinary figure environment:

```
beginfig(1);
  draw p;
endfig;
```

In other words, the compilation of the METAPOST file will have two (or more) outputs: a C file which will be postprocessed by a C compiler, and one or more ordinary PS figures.

4.3.2 Sets of paths

Sets of paths can be used to create shapes with holes. These shapes will be constructed in OpenGL using a tessellation algorithm.

The MP2GL library provides a function for multipath prisms. In that case, paths need to be split in "positive paths" (outside paths) and "negative paths" (holes). These paths do not need to be convex, and this function can therefore be used to draw simple non convex prisms.

The user creates two arrays of paths and hands them to the `storepaths` function.

```
path pospaths[],negpaths[];
numeric np,nn;
np=2;
nn=3;
pospaths0=...
pospaths1=...
negpaths0=...
negpaths1=...
negpaths2=...
storepaths(pospaths,np,negpaths,nn,"Paths_1");
```

Then the multipath prism is obtained with

```
new_multipath_prism("Prism2","Paths_1",3cm);
```

⁴The current version of the prism function works only for convex paths, because it relies on the polygon construction of OpenGL. For more general cyclic paths, the "multipath prisms" should be used.

After that, the object is used like any other to compose a scene.

Again, these paths can be drawn in an ordinary METAPOST figure environment.

The T_EX logo in figure 1 was obtained by this process. First, three ordinary METAPOST paths have been defined, one for ‘T’, one for ‘E’ and one for ‘X’. These paths were reduced and fed as holes of the non-reduced ‘T’ into the `new_multipath_prism` definition. A solid and a wire icosahedron were drawn over the T_EX logo.

4.3.3 Other path-constructed objects

Other objects based on paths can be imagined, and it suffices to either add them to the OpenGL library or to the METAPOST library.

4.4 Low-level constructions

Objects can be constructed using low-level components. For instance, a cube can be constructed from its six faces as follows (figure 5):

```
% builds a square on (0,X,Y)
def build_cube_face=
  begin_convex_polygon;
  normal(0,0,-1);
  vertex(0,0,0);
  vertex(0,1,0);
  vertex(1,1,0);
  vertex(1,0,0);
  end_convex_polygon;
enddef;

beginobject("Cube");
  set_diffuse_color(1.0,0.0,0.0);
  build_cube_face; % bottom face
  PushPosition;
  Translate(1,0,0);RotateY(-90);
  set_diffuse_color(0.0,1.0,0.0);
  build_cube_face;
  Translate(1,0,0);RotateY(-90);
  set_diffuse_color(0.0,0.0,1.0);
  build_cube_face;
  Translate(1,0,0);RotateY(-90);
  set_diffuse_color(1.0,1.0,0.0);
  build_cube_face;
  PopPosition;
  PushPosition;
  RotateX(-90);Translate(0,-1,0);
  set_diffuse_color(1.0,0.0,1.0);
  build_cube_face;
  PopPosition;
  PushPosition;
  Translate(0,1,0);RotateX(90);
  set_diffuse_color(0.0,1.0,1.0);
  build_cube_face;
  PopPosition;
endobject;
```

This, however, creates an object which is not parametric. This isn't very problematic for the cube, as we can still scale it afterwards. However, other objects benefit from being parametric. There is currently no extra support for such objects, as most of these can either be obtained from paths, or can be integrated in the OL library with a minimal effort.

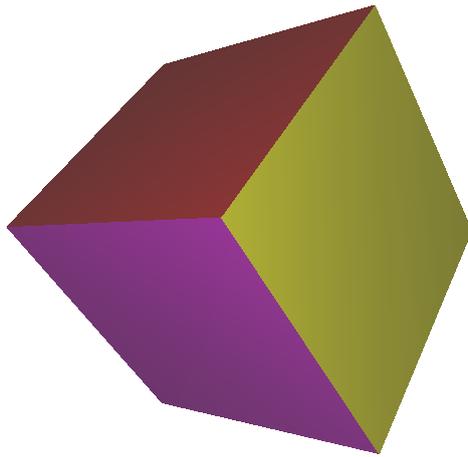


Figure 5: The cube entirely built within MP2GL.

For instance, assume we want to add a general pyramid function having a regular polygonal base. We can build any instantiation, and this can be enough, but we could also define the OpenGL function:

```
void create_pyramid(GLint n,GLfloat r,GLfloat h) {
  ...
}
```

and then call this function from within ML by adding:

```
def new_pyramid(expr name,n,r,h) =
  ...
enddef;
```

4.5 More on wire frames

As it was shown previously, a number of objects have a wireframe variant. Other such objects can be created.

Moreover, whenever an object is made of lines, we can set the line width, and also the stippling properties (figure 6).

4.6 More complex surfaces — NURBS

NURBS (*Non-Uniform Rational B-Splines*) provide a way to have 3D Bezier curves or surfaces. We haven't implemented an interface to them yet, but there isn't any problem doing it.

4.7 Lights and colors

There is currently a very simple support for colors in MP2GL. We can set the color when there is no lighting and these colors are used for wire frames.

When lighting is on, we can define the material properties of the next surfaces. These material properties follow the OpenGL model, and cover the emission properties, the diffusion properties (which account for the main color effect), the specular properties, the ambient properties and the shininess.

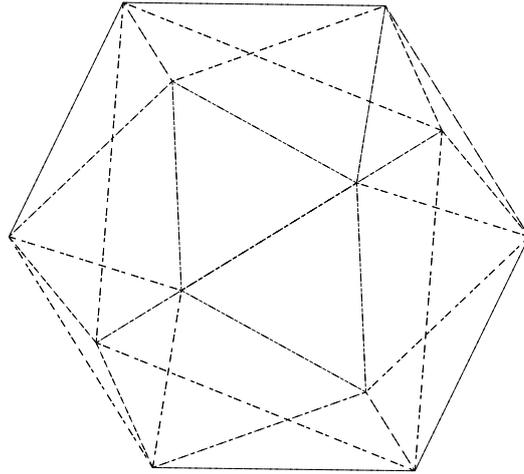


Figure 6: An icosahedron with line stippling.

Similarly, light support is very primitive on the METAPOST side. A scene is currently lit by two lights, one at a fixed position, another on the camera. There is no support to add lights from within METAPOST, but it could easily be added. It is also easy to change the lights within the OpenGL code.

5 3D Equations

METAPOST comes with a very convenient resolution of linear equations. This feature makes it possible to use a declarative approach for a number of drawings. For instance, in order to compute the intersections of the medians of a triangle (figure 7), one can do:

```
beginfig(1);
  pair A,B,C,D,E,F,I;
  A=origin;
  B=(6u,0);
  C=(2u,4u);
  D=.5[B,C];E=.5[C,A];F=.5[A,B];
  I=whatever[B,E]=whatever[A,D];
  draw A--B--C--cycle;
  draw A--D;draw B--E;draw C--F;
  pickup pencircle scaled 3pt;
  drawdot I;
endfig;
```

Imagine now that we want to do the same in space, say with a tetrahedron. Can we do that?

The answer is yes. And we can use the `Point` structure for the equations! Like above, we first do the computations, before drawing anything. We start with four points, the vertices of the tetrahedron.

```
Point A,B,C,D; % vertices
Point E,F,G,H,I,J; % edge middles
Point K; % tetrahedron middle

A=(0,0,0);
B=(1,0,0);
```

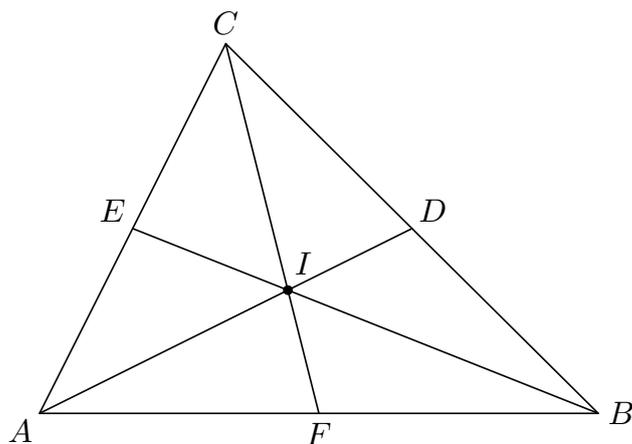


Figure 7: A triangle and its medians.

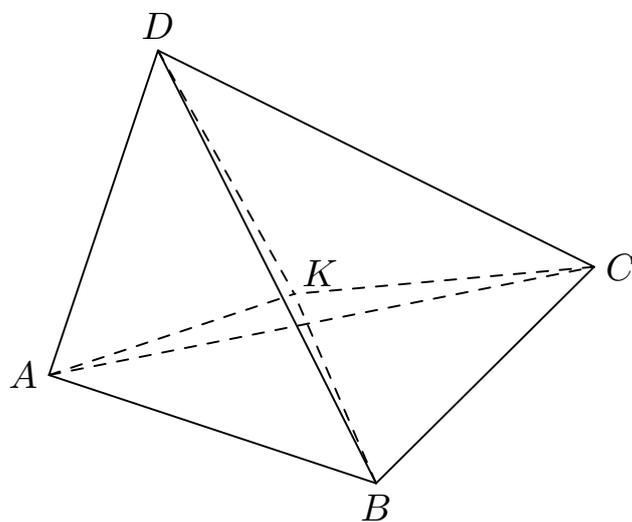


Figure 8: A tetrahedron and its center.

```

C=(0.3,1,0);
D=(0.5,0.5,1);

E=.5[B,C];
F=.5[C,D];
G=.5[B,D];
H=.5[A,D];
I=.5[A,B];
J=.5[A,C];

K=whatever[G,J]=whatever[H,E];

```

Now, we have the center of the tetrahedron, and we can split it in four smaller tetrahedra (A, B, C, K) , (C, B, D, K) , (A, C, D, K) and (B, A, D, K) . We can use the predefined function for tetrahedra:

```

new_tetrahedron("t1",A,B,C,K);
new_tetrahedron("t2",C,B,D,K);
new_tetrahedron("t3",A,C,D,K);
new_tetrahedron("t4",B,A,D,K);

```

and later:

```

begin_scene;
  use_object("t1");
  use_object("t2");
  use_object("t3");
  use_object("t4");
end_scene;

```

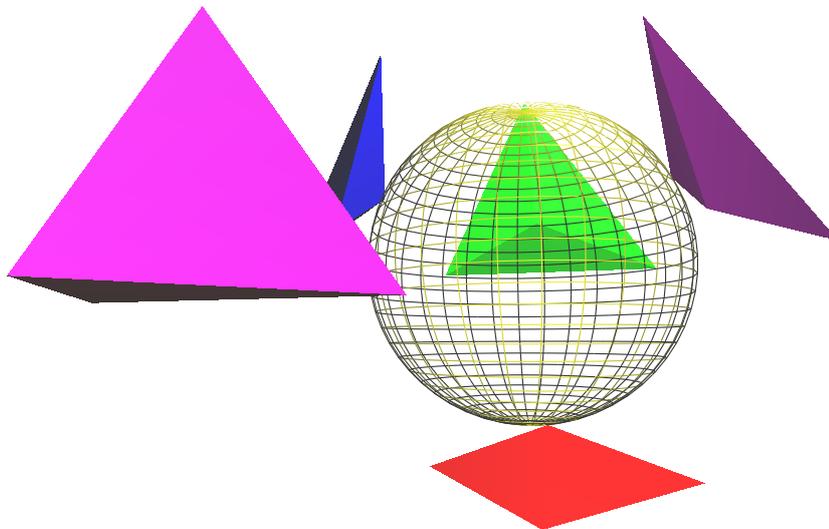


Figure 9: A scene where the tetrahedron shown left has been split in the four tetrahedra at the right, and the sphere is going through one vertex of each tetrahedron.

The tetrahedra are still bound together. In order to split them, we introduce translations from the center:

```

begin_scene;
  PushPosition;
  TranslateV(K-D);
  use_object("t1");

```

```

PopPosition;
PushPosition;
  TranslateV(K-A);
  use_object("t2");
PopPosition;
PushPosition;
  TranslateV(K-B);
  use_object("t3");
PopPosition;
PushPosition;
  TranslateV(K-C);
  use_object("t4");
PopPosition;
end_scene;

```

The initial point K has now been split into four points. As an interesting 3D geometry exercise, we can use these four points in order to find the sphere going through these points, and draw it. This is done as follows. Let W_1 , W_2 , W_3 and W_4 be the four vertices stemming from K :

```

Point W[];
W1=K+(K-A);
W2=K+(K-B);
W3=K+(K-C);
W4=K+(K-D);

```

The center of the sphere is obtained by first finding a median plane on which the center lies, then a line, then the center itself, by a total of three plane intersections, each being handled with two **whatever**s each. This is summarized below.

```

Point V[];
V1=.5[W1,W2];
V2=crossproduct(W2-W1,W3-W2);
V3=crossproduct(W1-W2,V2);
V4=.5[W2,W3];
V5=crossproduct(W3-W2,V2);
V6=.5[W3,W4];
V7=crossproduct(W3-W2,W4-W3);
V8=crossproduct(W4-W3,V7);
V9=V1+whatever*V2+whatever*V3
   =V4+whatever*V2+whatever*V5
   =V6+whatever*V7+whatever*V8;

```

In the three previous lines, it should be noted that the six **whatever**s represent six different values!

The last point, V_9 , is the center of the sphere. The sphere itself can be drawn by inserting the following code in the scene:

```

TranslateV(V9);
wire_sphere(norm(W1-V9),30,30);

```

where $\text{norm}(W_1-V_9)$ is the radius of the sphere, and 30 is both the number of parallels and meridians.

Equations also allow us to set some coordinates separately:

```

Xpart A=0.4;

```

or we can define equations on certain components only:

```

Xpart Q = Ypart U;

```

As usual in METAPOST, a value can be refreshed with **whatever** (this time with an assignment):

```
Xpart A:=whatever;
```

A Point can be refreshed like this:

```
A:=(whatever,whatever,whatever);
```

(like above, the three `whatevers` are different unknowns)

6 Text support

6.1 Basic text

Text can be added to a 3D object, but we currently have to provide a 3D position. The position of the text will depend on the point of view. An example is shown in figure 10. T_EX labels are obtained by generating two files: a PostScript file containing only the drawings, and a L^AT_EX picture environment with the labels. Labels are obtained via GL2PS and can be positioned in different ways.

When doing 2D graphics, an incremental approach can be used, whereby the final drawing is obtained by a number of modifications to the original source. This can also be achieved in 3D, but it is sometimes necessary or useful to work on the output, and therefore to be able to modify labels and their positions within the T_EX file. For instance, it can be necessary to replace a label by a shifted label and an arrow. The current version of MP2GL does not yet support this feature, but a future version may produce an additional T_EX/METAPOST file, which would be superimposed to the PostScript output and the labels, perhaps by the use of a simple postprocessor.

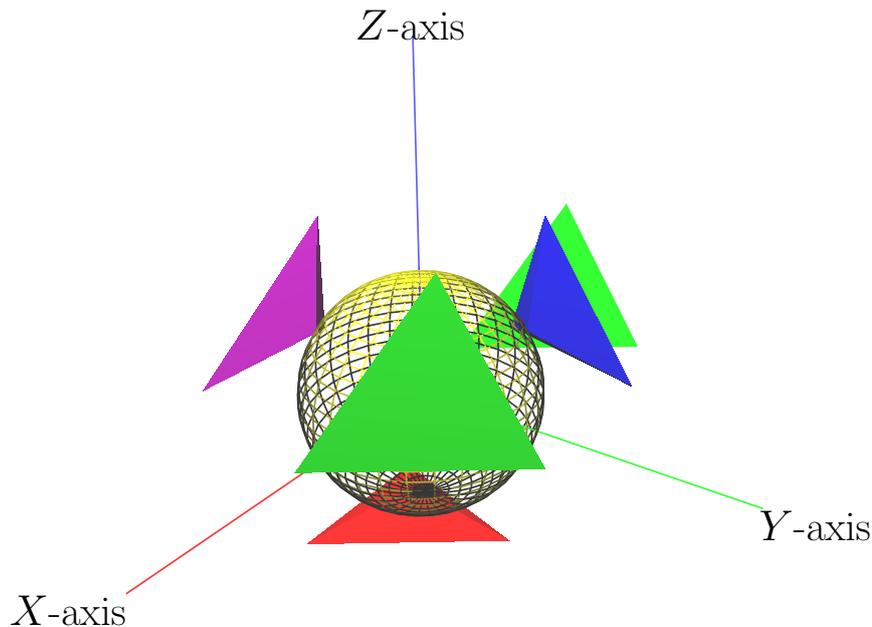


Figure 10: A scene with T_EX labels. Each label is positioned differently with respect to the ends of the segments. We didn't draw arrows, but a solution for the representation of vectors in space could be to use small cones.

6.2 More complex marks

The usual 2-dimensional drawings have both curves, labels, but also additional elements such as dots, arrows, angle marks, textured text, etc.

These elements can all be added to a 3-dimensional drawing, provided we know the final 2-dimensional positions. However, this is often not the case. GL2PS only provides for labels at specific positions, not for more complex elements such as arrows connecting two points.

There are two simple solutions to this problem.

1. the point of view can be frozen from within MP2GL, in which case MP2GL would know exactly where a point is projected; this would require adding support for the projection transformation, something that wouldn't be difficult;
2. a less constraining solution would be to introduce fake labels which would make it to the PostScript or T_EX output, and these labels could then in turn be used to specify paths (possibly in METAPOST), arrows, etc.; we would typically need two runs of METAPOST, the first for the main (fake) labels, the second for the second layer; possibly there could even be obfuscated cases needing more than two runs.

7 Animations

3-dimensional objects appear differently when seen from different points of view, and therefore a 3D scene is deprived of a lot of interest if it cannot be animated in some way.

The most elementary form of animation is obtained by choosing the point of view at the same time as the scene is constructed. When we need different points of view, this then requires either a tedious repetition of the processing, or some automation taking advantage of the camera path. This approach was the one used in our first 3d package, where a series of PostScript files could be produced, by slight changes of the camera parameters (position and orientation). A similar approach is also used by the package.

Although such approaches are most useful in certain cases, a more natural approach is also needed, where the scene is merely animated by a high-level interface such as a mouse or a keyboard.

MP2GL provides this kind of interface, allowing the user to examine the scene under various angles and choosing the best configuration for a screenshot (PS or JPEG). Specifically, the user can:

- get closer (PgUp) or farther (PgDn) from the scene;
- change the orientation (roll: <, >, pitch: Up, Down, yaw: Left, Right);
- rotate the whole scene around the center with the mouse;
- change the field of view ('.' and ',');
- and save the scene as a PS file ('s') or a JPEG file ('j').

The default animation uses a perspective projection, but this could easily be changed, and even toggled through a key. It could also be selected from METAPOST in the future.

This is, of course, a minimal interface.

We could, and actually can, go further, in that the animation would not only be that of the user, but an internal animation. The objects which have been created can actually interact in various ways. For instance, we can have a wheel turn, and this can produce a piston translation. Such animations are not directly supported, but it is currently sufficient to create the objects, and then to make slight modifications to the OpenGL code in order to obtain the internal animations.

The OpenGL code can also be easily extended to produce a motion of the camera and at the same time generating a bitmap at regular intervals. Various tools make it then possible to produce MPEGs (for instance ppm2mpeg), and other tools can be used to edit them (for instance cinelerra).

8 Limitations: textures, blending, ... and other advanced features

A number of METAPOST features are not handled, at least not outside METAPOST. For instance, there is no support for special pen shapes⁵. However, if MP2GL is extended to the point where a METAPOST run can create an additional layer to a 3D drawing, then such METAPOST features could come into play.

The main intrinsic 2D feature in use by MP2GL is the **path** type, but even in this case, we are only making an elementary use of it. So far, paths are considered as polygons, but this could change if we start generating NURBS.

There is no support for textures in GL2PS, and anyway textures may be thought of inherently non-vectorial. As a consequence, there is no support for textures in MP2GL.

⁵It should be remarked here that the author of 3DLDF (see § 9.6) intends to define 3D pens, such as sphere and cube balls.

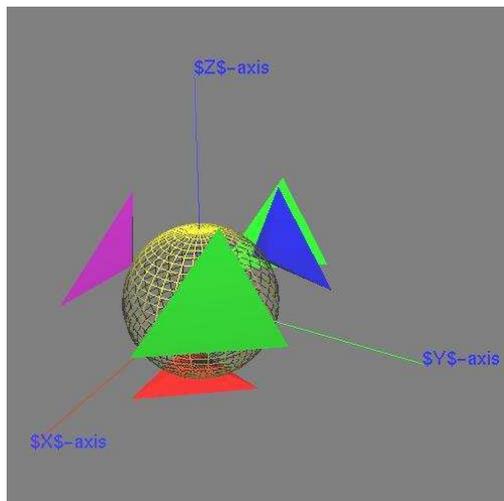


Figure 11: JPEG output of the scene shown previously. The labels are the ‘raw’ T_EX labels, shown as Helvetica strings in orthographic projection.

In principle, transparency or blending is supported by GL2PS when its output is PDF. This feature, however, is not yet supported by MP2GL.

Since shadows are by default not handled in OpenGL, they are also not covered by MP2GL. They could be handled, if implemented in OpenGL.

A 3-dimensional version of METAPOST should also be able to compute intersections, both real and projected. This is, of course, difficult, and we haven’t made any attempt to solve this problem. This doesn’t mean that the problem cannot be solved, but it remains to be done, either by a representation of the objects in OpenGL, or in METAPOST.

Finally, there is currently no support for a CSG ⁶ construction of objects, but a CSG OpenGL library could be linked to MP2GL and offer tremendous new possibilities.

9 Related work

Our work is not isolated and there have been a number of attempts at handling 3D with or around METAPOST over the years. One of the concerns of these packages has been to obtain a smooth integration with T_EX, and in particular to retain the vectorial characteristics of the output.

A number of commercial products, and other products independent of T_EX, produce vector output, but we will only survey the main T_EX-related tools ⁷. As it will be readily visible, these packages all have many features which are currently not present in our system. However, many of these features could be added to MP2GL.

9.1 Our own METAPOST 3d (aka ‘mp3d’) package

This package was described in TUGboat [11] and was later extended with features for space geometry [12]. The package provided the basic tools for the construction of 3D scenes made of segments and faces. Projections could be either perspective or parallel, but there was no support for hidden faces removal. The 3d package was created with 3D animations in mind, and in particular (but not exclusively) the animation of regular polyhedra.

The package was used by Denis Barbier and Sami Alex Zaimi for some experiments. We have also implemented extensions for handling parametric curves, surfaces and in particular revolution objects. These extensions were not released because they were limited by the absence of a hidden parts removal algorithm, which we were reluctant to code in METAPOST.

⁶CSG (Constructive Solid Geometry) refers to booleans operations (union, intersection, etc.) used for the construction of objects.

⁷A review of several tools has already been given recently by the author of [5]. We would like to remark that this review oversimplified the features of our 3d package and focused mainly on the *application* to convex polyhedra.

9.2 PStricks-3D

PStricks was written by Timothy van Zandt and its maintenance was stopped around 1993, but over the years many extensions were added, in particular by Denis Girou. The number of these extensions shows that the PStricks community is very active and that the PStricks model appears very fruitful. Several extensions handle 3D objects [3, 4, 15, 16, 9, 17].

9.3 m3dplain

Anthony Phan made a number of very interesting experiments over the years. He borrowed our ideas for the creation of animations, but the rest of his package is different and aimed at the manipulation of various mathematical objects, such as polyhedra, molecules, fractals, etc. In part of his code, he tries to implement a limited z -buffer, as well as PHIGS syntax. Phan has also worked on simulating transparency in METAPOST.

Sadly, there is no documentation available, other than the source code.

9.4 MetaGraph3D

This package is a Java interface for constructing simple 3D scenes interactively. The documentation available is very scarce or in a form which is unfortunately not easily searchable ⁸.

9.5

The package by Luís Nobre Gonçalves is written in METAPOST and provides 3D functionality [5, 6]. As the author describes it, he wrote it in METAPOST because he wanted to keep the METAPOST machinery.

Like MP2GL, uses the `color` type for points ⁹. Several projections are provided, including a fish-eye projection ¹⁰. The hidden object removal is done by sorting the objects by distance from the point of view. There are therefore also cases where the objects will not be drawn correctly.

The package comes with a large number of macros for various physical applications. For instance, it has a provision to draw triangular or hexagonal meshes. It can also produce non-interactive animations, by a procedure similar in spirit to the one used in our 3d package: METAPOST outputs are transformed in bitmaps with `netpbm` and these bitmaps are merged into an MPEG file.

The author of is now contemplating a reimplementing of his macros into 3DLDF (see below), because of the numerical advantages the latter provides.

9.6 3DLDF

3DLDF is a 3-dimensional drawing software with a METAPOST output created by Laurence D. Finston [1]. The program is written in C++ using CWEB. As of version 1.1.5 (January 2004), the input code had to be written in C++ and then compiled ¹¹.

In 3DLDF, there is a `Point` class and a `Point` is subject to the usual operations (translations, rotations, etc.). Similarly, there is a `Transform` class for storing 4×4 transformation matrices on homogeneous coordinates. Transforms can be applied to `Points`, inverted, etc.

3DLDF has provisions for drawing `Points` and labelling `Points`. It also has a 3D `Path` class, similar to METAPOST's `path` but in 3D. These paths can be drawn and filled.

The system provides a number of plane geometric figures (polygon, rectangle, circle, etc.). There are also a number of solid figures: cuboids, polyhedra,

It allows the specification of the projection. For the perspective projection, 3DLDF needs the specification of a camera ¹².

3DLDF's hidden surface algorithm currently doesn't work for intersecting surfaces. 3DLDF has four different ways to sort objects. It can also find the intersection of a few non-arbitrary paths, such as two polygons, a line and a polygon, two ellipses, etc. So far, 3DLDF doesn't have support for lights, shading, etc.

⁸In spite of our efforts, we were not able to locate an independent documentation file. It is hoped that future version of MetaGraph3D will contain *separately* (that is, not hidden within an archive file) a PDF file describing the whole system.

⁹Our 3d package doesn't use that type, although it was suggested to us in 1997 [11].

¹⁰In MP2GL, such a projection is naturally obtained when a large field of view is chosen.

¹¹The use of an external processor has also recently been applied to 2D plots by Brook Moses [10].

¹²In MP2GL, this is not done at the METAPOST level, but at the OpenGL level. We could do it at the METAPOST level, but we assume the user wants to animate the object and find the most convenient location. Nothing prevents him/her of setting the projection as perspective, parallel, isometric or axonometric.

3DLDF does not have linear equations solving in the METAPOST style, although there are plans to add equations. It also doesn't have macros.

Current plans are to implement NURBS in 3DLDF, but NURBS do exist in OpenGL and could easily be interfaced in our work.

3DLDF appears as an interesting approach, somewhat symmetrical to ours. It does however remind us of our two major previous METAPOST packages, `3d` [11] and `METAOBJ` [13, 14]. 3DLDF recodes a number of objects, such as polyhedra, as we did (modestly) in our `3d` package in 1997. 3DLDF also has an object-oriented approach, not unlike what we did for plane objects in `METAOBJ`.

3DLDF is bound to code a lot of features which are already present in OpenGL, but it may also produce code which can be reused in our OpenGL library. For instance, the author of 3DLDF plans to code a number of exotic polyhedra, which should be easy to recode in C. Actually, if our C part were written in C++, we could even output 3DLDF code!

3DLDF is also a very interesting approach in that its author is trying to extend to the third dimension features that may not be that easy to transfer, such as pen shapes. In a way, 3DLDF is aiming at the most orthodox extension of METAPOST, albeit by using an external processing stage.

Finally, one problem in METAPOST is the problem of the numerical values. This is one reason why the author of 3DLDF created his package. That is, by working in C++, the various computations associated to intersections, projections, etc., are easier and less constrained.

The MP2GL approach, on the contrary, uses very little computational features of METAPOST, apart from a few matrix operations, often confined to very small values. Moreover, objects can always be created at a small size, and then scaled within OpenGL. In the rare cases where an overflow would occur, a special mode could be selected which would turn off the matrix computations on the METAPOST side. In most cases, these matrix operations are not needed in METAPOST.

10 Conclusion

Our package is still in its infancy and our purpose has only been to explore its feasibility. In particular, it should be noted that most of the features presented here are still unstable, and that function names are likely to change. Technical problems can arise, either because OpenGL is not always correctly implemented (GL2PS uses the feedback buffer of OpenGL and this buffer may lack some of the elements it is supposed to contain), or because GL2PS is still in development, or for other reasons.

But it does anyway seem to us that we have achieved our goal and that it is or will be very easy to produce a great variety of high quality 3D graphics with MP2GL. Moreover, there are several possible future directions, which could be developed, in particular through a collaborative effort:

- The MP2GL code could be extended on the METAPOST side in order to cover a larger subset of OpenGL;
- the OpenGL library could be extended with various objects useful from a METAPOST perspective.

But, for many specific applications, some of the reviewed tools may both be more adapted, more complete, and maybe easier to use than MP2GL, especially with respect to text handling when all of the control lies within METAPOST. Our tool should therefore be seen as a new possibility to produce not only certain 3D graphics, but also to *prototype* objects which can be used beyond an article, for instance as part of a complex animation.

11 Acknowledgments

The author would like to thank Christophe Geuzaine for his kind help during the development of MP2GL.

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MetaPost Developments – Spring 2005

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March 31, 2005

Abstract

The MetaPost development team is pleased to announce version 0.9 of MetaPost. This article documents the changes since the previous version, and provides a road map for future development.

1 About this report

This article will be published in three different publications more or less simultaneously: In the proceedings of EuroT_EX2005 and BachoT_EX2005, as well as in issue 32 of the Maps. Parts of the contents of the starting page have already appeared in Maps 31, and some of the decisions documented by this report have not taken place until *after* EuroT_EX, so this article is a bit of a cheat when it comes to chronology.

We apologise for that, but it makes more sense to write a single ‘spring report’ than to create 3 slightly different articles.

2 Introduction

The MetaPost system by John D. Hobby implements a picture-drawing language very much like that of MetaFont, except that it outputs Encapsulated PostScript instead of bitmapped images. These graphics can be printed directly, or in embedded form from within T_EX documents. MetaPost includes facilities for directly integrating T_EX text and mathematics with the graphics.

In the summer of 2004, the version number of the MetaPost executable was still well below the 1.0 mark (0.641 was the current release at that time), but not much had happened in recent years. For some years, John Hobby simply could not find the time to solve the known bugs, let alone handle feature requests.

At that time, a group of people made a proposal to Dr. Hobby for the creation of a development team that would take care of the development of MetaPost from then on. Luckily, he agreed, on the condition that he will only allow tested code to be inserted into the MetaPost distribution. Among the currently active group are the following people: Karl Berry, Giuseppe Bilotta, Hans Hagen, Taco Hoekwater, and Bogusław Jackowski. This list is not fixed, people can be added or removed when needed or desired.

3 Contact information

A home page for MetaPost has been created on the TUG server <http://www.tug.org/metapost>, and TUG also provides a mailing list for discussions and questions (metapost@tug.org). Details on subscription to the mailing list can be found on the home page. MetaPost development is currently hosted at sarovar.org; visit <http://www.sarovar.org/projects/metapost> for the current development team members, sources, and much else.

Please report bugs and request enhancements either on the metapost@tug.org list, or through Sarovar. (Please do not send reports directly to John Hobby any more.)

4 The current release

MetaPost is Public Domain software. Recently the manuals (`mpman` and `mpgraph`) have been released under a BSD-ish license. Dylan Thurston at Debian converted the sources to L^AT_EX, and from now on they will become a standard part of the distribution.

4.1 We are pleased to announce MetaPost 0.9

For those of you who have noted the large gap between 0.641 and 0.9, and the fact that version numbers disagree with the slides that were presented at EuroT_EX:

We have deliberately chosen to step over some minor version numbers, such that the first major release by the current team (this release is planned for the autumn of 2005) can become version 1.0 without causing additional confusion.

4.2 Bug fixes

- Documentation improvements: all known errata and typos have been removed, better explanations of e.g. dash patterns and dotlabel have been provided, and a number of omissions has been rectified.
- The Bounding Box was not computed correctly when a filldraw command with a noticeable pen size was used at the edge of the picture.
- Paths starting with degenerate constructions like in this example:

```
draw (0,0)--(0,0)--(0,0)--...;
```

could cause an overflow error of MetaPost's internal memory.

- The PostScript output could accidentally contain 8-bit characters within PostScript strings in previous versions because the `is_printable` test was shared between terminal printing and PostScript printing.
- A bug has been found in the assignment of serial numbers to independent variables in metafont 2.71828. This bug affected MP as well, and the same patch has been applied. Diagnose and patch were supplied by Thorsten Dahlheimer.
- The return value of the `turningnumber` primitive was sometimes wrong in unexpected ways (`turningnumber` is supposed to report whether a cyclic path turns clockwise or anticlockwise). The new implementation is still sometimes wrong when there are strange path segments involved, but in a much more predictable way: the new code always draws straight lines between the actual points, and calculates the `turningnumber` based on that path instead of the actual path. The effect is that cusps and loops within segments are now completely ignored. A more thorough fix of `turningnumber` is planned for the next release.
- There was an ‘off by one’ error in `dvitomp`, in the interpretation of virtual fonts.
- The `mpto` command (which is part of `makempx`) uses a new and improved T_EX macro for the generation of labels, making it more robust with respect to strange user-supplied code within the actual label. The old version would sometimes lose track of the label's size information.
- A few macro bugs have been solved: a missing colon in `boxes.mp` that has been added, a missing `save` in `mfplain.mp` has been added, and the `generisize` macro in `boxes.mp` has been fixed so that it now accepts `[` as a valid variable name.

4.3 mpversion

Immediately after the presentation at EuroT_EX, it became clear that both Hans Hagen and Donald Knuth have a considerable amount of pictures that more or less count on bugs in 0.641. For Knuth, this is the ‘incorrect label size’ that he himself reported as a bug to JDH. For Hans, it is the miscalculation of the picture's bounding box when using `filldraw`.

After some thinking, we decided it was best to add the already planned `mpversion` primitive right away, instead of waiting for a feature release. That way, this bug fix release can be identified from within the language. The result of `mpversion` is of type `<string>`, and those version strings are of the form `<major digit>.<minor digit>`. Possible trailing digits indicate beta releases (when the first extra digit is a nine), bug fix releases (when the first extra digit is a zero), or releases for development purposes only. For example, "0.89", "0.891" and "0.892" were used to designate beta's for the current release.

For instance:

```
if known mpversion:
  message "mp = " \& mpversion;
  if mpversion > "1.0":
    message "time has flown by"
  fi
fi;
```

prints ‘mp = 0.9’ on the terminal. (Incidentally, > does a simple ASCII comparison of strings; that works here, because of our particular version numbering—until and unless MetaPost reaches version 10!)

The version number is also included in the `Creator` comment in the PostScript output.

4.4 What is new

- It has been mentioned already that the L^AT_EX sources of the `mpman`, `mpintro`, and `mpgraph` manuals have become part of the distribution package.
- There is a new internal string variable called `mpversion`, that reports the current MetaPost version, as explained above.
- The macro file `TEX.mp` acquired two additional routines to facilitate using L^AT_EX to typeset labels: `TEXPRE` and `TEXPOST`. Their values are remembered, and included before and after (respectively) each call to `TEX`. Otherwise, each `TEX` call is effectively typeset independently. `TEX` calls also do not interfere with uses of `verbatimtex`. An example is given below.
- MetaPost now writes a `%%HiReSBoundingBox` comment to the PostScript output file. The values of the picture’s bounding box in this comment are not rounded to integer values as the ones in `%%BoundingBox` are.
- The EPS output no longer contains actual spaces within PostScript strings. For example, the output of

```
label("a space")
```

is now

```
(a\040space) cmr10 9.96265 fshow
```

instead of (a space). This makes the generated PostScript easier to tokenize for post-processors.

- The EPS output now also has a `%%BeginProlog` DSC comment as well as `%%EndProlog`
- The comments in the Web source have been changed to point out that on modern machines, acquiring the random seed has actually become a system-dependant operation: a granularity of whole seconds is no longer small enough on new machines, where it is has become possible to start two separate `mpost` runs within one second.
- The ‘newer’ command now accepts more than two arguments. All of the supplied file arguments are tested in turn.

4.5 TEX.mp extension

Here is an example of how to use the two new macros in TEX.mp, using the L^AT_EX inline math command $\langle \ \rangle$ instead of dollar signs:

```
input TEX;
TEXPRE("%&latex" &
      char(10) &
      "\documentclass{article}" &
      "\begin{document}");
TEXPOST("\end{document}");
beginfig(100)
  last := 10;
  for i := 0 upto last:
    label(TEX("\langle n_{" & decimal(i) & "\rangle"),
          (5mm*i,0));
  endfor
  ...
endfig;
```

- The `%&latex` causes L^AT_EX to be invoked instead of T_EX. (See below, also.) Web2C- and MiK_T_EX-based T_EX implementations, at least, understand this `%&` specification; see, e.g., the Web2C documentation for details, <http://tug.org/web2c>. (Information on how to do the same with other systems would be most welcome.)
- The `char(10)` puts a newline (ASCII character code 10, decimal) in the output.
- The `\documentclass...` is the usual way to start a L^AT_EX document.
- The `TEXPOST("\end{document}")` is not strictly necessary, due to the behaviour of `mpto`, but it is safer to include it.

5 Bugs remaining

A few bugs have not been solved yet. We promise that those will be addressed before the following (1.0) release.

5.1 web2c-specific problems

These are usually caused by re-loading the mem file under different memory size settings than it was dumped with:

- strings reloading problems
- specials missing from the first output file

The solution is probably to save all of the configurable values inside the MEM file (like T_EX does already for the format files).

5.2 Polygonal pen with 180 degree angles

When a path segment turns exactly 180 degrees, MetaPost cannot decide which side of a polygonal pen to use on the ‘return trip’.



```
beginfig(1);
pickup makepen(fullcircle scaled 10 pt);
draw (0,0){up}..(50,50)..{down}(100,0);
draw (0,70){up}..{down}(100,70) withcolor red;
endfig;
end;
```

This happens because MetaPost cannot differentiate between an angle of 180 degrees and an angle of -180 degrees. The black line is what *should* be drawn, but the grey one is the one that current MetaPost actually outputs.

5.3 linecaps for polygonal pens

MetaPost does no attempt to handle linecap for polygonal pens. This can produce unexpected results when the pen has a ‘funny’ shape, as can be seen in this picture:



```
beginfig(1);
linecap := butt;
draw (0,0)--(90,0) withpen pencircle scaled 10;
draw (0,20)--(90,20) withpen pensquare
scaled 10 withcolor red;
endfig;
end
end;
```

On the left side of the grey line, MetaPost switches from the top left corner of the square pen to the bottom right corner of the pen. This behaviour can be rationalised after some thinking, but at first sight, the produced diagonal line is a very strange phenomenon indeed.

5.4 graph.mp bugs

There are a number of bugs in the graph.mp package. None of these have been tackled yet because in the current team nobody has used the package extensively. Most of these problems require familiarity with the macros and their usage:

- arrow heads are sometimes mis-rotated
- axis labels centre strangely
- data file format is too strict
- exponents cannot have a capital E, as in 1E4.
- curves from data are always polygonal
- axes can only be in the left of the graph, not through the origin.
- frames can only be avoided if an internal variable is set to false.

6 Future plans

The Birds of a Feather (special interest) gathering at EuroT_EX had a slow start before dinner, followed by a much better attended continuation after dinner. This session was about all desired new features, both identification and prioritisation. We started with the list from the slides (and that list, in turn, was created by compiling the feature requests in the Sarovar database).

6.1 For the next release

After a few hours of lively discussion, The top of the todo list became the following:

- Create an independent packaging system.

This item was not really on anybody's wishlist, but it simply needs to be done. The current distribution depends on Web2C (it is, in fact, a stripped down snapshot of T_EXLive) and we are far from happy with that. Even when we ignore the troff support, we feel that we should make the build process (how to compile MetaPost from source) as simple as possible.

Taco intends to write a replacement for the current 'tangle + convert' construction. That replacement will output C code directly, and will maintain as much of the symbolic names as possible. In doing so, it will make source-level debugging easier.

- Remove `emergency_line_length` from the Web source.

The web sources define a variable named `emergency_line_length`, with a compile-time value of 255, that is used solely to limit the maximum lines size of the PostScript output under unexpected conditions.

The benefits of this check are marginal and it interferes with web2c's dynamic arrays considerably.

- Fix the still present bugs.

As explained above.

- Allow access to the internally computed envelope of a path drawn with a polygonal pen.

```
<path>:= envelope <acyclic path> withpen <pen>;
<path>:= inner envelope <cyclic path> withpe...
<path>:= outer envelope <cyclic path> withpe...
```

It has meanwhile been noted by several people that these actual names will not work, because MetaPost already assigns a meaning to `inner` and `outer`. The final implementation will therefore have to use different keywords. Those names are still under consideration.

The implementation of this extension would be easy. Because MetaPost already does the needed work when writing the PostScript output file, it is just a matter of making this information available to the macro language.

In all likelihood, this is the limit of what we can put into the next release, version 1.0, to be released in the autumn of 2005.

6.2 Possibly for the next release

- Allow basic EPS inclusion.

The idea is to allow the same kind of EPS inclusion one can find in the `dvips` driver. This EPS file could contain PostScript drawing commands or a bitmap expressed using PostScript's `image` operator.

- Implement something that is like T_EX's `\special`.

This is so that user-supplied stuff can end up in the middle of the PostScript output, not only at the very top. Both Jacko and Hans need this to do special effects in post-processing.

- Improvements to string handling.

This was put on the board for Hans, who hopes that it is possible to improve the primitives that deal with strings.

- Implement edge structures.

Edge structures is Metafont's data model to express images.

This item is a huge undertaking, because it implies the recreation of all of Metafont's edge structure operations like `good.x`, `withweight` and `cullit`, and some of those in turn imply real unfill and overlap removal routines.

6.3 More wishes

A number of items were kept for the future, but tagged as 'more thinking needed'. These are things for which a partial solution would be easy to do, but for a complete solution it is not even clear how it should be implemented

- Support for alternative colour models.

Cmyk and grayscale would be easy but not very useful. Named colours and especially transparency would be very useful to have, but implementing that would be quite hard.

- Macro language enhancements

The first item on this list is the desire to have namespace support. Everybody knows what is meant by this, but a precise specification is lacking.

A second one of these is that symbolic token existence tests are missing from the language at the moment; `if known` is not always good enough. For instance, you may want to know if a variable name has been declared, regardless of whether or not it has a known value at the moment.

Yet another is that `let` behaves a bit strange compared to the `\let` command in T_EX.

- Support for 3D (or more dimensions).

Perhaps this support can be added gradually, but that needs to be investigated in the Web source of MetaPost first.

6.4 Even more wishes

Some ideas were tagged as ‘(much) later’:

- virtual font support.
Any code on this might become superseded within a year because of upcoming improvements to pdfT_EX, so it makes no sense to do anything in this area yet.
- Proper EPSF creation.
Embedded and possibly subsetted fonts should be included in the output.
- PDF output.
This has to be very much later, because it needs lots of extra code.
- Bitmapped output format
Some form of netpbm probably, to debug the edge structures. There is no sense in adding it before the edge structures are implement, because then it would need ghostscript or a similar PostScript rasterizer.

7 Remaining wishes

The rest of the list was agreed on as being nice, but remained unprioritized (by mistake or lack of time):

- A way to check if a path is completely within another path
- Non-continuous paths (as in PostScript)
- XML as an output format (nicer to parse for postprocessors)
- Fixed number arithmetic using 64 bits instead of the current 32 bits (also known as ‘megapost’).
- Unicode/UTF-8 support for easier string handling

8 Scratched ideas

Some ideas were scratched for the moment, either because it is strictly speaking unneeded (a macro solution is doable), or because there has not been a well-argued request for that feature.

Among those are some shortcuts for existing macros and a switch to output PostScript level 2 or 3.

9 Acknowledgements

We would like to thank everybody who has helped us creating this new release of MetaPost, especially to John D. Hobby for allowing us to do so.

Our next report will be available in the autumn of 2005.

From RTF to XML to L^AT_EX

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Februar 26, 2005

Abstract

This paper shows how the widely used Rich Text Format (originally specified by Microsoft) can be processed to produce XML and how the resulting XML-file can be processed by L^AT_EX to produce print-quality PDF-files. To convert the RTF-files to a specific XML-format we use the open-source-tool Majix which can be found on Sourceforge.

We then take XMLT_EX to process the generated XML-file. We had to create an output that is as near as possible to Word's. An effort was made to reach this goal even with constructs such as lists, tabstops and especially tables.

Using XML as an intermediary format in typesetting RTF has the advantage that structural transformations are much easier based on XML even if the XML 'only' reproduces the RTF as faithfully as possible.

Filtering or transforming certain objects or attributes and even correcting typesetting errors can be done by appropriate transformations of the XML files.

1 Introduction

For a commercial project it was necessary to typeset larger documents from automatically generated XML data with embedded references to external RTF files. It was decided to first transform the RTF to XML and include that into the existing XML-structure, all together then being typeset by XMLT_EX.

For this, the open-source-tool Majix was extended to achieve the RTF-XML translation. For typesetting the resulting XML an appropriate implementation using XMLT_EX was created which will be uploaded to CTAN eventually, providing another open-source way of handling RTF with T_EX.

2 Results

We begin with a RTF-File. As you can see in figure 2 OpenOffice isn't able to handle recorded changes to the file correctly. For example in 'Betrag für 20042 Tsd EUR' (first row, second column) the '20042' is meant to be a year. Originally is was 2002 but the last '2' was deleted and replaced with '4'. However the '2' remained as old version in the RTF and and is tagged as 'deleted'. In opposite to Majix OpenOffice doesn't recognise the responsible control word. The corresponding RTF-Code is shown in the following listing. We have selected a quite readable portion. When it comes to font management RTF isn't readable at all.

The RTF-Code looks like this

```

1 \s16\qj\sa40\widctlpar\adjustright \f18\fs16\lang1031\cgrid {\expnd0\expndtw-2 Anteil, der
2 aufgrund Artikel 9 des Verwaltungsabkommens vom 5.\~9.\~1957 i. d. F. vom 28.\~2.\~1991 zwi
3 schen Bund und L'e4ndern \'fc
4 ber die Err
5 ichtung eines Wissenschaftsrats im Haushaltsjahr 1994 voraussichtlich entf'e4llt.
6 \par }pard
7 \plain \s18\qc\sa40\widctlpar\adjustright \f18\fs16\lang1031\cgrid {\'dcbersicht \'fcber di
8 e Einnahmen und Ausgaben\line des Wissenschaftsrates
9 \par }\trow
10 d \clvertalt\clbrdr\brdrs\brdrw20 \clbrdrb\brdrs\brdrw20 \cltxlrb \cellx1021\clvertalt\cl
11 brdr\brdrs\brdrw20 \clbrdrb\brdrs\brdrw20 \clbrdr\brdrs\brdrw20 \cltxlrb \cellx2042\clve

```

Anteil, der aufgrund Artikel 9 des Verwaltungsabkommens vom 5.9.1957 i. d. F. vom 28.2.1991 zwischen Bund und Ländern über die Errichtung eines Wissenschaftsrats im Haushaltsjahr 1994 voraussichtlich entfällt.

Übersicht über die Einnahmen und Ausgaben des Wissenschaftsrates

	Betrag für 20042 Tsd. EUR	Betrag für 20031 Tsd. EUR	Istergebnis 20020 Tsd. EUR
Ausgaben	4.3444 035	4.4554 041	4.0194 228
Einnahmen	63	61	121
Fehlbetrag	4.3384 032	4.4494 040	4.0074 227

	20043 Tsd. EUR
Der Fehlbetrag soll gedeckt werden durch	
a) eigene Mittel des Zuwendungsempfängers	—
b) das Land mit	
c) den Bund mit	2242 10
d) sonstige Gebietskörperschaften und öffentliche Hand	2.1682 02
e) Private	9
	1.9461 81
	9
	—
Zusammen	4.3384 05
	8

Figure 1: We first have a RTF file. Note the mixed up old and new version of the years and amounts. (Please ignore the font type. The used one wasn't installed and had to be substituted by OpenOffice)

```

12 rtalt\clbrdrt\brdrs\brdrw20 \clbrdrb\brdrs\brdrw20 \cltxlrtb
13 \cellx3063\clvertalt\clbrdrt\brdrs\brdrw20 \clbrdrf\brdrs\brdrw20 \clbrdrb\brdrs\brdrw20 \c
14 ltxlrtb \cellx4253\pard\plain \qc\sb40\sa40\widctlpar\intbl\adjustright \f18\fs16\lang1031\
15 cgrid {\cell Betrag\line f'fcr 200}{\revised\revauth1\revdtm1182249745
16 4}{\deleted
17 \revauthdel1\revdtm1182249745 2}{\line Tsd. EUR\cell }\pard \qc\fi1\li-1\sb40\widctlpar
18 \intbl\adjustright {Betrag\line f'fcr 200}{\revised\revauth1\revdtm1182249745 3}{\deleted
19 \revauthdel1\revdtm1182249745 1}{\line Tsd. EUR\cell
20 Istergebnis
21 \line 200}{\revised\revauth1\revdtm1182249745 2}{\deleted\revauthdel1\revdtm1182249745
22 0}{\line Tsd. EUR\cell }\pard \widctlpar\intbl\adjustright {\row }\trowd \clvertalt\cltxlr
23 tb \cellx1021\clvertalt\cltxlrtb \cellx2042
24 \clvertalt\
25 cltxlrtb \cellx3063\clvertalt\cltxlrtb \cellx4253\pard\plain \s1\sb80\sa40\keepn\widctlpar\
26 intbl\outlinelevel0\adjustright \b\fs20\lang1031\cgrid {\f18\fs16 Ausgaben}

```

After the conversion by Majix we get the XML-Code shown in the next listing. Majix did a great job in giving the data a meaningful structure.

The generated XML is much more readable

```

1 <par align="justified">
2 <tabdeflist>
3 <tabdef type="default" align="left" position="12.49mm"/>
4 </tabdeflist>
5 <parcontent>
6 Anteil, der aufgrund Artikel 9 des Verwaltungsabkommens vom 5. 9. 1957 i. d. F.
7 vom 28. 2. 1991 zwischen Bund und Ländern über die Errichtung eines
8 Wissenschaftsrats im Haushaltsjahr 1994 voraussichtlich entfällt.
9 </parcontent>
10 </par>
11 <par align="center">
12 <tabdeflist>
13 <tabdef type="default" align="left" position="12.49mm"/>
14 </tabdeflist>
15 <parcontent>
16 Übersicht über die Einnahmen und Ausgaben<linebreak/>des Wissenschaftsrates
17 </parcontent>
18 </par>
19 <table>
20 <tbody>
21 <tr>
22 <td width="18.0093mm" valign="top" border-top="0.0pt"
23 border-bottom="1.0pt" border-left="0.0pt">
24 </td>
25 <td width="18.0093mm" valign="top" border-top="0.0pt"
26 border-bottom="1.0pt" border-right="1.0pt">
27 <par align="center">
28 <tabdeflist>
29 <tabdef type="default" align="left" position="12.49mm"/>
30 </tabdeflist>
31 <parcontent>
32 Betrag<linebreak/>für 2004<linebreak/>Tsd. EUR
33 </parcontent>
34 </par>
35 </td>
36 <td width="18.0093mm" valign="top" border-top="0.0pt"
37 border-bottom="1.0pt">
38 <par align="center">
39 <tabdeflist>
40 <tabdef type="default" align="left" position="12.49mm"/>
41 </tabdeflist>
42 <parcontent>
43 Betrag<linebreak/>für 2003<linebreak/>Tsd. EUR
44 </parcontent>
45 </par>
46 </td>
47 ...
48 </tr>

```

The resulting PDF is shown in figure 2. As you can see there are some differences between the OpenOffice and the L^AT_EX version. These are the result of some filtering on the XML data demanded by our client.

3 Filtering

Having a well-formed XML one can easily filter the data. For example harmonizing the indentation of unordered lists can be done by deleting the necessary attributes in the XML and providing corresponding defaults.

Another class of transformations deals with the enrichment of semantics by converting visual markup to logical markup: one could search for special XML-constructs perhaps with specific attributes and/or contents and replace them with a ‘meaningful’ structure.

A good example for this are the so called VEGrids. These are special tables which always have the same layout. A typical VEGrid is shown in figure 3. The headline is always the same as is the tablehead. In the first column there are years, the bottom row is a sum. Usually VEGrids are already given in a XML-structure but sometimes it seems the person dealing with the case doesn’t use the right program to input the data but uses Word to create a RTF file with a VE-lookalike. After the XML conversion we get a noname-table as shown in

Zu 685 24
Anteil, der aufgrund Artikel 9 des Verwaltungsabkommens vom 5. 9. 1957 i. d. F. vom 28. 2. 1991 zwischen Bund und Ländern über die Errichtung eines Wissenschaftsrats im Haushaltsjahr 1994 voraussichtlich [redacted] entfällt.
Übersicht über die Einnahmen und Ausgaben des Wissenschaftsrates

	Betrag für 2004 Tsd. EUR	Betrag für 2003 Tsd. EUR	Istergebnis 2002 Tsd. EUR
Ausgaben	4.344	4.455	4.019
Einnahmen	6	6	12
Fehlbetrag	4.338	4.449	4.007

Der Fehlbetrag soll gedeckt werden durch

	2004 Tsd. EUR
1. eigene Mittel des Zuwendungsempfängers	—
2. das Land mit	—
3. den Bund mit	224
4. sonstige Gebietskörperschaften und öffentliche Hand	2.168
5. Private	1.946
Zusammen	4.338

Figure 2: After processing with XMLT_EX

Belastungen, die aus bei Titel 06 05 – 663 01 in Vorjahren in Anspruch genommen / ausgebrachten Verpflichtungen entstehen:

Belastung (2004)

der Haushalts-jahr	durch die bis 2002 in Anspruch genommen VE in 1000 EUR	durch die 2003 ausgebrachte VE in 1000 EUR	durch die 2004 ausgebrachte VE in 1000 EUR	Gesamtbelastung in 1000 EUR
2004	553	-	-	553
2005	548	-	-	548
2006	467	-	-	467
2007	185	-	-	185
Summe	1 753	-	-	1 753

Figure 3: A special table called VEGrid in a RTF file

the next listing. Because of the constant layout we could identify these lookalikes and exchange them by ‘real’ VEGrids. This is shown in the last listing on the next page.

The generated XML (note the numerous omissions)

```

1 <table>
2 <tbody>
3 <tr border-bottom="0.5pt" border-left="0.5pt" border-right="0.5pt"
4 border-horizontal="0.5pt" border-vertical="0.5pt">
5 <td width="72.5135mm" valign="top" border-top="0.0pt"
6 border-left="0.0pt" colspan="4">
7 <par align="left">
8 <tabdeflist>
9 <tabdef type="default" align="left" position="12.49mm"/>
10 </tabdeflist>
11 <parcontent>Belastung (2004) </parcontent></par></td>

```

```

12 <td width="17.4978mm" valign="top" border-top="0.0pt"
13     border-right="0.0pt" colspan="2"></td>
14 </tr>
15 <tr border-top="0.5pt" border-bottom="0.5pt" border-left="0.5pt" ...>
16 <td width="17.5154mm" valign="top" border-top="1.0pt" ...>
17     ...
18     <parcontent>
19     <linebreak/>der<linebreak/>Haushalts-<linebreak/>jahre
20     </parcontent></par></td>
21     ...
22 </tr>
23 <tr border-top="0.5pt" border-bottom="0.5pt" border-left="0.5pt"...>
24 <td width="17.5154mm" valign="top" border-top="1.0pt"...>
25     ...
26     <parcontent>2004</parcontent></par></td>
27 <td width="18.1151mm" valign="top" border-top="1.0pt"...>
28     ...
29     <parcontent>553 </parcontent></par></td>
30 <td width="18.1328mm" valign="top" border-top="1.0pt"...>
31     ...
32     <parcontent>-</parcontent></par></td>
33     ...
34 </tr>
35 <tr border-top="0.5pt" border-bottom="0.5pt" border-left="0.5pt"...>
36 <td width="17.5154mm" valign="top" border-top="1.0pt"...>
37     ...
38     <parcontent>Summe</parcontent></par></td>
39 <td width="18.1151mm" valign="top" border-top="1.0pt"...>
40     ...
41     <parcontent>1 753 </parcontent></par></td>
42     ...
43 </tr>
44 </tbody>
45 </table>

```

The enriched and filtered XML

```

1 <VEGRID>
2 <VEROW>
3 <VECOLUMN1>2005</VECOLUMN1>
4 <VECOLUMN2>553</VECOLUMN2>
5 <VECOLUMN3>null</VECOLUMN3>
6 <VECOLUMN4>null</VECOLUMN4>
7 <VECOLUMN5>553</VECOLUMN5>
8 </VEROW>
9 <VEROW>
10 <VECOLUMN1>2004</VECOLUMN1>
11 <VECOLUMN2>548</VECOLUMN2>
12 <VECOLUMN3>null</VECOLUMN3>
13 <VECOLUMN4>null</VECOLUMN4>
14 <VECOLUMN5>548</VECOLUMN5>
15 </VEROW>
16 ...
17 <VESUMROW>
18 <VECOLUMN1>Summe</VECOLUMN1>
19 <VECOLUMN2>1753</VECOLUMN2>
20 <VECOLUMN3>null</VECOLUMN3>
21 <VECOLUMN4>null</VECOLUMN4>
22 <VECOLUMN5>1753</VECOLUMN5>
23 </VESUMROW>
24 </VEGRID>

```

4 Further Development

Because there was no need up to now we ignore changes of font size and type. Besides that the management of colours wasn't implemented yet. Perhaps these features will be implemented in future.

As said before it is planned to release the code of the package on CTAN. The extended version of the RTF converter Majix is already available via SourceForge.

The TEI/T_EX Interface

Sebastian Rahtz

March 2005

Abstract

In the view of many people, the natural way to prepare a typeset document is to use L^AT_EX or ConT_EXt. It produces high-quality output, the source document is a clean mixture of text and markup, and it works on any computer. For another group of people, however, the natural way to proceed is to prepare a validated XML document which can be used to either make a web page or to make a printed document. One choice of an XML encoding for this group is the Text Encoding Initiative (TEI) scheme.

This paper is in two parts. The first part examines the arguments for and against authoring in XML, rather than T_EX, and demonstrates how some common T_EX situations are catered for in TEI XML.

The second part of the paper examines how, if we *do* choose XML, we can continue to harness the power of T_EX. We examine the four main routes of

- a) using a modified T_EX to read XML directly;
- b) translating XML direct to high-level T_EX;
- c) translating our XML to another XML which is functionally identical to L^AT_EX and then translating that; and
- d) translating XML to an XML-based page description language (XSL FO), and processing that with T_EX.

None of these is completely satisfactory, and we end by considering what hope there is for the future.

1 The TEI / T_EX interface

musings and reports

2 Personal background

I am Sebastian Rahtz:

- Information Manager for *Oxford University Computing Services*
- Manager of *OSS Watch*, the UK national Open Source Advisory Service
- Oxford representative on the Board of Directors of the *Text Encoding Initiative Consortium*; member of the TEI Technical Council, and convenor of its Meta Language working party
- Long-time (coming up to 20 years) T_EX sorcerer (using the classification of Ursula Le Guin, not Don Knuth)
- Overall editor of T_EXlive

3 TEI Background

The TEI

- an international and interdisciplinary standard that helps libraries, museums, publishers, and individual scholars represent all kinds of literary and linguistic texts for online research and teaching
- a comprehensive and well-documented markup language for all kinds of text material, from manuscripts to dictionaries, from film scripts to web pages.
- An XML vocabulary, coming up to a new release (P5) using XML schema languages

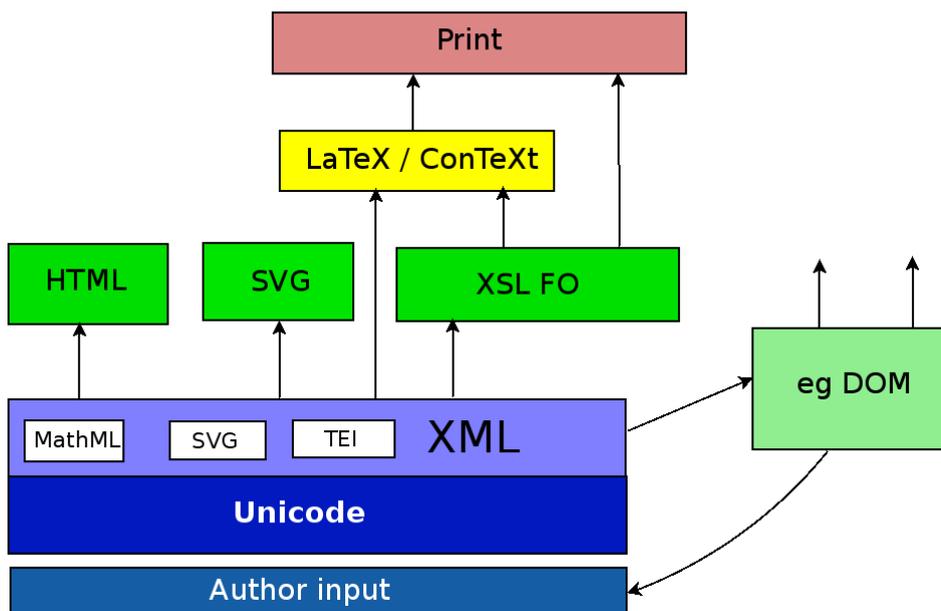
4 Example, part 1

```
<TEI xmlns="http://www.tei-c.org/ns/1.0">
<teiHeader>
  <fileDesc>
    <titleStmt>
      <title>The TEI/TeX interface</title>
      <author>Sebastian Rahtz</author>
    </titleStmt>
    <editionStmt>
      <edition>
        <date>March 2005</date>
      </edition>
    </editionStmt>
  </fileDesc>
  <revisionDesc>
    <change>
      <date>$Date: 2005/03/10 $.</date>
      <respStmt>
        <name>$Author: rahtz $.</name>
      </respStmt>
      <item>$Revision: #1 $.</item>
    </change>
  </revisionDesc>
</teiHeader>
```

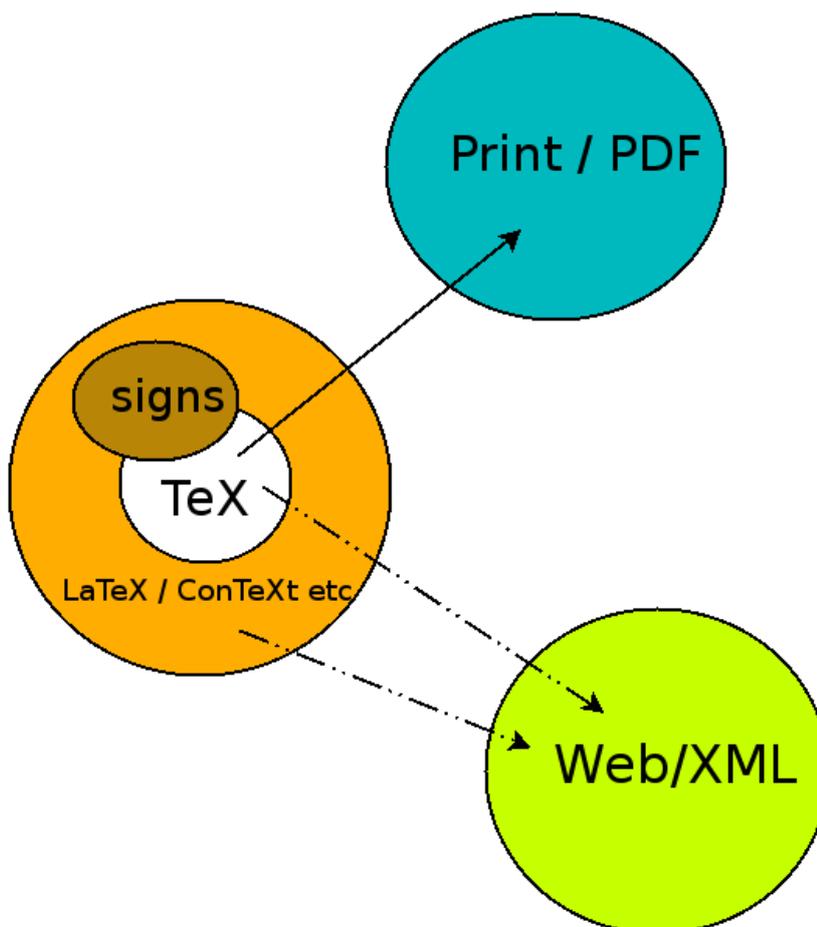
5 Example, part 2

```
<text>
<body>
<div>
<head>Personal background</head>
<p>I am <hi>Sebastian Rahtz</hi>:
<list>
  <item>
    Information Manager for<emph>Oxford University Computing</emph>Services
  </item>
  <item>
    Manager of <emph>OSS Watch</emph>, the UK national Open Source Advisory Service
  </item>
  <item>
    Oxford representative on the Board of Directors of the
    <emph>Text Encoding Initiative Consortium</emph>
```


7 The TEI world view



8 The L^AT_EX world view



9 Core differences between TEI XML and (eg) L^AT_EX

Markup using (most of) Unicode	Markup using ASCII (extensible with difficulty)
Verbose but consistent	Concise but arbitrary
International standard for markup	Private extensible markup
Unicode character encoding	Variable character encoding
Single syntax	Syntax determined by application
Vocabulary choice constrained by schema	Vocabulary dynamically extensible and changeable
Vocabulary checkable	Vocabulary only constrained by syntax
Language separate from processing	Processor and language intermixed
—	Builtin math engine
—	Builtin tabular engine
Multiple processors	One reliable processor

10 Why markup schemas?

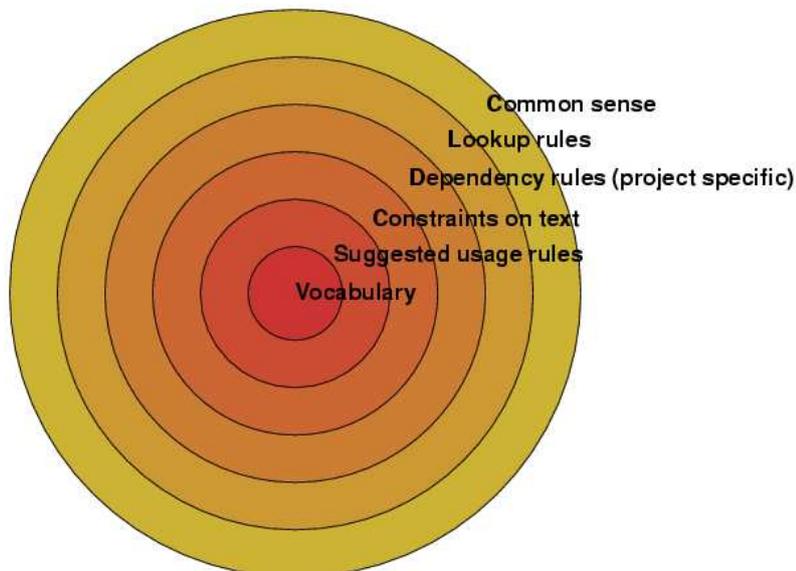
So we want machine readable text:

- We need a reasonable notation (XML or T_EX)
- We need a character encoding system (Unicode)
- We need to make up vocabularies
- We need to be able to process our texts

What influences our choice? We

- want to interchange texts and tools with others
- need to have a formal way to express conditions about our markup
- should find a place to document our vocabulary

11 What we might do with a schema



12 Layers, using an XML schema

1. vocabulary

```
<list>, <item>, <label>
```

2. suggested usage rules

```
element list { item+ }
```

3. constraints on text

```
figure.attributes.url.content = xsd:anyURI
```

4. dependency rules (project specific)

```
<if test="self::list[@type='gloss'] and not(child::label)">
  <message>gloss lists must have <label> children</message>
</if>
```

5. lookup rules

```
<if test="document('lookup.xml')/people/person[@id=current::@ref]">
  <message>this person does not exist in the database</message>
</if>
```

6. common sense rules

```
Don't use table markup to force layout
```

13 Does the TEI cover all these?

As of today, the TEI Guidelines contain:

vocabulary 362 elements, 95 attributes, 88 classes

suggested usage rules 24 modules with 7185 lines of rules in compact Relax NG

constraints on text W3C Schema datatyping

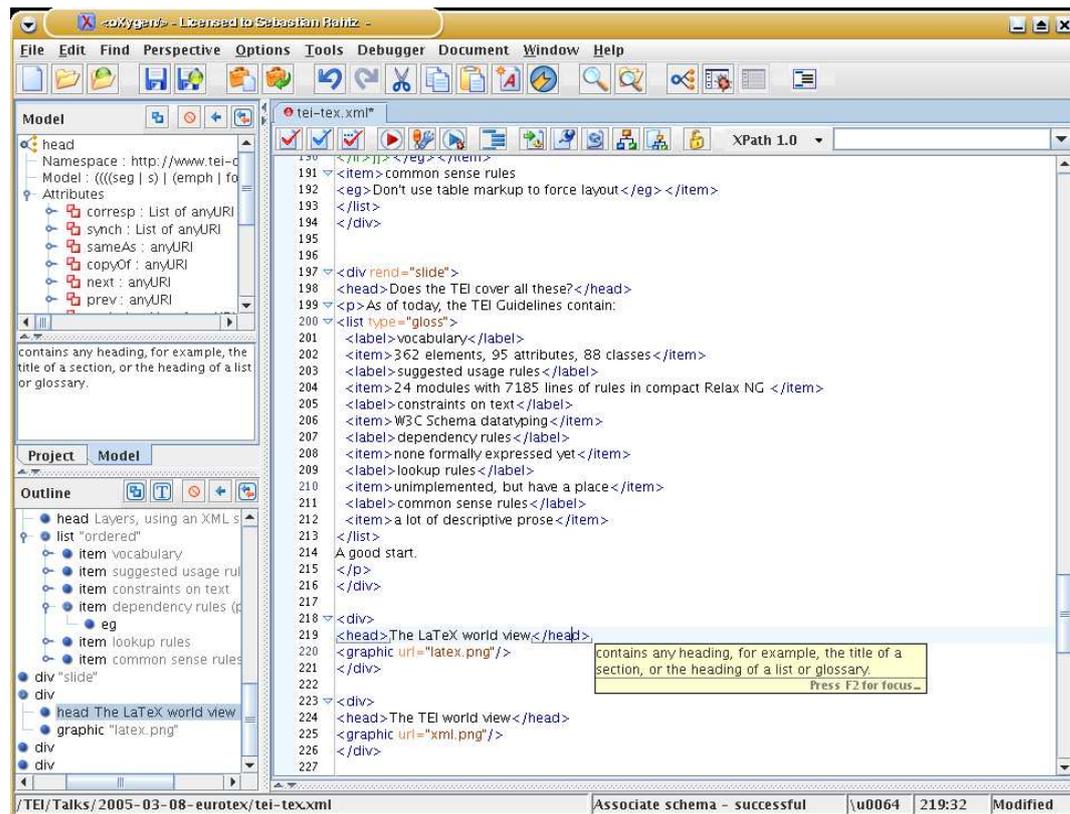
dependency rules none formally expressed yet

lookup rules unimplemented, but have a place

common sense rules a lot of descriptive prose

A good start.

14 An editors view



15 Example 3

Roma: **generating validators for the TEI** Search TEI database: Submit Query Text Encoding Initiative

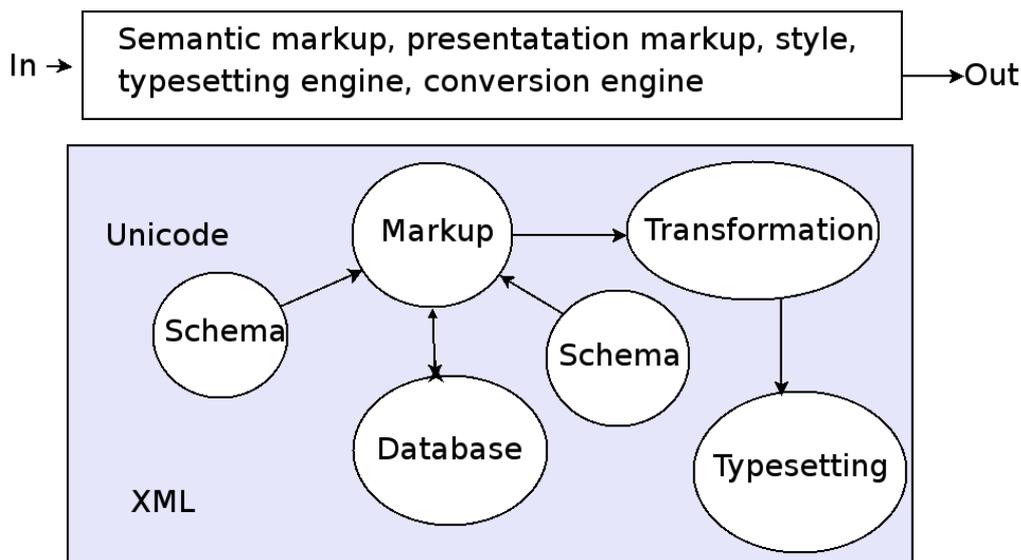
Save Customize New Help
 Modules Add Elements Change Classes Language Schema Documentation

Warning! this version of Roma uses a pre-release draft of TEI P5 from 1st October 2004

Modules

List of TEI Modules			List of selected Modules	
Module name	A short description	Changes		
add analysis	Simple analytic mechanisms		remove	core
add certainty	Certainty and uncertainty		remove	tei
add core	Elements available in all forms of the TEI main DTD		remove	header
add corpus	Header extensions for Corpus Texts		remove	textstructure
add declarefs	Feature System Declaration			
add dictionaries	Base tag set for printed dictionaries			
add drama	Base tag set for Performance texts			
add figures	Tables, Formulae, Figures			
add gajji	Character and Glyph documentation			
add header	The TEI Header			
add iso-fs	Feature Structures			
add linking	Linking, Segmentation and Alignment			
add msdescription	Manuscript Description			
add namesdates	Additional classes for names and dates			
add nets	Graphs, networks and trees			
add sharedheader	Auxiliary DTD for Independent Header			
add spoken	Base tag set for Transcribed Speech			
add tagdocs	Declares the elements making up the module documentation module			
add tei	Main document type declaration file			
add textcrit	Tags for text criticism			

16 Another graphical view of TEI and T_EX



17 Using T_EX behind XML

1. using a modified T_EX to read XML directly;
2. translating XML direct to high-level T_EX;
3. translating our XML to another XML which is functionally identical to L^AT_EX and then translating that; and
4. translating XML to an XML-based page description language (XSL FO), and processing that with T_EX (XSLFO).

17.1 [1] T_EX reads XML directly: ConT_EXt

Using mapping files:

```
\defineXMLenvironment[article][id=\undefined]
  {\XMLDBpusheselement\currentXMLelement
   \XMLDBmaystartdocument
   \XMLDBmayensurebodymatter}
{\XMLDBmayfinishdocument
 \XMLDBpopselement}

\defineXMLenvironment[itemizedlist]
  {\XMLDBpusheselement\currentXMLelement \XMLDBmayensurebodymatter
   \doifsamestringelse{\XMLpar{itemizedlist}{spacing}{normal}}{compact}
   {\startitemize[packed]}
   {\startitemize}%
   \defineXMLignore[titleabbrev]%
   \defineXMLenvironment[listitem]
     {\item\xMLDBcontinuepartrue\ignorespaces}{}%
   }
  {\stopitemize\xMLDBpopselement}
```

17.2 [1] T_EX reads XML directly: xmlT_EX

```

\XMLelement{TEI.2}{}
{ \documentclass{article}
  \usepackage[bookmarks=false]{hyperref}
  \usepackage{teixml}
  \begin{document} }
{\end{document}}
...
\XMLelement{ref}
{\XMLattribute{target}{\reftarget}{} }
{\xmlgrab}
{\hyperref[\reftarget]{#1}}

```

(used for PassiveT_EX XSL FO processor)

17.3 [1] T_EX reads XML directly: problems

1. gobbledygook, even by T_EX standards: only experts need apply
2. limited access to document tree
3. (xmlT_EX) forced grouping makes mapping some constructs almost impossible
4. catcode issues in auxiliary files

17.4 [2] Translate XML to high-level L^AT_EX

```

<xsl:template match="tei:list">
<xsl:choose>
<xsl:when test="@type='gloss'">
  \begin{description}
    <xsl:apply-templates mode="gloss" select="tei:item"/>
  \end{description}
</xsl:when>
<xsl:when test="@type='unordered'">
  \begin{itemize}<xsl:apply-templates/>
  \end{itemize}
</xsl:when>
<xsl:when test="@type='ordered'">
  \begin{enumerate}<xsl:apply-templates/>
  \end{enumerate}
</xsl:when>
<xsl:otherwise>
  \begin{itemize}<xsl:apply-templates/>
  \end{itemize}
</xsl:otherwise>
</xsl:choose>
</xsl:template>

```

17.4.1 (dirty details)

```

\usepackage[utf8]{inputenc}
\usepackage[T1]{fontenc}
\usepackage{ucs}

```

```

\catcode'\_ =12\relax
\let\tabcellsep&
\catcode'\& =12\relax
\catcode'\$ =12\relax
\catcode'\^ =12\relax
\catcode'\~ =12\relax
\catcode'\# =12\relax
\catcode'\% =12\relax

```

17.5 [2] Translate XML to high-level L^AT_EX: problems

1. Remaining catcode problems (\, {, })
2. When L^AT_EX signals an error, where is it in the source?
3. Where do you make style decisions?
 - \tableofcontents or <divGen type="toc"/>
 - \section{Introduction} or \section{1. Introduction}
 - \def{xxxxx \def{yyyyy} or \usepackage{foo}

17.6 [3] Transform XML to XML-ised L^AT_EX

Transform to

```

<cmd name="documentclass">
  <opt>12pt</opt>
  <parm>letter</parm>
</cmd>
<env name="document">
  <cmd name="author" nl2="1">
    <parm>A. U. Thor</parm>
  </cmd>
  <cmd name="title" nl2="1">
    <parm>A SHORT STORY</parm>
  </cmd>
  <cmd name="maketitle" nl2="1" gr="0"/>
  <cmd name="section*" nl2="1">
    <parm>A SHORT STORY</parm>
  </cmd>

```

and thence to

```

\documentclass[12pt]{letter}
\begin{document}
  \author{A. U. Thor}
  \title{A SHORT STORY}

```

17.7 [3] Transform XML to XML-ised L^AT_EX: ups and downs

- ✓ You don't have to worry about \ { and }
- ✗ It takes another processor
- ✗ It inserts yet another layer of obscurity between author and error on printout
- ✓ Allows for implementation using the first technique

17.8 [4] Transform XML to XML-based page description language

```

<fo:list-block margin-right="10pt" space-before="6pt"
  space-after="6pt" margin-left="15pt">
  <fo:list-item space-before.optimum="4pt">
    <fo:list-item-label>
      <fo:block margin-right="2.5pt" text-align="center">
        &#x2219;
      </fo:block>
    </fo:list-item-label>
    <fo:list-item-body>
      <fo:block font-weight="normal">Marley's ghost1</fo:block>
    </fo:list-item-body>
  </fo:list-item>
  <fo:list-item space-before.optimum="4pt">
    <fo:list-item-label>
      <fo:block margin-right="2.5pt" text-align="center">
        &#x2219;
      </fo:block>
    </fo:list-item-label>
    <fo:list-item-body>
      <fo:block font-weight="normal">
        The first of the three spirits 39
      </fo:block>
    </fo:list-item-body>
  </fo:list-item>
  ...

```

17.9 [4] Transform XML to XML-based page description language (creation)

```

<xsl:template match="tei:list">
  <fo:list-block margin-right="{ $listRightMargin }">
    <xsl:call-template name="setListIndents"/>
    <xsl:choose>
      <xsl:when test="@type='gloss'">
        <xsl:attribute name="margin-left">
          <xsl:choose>
            <xsl:when test="ancestor::tei:list">
              <xsl:value-of select="$listLeftGlossInnerIndent"/>
            </xsl:when>
            <xsl:otherwise>
              <xsl:value-of select="$listLeftGlossIndent"/>
            </xsl:otherwise>
          </xsl:choose>
        </xsl:attribute>
      </xsl:when>
      <xsl:otherwise>
        <xsl:attribute name="margin-left">
          <xsl:value-of select="$listLeftIndent"/>
        </xsl:attribute>
      </xsl:otherwise>
    </xsl:choose>
    <xsl:apply-templates select="tei:item"/>
  </fo:list-block>
</xsl:template>

```

18 Implementations of XSL FO

Open source

- PassiveT_EX: 4000 lines of incomprehensible T_EX macros by an amateur, incomplete and stalled
- FoXeT: 4000 lines of T_EX macros by a professional, getting closer
- FOP: free-standing Java program, in the doldrums for several years

Closed source

- Antenna House: excellent full implementation, Windows only
- XEP: excellent full implementation in Java

19 FO's good and bad points

- ✓ Simple to read and write, although very verbose
 - ✓ 'Standardised' by a reputable body
 - ✓ Multiple implementations
 - ✓ Understands colour, backgrounds, fonts, URLs, Unicode etc
 - ✗ Divorced from the typesetter
 - ✗ Simplistic and limited page model (eg floats)
- possibly "good enough" (anathema to T_EXxies!)

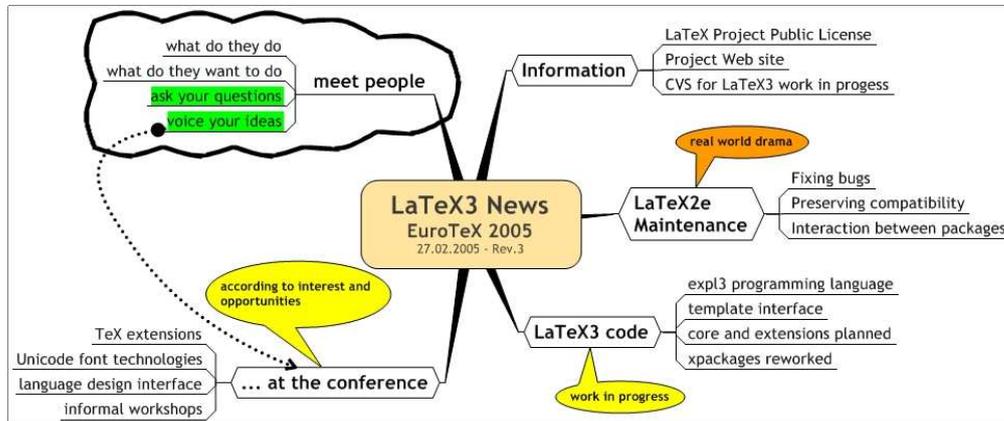
20 Which direction?

- Forget direct T_EX interpretation of arbitrary XML...
- ...embrace direct T_EX reading of constrained XML
- Forget trying to teach people \{ }...
- ...embrace semantically clean markup
- Forget trying to make T_EX the centre of the universe
- ...develop T_EX to keep being the best typesetting **engine**

LaTeX3 News

Frank Mittelbach

Chris Rowley

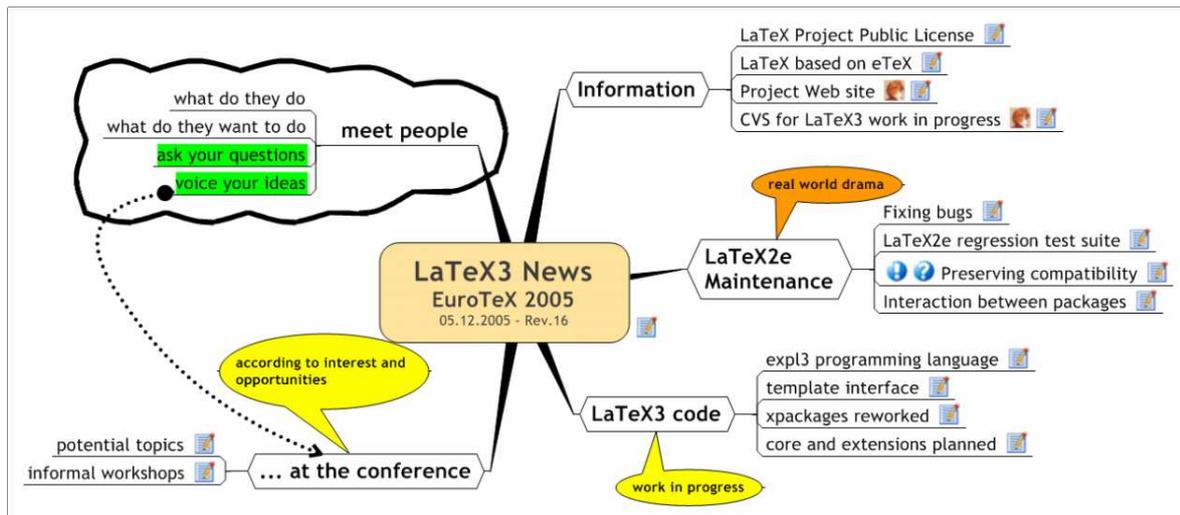


The main purpose of this event is to introduce the human side of the LaTeX3 Team and to explain what we are doing, both collectively and individually, to support and promote LaTeX and automated typography. Here is a summary of the team's recent, current and planned activities.

- General News
 - LaTeX Project Public License
 - The project Web site
- Maintenance
 - Fixing standard LaTeX
 - Helping packages work better with each other
- LaTeX3 Code — work in progress
 - Web access to experimental LaTeX3 code at <http://www.latex-project.org/cgi-bin/cvsweb.cgi/>
 - The next version of the LaTeX3 Programming Language, `expl3` at <http://www.latex-project.org/cgi-bin/cvsweb.cgi/experimental/expl3/>
 - Progress on `xpackages` (e.g., `xor` learns to balance) at <http://www.latex-project.org/cgi-bin/cvsweb.cgi/experimental/xpackages/>
 - Plan to provide full core and typical extensions based on `expl3` and the `template` mechanism
- Work at this conference
 - Investigate TeX extensions and quasi-TeX ‘extensions’ and their consequences for LaTeX
 - Investigate ‘Unicode font technologies’ (XeTeX and friends) possibly including ‘Unicode-encoded math chars/glyphs’
 - Work on language interface design

There will be plenty of opportunity for questions and discussion of our plans.

LaTeX3 News EuroTeX 2005



This presentation was given using an interactive mind map which is shown as a graphics above. Speaker notes have been added to the leaves to produce this document.

An interactive web version of this presentation is available at <http://www.latex-project.org/papers/>.

1 Information

1.1 LaTeX Project Public License

- LPPL 1.3 is now DFSG compatible
- approx 1600 messages exchanged on Debian-Legal

1.2 LaTeX based on eTeX

- official announcement in 2003-04
- reliable text/math support for inputenc needs eTeX --- not part of distribution yet
- Experimental LaTeX3 programming language (expl3) now based on eTeX

1.3 Project Web site

see url: www.latex-project.org

- after no change for a long time the project web site is now again actively maintained

1.4 CVS for LaTeX3 work in progress

see url: cvsweb.cgi

- LaTeX3 experimental language (expl3)
- xpackages

2 LaTeX2e Maintenance

- real world drama

2.1 Fixing bugs

- what is a bug?
- not necessarily what a user experienced as such

Questions:

- has the "bad behavior" become a feature that documents rely on?
- does a fix break other parts of the system?

2.2 LaTeX2e regression test suite

- close to 300 test files for the kernel sources
- changes to the system are checked against the full test suite, often enough showing surprising dependencies
- in theory every bug fix should be accompanied by a test file checking for the problem

2.3 Preserving compatibility

- yes or no ?
- and how ?

2.4 Interaction between packages

- updates in one package often breaks interfaces in others

3 LaTeX3 code

- work in progress

3.1 *expl3 programming language*

- the language is now fairly stable though adjustments and additions are possible
- further use of eTeX primitives envisioned

3.2 *template interface*

- further applications are planned
- from the resulting experiences updates or extensions to the interface are likely

3.3 *xpackages reworked*

- the xpackages currently reflect experiments at different stages of the expl3 language
- general overhaul of all packages to fully use expl3 is planned

3.4 *core and extensions planned*

- specification of a core set of functionality is planned
- similar for interface and extension specification

4 ... at the conference

- according to interest and opportunities

4.1 potential topics

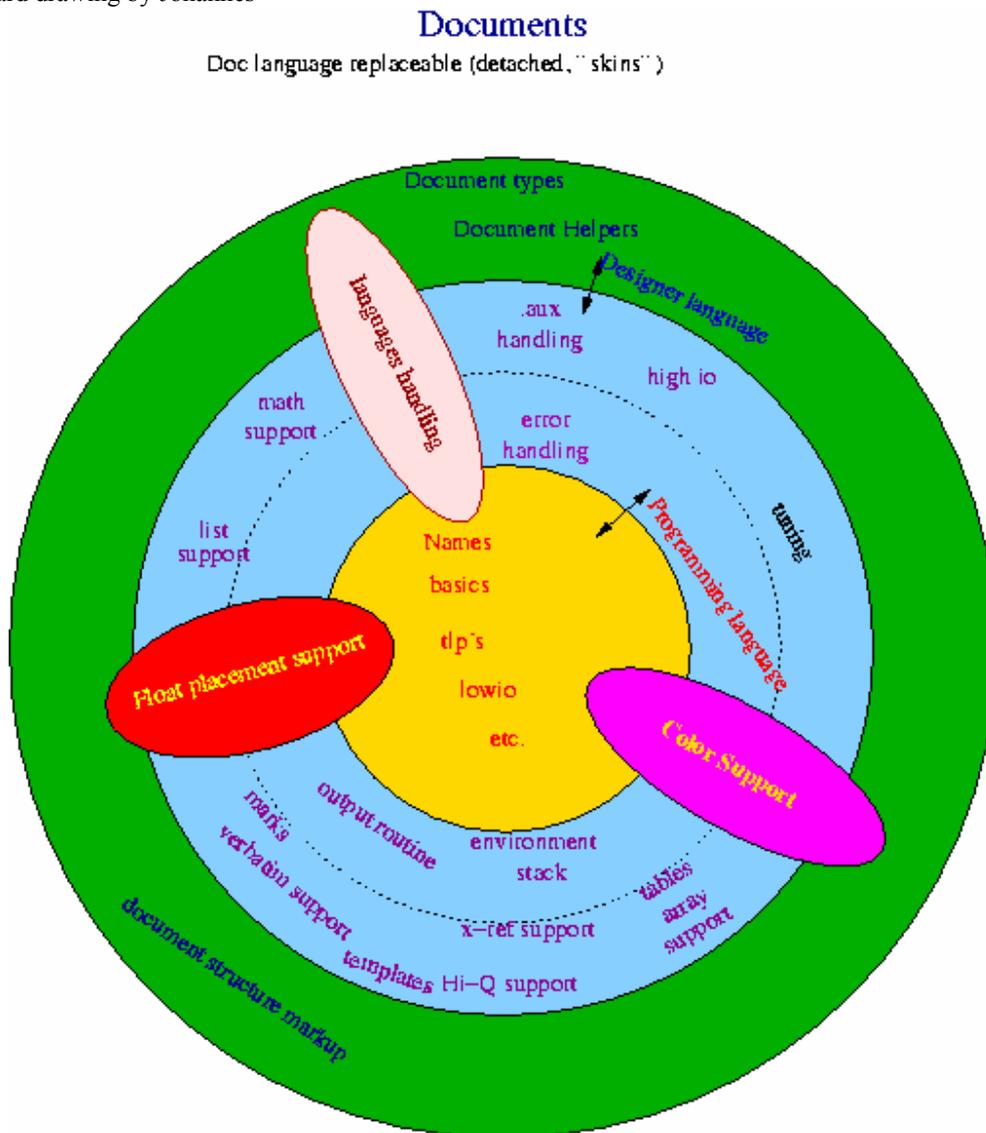
Potential topics for the informal workshops at the conference:

- TeX extensions
- Unicode font technologies
- Language design interface; see [Multilingual.mmap](#) (requires free reader software) or [Multilingual.jpeg](#)

4.2 informal workshops

Theses are notes taken during the workshop sessions:

- [ltx3-2005-03-10.pdf](#)
- [ltx3-2005-03-11.pdf](#)
- whiteboard drawing by Johannes



5 meet people

5.1 what do they do

5.2 what do they want to do

5.3 ask your questions

5.4 voice your ideas

see also: ... at the conference

Typographic Perfection with OpenType?

Adam Twardoch

February 26, 2005

Abstract

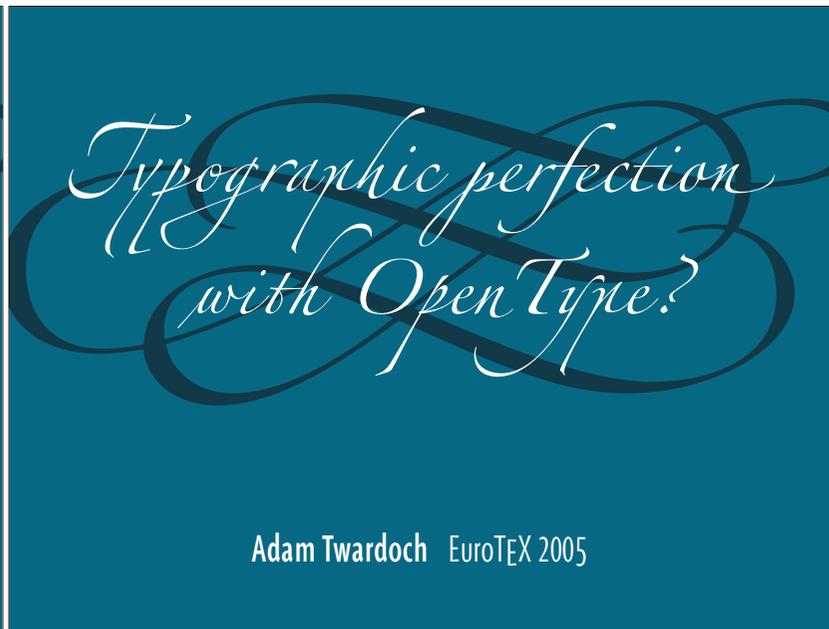
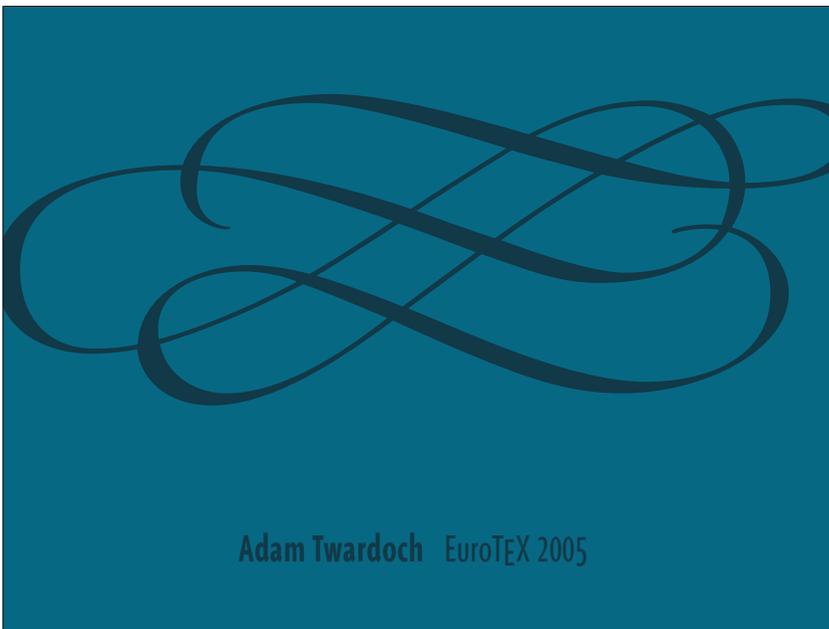
In September 1999, Adobe Systems declared their PostScript Type 1 font format "obsolete". Until then, this font format was dominating the professional pre-press and printing business, but now was to be replaced with OpenType – a font format developed by Microsoft and Adobe, with collaboration from Apple. Four and a half years later, OpenType is a fact: both the world's largest font foundries and individual type designer publish new fonts in this format.

OpenType fonts have numerous advantages: they can be used in many operating systems without any conversions (Windows 9x/2000/XP, MacOS 9/X, some Unix environments); they use the universal character encoding standard Unicode; finally, they can include typographic layout features that allow for comfortable use of ligatures, small caps, swash alternates or old-style numerals, as well as more advanced functionality such as justification alternates.

You may have heard that Unicode is the only solution for the encoding mess in electronic text processing. You may have also heard that OpenType is the new cross-platform font format that enables unprecedented typographic perfection. Adam Twardoch will present these technologies and discuss how much truth and how much myth these promises hold.

Bio:

Born 1975 in Poland, Adam now lives in Frankfurt (Oder), at the German-Polish border. He is Scripting Products and Marketing Manager at Fontlab Ltd., an international software vendor specializing in font editors and typography products. He serves as typographic consultant to MyFonts, a major online font distributor. Adam provides consulting services in font creation, font tool development, font technology and multilingual typography for Adobe, Bitstream, Corel, Linotype, Microsoft and other clients. Adam regularly writes and lectures about fonts and typography. He is member of Association Typographique Internationale (ATypI) and of the Polish T_EX Users' Group (GUST).



3 “No one will ever need more than 128 characters!” – ASCII

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
	!	"	#	\$	%	&	'	()	*	+	,	-	.	/
30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
P	Q	R	S	T	U	V	W	X	Y	Z	[\]	^	_
60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F
p	q	r	s	t	u	v	w	x	y	z	{		}	~	□

4 “No one will ever need more than 128 characters”?

The quick brown fox jumps over
the lazy dog. Zwei Boxkämpfer
jagen Eva quer durch Sylt.

5 "No one will ever need more than ~~28~~ characters!" 256

80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
€		,	f	„	...	†	‡	^	%	Š	<	Œ		Ž	
90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
	'	'	“	”	•	—	~	™	š	>	œ		ž	ÿ	
A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF
	ı	ç	£	¤	¥	ı	§	™	©	ª	«	¬	-	®	¯
B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB	BC	BD	BE	BF
°	±	²	³	´	µ	¶	·	¸	¹	º	»	¼	½	¾	¿
C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
À	Á	Â	Ã	Ä	Å	Æ	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï
D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF
Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
E0	E1	E2	E3	E4	E5	E6	E7	E8	E9	EA	EB	EC	ED	EE	EF
à	á	â	ã	ä	å	æ	ç	è	é	ê	ë	ì	í	î	ï
F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FB	FC	FD	FE	FF
ð	ñ	ò	ó	ô	õ	ö	÷	ø	ù	ú	û	ü	ý	þ	ÿ

7 Typesetting multilingual text has always been a challenge in GUI layout applications and in T_EX

Pięć flakonów wody „Экземпляръ”.
actual text

Pięć flakonów wody „Ÿęçłěďě·đú”.
text encoded as Windows 1250 (Central European)

Рікж flakonyw wody „Экземпляръ”.
text encoded as Windows 1251 (Cyrillic)

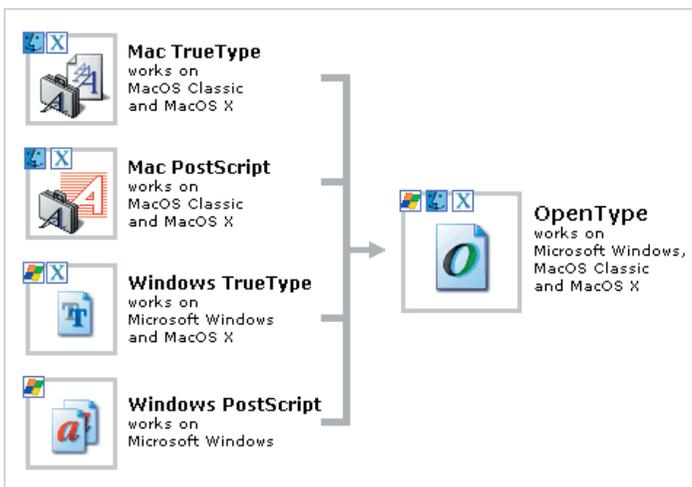
6 Codepage soup: incompatible 8-bit encodings that only cover a subset of the necessary character set

80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
Ä	Å	Ç	É	Ñ	Ö	Ü	á	à	â	ä	ã	å	ç	é	è
90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
ê	ë	í	ì	ï	ñ	ó	ò	ô	õ	ú	ù	û	ü		
A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF
†	°	¢	£	§	•	¶	ß	®	©	™	´	¨	≠	Æ	Ø
B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB	BC	BD	BE	BF
∞	±	≤	≥	¥	µ	∂	Σ	Π	π	∫	ª	º	Ω	æ	ø
C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
¿	ı	¬	√	f	≈	Δ	«	»	...		À	Ã	Ö	Œ	œ
D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF
—	—	“	”	‘	’	÷	◊	ÿ	ÿ	/	¤	<	>	fi	fl
E0	E1	E2	E3	E4	E5	E6	E7	E8	E9	EA	EB	EC	ED	EE	EF
‡	·	,	„	%	À	É	Á	Ê	È	Í	Î	Ì	Ó	Ô	
F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FB	FC	FD	FE	FF
□	Ò	Ú	Û	Ü	ı	ˆ	˜	˘	˙	˚	˛	˜	˜	˜	˜

8 Typesetting multilingual text has always been a challenge in GUI layout applications and in T_EX

§89. Zdanie, w którym występują wszystkie litery alfabetu, nazywamy pangramem. Autorem najstarszego polskiego pangramu „Pójdźże, kiń tę chmurność w głąb flaszki!” jest J. G. H. PAWLIKOWSKI. Autorem filigranowego quasi-pangramu „Książęcych spóźnień czułość” jest WALDEMAR PAŁASZ. Ogłosił on w 1998 roku konkurs na polskie pangramy

17 One format, many platforms: OpenType



18 One character, many glyphs

a → a a A a a a a a

19 In addition to default character forms, OpenType fonts can have variant glyphs associated with so-called layout features

	0 0030	1 0031	2 0032	A 0041	K 004B	a 0061	b 0062	e 0065	s 0073
onum	0	1	2	A	K	a	b	e	s
smcp	o	1	2			A	B	E	S
fina						a		e	
init								e	
salt					K				
hist									f

20 Brioso Pro (Robert Slimbach, Adobe Systems)
Layout features: standard ligatures (liga)

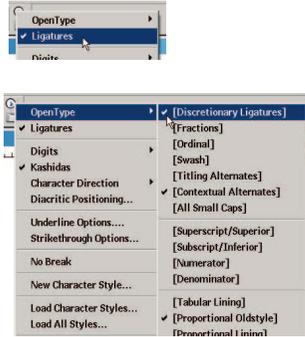
JAN KOTT Jonasz Kofta
 JAN KOTT Jonasz Kofta
 Thorgal fjord szufla firet motto
 Thorgal fjord szufla firet motto



21 Poetica Std (Robert Slimbach, Adobe Systems)
Layout Features: liga, dlig, salt, ornm

Wspaniali
Jonasz Kofta i Jan Koff

Historia
Kabaretu Starszych
Panów



22 In the Arabic writing system, each letter has four different forms: isolated, initial, medial and final

	isol	init	medi	fina
t 062A	ت	تـ	تسـ	تسـت
h 062D	ح	حـ	حسـ	حسـح

23 The OpenType font contains appropriate layout features (init, medi, fina) that map the default form to the contextual forms

لح ق ← لح ق

tekst Unicode: 0x0020, 0x0642, 0x062D, 0x0644, 0x0020 → لام, هاء, قاف

لح ق ← لـ ح ق ← لـ ح ق

procesor Uniscribe → لام (init), هاء (medi), قاف (fina), لام, لام.init, هاء.medi, قاف.fina,

24 Some languages have localized glyph forms in handwriting

Godło Polski.
Godło Polski.

godło
g-o-d-ł-o
ł-ł
g-o-d-ł-o
godło

godło
g-o-d-ł-o
ł-ł
g-o-d-ł-o
godło

łódka łyżwy łóżko łyżki

25 OpenType allows for language-sensitive substitutions so for Polish language, the calligraphic Islash can be substituted

Władystaw Jagiello
international forms

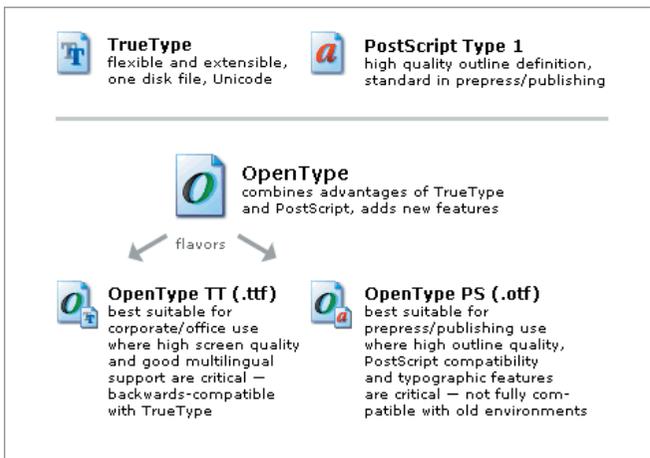
Władystaw Jagiello
localized forms

Władystaw Jagiello
ligatures

26 OpenType allows for language-sensitive substitutions so different glyph variants can be selected depending on language

Típográfica Félix
Póltawski Toruń
Típográfica Félix
Póltawski Toruń

27 OpenType fonts exist in two "flavors": OpenType TT and OpenType PS

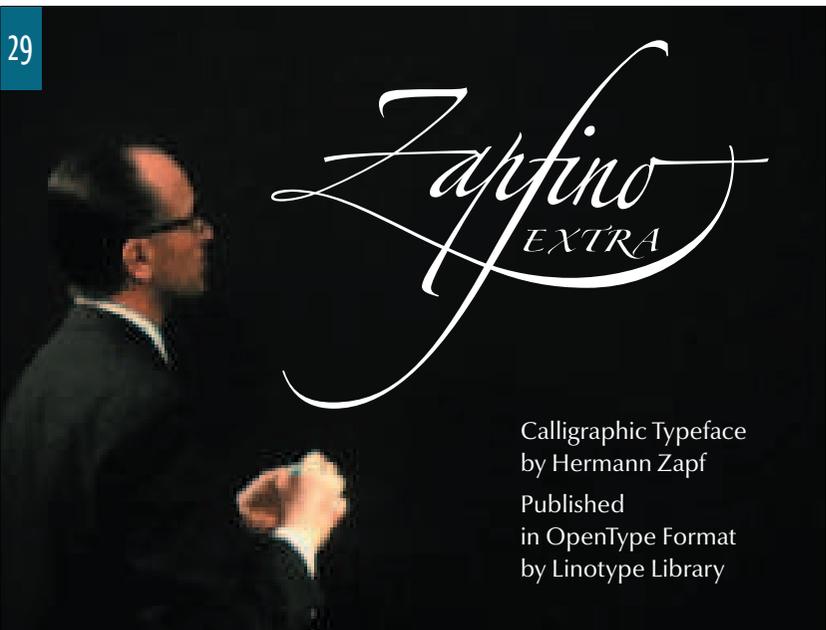


28

	MacOS		Microsoft Windows	
	OpenType TT (.ttf)	OpenType PS (.otf)	OpenType TT (.ttf)	OpenType PS (.otf)
Microsoft Word 2000, 2001, XP	Az		Az LN	Az
Microsoft Word 2003, X	Az		Az LN	Az LN
Adobe InDesign 1.0, 1.5, 2.0	Az LN O	Az LN O	Az LN O	Az LN O
Adobe Photoshop 7.0	Az LN O	Az LN O	Az LN O	Az LN O
Adobe Illustrator 10	Az LN	Az	Az LN	Az
Quark XPress 4, 5	Az	Az	Az	Az
Macromedia Freehand 10, MX	Az	Az	Az	Az
Coral Draw 10, 11	Az LN	Az LN	Az LN	Az LN

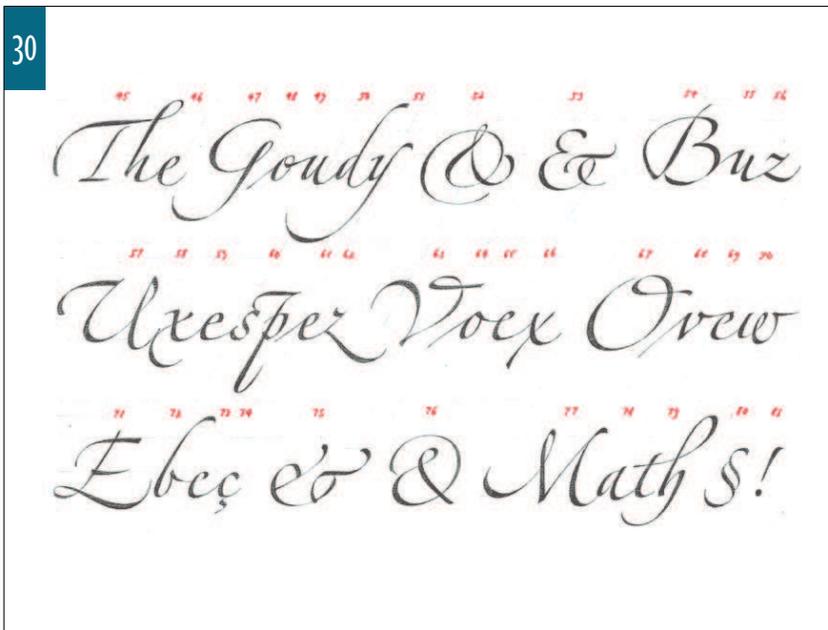
Az basic Roman support LN multilingual support O advanced features support

29



Calligraphic Typeface
by Hermann Zapf
Published
in OpenType Format
by Linotype Library

30



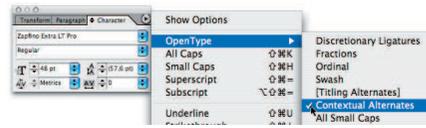
The Goudy & E & Buz
Uxesper Voex Orew
Ebec e' & Math S!

31 Originally published as a series of Type 1 fonts

- ▶ Zapfino One
A B C D E Q Z a b c d e f g x y z
- ▶ Zapfino Two
A B C D E Q Z a b c d e f g x y z
- ▶ Zapfino Three
A B C D E Q Z a b c d e f g x y z
- ▶ Zapfino Four
a B C D E Q Z a b c d e f g x y z

32 Zapfino Extra LT Pro contains an extensive set of contextual features that simulate calligraphic "randomness"

cal ▶ calligr ▶ calligrap ▶
▶ calligraph ▶ calligraphic



Namespaces for $\varepsilon\chi\text{T}_{E}X$

Gerd Neugebauer

February 21, 2005

Namespaces for T_EX are a long awaited extension. In this talk the requirements for such an extension are described. Namespaces primarily restrict the visibility of macros and active characters. Thus the probability of name clashes is reduced. As addition one can imagine to apply namespaces to other entities like registers, catcodes etc as well.

$\varepsilon\chi\text{T}_{E}X$ is an attempt to reimplement T_EX. The major goals behind the reimplementbtation are a modular and configurable structure tailored towards experiments and extensibility.

Fortunately the integration of namespaces can be located at very few places in the $\varepsilon\chi\text{T}_{E}X$ architecture. As a consequence an implementation idea for $\varepsilon\chi\text{T}_{E}X$ can be sketched and the experimental implementation in $\varepsilon\chi\text{T}_{E}X$ is shown.

1 Introduction

With the vast amount of packages emerging on CTAN the need came up to separate the packages. In other programming languages this is accomplished by using namespaces – sometimes also called modules or packages. The classical T_EX system lacks such a mechanism.

In this proposal an analysis is provided which shows where modifications of a T_EX-like system are necessary to implement namespaces. The proposed solution tries to be minimalistic. This means that one goal is to change the underlying system as few as possible. In addition existing T_EX code should continue to work without any change.

2 Encapsulation

The primary requirement for namespaces is that they encapsulate the internals of “modules”. This means that each information about the state is hidden in the outside world. The access is enabled via well-defined interfaces only.

In this document the focus is put onto namespaces for control sequences and active characters.

3 Backward Compatibility and Initialization

The namespace extension should be backward compatible. This means that the behaviour of the system should not depend of the use of a namespace. This can be achieved by using a default namespace in any case where no other namespace is specified.

On the other hand the definitions in the namespace should be properly initiated. Thus we want to ensure that the namespaces can be used without the burden of too much initialization.

4 Definition of Namespaces

The definition of the current namespace is just a string to be kept somewhere. In terms of T_EX it is advisable to store the current namespace as tokens in a special tokens register to allow read and write access to it.

Consider the name `\namespace` for this toks register then the following instruction can be used to advice T_EX to set the appropriate namespace:

Namespaces for $\varepsilon\chi\text{T}_{E}X$
Gerd Neugebauer

```
\namespace{tex.latex.dtk}
```

The default namespace should be denoted by the empty toks register:

```
\namespace{}
```

The wellknown primitives `\the` and `\showthe` can be used to get access to the current value of the namespace:

```
\namespace{tex.latex.dtk}
\the\namespace
```

5 Communication between Namespaces

Namespaces provide a means for separation of different modules. Thus we need a way to communicate between namespaces. For this purpose we want to provide a primitive to declare that a certain set of entities are visible from the outside. All entities not declared to be visible are purely private.

The primary entities to consider are macros and active characters. They are characterized by tokens. Thus we can again use a token list to keep this information.

Consider the name `\export` for the names toks register. Then the following example declares that the macros `\abc` and `\xyz` and the (active) character `~` can potentially be accessed non-locally:

```
\export{\abc \xyz ~}
```

The other side of communication is the import of the exported entities into another namespace. In analogy to the name `export` we want to call this functionality `import`. For the import it is sufficient to name the namespace to be imported:

```
\import{tex.latex.dtk}
```

The semantics is that all entities exported by the namespace – i.e. contained in the toks register `\export` – are assigned to in the current namespace as well. This is similar to a multitude of `let` invocations.

As a consequence of this definition the meaning of a macro can be changed in the defining namespace without affecting the meaning in the importing namespace.

6 Namespaces and Groups

Since the main task of the declarations is performed by special tokens registers it is clear that the namespaces are coherent with the groups structure already present in T_EX.

In the following example the macro `a` is defined in the namespace `tex`. Since the group ends afterwards the namespace returns to its previous value. Thus the definition of `\y` is performed in the outer namespace.

```
\begingroup
  \namespace{tex}
  \gdef\x{123}
\endgroup
\def\y{123}
```

One question which arises is, how the macro `\import` interacts with the grouping. The answer to this question is that the import should influence the current group only. Similar to the definition of `\let` the prefix command `\global` can be used to indicate that the imports should be applied globally instead of locally in the current group:

```
\global\import{tex.latex.dtk}
```

The macro `\import` has to take into account the `\global` prefix.

Another inference of namespaces and groups can be seen in the following example:

```

\begingroup
  \namespace{one}
  \global\export{\x}
  \gdef\x#1{-#1-}
\endgroup

```

Note that the `\export` declaration is preceded by a `\global` modifier. Consider the case that this modifier would not be there. Then the end of the group would revert the meaning of `\export` the previous binding. In general this would destroy the intended meaning. The `\global` modifier ensures that the intended meaning of `\export` survives the end of the group and can be used in subsequent imports.

7 Namespaces and Expansion

Let us consider the following example where a macro with an argument is exported:

```

\namespace{one}
\begingroup
  \namespace{two}
  \global\export{\x}
  \gdef\x#1{-#1 \y-}
  \gdef\y{in one}
\endgroup
\import{one}
\def\y{two}
\x\y

```

The intuitive meaning of the last expression `\x\y` is that `\y` is taken from the namespace `two` and `\y` is taken from the outer namespace `one`. Now we follow the expansion of `\y`. It leads to

`-\y_\y-`

where the first `\y` comes from the argument. As such it is rooted in the outer namespace `one`. Whereas the second `\y` is defined in the namespace `two`.

As we can conclude that the namespace has to be attached to the token. Then the two tokens can be expanded in their original namespaces. To illustrate this we use the namespace as subscript to the macro name. With this convention we have the following tokens in the situation above:

`-\yone_\ytwo-`

With this refined understanding we can come to the conclusion that the expansion will indeed lead to the expected result:

`-two in one-`

8 Explicit Expansion without Import

In several programming languages there is the possibility to invoke a method in another namespace. With the means we have depicted so far we can achieve the same effect:

```

\begingroup\namespace{tex}\expandafter\abc\endgroup

```

This construct can even be used to expand a macro which is not exported. Since it is in general not a good idea to use this feature no provision is made to provide a shortcut for such an expansion.

In this document a minimalistic approach has been proposed. To provide some syntactic sugar would require some more adaptations to the basic machinery. Since all basic requirements can be fulfilled within the minimalistic approach it has not been considered worthwhile to explore these adaptations any further.

9 Namespaces and the Basic Definitions

Usually nobody actually starts with `iniTEX` since nearly no definitions and settings are defined in it. At least something like the `plain` definitions are used. With the means given in the previous sections each new namespace would start out like a new `iniTEX` instance.

To solve this problem, we define a fallback strategy for the resolution of control sequences and active characters. If a definition is not found in the current namespace then the definition is taken from the default namespace.

The default namespace is denoted by the empty token list. Initially the namespace is set to the default namespace.

With this definition it is possible to load the some macros into the default namespace – e.g. the `plain` definitions. Then they are available in any namespace unless redefined in it.

10 Implementation in ϵ_{χ} T_EX

ϵ_{χ} T_EX (<http://www.extex.org>) is a project to provide an implementation of a typesetting system based on the ideas of T_EX. It is designed to be highly configurable and should provide a base for extensions and experimentation. As a starting point a T_EX compatibility mode is provided.

According to the considerations in the previous sections we need the following additions to ϵ_{χ} T_EX:

- The definition of tokens and their factory have to be extended to carry the namespace.
- The group has to be extended to provide means to store the current namespace.
- The binding mechanisms for control sequences and active characters needs to be extended to take into account the fallback to the default namespace.
- The primitive `\namespace` has to be provided which allows the reading and writing access to the namespace stored in the group.
- The primitive `\export` has to be provided to allow access to a special tokens register in the current namespace.
- The primitive `\import` has to be provided which is similar to the implementation of `\let`. New bindings for the exported control sequences or active characters have to be introduced to reference the definitions in the defining namespace.

11 Namespaces for Registers

In the current extension of ϵ_{χ} T_EX the registers are not affected by the namespaces. Nevertheless it might be desirable to extend namespaces to registers.

For instance count registers can be made aware of namespaces. Then each namespace can have its own incarnations of count registers. The extensions into this direction is straight forward. Experiments into this directions have been performed within ϵ_{χ} T_EX. Nevertheless they where not really convincing. The plain format makes use of several count registers. The adaption of the visibility of count registers would require adaptations on the macro level as well.

The restrictions to a limited number of count registers has already been relaxed in ϵ T_EX and in ϵ_{χ} T_EX even further. Thus with the use of the allocation macros it is no problem to have separate registers in separate modules – even when namespaces are used.

12 Conclusion

In the previous sections we have seen how a basic namespace support has be integrated into ϵ_{χ} T_EX. The changes required for this extension are restricted to very few modifications in the core components. These modifications provide a base upon which the externally visible extensions can act. The extensions are purely optional – to be enabled in a configuration file or even loaded dynamically within ϵ_{χ} T_EX. Without the definitions of the three new primitives the behaviour of ϵ_{χ} T_EX has not been changed.

The base mechanism for the use of namespaces is provided. Now it is up to the macro level to make use of it.

contextgarden.net

Patrick Gundlach

February 25, 2005

Abstract

The goal of the *contextgarden.net* project is to enhance the documentation of ConT_EXt. It consists of several web services that together provide the technical framework behind the documentation. A large (and growing) percentage of the supplied content is actually provided by the visitors of the interconnected web sites.

1 Introduction

Many users have tried the L^AT_EX-alternative ConT_EXt. But more than a few have given up almost right at the start, simply because they didn't know how to proceed any further. Unnecessarily so, since there is an active user group that is very helpful. And there is a vast amount of information and documentation on ConT_EXt readily available. One just has to find it.

2 What is available?

The official documentation for ConT_EXt is available on the web server of PRAGMA ADE¹. There, you will find many PDF-files that can answer your questions as well as show you some interesting possibilities of typesetting with ConT_EXt. There are two distinct ways to access the documentation on the web site.

The first possibility is to use PDF-based navigation. Just select *showcase* on the web site of PRAGMA ADE, and you will get a hierarchical overview of all available PDF-documents. The navigation itself shows some aspects of the vast possibilities of ConT_EXt. This makes it plain to see that it will be worth having a closer look at the program, even before you have read the first document!

The second possibility is to select *overview* on the web page. This will present you with a rather simple listing of the available files based on their category. You can see all available manuals and some supplementary documentation at a glance.

The novice user should definitely have a look at the beginner's manual *ConT_EXt, an excursion* and, after that, *ConT_EXt, the manual*.

Besides these two important documents, there are different sets of manuals:

manuals This is the most important set of documentation files. Besides the beginner's manual and the main manual, there are manuals dealing with XML processing, grid-based typesetting, stepcharts, MetaFun and MathML, and more.

magazines This relatively new set describes smaller aspects of ConT_EXt and typesetting. A specific volume, for example, is about formatting digits, and another volume is about hiding parts of section titles inside running heads.

qracs quick references. Each one of these documents contains a list of all available user level commands within a language interface. For every command, its general syntax is described along with the list of allowed parameters and keywords, but nothing else.

sources sample documents with source code. Currently this set consists mainly of the presentation styles that are shipped with ConT_EXt. The source of these styles is also well documented using T_EX comments.

technotes At the moment there is only one article about graphic inclusion and positioning in PDF available.

¹<http://www.pragma-ade.com>

uptodate like the special documents in the section *manuals*, the *uptodate* documents are about specific issues in ConT_EXt. There are manuals about flowcharts, tables, typesetting Chinese and JavaScript. Nowadays most of the *uptodate* documents are renamed and put into the *manuals* section.

3 What is missing?

Considering the great number of manuals, it may sound strange that there could be something missing. But those who look at *the manual* will probably notice that it lacks a chapter about typesetting tables. There is a section about a simple table variant (*tabulate*), but it is not explained in any detail. Another variant (*table*) appears often in the examples, but a more helpful explanation is missing. And it lacks an overview of the many different options that can be used when trying to typeset a table.

Another thing you will not find in the printed manuals are practical hints. Things like installation issues, design discussion, tricky problems that are due to misunderstanding or misconfiguration, et cetera.

Yet another problem is that the descriptions in the manuals are partly outdated. The *uptodate* (or the descendants) are, despite their name, already several years old. And because the development of ConT_EXt is quite fast, the descriptions of the commands are often incomplete and in some areas, even the underlying concepts have changed. You can only keep track of these things by keeping an eye on the mailing list and watching the changes in the ConT_EXt distribution.

Moreover, because there are so many documents, you can actually lose the grand picture. Where are the rules for grid typesetting? What line separators am I allowed to use in *tabulate*? The answers are spread throughout the documents. A global index would be helpful.

A specific request that frequently arises on the ConT_EXt mailing list is the lack of sample documents with source code. On the web pages of PRAGMA ADE you can download a few: the magazines (ThisWay); the pdfT_EX manual; and the commented sample presentation styles. But for many users this is not sufficient.

Yet another issue that some users are unhappy about has nothing to do with documentation. ConT_EXt is not perfectly supported by the T_EX-distributions, although the situation has greatly improved over the last years. “Just” trying out ConT_EXt sometimes fails because the local distribution lacks some files or because it contains a way too old version of ConT_EXt. At present there is a change in the T_EX directory structure in *web2c* and accordingly a change of the directory layout of ConT_EXt. This brings a whole new set of compatibility problems.

4 In the garden

With the project *contextgarden.net*, I provide some applications and web services that jointly try to address the problems mentioned above. Right now, the following services are available: the wiki, texshow-web, live ConT_EXt, source browser and archive. The services are all linked from the main page.² *contextgarden.net* is kindly sponsored by DANTE e.V., the German T_EX user group.

4.1 Wiki

A wiki is a service, where the visitors of the web page create content. Every visitor can add, change and delete the web pages. The following definition is taken from the wikipedia, a free encyclopedia that is based on the same principle:³

A Wiki or wiki (pronounced “wicky” or “weekee”) is a web site (or other hypertext document collection) that allows a user to add content, as on an Internet forum, but also allows that content to be edited by any other user [...] Wiki wiki comes from the Hawaiian term for “quick” or “super-fast”.

On every wiki page there is a button labeled “edit”, that lets you modify the page content. The wiki syntax is simple, plain ascii text with some extensions for mark-up, such as = for heading and *, # for items in an unordered and ordered list respectively. The following example should be easy to understand for all L^AT_EX and ConT_EXt users.

²<http://contextgarden.net>

³<http://en.wikipedia.org/wiki/Wiki>

```

1 == This is the main title ==
2 Every page should begin with an introductory
3 paragraph.
4
5 * first item in an unordered list
6 * and the second
7
8 <code>
9 an environment like verbatim or \starttyping ...
10 \stotyping
11 </code>

```

A table of contents is inserted automatically if there are enough headings on a page.

The main application on *contextgarden* is a wiki especially for ConT_EXt. Its content is mainly filled by only a few, but quite active, users of the site. There are about 100 pages on the different topics that cannot be (easily) found in the manuals. One of the most obvious differences between the wiki and the manuals is that in the wiki, you *can* find practical texts like installation experiences and overviews such as a list of text editors with ConT_EXt support. Every user can upload T_EX and PDF files to the site, and therefore the wiki is a good platform for the publication of sample documents.

One of the important features in a wiki is that you can get a list of recent changes. This leads to a pragmatic way of editing content: one user creates a page on a specific subject, that is not perfectly worded nor 100% complete yet. Afterwards, other users complete this page by supplying their own knowledge on the subject. As a result, the quality of the page increases over time.

Even news items are put into the wiki. For example, the users can see the list of included changes whenever a new ConT_EXt distribution is released. The wiki was started around July 2004. In the long term it should be a full complement to the official manuals.

The wiki on *contextgarden* has several features that makes it well suited for ConT_EXt documentation. One extension is the direct rendering of ConT_EXt input. Taking the following input:

```

1 <context>
2 \defineoverlay
3   [tea]
4   [{\green \ss \bf GREEN TEA }]
5 \framed [height=40pt,
6         background=tea,
7         align=middle]%
8   {\em today \blank for sale}
9 </context>

```

you get



The wiki internally passes the text to ConT_EXt to be typeset. This creates a PDF file from the input, and then the wiki calls on ghostscript to convert this PDF file to a PNG image. The end result is that you can view the typeset example directly from within your web browser.

Also included is a pretty printer for T_EX and XML source. This formats and colors source code for readability. Perhaps you are familiar with this behaviour from your text editor. The final extension to the wiki is the ability to create hyperlinks to *texshow-web* (see below). With

```

1 <cmd>adaptlayout</cmd>

```

a link will be created. When that link is clicked, the page that contains the definition of the command *adaptlayout* within *texshow-web* will be opened.

4.2 texshow-web

texshow-web is an alternative implementation of the perl/Tk program *texshow* that comes with every ConT_EXt distribution.

What follows is a quick summary for those of you who are unfamiliar with *texshow*: This program gives an overview of all user commands. The full set of the parameters and arguments belonging to a specific command can be shown in a syntactical overview, like this one:

```

1 \adaptlayout[...,...][...,...=.,...,...]
2
3     [...,...,...]    number
4     height          dimension max
5     lines           number

```

The output is colored, so that you can easily see what parameters you can use in each argument. In this example the first parameter accepts a list of numbers whereas the second parameter takes a list of assignments. Allowed keywords for the assignment are *height* and *lines*, and the allowed values for height are a *dimension* or the word *max* and for lines a *number* (within T_EX's limits of course).

The new web-based variant, *texshow-web* makes it possible to add a comment, a description and any number of examples to the a specific command. Of course *texshow-web* also offers a full-text search, so that you can find the command you need with more ease. As with the wiki, all users have the possibility to complete missing information or to correct pages when needed.

ConT_EXt users often struggle because one not only has to know all of the possible parameters for a command by name, but one also has to understand their effects on typesetting. In the manuals the parameters are only partly described. For example, there is no explanation of the parameter *beforehead* in an *itemize* environment. That is why *texshow-web* has a field *description* where this kind of information can be stored. Currently, there are only a few entries with that additional content, but progress is slowly being made.

The original *texshow* program from the distribution has recently been adapted to show all the comments, descriptions and examples from *texshow-web* as well, but does not allow editing.

Features currently in development are: a way of categorizing commands into logical units (graphic inclusion, section and headers, typographic commands), a multi-lingual user interface, and documentation for ConT_EXt's programming interface (API). The API documentation will cooperate with the *source browser* (see below) that shows the definition of the commands within ConT_EXt's source code.

Until now, *texshow-web* has only been used for ConT_EXt documentation. But it should be possible to use it for L^AT_EX documentation without big difficulties.

4.3 Archive

There were already several searchable archives for the ConT_EXt mailing list: the NTG has one and the news-mail portal Gmane has one as well. Slavek Zak used to host one, too. There are some other, less popular, archives as well. But none of the those is complete as well as easily searchable. Therefore I have installed yet another mailing list archive at *contextgarden.net*. This one is almost complete, very quick and searchable. The two new lists are also archived on this server: the ConT_EXt developer list and the *foxet* (a ConT_EXt based XML-FO processor) list.

4.4 Live

Live ConT_EXt is an on-line ConT_EXt typesetting service. You type your document into a web-form and after you submit the form to the server, your source gets processed by *texexec* and typeset. The resulting pdf document as well *texexec*'s screen output can be viewed online or saved to your harddisk. This makes it possible to use ConT_EXt without actually installing it. The underlying T_EX system uses the latest teT_EX beta and ConT_EXt distribution. *Live ConT_EXt* is also used as a sort of reference installation. Errors that do occur on a local system but cannot be reproduced on *Live ConT_EXt* are most likely a local problem only.

4.5 Source

With the *source browser* you can view ConT_EXt's source code. Using a simple navigation system you have access to the almost 600 files from the current distribution. This is especially interesting to the programmers that

need to see the definition of the commands. The included full-text search helps finding commands. You can access the definition of the commands via hyperlinks: <http://source.contextgarden.net/tex/context/base/core-pos.tex#setpositions> and <http://source.contextgarden.net/core-pos.tex#setpositions> points to the definition of *setpositions*, without having to know the line number in advance.

5 Future work

The services mentioned here are provided by *contextgarden.net*. The most important one is certainly the *wiki*. Until now it was not necessary to structure the information in the wiki. If it continues to grow as it did in the past, a more formal structure will be necessary. *texshow-web* should become the preferred reference for the ConT_EXt commands. The resources provided by *texshow-web* will be used by the existing tools (*texshow*) and documentation in future releases. Because the number of descriptions, comments and examples is still low, the ConT_EXt community is asked to fill in the missing information.

Currently a search engine is in development that allows the user to search *texshow-web*, the *wiki*, the manuals and the mailing list archive all from one place. This should provide an even more powerful tool in your quest to find the necessary information.

“With a little help from the wizards”

Panel discussion with Hermann Zapf and Donald Knuth

Taco Hoekwater

The highlight of this Tuesday and possibly of the complete conference was the panel discussion with Hermann Zapf and Donald Knuth. The discussion was presented by Hans Hagen and Volker Schaa, but almost all of the actual talking was done by Zapf and Knuth.



Knuth started off by explaining the problems faced in digitizing curves. Basically he demonstrated the material covered in the ‘Discreteness and discretion’ chapter of the *Metafont* book, but it is nice to hear Knuth actually teaching this subject.

The first large subject was Hermann Zapf’s *OptimaNova*. Fifty years after the first version of the *Optima* font, Linotype inc. has enabled Zapf to design a new version of the font without the limitation that were imposed by the production processes half a century ago. The new version of the font has

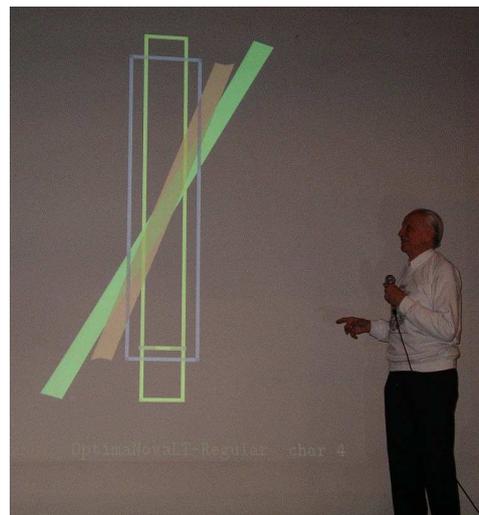
been released as an OpenType font. Apart from some shape corrections, it contains a number of extra glyphs that people have come to expect from modern fonts.

We had a good time listening to recollections of the woes of type design in the early fifties, and how it came to be that it took a whole eight years before the first version of *Optima* was released. It turns out that the original digital version of *Optima* was created without any supervision by Zapf himself!

In order to visualize the differences between the old and the new version, Hans had made a presentation with on each page, the same glyph from both the old and new version of the font. Both glyphs overlapped each other and were partially transparent, so that the differences between both versions became clear in a single glance. Using a number of these slides, Zapf spent a good time explaining in detail explain why ‘the old version is worse than the new version’.

At the moment, Hermann Zapf is busy working on a similar cleanup project for his *Palatino* font family. When the final *PalatinoNova* family will be released, the list of extra glyphs will be quite a bit longer than for *OptimaNova*.

The other large subject was the *Latin Modern* font family. Using a similar series of slides with overlapping glyphs as visual aids, Donald Knuth (and Zapf) were invited to give comments on the new glyphs as designed by Bogusław Jackowski and his team. Knuth explained that a number



of the strange properties of Computer Modern are side-effect of his attempt to make his version as faithful as possible imitation of the original Monotype font.



Knuth then told us a nice tale explaining how the first version of Computer Modern was made by manually tracing projected 35mm slides of typeset text and then digitising the resulting drawing. Not until much later did he have access to the original lead characters of the font. Of all the glyphs in Computer Modern, he is least happy with the shape of the dollar-sign.

The panel ended off with Bogusław showing a number of the new glyphs in Latin Modern for perusal by Knuth and Zapf. In total the session lasted two full hours, with not a single boring minute in it.



Hermann signing his 'onstage' drawings



Panel discussion with Hermann Zapf and Donald Knuth: 'With a little help from the wizards'
Hermann Zapf, Donald Knuth

ProT_EXt, a new T_EX-Collection for Beginners

Thomas Feuerstack, Klaus Höppner

Februar 27, 2005

Abstract

One of T_EX's largest strengths is embedded in the high modularity of the program. Beside the processor itself, every T_EXnican might use the Editor, Post-Processor-Program, etc. he prefers most. For beginners or only interested person this advantage can lead to difficulties, especially in times, where users have gotten accustomed at "complete environments".

ProT_EXt shows a way, how even Beginners can easily setup a complete running system and therefore it eliminates one of the main obstacles in using T_EX.

proTeXt — yet another TeX-Collection?

Th. Feuerstack/
K. Höppner

March 9, 2005

proTeXt — yet
another
TeX-Collection?

Th. Feuerstack/
K. Höppner

Prelude on the
stage

The general Setup
of the kit

Things to discuss

Prelude on stage

The year 2005 – the whole world seems is occupied by M\$-Wordians.

- ? Really the whole world?
- ▶ According to our experience there are still some TeX interested individuals
- ! And lately they become even more...

proTeXt — yet
another
TeX-Collection?

Th. Feuerstack/
K. Höppner

Prelude on the
stage

The general Setup
of the kit

Things to discuss

Prelude on stage

Compared to the mainstream users named above, the coming TeX-user suffers from a handicap which usually is an advantage, i.e.:

- ✓ A complete TeX-environment is highly adjustable to the user's needs. Everybody can choose the editor, TeX-engine, postprocessing tools, ... she/he likes best.
- ✗ Unfortunately most "rookies" are no more accustomed to such conditions, because "modern software" claims an "All-in-One"-Status.

proTeXt — yet
another
TeX-Collection?

Th. Feuerstack/
K. Höppner

Prelude on the
stage

The general Setup
of the kit

Things to discuss

The "Furthermore you also need" situation

Lets imagine someone asks you, how to find an entrance in TeX. So you'll point him to

- ▶ an easy to install TeX-implementation...
- ▶ ... an easy to use editor to compose his texts...
- _____
- ▶ ... additional information and How-To's to learn the way TeX works...
- ▶ ...
- ! As to us, most "someones" give up between the items 2 and 3 and fade...

proTeXt — yet
another
TeX-Collection?

Th. Feuerstack/
K. Höppner

Prelude on the
stage

The general Setup
of the kit

Things to discuss

A picture of this situation

If the goal is something like this...



... we'll have to provide a starting-kit to let our "someone" enter the game.



proTEXt — yet another TeX-Collection?

Th. Feuerstack/
K. Höppner

Prelude on the stage

The general Setup of the kit

Things to discuss

What is actually needed?

Depending on our experiences (and therefore included in proTEXt):

- ▶ An easy to install TeX-implementation for *Windows*
- ➔ MiKTeX
- ▶ A simple to use editor with hooks to TeX
- ➔ WinEdt, TeXnicCenter
- ▶ Postprocessing tools like Ghostscript and GSView

- ▶ A short description how to combine these things!

proTEXt — yet another TeX-Collection?

Th. Feuerstack/
K. Höppner

Prelude on the stage

The general Setup of the kit

Things to discuss

Practical Demonstration



proTEXt — yet another TeX-Collection?

Th. Feuerstack/
K. Höppner

Prelude on the stage

The general Setup of the kit

Things to discuss

What could/should be changed in future releases?

- ▶ Which editor ist the easiest/the best?
- ▶ Is there a *free* graphical frontend for Ghostscript?
- ▶ Are there any volunteers to translate the Install-Doc into additional languages?
(Many thanks to Steve Peter, Grzegorz Domański and Denis Bitouzé!)

proTEXt — yet another TeX-Collection?

Th. Feuerstack/
K. Höppner

Prelude on the stage

The general Setup of the kit

Things to discuss

“La machine à formulaires”
 (the forms’ machine),
 or T_EX for a Kafkaian world

Antoine Lejay

November 29, 2004

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Abstract

This article describes the *Machine à formulaires*, whose goal is to fill in different forms from a single file. Its aim is to help candidates to positions of (assistant) professors in a French University not to lose time in copying various informations regarding each position they apply.

1 Introduction

This article contains a short description of a set of T_EX files designed to help candidates to professors’ or assistant professors’ positions in French Universities to fill in heavy forms. In some sense, it is similar to the AMS cover initiative [1], but with a different philosophy and design, and where informations specific to each position are reported in each form.

The *Machine à formulaires* (the forms’ machine, or MAF in short) has been made available since 2001 on the WEB sites of the *Opération Postes* [5] and the *Guilde des Doctorants* [2]¹ whose goal is to help Ph.D. holders looking for a job. It seems to have been appreciated by numerous candidates, since it allows them to gain a lot of time in the constitution of their application forms. The MAF does not need any real knowledge in T_EX/L^AT_EX (only common sense) and shows the ability of T_EX to deal with tasks such as automatic creation of forms without using exterior softwares.

Basically, all the informations are entered in a single file with a rather natural syntax (provided by the `keyval` package) and any repetition is avoided. Various forms may be produced simply by changing the class file which is loaded. Of course, data and presentation commands are completely separated.

2 The difficulty of applying to a French university...

The procedure for applying to a French university as *maître de conférences* (assistant professor) or professor relies on a national-wide, official and strict process. Almost all the French universities are public and then (assistant) professors are state-employees. In autumn and winter, there are discussions between each university and the French Department of Education to obtain the creation of new positions, or the replacement of people leaving or retiring. Then all the available positions, whatever the university and the domain, are published around February of each year in the *Journal Officiel de la République Française* (also called the “JO”), which is a daily publication for the new legal or official texts (laws, decrees, ...) of the French government. In the JO, a range of dates are given for: applying for a position (for the candidate), choosing the candidates the university

¹A package with the same goal have been already available on that site and the MAF represents an attempt to have a more flexible way to do the job.

wishes to hire and sending their name to the French Department of Education. The JO also specifies what the applicants send to the universities.

Basicall, to each position is assigned: (a) an identification number; (b) a university; (c) one or many research domains. Generally, the lab proposing this position may be deduced from this information, but this is not always true. The research domains are classified, each one corresponding to a subgroup of the *Conseil National des Universités* (CNU). Each of these subgroups is labelled by a number (for example, 25 for Pure Mathematics, 26 for Applied Mathematics, 27 for Computer Sciences, ...). Every French Ph.D. thesis is also classified according to these domains (but a Ph.D. holder is not restricted to apply to positions only in his domain); (d) possibly some precisions about the (research or teaching) skills that are required (The position may be for a team within a lab, but it may also happen that all the teams of a lab have to choose together who to hire); (e) possibly other legal informations that would be too long to explain here. Yet it concerns only a few positions each year.

For example, one could read in the JO containing some lists of positions looking like

POSTES DE MAÎTRES DE CONFÉRENCES

...

26^e section : mathématiques appliquées et applications des mathématiques

Université Grenoble-I : et 27^e section, bio-informatique : 1445.

Université de Pau : 0706.

...

The first position — identified by the number 1445 — is available at one of the two universities of the city of Grenoble. It is primarily for people working in bio-informatic, either with a Ph.D. in Computer Science or Applied Mathematics. The applicant have to contact the University Grenoble I if she/he want to known which lab or team is concerned by this position. The second position, at University of Pau, is for an applied mathematician whatever his/her speciality. Of course, the priority will generally be given to the candidates that may interact with the people there.

Once having read the JO, the candidate willing to apply for some position shall send to the university offering it two copies of: (a) a normalized form (nicknamed² *Annexe B* by the candidates, since its presentation appears each year in the JO in the Section *Appendix B*) in which he states he applies to this position, with personal informations and all the informations given above (identification number, ...); (b) a curriculum vitæ whose first page (nicknamed *Annexe C*, since its appears each year in the Section *Appendix C*) also follows a normalized presentation with again these informations. These two forms may be found in Figure 1

Since a candidate generally send 10, 20 or more application forms that are all different, filling them within a few weeks takes a lot of time, increases the natural stress of the candidate (it is not easy to get a job) and looks like an administrative nightmare.

3 Goals and design

Of course, in days where everybody has access to a computer, the candidate may wish to produce automatically these forms. A truly helpful code shall in my opinion follow the following specifications: (a) the syntax shall be simple and rather natural; (b) data and presentation shall be separated; (c) replication of information shall be limited to reduce the risk of errors; (d) it must be system independent to be available to the maximum amount of people; (e) extensions must be easy to write in order to produce envelops labels, cover letters,...

Although many word-processors allow to do such a thing, T_EX is probably the best candidate to satisfy point (d) while it does not take too much time to write some code satisfying the other requirements.

The design of the MAF is the following: (a) The candidate enters in a single file (**form.tex**) both personal informations (name, address, ...) and the list of positions she/he plans to apply. We use the functionalities of the D. Carlisle's **keyval** package [3] in order to have a simple and clear syntax. (b) The class used in **form.tex** specifies the form to be produced: a single compilation of **form.tex** with the class **annexeC.cls** produces all the first pages of the curriculum vitæ for all the positions. (c) All the class files call the style file **formul.sty** whose goal is to parse **form.tex**, while the class file is devoted to the presentation of the form. Thus, it is rather easy to write or change a class file, while **formul.sty** contains more complex code (not to speak of **keyval.sty**). (d) The complete names and addresses of the universities are available in the separate file **listuniv.tex**, so that the candidate does not lose time in entering these informations.

As such, there are three layers: the front-end user, even if a complete beginner, has only to enter the informations in **form.tex**. If she/he is not satisfied by the output (which tries to be faithful to the given

²It is interesting to note how an administration tends to create its own jargon...

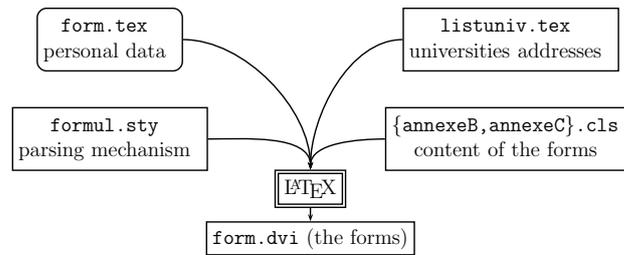


Figure 2: The design of the MAF.

models, but which is not aesthetic), an average L^AT_EX user may rather easily change the class files or create new ones simply by playing with boxes, spaces and springs, since the parsing and sometimes tricky job is done in `formul.sty`³.

4 The structure of the files

The end-user has only to change or complete the file `form.tex` that begins with

```

\documentclass{annexeB}
%\documentclass{annexeC}
\input{listeuniv}
\begin{document}

```

Here, the user chooses which form to produce by commenting and uncommenting the first lines. Then, she/he enters some personal informations (name, address, ...), using key-values syntax.

```

\candidat{
  MMmeMlle={M},
  nom={Doe},
  prenom={John},
  ...}

```

In order to avoid repetitions (and mistakes), some default informations can be entered with the command `\postedefault`. For example, a Ph.D. holder in pure mathematics generally applies to positions in the research domain labelled by the number 25. Thus, there is no need to repeat this information, which is then entered as a value for the key `sect`. The key `mdcouprouf` accepts `mdc` (for positions of assistant professor) or `prof` (for positions of professor).

```

\postedefault{
  mdcouprouf={mdc},
  sect={25},
  type={recrutement},
  dateJO={27 f\evrier 2004},
  articleJO={26I-1}
}

```

Here, the other informations specify in some sense the statut the applicant: for example, the recruitment procedure is also valid for people already having a job as (assistant) professor but willing to go elsewhere. It may also happen that some positions, although rare, are opened only to a restricted category of people.

The file ends by a list of commands `\postes`, one for each position, with two mandatory arguments (the number of the position and the “tag-name” of the university. This “tag-name” is defined in the file `listuniv.tex` but it is easily deduced from the real name of the university). Some optional arguments, again with the key-value syntax, may be used to give more precision about the position or to override the arguments used by default.

³This style file also provides also some macros for formatting lists and other typesetting issues.

```
\poste[
  sect={26},
  profil={statistiques}
]{1012}{aix-marseille1}
```

The file `listuniv.tex` contains the list of all the Universities with their addresses, under the form (this list, with 91 entries, was established from the informations given in the WEB site of the french Department of Education [4]):

```
\defuniv{aix-marseille1}{
  nom={Universit\'e de Provence~: Aix-Marseille I},
  academie={\dapostrophe Aix-Marseille},
  adresse={3, place Victor Hugo\
  13331 MARSEILLE CEDEX 3 }
}
```

The command `\dapostrophe` may be used to write “d’Aix-Marseille” (literally “from Aix-Marseille”) or “Aix-Marseille” in function of the context. Thus, in the last call of the command `\poste` above, the tag-name `aix-marseille1` means that the full name, address, ... of the corresponding entry in `listuniv.tex` will be used. These data are stored in T_EX’s memory using a `\csname/\endcsname`’s scheme.

When compiling the file `form.tex` with L^AT_EX, the appropriate class file will be called. Every class file shall have the following structure:

```
\LoadClass[11pt]{article}
\RequirePackage{formul}
\newcommand{\codeposte}{
  ...
}
```

The package `formul.sty` contains the parser. The informations on the candidate are transformed into some commands. For example, the name of the candidates is defined as the expansion of the command `\nom`, ... The command `\codeposte` is called each time the command `\poste` is encountered in the file `form.tex`. Its effect is to typeset and fill the form with the specific informations on the position. The file `formul.sty` also contains some commands regarding typesetting (lists manipulations, ...), so that new class files can be easily created.

5 Conclusion

The first version was released in 2001 and it seems that many candidates enjoyed it (I have absolutely no statistics at all, but I have received some very enthusiastic emails), since it allows them to concentrate on the content of the curriculum vitae and not on writing boring, repetitive informations.

Using T_EX for this task is advantageous since only one version needs to be maintained due to its computer-independent design. Besides, the MAF is easily installed, adapted if needed and the end-user does not need any specific skills or knowledge of a particular software. Finally we use the fact that the T_EX language allows to mix both data processing and typesetting issues, maybe in a more complex way than usual word-processors and this is essential for the automatic production of forms.

Acknowledgment. I wish to thank all the people who have contributed to the MAF and proposed some extensions and corrections. Moreover, E. Schost and T. Zell have suggested some corrections to this article. Finally, I was glad to have benefited from the informations given on the WEB sites — maintained by volunteers — of the *Guilde des doctorants* and *Opération Postes* while looking for a job.

References

- [1] AMS coversheet <<http://www.ams.org/coversheet>>.
- [2] Guilde des doctorants <<http://gilde.jeunes-chercheurs.org/>>.
- [3] D. Carlisle. `keyval.dtx`, part of the *graphic bundle*.
- [4] Ministère de l’Éducation Nationale (France) <<http://www.education.gouv.fr>>.
- [5] Opération Postes <<http://smai2.emath.fr/postes>>.

ŠäferT_EX: Source Code Esthetics for Automated Typesetters

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February 26, 2005

Abstract

In 2003, the first attempts towards ŠäferT_EX were made, targeting to create a text processing with the goal of optimizing its ease of use, i.e. the beauty of its code appearance. The macro based T_EX system still lives in niches of typesetting experts, computer scientist, and engineers who are willing to learn the overhead required to use the system - for the sake of high quality typesetting. ŠäferT_EX faced the challenge to provide an interface language that does only differ minimally from a normal human edited text, while the compiler itself extracts the commands it requires.

Despite to simple wrappers programs, ŠäferT_EX is a real three phases compiler, consisting of a lexical analyzer, a parser, and a code generator. In the last year the system mainly underwent internal changes that allowed to maintain this structure, while allowing a rather unusually simple and transparent programming syntax. As a consequence, the system now reached a robustness, so that it can be used by a wider audience.

This presentation shall give the reader an overview over the system of ŠäferT_EX and demonstrate its abilities with a example application. Also, the fundamental ideas which allowed to maintain the classical three phases compiler structure are introduced. With the start of this conference the system can be downloaded at safertex.sourceforge.net.

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ŠäferT_EX

Source Code Esthetics

Frank-René Schäfer

March 9, 2005 / EuroT_EX-2005

Frank-René Schäfer ŠäferT_EX

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The Goals

Optimized Code Appearance

- **Avoiding Visual Noise**
 - 'Natural Appearance' of Commands
 - Unicode Based Input
- **Three Phases Compiler**
 - Lexical Analyzer
 - Parser
 - Code Generator (for T_EX)
- **Organization of Variables**
 - Symbol Table Mechanism (OO Support)
 - XML Interfaces

Frank-René Schäfer ŠäferT_EX

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Paradigms of ŠāferTEX

Means to Improve Code Appearance

Example

```

\section{Voil\'(a), une section}

\begin{itemize}
\item character sequences that do something
either start
\begin{enumerate}
\item with a backslash, or
\item with a double non-letter character
\end{enumerate}
\item und nun ein wieder Gliederungspunkt in der
\'(u)bergeordneten Liste.
\end{itemize}

\begin{quote}
We should not produce #100 pieces/week in order to get 10\%
more profit, if the adaption process costs us \$25.000.
\end{quote}
                
```

- Automatic Scope/Group Detection

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Paradigms of ŠāferTEX

Means to Improve Code Appearance II

Example

```

\section{Voil\'(a), une section}

-----\item character sequences that do something
-----either start
-----\item with a backslash, or
-----\item with a double non-letter character
-----\item und nun ein wieder Gliederungspunkt in der
-----\'(u)bergeordneten Liste.

\begin{quote}
We should not produce #100 pieces/week in order to get 10\%
more profit, if the adaption process costs us \$25.000.
\end{quote}
                
```

- Automatic Scope/Group Detection
- Indentation as Scope Delimiter

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Paradigms of ŠāferTEX

Means to Improve Code Appearance III

Example

```

(*) Voilá, une section

-- character sequences that do something
-- either start
-- ## with a backslash, or
-- ## with a double non-letter character
-- -- und nun ein wieder Gliederungspunkt in der
-- @bergeordneten Liste.

\quote:
We should not produce #100 pieces/week in order to get 10 %
more profit, if the adaption process costs us $25.000.
                
```

- Automatic Scope/Group Detection
- Indentation as Scope Delimiter
- Intuitive Treatment of Characters

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 Processing
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Lexical Analysis III

The Country Hut Solution

\quote: Der Apfel fällt nicht weit ...

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Lexical Analysis III

The Country Hut Solution

\quote: Der Apfel fällt nicht weit ...

Frank-René Schäfer LaTeX

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Lexical Analysis

Achievements on Lexical Analysis

- 1 Object Oriented Lexical Analysis (-> 'quex')
- 2 Country Hut Solution
(Framework for indentation based lexical analysis)
- 3 Platform for the '3 Paradigms of LaTeX'
- 4 Classical Token Stream as Output

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The ŠäferTeX Engine

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Parsing

Problems

- 1 Proliferation of rules
- 2 Confusion by **Precedence** rules
- 3 Malformation of parse trees

Solutions

- 1 Improvements to parser generator (-> 'Lemon++' and 'quakk')
 - 1 Grammar clarity by separation of rules and rule action
 - 2 Streaming ability of operational classes
 - 3 Automatic C++ code generation for non-terminal tokens
- 2 Avoidance of Precedence
- 3 Automatical XML code generation for parse tree

Frank-René Schäfer ŠäferTeX

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Summary

- Development of tools for lexical analysis: **Quex** (Object oriented pattern recognition)
- Development of tools for parser generation: **Lemon++** and **Quakk**. (Clarity of code and Ease of programming)
- Stable platform for the '3 Paradigms of ŠäferTeX'
 - Automatic Scope/Group Detection
 - Indentation as Scope Delimiter
 - Intuitive Treatment of Characters
- **First official release of ŠäferTeX 0.0.0 at sourceforge.net**

Frank-René Schäfer ŠäferTeX

Mem. A multilingual package for L^AT_EX with Aleph

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Abstract

Mem provides an experimental environment for multilingual and multiscrypt typesetting with L^AT_EX in the Aleph typesetting system. Aleph is Unicode-savvy and combines features of Omega and eT_EX. With Mem you should be able to typeset Unicode documents mixing several languages and several scripts taking advantage of its built-in OCP mechanism and with a high level interface.

Currently still under study and development, Mem is designed to be capable of following the development of Omega and L^AT_EX3, and I'm publishing it to encourage other people to think about the ideas behind it and to discuss the advantages and disadvantages of several approaches to the involved problems.

The project is now hosted in the public repository SourceForge.net to open its development to other people.

Introduction

Until now, the only way to adapt L^AT_EX for it to become a multilingual system is `babel`; although another systems like `mlp` (by Bernard Gaulle) or `polyglot` (by me) have appeared now and then, in practice only `babel` is used. It exploits T_EX in order to accomplish some tasks which T_EX was not intended for, like right to left writing and transliterations, but it's clear that the next step requires features not available in T_EX. Further, while one can write documents in several languages, `babel` is essentially a way to change the main language in monolingual documents.

Long ago, Omega and ϵ -T_EX development started independently and recently a new project named Aleph, combining features from both systems, has been launched. There are several packages for specific languages taking advantage of the features in Omega (`devnag`, `makor`, `CJK`, etc.) and the package `omega` provided a few macros to ease its use, now expanded with the name of `Antomega` by Alexej Kryukov [5], but they don't provide a generic high level interface to add a language and to synchronize it with other languages in a consistent and flexible framework. On the other hand, L^AT_EX3 continues evolving and one of its aims is to have built-in multilingual capabilities.

It is in this context that Mem was born. Actually, it was born several years ago with the name of Lambda and presented in the Fifth Symposium on

Multilingual Information Processing (Tokyo, 2001), but for several reasons its development was paused.¹ Its goal is twofold: in the short-term, to provide a real working package for Aleph to become useable with L^AT_EX, taking advantage of features like the OCP mechanism; in the mid-term, to use the experience gained with a real life system in order to develop better multilingual environments with L^AT_EX3 and Omega.

The rest of this paper of devoted to highlight some of the issues and therefore it does not intend to be exhaustive. To get a full picture of the package please refer to the manual [3], which is being written at the same time as the package, because I think the documentation is an integral part in the development process. I've divided the topics in two parts, those related directly to T_EX, and those related to the Aleph/Omega extensions, particularly to the OCP mechanism.

The T_EX part

Organizing and selecting features Language commands are grouped in *components*, with a few predefined ones—namely, `names`, `date`, `tools` and `text`. At first sight this resembles `babel`, but in fact this similitude is only superficial, because you are free to organize and to select components. The limit

¹ There is no paper, but you can find the slides on <http://perso.wanadoo.es/jbezos/mlaleph.html>. In fact, Mem was born even before, in 1996, with the name of `polyglot` as I shall explain shortly.

would be a component per macro but this does not seem sensible; for example, left and right guillemets could be a single group. On the other hand, too many components would be inconvenient for the user. I think a sort or component/subcomponent model should be devised (eg, `text.guillemets`), and at the time of this writing I'm working on a system to allow even decisions at macro level like `text.guillemets.\lguillemet`.

This poses the problem to determine which components are active at a certain point of the document. There are, of course, systems like those in CSS and other formatting languages based on description rules for transformations based on content (for example, with the keywords `inherit` and `ignore`). However, T_EX allows programmable rules for transformation based on format and such a model seems very limited (and the term “inherit” can be inappropriate in the context of an object-like environment).² Unlike CSS, with its closed set of properties, T_EX allows creating new properties and therefore new ways to organize the document layout.

There is a proposal from Frank Mittelbach and Chris Rowley [7] based on nesting levels, with comments about the main issues to be addressed, but since this paper is somewhat abstract regarding the possible solutions it's difficult to determine if that model will be enough for many purposes. In particular, it presumes the structure of the document is a tree, and therefore, as its authors point out, the model has to be extended to provide the necessary support of “special regions” that receive content from other parts of the document.

A basic idea in that paper is that there is a base language for large portions of text as well as embedded languages segments, which are nestable. Although in a limited way, these concepts shown at TUG 1997 related to a clear separation between base and embedded languages were present at that time in my own polyglot package (first released early 1997) whose code I used as the base to develop Lambda and now Mem.

On the other hand, Plaice and Haralambous in [9] and I (in Lambda) proposed independently to follow a model based in context information; the versioning system for Omega described in the former has been worked out and much extended from a theoretical point of view in [11] by Plaice, Haralambous and Rowley, with the introduction of the concept of a *typographical space*. Unfortunately, such a model cannot be carried out in full with T_EX and it has not

² See [2]. An English summary is available on <http://mem-latex.sourceforge.net>.

been implemented in Omega, but to me it's clear it should be taken as a guide for Mem, and for that matter for any multilingual environment. At the time of this writing I was studying how to tackle this task and the resulting model will be left for a future paper.

Never again default values! In a well-known article published in the TUGboat ten years ago, Haralambous, Plaice and Braams proclaimed “Never again active characters!” [4]. Now I proclaim the end of another source of problems in the babel package—namely, default values. Actually, default values are mainly associated with active characters, but they are also present in macros. Having default values for a certain language is not a bad thing, but when those values are restored every time the language is selected and they cannot be redefined with the standard L^AT_EX procedures then problems arise.

In Mem, a default value in a language is only a proposal, while the final decision is left to the user, which can change it by means of `\renewcommand`, `\setlength` and similars. No special syntax is required, like for example `\addto\extrasspanish`. The behaviour of language commands is exactly that of normal commands, except that their values change when the language changes.

A macro is made specific for a certain language with `\DeclareLanguageCommand`, which provides a default definition to be used if the users likes it; if you don't like it, you can redefine it, since the default value is not remembered any more. Outside that language, there could be macros with similar names, but they are not language specific (except if defined for another language, of course).

Furthermore, if a language defines an undefined macro, this is only defined in the context of that language and you not are required to provide a default for *another* language, because I firmly believe loading a language should not change at all the behaviour of another language. In other words, with Mem languages are much like black boxes.

A good example could be the Basque language, which places the figure number before the figure name. For that to be accomplished we must make Basque dependent several internal macros. Considering the number of languages and the fact we cannot know *a priori* which changes will be necessary, the fact languages can (or even must) decide which macros have a default value could lead to an unmanageable situation which could even prevent a proper writing of packages, because we don't know if we need to use `\(re)newcommand` or something else.

The Aleph/Omega part

OTP files The OCP mechanism provides a powerful tool to make a wide range of text transformations which are not possible with preprocessors. Since OCPs perform transformations after expanding macros, we can guarantee all characters, and not only that directly “visible” in the document, are taken into account. One of the main aims of *Mem* is to develop a high level interface for them, because using the Omega primitives is somewhat awkward. Moreover, since OCPs must be grouped in OCP-lists before actually applying them, the advantages of a high level interface becomes apparent—OCP-lists are hidden to users and language developers and they are built and applied on the fly depending on the language and the context, thus avoiding the danger of a combinatorial explosion [11, p. 107]. For further details on how OCPs works, see the Omega documentation [8] and the very useful case study [10].³

A key concept in *Mem* is that of *process*, a set of OCPs performing a single logical task. Very often, a task cannot be carried out by just one OCP, but in more complex cases a set of interrelated OCPs will be necessary. A very good example of this is the *devnag* package for Omega by Yannis Haralambous, where mapping from Unicode to the target font requires three OCPs. At the time of this writing I’m working on OCPs to handle the Latin/Cyrillic/Greek family of scripts, which is being a lot more involved as one could think at first sight, and very likely a set of three OCPs will be necessary to carry out the single process of mapping from Unicode to the T1, T2n and LGR encodings.⁴ This is particularly true for Greek with its many possible ways to represent the many possible combinations of letters and accents, which is far from trivial.⁵

³ Still, the former is very technical and the latter is very basic, and unfortunately an “intermediate” manual explaining the implications of OCPs is not available yet, thus meaning developing OTPs must be done very often by trial and error. The Aleph Task Force and I are considering the possibility to write such a manual.

⁴ In addition, it should be investigated if several of the tasks done by these OCPs can be delegated to a virtual font.

⁵ And the LGR encoding has some odd assignments, like placing GREEK PSILI AND OXIA at "5E (˘) thus having the catcode of superscript. There is another symbol mapped to the backslash. That would not be important except for a long-standing bug in how OCPs treat catcodes which the Aleph Task Force is trying to fix, because it’s a critical one. Since there are very few LGR fonts, and very likely their number will not increase, I’m thinking about removing the support for that encoding and instead to write a virtual file. To add further confusion, the Omega standard font *omlgc* moves the Unicode Greek Extended chars to a non standard placement.

It’s important to remember where OCPs are not applied: when writing to a file (e.g., the *aux* file), in `\edef`’s, in arguments of primitives like `\accent`, and in math mode. The latter is a serious limitation, and the Aleph Task Force is working on a solution. This means *Mem* has done very little in these areas, except redefining `\DeclareMathSymbol` to allow higher values.

Extending OTP syntax: MTP files Perhaps the main limitation of OTP files, containing the source code of OCPs, is that the only letters we can use are those in the ASCII range, while for the rest of the Unicode range we must use numerical values. MTP files have been devised to overcome these limitations so that we can use Unicode names instead of numbers (see figure 1). Currently, they are converted to OCP with a little script named *mtp2ocp*, a preprocessor written in Python.

Another addition to OTPs is that it maps special characters to several points in the Private User Area whose catcodes are fixed (as defined by the *Mem* style file). This way, characters like `\`, `{`, `$`, etc., have the expected behaviour even in verbatim mode.

I hope MTP files could help in the near future to make the task somewhat simpler, so suggestions are most welcome. This way we can have prototypes to experiment with, so that in the future *otp2ocp* itself could be extended with new features if necessary. (One of the reasons I use Python is that it’s a great language for prototyping.)

Unicode as input encoding Unicode, unlike many other encodings, clearly separates characters and glyphs. This means that at character level, Unicode can introduce controls to provide further information about these characters, including how they should be rendered. It is expected that this information has to be processed in order to decide which glyph to use. Traditional font formats (TrueType and PostScript) do not have this capability or it is limited.

Unicode, considered as an input encoding, is quite different from other encodings and poses several challenges which must be taken into account if we want to read properly Unicode text. Currently, conversions done by L^AT_EX packages or Omega OCPs just ignore these controls and instead it is supposed the user must supply them with T_EX macros.

For example:⁶

- letters with diacriticals, either composed or decomposed,

⁶ For some hints on that, see [13]

```

.....
[LATIN CAPITAL LETTER L WITH STROKE]    => <= @"8A ;
[LATIN SMALL LETTER L WITH STROKE]     => <= @"AA ;
[LATIN CAPITAL LETTER N]{botaccent}<0,>[COMBINING ACUTE ACCENT]
=> <= @"8B \>(*+1-1);
[LATIN SMALL LETTER N]{botaccent}<0,>[COMBINING ACUTE ACCENT]
=> <= @"AB \>(*+1-1);
[LATIN CAPITAL LETTER N]{botaccent}<0,>[COMBINING CARON]
=> <= @"8C \>(*+1-1);
[LATIN SMALL LETTER N]{botaccent}<0,>[COMBINING CARON]
.....
[LATIN SMALL LETTER I WITH MACRON]
=> <= [LATIN SMALL LETTER I][COMBINING MACRON];
[LATIN CAPITAL LETTER I WITH BREVE]
=> <= [LATIN CAPITAL LETTER I][COMBINING BREVE];
.....
[CENT SIGN]                            => "\UseMemTextSymbol{TS1}{162}";
[POUND SIGN]                            => "\UseMemTextSymbol{TS1}{163}";
[CURRENCY SIGN]                         => "\UseMemTextSymbol{TS1}{164}";
[YEN SIGN]                               => "\UseMemTextSymbol{TS1}{165}";
.....
<acc> [COMBINING GRAVE ACCENT]          => "\UseMemAccent{t}{0}";
<acc> [COMBINING ACUTE ACCENT]          => "\UseMemAccent{t}{1}";
<acc> [COMBINING CIRCUMFLEX ACCENT]     => "\UseMemAccent{t}{2}";

```

Figure 1: Several chunks from MTP files using Unicode names. Currently symbols are hardcoded, not an ideal situation.

- ligatures marked with ZERO WIDTH JOINER,⁷
- hyphens, non breaking hyphens, non breaking spaces, etc.,
- fixed width spaces,
- variation selectors,
- byte order mark.

In order to unify the character encoding used in style files, only utf-8 and explicit Unicode values (eg, `^^^^0376`) are used, but that poses the problem with a non-Unicode document since changing the OCP for the input encoding would mean kerning and ligatures are killed. To overcome this well known T_EX limitation, input OCPs use an internal switch mechanism to escape temporarily to utf-8 or utf-16 (see figure 2). The trick is to pass information to the OCP with the character `^^1b`, whose meaning in many character encodings is ESCAPE, followed by another character with the operation to be performed. I'm not sure if this mechanism is robust enough, but if it were the idea could in the future serve as a way to pass context information to a certain OCP so that its behaviour may be changed, although of course a built-in mechanism as that proposed by John Plaice *et al.* [11] would be preferable.

⁷ The semantics of this character has been extended in Unicode 4.0 and now can be used to mark ligatures [12, p. 389ss]

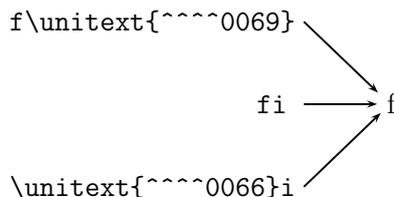


Figure 2: Entering a Unicode character with Mem does not break ligatures.

L^AT_EX Internal representation This section is devoted in part to a few ideas which I put forward in the L^AT_EX3 list, which was followed by a very long discussion about a multilingual model (or more exactly, multiscrypt) for L^AT_EX. These ideas lead to introduce the concept of LICR (L^AT_EX internal character representation). Actually, L^AT_EX has for a long time had a rigorous concept of a L^AT_EX internal representation but it was only at this stage that it got publicly named as such and its importance realised.⁸ The reader can find more on LICR in the second edition of *The L^AT_EX Companion*, by Frank Mittelbach and others [6, section 7.11.2].

What LICR does is essentially to ensure there is only a way to represent a certain character so that

⁸ Chris Rowley, “Re(2): [Omega] Three threads”, e-mail to the Omega list, 2002/11/04.

different input methods (say, \tilde{a} and $\backslash'a$) lead to the same representation (in that case $\backslash'a$) and that this representation is able to find a correct glyph somehow.⁹ The required functionality for that to be accomplished is splitted in two well know packages—namely, `inputenc` and `fontenc`.

As far as I know, no paper explaining the technical details of the LICR has been published, so I'm going to attempt an operational definition. Before doing that, I think remembering different kinds of T_EX expansion process is to the point (I exclude one level expansion as done by `\expandafter`):

- `\def` no expansion.
- `\edef` expands anything except non expandable tokens.
- protected `\edef` expands anything except non expandable tokens *and* protected tokens (even if expandable).
- execution expands anything and performs the actions of primitives.

So, we can say LICR is what we get in a protected expansion.

Unicode provides this kind of “internal representation” but without the normalization of LICR. Let's remember Unicode allows representing characters with diacritics in composed form (eg, \tilde{a}) or in decomposed form (eg, $a\grave{}$), and that these forms *may* be normalized to either composed or decomposed forms. There are three possibilities:

- normalizing to composed forms.
- normalizing to decomposed forms.
- not normalizing at all.

Decomposition has, in turn, several types, but we won't discuss them in this paper.

The questions here are: Is it possible the preserve the LICR in Mem?; if so, must be the LICR preserved in Mem? Does it fit in the Unicode model?

In order to answer these questions, we must remember the LICR relies heavily in active characters, which will be replaced in Mem by OCPs. Furthermore, macros are expanded and executed (see above) before OCPs are applied thus making impossible any attempt to catch things like $\backslash'a$. It seems that an alternative method to `inputenc`/`fontenc` must be provided.

Once we have an expanded string, characters are normalized to decomposed characters instead of the composed form favoured by the Web Consortium, for example (it should be noted that in the LICR letters are decomposed). The reasons are

⁹ Note the LICR is not necessarily a valid input method, because $\backslash'a$ is not always correct in L^AT_EX.

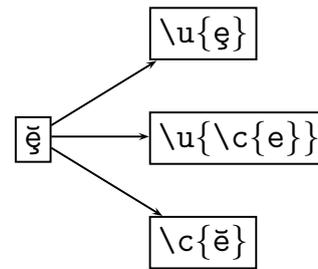


Figure 3: Several ways to input the same character. With Mem the four are strictly equivalent, because they are converted to Unicode and normalized. With the NFSS, if $\grave{}$ does not exist, then the $\grave{}$ is always faked. However, with Mem, if $\grave{}$ does not exist but $\grave{}$ does, then $\grave{}$ is added to the real composite character.

mainly practical, because the composed form to be selected in some cases depends on the glyphs available. Since normalizing to composed forms would require decomposing, sorting diacriticals and then composing, and font processes would require decomposing again and sorting again to see if there are matching glyphs for the first accent above or the first accent below (or even a combination of both), by using directly the decomposed form we are avoiding a lot of overhead (see figure 3). In fact, the Unicode book says [12, p. 115]:

In systems that *can* handle nonspacing marks, it may be useful to normalize so as to eliminate precomposed characters. This approach allows such systems to have a homogeneous representation of composed characters and maintain a consistent treatment of such characters.

This dual representation of characters is what is making processes for the Latin/Cyrillic/Greek script so complex, but we have to deal with them if we want a Unicode typesetting engine.

The Latin script has a rich typographical history, which not always can be reduced to the dual system character/glyph. As Jaques André has pointed out, “Glyphs or not, characters or not, types belong to a class that is not recognized as such” [1]. Being a typesetting system, neither Aleph nor Mem can ignore this reality, and therefore we will take into account projects like the Medieval Unicode Font Initiative (MUFI)¹⁰ or the Casetin Project. However, it doesn't mean a Unicode mechanism will be rejected when available. For example, ligatures can be created with the ZERO WIDTH JOINER. If there

¹⁰ <http://www.hit.uib.no/mufi/>

is a certain method to carry out a certain task in Unicode, it will be emulated.

Diacritical marks The Unicode 4.0 book states [12, p. 184] when discussing spacing modifier letters:

A number of the spacing forms are covered in the Basic Latin and Latin-1 Supplement blocks. The six common European diacritics that do not have encodings there are added as spacing characters.

In other words, except for these six diacritics (U+02D8-U+02DD), the spacing forms of combining characters are those in the range U+0000-U+00FF. Unfortunately, it happens this is not true, since the spacing caron accent (U+02C7) is not encoded in these blocks. Further, one of these six diacritics encoded separately—namely, the tilde U+02DC—does exist in these blocks (U+007E).

What to do, then? One will be forced to find some kind of hint, and one can do it readily—all characters in the block Spacing Modifier Letters are prefixed with `MODIFIER LETTER`, except the six spacing clones and `CARON` (U+02C7). From this, we can infer that the right spacing form for the circumflex accent is not the `MODIFIER LETTER` variant, but the one in the Basic Latin Block, exactly like the `ACUTE ACCENT`. No doubt the “small” tilde has been encoded separately because the ASCII tilde has already a special meaning in several OS’s.

Still, I think there is a better solution, or rather a better encoding which does not pose this problem. Since the glyphs for diacritics are mainly intended for use with the `\accent` primitive, one can conclude they are, after all, combining characters. The fact we need further processing with T_EX does not prevent considering these glyphs conceptually as non-spacing characters—this is just the way T_EX works. Since composing diacritical marks are encoded anew in Unicode, we don’t need to be concerned with legacy encodings and their inconsistencies.

Conclusions

In this paper I have scratched only the surface of some topics, which deserve by themselves a whole paper. In addition, many others have not been even treated like for example:

- Hyphenation, including patterns for Unicode-like fonts.
- Automatic selection of languages and fonts depending on the current script.
- Since letters are not active any more, one should be allowed to write `\capítulo` or `\κεφάλαιο` instead of `\chapter`.

- Fonts—monolythic or modular?
- OpenType—must its information be extracted so that it’s under our control? (However, using OpenType fonts with T_EX is still a failed subject, although there are interesting projects like XeT_EX.¹¹)

Before finishing this paper, I would like to cite Frank Mittelbach in a message posted to the L^AT_EX3 list:

The fact that we don’t agree with some points in it only means that the processes are so complicated that we haven’t yet understood them properly and so need to work further on them.

I hope Mem will provide an environment which would help us (including me) to understand better how OCPs work as well the issues a multilingual system poses.

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Omega Becomes a Sign Processor

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Characters and Glyphs

The distinction between “characters” and “glyphs” is a rather new issue in computing, although the problem is as old as humanity: our species turns out to be a writing one because, amongst other things, our brain is able to *interpret* images as symbols belonging to a given writing system. Computers deal with text in a more abstract way. When we agree that, in computing, all possible “capital A” letters are represented by the number 65, then we cut short all information on how a given instance of capital letter A is drawn. Modern computing jargon describes this process as “going from glyphs to characters.” If a *glyph* is the image of a writing system’s atomic unit, a *character* is an interpretation of that image, an interpretation shared by many glyphs drawn by different people in different places at different times. If all these drawings are equivalent in terms of interpretation, we can consider character as an equivalence class of glyphs. To be operational such an equivalence class must be described in a clear and unambiguous way. This is why we define *character* as being a *description of an equivalence class of glyphs* [7, pp. 53–58], [6].

Arabic text provides a typical illustration ground for the concepts of character and glyph. In Arabic alphabet, letters are contextual, in the sense that a given letter will change form according to the presence or absence of other surrounding ones. When we refer to an Arabic letter and represent it graphically, we use the isolated form. We can also refer to it by its description (for example: ARABIC LETTER JEEM) and this can be considered as description of a “character”: the equivalence class of shapes this letter can take in millions of Arabic documents. While there may be millions of instances of this letter, according to Arabic grammar they all belong to one of only four forms: isolated ج, initial ج, medial ج, or final ج. Hence, we could choose to have

not one but four equivalence classes of shapes: ARABIC INITIAL LETTER JEEM, ARABIC MEDIAL LETTER JEEM, and so on. But are these “characters”?

Answering to this question requires a pragmatic approach. What difference will it make if we have one or rather four characters for letter *jeem*? There will indeed be a difference in operations such as searching, indexing, etc. A good question to ask is: “when I’m searching in an Arabic document, am I looking for *specific forms* of letters?” Most of the time, the answer is negative.¹ Form-independent searching will, most of the times, produce better results and this implies that having a single character for all forms is probably a better choice.²

Unicode is a *character encoding*. In other words, it contains *descriptions of characters* and tries hard to define characters properly by avoiding dependence on glyphs.³

¹ Arabic words are not always visually segmented as English ones—there is, for example, no guarantee that the first letter of a word will always be in initial form: if a word starting with *jeem* is preceded by the definite article *al*, then the *jeem* will end up being in medial form.

² Greek is different: *sigma* doesn’t “become” final because it “happens” to be at the end of a word. While medial *sigma* can appear anywhere, final *sigma* is used mainly for the endings of particular grammatical forms and in onomatopoeias or foreign words. One would hardly ever search for *both* the final and medial form of *sigma* since their rôles are distinct. To illustrate this, when we abbreviate a word by a period at a *sigma* then the latter does remain medial despite being the final letter: φιλοσοφία → φιλοσ. Hence it is quite logical to use distinct characters for medial and final *sigma*.

³ This is not always the case because of Unicode’s tenth founding principle, namely convertibility of legacy encodings—and legacy encodings contain all kinds of things. For example, again in the case of Arabic, the main Unicode Arabic table indeed contains only form-independent “characters.” But, hidden towards the end of the first Unicode plane, one finds several hundreds of codepoints containing Arabic letters and ligatures in fixed forms, for legacy reasons. Like human history (or Stephen King’s movies) Unicode has shadowy places which people try to avoid and even to forget that they exist.

The character vs. glyph issue is far from being solved. In this paper we give an attempt to transcend it by introducing a new concept: the *sign*.

A *sign* is a set $\{c, p_1 = v_1, \dots, p_n = v_n, g\}$ where c is a character, g a glyph, and p_i an arbitrary number of named properties taking values v_i . Character, glyph, number of properties, their names and their values can be changed at any time, by special syntax in the input file, or by OTPs, or by interaction with fonts.

Using the term “sign” we clearly refer to a Saussurian linguistics tradition whose relevance for nowadays semiotics needs not to be proven. For Saussure [11, p. 99], sign is the basic discrete unit of meaning. It is a dual entity made up of a *signifier* and a *signified*. For instance, when we write or pronounce the word “tree,” the visual or auditory image of this word is the *signifier* and the concept of tree is the *signified*. Inspired of this analysis one could attempt to apply the notion of sign to characters and glyphs, by asserting that glyph is signifier, and character is signified. Nevertheless, in semiotics things are not that simple because linguists generally deal with units of meaning rather than with words *per se*, and even less with letters. A letter inside a word is not considered to be a Saussurian sign.

This is why we are bound to warn the reader that our concept of *sign* is inspired from but not identical to Saussurian sign.

In Principio Creavit Knuth T_EXum

How does T_EX deal with characters and/or glyphs?

First of all, `.tex` files contain characters. When T_EX reads a file, it converts the data stream into tokens. A *token* ([10, §289] or [8], which is an exegesis of Knuth’s B) is either a “character token” (that is, two numbers: a character code and the character’s “category,” which provides the specific rôle played by the given character code, for example whether it is a math mode espace character like \$, or a comment escape character like %, or a group delimiter like {, and so on), or a “control sequence token.”

If we leave aside for a moment the fact that T_EX cannot read character codes above 255, one could claim that “character tokens” can still be considered as “characters.” What happens next?

Parsing these tokens, T_EX builds node lists (horizontal and vertical). A *node* is a typed atomic unit of information of a list. The amount and nature of data contained in nodes depend on their type. A “character node” [10, §134] (or “charnode”) is made of two numbers: a font ID and the position of the glyph in the font table. But the latter is not bound

to have any relation whatsoever with its character code. Obviously, we can hardly talk about *characters* at this point: we have crossed the bridge to Glyphland.

Another very interesting node type is the “ligature node” [10, §143]. This one contains a font ID, a glyph position in the font table, and a pointer to a linked list of charnodes. This list is in fact the “decomposition” of the ligature. T_EX needs it in case it has to “break” the ligature during paragraph building, for example when a word needs to be hyphenated inside a ligature.

Talking about hyphenation, there is a node called “discretionary node” [10, §145]. This node contains two pointers to horizontal lists, as well as an integer. These horizontal lists are what is typeset when we break a word, before and after the line break (in standard cases the first one contains only a hyphen, and the second one is empty). The integer is the number of nodes of the main horizontal list to delete if the word is hyphenated (in other words: how many nodes to replace by the two horizontal lists we mentioned).

As we see, in the three node types described above only glyphs are used—never characters. There seems to be a contradiction with the very nature of hyphenation: after all, words are hyphenated according to rules given by natural language grammars, and these grammars apply to characters, not to glyphs. Indeed, would you hyphenate a word differently if some letters had calligraphic shapes? Certainly not, but for T_EX, these letters are glyphs in font tables, and if variant forms exist, then their positions in the font tables are necessarily different from the standard ones. How does T_EX deal with this?

There is in T_EX a primitive called `\lccode` (and a corresponding WEB macro called `lc_code`). Each glyph in a font participating in hyphenation has necessarily a `lc_code` value. These values are usually initialized in the format.

`lc_code` is in fact a mapping between glyphs and characters. Hyphenation rules are written using patterns, and patterns use characters. When T_EX needs to hyphenate words in a paragraph, it first maps glyphs back to characters using `lc_code` [10, §892–899], and then applies hyphenation rules.

This method seems to work, but the user must, at all times, use the appropriate `lc_code` settings for each font.⁴

⁴ It is worth mentioning that `lc_code` has a big advantage after all: it allows *simplification* of hyphenation patterns. Indeed, instead of mapping a glyph to the precise character it represents, one can use equivalence classes of characters.

Let us continue our journey through T_EX and see what happens in the final stage. There is no surprise: the information contained in charnodes (namely font ID and glyph position) is output to the DVI file [10, §619]. Ligature nodes are treated similarly [10, §652]: only font ID and glyph position of the ligature remains, provided of course that the ligature has survived hyphenation. Discretionary nodes vanish long before output since either hyphenation has occurred and the two horizontal lists pointed by the node have found their way into the DVI file, or no hyphenation has occurred and the discretionary node falls into oblivion.

When T_EX and the DVI file format were developed, this was the best possible approach: DVI files had to be short, and there was no need to insert more information than required to print. And indeed, a printing device doesn't care whether a glyph is a ligature or whether it derives from hyphenation; printing is done in Glyphland, at the very end of the line of document production process. Even PostScript language didn't change that situation, although it made printing devices more clever (clever enough to interpret a very rich programming language).

Dixitque Berners Lee: fiat Web et facta est Web

Things changed when DVI and PostScript were not anymore the only targets of T_EX document production process. The Web brought the era of electronic documents in various formats such as PDF, XHTML, etc. These documents allow interaction with textual contents: copy-and-paste of text blocks, searching, indexing, etc.

When we search for a word inside a document, or in a collection of documents, do we care about the shape of its letters? Most of the time, the answer is no. Otherwise, it would be quite hard to find a word in a document written in *Zapfino* or *Poetica*, since one has to predict the precise variant form used for every letter, and there are many of them.

In this kind of situation one would like to interact with the document on the character level. But if PDF or XHTML files are produced by T_EX, then the information on characters is lost. A very simple example: if 'fi' is represented in a DVI file as glyph 12 of font cmr10, with no reference whatsoever to the character string 'f-i', then how on earth can we search for the word 'film' by entering characters 'f', 'i', 'l', 'm' in our program's search interface?

For example, in Greek, hyphenation does not (or very rarely) depend on accents and breathings, so we can map all letters with diacritics into base letter classes and write patterns using the latter.

There is no natural solution to this problem. Acrobat Distiller tries to give an algorithmic solution by using PostScript font glyph names ([7, pp. 651–653], [1]). The idea is the following: in PostScript type 1 fonts, glyphs have names (namely the names of PostScript subroutines which contain the Type 1 operator glyph's description); when creating a variant glyph of, let us say, letter 'e', designers are requested to use a name like `e.foo` where `foo` is some description of the variant: the first part of the name identifies the Unicode character and the second, the variant; Distiller goes through all glyph names in all fonts used in a document and maps glyphs to Unicode characters according to their names. There is a similar syntax provided for ligatures (that is: glyphs mapped to more than one Unicode character).

TrueType fonts have a table (called `cmap` [7, pp. 703–706]) dedicated to this mapping: we map (single) Unicode characters to (single) glyphs.⁵

These solutions are sub-optimal. There is no way to modify the mapping between characters and glyphs without hampering with the font, and this is not always desirable.

Instead of finding sub-optimal solutions to a problem which is the consequence of information loss in the DVI file, let us attack the origin of this problem. Is it possible to keep character *and* glyph information all the way long, from input file to DVI (and beyond)?

“How now, spirit! whither wander you?” (Enters Omega₁)

One of Omega₁'s goals was to achieve Unicode compliance. The least one could expect of Omega₁ is an affirmative answer to the final question of previous section: Can we obtain Unicode information in a DVI file?

Before answering that question let us see whether Omega₁ is actually different from T_EX when dealing with characters and glyphs. It isn't: Omega₁ can read 16-bit characters (some versions of it can even read UTF-8 representation of Unicode data directly), but once inside Omega₁, Unicode characters become “character tokens” and then charnodes, ligature nodes and discretionary nodes

⁵ In fact, things are worse than for PostScript Type 1 fonts: while PostScript glyphs have names (and names are usually meaningful and stable vs. font transformations), TrueType glyphs are accessed by their “glyph index values” which are plain integers. A TrueType font opened and saved by some font editing software can be re-organized, glyph index values can change without further notice, and hence accessing a glyph directly by its index, without going through the `cmap` table, is quite risky.

all the same as in T_EX.

How then does Omega₁ manage to do Arabic, a writing system where one just *has* to go from characters to glyphs? By using OTPs [9]. An OTP is an internal filter, applied to “character tokens.” It can be compared to a pre-processor but has some major advantages: the fact that only tokens are targeted (not comments, for example), and that the catcode of each token is known and that transformations are applied to selected categories only (usually plain text, that is: catcodes 11 and 12). Furthermore, OTPs have the tremendous advantage of being dynamically activated and de-activated by primitives.

Let us analyse the example of Arabic typesetting via Omega₁. When Arabic Unicode characters are read, they become “character tokens” (the first part of the token takes the numeric value of the Unicode codepoint, the second part is the catcode, in this case probably 12). No contextual analysis is done yet. It is an OTP that analyses the context of each glyph, and, using a finite-state machine, calculates its form; the result of the transformation by this OTP is one or more new tokens, replacing the previous ones. These tokens correspond to given forms of glyphs. Other OTPs will act upon them and produce esthetic ligatures, and usually the final OTP will map these tokens to font-specific ones, which in turn will become charnodes, and will end up in the DVI file.

The purpose of keeping only the last OTP font-dependent is to improve generality and re-usability of the previous OTPs. But from the moment we perform contextual analysis we have left Unicode data behind and are travelling in a no-man’s land between characters and glyphs. In this de Chirico-like surreal place, characters are more-or-less “concrete” and glyphs more-or-less “abstract.” Obviously, if the result is satisfying—and this is the case with Omega₁’s Arabic typesetting—it is of no importance how we manage to obtain it, whether we go through these or those OTPs and in which ways we transform data.

But the fact is that we do lose character information, just as in T_EX. In the DVI file we have beautiful Arabic letters and ligatures . . . but there is no way back to the original Unicode characters.

This situation is changing with Omega₂ (work in progress). Instead of characters, character tokens and charnodes we are using signs (sign tokens and sign nodes), links and bifurcations. Sign nodes are data structures containing a character, a glyph, and additional key/value pairs, where the value can be simple or complex, involving pointers to other signs,

etc. Links are groups of signs which contain alternative sets of glyphs based on a graph: the paragraph builder includes this graph into its own acyclic graph through which it will obtain the optimal paragraph layout as the shortest path from top to bottom.

Before we enter into the details of signs, let us briefly describe another paradigm of character/glyph model implementation: SVG.

The SVG Paradigm

SVG (= Scalable Vector Graphics, [4]) has at least one very nice property: the way text is managed is quite elegant.

First of all, an SVG document is an XML document, and the only textual data it contains is actual text displayed in the image. In other words: however complex a graphic may be, all graphical elements are described solely by element tags, attributes and, eventually, CDATA blocks. Not a single keyword will ever appear in textual content.

This is not at all the case of L^AT_EX, where we are constantly mixing mark up and contents, as in:

```
Dieser Text ist \textcolor{red}{rot}.
```

where `red` is markup and `rot` is text, and where there is no way of syntactically distinguishing between the two. In SVG, this example would be:

```
<svg:text>
Dieser Text ist
<svg:tspan color="red">rot</svg:tspan>
</svg:text>
```

where separation between text and markup is clear.

In SVG, as this is the default for XML, text is encoded in Unicode. In other words, text is made of characters only. How then do we obtain glyphs?

As in T_EX, SVG uses the notion of “current font,” attached to each `text` or `tspan` element, and this information is inherited by all descendant elements, unless otherwise specified. Fonts can be external, but the model is even more elegant when fonts are internal.

An internal SVG font is an element called `font` containing elements called `glyph`. The latter has an attribute called `unicode`. This attribute contains the one (or more, in case of a ligature) Unicode characters represented by the `glyph`.

The contents of the `glyph` element can be arbitrary SVG code (this is quite similar to the concept of T_EX’s virtual fonts, where a `glyph` can contain an arbitrary block of DVI instructions). In this way, any SVG image, however complicated, can become a single `glyph` of a font. To include this `glyph` in the SVG graphic one only needs to select the font and ask for the same Unicode character sequence

as in the `unicode` attribute of the glyph, in a `text` element.

Besides `unicode`, the `glyph` element takes a number of attributes :

- `glyph-name`: in case we want to access a glyph directly (useful when we have more than one variant glyphs representing the same character);
- `d`: the actual outline of the glyph, if we want to keep it simple and not include arbitrary SVG graphical constructions as contents of `glyph`;
- `orientation`: when mixing horizontal and vertical scripts, how is this glyph oriented?
- `arabic-form`: initial, medial, isolated or final?
- `lang`: use this glyph for a number of given language codes only;
- `horiz-adv-x`, `horiz-adv-y`: the advance vector of the glyph when typeset horizontally;
- `vert-adv-x`, `vert-adv-y`: idem, when typeset vertically;
- `vert-origin-x`, `vert-origin-y`: the origin of the glyph when typeset vertically.

What happens if we want a specific glyph, other than the standard one obtained directly going through Unicode character sequences? We can use element `altGlyph` which allows “manual” insertion of glyphs into text, and the PCDATA contents of which is the Unicode character sequence corresponding to the alternate glyph (in this way we get, once again, textual data for indexing, searching, etc.). But `altGlyph` also takes some attributes:

- `xlink:href`: if the font is described as an SVG font element, an XLink reference to the corresponding glyph element inside the font—our way of going directly to the glyph, no matter where it is located: server on the Web, file, font;
- `format`: the file format of the font (SVG, OpenType, etc.);
- `glyphRef`: a reference to the glyph if the font format is other than SVG (the specification provides no additional information, we can reasonably assume that this could be the PostScript glyph name in case of CFF OpenType fonts, or the glyph index value in case of TrueType-like fonts, but, as we said already, this is quite risky);
- `x` and `y`: if the alternate glyph is indeed typeset, then these should be the absolute coordinates of its origin;
- all usual SVG attributes (style, color, opacity, conditionality, etc.).

Let us suppose, for example, that we want to write the word “Omega” with a calligraphic ‘e’ (font *Jolino*) described in the element:

```
<svg:glyph unicode="e" glyph-name="e.joli"
  d="... its path ..."/>
```

We only need to write:

```
<text>
  <tspan font-family="Jolino">
    Om<altGlyph
      xlink:href="#e.joli">e</altGlyph>ga
  </tspan>
</text>
```

We can conclude by saying that SVG jolly well separates textual contents from markup (characters are provided as contents, glyphs as markup), and that `altGlyph` element comes quite close to the goal of our notion of sign: it provides both a character (in fact, one or more characters), a glyph, and some additional properties expressed by attributes. These are not really entirely user-definable as in the case of sign properties, but one could very well introduce additional attributes by using other namespaces.

When the Signs Go Marching In

In the remainder of this paper we will describe the sign concept in more detail and give some examples of applications. We will use the notation

c=0061	a
g= a, 97	

 for a sign containing character U+0061 LATIN LETTER A, glyph “a” (position 97 in the current font), and no additional properties.

Using this notation, an initial Arabic *jeem* would need a sign

c=062C	ج
form=1	
g= ج, 18	

. If we would like to typeset this sign in red color, we would add another

property:

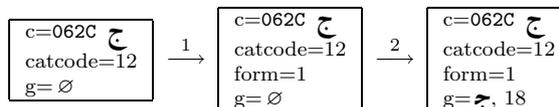
c=062C	ج
form=1	
color=red	
g= ج, 18	

.

Here is how it happens: Ω_2 reads a file containing Unicode character U+062C. Tokenisation produces sign

c=062C	ج
catcode=12	
g= \emptyset	

 (no glyph for the moment). Then we go through the OTPs for contextual analysis and font re-encoding:



The first OTP provides the contextual form value, without affecting the character (or catcode) value. The second OTP adds the glyph information (which would otherwise be added implicitly when

reading the font data).

Now what if we wanted the glyph to be typeset in red? All depends if we want (a) only the specific instance of sign to be red, or (b) all *jeem* characters, or (c) all initial *jeem* characters. In the first case one would manually change the `color` property of this sign to value `red`.⁶ In the second case one would use an OTP matching all signs conforming to the

pattern

c=062C
*
g=*

 (where asterisks indicate arbitrary values), and would add (or modify the value of) property `color`. In the third case one would, again, use an OTP but this time matching signs con-

forming to the pattern

c=062C
form=1
*
g=*

. That way only

initial form signs will be caught.

One can also imagine OTP patterns based solely on properties. If we wanted to change the color of all red glyphs into green, we would use an OTP as the following:

c=*
color=red
*
g=*

 →

c=(same)
color=green
(same)
g=(same)

Besides catcode, (Arabic) form and color, one can imagine many other properties: horizontal and vertical offset, hyphenation (or hyphenation preference), penalty, glue, bidirectionality level, language, style, word boundary, etc. We will discuss them while describing selected examples of sign applications.

Locked Properties Whenever we define rules, we also need ways to allow exceptions. In our previous color example, let us suppose that there is a given sign which has to remain blue, despite all OTPs which will try to change its color. Properties can

be locked: if

c=ج
form=1
color=blue
g=ج, 18

 becomes

c=ج
form=1
☞ color=blue
g=ج, 18

,

then no OTP will ever be able to change this property. Of course, OTPs can lock ☞ and unlock ☞

⁶ Why should we insert the color information into the sign as a property, when we can simply use a macro like `\textcolor`? Because OTPs use buffers and control sequence tokens and character tokens of categories other than 11 and 12 will end the buffer and send the buffered text for processing. If the buffer happens to end inside an Arabic word, then there is no way to do proper contextual analysis since the OTP cannot know what will follow in the next buffer. The only way to obtain a sign string sufficiently long to perform efficient contextual analysis, is to avoid control sequence tokens inside Arabic words, and this is easily achieved by storing information in properties.

properties, so if that color has to be changed after all, then it can always be unlocked, modified, and locked again ...

Signs in Auxiliary Files What's the use of having signs and sign properties if all the information is lost when tokens are written into a file? For example, when signs happen to be in the argument of a `\section` command which will be written in a `.toc` file. Instead of losing that information we will write it into that file (which becomes a *sign file*), and have Omega₂ read it at the subsequent run and import signs directly.

Sign Documents And since Omega₂ reads and writes auxiliary sign files, why not input the main file as a sign document? One could imagine a sign-compliant text editor, a kind of super-Emacs in which one would attach sign information (characters, glyphs, predefined or arbitrary properties) to the T_EX code. One can imagine how simple operations like the verbatim environment would become: if we can fix the catcode of an entire text block to 12, then all special characters (braces, backslashes, percents, ampersands, hashes, hats, underlines) lose their semantics and become ordinary text, L^AT_EX only needs to switch to a nice typewriter font and use an `\obeylines` like command and we're done.

Such a text editor is nowadays necessary when we are dealing with OpenType fonts requiring interaction with the user. For example, the `aalt` feature [7, p. 798] allows choosing variant glyphs for a given character. It would be much more user-friendly to use a pop-up menu than writing its glyph index value in the T_EX code. That pop-up menu would insert the glyph index as a sign property, and bingo.

Explicit Ligatures

To understand how we deal with ligatures let us recall how T_EX uses them in the first place. When building the horizontal list (this part of code is called the chief executive) every charnode is tested for the presence of eventual ligatures (or kerning pairs) in the font's `lig/kern` program [10, §1035]. If a ligature is detected then a ligature node is created. There is a special mechanism to ensure that the created ligatures is always the longest one (so that we get 'fff' instead of an 'ff' followed by an 'l').

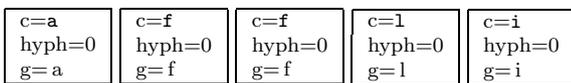
This ligature node contains a pointer to a horizontal list containing the original charnodes. These will be used in the paragraph builder if hyphenation is necessary.

If we need to hyphenate inside a ligature then it the lignode is first disassembled into the original charnodes [10, §898] and then a discretionary

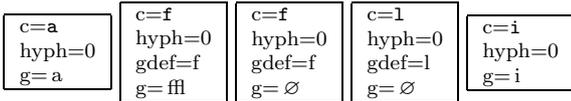
node is created with the two parts of the ligature as pre-break and post-break lists [10, §914]. This approach allows only one possible hyphenation inside a ligature—as Don says in [10, §904]: “A further complication arises if additional hyphens appear [. . .] T_EX avoids this by simply ignoring the additional hyphens in such weird cases.” This can be quite annoying for ligatures of 4 or more letters containing 2 or even 3 potential hyphenation points, and due to the increasing popularity of OpenType fonts we will get more and more of such ligatures in the future.

In T_EX a ligature can be inserted *only* by reading the font lig/kern program. It is impossible to instruct T_EX to create a ligature node using control sequences or other means, and hence it is equally impossible to do it in Omega₁ using OTPs.

Our goal is to do this in Omega₂, using signs. We call such a ligature an *explicit* one (in contrast to *implicit* ligatures contained in fonts). Let us take the example of the ‘ffl’ ligature in the word “affligé.” Let us first suppose that there is no hyphenation point in this word:



To insert a ligature one would replace it by:

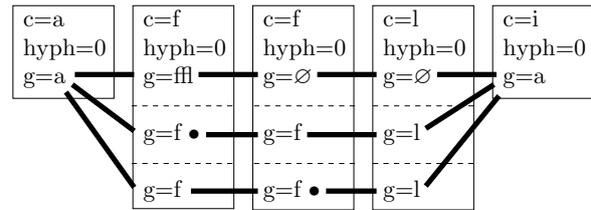


In this string, character information is left untouched and the ligature glyph is placed in the first sign participating to the ligature (the remaining ones have void glyphs). The *gdef* properties contain the “default glyphs,” in case the ligature is broken.

This brings us to a new notion, the one of *link*. The sign string shown in the previous example is, in fact, a doubly linked list. A link is a set of doubly linked signs, in our case those producing the ligature. We say that they participate to the link. The reason for linking these signs is that, at any moment, some OTP may insert additional signs between the ones of the link. We have to be sure that when these signs arrive to the paragraph builder, they will produce a ligature only if they are still consecutive, otherwise we will fall back to the default glyphs.

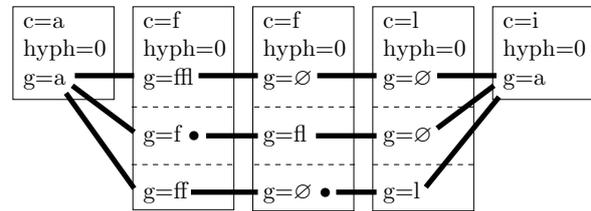
Things get more complicated if there is a hyphenation point. In this case we must provide all possible combinations of ligatured and non-ligatured glyphs. These combinations form an acyclic graph, very much like the one of T_EX’s paragraph builder, we call it a set of *bifurcations*. In the figure below, we have illustrated a quite complex case: a ligature ‘ffl’ surrounded by letters ‘a’ and ‘i’ and contain-

ing two hyphenation points (after the first and the second ‘f’ letter), a mission impossible for T_EX:



The fat strokes in the figure are the vertices of the graph. These vertices will be examined later for eventual kerning pairs or for other ligatures. The bullet after a glyph indicates that at this location we have a mandatory line break.⁷ Notice that all *hyph* properties are now set to 0 since the discretionary hyphenation is handled “manually” by bifurcation.

Here is the same figure, completed with ‘ff’ and ‘fl’ ligatures which will only be used in cases the original ‘ffl’ is broken:



Let us not forget that this graph deals only with glyphs. Characters still form a plain (one-dimensional) string, and macro expansion will use signs in exactly the same way as it currently uses character tokens. The paragraph builder, on the other hand, will include this graph as a subgraph of its network for finding the shortest path. Where we have placed a bullet, the paragraph builder will consider it as a mandatory end-of-line preceded by a hyphen glyph.

Non-Standard Hyphenation

Standard hyphenation corresponds to T_EX’s \-: the first part of the word stays on the upper line and is followed by a hyphen glyph but otherwise unchanged, and the remaining part is placed on the lower line, also unchanged.

But “there are more things in heaven and earth, Horatio.” Typical examples of deviant hyphenation are German words containing the string ‘ck’ (which,

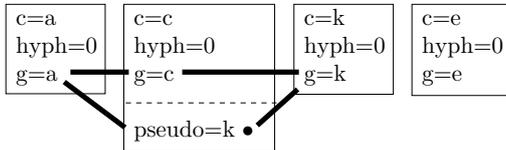
⁷ The purpose of this bullet is to postpone until the very last moment the creation of a sign

c=∅
g=-

 followed by a line break. The user should be able to decide whether character properties of line break hyphens should be void or U+00AD SOFT HYPHEN, or ant other character.

together with ‘ch’ is a ligature in traditional German typography in the sense that glyphs are brought closer to each other) or Hungarian ‘ssz’ which in some cases is hyphenated ‘sz-sz’ (*ősz-sze*) and in other cases (when the word is composite, like in *kisszerű*) ‘s-sz’.

Obtaining this using bifurcation is very easy:



The paragraph builder will have to choose between an unbroken glyph string ‘ack’ and a string ‘ak’ followed by a hyphen, a line break, and another ‘k.’ We can insert this information in signs very early, it will remain alive until the paragraph builder. On the character level we keep ‘ack’ so that in text extraction or in conversion to a file format without explicit line breaks (like XHTML) we will always keep the regular ‘ack’, whether or not there has been hyphenation in the DVI file.

There are similar phenomena involving punctuation or diacritics: in Polish, when a word is broken after an explicit hyphen, then we get a hyphen at the end of line, and another hyphen at line begin. In Dutch, ‘oe’ is pronounced ‘ou’ unless there is a diaeresis on the ‘e’; when a word is broken between ‘o’ and ‘ë’, then the diaeresis disappears (since breaking the word at that point makes it clear that the two letters do not form a diphthong). In Greek we have exactly the same phenomenon as in Dutch.

It should be interesting to note that this situation of discrepancy between visual information and text contents is being taken into account by formats like PDF. Indeed, version 1.4 of PDF has introduced the notion of *replacement text* where one can link a character string (\leftarrow the characters) with any part of the page contents (\leftarrow the glyphs) [2, p. 872]. The example given is the one of German ‘ck’ hyphenation:

```
(Dru) Tj
/Space
<</ActualText (c) >>
BDC
(k-) Tj
EMC
(ker) ’
```

The `ActualText` operator specifies that the string “c” is a “logical replacement” for the contents of the BDC/EMC block, which contains precisely the string “k-.” As we see, using sign properties to keep this particular information until the DVI file (and

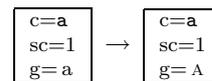
beyond) makes sense since PDF is already prepared for handling it, and by using it one can enhance user-interaction with the document.

OpenType Features

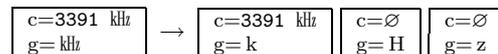
OpenType fonts contain information on various glyph transformations. This works roughly in the following way: the user activates “features,” for each feature the font attempts “lookups” (pattern matching on the glyph string), and for each matched lookup there is a series of glyph positionings or glyph substitutions. In our case, activated features become sign properties (so that they can be entered and modified at any time, independently of macro expansion, and so that they are carried over when tokens are stored, moved or written to files), then at some point, chose by the user, lookups are applied to sign strings, and the effect of positionings and substitutions is again translated into sign properties, before the signs arrive to the paragraph builder.

Both glyph substitution and positioning act on the glyph part of signs only. Let us review briefly the different types of OpenType transformations [7, p. 746–785]:

- *single substitution*: a glyph is replaced by another glyph. For example, a lowercase letter is replaced by a small cap one;

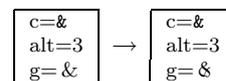


- *multiple substitution*: a glyph is replaced by more than one glyphs. For example, we may want to replace the ideographic square kHz by the glyph string “kHz”:

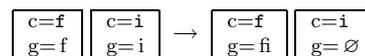


We generate additional signs with empty character parts so that eventual interaction between the glyphs of these signs is possible (for example, they may kern or be involved in some other OpenType transformation).

- *alternate substitution*: one chooses among a certain number of alternate glyphs for a given sign. The user provides the ordinal of the desired variant glyph as a sign property:



- *ligature substitution*: the ordinary ligature. Once again we have to use glyph-less signs:



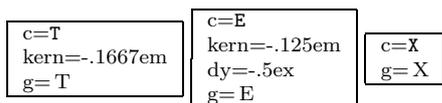
- *contextual substitution, chaining contextual substitution, reverse chaining contextual substitution*: meta-substitutions where one has a pattern including glyphs before and/or after the ones we are dealing with, with eventual backtrack and lookahead glyph sequences, and sometimes going from end to start;
- *single adjustment*: this is a transformation that adjusts the position of a glyph. In T_EX, you can move a glyph horizontally by using `\kern` or `\hskip` commands, and vertically by putting it in a box and `\raise-ing` or `\lowering` that box. In both cases you lose hyphenation and kerning, and since control sequence tokens are involved, OTP buffers are terminated.

This is why we introduce two very important sign properties: `dx` and `dy`. They provide horizontal and vertical offsets without going through control sequence tokens. There is no boxing, the advance vector of the glyph does not change, and the effect of moving the glyphs around does not affect surrounding boxes. In other words: even if you raise a glyph using `dy`, this will not affect your baseline—it is rather like if you had used a `MOVEUP` instruction in a virtual font.

Our favourite example of such a transformation: the T_EX logo (one of the first things people learn about T_EX, since it is described on page 1 of the T_EXbook) becomes a plain sign string without any control sequence in-between. Here is the standard T_EX code, taken from `plain.tex`:

```
\def\TeX{T\kern-.1667em\lower.5ex%
\hbox{E}\kern-.125emX}
```

and here is the sign string:



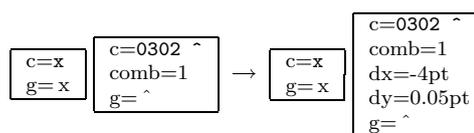
(see below for the `kern` property);

- *pair adjustment* is like single adjustment, but is applied to a pattern of two glyphs. Kerning is the most common case of pair adjustment. Besides `dx` and `dy` we also provide `kern` and `vkern` properties for this. The difference with `dx` and `dy` is that the advance vector of the glyph is modified. To see the difference, here is the T_EX logo first with a `kern` property and then with a `dx` property on sign ‘E’: T_EX, T_EX;
- *cursive attachment* is a very interesting transformation: we define a mark (that is a point in the glyph’s coordinate space) on each side

of a glyph, and we declare that proper typesetting in this font is achieved when the right mark of glyph *n* is identified with left mark of glyph *n* + 1. This eliminates the need of kerning pairs (both horizontally and vertically) and is ideal for cursive fonts with connected letters (as we used to write on the blackboard in primary school). We define a property called `cursive`, when it is activated Omega₂ will first check that the marks exist in the font, then do the necessary calculations, and finally insert `kern` and `vkern` values to match marks;

- *mark to base attachment*: the same principle as cursive attachment, but this time the goal is to connect a “base” to an “attachment.” Usually this will be the glyphs of a Unicode base character and the one of a combining character. The simplest example: a letter and an accent. T_EX veterans still remember the headaches caused to Europeans by the `\accent` primitive. Since 1990, thanks to the Cork encoding and its followers, we have been able to avoid using this primitive for many languages. But there are still areas where one cannot predict all possible letter + accent combinations and draw the necessary glyphs. To make things worse, Unicode compliance requires the ability to combine any base letter with any accent, and even *any number* of accents!

To achieve this, one once again defines marks on strategical positions around the letter (accent scan be placed above, beyond, in the center, etc., these positions correspond to Unicode combining classes) and around the accent. When the glyph of a combining character follows the one of a base character, all we need to do is find the appropriate pair of marks and identify them, using `dx` and `dy` properties. Here is an example:



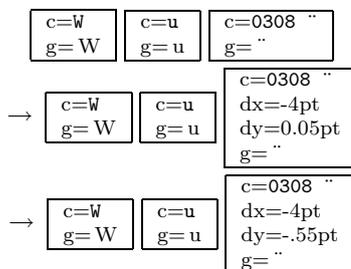
and the result is ‘x̂’ (we have deliberately chosen a letter-accent combination which is used in no language we know of, so that there is no chance to find an already designed composite glyph in any font);

- *mark to mark attachment*: instead of attaching the glyph of a combining character to the one of a base character, we attach it to the one of another combining character. The method is strictly the same;

- *mark to ligature attachment*: same principle but things get more complicated since a ligature can have more than one marks in the same combining class and corresponding to individual letters. The idea is to read a ligature of n glyphs followed by n combining glyphs and to place the latter on appropriate locations above (or more generally, around) the former. This is rarely encountered in Latin fonts, but becomes crucial in Arabic fonts with many ligatures (since short vowels and other diacritics are considered as combining characters by Unicode);
- *contextual and chaining contextual positioning*: again a meta-transformation where a pattern of glyphs is matched (with eventually a backtrack and a lookahead) and then one or more of the previous positioning transformations are applied. This is crucially missing from T_EX.

A typical example is the acronym S.A.V. (= “Service Après-Vente”), where the ‘V’ should be brought closer to the period preceding it because the latter is itself preceded by an ‘A’. In the case of, for example, S.V.V. (= “Schweizerische Vereinigung für Vegetarismus”) kerning between period and second ‘V’ should better not be applied.

Another example is German word “Würze,” where, in some fonts with a very expansive ‘W’, the Umlaut has to be brought closer to the letter to avoid overlapping ‘W’. In this case we (a) match the pattern of three signs ‘Wu’’, (b) place the accent on the ‘u’, and (c) lower it:



Application of transformations contained in GPOS and GSUB tables will be considered like activating an OTP, so that the user may insert additional OTPs between those two, or after them.

Doing Better Than OpenType

Positioning of diacritics on Arabic ligatures [3], or of Masoretic diacritics in Biblical Hebrew [5] is a non-trivial task. There are algorithms calculating positions of diacritics using methods such as force-fields, blank area calculation, etc. Until now it is

impossible to apply such algorithms without implementing them into the very kernel of T_EX.

Using sign OTPs one would first apply contextual analysis, then GSUB transformations (and GPOS for whatever it is worth) and finally, after the string chain has gone through all OpenType transformations, apply positioning algorithms as external OTPs. At that stage we know exactly which ligatures are used and what the final shape of each word is. The algorithm would obtain the glyphs of ligatures and vowels used—as well as special information such as the presence of keshideh—from sign properties. Having access to the glyph contours of the specific font, it would then reconstruct in memory an envelope of the global graphical image of the word, containing visual centers of individual letters and other relevant information. The result of calculations would be included in dx and dy properties of vowel signs. After that, processing would continue normally.

In fact, our approach not only uses all resources that OpenType fonts can provide but, contrarily to other systems which rely on OpenType for the final typesetting steps, it allows OTP transformations before GSUB, between GSUB and GPOS and even after GPOS. And if we want to use OpenType transformations only partially, we can always lock properties and hence avoid them to be modified by the font.

Meta-information

For T_EX, the only way to include metadata (that is: information which is not part of the page description) in a DVI file is through the \special primitive. “Specials” are not supposed to interfere with typesetting, but they actually do: if we write

```
A\special{blabla}V
```

there will be no kerning between these two letters. Which means that if we want to change the color of letter ‘V’ only, we will lose kerning. In Omega₁, there is a primitive allowing us to avoid this problem: \ghost (which would emulate the behaviour of a glyph related to kerning, without actually typesetting the glyph), but this solution is rather clumsy.

Using signs, we can insert the color information as a property and then include the necessary PostScript code for changing color, long after kerning has been applied (kerning, which, by the way, is also a sign property), or even leave the color property in the DVI file and let (sign-compatible) dvips read that information and write the appropriate PS code.

One could even define sign properties having no effect whatsoever on typesetting. For example, in

Arabic, one could mark the letters *alef* and *lam* of the definite article, or the letter *waw* of the “and” particle, as playing these specific grammatical rôles, so that we can easily distinguish them from letters *alef+lam* or *waw* which just happen to be at the beginning of a word. The interest of this lies in the fact that Arabic is not visually separating them from the following word.

Or, again in Arabic, one could imagine a morphological analyser (acting as an external OTP) which would give the letters of the Semitic root of each word a specific sign property. Such letters would be *alkitābu* (the book), *kutubun* (books) *aktubu* (I write), etc. This is the kind of information which would enormously facilitate searching and indexing, but which we would like to avoid representing visually since it would only obstruct reading.

Characters, Sign Properties or Higher Order Markup?

In the previous section we have suggested uses of sign properties which do not affect typesetting. Most often these can also be achieved by characters or by higher order markup.

For example, Ω besides being a popular software project is also a letter of the Greek alphabet *and* the symbol for the SI unit for resistance, named after its inventor Georg Simon Ohm (1789–1854). To distinguish between these two uses of the same symbol, Unicode provides two different characters (U+03A9 and U+2126). Clearly it would be preferable to use one of them should to distinguish between “Omega” and “Ohm,” rather than sign properties or higher order markup.

We mentioned the possible use of sign properties for marking the current language. This can seem practical but also has drawbacks: languages are nested, even if their nesting is not always compatible with the logical structure of the document. It would be better to use L^AT_EX commands for marking languages since these commands will not interfere with micro-typography. Indeed, the author can hardly imagine the need of changing the language of a word in the very middle of it, so that we incur the danger of losing kerning or hyphenation⁸).

⁸ Although, nowadays, people use more and more language mixtures, like the notorious French *antislash* for “backslash” . . . In fact, in French one has anglicisms (French words used with their English meaning, like *librairie* for [code] library, etc.), English words that found their way into French vocabulary (*week-end*, *starlet*, etc.), English words that have been artificially gallsized (*débogage* ← “debugging,” *shunter* ← “to shunt”, etc.) and many other levels of interaction between the two languages. Hyphenation of these words de-

Hence, such properties can, at first sight, very well be handled by usual higher level markup.

The best possible use of sign properties is for cases where control sequence tokens would otherwise interfere with the very fragile operations of microtypography and hyphenation.

Glue, Penalty, CJK Languages

Be it fixed or flexible glue, it is now possible, through sign properties, to add it to glyphs, without affecting already existing kerning (which would be added to this glue), ligatures, hyphenation, OTPs that may match the word, etc.

The typical example is letterspacing: how do you increase space between letters⁹ while keeping hyphenation of the word, f-ligatures, etc.? Before Omega₂, to achieve this, the author was bound to define special font metrics (with tens of thousands of kerning pairs). Now it suffices to add a simple *kern* property to each sign.

Glue for all glyphs is also required in CJK languages where there are no blank spaces between ideographs but where one sometimes needs to shrink or stretch the contents of a line because of a punctuation mark or a closing delimiter which are not allowed to be on line begin, or an opening delimiter which is not allowed on line end. So, even if this is not obvious when reading such text, we do put some glue (with a very small amount of flexibility) between *every* pair of ideographs. In Omega₁ this is handled by OTPs, but once such an OTP is used, the ones following it cannot match patterns of ideographs anymore because of the control sequence tokens between them. Once more, it is more natural to systematically add a small amount of glue to each ideograph, using a sign property.

Adding glue to every ideograph is a good thing, but how do we avoid lines starting with punctuation or closing delimiters?

If we can add glue to signs, why not penalties? In that way the space between an ideograph and a punctuation mark or a delimiter will be exactly the same as for all other ideographs, but using an infinite penalty value, line breaking will be prohibited at that point.¹⁰ Here is an example of some ideographs

depends on their level of French-ness, which can vary temporally and geographically.

⁹ *Cave canem!* Letterspaced typesetting should be attached to specific semantics and should never be done for justification reasons only, otherwise it is like stealing sheep.

¹⁰ We don’t have that problem in Latin typography because line breaking is allowed only at glue nodes (that is, mostly between words) and inside words using hyphenation—but a punctuation mark has no *lc_code* and hence cannot be matched by a hyphenation pattern.

and the corresponding values of glue and penalty (as used by the author):

c=9019 這 glue=0pt stretch=.025em g=這	c=672C 本 glue=0pt stretch=.025em penalty=10000 g=本	c=3002 。
---	--	----------

to obtain: 這本。

Glue vs. the “Space Character”

It is well known to us T_EX users, that T_EX (and thus also DVI) has its own philosophy about how words are separated, namely by glue. The DVI page is like a sea of glue in which glyphs navigate and give the impression of forming words by getting closer to each other. But this is only illusion. In DVI there is no way of distinguishing between, for example, inter-word space and kerning. It is the human eye that deciphers spaces between some letters as being word separators (and the narrower these spaces are, the more difficult is reading). In other markup or typesetting systems, things are different. Unicode defines character U+0020 SPACE as well as a dozen other “whitespace characters.” Some of them are extensible and others of fixed width. PostScript uses a mixed approach: when the glyph of the space character has the right width, it is used in strings; when a different width is needed, due to justification, PostScript uses horizontal skips, similar to DVI ones. But in PDF space characters must be present, since people may copy-paste text into other applications: they would be quite surprised to find blank spaces are missing . . .

To be able to distinguish glue produced by interword space from glue entered explicitly, we use a sign for interword glue. This sign has a character part which is one of the Unicode whitespace characters and a blank glyph part. “Blank” is not the same as “void”: this sign has indeed a glyph, which can therefore be matched by OpenType lookups, but this glyph has no contour and its advance vector can vary.

Using this approach, not only can OpenType lookups match whitespace glyphs but we can also produce adequate PDF, SVG and XHTML code (for example: in XHTML, interletter kerning should be ignored but interword spaces must be kept in form of Unicode whitespace characters).

Conclusion and Caveats

Work described in this paper is experimental. In other words: what we present here is the latest status of our investigations and experimentations, in the frame of the research project INEDIT of ENST

Bretagne. Our goal is to provide a new microtypographical model for typesetting (different from the node-model of T_EX) which will be Unicode- and OpenType-compliant, which will provide more control to the user than any Unicode or OpenType-compliant application, and which will produce documents with sufficient information to be converted into any present or future electronic document file format.

There is a discussion list omega@tug.org hosted by TUG and dedicated to this project. To subscribe, please visit:

<http://tug.org/mailman/listinfo/omega>

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Designing an implementation language for a T_EX successor

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February 27, 2005

Abstract

Managing the complexity of T_EX's codebase is an arduous task, so arduous that few mortals can hope to manage the underlying complexity. Its original author's computational roots date back to a time where the maturity and expressive power of existing programming languages was such that he chose to employ the assembly language of a fictional processor for the examples in his seminal work "The Art of Computer Programming". In a similar vein, T_EX is written in a stripped-down subset of a now-extinct Pascal dialect. Current adaptations of the code base include more or less literal translations into Java (NTS and exTeX), C++ (the Omega-2.0 codebase), mechanically generated C (web2c) and a few others. In practically all currently available cases, the data structures and control flow and overall program structure mimic the original program to a degree that again requires the resourcefulness of a highly skilled programmer to manage its complexity. As a result, almost all of those projects have turned out to be basically single-person projects, and few projects have shown significant progress beyond providing an imitation of T_EX.

It is the persuasion of the author that progressing significantly beyond the state of the art as represented by T_EX will require the expressiveness and ease of use of a tailor-made implementation and extension language. Even a language as thwarted as Emacs Lisp has, due to its conciseness, rapid prototyping nature, extensibility and custom data types and its coevolution with the Emacs editor itself, enabled progress and add-ons reaching far beyond the original state as conceived by its original authors. This talk tries to answer the question what basic features an implementation platform and language for future typesetting needs should possess.

1 Problems of T_EX

Managable problems

- Simplest measures such as `\boxstretch`, `\boxfilstretch`, `\boxshrink` etc are not available.
- Boxes can't reliably be deconstructed (`\special`, single character etc. can't be removed, boxes can only be taken apart from the end)
- Variables that T_EX employs for decisions are partly unavailable (in some cases because of system-dependent rounding)
- Peculiarities like the loss of the first line's baseline (for `\vtop`) by whatsits, `\splittopskip0pt` and other.

Problems of the macro language

- Only global register pools indexed by number are available. There are no lexically local variables, the grouping structure does not match the macro structure.
- macro arguments get `\catcodetoo` soon, complex patterns are not easily parseable. Maybe `\lazy\def` would help?
- Implementing regular input languages is hard.

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Interoperation problems

T_EX

- only knows its own font formats, metrics and ligatures.
- does not talk to graphic programs
- can't trigger reformatting of external material.

Algorithmic problems

- T_EX is either perfect, or deficient: paragraphs are optimized globally, but the vertical breaks are “local best fit” without feedback to horizontal breaks or future pages.
- T_EX has no sane concept for asynchronous user code. `\output` is shielded with the expedient of additional grouping and has no multithreading concept.
- T_EX has no possibilities for making use of side-effect free user-defined code. Consequently, user-defined code can't be used in several speculative contexts.

2 Document examples

2.1 Line numbers

Task at hand

- 1 If your ultimate goal is to produce a set of files in a different format that can be produced by GhostScript, take a
- 2 look at the `tightpage` option of the preview package. This will embed the page dimensions into the PostScript
- 3 code, obliterating the need to use the `-E -i` options to Dvips. You can then produce all image files with a single
- 4 run of GhostScript from a single PostScript file for all images at once. The `tightpage` option requires setting
- 5 the `dvips` option as well.
- 1 Various options exist that will pass T_EX dimensions and other information about the respective shipped out
- 2 material (including descender size) into the log file, where external applications might make use of it.
- 1 The possibility for generating a whole set of graphics with a single run of L^AT_EX, Dvips, and GhostScript increases
- 2 both speed and robustness of applications. It is to be hoped that applications like L^AT_EX2HTML will be able to
- 3 make use of this package in future.

Current line number implementations

Implementation with `lineno.sty`:

1. Replaces all interline penalties with forced page breaks.
2. This triggers a special output routine placed before the principal output routine.
3. This special routine places the line numbers and reinserts the correct penalties.
4. The normal Output routine is called.
5. A label-like multipass mechanism resets line numbers at the start of the page.

What would be saner for line numbering?

1. For migrating boxes into the main vertical list, a special “context” is defined that assembles a parallel column of ‘unfinished’ line numbers.
2. The unfinished objects take up constant dimensions and will be translated into glyphs either in the context of the output routine or at shipout time, since then the page start is known.
3. Consequently, a multipass algorithm is not necessary.
4. In the same context `\label`-commands referencing line numbers are expanded.

2.2 More complex Problems

Synchronized texts...

<p>κεῖνος δ' αὖ περὶ κῆρι μακάρτατος ἔξοχον ἄλλων ὅς κέ σ' ἐέδνοισι βρίσας οἰκόνδ' ἀγάγηται. οὐ γάρ πω τοιοῦτον ἴδον βροτὸν ὀφθαλμοῖσιν, οὔτ' ἄνδρ' οὔτε γυναῖκα· σέβας μ' ἔχει εἰσορόωντα. ἔχθεσθ', ἀλλ' ἔτι ποῦ τις ἐπέσσειται ὅς κεν ἔχησι δῶματά θ' ὑπερέφεα καὶ ἀπόπροθι πίονας ἀγρούς.« ὡς φάτο, τῆς δ' εὐνήσε γόνον, σχέθε δ' ὄσσε ῥόοιο.</p> <p>ἦ δ' ὑδρηναμένη, καθαρὰ χροῖ εἴμαθ' ἔλοῦσα, εἰς ὑπερῶν ἀνέβαινε σὺν ἀμφιπόλοισι γυναιξίν,</p>	<p>160</p> <p>760</p>	<p>Aber keiner ermißt die Wonne des seligen Jünglings, [Hause! Der dich gewinnt mit den reichsten Geschenken und führt dich nach Denn ich sah noch nie solch einen sterblichen Menschen, 160 Weder Mann noch Weib! Mit Staunen erfüllt mich der Anblick! Ganz verhaßt; es bleibt ihm noch ein, daß er beherrsche Dieses hohe Haus und die weiten gesegneten Felder. Also sprach sie und stillt' ihr den Gram und hemmte die Tränen. Und sie badete sich und legt' ein reines Gewand an, Ging hinauf in den Söller, von ihren Mägden begleitet, 760</p>
--	-----------------------	---

Footnotes in running paragraphs

ösen Neigungen zusammen.^d Methodisch bedeutsam ist aber^e wieder die Gewinnung des Endpunktes <für die Gegenwart>. Dieser^f muß in einer absoluten und endgültigen Synthese liegen, die eben deshalb nicht aus der natürlichen<, ihrem Wesen nach relativistischen> Lebensbewegung ^gstammen oder hervor-

-
- a** *In A folgt:* wesentlich **b** *A:* Staatsorganismen,
 - c-c** *A:* zukünftige und gegenwärtige
 - d-d** *A:* Dass er dabei materiell zu einer sehr konservativen, mittelalterlich ständisch gefärbten und zugleich wieder real-politisch und national gesinnten Staatsauffassung kommt, ist eine Sache für sich. Auch dass die Konstruktion der Entwicklung, die im Grunde immer nur mit einem sehr biologisch getönten Lebensbegriffe arbeitet, kein logisches Fortschrittsprinzip hat, sondern an dessen Stelle sich auf die Vorsehung beruft, ist eine der besonderen Ausführungen des Grundgedankens. Es gibt hier nicht viel mehr als Spielereien mit völlig unzulänglichen historischen Kenntnissen.
 - e** *A:* erst **f** *A:* Er
 - g-g** *A:* mit ihrem unaustilglichen Realismus und Relativismus stammen könne

Nested footnotes

<dabei> ist, daß alles das immer nur Einzelentwicklungskreise sind^b und daß der Fortgang zu einer universalen Verknüpfung all dieser Kreise mit dieser Me-

en und Konsequenzen recht interessant, ganz abgesehen von ihrem materiellen Inhalt. Hier über das Problem der Geschichtsphilosophie und des Entwicklungsbegriffes Bd. I S. V und ^c97. Der^c alles durchdringende Bewegungsbegriff I 5, 49 f., 30, 179, 251. Universalgeschichte und Vorschung ^I 79, 147, 95 f. Zusammenfassung von Smith, Montesquieu und Burke ^I 86. Mangel eines archimedischen Punktes ^I für Natur und (offenbarungslose) Geschichte ^I 35 f. Die Tendenz des Ganzen ^{III} 328: „Den Staat ideenweise (d. h. als Synthese aus Gegensätzen und intuitiv) begreifen heißt ihn für die Gegenwart beseelen, beleben, mit Religion tränken.“^d ¹²⁰ <Damit ist auch hier der Zusammenhang der Historie und der gegenwärtigen Kultursynthese scharf behauptet.> Die Ablösung Burkes durch De Bonald, Verm. Schriften^e I 311 ff. Wichtig und interessant ist^f der „Briefwechsel mit Gentz ^I 1800–1829“, Stuttgart 1857. – Außerdem hat mir eine lehrreiche Berliner Dissertation von Georg Strauß über „Die Methode A. Müllers in der Kritik des 19. und 20. Jahrhunderts“¹²¹ vorgelegen^g.

a–a *A*: Romantiker hat dann weiterhin in die Ferne geführt, indische, persische, spanische, französische, englische Geschichte und Geistesentwicklung den Forschern als Gegenstände unterbreitet. Es ist hier nicht möglich, all dem ins einzelne zu folgen und ebenso unmöglich, die mannigfachen Fortwirkungen H. W. Riehl und Gustav Freytag, bis Radowitz und Gierke, Roscher und Knies, Heinrich Leo und Stahl, Boisserée und Schnaase usw. zu schildern, wobei das Hauptinteresse in den jeweiligen Modifikationen läge.

b *A*: sind, **c–c** *A*: 97; der

d–d *A*: III, 322. Den „Staat ideenweise zu begreifen“ heisst ihn für die Gegenwart „beleben, beseelen, mit Religion tränken.“

e *A*: Schr. **f** *In A folgt*: auch

120 Vgl. Adam Müller: Elemente der Staatskunst, Dritter Theil (1809), S. 238: „Erinnern Sie sich aber, daß es die Grundbestrebung war, den gesammten Staat und alle seine Institute ideenweise zu ergreifen – d. h. ihn zu beleben, zu beseelen, mit Religion zu tränken.“

Objects

- are elements of the various horizontal and vertical lists.
- can belong to different classes.
- classes can be added as well as extended.
- objects can have their own contexts for particular migrations.

Optimization

Global optimization leads to combinatorical explosion of run time. Countermeasures:

1. reduction of interdependencies by separated contexts
2. serialization by tying the optimization to migrations
3. limited backfeed, preferring multiple passes.
4. make do with less than full optimization.

Disadvantages

- higher memory impact since decisions need to remain revertible to some degree.
- higher computational resources because of backtracking
- quite a bit of potential for infinite or almost infinite loops and calculations.
- Programming a full T_EX clone on such a platform appears possible, but pointless.
- Decomposition or analysis of several variants can be expensive.

Implementation language

- should offer natural expressivity for lists, T_EX-typical strings and token lists.
- should make the required mechanism natively available.
- automatic garbage collection.
- need not be a single layer: instead of T_EX's Pascal/T_EX-macro layering a more tiered concept like C/Scheme/T_EX-core/T_EX-Macros would be possible.
- Problematic: Coroutines. Smalltalk? Ada?
- Problematic: I/O (memory for tentative I/O)?
- Combination with low-level languages like C desirable.
- Low-level implementation of fast algorithms on custom data structures should be possible
- Avoidance of unnecessary language features.

CTAN progress report

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2005-March-07

Abstract

This is an update on the work being done on CTAN, and is a follow-up to the prior article *CTAN Plans*.¹ We sketch some challenges, outline our goals, and describe the work to date.

CTAN could be considered, at present, a great success. It is the authoritative collection of T_EX-related materials, with about eight gigabytes of community contributions. It has many visitors, who seem to be leaving with what they want— for instance, every day the `tug.ctan.org` site alone sees seven thousand web visitors and has ten gigabytes of FTP downloads.

But despite this, CTAN must change. It was developed in early 1990's as an FTP archive with an expected audience of sysadmins and T_EXperts. Now, with the rise of personal systems, the average T_EX maintainer is a struggling user who relies on their distribution and who works in isolation (i.e., has no easy access to an expert, either in computer systems or in T_EX).

In recent years, DANTE has generously sponsored meetings among CTAN maintainers and others to discuss how to move forward in response to this new world.

What's wrong?

We will sketch the most pressing issues facing CTAN, but for more discussion see the *CTAN Plans* article.

Issue number one is that our visitors often have trouble finding things. Some reasons are that the archive is big, that many packages could fit into it in more than one place, and that some places on the archive hold so many packages that browsing through them all is impossible. That is, CTAN's growth has become sprawl.

One reason for this is our second issue, that administration is labor-intensive. Each of the maintainers is a volunteer. Yet each spends hours a day on the archive and energy for organizational efforts beyond routine installations can be hard to find. (Note, however, that a sometimes-proposed alternative to an administered archive where individual package authors decide what files to include and where their package should go could easily make the archive even more poorly organized than it is now.)

The third issue for CTAN is that we should offload more traffic to our mirrors. Users are poorly served by being forced to contact the core locations. The chief roadblock with mirrors has been that users often want to get a `.zip` bundle of an entire directory and most mirrors do not provide the bundling functionality.

Another issue is our desire to keep histories of at least some packages. This would allow users with a document that works only with an old version of a package to regenerate their output.

The fifth issue that has been a theme in our discussions is that we must do at least some customized stuff. For instance, a Google search of CTAN for “margins” yields many hits that are not helpful to inexperienced visitors, such as `.dtx` files. We need directed searching.

The final issue—perhaps the most important—is that we need to interface with distributions. If a new package is uploaded, or a new version of an existing package, we should be able to right away offer it to people who rely on a distribution. This means packaging it for the distributions. Everyone involved regards this need as critical.

What has been done?

The change that has been the most important, even though it was behind the scenes, is that Graham Williams has moved his wonderful *Catalogue* of CTAN packages to a CVS tree. This database now consists of about 1500 XML files. He has also expanded the data model, the DTD for the XML files, to allow more kinds of metadata, such as documentation links

¹See http://www.tug.org/TUGboat/Articles/tb24_2/tb77heff.pdf.

and keywords. Maintaining these files is by-hand work, and so has increased the administrative load, but moving to CVS has cleared the flow of information in.

Another change is that we now ask for documentation from all contributors. We request it in PDF format, using Type 1 fonts. These have two advantages: in contrast with `.dvi` or `.ps` files they are readable to almost all of our visitors and so are better suited to be the target of search engine hits, and they showcase T_EX's typographic excellence.

We have also merged the directory `/macros/latex/contrib/supported` with its sibling `unsupported` to make the single directory `/macros/latex/contrib`, as the distinction between the two proved to be not useful.

These changes have something in common. All American schoolchildren know the joke, "Where does an 800 pound gorilla sit? Anywhere that he wants." and so in the US the phrase "800 pound gorilla" has come to mean something so big that it is hard to move. In some ways, CTAN is such a beast. All three changes were clearly the right thing to do, but all three were more involved than a person would think possible. For instance, a Google web search for `'/macros/latex/contrib/supported'` shows that even now, quite some time after the directory change was made, the Internet still contains many links to the old location.

What is being done now?

These are our major goals.

- We are moving to further integrating package metadata into the archive. An example is that we plan to drop the `nonfree` tree and maintain the license distinctions in metadata.
- For this, we are enriching the metadata. For instance, it will include more extensive package descriptions, keywords, lists of related packages, and categorizations of packages by functionality.
- We are engineering our processes to keep the metadata information accurate as our holdings change over time. In particular, we will give uploaders the ability to edit the metadata using web forms at the time of upload. (Actually, it can be edited anytime but we expect that most information will come in as the packages come in.)
- With the information accessible to us in those files, we will give our visitors ways to leverage it such as a database-backed web site, and extensive search facilities including full-text searches of the descriptions and of the package documentation and keyword searches.
- We will offer visitors better integration with our mirrors.

Our present targets are: Rainer's Schöpf's initiative to store the package `.zip` archives right in the file system (instead of having them generated on the fly) and the resulting upgrades of install script will greatly help us refer visitors to mirrors, Graham Williams's and Robin Fairbairns's work on enriching the *Catalogue* information is at the core of being able to build an information-rich site, and Jim Hefferon's work on a web interface that is further described below.

The outstanding major goal that remains stalled is to work out and implement a standard for interfacing with distributions.

Example: ctanWeb

Development of the web component of the project is proceeding steadily. The code is in a Subversion archive, and there is now a beta site development testing. This section describes some features that will likely be present in the end.

One of the main goals of the updated site is to be welcoming to T_EX beginners. For instance, the present top page has, in its second sentence, a link to an overview of T_EX and friends, and another link to a short description of the steps needed to get started on a Unix system, on Windows, or on OS X.

Visitors can browse the archive's directories in a way similar to that offered by `tug.ctan.org` today. However there have been some improvements, such as the incorporation of package descriptions into the browsing. (Also, these web pages are now static for faster response and decreased server load.)

Visitors can browse the packages by functionality. The exact description tree is still under development, but perhaps a person looking for information on how to set page headers under L^AT_EX would navigate their way through `Top > LaTeX > Page layout > Headers and footers` to get to a page listing a small number of packages, one of which is `fancyhdr`.

The updated site includes a provision to keep a history of certain packages as part of the package installation script.

Uploading of packages by developers is metadata-driven. For instance, a package author who gives us an update will get a screen to edit the metadata — description, version number, related packages, keywords, etc. This puts maintenance of the metadata in the hands of those best qualified to do it.

All metadata will continue to require approval by a CTAN administrator. However much of the approval process has been moved to the web so we can have people administering parts of CTAN remotely. In this way, we hope to increase the number of people involved in CTAN without requiring them to be system administrators.

Search facilities are considerably more advanced than on the present site. There is a search of package descriptions. There is also a search of all documentation files, including README files and .pdf files. This is better targeted than, say, a general `htDig` result; for instance, results show the package caption along with a link to the documentation so a person can better tell which responses are incidental hits and which are really of interest. (And, behind the screen, all of the searching relies on a database instead of `tug.ctan.org`'s present kludge.)

Conclusion

We've made progress on CTAN, and many of the elements of the final form have appeared (but much remains to do). We hope that the changes will help our visitors.

Acknowledgments

The CTAN team would like to gratefully acknowledge the support of the T_EX community in general, and especially that of the user groups TUG, UK-TUG, and DANTE. In particular, the author would like to thank DANTE for support to attend recent conferences, including EuroT_EX 2005. Without that support the work described here would not have been done.

Verbatim phrases and listings in L^AT_EX

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2004-11-11

Abstract

The `examplep` package written by the author recently provides sophisticated features for typesetting verbatim source code listings, including the display of the source code and its compiled L^AT_EX or METAPOST output side-by-side, with automatic width detection and enabled page breaks (in the source), without the need for specifying the source twice. Special care is taken so section, page and footnote numbers do not interfere with the main document. For typesetting short verbatim phrases, a replacement for the `\verb` command is also provided in the package, which can be used inside tables and moving arguments such as footnotes and section titles. The listings package is used for syntax highlighting.

The article reviews the design decisions made during the package development and also presents some interesting implementation internals. `examplep` is compared to standard L^AT_EX packages such as `listings`, `ltxdoc`, `sverb` and `moreverb`. The new `codep` package and its accompanying Perl script, which provide a convenient interface to the `examplep` package for authors of manuals, is also presented. With `codep` it is possible to generate the source code, the L^AT_EX or METAPOST output and the compilable example file onto the CD from a single source embedded into the appropriate place of the `.tex` document file.

1 Terminology

verbatim text A visually distinguishable textual part of the document (usually typeset with a monospaced, or typewriter font) that is allowed to contain the full ASCII character set. Verbatim text is often used to typeset parts of program source files, including T_EX source. Verbatim text must be marked up (i.e. surrounded) in the source of the L^AT_EX document, so backslash and other control characters are typeset verbatim instead of being interpreted as commands or special L^AT_EX characters.

inline verbatim A verbatim text passage inside a paragraph or table cell.

display verbatim is a vertical verbatim text block between paragraphs.

side-by-side display When typesetting program source in a display verbatim, it is often desirable to show the output of the program as well. This is especially useful when teaching scripting languages, so the reader can see the command and its effect side-by-side in a quick glance. For T_EX or METAPOST sources and EPS and PDF source files it is also useful to see the source and the typeset result side-by-side.

Source and Sample Side-by-side displays can be divided to *Source* and *Sample*, the latter being program output or typeset material.

CD-files Files accompanying a book, usually on a CD or DVD shipped with the book, or available for download on the home page of the book. These files usually contain some of the display verbatim material in the book, so readers do not have to retype them.

*Thanks to Ferenc Wetli for the fruitful long discussion about the line syntax of the `code` environment, and also for reviewing the article.

2 Special characters in the L^AT_EX source

The special meaning of the input characters in the source file must be disabled in verbatim mode – except for the character(s) that delimit the end of the verbatim text. The following characters have to be dealt with:

ASCII symbols The ligatures have to be disabled, especially ? ‘ → ¿ etc. The safest way is to make both characters of such a ligature active, and defining `\def?{\relax\string?\relax}` and `\def‘{\relax\string‘\relax}`. `examplep` issues similar definitions covering all such ligatures in the OT1- and T1-encoded CM fonts.

ASCII letters Most verbatim fonts don’t contain the “fi” or similar ligatures, so `examplep` takes no care to disable them.

special T_EX source symbols To disable the special meaning of the symbols `\ { } $ % ^ & _`, `examplep` redefines their `\catcode` for display verbatim. However, catcode changes are not always appropriate for inline verbatim, so `examplep` provides `\÷` (see below) which doesn’t change catcodes at all.

other ASCII punctuation Some of these characters (`[] ; ’ , . / ~ ! @ * () + | : " < > ? ‘ - =`) may be active, for example, `~` is `÷ ÷`, `‘` is a Babel shorthand (e.g. in the Hungarian language module, `magyar.ldf`); `"` is a Babel shorthand (e.g. in the German language module); `?`, `!`, `:` and `;` are activated (e.g. by the French language module), and other characters may be activated, too. So `examplep` sets the catcode of all characters in the range 33...126 to other (12). This includes all ASCII punctuation, letter and digit characters.

double carets For example, the letter “J” can be input as its ASCII code in hex, prefixed by double carets: `^^4a`. However, in verbatim mode we want the 4 characters, not the letter J. There is no problem in inline verbatim mode, because `^` loses its special meaning once its catcode is changed. However, when the verbatim material is written to a file or to the terminal, T_EX may change “unprintable” characters to escapes prefixed by `^^`. These changes must be reverted when reading the file back. See Subsection 7.2 for more.

high characters Input characters in the range 128...255 are usually activated by the `inputenc` package, and they know how to typeset themselves – so `examplep` leaves the catcode of such characters intact. However, in some modes, `examplep` has already changed all catcodes to 12 and 10 (with `\meaning`), so it has to change the catcodes of such high codes back to 13 (active).

3 Features of `examplep`

These are the most important, unique features:

- layout of side-by-side display may depend on maximum Source width
- automatic hyphenation of inline verbatim. The text is divided into words and punctuation symbols (based on catcodes). For words, the normal T_EX hyphenation patterns apply, and it is allowed to break the line on both sides of a punctuation symbol.
- customizable isolation of page, section etc. numbers in the Sample and the host document with the `PexaMiniPage` environment
- besides the outer level, inline verbatim (when properly escaped inside `\Q` or `\÷`) works safely inside macro arguments, section titles, footnotes, table cells and index entries
- generated CD-files with automatic page and chapter number
- writing verbatim data to CD-files with a Perl script; exact, binary reproduction of verbatim text is guaranteed
- ability to write different material to Source, Sample and CD-files

Table 1: Contexts and features of inline verbatim commands

	outer	argument	tabular	elsewhere	escaped
<code>\verb</code>	+	- ¹	+	- ¹	no
<code>\PVerbOpt</code>	+	+ ²	+	-	no
<code>÷</code>	+	+ ²	-	+ ²	no
<code>\÷</code>	+	+	+	+	yes
<code>\Q</code>	+	+	+	+	yes

¹sometimes displays the proper error message

²inner mode only (spaces compressed or lost, % is comment etc.)

- the accents `\H` and `\.` work as expected with monospaced fonts in the OT1 encoding. By default, `\texttt{\H o}` produces `ø` in OT1 encoding, because such typewriter fonts (such as *cmtt10*) have those accents replaced by ASCII symbols. `examplep` solves the problem by getting the accent from the *cmr* font family.

Some other features:

- side-by-side display of the Source and the Sample
- between-word hyphenation of inline verbatim
- customizable left and right indentation of display verbatim
- specifying inline verbatim with nested braces (`\PVerb`, `\Q`) or terminating character (`\PVerb`, `÷`, `\÷`)
- automatic line breaks with hyphenation in display verbatim
- the discretionary hyphen (`\hyphenchar`) of verbatim text is different from the one in normal text
- line numbering in display verbatim
- writing to temporary files only if needed
- reading back contents of any file in display verbatim
- inline verbatim with a single character (`÷`) and its escaped version (`\÷` and `\Q`)
- automatic `\indent`/`\noindent`, based on empty line above `\begin{...}`
- ISO Latin accented input character support in all modes (also present in `\verb`)
- support for syntax highlighting with the `listings` package [1]
- emits a tab as eight spaces in normal mode, but tabs are supported properly with `ttlistings=yes` and `ttlistings=showtabs`
- simple side-by-side display emulation without temporary files, using `srcstyle=leftboth` or `srcstyle=leftleft`

3.1 Escaped mode of inline verbatim locations

For compatibility reasons, `examplep` doesn't change the original `\verb` and `\verb*` commands in any way, but defines its own commands: `\PVerb`, `\PVerbH`, `\PVerbInner`, `\PVerbOpt`, `\Q`, `÷` and `\÷`. Most of the `\PVerb...` commands are historical. For new documents, only the use of `\PVerbOpt`, `\Q`, `÷` and `\÷` is recommended. Some of these commands have to be activated with package load options:

`\usepackage[Q=yes,div=yes,bsdiv=yes]{examplep}`. The reason why `÷` was introduced is that it is a high Latin-1 (and Latin-2) character available on the Hungarian keyboard, which is usually not used in L^AT_EX documents (in fact, `\div` is used instead). Inline verbatim sources with such a character are compact, and they can contain all ASCII symbols.

`examplep` supports inline verbatim text at the outer level, inside macro arguments, in table cells and elsewhere (in section titles, in footnotes and in index entries), see also in Table 1. The reason why some of these cases are treated differently is that catcode changes must be timed correctly so that the proper catcodes are active by the time T_EX reads the verbatim text from the input file for the first time. (Please note that section titles and index entries are also written to and read back from auxiliary files.)

This is quite hard to accomplish in several cases (because T_EX’s mouth gathers macro arguments at high speed, a way before T_EX’s stomach could change the catcodes), so `examplep` provides the commands `÷` and `\Q`, which do not change catcodes at all, so they work everywhere. Each special (say, not alphanumeric) character of the source text of these commands must be prefixed by a backslash, so T_EX’s eyes will see it as a controls sequence token. The backslashes are retained when the construct is written to auxiliary files, but they get removed upon typesetting. Letters, when prefixed by a backslash, get special meaning, for example `\V` denotes a visible space. For example, The construct `\÷\}\}` is seen by T_EX’s eyes as `\÷13\}\}`, and its gets typeset as `\}` (by running the command `\÷`). Please note that the construct is properly nested, because all braces are inside control sequence names. The same result (`\}`) can be achieved with `\Q{\}\}`. Both constructs are safe, because they can be freely moved to anywhere in the source file. However, for compatibility reasons, `\Q` is recommended, because its execution doesn’t rely on the current catcode of the terminating `÷` or `\÷`. A more complicated example: `“\Q{\}\V X\ }` gets typeset as “`_X`”. In escaped mode, `\V` denotes a visible, unbreakable space, `\S` and `_` denote default space (affected by the `pverb-space=` option), `\B` allows a line break there with a discretionary hyphen (affected by the `pverb-linebreak=` option), and `\n` flushes left and starts a new line.

The `\Pverb` macros can detect whether they have been invoked from within a macro argument. If so, they do not insist on catcode changes, but they emit all the tokens that has been seen by T_EX’s eyes. (Spaces are already compressed now, and everything after `%` is ignored etc., so this is not purely verbatim anymore.) However, this works only if the macro argument is properly nested with respect to braces, and it is delimited by braces (not a terminator character).

Please note that there might be problems with verbatim material in index entries processed by `makeindex` if characters `"`, `@`, `!` and `|` are not quoted properly with `"`. This is a generic `makeindex` issue. The quoting must be applied even inside verbatim material.

3.2 Horizontal alignment of the Source lines

The `verbatim` environment of standard L^AT_EX reads the whole verbatim text into a macro argument, thus limiting the length of the verbatim material to the available main memory. This is enough for about 3400 80-character lines. The `verbatim`, `moreverb`, `listings` and `examplep` packages parse the input line-by-line, so there is no such limit. However, with `examplep`, additional memory is required for aligned mode, which limits the maximum number of lines to about 2200 (32 pages) when the average line width is 80 characters. Please note that the maximums mentioned here may be lower if more packages are loaded; in another situation the maximum number of lines was 375. As a reference, a plain `\halign` with all lines having `(9999)\hfil\cr` only could accomodate about 5000 lines when no packages were loaded. The maximum memory can be increased by increasing the `extra_mem_bot` variable in `texmf.cnf` or in the environment.

There are two display modes used for display verbatim: paragraph and aligned (see the `\pexa@show@pars` and `\pexa@show@halign` macros, respectively, in the source). Aligned mode is used when multiple columns (such as line numbers and text) have to be aligned horizontally. Aligned mode uses the T_EX `\halign` primitive to do the alignment, and this primitive reads the whole construct into memory before typesetting it (in order to be able to calculate the column widths). The other one, paragraph mode, is used when horizontal alignment is not needed and side-by-side display is not used. In paragraph mode, each line is typeset as a separate paragraph, so the length of the verbatim text is only limited by the available disk space to hold the resulting DVI file. `examplep` chooses the mode automatically: for side-by-side display it always chooses aligned mode (so it can measure the width of the Source before typesetting it), otherwise, if the `srcstyle=` makes it possible, it chooses paragraph mode, otherwise it chooses aligned mode. See Figure 1 for details about Source styles.

Please note that the Source styles `leftboth` and `leftbothnumcol` display each line twice, as Source and as Sample, too. This is different from regular side-by-side display, because lines of the Source and Sample here are forcibly aligned, and this solution doesn’t use a temporary file. The source style `leftleft` is similar, but it lets the author specify different Source and Sample for the same line (they should be separated by `&` in the source).

```

srcstyle=left PAF
9srcstyle=leftnumhang PAF
9srcstyle=leftnum PAF
9srcstyle=leftnumcol AF when the last page number has 2 digits
srcstyle=center PAF

srcstyle=paralign PF with srcstyle=right PAF
srcstyle=leftboth | srcstyle=leftboth A source-par-align=justjust
9srcstyle=leftbothnumcol | srcstyle=leftbothnumcol A
srcstyle=leftleft | anything A

```

P: works in paragraph mode
A: works in aligned mode
F: works when Source is read back from file

Figure 1: The effect of the `srcstyle=` option

<pre> 1\chapter{My chapter}\label{c} 2Welcome\footnote{to our isolated 3minipage environment}! 4\newpage 5\section{My section}\label{s} 6The chapter begins on page 7\pageref{c}.\par 8\begin{equation}a^2+b^2=c^2 9\end{equation} 10\par Indented. </pre>	<pre> I My chapter Welcome¹! ----- ¹to our isolated minipage environment ----- 1 ----- 1 My section The chapter begins on page 1. $a^2 + b^2 = c^2 \quad (1)$ Indented. ----- 2 </pre>
--	---

Figure 2: Display verbatim isolation with the `PexaMinipage` environment

3.3 Display verbatim isolation

The `PexaMinipage` environment is provided, which is similar to the built-in `minipage` environment, but provides better isolation of the Sample from the container document, because it saves and restores section, page, equation (etc.) numbers and also marks (section titles in page headers). Labels (for `\label`, `\ref` etc.) are not isolated, because many packages use them in a non-standard way. See Figure 2 for an example.

The environment also cancels vertical skips (including `\belowdisplayskip`) at the bottom of its contents. For space conservation, `\abovedisplayskip` above the very first displayed equation is also canceled. To void this, put `\everydisplay{}` before the formula. The environment starts with `\noindent`, but subsequent paragraphs are indented.

3.4 Feature comparison

Although there are several L^AT_EX packages providing display and/or inline verbatim environments for L^AT_EX, `examplep` has some important unique features not found in other packages (see the beginning of this section for details). The author has tried the following packages before deciding to write `examplep`:

`verbatim` Although the `verbatim` environment is built-in into L^AT_EX, its most important limitation is that it eats up T_EX memory when typesetting very long verbatim material (of several hundred or thousand lines). The `verbatim` package fixes this, and provides the `\verbatiminput` command (similar to the `\PexaShowSource` command of `examplep`) and the `comment` environment (similar to `PIgnore` in `examplep`).

moreverb This package extends the `verbatim` package with additional features: proper handling of tabulators (also accessible from `examplep` with the `listings` interface), line numbering (also available in `examplep` with much more customization), `verbatim` surrounded by a frame (this is not available in `examplep`, but it works with `listings`, with page breaks allowed), the `verbatimwrite` environment writes its contents to a file (similar to the `WFile` environment in `examplep`).

sverb It provides display `verbatim` with tabulators and long environments, and it can read and write text from files. It also has a side-by-side environment (`demo`) with fancy frames. The `verbfwr` package (part of the `examplep` distribution) was derived from parts of this package.

syntax This package is written by the author of `sverb`. It provides generic and customizable inline `verbatim` support and it also has powerful features to typeset BNF-like grammars and syntax diagrams. It is documented that no attempt is made to make the constructs work inside macro arguments or section titles.

alltt This standard L^AT_EX package defines the `alltt` environment in which the characters `\ { }` retain their original meaning, so it is possible to do some manual formatting in the `verbatim` text.

fancyvrb [5] This is extremely configurable `verbatim` package provides inline `verbatim` even in footnotes, display `verbatim` even with side-by-side, line numbers on any side, all kinds of fancy frames even with page breaks, text formatting and writing and reading from files; and very long display `verbatim` text. Options can be specified any time within the argument of the `\fvset` command. The original `verbatim` environment is not modified, but a new one, `Verbatim` is defined. Setting the background color is not possible.

This package is not actively developed. Version 2.7 (dated 2000/03/21) is part of `teTEX`. Oddly enough, the newest version on CTAN is 2.6, which a file timestamp in 2004, but it dated 1998/07/17).

fvrb-ex This package is part of the `fancyvrb` distribution and uses the `fancyvrb` package. It provides a side-by-side display `verbatim` environment (`SideBySideExample`). A page break is not allowed in the Source after the `Sample`. The `xrightmargin` option has to be specified manually (e.g. `xrightmargin=3cm`). The first two characters of each line in the environment are ignored.

ltxdoc The most important features of `examplep` inspired by the L^AT_EX documentation package are display `verbatim` line numbering with `srcstyle=leftnum` and inline `verbatim` started with `÷`. The `ltxdoc` package typesets everything between two `|` characters as inline `verbatim`. This is not supported by `examplep` to avoid making an ASCII character active.

listings [1] The most important layout elements of this sophisticated, highly customizable, actively developed package missing from `examplep` are: background color, frames (with page breaks allowed), syntax highlighting and proper tabulator support. Except for the background color and frames, these features can be used from `examplep` with its interface to `listings`, see in Subsection 4.1. Use `\lstset{columns=fullflexible,language=C,backgroundcolor=\color{red},frame=trBL}` to try these features. `listings` also provides inline `verbatim` mode (with syntax highlighting), in the character-delimited argument of the command `\lstinline`; unfortunately, spaces at line breaks (with option `breaklines`) are rendered in an inconsistent way, and line breaks do not work well with background color.

`listings` has an important weak point: it cannot typeset ISO Latin accented characters with the `inputenc` package; the way described in the manual doesn't work as expected: it puts the accented characters to the wrong place in the line. This problem, however, is solved when `listings` is invoked from `examplep`. See more about `listings` in Subsection 4.1.

4 Customization

The operation of `examplep` can be customized with options as `<key>=<value>` pairs. Global options, which affect all subsequent commands within the current block, can be specified as package load options (`\usepackage[...]{examplep}`) or as argument of the `\PexaDefaults` command. L^AT_EX doesn't allow complicated option values (such as values containing some expandable macros, for example after `linenumberformat=`) to be specified in the `\usepackage` line – use `\PexaDefaults` in such cases. Many commands and environment accept local options, which affect only that construct.

All options have default values, which are indicated below right after the option name. If the option has a fixed set of possible values, all of them are mentioned, and they are prefixed by =. The defaults have been chosen so the `PSource` environment matches the builtin `verbatim` environment as closely as possible. Note that the original environment is not overridden before the `verbatimenv=yes` is specified.

`Q=unchanged` To enable `\Q`, use `=yes` instead of the default.

`abreak=unchanged` To enable `\abreak`, use `=yes` instead of the default.

`addvspace-bottom={\vskip\z@skip\addvspace}` Specifies the command to add vertical space below display `verbatim`. The default works fine, but e.g. packages maintaining the baseline grid might want to change it.

`addvspace-top=\addvspace` Command to add vertical space above display `verbatim`. The default works fine, but for example, packages maintaining the baseline grid might want to change it.

`allowbreak=yes` Use `=no` to disable page breaks in the Source of display `verbatim`.

`allowshrink=yes` The default will shrink the Sample horizontally if the Source is too wide. Use `=no` to disable this. Use `=force` to enable shrinking of Source, and with `srcstyle=leftleft` or `srcstyle=leftboth`, also enable shrinking of the Source if it is narrow.

`baseline-grid=no` Use `=yes` to adjust the height of the Sample to be an integer multiply of `\baselineskip` (with `yalign=u` and `yalign=v`).

`boxstyle=p` Controls how the Sample is boxed. Capital letters are not allowed for side-by-side display. By default (`=p`), a `PexaMinipage` environment is put inside a `\vtop`. Use `=h` to put a `\hbox` only, `=v` to put a `\vtop` only, `=V` to put a `\vbox` only, `=m` to put a `minipage` environment inside a `\vtop`, `=M` to put a `minipage` environment inside a `\vbox`, `=P` to put a `PexaMinipage` environment inside a `\vbox`, `=G` to add `\begingroup` and `\endgroup` only. The default is recommended for most cases, because the `\vtop` provides proper alignment with the Source, and the `PexaMinipage` environment provides isolation (of page and section numbers etc.) from the main document.

`bsdiv=unchanged` To enable `\÷`, use `=yes` instead of the default.

`div=unchanged` To enable `÷`, use `=yes` instead of the default.

`firstlinenum=1` Specifies the number of the first line of a numbered Source listing. Useful with `srcstyle=leftnumcol` and `srcstyle=leftnumhang`.

`linenumberformat={\dots}` Commands to display a line number and the separator in a numbered Source listing. See the default value in `examplep.sty`.

`linenumbersep={}` Commands to display the separator in a numbered Source listing.

`listings=no` Use `=yes` to display each Source line with the `listings` package. Specify options (to be executed in `\lstset`), separated by commas in the argument. Read more about the options in the documentation of the `listings` package. For example, `listings=yes` and `listings={}` uses `listings` with default options (no syntax highlighting), and `listings={language=C,showtabs}` enables syntax highlighting for C language and enables visible tabulators. See Subsection 4.1 for more information.

`listings-verbatimfont=pexavf` Set the font to be used in the Source when `listings=` is active. See `source-verbatimfont=` for the possible values.

`mp-equation-reset=yes` Use `=no` to make the main document and the Samples inside `PexaMinipage` share the same equation counter.

`mp-varioref-reset=no` Use `=yes` to make the internal counter `vrCnt` of the `varioref` package to be reset for each Sample inside `PexaMinipage`. This option doesn't affect the final output, and `varioref` expects this counter not to be reset, so it is not recommended to change the default.

`noligs=some` By default, only those ligatures are disabled whose second character is one of ‘ ’ , - < >. Use `=kernel` to get the same effect, but using the L^AT_EX built-in `\noligs`. Use `=most` to get all ligatures with either the first or the second character having code between 32 and 127 and catcode 12. Please note that ligatures in inline verbatim mode are disabled anyway, because `\allowbreak` is inserted between characters of catcode 12, depending on the value of `pverb-linebreak=`.

`pexamini-page-setuphook={}` Extra commands to run when starting the PexaMiniPage environment, just after the environment has finished its own initialization.

`pverb-hash=full` Use `=half` to make `\PVerb` convert `##` to `#`. The command `\PVerbH` is the same as `\PVerb` but forces `=half`. This is required when `\PVerb` or `÷` is used inside a macro argument. For example, `\textit{÷#÷}` yields the error message *Illegal parameter number in definition of \reserved@a*, but `\textit{\PVerbH{##}}` works fine. The error message is a general L^AT_EX kernel limitation, for example `\textit{@gobble{#}}` doesn't work either.

`pverb-hyphenchar=hyphen` By default, the minus character (ASCII code 45) is used to for automatic word hyphenation in inline verbatim. Use `=char'30` to have character with code 24; see also Subsection 7.6. Use `=none` to disable word hyphenation (by setting `\hyphenchar` to `-1`). Use `=unchanged` to get the `hyphenchar` from the font (the *cmtt* and *ectt* fonts have word hyphenation disabled). Please note that hyphenation around symbols is affected the `pverb-linebreak=` option, not this one.

`pverb-leftbreakmin=2` Specifies the minimum number of characters in inline verbatim after which it is allowed to break the line (with `pverb-linebreak=`). Values allowed are 0, 1 and 2, but 0 usually doesn't make sense.

`pverb-linebreak=char` By default, `\PexaAllowBreak` is inserted around symbols in inline verbatim, so a line break (with a discretionary hyphen affected by `pverb-linebreakchar=`) is allowed there. Use `=yes` to insert `\allowbreak` instead, which allows a line break without discretionaries. Use `=no` to disable line breaks around symbols in inline verbatim. The option `pverb-hyphenchar=` affects intra-word hyphenation in inline verbatim, not this one.

`pverb-linebreakchar={\lnot$}` Specifies the discretionary hyphen to be used in `\PexaAllowBreak`. See also `pverb-linebreak=`.

`pverb-space=invbreak` By default, spaces in inline verbatim are invisible, variable width (as allowed by the font, see also `pverb-stretchshrink=`) and breakable (i.e. a space can be replaced by a line break if necessary). Use `=invdisc` to get an invisible, variable width space which becomes visible (□) when it is broken at the end of the line. Use `=invfixbreak` to get an invisible, fixed width and breakable space. Use `=invnobreak` to get an visible, variable width and unbreakable space. Use `=visnobreak` to get a visible, fixed width and unbreakable space. Use `=visbreak` to get a visible, fixed width space with line breaks allowed on both sides. Use `=invbreakleft` to get a visible, variable width space with infinite stretchability if the line is broken there (this may have strange effect on other line breaks in the paragraph, so please try to avoid it). The built-in `\verb*` command uses `source-space=visnobreak`.

`pverb-stretchshrink=yes` By default, spaces in inline verbatim are forced to be stretchable and shrinkable (by `\quad/9`). Use `=no` to disable stretchability and shrinkability. Use `=unchanged` to keep the settings in the font. Note that `\fontdimen3` and `\fontdimen4` are changed by this option, and the changes are local to inline verbatim mode.

`pverb-verbatimfont=pexavf` Set the font to be used in inline verbatim mode. See `source-verbatimfont=` for the possible values.

`samplewidth=.5\PexaWidth` Specifies the maximum width of the Sample in side-by-side display as a T_EX dimension. The actual Sample can become actually narrower (see `allowshrink=`. The dimensions `\hsize`, `\linewidth` and `\PexaWidth` can be used. (Our L^AT_EX book used `samplewidth=.45\PexaWidth`.) `\leftskip` and `\rightskip` do not affect this option. `\hsize` can be used, which is the total width available (including the extra margins added by surrounding list environments), `\linewidth` is `\hsize` without the extra margins produced by lists, and `\PexaWidth` is the total width of the Source, the separator (see `vrule=`) and the Sample.

`source-par-align=left` Specifies the alignment of Source lines when `srcstyle=paralign` is active. Use `=left` (default), `=right` or `=center` to specified flush-left, flush-right or centered alignment, respectively. Use `=justify` to have the last line flush-left and the previous line justified (please note that each Source line is mapped to a single paragraph, so the paragraph will have more than 1 line only if the source line is too long). Use `=justjust` to have all lines justified. Use `=unchanged` to keep the alignment of the enclosing block.

`source-sepwidth=\tabcolsep` Specifies the horizontal distance between the Source and the Sample. See also `vrule=`.

`source-space=invfixbreak` Specifies how to typeset spaces of the Source. See `pverb-space=` for the possible values. The built-in `verbatim*` environment uses `source-space=visnobreak`.

`source-verbatimfont=pexavf` Sets the font to be used for the Source when `listings=` is not active (see also `listings-verbatimfont=` for `listings=`). Give `=ttfamily` to use `\ttfamily`, `=pexavf` to use `\pexa@@verbatimfont` (which defaults to `\verbatim@font`), `=latexvf` to use `\verbatim@font` (which defaults to `\normalfont\ttfamily`), `=unchanged` to keep the current font, or `=normalfont` to use `\normalfont`.

`srcstyle=left` Specifies the horizontal alignment of the Source lines. See more in Subsection 3.2 and Figure 1.

`ttlistings=` (no default) Shorthand of `listings-verbatimfont=ttfamily,listings=`.

`url=unchanged` To enable `\url`, use `=yes` instead of the default. The `\url` will be defined as `\def\url{\PVerbOpt{}}`. This has the disadvantage that inside `\textit` etc. it cannot typeset URLs having a single # (see `pverb-hash=` for more), but the `url` package has the same limitation. A quick fix: use `\itshape` instead of `\textit` etc.

`usewidth=skipwidth` Specifies which horizontal part of the main text should be used in a display verbatim. By default, left and right margins introduced by list environments (such as `itemize`) and `\leftskip` and `\rightskip` are respected. Use `=linewidth` to ignore `\leftskip` and `\rightskip` but respect list environments. Use `=hsize` to use the whole width of main text. Note that this option affects the calculation of `\PexaWidth`.

`vextrabotdepth=\z@` Dimension to add to the depth of the display verbatim with `yalign=v`. The default works fine, but for example, packages maintaining the baseline grid might want to change it for each instance.

`vextravskip=\z@` Amount of vertical space to be added above display verbatim with `yalign=v`. The default works fine, but for example, packages maintaining the baseline grid might want to change it for each instance.

`vsmallht=1pt` Specifies Sample height threshold for `yalign=v`. If the Sample is lower than this (or sample a higher than the 1st line of the Source plus `\vextravskip` – typical for `\includegraphics`), its top will be aligned to the top of the Source, otherwise its top baseline (with `\vtop`) will be aligned to the top baseline of the Source.

`xalign=1` Specifies horizontal alignment (`=1` for left, `=r` for right) of the Sample box (and the separator) within its allocated width for side-by-side display. Please note that `=r` works only with `boxstyle=h`, because all other box sizes use their full allocated width.

`xindent=deeeper` Specifies additional horizontal indentation in display verbatim mode. Use `=none` to get no extra indentation. Use `=narrower` to get `\narrower` (both `\leftskip` and `\rightskip` are decreased by `\parindent`). Use `=deeper` to move one level deeper in the list environment hierarchy and get that indentation. Use `=deeeper` (default) to move one level deeper, but don't change indentation (this is useful with `yindent=deeper` – otherwise it is equivalent to `=none`). Use `=deeperight` to set both left and right indentation from the left indentation of `=deeper`.

`yalign=u` Specifies vertical alignment in side-by-side display. By default, the top of the bounding boxes of the Source and the Sample is aligned, which looks nice if the Sample is an image, but doesn't align properly if the Sample is text with a font of similar size to the Source. Use `=b` to align the topmost baselines of

the Sample and the Source. This looks nice if the Sample is text, but it is ugly if the Sample is an image higher than `\baselineskip`. The use of `=v` is recommended, which decides between `=b` and `=u` based on the height of the Sample (see `vsmallht=` for the details).

`yindent=deeper` Specifies the vertical space separating display verbatim from the surrounding text. Use `=none` no have no extra vertical space, the display verbatim appears to be a new paragraph as far as `\baselineskip` and `\vskips` are concerned. Use `=deeper` (default) to move one level deeper in the list environment hierarchy (and use the `\parsep` and `\partopsep` etc. specified there). It is recommended to have `yindent=deeper` and `xindent=deeper` together, so there is no extra horizontal indentation.

`verbatimenv=unchanged` Use `=yes` to change the implementation of the `verbatim` and `verbatim*` environments to use the `PSource` environment.

`vrule=rule` By default, the Source and the Sample are separated with a vertical rule of width `\arrayrulewidth` in the middle of a horizontal space specified by `source-sepwidth=`. Use `=skip` to omit the rule but keep the space. Use `=none` to have no separator at all.

The other packages (`codep` and `verbfwr`) shipped with `examplep` do not have load options.

4.1 Interface to the listings package

The `listings` package [1] provides advanced typographic for display verbatim, including proper typesetting of tabulators and syntax highlighting for more than a hundred languages. `examplep` doesn't try to reimplement these features, but it supports calling the `listings` package to typeset the Source lines in display verbatim. The surroundings (line numbers, vertical separation, horizontal margins and the Sample) are not effected, only the Source line contents are passed to `listings`. This implies that the border and the background color support provided by the `listings` package doesn't work with `examplep`. To use the interface, the `listings` package must be loaded, and either the `listings=` or the `tlistings=` options of `examplep` has to be active when the Source is typeset. Additional options can be specified to `listings` in the argument of `\lstset` at any time. The interface has been tested with the `listings` package dated 2000/08/23 and 2004/09/07.

`examplep` treats tabulators (ASCII code 9) as 8 spaces. This is acceptable at the beginning of the line, but it may be incorrect elsewhere. To get tabs right, specify the `tlistings=yes`, or, to be more precise, the `tlistings={tabsize=8}` option to `examplep`. It is also possible to have visible tabulators: specify, for example, `tlistings={tabsize=8,showtabs}`. In our tests `listings` failed to detect the width of a character of a fixed width font, so `examplep` enforces character width using the natural width of the space each time it calls `listings`. This workaround made the `showtabs` `listings` option work properly. See the documentation of the `listings` package for options that affect the typesetting of Source line contents. See an example of using `listings` from `examplep` on page 16.

`listings` supports fixed width characters with a variable with fonts. However, this support seems to be broken when used with `examplep`, so the `columns=fullflexible` `listings` option is enforced so proportional fonts will look proportional. Although the `listings` package claims that it has accented letter support, this didn't work well with the single-character accented letters input using the `inputenc` package (those characters were positioned to a wrong place inside the line, possibly because `listings` has failed to recognise that `\lst@UseLostSpace\lst@PrintToken` has to be inserted in front of the accented character into its internal token list). `examplep` contains a work-around to this problem, with the following limitations: multibyte input encodings such as UTF-8 are not supported (will print strange error message); accented characters may not be part of keyword names in syntax highlighting; accented characters are shown as `^^` hex escapes in aligned mode (see in Subsection 3.2), so they don't work with `\PexaShowBoth`.

`listings`, when called from `examplep`, failed to break ligatures such as `'?` and `<<`. This has the side effect that guillemots would be typeset instead of bitwise right shift in C language sources. `examplep` modifies the `\lst@FillOutputBox@` macro so it will add a `\relax` between each character displayed – so all ligatures are broken. (This approach is quite different from the way L^AT_EX disables a few ligatures with `\@noligs`; `\pexa@noligs` is similar to `\@noligs` in this respect.)

It is possible to customize the `listings` package so it typesets some strings differently. For example, with the `literate={<=}{{\leq$}}1` `listings` option, all occurrences of `<=` (even those inside strings of the target programming language) are typeset as `≤`. There are no problems when using this feature from within `examplep`. It is also possible for strings and comments in the syntax-highlighted Source to span multiple lines – `listings` takes care to remember its internal state between lines.

5 Commands and environments

The arguments between brackets (`[` and `]`) are optional: either the the argument and the brackets are all missing all all present. The arguments named “options” is a comma-separated list of local customization options, defined in Section 4. The `{+}` notation in front of an argument means that the argument can be delimited by braces (thus it must be properly nested), or with any symbol in `\dospecials` (`\ $ & # ^ _ % ~`) or in `\pexa@cverb@donormals` (`' ! @ * - + = | : ; ' " , . / ? < > () []`).

`\PVerb[options]{+<verbatimtext>}` Typesets its argument in inline verbatim mode. Similar to the L^AT_EX `\verb` macro, but respects the options. The use of `[]` is recommended instead of omitting the options altogether, because `[]` will ensure that the proper catcode changes are in effect even for the first verbatim character. This command is robust.

`\PVerbH{+<verbatimtext>}` Shorthand for `\PVerb[pverb-hash=half]` (extra options cannot be specified). This command is robust.

`\PVerbInner\PVerb...` Forces the `\PVerb...` command immediately following it to work in inner mode, thus compressing spaces, respecting comment characters etc. Because of how T_EX works, it is impossible to go the other way round, and force outer mode, because it is too late change catcodes – the argument has already been tokenized in inner mode. This command is robust.

`\PVerbOpt{options}{+<verbatimtext>}` Equivalent to `\PVerb`, but uses a different syntax. For example, `\item[\PVerb[pverb-space=visbreak]{xy}]` doesn't work because of the nested `[`. Use this instead: `\item[\PVerbOpt{pverb-space=visbreak}{xy}]`, or `\item[{\PVerb[pverb-space=visbreak]{xy}]`. This command is robust.

`\Q{<verbatimtext>}` Similar to `\PVerb`, but its argument must be escaped (see in Subsection 3.1), and it can be used in section titles etc. Must be enabled with `Q=yes`. This command is robust.

`÷<verbatimtext>÷` Similar to `\PVerb`, but it can be used in section titles etc. (but not in `tabular`) (see in Subsection 3.1). Must be enabled with `div=yes`. This command is robust.

`\÷<verbatimtext>÷` Equivalent to `\Q`, but the argument delimiter is different. Similar to `\PVerb`, but its argument must be escaped (see in Subsection 3.1), and it can be used in section titles etc. Must be enabled with `bsdiv=yes`. This command is robust.

`\url{url}` Must be enabled with `url=yes`. This command is robust.

`\begin{WFile}{filename}` (defined in the `verbfwr` package) Writes its contents verbatim to the specified file. T_EX `.tcx` and line ending transformations apply, so it is possible that accented letters will be converted to `^^hex` according to the input encoding.

`\begin{WAux}` (defined in the `verbfwr` package) Writes its contents verbatim into the current `.aux` file. T_EX `.tcx` and line ending transformations apply, so it is possible that accented letters will be converted to `^^hex` according to the input encoding.

`\begin{PWSource}[options]` Combination of `\begin{WSource}` and `\PexaShowSource`. It is recommended to have a `[]` even if there are no options, so the very first token of the contents will be read with proper catcodes.

`\begin{WBoth}` Writes its contents to the Source and the Sample temporary file. It is a combination of `WSample` and `WSample`.

`\begin{WSample}` Writes its contents to the Sample temporary file (`pexa-sam.tex`), to be typeset by a subsequent `\PexaShowSample` or `\PexaShowBoth`. The line must end at `\end{WSample}` because of technical reasons.

`\begin{WSource}` Writes its contents to the Source temporary file (`pexa-src.tex`), to be typeset by a subsequent `\PexaShowSource` or `\PexaShowBoth`. It is similar to `\begin{verbwrite}` in the `sverb` package and the `\begin{filecontents}` L^AT_EX built-in environment. The line must end at `\end{WSource}` because of technical reasons.

`\begin{PIgnore}` Ignores everything up to `\end{PIgnore}`. The environment closer must be at the end of its line. Similar to the `comment` environment in some other packages.

`\begin{PSource}[options]` Typesets its contents in display verbatim. Similar to the L^AT_EX `\begin{verbatim}` environment, but respects the customization options. It is recommended to have a `[]` even if there are no options, so the very first token of the contents will be read with proper catcodes. This environment is similar to `PWSource`, but it doesn't create a temporary file, so it is faster, `srcstyle=leftboth` (etc.) can be used, and there is no ambiguity between `^~e1` and `ã` (etc., see more in Subsection 7.2). Page breaks are allowed between each Source line. (The implementation of this environment is fairly complex compared to `PWSource`.)

`\begin{verbatim}` Equivalent to `\begin{PSource}[]`. Must be enabled with `verbatimenv=yes`.

`\begin{verbatim*}` Equivalent to `\begin{PSource}[source-space=visbreak]`. Must be enabled with `verbatimenv=yes`.

`\begin{PexaMinipage}[vbox-type]{width}` Similar to the L^AT_EX `minipage` environment (and accepts the same arguments), but isolates (concerning section numbers etc.) of its contents from the main document more thoroughly. See Subsection 3.3 for details of isolation.

`\PexaShowBoth{options}` Typesets the Source and the Sample side-by-side in display verbatim mode. The Source comes from the temporary file written by the last `WSource` or `WBoth` environment, and the Sample comes from the temporary file written by the last `WSample` or `WBoth` environment. By default, a vertical separator line is drawn between the Source and the Sample, and page breaks are allowed in the Source after the end of Sample. It can be called multiple times with different options for the same file.

`\PexaShowSample{options}` Typesets the Sample (written by the last `WSample` or `WBoth` environment) in display mode. It can be called multiple times with different options for the same file.

`\PexaShowSource{options}` Equivalent to `\PexaInputSource` with the file written by the last `WSource` or `WBoth` environment. It can be called multiple times with different options for the same file.

`\PexaInputSource{filename}{options}` Typesets the contents of the specified file as Source in display verbatim mode.

`\begin{code}` (defined in the `codep` package) Typesets its contents side-by-side and also marks its contents to be dumped to the CD. By default, each line is emitted to all three streams, but lines with special prefixes will go into the Source, Sample or CD-file stream only. See Section 6 for details.

`\PexaAllowBreak` Allows a line break here with a discretionary specified in the option `pverb-linebreakchar=inserted`.

`\abreak` A robust command which inserts `\PexaAllowBreak` when the font `{\ttdefault}{m}{n}` is active; inserts `\allowbreak` otherwise. Must be enabled with `abreak=yes`.

6 Writing examples with the `codep` package

Textbooks and manuals tend to have many display verbatim examples. The examples are usually code snippets which can be further processed by a compiler or another program. Sometimes minor modifications, such as adding the proper header or trailer, are necessary before the code snippet can be processed. It is customary to put all code snippets in the book onto the CD accompanying the book. The `code` environment of the `codep` package (part of the `examplep` distribution) generates CD-files automatically.

Three streams are generated from the contents of each `code` environment: the Source, the Sample and the CD-file streams. Most parts of these streams are identical. The Sample usually differs from the Source because the code snippet has to be typeset specially in the book (for example, `\includegraphics` has to be used to typeset an EPS file whose Source is displayed). The CD-file differs from Source because additional header and footer may be required (such as `\begin{document}` etc.), which are omitted from the book to conserve space.

The `code` environment reads the code snippet line-by-line. The type of the line is specified in first two characters. Lines having the default type are written to all 3 streams, and special line types exist to write to a specific stream only. The `code` environment writes the Source and Sample streams to temporary files, and

upon the end of the environment, it calls `\PexaShowBoth` (or `\PexaShowSource`, if the Sample stream is empty) to typeset the example. The CD-file stream is not written to a file by T_EX, but the file name and starting line number of the code environment is reported in the `.aux` file. A Perl script (`wrfiles.pl`, part of the `examplep` distribution) has to be called later to the actual generation of CD-files. It will examine the `.aux` files, extract the CD-file stream from the `.tex` files, and dump these streams to individual files in the `CDfiles` directory. The file names can be specified in the `code` environment, and the environment can generate file names based on chapter and page numbers (so the reader will know from the file name where to read more about the example). The same file name is never generated again.

The `code` package was used in our recent L^AT_EX textbook [4] to typeset its examples. Most of the examples were written in L^AT_EX, but many of them were METAPOST sources, and some of them were others (e.g. configuration files, shell scripts or EPS files). Because of the huge amount of L^AT_EX examples, special features were added to make them easy and convenient to input for the author. For example,

```
\begin{code}
t \usepackage{url}
  URL:
  \\url{http://foo.org/~user/}
\end{code}
```

is displayed as (depending on the `examplep` options)

```
1%~\usepackage{url}          | URL:
2URL:                        | http://foo.org/~user/
3\\url{http://foo.org/~user/}
```

As seen above, examples are quite convenient to input, and `examplep` takes care of typesetting side-by-side, determining width of the Source, allowing page breaks, putting margins and `\vskips` right, adding the rule the separate the Source and the Sample, adding line numbers, generating file name for CD-file and writing the CD-file with header and footer.

With `codep` it is easy to fulfill the following quality criterias: the Sample must be consistent with the Source (i.e. if the Source is changed during editing to book, the Sample should change automatically); the CD-file must be consistent with the Source; the CD-file must be directly compilable with L^AT_EX (so a header and a footer have to be added). When the deadline of finishing the book approaches, there might not be enough time left to ensure these manually, so a package such as `codep` is very useful in this situation.

6.1 Example files on the CD

The following CD-file is generated from the code snippet above:

```
\documentclass{article}

\usepackage[latin2]{inputenc}
\usepackage[T1]{fontenc}
\usepackage[magyar]{babel}
\usepackage{url}

\begin{document}

URL:
\\url{http://foo.org/~user/}

\end{document}
```

The `CodeDefaultD`, `CodeDefaultL`, `CodeDefaultB` and `CodeDefaultE` environments can be used in the preamble to customize the default header and footer generated into the CD-file. For example:

```
\begin{CodeDefaultD}
\documentclass[10pt]{article}
\end{CodeDefaultD}
\begin{CodeDefaultL}
```

```

\usepackage[latin2]{inputenc}
\usepackage[T1]{fontenc}
\usepackage[english]{babel}
\end{CodeDefaultL}

```

Although T_EX is able to write to external files with `\textsf{write}`, there were several reasons for using an external program (a Perl script) to extract the source snippets from the document sources:

- with `\write` the file always ends at end-of-line
- `\write` forces `.tex` if no extension is specified
- `\write` removes whitespace from end-of-line
- `\write` translates accented letters to hat-escapes (e.g. `á` to `^^e1`) unless compiled with `latex -translate-file cp8bit.tcx (-translate-file il2-t1.tcx` makes `ö` in DVI incorrect). There is the same problem when emitting UTF-8 text.
- it is impossible to distinguish missing files from empty files, so accidental file overwrites are hard to prevent
- it is too late to verbatize if the verbatim text is inside braced macro arguments

The only limitations of this solution are: is not possible to `\input` or `\include` a subfile, and then use the `code` environment in the referrer file; the subfile has to be included with `\include{...}` or `\input{...}` (with braces); and the subfile must have extension `.tex`. The first one is usually not a problem, since referrer files themselves do not typeset text, they only include subfiles. See Subsection 7.7 for implementation details.

6.2 `\begin{code}` invocation

The input syntax of the `code` environment has been designed so that typing the most common examples (short L^AT_EX code snippets) is simple and straightforward, but the author can have full control over all three streams if he wants to. The contents of the environment is divided into lines. The first two characters of each line specify the line type and the rest is the line data. The first character of the line type is usually a lowercase ASCII letter or a punctuation symbol. Line types belong to classes, which are denoted by capital ASCII letters. The order of the classes in the environment is significant, but the order of the individual types or lines within the class is irrelevant. Some classes have default lines, which are used only if the class is omitted from the environment. The default lines make it possible to have default CD-file header and trailer. The classes, in proper order with allowed types in parentheses, are:

F (**f**, **f!**, **v**, **v!**) specify the file name.

D (**d**) the `\documentclass` line, default uses `article`

L (**l**) the preamble specific to the natural language, defaults for Hungarian `babel`, Latin-2 `inputenc`, T1 `fontenc`. Use the `CodeDefaultL` environment to override.

P (**p**≡**0**, **t**) the preamble with the `\usepackage` lines

B (**b**) `\begin{document}`

C (<≡**c**, >≡**o**, ⌋≡**2**, **w**, **s**, **x**, **%**) the document contents

E (**e**) `\end{document}`

The meaning of the complicated types are:

f Accepts a file name with extension. The use of `_` in the name is not recommended. The extension (e.g. `.tex`) is mandatory. The chapter and page numbers will be prepended to the file name (only the page number for document classes without chapters), for example `f foo.mp` may become `2_63_foo.mp` in chapter 2, on page 63.

v Like **f**, but removes the default lines from classes D, L, P, B and E. This is ideal for emitting non-L^AT_EX examples.

f! Like **f**, but don't prepend numbers to the file name.

v! Like **v**, but don't prepend numbers to the file name.

p≡0 Writes only to the preamble of the CD-file.

t Writes to CD-file, appends line prefixed by `%^` to Source. Useful to indicate in the book that a package is needed. Example: `t□\usepackage{url}`.

<≡c Writes to Source and CD-file.

> Writes only to Sample.

x Writes to Sample and CD-file.

⌋≡2 Writes to Source, CD-file and Sample.

w Writes only to CD-file.

s Writes only to Source.

% Comment, ignored.

The `code` environment omits the Sample part from the book if the Sample is empty, and it omits the whole display verbatim environment (but still writes to CD-files) if both the Sample and Source are empty.

6.3 An example with METAPOST code

If the `eempost` package is also loaded, the following code can be used to typeset a simple, syntax-highlighted METAPOST source and its output:

```
{\PexaDefaults{listings={language=metapost}}\begin{code}
v house.mp
> \begin{EempDef}{house.1}{\}{}
w beginfig(1)
  u:=18bp; picture V; V:=image(
    draw unitsquare scaled u xscaled 2;
    fill (0,u)--(2u,u)--(u,1.5u)--cycle
    withcolor red);
  draw V rotated 10;
  draw V shifted (3u,0);
w endfig; end
> \end{EempDef}
> \leavevmode\EempUseFig{house.1}{0}{0}
% ~~~ Dat: \leavevmode to get the Overfull \hbox warning
\end{code}
} % Dat: nothing allowed after \end{code} in its line
```

If `eempost` is not loaded, the following code should be used instead:

```
{\PexaDefaults{listings={language=metapost}}\begin{code}
v house.mp
> \begin{WFile}{house.mp}
x beginfig(2)
  u:=18bp; picture V; V:=image(
    draw unitsquare scaled u xscaled 2;
    fill (0,u)--(2u,u)--(u,1.5u)--cycle
    withcolor red);
  draw V rotated 10;
  draw V shifted (3u,0);
x endfig; end
> \end{WFile}
```

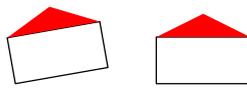
```
> \leavevmode\includempshouse.2}
\end{code}
}
```

The `\includempshouse` command should be defined in the preamble as:

```
\usepackage{graphicx}
\DeclareGraphicsRule{*}{mps}{*}{}
\makeatletter
\ifundefined{Gininclude@eps}{\def\Gininclude@mps{\Gininclude@eps}}
\def\includempshouse{\ifnextchar[\includempshouseb{\includempshouseb[]}}
\def\includempshouseb[#1]#2{\includempshousec[#1]#2@nil}
\def\includempshousec#1#2.#3@nil{%
  \IfFileExists{#2.#3}{\includegraphics[#1]{#2.#3}}{
    \GenericWarning{Please run: mpost #2^^J@gobble}}
\makeatother
```

This should work with both `dvips` and `pdflatex`. The typeset output looks like this:

```
1u:=18bp; picture V; V:=image(
2 draw unitsquare scaled u xscaled 2;
3 fill (0,u)--(2u,u)--(u,1.5u)--cycle
4 withcolor red);
5draw V rotated 10;
6draw V shifted (3u,0);
```



7 Some implementation details

7.1 Starting from poor man’s inline verbatim

The following macro, derived from a macro in the `.dtx` documentation of David Kastrup’s `binhex` package [2], typesets its argument in inline verbatim mode:

```
{\catcode\string'>12 \gdef\stripprefix#1>{}}
\def\verbatimize#1{\ttfamily
  \toks0{#1}\edef\next{\the\toks0}% Dat: make # OK
  \fontdimen2\font=0pt % Dat: hide spaces
  \expandafter\stripprefix\meaning\next
  \unskip % Dat: strip final space, possibly after command
  \fontdimen2\font=\dimen0}}% Dat: reset global change
```

This demonstration shows how useful the `TEX` primitives `\string` and `\meaning` are. Both of them convert tokens to characters with catcode 12 (other) or 10 (space). Token lists with spaces are hard to post-process by `TEX` macros, because `TEX` macro expansion ignores spaces before undelimited macro arguments. But it is possible to write a macro which converts spaces to anything with catcode 12, for example the `\sca` macro below does this:

```
\begingroup\catcode\string'‘12 \lccode'‘‘%\lowercase{\endgroup
  \def\scc#1 {\ifx\hfuzz#1\else#1\expandafter\scc\fi}}
\def\scb#1#2{\scc#2\hfuzz#1} \def\sca{\scb{ }}
% try with: \message{\sca{foo bar}}
```

It is possible to change `%` in the definition above to anything, including a space: the replacement character will have catcode 12. After such a conversion, the text to be emitted can be easily processed to add `TEX` macros, change catcodes back to 13 for ISO Latin high accented characters, replace spaces with appropriate constructs, insert `\allowbreak` to the right places to enable line breaks etc. The `\PVerb` macro, when invoked in inner mode (i.e. read inside a macro argument) works this way, and respects the options specified by the author.

7.2 Hex escapes with output translation

The T_EX primitives `\write`, `\message` and `\errmessage` may escape some characters when printing them. By default, T_EX changes the code ranges 0–31 and 127–255 (the codes outside the printable ASCII range), escaping such codes with a `^^`: for example, the tabulator (code 9) becomes `^^I`, and characters having a high code in the font (not the input) encoding are dumped in hexadecimal, for example `ø` (having code 174 in T1 encoding) becomes `Ž`. (This behaviour depends on the default `.tcx` file the T_EX distribution uses. No translation occurs with `cp8bit.tcx`. To spot the difference, run `tex -translate-file cp8bit "\message{^^I^^ifá}\end"`, and then change `cp8bit` to `.missing.`, and run again.) The transformation is lossy: both `\message{ø}` and `\message{\string^^ae}` yield the same result: `^^ae`. Escaping the caret as `^^5e` doesn't help either, because the T_EX unescapes carets recursively when reading back the written file. Since ISO Latin accented characters are more often needed in verbatim environments than double carets, `examplep` does the necessary unescaping when it reads the file back. The back-transformation doesn't work with UTF-8, because the 2nd byte is not decoded by the time the first one is being executed. The unescaping would be done by T_EX itself if the caret had its original catcode 7, but that would imply that the non-escaping, verbatim carets wouldn't work.

The unescaping is implemented in a straightforward, but ugly way in the `\pexa@dohex@low...` macros. The caret escapes are parsed in a huge `\if\else\if` construct nested in 40 levels, and once the hexadecimal code is available and converted to upper case, the `\lccode'+="(code)\lowercase{+}` construct is used to insert the appropriate character with catcode 12 (`~` is used instead of `+` to get an active character, catcode 13). The construct is not expandable, but it works because it is used for typesetting. The caret is made active and defined to execute `\pexa@dohex`, so each caret in the file will get unescaped.

7.3 Disabling ligatures

The only way to disable a ligature in T_EX is to insert a nonexpandable tokens into the input stream between the characters forming the ligature. For example, `f{i}` or `f\relax i` can be used to get “fi” instead of “fi”. The most important ligatures (in addition to ligature letters) to be disabled in verbatim mode are: `<< >> ? ' ! ' , , ' ' ' --` and `---`. This can be accomplished by inserting a `\relax` token in front of each `' ' , - <` and `>`. The `\pexa@noligs@some` command of `examplep` does exactly this, for example, it defines `{\lccode'~<13 \gdef~{\relax\string~}}`. The definition slightly different from the one of the `\@noligs` command in the L^AT_EX kernel: `\def<{\leavevmode\kern\z@\char'\<}`; but the effect is the same. The `\pexa@noligs@most` command, on the other hand, makes all characters with category code 12 in the range 32..127 active, and adds `\relax` to both sides. This change doesn't affect ASCII or accented letters, but usually there are no ligatures with letters in typewriter fonts. See also the `noligs=` load option.

7.4 Detecting inner/outer brace in inline verbatim mode

The `\PVerb` commands work differently based on whether they are inside a macro argument or not. More precisely, they detect whether they are able to change the catcode of the following token. If so, they are in outer mode (i.e. outside a macro argument), so they change all the other catcodes as well, so consecutive spaces and comment characters will be included in verbatim, too. Otherwise, they are in inner mode, their argument is already read and tokenized by T_EX's eyes, so changing catcodes is pointless.

The auto-detection works this way: the catcode of all the special characters (as enumerated in `\dospecials`; including braces) is changed to 3 (math-shift). Then the next token is read into `\reserved@a` with `\afterassignment\pexa@cverb@gottoken\let\reserved@a=`. No tokens are ignored this way, not even spaces. The `\pexa@cverb@gottoken` macro then examines the catcode of the character in `\reserved@a`, and if it is 3, it continues in outer mode, otherwise it continues in inner mode. In inner mode, the next token is forced to be an open-brace, because verbatim material with braces not nested cannot be read into inner mode anyway (T_EX would print an error message when it is trying to find the end of the macro argument containing the `\PVerb` construct).

Another common trick is used when parsing the argument in outer mode when it is delimited by braces. Normally a T_EX macro expansion (using the definition `\def\pexa@cverb@outerc#1{...}`) can read an argument that is in braces, but in our case the very first opening brace has been already read (by `\let` above), so we have to insert it back: `\catcode'\{1 \catcode'\}2 \expandafter\pexa@cverb@outerc\expandafter{\iffalse}\fi`. The `\iffalse}\fi` here is needed for making the definition properly nested.

7.5 Inline verbatim in section titles

The T_EX command `\write`, `\message` and `\edef` fully expand their arguments, and similar expansion is enforced by the `\markboth` built-in L^AT_EX macro for section titles and page headings. Therefore macros in section titles have to be protected so their expansion is delayed until the section title is typeset. L^AT_EX offers `\protect` for this: if the macro control sequence is preceded by `\protect`, its expansion is properly delayed; the expansion of the argument has to be delayed manually in a similar way. Some macros have `\protection` included; they are called “robust”. If the definition a macro starts with `\DeclareRobustCommand` instead of `\newcommand`, the macro is defined to be robust (and its body can be retrieved by looking at the control sequence with a space added, e.g. `\expandafter\show\csname□sqrt□\endcsname`).

`\protect` can have three definitions depending on what time it is processed: it is `\string` in a `\typeout` or a L^AT_EX error or warning message (try `\typeout{\meaning\protect}`); it is `\noexpand\protect\noexpand` when `\write`ing to a file (most commonly the `.aux` file); otherwise it is just `\relax` (\equiv `\@typeset@protect`; try `\pagestyle{headings}\section{\meaning\protect}` and spot the difference between the main text, the section title and the `.aux` file).

The `\÷` and `\Q` inline verbatim commands are made robust, so they can be used in macro arguments. In fact, they are extra-robust, since they take care of protecting their arguments when being written to a file by L^AT_EX. Protecting here means adding `\noexpand` in front of each token in the argument. The token parsing is easy since the argument – by the nature of these commands – may not contain braces or spaces. The implementation looks like this.

```
\long\def\÷#1÷{\Q{#1}}
\long\def\Q{\ifx\protect\@typeset@protect\expandafter\@gobble\fi
  \@thirdofthree\@firstoftwo\displayit\protectit}
\def\displayit#1{...}
\def\protectit#1{\noexpand\÷\protectnext#1÷}
\long\def\protectnext#1{\noexpand#1%
  \ifx#1÷\else\expandafter\protectnext\fi}
```

The first trick is in the body of `\Q`: the argument is passed to either `\displayit` or `\protectit`, depending on the current value of `\protect`. If the condition is true, `\@gobble` is called, which removes `\@thirdofthree`, so `\@firstoftwo` will choose `\displayit` (otherwise, `\@thirdofthree` chooses `\protectit`). The second, more classical trick is the rôle of `\expandafter` in the definition of `\protectnext`: it makes the `\fi` token disappear, so the tail-recursive call to `\protectnext` will grab the next token into `#1` instead of `\fi` itself.

7.6 Special hyphenchar in inline verbatim

When inline verbatim is hyphenated, care has to be taken to make the discretionary hyphen different from a regular, verbatim hyphen. (There is a similar problem with spaces disappearing when the line is broken; to avoid this, try setting the option `pverb-space=visbreak` or `pverb-space=invdisc`.) T_EX auto-hyphenation takes the discretionary hyphen from the `\hyphenchar` of the font. So the solution is adding a new glyph to the verbatim font, changing the font encoding vector to include the glyph, and then setting `\hyphenchar`.

We have chosen character position 24 (per-thousand sign) of the T1 encoding to be replaced by a soft hyphen (-), which is deliberately narrower than all the other characters, so the reader immediately sees its function. For example:

“foo-bar”. We have drawn the glyph in Fontforge, saved the data to PFB, converted it to human-readable format with the command `type1fix.pl shorthyp.pfb gsx: shorthyp.gsx`, extracted the human readable glyph definition (`/shorthyp { ... }`) from the output. We have changed the `/FontName` and injected the glyph to original font with the following command:

```
perl -x -S type1fix.pl --set-leniv=0 --dump-spaces=no --pack \
  --dump-bars --dump-stde --dump-ends=no --debug-warnings \
  --chk-insize=no --set-uniqueid=random --set-fontname=t1xtts \
  --set-glyph="/shorthyp { 50 354 hsbw 315 vmoveto -17 vlineto 0
-8 0 -8 6 -4 rrcurveto 4 -6 8 0 5 0 rrcurveto 195 hlineto -124
vlineto -11 0 -21 15 vhcuroveto 2 0 3 1 2 1 rrcurveto 10 2 1 12
0 12 rrcurveto 0 8 -1 8 0 5 rrcurveto 130 vlineto 0 5 1 7 0 7
rrcurveto 0 12 -2 11 -11 3 rrcurveto -5 1 -6 0 -5 0 rrcurveto
-12 0 -12 -1 -10 0 rrcurveto -98 hlineto -16 0 -19 2 -17 0
```

```
rrcurveto -32 -6 -3 -24 hvcurveto closepath endchar} def" \
t1xtt.pfb pfb: t1xtt-shorthyp.pfb
```

We have changed six lines in `tex256.enc` to match the glyph names in the font (e.g. `/endash` → `/rangedash`), and we have changed position 24 to `/shorthyp`. We have also changed the name of the encoding in the beginning of the file. We have inserted the following line to the PostScript font map files (e.g. `psfonts.map`), without the line break:

```
t1xtts t1xtts "TeX256-shorthypEncoding ReEncodeFont"
<tex256-shorthyp.enc <t1xtt-shorthyp.pfb
```

We have also added a new TFM file based on the old one. We have dumped the old one with `tftopl -charcode-format=octal t1xtt.tfm`, modified the width (`CHARWD`) of character 24 (`CHARACTER 0 30`), and saved the modifications with `pltotf modified.pl t1xtts.tfm`. We've added the L^AT_EX font map file `t1xtts.fd` with the following content:

```
\DeclareFontFamily{T1}{xtts}{\hyphenchar\font\m@ne}
\DeclareFontShape {T1}{xtts}{m}{n}{<->t1xtts}
```

The `\hyphenchar` settings above disables automatic word hyphenation, so words inside `\texttt` etc. won't be accidentally hyphenated. We have copied all the files above to the appropriate directories and we have run `mktexlsr` to update the file list. We have included some options in `\PexaDefaults` line in the document preamble: `pverb-hyphenchar=char'30` (for automatic word hyphenation) `pverb-linebreak=char, pverb-linebreakchar={\string\char'30}` (inserted around symbols).

We have also defined `\def\pexa@verbatimfont{\normalfont\fontfamily{xtts}\selectfont}`, and we have made sure that the T1 encoding is in use (`\usepackage{t1enc}`).

The overall effect of these modifications was that `examplep` now used our glyph for automatic word hyphenation and as discretionary hyphen around symbols in inline verbatim mode. The demonstrations above shows that it is quite complicated to change a single glyph in a L^AT_EX font. It is hoped that the situation will improve with T_EX's successors.

7.7 Passing information about the CD-files to `wfiles.pl`

`wfiles.pl` is used to extract the CD-files from the L^AT_EX sources of a book. The reasons why an external program is used instead of T_EX's built-in `\write` command are described in Subsection 6.1.

The file names and environment start line numbers are passed to `wfiles.pl` in the `.aux` file(s). For example, the line `\@gobble{code:foo.tex:156:2_pic3.mp}` is a declaration that there is a `code` environment starting at line 156 in the file `foo.tex`. `wfiles.pl` understands such declarations, and it also understands lines like `\@input{foo1.aux}`, so dumping works even if the document is separated to several `\included` source files. The declaration above is ignored by L^AT_EX when it reads back the `.aux` file (because `\@gobble` gobbles its argument).

Although the `\inputlineno` primitive is mentioned twice in the T_EXbook [3], its – rather straightforward – purpose is not documented there. But the real problem is that T_EX doesn't remember the name of the file being read. `\jobname` contains the name of the top-level `.tex` file, so it doesn't work when that file `\includes` or `\inputs` subfiles containing `code`. The `codep` package thus modifies the `\InputIfFileExists` command to save the file name to the macro `\codep@code@inputfile` if the extension is `.tex`. (The other most common extension after the preamble is `.fd`: such a file is loaded each time a L^AT_EX font that has not been used yet is selected.) The implicit limitation here that `code` won't work unless the extension of the file included is `.tex`. Hooking `\InputIfFileExists` affects `\include{...}` and `\input{...}`, but not `\input_...`, `\documentclass` or `\usepackage`. This is not a problem if the author remember that he has to use braces around the file name.

Since there is no hook for `\endinput` (and some packages rely on that `\endinput` is an expandable primitive), it is not possible to set up a stack of names of files being read. Thus, if file *A* has included file *B*, an after that `code` environment placed in *A* will not work, because the declaration line read by `wfiles.pl` will contain the name of *B* instead of *A*. This is not a serious limitation, because files including other files usually don't typeset text by themselves after the inclusion.

The primary reason why `wfiles.pl` needs the `.aux` file is that it has to embed the page and chapter numbers into the file names. Although `wfiles.pl` could find the source file with the `code` environments by trying to match line numbers with all source files in the current directory, we have decided to make it fail when the file name is not emitted properly into the declaration, so it is sure that the examples in the book and on the CD are consistent.

8 Future work

The most important features to be added and other improvement possibilities:

- a better approach towards automatic hyphenation of inline verbatim, after studies in typography
- allow wider sample if source is small enough
- why doesn't `\selectlanguage` work inside `\begin{PSource}[srcstyle=leftboth]`
- `\PVerb{foo}` mustn't insert “–” if foo is at end-of-line
- `\PVerb{...}` inner unnested braces (`\futurelet?`)
- differentiated `\penalty` values in `\PVerb`
- paragraph mode should work with side-by-side displays (of course, measuring the width of the Source has still to be done in aligned mode)
- ASCII tabulator (9) characters aren't supported properly, they are just converted to spaces. The width of the tab character should depend on its horizontal position in the line. (With `listings=`, the results are already correct.)
- framing and background color support to display verbatim
- accented characters should work with `listings` and `\PexaShowBoth`. The original catcode of `^` should be kept so T_EX itself would parse the hex escapes.
- an interface to `\lstinline` in `listings`, with line breaks allowed

9 Conclusion

`examplep`, as it is now, is a highly customizable L^AT_EX package that provides both inline and display verbatim mode with several advanced features, many of which are not available in any other packages. The `code` environment is also provided which can typeset both the Source and the Sample column of a side-by-side display verbatim from the same L^AT_EX source stream, furthermore it can emit the stand-alone working version of the Source into a CD-file. These features make the `code` environment especially useful for software textbook and manual authoring. The whole `examplep` distribution is under the GNU GPL, and it is freely available from CTAN. An earlier version of the packages was used to typeset all the examples in a 770-page introductory book about L^AT_EX.

`examplep` is not complete. Some important features are not implemented yet and the package has not been tested thoroughly. Some parts of the code are really ugly, partially because it has not been polished up after writing, and partially because the architecture of T_EX and L^AT_EX doesn't provide an elegant way to address the problem. For example, active characters are overloaded: they are used by `inputenc`, `babel` (shorthands) and `listings` (syntax highlighting) for different purposes – these packages have to make extra effort to cooperate with each other. We hope that T_EX's successors will improve these conditions, and the core system will provide a generic way to tokenize verbatim text instead of changing catcodes.

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T_EX forever!

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Abstract

This paper explores new ways of doing input to and output from T_EX. These new ways bypass our current habits, and provide fresh opportunities.

Usually, T_EX is run as a batch program. But when run as a daemon, T_EX can be part of an interactive program. Daemons often that run forever, or at least for a long time. Hence the title of this paper.

Usually, parsing and transformation of the input data is done by T_EX macros, with little outside help. Often, this results in input documents that only T_EX can understand. Also, T_EX macros can be hard to write. We demonstrate the replacement of T_EX macros by an external program. This is done in real time.

Usually, T_EX's principal output is a dvi representation of typeset pages, for processing by a printer driver. However, T_EX's log file or console can be used to allow T_EX to output the boxes it holds internally. (Alternatively, an extension of T_EX could write this data out in a binary form.) Shipping out boxes rather than dvi allows an external program to do the page makeup.

Don Knuth's original conception was that T_EX would be "just a typesetting language". In some sense he "put in many of T_EX's programming features only after kicking and screaming". The developments described above reduce our dependence on T_EX macros, and so bring our use of T_EX closer to Knuth's original conception. Doing this will greatly improve its usefulness.

Long live T_EX!

Introduction

In 1990, Don Knuth told us [8, p.572] that his work on developing T_EX had come to an end. He went on to say:

Of course I do not claim to have found the best solution to every problem. I simply claim that it is a great advantage to have a fixed point as a building block. Improved macro packages can be added on the input side; improved device drivers can be added on the output side.

In this paper, the author tries to follow this advice. There are imperfections in T_EX, and the lack of proper support for Unicode fonts and filenames is a major weakness. However, T_EX also has enormous strengths. It is archival. It carefully uses integer arithmetic to ensure that it gets the same line and page breaks, regardless of the machine it is running

on. Its algorithm for breaking a paragraph into lines is reliable, adaptable and efficient. T_EX is without rival for complex mathematical typesetting.

Often, T_EX is used with L^AT_EX as the macro package front end, and with dvips as the device driver. Sometimes, the word 'T_EX' is used to refer to the whole system. However, in this paper we mean by 'T_EX' the typesetting program written by Don Knuth. And so L^AT_EX and dvips are tools for use with T_EX.

This paper is concerned with making improvements on the input and output sides of T_EX, both areas of work where there is an enormous amount still to do. However, our proposals are not exactly macro packages and device drivers.

A note to the reader: This paper has been written for a general audience, and in particular for those who are not T_EX experts. At the same time, discussion of technical details is at times either unavoid-

1 ¶	textfile → marked up text and math
2 †	text + transform → horizontal primitives
3 *	horizontal primitives → hlist
4 †	math + transform → math primitives
5 *	math primitives + parameters → hlist
6 *	hlist + parameters → vlist
7 †	vlists + page make up → page boxes
8 *	page boxes → sequential dvi file
9 ¶	sequential dvi file → random access dvi file
10 ¶	random access dvi file → rendered page

Table 1: How T_EX works, in 10 stages

† usually done using T_EX macros.

* usually done using T_EX’s built in procedures.

¶ file input and output matters.

able or helpful. Therefore, I hope that the experts will forgive my stating the obvious, and that the others forgive my discussing the difficult.

References: Many of the articles cited here have been reprinted in the collection *Digital Typography* [13]. Page numbers in citations refer to [13], and not to the original publication.

How T_EX works

Table 1 gives a concise description as to how T_EX works. On the input side we propose that an external program perform the transformation in steps 2 and 4.

On the output side we have two proposals. The first is that (8) be replaced by:

8'. page boxes → stream of dvi pages

The second, which is more ambitious, is that (7) be replaced by:

7'. vlist → external program

followed by page makeup in that external program.

Thus we continue to use T_EX’s excellent typesetting, but reduce the use of its macros.

T_EX — just a typesetting language

T_EX is a typesetting program, written by Don Knuth, that is particular good at mathematical and technical typesetting. T_EX is reliable and stable, and is very widely used by academic mathematicians and physicists.

T_EX has a macro programming language, which allows features to be added. The best known and most widely used T_EX macro package is L^AT_EX. (This is not quite accurate. Although originally L^AT_EX used T_EX, since 2003 it by default uses e-T_EX, which is an extension of T_EX. So it is no longer purely a T_EX macro package. This has no bearing on our discussion.)

In 1996 Don Knuth, describing his intentions when he started to develop T_EX, said [11, p.648]:

I’m not going to design a programming language; I want to have just a typesetting language.

and at the same time he said (loc. cit.):

In some sense I put in many of T_EX’s programming features only after kicking and screaming. [...] In the 70s, I had a negative reaction to software that tries to be all things to all people. Every system had its own universal Turing machine built into it somehow, and everybody’s machine was a little different from everybody else’s.

But the need for more features caused the programming constructs to grow (see Table 2 below). See also [16] for a ‘wish-list’ of future developments.

Therefore, by *removing* commands from T_EX, we can come closer to Don’s original conception of T_EX. However, for this to succeed in practice, some other means of adding new features is required. Indeed, one of the major problems T_EX users have now is that the existing programming constructs barely support the demand for new features. This we discuss later.

In this section we outline how to cut T_EX down to the bare minimum. To be specific, in this section we ask: What commands are required in order to access T_EX’s algorithm for breaking a paragraph into lines?

To create a paragraph one needs to be able to load fonts, change fonts, and set a character in the current font. One also needs commands for appending glue, kerns and the like to the paragraph.

To break the paragraph into lines, one needs the `\par` primitive (also known as `\endgraf`) and a means of assigning values to the line-breaking parameters, such as `\hsize`.

In other words, the basic operations are to add an item to the current horizontal list, and to form a paragraph out of the current horizontal list. (For mathematics and table typesetting there are similar basic operations.)

It should at this point be clear that certain primitive T_EX commands are *not* required in order to do typesetting. These commands include all the `\def` commands (such as `\def`, `\chardef`, `\xdef`), `\let`, `\begingroup` and `\endgroup`. Once category codes have been set up, there is no further need for `\catcode`. And there is certainly no need for commands such as `\expandafter`, `\noexpand`, `\aftergroup` and `\futurelet`. All these are *not*

Control sequence	Date added
<code>\if</code>	21 Jun 1978
<code>\pausing</code>	16 Mar 1978
<code>\uppercase</code>	25 Nov 1978
<code>\xdef</code>	28 Nov 1978
<code>\ifmmode</code>	23 July 1978
<i>active characters</i>	25 Jan 1980
<code>\let</code>	25 Mar 1980
<code>\ifx</code>	13 July 1981
<code>\catcode</code>	July 1982
<code>\expandafter, \openin</code>	12 Sep 1982
<code>\string</code>	12 Sep 1982
<code>\immediate</code>	12 Oct 1982
<code>\csname, \endcsname, \fi</code>	13 Nov 1982
<code>\everymath, \everydisplay,</code> <code>\futurelet</code>	2 Dec 1982
<code>\endinput</code>	7 Dec 1982
<code>\jobname</code>	25 Dec 1982
<code>\globaldefs</code>	20 Jan 1983
<code>\iffalse, \iftrue</code>	3 Feb 1983
<code>\everyvbox, \everyhbox</code>	6 Mar 1983
<code>\everyjob</code>	18 Mar 1983
<code>\advance, \multiply, \divide</code> <code>\noexpand, \meaning</code>	25 May 1983
<code>\afterassignment</code>	27 May 1983
<code>\escapechar, \endlinechar</code>	4 Jul 1983
<code>\errhelp</code>	11 Jul 1983
<code>\aftergroup, \newlinechar</code>	16 Jul 1983
<code>\ifhbox, \ifvbox</code>	27 Aug 1983
<code>\holdinginserts</code>	30 Sep 1989

Table 2: Some T_EX control sequences not needed for typesetting (after [7])

typesetting commands, and exist only to allow features to be added to T_EX.

Moreover, these commands cause difficulty for both T_EX users and programmers. Their introduction is perhaps a sign that things were starting to go in the wrong direction.

In [7] Knuth published, in edited form, the log books he kept while he was developing T_EX. In these, we can see the introduction of features. (See Table 2.)

Suppose all programming commands are disabled by `\let`-ting them be undefined, like so:

```
\let \afterassignment = \undefined
```

Provided we remove enough commands, we will have, as Don wanted T_EX to be in the first place, “just a typesetting language”. A language without features, and without the capability of adding features (which is itself a feature).

Comparison with PostScript and with machine code is instructive. Most PostScript is generated by programs that translate from a higher-level language

down to PostScript. Similarly, much machine code is generated by compiling ‘C’ source files.

Many of us write input files for (L^A)T_EX, using a text editor. We won’t do that for a featureless T_EX. It’s too much hard work, and anyway we want to write in a higher-level language. We are suggesting that an external program perform the text transformation that is traditionally performed by a T_EX macro package.

Improved macros — input transformation

This section could also be titled:

```
\let \def = \undefined
```

Don suggested that we add improved macro packages on the input side. Now, a macro package has two main purposes. One is issuing typesetting instructions to T_EX. This will create a galley (or page of unlimited depth). The second purpose is the output (or page makeup) routine, which breaks the galley into pages of a suitable size.

In this section we consider the creation of a galley. Marked-up text, such as

```
\section{Improved macros}
```

is translated (by L^AT_EX in this case) into a large number of low-level instructions. The title

```
Improved macros
```

is scarcely translated. Each character sets itself, and space characters produce default interword glue. (Later, we present an example of this.)

It is `\section{}` that does most of the work. Here are some of the technical details. It selects the font to be used, and the paragraph parameters for the title (in case it is wider than the measure). It also places glue and penalties before and after the title on the galley. It might also add a section number, and record information for the table of contents.

High-level commands are being translated into low-level typesetting instructions. This translation need not be done by L^AT_EX (or indeed by any other T_EX macro package). For example, in the WEB system of literate programming, much of the work is done using external programs. Similarly, XSLT templates are often used to transform text, prior to it being passed to T_EX to typesetting.

For over 10 years the L^AT_EX3 project has been working to enhance L^AT_EX by providing [15, p.1]

a flexible interface for typographic designers to easily specify the formatting of a class of documents.

Such an interface might, for example, be similar to Cascading Style Sheets (CSS) for HTML. We have seen that Don Knuth only reluctantly added

programming features to T_EX. The author believes that T_EX macros are not a suitable language for creating the above interface, and that the long delay in its delivery is evidence for this.

This interface could instead be written as an external program. In a later section we describe Q_AT_EX, which is a wrapper around T_EX that effectively allows T_EX to interact with external programs.

Improved macros — output routines

This section could also be titled:

```
\let \output = \undefined
```

One of the most interesting and best parts of T_EX is the algorithm it uses for breaking a paragraph into lines. The algorithm for breaking the galley into pages is not so good, although for simple technical material it is more than adequate.

In this paper we do not suggest improved output algorithms (we have discussed this elsewhere [4]). Instead, we describe a solution to a related problem. The T_EX macro language is not a suitable environment for the writing of complicated page makeup algorithms. Here we describe a means of moving the problem to another domain.

The galley produced by T_EX consists of a vertical list. This vertical list consists of boxes, glue, penalties, and so forth (see *The T_EXbook*, page 110 for a complete list). The `\showlists` command prints a detailed description of the content of this vertical list.

The output of `\showlists` can be parsed by an external program, and used to reconstruct within that program the vertical list created by T_EX. If the external program can also send low-level typesetting instructions to T_EX, then T_EX in effect has become a callable function available to the external program. (As in Q_AT_EX, the interactive console or more exactly stdin and stdout can be used for this communication.)

This is not a completely new idea. In 1996, Jiří Veselý asked [10, pp620–621]:

Once I was asked about the possibility to make a list of all hyphenated words in the book. I was not able to find a way in your book to do this.

To this, Don replied (loc. cit.):

This would be easy to do now in a module specially written for T_EX. I would say that right now, in fact, you could get almost exactly what you want by writing a filter that says to T_EX “Turn on all the tracing options that cause it to list the page con-

tents.” Then a little filter program would take the trace information through a UNIX pipe and it would give you the hyphenated words. It would take an afternoon to write this program; well, maybe two afternoons . . . and a morning.

We develop this idea later in the paper.

Instant Preview and T_EX as a daemon

This section could also be titled:

```
\let \end = \undefined
```

Interactive programs typically require a response time of less than a tenth of a second, while a response in a hundredth of a second is seen as instantaneous.

On my current 800 MHz PC, the command

```
$ tex story \end
```

takes about 0.137 seconds, while

```
$ tex \end
```

takes 0.133 seconds. The first command typesets a small page of material; the second does nothing but start T_EX and then exit. Thus, typesetting the small page takes about 0.004 seconds.

It follows from this that typesetting material for Instant Preview is tolerable if the start-up time is included, while it will be perceived as instantaneous if T_EX is run as a daemon.

Running T_EX as a daemon is an example of T_EX forever. We wish for T_EX to start up when the computer boots, and to remain running indefinitely. Moreover, we might prefer that there were only a single instance of the T_EX daemon running.

Documents and macro packages may have to be adapted, to make the most of Instant Preview. The key concept seem to be this: That the source file be partitioned into regions by markers, which we call ‘belays’, and that the macro package be able to typeset each region independently. In other words, that the macro package support random access typesetting. This is, again, an example of T_EX being enhanced by an improved macro package on the front end.

The author has already written [5] about Instant Preview. At the conference he hopes to demonstrate the latest progress.

Decorating dvi files

T_EX has no built-in notion of colour, or of graphics inclusion. However, the `\special` command allows device drivers to produce special effects. By decoration we mean the application of colour, change bars and the like to the rendered page.

In the domestic setting, decoration of a room or a house does not move the walls or make other structural alterations. In typesetting, adding decoration should not affect typesetting decisions, such as the line breaks and the placement of items on the page. (This is not to say that the typographic design should not take into account the subsequent application of decoration.)

The current practice regarding decoration is to use a fairly simple dvi processor, and to have the (L^A)T_EX macro package place appropriate `\special` commands into the dvi file. From the point of view of a device-driving dvi processor, this is probably correct. It seems that, historically, low-level capabilities were added to device drivers. Then macro packages were written to access these new features.

From the point of view of the macro package, this approach is probably wrong. As already noted, decoration should not affect typesetting decisions. This is an important property, whose fulfilment should be central to the approach taken.

Suppose, for example, that some text is to be printed in a spot colour. Placing a `\special` at the start or end of a word does not affect its hyphenation. Therefore something like

```
% usage: \color{red}{Text to go in red}
\def\color#1#2{%
  \special{push #1}%
  #2%
  \special{pop}%
}
```

will suffice, at least in the simplest cases.

However, a page boundary might break the red text. This places a burden on the dvi processor, to keep track of this information. Typical dvi processors allow random access to the pages in the dvi file. Having to look at previous page(s) breaks this random access.

The solution we suggest is to write a dvi-to-dvi filter that resolves these random access problems. Such a filter is not, of course, a device driver, but it can be used with any device driver. Its purpose is to translate high-level specials into low-level specials.

T_EX is being held back by the weakness of tools for decorating text. For example, a common requirement is to place a background rectangle behind a paragraph of text. If the paragraph is broken over two pages, the background rectangle should be similarly broken.

In 1987 Don Knuth and Pierre MacKay discussed a similar problem, namely implementing bi-directional typesetting without extending T_EX. They wrote [14, p159]:

How can we get T_EX to do this? The best approach is probably to extend the driver programs that produce printed output from the dvi files that T_EX writes, instead of trying to do tricky things with T_EX macros.

In the same article [13, p161] they then produced a “much more reliable and robust scheme by building a specially extended version of T_EX”.

QAT_EX — or ask a friend a question

T_EX is a typesetting language, with limited text-processing and other capabilities. Things that are easy to do in other languages are hard to do in T_EX. Examples are to find the dimensions of an EPS or other graphics file, or to calculate the sine and cosine of an angle, so that space can be left for rotated text.

Traditionally, such questions have been answered by writing T_EX macros. The author finds that T_EX macros are not a suitable language for such text manipulation tasks.

Here is an extract from the `\Gread@eps` macro in the L^AT_EX file `graphics.sty`.

```
\immediate\openin\@inputcheck#1 %
\ifeof\@inputcheck
  \latex@error{File ‘#1’ not found}%
  \@ehc
\else
  \Gread@true
  \let\@tempb\Gread@false
  \loop
    \read\@inputcheck to\@tempa
    \ifeof\@inputcheck
      \Gread@false
    \else
      \expandafter\Gread@find@bb
      \@tempa:.\%
    \fi
  \ifGread@
  \repeat
\immediate\closein\@inputcheck
\fi
```

The author has developed QAT_EX, which allows the T_EX macro programmer to ask another process to answer questions. Such as: What is the bounding box of `myfile.eps`?

QAT_EX (pronounced ‘kwa-tech’) provides a different route. Questions and answers are the essence of QAT_EX. When QAT_EX is used, lines such as:

```
!Q=qatexlib.eps.bbox(myfile.eps)
!A=0,0,0 0 35 97
```

appear in the T_EX’s log file.

The first line is a question, produced using a `\write` command. The second line is the answer.

The characters `!A=` are a prompt, produced using a `\message` command.

The remainder of that line is the answer to the question. The prefix `0,0,` tells T_EX that the question was successfully posed and answered. There follows the information asked for. This information is supplied by a process external to T_EX.

T_EX uses `\read -1 to \temp` to read this information from its stdin stream. So far as T_EX is concerned, this data might have come from the user. In fact, it has come from a program, namely Q_AT_EX.

Q_AT_EX works as follows. It is a wrapper program that invokes T_EX, and takes control of its standard input and output. When it sees a question line, followed by the answer prompt, it parses and answers the question, then sends the answer to T_EX, using T_EX's standard input. However, Q_AT_EX does not answer the question itself. It imports a module—in the example above the `eps` module—to answer the question for it.

Here is the definition, in Python, of a function that returns the bounding box of an EPS file, as a string. If not found, it raises an exception. It took me less than 10 minutes to write. It would be part of a `eps` module for use with Q_AT_EX.

```
# File: qatexlib/eps.py
_bb_prefix = '%BoundingBox: '
def qa_bbox(filename):
    f = open(filename)
    for line in f:
        if line.startswith(_bb_prefix):
            sizes = line.split()[1:]
            return ' '.join(sizes)
    msg = "File '%s' has no bounding box"
    raise Exception, msg % filename
```

Alternatives and complements to Q_AT_EX

In this section we compare Q_AT_EX to shell escape, `eval4tex`, PerlT_EX, `sTeXme` and Pymacs. Each of these has some similarity with Q_AT_EX.

Shell escape. Modern implementations allow T_EX to issue shell commands, as if they had been typed at a command prompt. This allows, for example, a command such as `makeindex` to be run after T_EX has processed the body of a document, but before setting the back matter.

However, it also allows other commands to be run, such as the deletion of files. And T_EX documents can execute arbitrary T_EX commands. (Strictly speaking, this is not true. For example, in Active T_EX [3] all characters are active. This allows a macro package to prevent execution directly from a document of all but specified commands.)

Often, T_EX documents are distributed in source form. If shell escape is enabled, the typesetting a document could result in a shell escape command being run, that finds and deletes all your files. Clearly, shell escape is a security risk. For this reason, shell escape is disabled by default, and is rarely used.

Even without shell escape, T_EX macros and therefore documents can overwrite existing files. (T_EX has no inbuilt ability to delete files. But it can destroy their contents.) Therefore, modern implementations of T_EX refuse to open for writing files that are not in or beneath the current directory, or a similarly specified area.

This restriction is not applied to the reading of files. Therefore, it is possible for a T_EX document, when typeset, to include in it other files. These other files might be confidential.

Therefore, in line with the theme of T_EX being “just a typesetting system”, it might be sensible to:

```
\let \openout = \undefined
\let \openin = \undefined
\let \input = \undefined
```

and have another program take responsibility for security. The security monitor could then send material to be typeset to T_EX's standard input stream.

eval4T_EX (by Dorai Sitaram) is a two-pass process that allows T_EX to send expressions to Scheme for evaluation [1]. It provides a `\eval` macro, that is used as below. (The example is Sitaram's, and my exposition follows his).

```
\eval{(display (acos -1))} % gives pi
On the first pass, the Scheme code
(display (acos -1))
```

is written to an auxiliary file, together with some indexing information.

Before the second pass, a helper program `eval4tex` runs Scheme on the auxiliary file, to create a second auxiliary file. On the second pass, the `\eval` command picks up values from the second auxiliary file, and refreshes the data in the first.

As Sitaram writes:

This strategy is quite common in the T_EX world. The popular T_EX-support programs BibT_EX and MakeIndex, which generate bibliographies and indices respectively, both operate this way.

sTeXme (by Oleg Paraschenko) is another approach to integrating T_EX with Scheme [19]. Here is his summary of the goals of the project.

The (A)T_EX macro language was a great development when it appeared, but now it is

too out-of-date. Programming in T_EX is a fun, but more often it is a pain.

As it seems for me, only very few people can write (L^A)T_EX macros, but a lot of people would like doing it (like me, for example). This is the problem.

One of the solutions is to provide another scripting language for T_EX. That's what is the goal of the sT_EXme project. It should provide the Scheme programming language as a T_EX scripting language.

This project has two parts, namely an extension to T_EX, that allows it to interpret Scheme code, and an extension to Scheme that allow it access T_EX internals. We say more on this later.

PerlT_EX (by Scott Pakin) uses standard Perl and T_EX without extensions [17]. Here is his summary of the goals of the project.

T_EX is a professional-quality typesetting system. However, its programming language is rather hard to use for anything but the most simple forms of text substitution. Even L^AT_EX, the most popular macro package for T_EX, does little to simplify T_EX programming.

Perl is a general-purpose programming language whose forte is in text manipulation. However, it has no support whatsoever for typesetting.

PerlT_EX's goal is to bridge these two worlds. It enables the construction of documents that are primarily L^AT_EX-based but contain a modicum of Perl. PerlT_EX seamlessly integrates Perl code into a L^AT_EX document, enabling the user to define macros whose bodies consist of Perl code instead of T_EX and L^AT_EX code.

Here is Scott Pakin's equivalent to `\eval`:

```
\perlnewcommand{\reversewords}[1]
  {join " ", reverse split " ", $_[0]}
\reversewords{TeX forever!}
```

PerlT_EX, like Q_AT_EX, invokes T_EX under the control of a separate process. Unlike Q_AT_EX, it does not take control of T_EX's standard input and output. Invoking `\reversewords` causes T_EX to write material to a specially named file. This file corresponds to the question in Q_AT_EX. The controlling Perl process then computes the answer to the question, and writes it to another specially named file. Meanwhile, the T_EX process goes into a loop, to poll for the existence of the answer file. Once found, it is `\input` by T_EX.

PerlT_EX seems to have a performance problem. On my 800 Mhz PC, the following example:

```
\documentclass{article}
\usepackage{perltex}
\perlnewcommand{\nothing}{}

\begin{document}
% I've got plenty of nothing ...
\nothing\nothing\nothing
\nothing\nothing\nothing
\nothing\nothing\nothing
\nothing          % 10 nothings
% We're busy doing nothing ...
\end{document}
```

takes about 3.0 seconds to execute. This includes startup time. (On the same machine, it takes Q_AT_EX about 1/3000 seconds to do nothing once.)

Here is at least a partial explanation. Instrumenting the code for PerlT_EX shows that in compiling the above document, T_EX polls for the existence of the helper file approximately 5,000 times. The exact number varies. Adding:

```
\input nothing % input an empty file
```

to the polling loop *reduces* the time taken to about 1.8 seconds, and reduces the number of pollings to about 500. The UNIX `nice` command could also help here.

Pymacs (by François Pinard) is not a way of using Python with T_EX. It is a way of using Python with the Emacs editor [18]. To quote its author:

Pymacs is a powerful tool which, once started from Emacs, allows both-way communication between Emacs Lisp and Python. Pymacs aims Python as an extension language for Emacs rather than the other way around, and this asymmetry is reflected in some design choices. Within Emacs Lisp code, one may load and use Python modules. Python functions may themselves use Emacs services, and handle Emacs Lisp objects kept in Emacs Lisp space.

Pymacs is mentioned because it was highly influential on the author's approach to the integration of T_EX with a scripting language. (At that time, Python had not been chosen.)

Different approaches compared

In the previous two sections we looked at Q_AT_EX, shell escape, `eval4tex`, sT_EXme and PerlT_EX. In this section we make some comparisons.

Philosophy QATeX is like shell escape, in that simple queries are sent to another process. The other approaches assume that complex code will be written within, or otherwise produced by, TeX macros. This code is then evaluated by another program.

For example, in QATeX the problem of reversing words might result in the following conversation between TeX and the external process:

```
!Q=qatexlib.string.reverse(TeX forever!)
!A=0,0,forever! TeX
```

The question sent to QATeX could not be along the lines of: “What is the result of evaluating this complex Perl or Scheme expression?” However, such is not the expected use. Rather, it is expected that TeX will send a short and simple query. If the answer is long, it could be placed in an external file. Once that is done, TeX can be told, as the answer, that the file is ready to be `\input` (assuming `\input` is still defined).

Architecture The architecture of the implementation of PerlTeX is closer to that of `eval4tex` than that of `sTeXme`. Perl code is placed in the body of TeX macros, and this code is sent out to Perl for evaluation. Unlike `sTeXme`, and like `eval4tex`, it does not require either an extension to TeX or a special version of the command interpreter for the extension language.

PerlTeX is similar to QATeX in that TeX is run under the control of an external program. However, QATeX uses standard input and output for communication, whereas PerlTeX polls named files.

QATeX provides an efficient and portable low-level interface between TeX and an external process. PerlTeX is a higher-level package. There is no reason why the QATeX interface, or something similar to it, should not be used by PerlTeX, so as to improve performance. The same applies to `eval4tex`, where using this interface would remove the need for a second run. It would also provide better interaction.

Security Any process that evaluates code supplied by a document will expose a security problem, unless the code evaluator is already secure (as in Java, for example). PerlTeX provides security by using a secure Perl sandbox. QATeX provides security by having TeX (and thus the document) supply only data.

Of course, any program that evaluates untrusted data as if it were trusted code has a security issue. If it is necessary to evaluate safely untrusted code, then a secure sandbox is required. This is the key security issue. QATeX is a small interface

application, which does not attempt to solve this problem. There is no reason why QATeX should not be used with such a secure sandbox. But that is a matter for the developer who builds upon QATeX.

Integration and extension Of all the projects considered in this section, `sTeXme` is the most ambitious. It involves making major extensions to TeX, to produce a new program, called `sTeXme`.

The new name is necessary. TeX experts will already know that Don Knuth does not object to the sources of TeX the program being used as the basis for creating a superior program. However, he is most insistent that programs that are not TeX must not be called TeX. More exactly, in [8, p572] he wrote:

That is all I ask, after devoting a substantial portion of my life to the creation of these systems and making them available to everybody in the world. I sincerely hope that the members of TUG will help me to enforce these wishes, by putting severe pressure on any person or group who produces any incompatible system and calls it TeX or METAFONT or Computer Modern — no matter how slight the incompatibility might seem.

This insistence on the stability and consistency of TeX is, in this author’s view, a significant contribution to its longevity. Users know what to expect, and get what they expect, when they use TeX.

Regarding the scope of his new program `sTeXme`, Oleg Paraschenko reports:

[...] Scheme code can be executed from TeX and that Scheme code can access TeX internals (getting a string from the TeX string pool, getting a macro definition as the Scheme list).

The source file `stexmelib.c` on the SourceForge repository indicates that Paraschenko is building a C-coded Scheme extension, in which equivalents to TeX boxes and the like can be stored. This indicates that there are many points of contact between his project and the next section.

PyTeX

The goal of the PyTeX project is to combine Python programming with TeX typesetting. To understand this, think of Tcl/Tk: Tcl is a scripting language and Tk is a toolkit for building GUI programs. Perl and Python also have interfaces to Tk, allowing them to use Tk when building GUI programs.

Now think of L^ATeX as L^A/TeX. L^A is a front end to the TeX typesetting program written in TeX’s

macro language. PyT_EX, or Py/T_EX if you prefer, is to be a front end to T_EX written in Python.

PyT_EX replaces the part of T_EX that Don Knuth said he did not want to write, namely the T_EX macro programming language, with something more widely used. Our aim is to provide an alternative means of programming typesetting decisions and logic. This will make T_EX easier to use.

Here is an example of the interface. We are in Python, and wish to typeset a paragraph of text, namely

The cat sat on the mat.

to a measure of 6 picas, which is about one inch (or 25 millimetres). This is a toy example. After typesetting the paragraph, we wish to bring it into Python for page makeup.

To see how this is done, issue the command

```
$ cat cat_sat.tex | tex | grep '^[.\\]'
```

where the source stream is

```
% cat_sat.tex
\tracingonline 1
\showboxbreadth \maxdimen
\showboxdepth \maxdimen
\scrollmode

\setbox0\vbox{%
\hsize 6pc
The cat sat on the mat.\par
\showlists
}
```

The annotated output of the `grep` is:

```
# This is an annotation.
# Start of the first line of paragraph.
\hbox(6.94444+0.0)x72.0, glue set 0.58331
# indentation box, 20pt wide
.\hbox(0.0+0.0)x20.0
# The word "The".
.\tenrm T
.\tenrm h
.\tenrm e
# normal interword glue
.\glue 3.33333 plus 1.66666 minus 1.11111
# The word "cat".
.\tenrm c
.\tenrm a
.\tenrm t
.\glue 3.33333 plus 1.66666 minus 1.11111
.\tenrm s
.\tenrm a
.\tenrm t
# Zero width line filling glue.
.\glue(\rightskip) 0.0
# Penalty for breaking page at this point.
\penalty 300
```

```
# Interline glue.
\glue(\baselineskip) 5.05556
# Start of second line of paragraph.
\hbox(6.94444+0.0)x72.0, glue set 20.88878fil
.\tenrm o
.\tenrm n
.\glue 3.33333 plus 1.66666 minus 1.11111
.\tenrm t
.\tenrm h
.\tenrm e
.\glue 3.33333 plus 1.66666 minus 1.11111
.\tenrm m
.\tenrm a
.\tenrm t
.\tenrm .
# Inserted by TeX, for internal reasons.
.\penalty 10000
# Allow the last line of para to be short.
.\glue(\parfillskip) 0.0 plus 1.0fil
.\glue(\rightskip) 0.0
```

This is a complete description of the paragraph formed by T_EX's line breaking algorithm.

This is the essence of the interface between Python and T_EX. Material is sent to T_EX to be typeset, say using `stdin`. The `\showlists` command is used to write the results to `stdout`, from which they are picked up by Python.

On the input side, Python is responsible for parsing the input stream, and placing appropriate items on the horizontal list. It is also responsible for ensuring that nothing inappropriate is placed on the list. The whole process should not generate T_EX errors (although warnings about overfull boxes and so forth are welcome).

On the output side, Python parses the output stream, and from it reconstitutes the boxes that T_EX has formed, thus forming a Python object.

```
In Python code, our example might look like
hlist = Hlist() % new horizontal list
text = "The cat sat on the mat."
hlist.extend(text)
vlist = hlist.linebreak(hsize=6*pica)
```

where hidden in the call to the `linebreak()` method there is a sending of data to T_EX, and a reconstruction in Python of the boxes that T_EX built. From here on, the output or page-makeup routine can be written in Python. Note that `cat_sat.tex` invokes no T_EX macros.

Conclusions

In the 15 years since T_EX has been frozen, very few deficiencies have been found in the algorithms it uses for breaking a paragraph into lines, for typesetting mathematics, and for setting tables. Since 1990 there has been little (but valuable) progress in

the area of Unicode fonts, for which an extension of T_EX genuinely is needed. T_EX was written to be archival, and it is holding up well after its first quarter-century or so.

There are many problems in our use of T_EX. This paper has discussed several:

- coloured text and other decorations,
- interactive use of T_EX,
- input transformation,
- programming page makeup.

All of these arise not out of T_EX itself, but out of the way in which we use T_EX.

There is an irony in our use of T_EX macros. Recall that when Don was looking at the design of T_EX he found that: [11, p.648]:

Every system I looked at had its own universal Turing machine built into it somehow, and everybody’s machine was a little different from everybody else’s.

He then went on to say:

I was tired of having to learn yet another almost-the-same programming language for every system I looked at; I was going to try to avoid that.

What we have now with T_EX macros is a Turing machine very different from any other. This is just what he wished to avoid. However, Q_AT_EX provides a powerful complement to existing T_EX macro packages, and PyT_EX will use T_EX as “just a typesetting language”, which is what Don wanted it to be in the first place.

In 1996, Piet van Oostrum asked Don Knuth about T_EX’s macro programming language [11, p648–9]:

I don’t know if you have ever looked into the L^AT_EX code inside, but if you look into that, you get the impression that T_EX is not the most appropriate programming language to design such a large system. Did you ever think of T_EX being used to program such large systems and if not, would you think of giving it a better programming language?

In response to this, Don Knuth said (loc. cit.):

It would be nice if there were a well-understood standard for an interpretive programming language inside an arbitrary application. Take regular expressions—I define UNIX as “30 definitions of regular expressions living under one roof.” [laughter] Every part of UNIX has a slightly different regular expression. Now, if there were a

universal simple interpretive language that was common to other systems, naturally I would have latched onto that right away.

The theme of this paper is T_EX typesetting with fewer macros. We use instead a “simple interpretive language”, namely Python. If we learn to use T_EX in new ways, and take good care of it, T_EX will be good for its second quarter-century.

Long live T_EX!

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The 16 Faces of a Dutch Math Journal

Hans Hagen

Abstract

Much of what ConT_EXt originally provided originated from our daily needs, at that time dictated by educational consultancy and course development. However, the last couple of years most features find their origin in the demands of publishers, users as well as an occasional "Let's see (prove) if T_EX can do it (better)". One of those users is the Dutch Math Society (NAW).

Quite a while ago the Dutch Math Society decided to restyle their journal and the decision was made to use ConT_EXt as typesetting engine, one reason being its ability to typeset on a grid and place graphic in columns. Since it happened in the early days of ConT_EXt, some of the demands resulted in rather complex and often weird macros.¹

Advanced mixed font support, magazine-like column features, tight integration with MetaPost, flexible placement of elements etc. are nowadays supported in the kernel in a more natural way, if only because the core of ConT_EXt has become more flexible and mature. And so the moment has come to let the editors switch to the reimplemented journal style.

In this talk I will illustrate how needs by demanding users like the Dutch Math Society's Journal have brought ConT_EXt to where it stands today and is heading tomorrow.

¹These were written by Taco Hoekwater, who did a pretty good job, as proven by the fact that up to date these macros are still in use.

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Tensegrities

Wie wel eens het Krollier-Müller museum heeft bezocht, zal in de beeldentuin zeker de hoge toren, opgetrokken uit louter stalen balken en kabels, hebben gezien. Deze 'Nieuwe Toren' is een werk van Kenneth Snelson en dit beeld is niet de enige vorm die op deze manier is te construeren. In dit artikel wordt ingegaan op enkele wiskundige aspecten van deze constructies: hoe kunnen we deze zogenaamde tensegrities, of houthou- of touwfiguren, klassificeren op structuur? Chris Heunen studeert momenteel af op het gebied van complexiteitsentheorie bij onder andere Dick van Leijenhorst, universiteitshoofd van de faculteit der Natuurwetenschappen, Wiskunde en Informatica van de Radboud Universiteit Nijmegen. Zij stellen een nieuwe aanpak ter classificatie voor, waarbij ze echter snel tegen complexiteitsentheoretische problemen aanlopen.

Een tensegrity is een structuur die integriteit behoudt onder spanning. Het concept is van Kenneth Snelson (1918), een Amerikaanse beeldhouwer, en is populair geworden door de bekende architect Buckminster Fuller. De voornaamste toepassingen liggen dan ook in de bouw: kranen van hoge getreue, opvoerapparaten, en de getreue invloed van atmosferische krachten, zijn tensegrities ideaal voor bijvoorbeeld dakken van voorhalstadia. Maar ook in de ruimtevaart liggen toepassingen, en in de celbiologie.

Tensegrities bestaan slechts uit twee elementen: balken en kabels. Tenzij, zo worden ze in de bouw-kunde genoemd. Maar je kunt ook zelf speelgoedvoertuigen construeren uit houtjes en

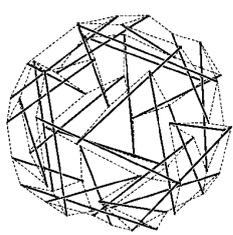
touwjes, en ze hebben dan ook wat weg van Hébrunian spheren en Bucky balls. Als je het goed doet, kun je de touwjes zelfs vervangen door elastieken, zonder dat dat invloed heeft op het uiterlijk in plaats van een rigide bouwwerk krijg je er een dat even zelfzinnig vorm voor aanneemt en een val of een rimpel. (Maar daarvoor later meer!) De touwjes houden dus tegelijkertijd het hele bouwwerk bijeen maar de houtjes zijn niet aan elkaar.

De figuren zijn niet alleen fascinerend om te zien (Snelson maakt er kunstwerken van) en om mee te spelen, maar ook wiskundig interessant: wat is een tensegrity eigenlijk, wiskundig gezien? Hoe kan het zijn vorm behouden? Kunnen we ze klassificeren? Welke is groepentheorie aangeleerd aan de hand van de 17 behangpatronen. Zo lijken ook de wat onbekendere tensegrities geschikt om mooie wiskunde met een fraai voorbeeld te onderhouden.

Wat is een tensegrity?

Laten we maar meteen beginnen met de definities en eisen. Een tensegrity is een verzameling punten $p_1, \dots, p_n \in \mathbb{R}^3$. Tussen twee van zulke punten loopt ofwel een houtje, ofwel een touwje, ofwel niets. Dit stellen we voor met de 'typefunctie' $t : \{1, \dots, n\}^2 \rightarrow \{\text{houtje, touwje, niets}\}$.

Elke verbinding heeft een bepaalde 'stijfheid'; dit modelleren we met een functie $c : \{1, \dots, n\}^2 \rightarrow \mathbb{R}^+$. Voor elastiek zal c kleiner zijn dan voor staalband, want de eerste 'trekt minder hard' dan de laatste bij gelijke uitdrukking. Uiteraard is $c(i, j) = c(j, i)$ als $t(i, j)$ niet verboden zijn. (Natuurkundigen zullen c als de veerconstante herkennen.)



Een tensegrity met 30 houtjes (blauwgetekend) en 70 touwjes (groengetekend).

en $t(i, j)$ niet verboden zijn. (Natuurkundigen zullen c als de veerconstante herkennen.) Tenzijde veronderstellen we een functie $f : \{1, \dots, n\}^2 \rightarrow \mathbb{R}$, die de rangfunctie van elke verbinding representeert. Te allen tijde hebben we dus voor elke $i, j \in \{1, \dots, n\}$

f(i, j) = houtje => |p_i - p_j| <= r(i, j)

f(i, j) = touwje => |p_i - p_j| >= r(i, j)

Een houtje 'duwt een punt weg', terwijl een touwje 'aan een punt trekt', het lijkt misschien verwarrend dat houtjes uit kunnen rekken, maar in de bouw-kunde worden vaak elastische staven gebruikt. Daarom is het ook nutteloos zowel een houtje als een touwje tussen twee punten te hebben, en zijn onze t, c en r dus welgedefinieerd.

Een fatsoenlijke tensegrity is stabiel, wat wil zeggen dat bij elk puntje de trekkrachten die daarop werken opheffen. Een stabiele tensegrity voldoet dus volgens Hooke aan

sum_{j=1}^n c(i, j) * (p_j - p_i) / |p_j - p_i| = 0

En eisen ook dat een tensegrity samenhangend is. Bovendien mogen de houtjes elkaar niet aantakken, in het bijzonder niet in hun eindpunten. Dit weer om bouw-kundige redenen: losgevoerde touwen zijn moeilijk. Zo'n gewicht kunnen we echter gemakkelijk simuleren, in figuren 1 zijn bijvoorbeeld 3-gewicht gesimuleerd door touwjes.

De hoofdzaak waarin we nu geïnteresseerd zijn, is 'terke' tensegrity-structuren (p_1, \dots, p_n, c, t) voldoen aan (1) voor onze $n \in \mathbb{N}^+$. 'Structuur' bedoelen we hierbij in de groepentheorie

Van gaan we alle klassen met K touwjes uitbreiden tot $K + 1$ touwjes. Neem een klasse met K touwjes. We fixeren deze eerste K touwjes, en bekijken waar het volgende touwje gespannen kan worden. Dus voor elke klasse met K touwjes krijgen we nul of meer klassen met $K + 1$ touwjes.

Hoewel er bij N houtjes maar $2N(N - 1)$ touwjes mogelijk zijn, hoeven we niet verder te gaan dan halverwege, $K = N(N - 1)$. Dit omdat een tensegrity met $K > N(N - 1)$ een joligke-structuur heeft als een tensegrity met $(N - 1) \cdot K$ touwjes. We hoeven alleen maar de touwjes te 'invertieren', dat wil zeggen touwjes verwijderen waar die waren, en invogen waar ze niet waren. En dat is veel gemakkelijker dan de tweede helft net zo berekenen als de eerste.

We hebben dus het volgende algoritme: zij N gegeven, en G onze symmetriegroep. Begin met $K = 1$ en neem als eerste touwje $t_1 = \{1, 3\}$. Zet $R = \{G\}$. Voer nu het eerste touwje, dat wil zeggen, beschouw als nieuwe groep $G := \langle G, c \text{Stab}_{G_1}(t_1) \rangle$, en neem $R := R \cup G$. Herhaal dit proces totdat $K = N(N - 1)$, en bepaal de tweede helft door 'touwjes-inversie'.

Als we dit procedureel uitvoeren voor $N = 4$ krijgen we $2 \cdot 2$ klassen met $N = 4$ touwjes, zie figuur 2. We bedoelen dat we initieel zouden verwachten, zie figuur 2.

Met het lemma van Burnside en de daarop voortvloeiende stelling van Polya kunnen we nu het aantal banen (en daarmee het aantal gezamenlijke representanten) verifiëren [8].

Lemma. (Burnside) Stel dat een eindige groep G op een verzameling X werkt. Dan is het aantal banen van X onder G gelijk aan $\frac{1}{|G|} \sum_{g \in G} |\text{Fix}_X(g)|$.

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Helaas is het bewijs van het lemma van Burnside een kwestie van tellen en sommige objecten daarbij weg te laten, en is niet constructief. Maar we kunnen het nog steeds gebruiken ter verificatie.

Realisatie Goed, we hebben dus nu alle theoretisch mogelijke klassen van tensegrity-structuren met N houtjes. Maar we hebben ook alleen pas die structuur. In termen van onze definitie, we hebben alleen pas rekening gehouden met de typefunctie t , en nog niet met de stijfheid c , en (1). Uit al deze klassen moeten we nog degene picken die echt mogelijk zijn, dus degene waarvoor c en t bestaan die aan (1) voldoen.

Laten we eerst maar eens aannemen dat c constant is (behalve natuurlijk de verplichte $c(i, j) = 0$ zodra $t(i, j) = \text{niets}$). Dit is niet zo onrealistisch, want als je een tensegrity bouwt heb je toch niet de neiging om hier weer eens elastiek, dat weer eens staalband te gebruiken.

We doen dus even met c_1, \dots, c_n en variabel zijn, en proberen hiervoor de stabiliteitsvergelijkingen (1) op te lossen. Het slechte nieuws is nu dat dit nog niet meevalt. Het gaat hier om een vectorieel stelsel non-lineaire vergelijkingen. Daar kennen wij helaas geen specifieke oplossingsmethode voor. Dus groepen we maar naar een generieke methode, die van Grobner-bases. Helaas is deze methode dubbel-exponentieel, als er n betrokken zijn, kost het het $O(2^n)$ elementaire rekenstappen om een oplossing te vinden.

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Zo bleek dat er maar één essentiële tensegrity-structuur is met

in t weg. We kiezen de punten zo, dat precies tussen $2i - 1$ en $2i$ een houtje loopt ($t(2i - 1, 2i) = \text{houtje}$ (zie figuur 2)). Merk trouwens even op dat niets uitmaakt of we nu met de complete graaf werken, of dat we de n -knooppunten gevoerd uit de graaf weglaten.

Zij nu F de verzameling van al deze complete, ribb-gekanteerde grafen met $2N$ punten. Een element γ van F is dus een functie, die aan een ribbe $\{i, j\}$ zijn kleur $t(i, j)$ toekent. Zij verder G de deelverzameling van F van alle grafen op normaalvorm. $F = \{ \gamma \in F : \forall i, j \in \{1, 2, \dots, 2N\} (2i - 1, 2i) = \text{houtje} \}$.

Mit S_2 nemen we de symmetrische groep op de eindige verzameling X , dus de verzameling permutaties van X met als operator functiecompositie. Hierbij zullen we $S_{2, 2, \dots, 2}$ afkorten tot S_2 . Merkmer dat een groepsworping van een groep G op de verzameling F een homomorfisme $G \rightarrow S_2$ is, dus een afbeelding die de groepstructuur bewaart. Maar gaat eenvoudig na dat permuteren van de punten een groepsworping is op F . Niet andere woorden: S_2 werkt op F .

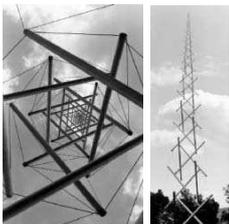
We zouden nu direct kunnen proberen de banen van F onder S_2 te bepalen. Het blijkt echter dat dit erg inefficiënt is qua rekenwerk. Maar nadat we de klassen bepaald hebben, gaan we toch de realiseerbare tensegrity-structuren ontdekken in het proces kunnen elimineren, schied dit alleen maar rekenwerk.

En we kunnen net zo goed wat heuristisch eerder toepassen. Een goed idee is om houtjes te permuteren in plaats van punten (S_2 in plaats van S_{2N}). Maar omdat een permutatie van punten ook de omlieptraan van een houtje kan veranderen, moeten we naast alle houtjes permuteren ook elk houtje apart omkeren (met S_2). Deze combinatie heet het kraanproduct [9].

Definitie. Zij G en H groepen, waarvan H op een verzameling X werkt. Schrijf G^X voor de verzameling functies $X \rightarrow G$. We maken nu van G^X een groep door de operatie van G puntsgewijs door te voeren: voor $f, g \in G^X$ definiëren we $(f \cdot g)(x) = f(x) \cdot g(x)$, waarbij \cdot in G de rechtezijdige operatie van G is. Nu wordt H op G^X door de operatie $h(x) = f(x)$ voor $f : X \rightarrow G$, $h \in H$ en $x \in X$. Het kraanproduct van G en H notatie $G \ltimes H$, is het direct product $G^X \ltimes H$.

Het is de grootste ondergroep van S_2 die de partities van X , getiteld door de actie h op X , invariant laat. Niet als S_{2N} op F werkt, werkt ook $S_2 \ltimes S_2$ op F . We bewijzen nu dat we door houtjes in plaats van punten te permuteren geen essentiële mogelijkheden verliezen.

Stelling. Door $S_2 \ltimes S_2$ te gebruiken in plaats van S_{2N} verliezen we geen banen. Preciezer: representanten van banen van F onder



Snelson's Nieuwe Toren op het Krollier-Müller museum

$S_2 \ltimes S_2$ vormen tevens een compleet stel baanrepresentanten voor F onder S_{2N} .

Bewijs. $S_2 \ltimes S_2$ werkt op F , en dus zijn er onder deze groep een aantal banen O_1, O_2, \dots, O_k voor zekere $k \in \mathbb{N}$. Elke baan bevat nu een representant (op normaalvorm) er zijn $\gamma_1 \in O_1, \gamma_2 \in O_2, \dots, \gamma_k \in O_k$ zodat $\forall i \in \{1, 2, \dots, 2N\}$ $\gamma_i(2i - 1, 2i) = \text{houtje}$ voor $1 \leq i \leq k$ en $1 \leq j \leq N$.

We zeggen al dat ook S_{2N} op F werkt, en dat er onder S_{2N} dus ook banen O_1, O_2, \dots, O_k zijn voor zekere $k \in \mathbb{N}$. Het is triviaal dat iedere S_{2N} -baan O een γ op normaalvorm bevat. Maar dan bevat O ook de baan O_j van γ onder de werking van $S_2 \ltimes S_2$ op F , en daarmee ook diens representant γ_j .

Stel nu dat O ook nog een γ bevat. In dat geval geldt voor $e \in S_{2N}$ dat $e(\gamma) = \gamma$. Maar dan laat τ de partitie $\{1, 2\}, \{3, 4\}, \dots, \{2N - 1, 2N\}$ invariant, en is τ dus een element van $S_2 \ltimes S_2$. Dus moet wel $\tau \in O$ gelden. Dit τ vormt dus inderdaad een compleet stel baanrepresentanten voor S_{2N} , en we mogen ons inderdaad beperken tot het berekenen van de γ_j . \square

Merk op dat de groep G die we zo krijgen en willen laten werken op F voortgebrecht wordt door de permutaties $(1, 2), (1, 3)(2, 4)$ en $(1, 3 \dots 2N - 1)(2, 4 \dots 2N)$.

We hebben nu dus een kanonieke groep G , die op een natuurlijke manier alle symmetriën van onze graaf bevat. Bekijk nu de collectie F van alle grafen op normaalvorm, en laat G hierop werken. Wat we nu zoeken zijn de banen van F onder G . Eén representant van elke baan is zelfs voldoende.

Om dit exponentieel probleem aan te pakken gebruiken we de methode van tabular programming; we beginnen bij de 'Stadsjes van de recursie' en combineren die opwaarts, terwijl we onderweg alles weggevoerd wat we niet meer nodig hebben. In dit geval vertelden we de groeiclassen onder in aantal touwjes K , en



Figuur 2. Standard-oriëntaties van punten, en de zes gevonden structuren voor N houtjes en hoogstens 2 touwjes ($N = 4, 6, 8, 10$)

bepalen de verzameling representanten van banen incrementeel. De structuur waarvan we gebruikmaken is die van de normaalvorm. Voor de beginwaarde $K = 1$ is het duidelijk dat er maar één tensegrity-structuur is met N houtjes en 1 touwje: het maakt niet uit tussen welke twee houtjes het touwje is gespannen (het merkt niet). Dus voor elke klasse met K touwjes krijgen we nul of meer klassen met $K + 1$ touwjes.

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Zo bleek dat er maar één essentiële tensegrity-structuur is met

Figuur 1. Simulatie van 3-gewichten door touwjes

Figuur 3. De enige tensegrity met 3 houtjes

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Research Spin glasses

A mystery about to be solved

The study of spin glasses started some thirty years ago, as a branch of the physics of disordered magnetic systems. In the late 1970's and early 1980's it went through a period of intense activity, when experimental and theoretical physicists discovered that spin glasses exhibit new and remarkable phenomena. However, a real understanding of the behaviour of these systems was not achieved and little progress was made in the next twenty years, especially in mathematical terms. In the 1990's various related systems were studied with mounting success, most notably, neural networks and random energy models. Since a couple of years the field has again entered a phase of exciting development. Some of the main mathematical questions surrounding spin glasses are currently being solved and a full understanding is at hand. In this paper we sketch the main steps in this development, which is interesting not only for the physical and the mathematical relevance of this research field, but also because it is an example where scientific progress follows a tortuous path.

Fabio Toninelli worked as a postdoc in the Random Spatial Structures programme at ERANDOM, and recently left for a post-doc position at the University of Zürich. Frank den Hollander is supervisor of the RSS-group and scientific director of EURANDOM.

Let us begin with a brief history of magnetic materials. All matter is composed of a large number of atoms. Atoms carry a spin, i.e., a microscopic 'magnetic moment' generated by the motion of the electrons around the nucleus. This spin, which in turn generates a microscopic magnetic field around the atom, can be viewed as a vector in three-dimensional space. To simplify matters, assume that for this vector only two opposite directions are allowed, up and down. In ferromagnets, materials capable of attracting

pieces of iron placed in their vicinity, each spin has a tendency to align with the spins in its neighbourhood. At high temperature, the motion of the spins is so erratic that at any time about half of them are pointing up and half are pointing down. Consequently, the net macroscopic magnetisation is zero, i.e., the individual microscopic magnetic fields generated by the spins cancel each other out. As the temperature is lowered, the erratic motion of the spins induces and the spins become more and more sensitive to their mutual

interaction. The characteristic feature of ferromagnets is that there is a critical temperature, T_c , below which the spins exhibit a collective behaviour in that a majority of them point in the same direction (either a majority up or a majority down). This phenomenon is called spontaneous magnetisation (see Figure 1).

Below T_c the individual microscopic magnetic fields sum up coherently to create a macroscopic magnetic field, which is what is ultimately responsible for the ferromagnet's capability to attract iron. It is important to emphasize that this seemingly natural picture took a long time to emerge — from 1895 (Curie) until 1944 (Onsager) — and that the genius of many illustrious theoretical physicists and mathematicians was necessary in order to find a different solution, known as the replica symmetry breaking scheme, which is what we will discuss in this paper.

The microscopic theory that explains the collective behaviour of atoms is called statistical physics. According to this theory, a system in equilibrium is described with the help of an energy functional, called Hamiltonian, which associates with each microscopic configuration of the system a macroscopic energy. In our case a config-

uration means a complete list of the orientations of all the spins. If the spins are located at the sites x in a macroscopic box Λ , and if $s_x \in \{-1, 1\}$ denotes the value of the spin at site x (+1 for up and -1 for down), then the configuration is

$$s = \{s_x : x \in \Lambda\}$$

and the Hamiltonian of the ferromagnet is

$$H(s) = - \sum_{x \sim y} J_{xy} s_x s_y$$

where $x \sim y$ means that x and y are neighbouring sites. Thus, each pair of neighbouring aligned spins gets energy -1 , each pair of neighbouring anti-aligned spins gets energy $+1$. At a given temperature T , the state of the system is described by the Gibbs distribution associated with H ,

$$\mu_T(s) = \frac{e^{-\beta H(s)}}{Z_T}, \quad s \in \{-1, 1\}^\Lambda,$$

where $\beta = 1/T$ is Boltzmann's constant and Z_T normalizes μ_T to a probability distribution. $\mu_T(s)$ is the probability that the system assumes configuration s . When T is

lowered, μ_T tends to concentrate more and more around the configurations having minimal energy, the so-called ground states of the system. For the ferromagnet these ground states are those configurations where all the spins have the same value. Indeed, it is only when $s_x = +1$ for all x or $s_x = -1$ for all x that all terms in $H(s)$ give a negative contribution, leading to the maximal value for $\mu_T(s)$. This maximum is a pronounced peak when T is small, explaining why low temperature in a typical configuration of the majority of the spins is aligned.

Spin glasses

Now that we have briefly introduced some important concepts from the theory of magnetism, we are in a position to explain what spin glasses are. Consider a system of spins, as before, but assume that some pairs of neighbouring spins prefer to be aligned, while the others prefer to be anti-aligned. The former are said to have a ferromagnetic interaction, the latter an anti-ferromagnetic interaction. Say that for any given pair of spins the type of interaction is chosen randomly with equal probability. It is because of this randomness in the in-

teractions that such systems are called disordered.

In terms of the Hamiltonian, the above model can be defined as

$$H(s) = - \sum_{x \sim y} J_{xy} s_x s_y$$

where, for each $x \sim y$, J_{xy} can be either $+1$ (indicating a ferromagnetic interaction) or

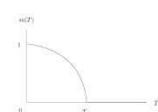


Figure 1: Spontaneous magnetisation: the magnetisation $m(T)$ as a function of the temperature T for a typical configuration of spins. The area under the curve is the total number of spins. The characteristic feature of ferromagnets is that there is a critical temperature T_c below which the spins exhibit collective behaviour in that a majority of them point in the same direction (either up or down). By symmetry, configurations with the opposite magnetisation $m(T) = -m(T)$ are equally likely.

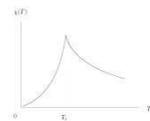


Figure 2: The magnetic susceptibility $\chi(T)$ as a function of the temperature T . $\chi(T)$ measures the sensitivity of the system to the application of a magnetic field and shows a sharp peak at the critical temperature T_c . This peak signals a transition of the spins to random directions.

-1 (indicating an anti-ferromagnetic interaction), with probability $\frac{1}{2}$ each. This Hamiltonian was introduced in 1975 by Edwards and Anderson [8], in an attempt to describe a class of disordered magnetic systems found a few years earlier by experimental physicists and termed 'spin glasses'. Examples in this class are disordered magnetic alloys, i.e., metals containing random magnetic impurities, such as AuFe or CuMn.

What is the analogue in this case of the behaviour depicted in Figure 1? Even at low temperature there is no reason why the majority of the spins should be aligned. Indeed, due to the equal competition between ferromagnetic and anti-ferromagnetic interactions the corresponding magnetisation $m(T)$ will be zero for all T . One might thus conclude that the model simply has no critical temperature and therefore exhibits no interesting phenomena.

However, in the early 1970's it was found experimentally by Cannella and Mydosh [6] and by Thouless and Thouless [19], that there still is a critical temperature below which the system undergoes an ordering transition, in the sense that the spins act coherently in some sort of way (see Figure 2). This fact came as a surprise to the physicists.

In simplified terms, what happens is the following. Above T_c the spins behave essentially independently from one another, i.e., their orientation is hardly influenced by the spins in their neighbourhood. As a result, the typical configurations of the system are those that are completely disordered. This is true both for the ferromagnet and for the spin glass. Below T_c , however, the spins show cooperative behaviour and can be found in

more than one class of typical configurations. In the case of the ferromagnet described above, there are two classes of typical configurations, namely, those having magnetisation $m(T) = +1$ and $m(T) = -1$, respectively. These classes of configurations are called pure states. In the case of the spin glass, instead, there are many pure states, which are not characterized by a non-zero magnetisation, but rather by the occurrence of many 'mesoscopic domains' (microscopically large but macroscopically small) in which the spins show some form of 'local magnetic order'. In fact, a whole 'hierarchy' of such domains occurs.

At present it is not yet clear what the features of these domains precisely are. The important point, however, is that the existence of a transition at T_c is experimentally observable.

The Edwards-Anderson model is far too difficult to be analysed theoretically in detail, even today. In fact, condensed matter physicists have been disputing heatedly in the past three decades about what precisely happens at low temperature. In 1975 Sherrington and Kirkpatrick [15] introduced a simplified version of this model. The difference with the Edwards-Anderson model is that each spin is considered not only by its neighbouring spins, but by all the spins in the system. The corresponding Hamiltonian reads

$$H(s) = - \frac{1}{|\Lambda|^{1/2}} \sum_{x \sim y} J_{xy} s_x s_y,$$

where J_{xy} is $+1$ or -1 , with probability $\frac{1}{2}$ each, for all $x \neq y$ (rather than for $x \sim y$ only), and a factor $1/|\Lambda|^{1/2}$ is added to normalise the interaction. In statistical physical jargon, the Sherrington-Kirkpatrick model is a mean-field approximation of the Edwards-Anderson model. Strange as it may seem, this type of approximation actually makes the model easier.

For a history of spin glasses up to 1986, we refer to Binder and Young [2].

Replica symmetry breaking

The article by Sherrington and Kirkpatrick carried the rather innocent title *A soluble model of a spin glass*. The authors never imagined that they were giving birth to one of the most exciting enigmas of modern statistical physics. The solution they proposed, assuming so-called 'replica

symmetry', turned out to be incorrect, and even self-contradictory as they themselves realised very well. It was only a few years later, in 1980, that the Italian theoretical physicist Giorgio Parisi [14] proposed a different solution, known as the replica symmetry breaking scheme, which could account for many of the experimental observations (both laboratory experiments and computer simulations).

Replica symmetry breaking theory predicts the existence of a collective behaviour with many exotic features, never before observed in any physical system. In simple words, Parisi's theory predicts that the Hamiltonian of the Sherrington-Kirkpatrick model has many ground states (growing in number as the volume of the system increases), which are highly disordered and which do not seem to be related to one another via simple transformations. In contrast, recall that the ferromagnetic Hamiltonian has only two ground states, one with all spins up and one with all spins down, which are fully ordered and which are related to one another via a global inversion of all the spins. Moreover, it turns out that for the Sherrington-Kirkpatrick model, by choosing a different realisation of the disorder (i.e., a different choice for the random interactions $J_{xy} = \pm 1$, again with probability $\frac{1}{2}$ each), the new ground states in general have nothing to do with the old ones. Even more surprisingly, if the disorder realisation is kept fixed but the volume of the system is increased, then the new ground states are not related to the old ones either ('chaotic size dependence'). In spite of this extremely irregular situation, according to Parisi's theory the collection of all the ground states has some regular highly non-trivial, geometrical structure, called ultrametricity, which is not modified when the disorder realisation is changed. So, what distinguishes the region above the critical temperature T_c from the one below for the Sherrington-Kirkpatrick model? Suppose that we take two copies — two replicas — of the system, with the same realisation of the disorder, and compare the overlap between them, i.e.,

$$q^{(1),(2)} = \frac{1}{|\Lambda|} \sum_{x \in \Lambda} s_x^{(1)} s_x^{(2)},$$

where $s^{(1)}$ and $s^{(2)}$ are the configurations of the first and the second replica, respec-

tively. Then, above T_c the overlap is zero for typical configurations (typical with respect to the Gibbs distribution and the disorder realisation), while below T_c it can assume a range of non-zero random values. This can be explained as follows. Recall that, at low temperature, the Gibbs distribution is peaked around the ground states of the system. Consequently, the configurations in the two replicas will each be very close to one of the ground states (not necessarily the same one), which causes a non-zero overlap. Due to the erratic nature of the ground states, the overlap does not have a fixed value: it varies randomly with the ground states.

Replica symmetry breaking theory came as a shock to the physics community, not only for the novelty of the phenomena predicted, but also for the way in which it was presented. It happens frequently that theories formulated by physicists are not mathematically rigorous, and contain a number of assumptions and simplifications that need to be justified. Often full mathematical proofs come only much later. Here the situation was more delicate: the works of Parisi and co-workers were not only non-rigorous, they were based on such strange and daring techniques that it was hard to see how the relevant statements could be formulated in a proper mathematical language. This is why part of the mathematics community has regarded Parisi's theory as somewhat magic. Still, the phenomena predicted by the theory were so appealing, and its range of applications so wide, that it soon became a standard tool for theoretical physicists, who were much more excited by its power than worried by its lack of mathematical sense and precision. One could say that Parisi had discovered a new world.

A review of the results of replica symmetry breaking theory up to 1987 can be found in Mézard, Parisi and Virasoro [12].

Towards a solution

The reader might wonder at this point whether all the excitement about the Sherrington-Kirkpatrick model is really justified. After all, it is only an approximate version of the more difficult — but more realistic — Edwards-Anderson model, which remains unsolved. In fact, it is not yet clear how much we really learn about the Edwards-Anderson model from a detailed analysis of the Sherrington-

Kirkpatrick model. According to a scenario put forward by Newman and Stein (see Newman [23]), the behaviour of the two models may well turn out to be qualitatively different: the main phenomena related to replica symmetry breaking may not occur in 'short range' models like the Edwards-Anderson model. Still, the excitement is understandable. First, the study of the Sherrington-Kirkpatrick model has taught us a lot and continues to do so. In the attempts to understand this model, new ideas and techniques have been invented and further developed that are extremely interesting and that have turned out to be fruitful for other statistical physical models as well. Second — and more importantly — it has gradually become clear that the knowledge gained through the analysis of the Sherrington-Kirkpatrick model can be applied to a variety of — apparently unrelated — problems in mathematics, physics and engineering. These problems have therefore come to be considered as belonging to the realm of spin glasses. Examples are neural networks (models for memory and learning), error correcting codes (used in communications engineering to recover the information transmitted through a noisy channel) and random combinatorial optimisation (problems of decision in the presence of many mutually competing requirements).

From the moment the replica symmetry breaking theory came into being, trying to prove — or to disprove — the predictions of Parisi and co-workers became an exciting challenge for many among the best mathematical physicists. The task proved to be quite hard and frustrating, and for almost twenty years progress was painfully slow. Much effort was devoted to the search for and the study of mathematical models that would be easier than the Sherrington-Kirkpatrick model, but that would still exhibit replica symmetry breaking effects. In particular, the Generalized Random Energy Model, introduced by Derrida [7] in 1985, shows striking similarities with the Sherrington-Kirkpatrick model, yet is exactly solvable. The structure of the Gibbs distribution in this model has been analysed in full mathematical detail by Bovier and Kurkova [4]. Similarly, extensive rigorous results have been obtained by Bovier, Gayraud and Pico for the Hopfield model of neural networks (see [3] and references therein). The

latter is a paradigm for auto-associative memory, i.e., systems that try to recognize words — or patterns — that were previously memorized. In this case, the spins should be interpreted as the states of the neurons located at the various sites $s_x = +1$ if the neuron at site x is sending electric pulses, $s_x = -1$ if it is not. When varying the number of memorized patterns, the behaviour can range from a ferromagnetic type to a spin glass type. For an overview of the expanding panorama of spin glasses up to 1998, see Bovier and Pico [5].

It gradually became clear — more through failures than through positive results — that completely new ideas were needed to make significant progress in the comprehension of replica symmetry breaking. It is only in the last few years that we are witnessing a rapid and unexpected boost in the mathematical understanding of the key questions. Surprisingly, the missing new ideas turned out to be relatively simple, although they were very hard to find. The first steps in this breakthrough were taken in 2000–2002 by the Italian mathematical physicist Francesco Guerra [10], together with Fabio Toninelli [11], building on earlier work by Ghahramani and Guerra [9]. As a result, some of the mathematical questions (problems of decision in the preceding twenty years could finally be solved. One important result is the existence of the 'thermodynamic limit' for the Sherrington-Kirkpatrick model. This means that physical quantities, like the energy of the ground states divided by the volume of the system, converge to a well defined limit when the volume of the system tends to infinity. The proof of this fact is quite standard in statistical physics for models with 'short range' interactions, but it is not for mean-field models, especially not for disordered ones. Another important result is that with the help of certain rigorous comparison identities — so-called *coupling* — the thermodynamic properties of the Sherrington-Kirkpatrick model can be compared with the corresponding expressions given by Parisi's theory. These new results concern the free energy $F(T, \Lambda)$ as a function of the temperature T and the volume $|\Lambda|$, a quantity of central importance in statistical physics, from which all thermodynamic properties of the system can be deduced. This free energy is related to the Gibbs distribution μ_T via the relation $F(T, \Lambda) =$

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In memoriam Harold Scott Macdonald Coxeter (1907–2003)

Een meetkundekunstenaar

Op 30 maart 2003 overleed op 96-jarige leeftijd de meetkundige Harold Scott Macdonald Coxeter, sinds 1936 verbonden aan de Universiteit van Toronto (Canada). In Nederland had hij vele vrienden, waarvan de graficus M.C. Escher veel de bekendste is. Hij ontving diverse onderscheidingen en acht eredoctoraten. In 1948 werd hij Fellow van de Royal Society van Canada en in 1950 van de Britse Royal Society. Sinds 1976 was hij erelid van het Wiskundig Genootschap en in 1978 werd hij benoemd tot buitenlands lid van de Koninklijke Nederlandse Akademie van Wetenschappen. Dit is Memoriam is geschreven door T.A. Springer voor de Levensberichten (Groot) van de Koninklijke Nederlandse Akademie van Wetenschappen. De auteur is emeritus hoogleraar in de wiskunde aan de Universiteit Utrecht.

Donald Coxeter werd geboren in Kensington (Londen) in een familie van Quakers. Zijn vader had een familiebedrijf waar chirurgische apparatuur vervaardigd werd, maar in zijn tijd was hij kunstenaar. In het huis was dan ook veel artistieke activiteit. Coxeters vader musiceerde en zijn moeder schilderde.

Al heel vroeg bleek dat Donald wiskundig en muzikaal begaafd was. Als kleuter keek hij graag in de financiële pagina's van de krant, omdat daar zoveel getallen te vinden zijn. Hij wilde eerst componist worden; omstreeks zijn twaalfde had hij al een strijkkwartet en een opera gecomponeerd.

Maar wiskunde ging de boventoon voeren. In 1924 ging hij naar een boarding school (St. George's School te Harpenden ten Noor-

den van Londen). Hij vertelt dat hij daar, toen hij met een klein aandoening op de ziekmalfdeling lag, met zijn buurman John Petrie (zoon van de egyptoloog Sir Matthew Flinders Petrie) aan de praat kwam over regelmatige lichamen (de vijf platonsche lichamen), die ze in hun meetkundeboek ontdekten hadden. Donald kreeg in ingang dat zulke lichamen ook in vier dimensies zouden moeten bestaan en John kon een paar dagen later een realistisch model van zoets tekorten, waartoe zij de extra dimensie konden zien. Toen wist Donald dat wiskunde, en meetkunde in het bijzonder, zijn toekomst moest zijn. Hij was toen veertien jaar.

Coxeter senior vond dat de school zijn zoon niet voldoende uitdaging bood en bracht Donald in contact met wiskundigen. Hij kreeg het advies zich via privé-onderwijs voor te bereiden op een studie in Cambridge, en dat gebeurde. In 1926 won hij een studiebeurs van Trinity College. Hij kwam er in contact met conyfeeten als G.H. Hardy, J.E. Littlewood (zijn 'director of studies'), L. Wittgenstein. De Ph.D. graad behaalde hij in 1931, zijn supervisor was de meetkundige H.F. Baker. Het proefschrift gaat – ultra-rand – over meerdimensionale regelmatige lichamen.

In de entourage van Baker leerde de jonge Coxeter de groepsentheorie kennen, die de wiskundige aanpak belichaamt een meetkundige symmetrieën. De regelmatige-euwa wiskundigen hadden ingezien dat de symmetrieën van de platonsche lichamen in interessante twee- en driedimensionale groepen van lineaire transformaties georganiseerd zijn. Coxeter begreep dat zijn meerdimensionale

regelmatische lichamen samenhangen met interessante meerdimensionale lineaire groepen en hij begon omstreeks 1930-veer die groepen na te denken.

Tot 1936 was hij 'research fellow' van Trinity College. Hij bracht ook twee academische jaren (1937–1938) en 1938–1939) door in Princeton in de Verenigde Staten. Daar leerde hij veel van O. Veblen en hij maakte kennis met latere prominente van zijn generatie als B. Brouwer en H. Jacobson. In 1936 publiceerde hij de resultaten van zijn groepsentheoretisch werk: de classificatie van 'kaleidoscoppen' of spiegelingsgroepen, dat wil zeggen groepen van reële lineaire transformaties voortgebracht door spiegelingen. In dat fundamentele artikel vindt men ook de diagrammen die deze groepen beschrijven (thans Coxeterdiagrammen of Coxeter-Dynkin-diagrammen genoemd). Hij gaf een exposé van zijn resultaten in de vermaarde 'notes' van een college van H. Witt over Liegroepen aan het Institute for Advanced Study in Princeton.

Tegenwoordig komt ieder die in wiskunde of natuurkunde van doen heeft met continue symmetrieën (belichaamd in de Liegroepen) de Coxeterdiagrammen tegen. In genoemd artikel vindt men ook wat nu het Coxeterelement genoemd is: het product van de voortbrengers van een spiegelingsgroep.

Een ander artikel uit 1936, dat gaat over groepen met een presentatie $[K^2 = (a,b)^2, P^2 = 1]$ die van de spiegelingsgroepen, is het begin van de theorie van de Coxetergroepen.

In 1936 werd Coxeter een assistant professorship aangeboden in Canada, aan de Uni-

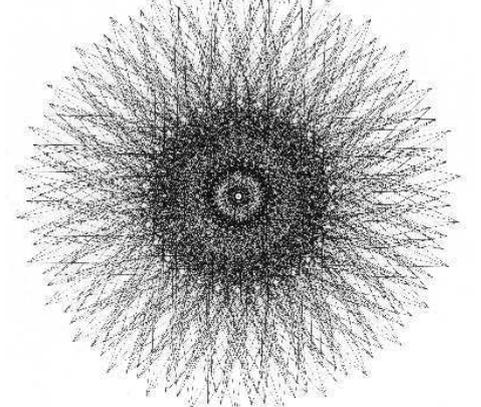
versiteit van Toronto. Op advies van zijn vader, die de ontroepelingen al zag hangen, en van G.H. Hardy besloot hij het aanbod aan te nemen. Hij is tot zijn dood in Toronto gebleven. Dak in 1936 trouwde hij met de Nederlandse sien (Hendrina) Brouwer, die hij in 1935 in Engeland ontmoet had bij gemeenschappelijke kennissen. Zij was toen vierde jaars een trouwe steun; zij overleed in 1999. Het echtpaar had twee kinderen, een zoon en een dochter. Coxeters academische carrière verliep langzaam, na zeven jaar werd hij associate profes-

sor en pas na twaalf jaar full professor (Coxeter zei dat hij zich voorde als de aartsvader Jacob), die zeven jaren moest werken voor Lee en zeven jaren voor Rachel.

Coxeter was een productieve wiskundige; hij publiceerde ongeveer 200 artikelen. Daar naast schreef hij verschillende boeken. Een standaardwerk is *Regular Polytopes* (1948, nieuwe uitgave 1973), waar zijn encyclopedische kennis blijkt van de literatuur over regelmatige lichamen. In dat boek komt men ook Coxeter's vriend John Petrie tegen als ontde-

ker van de Petrie-veelhoeken van een regelmatig lichaam.

In vele talen vertaald is *Introduction to Geometry* (1964/1984). De titel van de Duitse vertaling *Unregelmäßige Geometrie* geeft weer wat Coxeter in dat boek voor ogen stond. Naast boeken over meetkundige onderwerpen is er het algemeenere goriënteerde boek met W.O.J. Moser, *Generators and Relations for Discrete Groups* (1957/1980). Coxeter zelf was het meest gesteld op zijn boek *Regular Complex Polytopes* (1974/1990) over re-



De Great grand dodecahedron (200-cell), een van de vele figuren uit het boek Regular Complex Polytopes van Coxeter. Coxeter liet zich graag inspireren door muziek; uit het voorwoord: "This book has occupied much of my time and attention for nearly twenty years. [...] I have made an attempt to construct it like a Bruckner symphony, with recurrences and climaxes, little fantasies of phrases to be used and depicted consecutively. The geometric, algebraic and group-theoretic aspects of the subject are interwoven into a musical structure of the entire work."

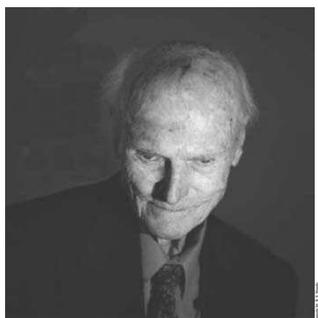
gelmatige lichamen in een complexe ruimte, een boek met spectaculaire illustraties. De bijbehorende symmetriegroepen zijn zijzelf groepen van complexe lineaire transformaties, voortgebracht door complexe spiegelingen, een soort generalisatie van Coxetergroepen. De belangstelling ervoor is in de loop van de jaren steeds meer toegenomen.

Coxeters publicaties zijn zorgvuldig geredigeerd en helder geschreven; esthetische aspecten waren voor hem belangrijk. Hij was een inspirerend spreker die altijd iets verassends bracht. Zijn grote meetkundige intuïtie blijkt overal; hij kon meerdimensionale objecten 'zien'. De thema's van Coxeters publicaties zijn al genoemd: regelmatige lichamen, meetkundige symmetrieën en de bijbehorende groepsentheorie, thema's waarop vele variaties kunnen worden gemaakt, waarvan hij zelf ook gewerkt heeft. Hier volgen enkele voorbeelden.

In een artikel uit 1953 werden de (reeds genoemde) Coxeter-elementen nader bekeken. Coxeter vertelt dat de aanleiding was een voordracht van C. Chevalley over de Bethe-tallen van compacte Liegroepen. Coxeter herkende getallen die hij in zijn *Regular Polytopes* was tegengekomen. Dit bracht hem er toe de eigenwaarden van Coxeter elementen te bekijken. Die bleken een fraaie wetmatigheid te vertonen, later door andere uitvoerig geanalyseerd (een voorbeeld van wisselwerking tussen Coxeters concrete meetkunde en meer esthetische delen van de wiskunde).

De icosaeder (het regelmatig twintigvlak) leeft men aan als ruimtelijke configuratie in sommige wetenschappen. Het optreden van regelmatige of halfregelmatige lichamen buiten de wiskunde interesseerde Coxeter steeds. Vervolgens was er bij niet-wiskundigen belangstelling voor zijn werk. De Amerikaanse ontwerper en architect Buckminster Fuller kreeg één van zijn boeken op aan Coxeter. Fuller maakte in de jaren '40 van de vorige eeuw huroon met zijn 'geodesic dome's'. Daarvan is een belangrijk constructie-element de 'buckyball', een afgeknotte icosaeder met 60 hoekpunten, 32 regelmatige vijfhoeken en 20 regelmatige zeshoeken als zijvlakken, natuurlijk goed bekend aan Coxeter (Baastard da Vinci) had er overigens al een tekening van gemaakt.

In de jaren '80 bleken buckyballs op te treden als bouwstenen van moleculen genaamd fullerenes. Eén ervan is C_{60} , waarvan de moleculen buckyballs zijn met in ieder hoekpunt een koolstofatoom. C_{60} heeft zeer bijzondere chemische eigenschappen. De ontdekkers ervan ontvingen in 1996 de Nobelprijs voor chemie.



Coxeter in Baarn, augustus 2001, gedurende een lezing over meetkunde bij Escher.

Coxeter had een speciale relatie met Nederland. Hij kwam regelmatig met zijn vrouw op familiebezoek in Nederland en kreeg contacten met Nederlandse wiskundigen. Er waren ook andere wiskundige connecties. Coxeter was verwant met het werk over meerdimensionale regelmatige lichamen van Nederlandse wiskundigen die het begin van de twintigste eeuw (onder anderen E.L. Elk, S.L. van Oss, P.H. Schoute, W.A. Wythoff). In Nederland zijn zij wat in het vergetenboek gezakt. Maar hun werk komt uitvoerig aan de orde in *Regular Polytopes*.

Tijdens een bezoek aan Nederland in 1954 nam Coxeter deel aan het vierjaarlijkse internationale Wiskundecongres dat toen in Amsterdam plaats vond. In het kader van het congres was er een expositie van het grafische werk van M.C. Escher, toen buiten Nederland nauwelijks bekend. Coxeter werd er zeer door geboeid en bezocht Escher in Baarn. Zij raaken bevriend en Coxeter bracht Escher in contact met de symmetrieën van het niet-Euclidische vlak (gevisualiseerd als het Inwendige van een cirkel). Deze symmetrieën heeft Escher in zijn latere werk geïmponeerd.

Bijvoorbeeld in zijn houtsnede *Kirkellimier III* uit 1959 (met wisselen die naar de rand toe steeds kleiner worden). Coxeter heeft de trigonometrie die er achter zit geanalyseerd. Hij was geïnsponeerd door Eschers intuïtieve gevoel voor de wiskundige details die Coxeter alleen met ingewikkelde trigonometrie kon aanpakken. Coxeter vertelt dat na afloop van een lezing waarbij Escher ook aanwezig was, deze hem vertelde dat hij er geen woord van begreep had. Coxeter heeft veel gedaan voor het bekend maken van Escher's werk buiten Nederland.

Coxeter overleed plotseling op 96-jarige leeftijd, op 30 maart 2003. Hoewel zijn mobiliteit achteruit ging, was zijn geest nog fit. De meetkunde bleef hem tot het laatste bezigegehouden.

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Vakantiecursus 2003

GPS and integer estimation

Het Global Positioning System (GPS) is een wereldwijd plaatsbepalingssysteem op basis van satellieten. De eerste plannen en ontwerpen voor het systeem dateren uit de vroege jaren zeventig in de vorige eeuw, reeds in februari van 1978 werd de eerste GPS-satelliet gelanceerd. De nominale constellatie omvat 24 satellieten, die elk in ongeveer 12 uur om de aarde cirkelen. Daardoor kunnen overal ter wereld, doorgaans minstens vier satellieten tegelijkertijd waargenomen worden. Peter Teunissen, hoogleraar wiskundige geodesie en positiebepaling aan de Technische Universiteit Delft verzorgde in de zomer van 2003 colleges over Global Positioning Systems in het kader van de, door het CWI georganiseerde, vakantiecursus voor wiskundeleraars.

The Global Positioning System (GPS) nowadays is used for a whole variety of positioning and navigation applications. These applications range from navigating your private sailboat to determining the millimeter movements of the earth's tectonic plates. For the very high-accuracy applications of GPS one needs very precise range information. These precise ranges for positioning with GPS are obtained from carrier phase measurements. These measurements of range inherently contain unknown integer ambiguities to account for the mismatch of a whole number of wavelengths or cycles. This contribution describes the problem of GPS carrier phase ambiguity resolution, discusses some relevant elements of integer estimation theory and reviews some of the high precision positioning applications that come into reach when the integer carrier phase ambiguities can be resolved quickly and correctly.

Redundant measurements
 As in other physical sciences, empirical data are used in geodesy to make inferences as to describe the physical reality. Many such problems involve the determination of a number of unknown parameters which bear a linear or linearized relationship to the set of data. In order to be able to check for errors or to reduce for the effect these errors have on the final result, the collected data often exceed the minimum necessary for a unique solution (redundant data). As a consequence of measurement uncertainty, redundant data are usually inconsistent in the sense that each sufficient subset yields different results from another subset. Hence, redundancy generally leads to an inconsistent system of linearized equations, say

$$y = Ax \tag{1}$$

where vector y contains the m observations, vector x the n unknown parameters. The $m \times n$ matrix A relates the observations to the parameters. Redundancy of the above system is defined as $m - \text{rank}(A)$, which in case of a full rank matrix simplifies to $m - n$, the difference between the number of observations and the number of unknown parameters.

The above inconsistent system is without additional criteria not uniquely solvable. The problem of solving an inconsistent system of equations has attracted the attention of leading scientists in the middle of the 18th century. Historically, the first methods of combining redundant measurements originate from studies in

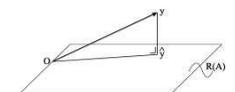


Figure 1 Least-squares estimation (optimal in a orthogonal) projection of the observation vector y onto the plane spanned by the columns of matrix A . Example with three observations and two unknown parameters.

GPS positioning basically is determining the location of a (user) receiver with respect to satellites of which the locations (orbits) are known. This determination takes place by measuring distances, and from a geometric point of view these measurements would suffice to determine the three coordinates of the user (fortunately we know on which side of the satellite configuration the earth is located). The simplest example of (1) in case of GPS is the referee when distances are measured from an unknown GPS receiver position to more than three GPS satellites of which the positions are known. Since the distance from the unknown receiver position to the known position of satellite i is a nonlinear function of the unknown position coordinates,

$$l_i = \sqrt{(x - x_i)^2 + (y - y_i)^2 + (z - z_i)^2} \tag{2}$$

the common approach is to approximate the relation by a Taylor series with zeroth and first order terms only, using good approximate values for the unknown parameters. As a result the (increments of the) observed distances are collected in vector y , the (increments of the) three unknown coordinates in vector x and the partial derivatives in matrix A . In reality the equations are far more complicated than (2) due to the fact that one also has to account for clock errors, atmospheric delays and orbital errors.

Least-squares
 Around 1800 Legendre and Gauss at the same time (most likely independently), invented the method of least-squares for solving an inconsistent system of equations. The least-squares solution to (1) reads

$$\hat{x} = (A^T Q_y^{-1} A)^{-1} A^T Q_y^{-1} y \tag{3}$$

with Q_y^{-1} being the weight matrix. This solution is obtained by first adding an unknown error vector e to (1), giving the consistent but underdetermined system $y = Ax + e$, and then minimizing the

weighted norm of e , $\|e\|_{Q_y}$, as function of x . The least-squares estimator has various desirable properties. When the positive definite matrix Q_y is chosen as the variance-covariance matrix of the observations, the least-squares estimator has the smallest variance (best possible precision) of all linear unbiased estimators.

The geometric interpretation of what least-squares does to the observations is shown in figure 1. The inconsistency between observations on one hand and model (with unknown parameters) on the other is removed by orthogonal projection. Vector $\hat{y} = Ax$ eventually lies in the plane or linear manifold spanned by the columns of matrix A (indicated by $R(A)$). The orthogonal projection realizes shortest distance between the original observation values y and the adjusted ones \hat{y} ; the observation values are modified as little as possible, though satisfying the assumed model afterwards. This follows from interpreting the least-squares estimation principle as the principle of least distance

$$\min \|y - Ax\|_{Q_y}^2 \tag{4}$$

(The squared and weighted) distance between y and $\hat{y} = Ax$ is minimized.

In order to evaluate the quality of the least-squares solution in a probabilistic sense, we need the probability density function (PDF) of \hat{x} . Since f of (3) is a linear function of y , the least-squares estimator has a Gaussian distribution whenever y is Gaussian distributed. The PDF of the unbiased least-squares estimator \hat{x} can therefore be uniquely characterized by means of the variance-covariance matrix of \hat{x} . With Q_y being the variance-covariance matrix of the observations, application of the error propagation law to (3) gives the variance-covariance matrix of the estimated parameters as

$$Q_{\hat{x}} = (A^T Q_y^{-1} A)^{-1} \tag{5}$$

This matrix can be used to evaluate the precision of the parameter estimates, as for instance the covariance coordinates.

GPS carrier phase observables

GPS observations of distance or range are obtained by measuring signal travel-times (from satellite to receiver) and multiplying these by the speed of light. Two types of distance measurements are employed: pseudo range code and carrier phase. The code observation is based on the (binary) code the satellite modulates onto the signal carrier; the distance can be measured virtually unambiguously. For the carrier phase, the receiver measures the difference in phase between the carrier wave received from the satellite and the reference carrier wave it generated itself. (The physical phase difference reads

$$\phi_r - \phi_s - \phi_e$$

With some simplifying assumptions, the phase of a carrier wave at some epoch t equals frequency f multiplied by time t , $\phi = ft$. The receiver compares the reference carrier at a time of observation t_r with the carrier received from the satellite, which was generated a little earlier in order to be 'in time' at the receiver, namely at $t_r - \tau$, where τ is the signal travel time from satellite to re-



Figure 2 A GPS receiver and antenna permanently installed for precise monitoring motion of the earth's crust. Site Benares in California in the US. Photo taken from aircraft at <http://www.cnr.gov>

The above phase difference becomes

$$\phi_r - \phi_s = f \tau$$

and when multiplied by wavelength $\lambda = c/f$, $\lambda \phi_r - \lambda \phi_s = c \tau = l$, the distance in meters is obtained; it equals the travel time pre-multiplied by the speed of light c , exactly as with the code observation.



Figure 3 Measurement of phase on the continuous carrier wave transmitted by the satellite. The satellite keeps on transmitting the carrier wave, cycle after identical cycle.

As a consequence of carrying out measurements on a (monotone) continuous carrier wave, the receiver can not distinguish one cycle from another. The satellite keeps on transmitting the carrier wave, in principle cycle after identical cycle, see figure 3. At some epoch in time the receiver simply starts outputting the measured fractional difference in phase, $\text{frac}(\phi_r) \in [0, 1)$ cycle. The full (physical) phase difference is then decomposed into

$$\phi_r = \text{int}(\frac{\phi_r}{\lambda}) + \text{frac}(\frac{\phi_r}{\lambda})$$

The observed (fractional) phase difference ϕ_r^f (times the wavelength) does therefore not equal the distance from satellite to receiver l_r , but equals this distance apart from an integer number of wavelengths

$$\lambda \phi_r^f = l_r - l_r^i \lambda N_r$$

As a consequence the vector x in (1) will, next to the unknown receiver coordinates, now also contain unknown integer cycle ambiguities N_r .



Figure 4 Least-squares with integer parameters: possible solution for the vector of observations from a grid in the column-space of matrix A and Q_y and two columns of matrix A ; the solution is no longer allowed to be anywhere in the plane $R(A)$.

Integer least-squares
 The least-squares solution (3) is obtained from solving (4), where x is allowed to vary over the whole n -dimensional space of real numbers. In case of GPS however, when use is made of the carrier phase observations, the vector of unknown parameters x consists of both real-valued and integer-valued parameters (real-valued coordinates and integer-valued carrier phase ambiguities). We therefore need to modify the solution (3) so as to take the integerness of some of the parameters into account. To keep the discussion simple, it will be assumed here that all parameters in vector x are integer-valued. Due to the integerness of the parameters, orthogonal projection of y will now not do the job properly, see figure 4. Nevertheless one can start with 'ordinary' least-squares as a first step, see figure 5. The solution so obtained for the unknown parameters will be real-valued and is usually referred to as the 'float' solution.



Figure 5 Least-squares with integer parameters: the first step consists of 'ordinary' least-squares (orthogonal projection); the solution for the parameters will consist of real-valued numbers.

To apply the least-squares principle (4), but now under the condition that the parameters in x are all integers, a second step has to be carried out. Since the first step projects orthogonally to the plane $R(A)$, the second step takes place in the plane. From the orthogonal decomposition

$$\|y - Ax\|_{Q_y}^2 = \|y - \hat{y}\|_{Q_y}^2 + \|y - Ax\|_{Q_y}^2 \tag{6}$$

it follows that the second step amounts to solving the minimization problem

$$\min \|y - Ax\|_{Q_y}^2 (y - Ax) =$$

$$\min \|x - x\|_{Q_x}^2 A^T Q_y^{-1} A (x - x) = \min \|x - x\|_{Q_x}^2 (x - x) \tag{7}$$

for x being integer, where in the last equation (5) has been used. This minimization can also be visualized in the parameter space, see figure 6, instead of in the observation space as in figures 1 and 4.

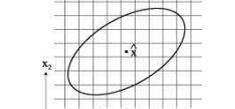


Figure 6 Least-squares with integer parameters: in the second step the integer solution for x is sought that is closest to the real-valued solution \hat{x} of the first step, 'closest' in the sense of the metric of the variance-covariance matrix Q_x . The shaded form $S_{\hat{x}}$ set near to \hat{x} is assumed, it is separated by the ellipse in this example with two ambiguities x_1 and x_2 .

The integer least-squares principle has been applied very successfully to GPS ambiguity resolution. By the presence of the variance-covariance matrix Q_x in (7), the precision and correlation of the individual real-valued ambiguity estimates is properly and fully exploited. In contrast to the 'ordinary' least-squares solution (3), there does not exist an analytical solution to (7). In practice a search over possible integer solutions has to be carried out. The space of integer solutions is restricted by limiting the squared and weighted distance in (7) to a convenient value. As a result, the volume of the corresponding ellipse (or hyper-ellipsoid in higher dimensions) has to be searched through in order to find the integer least-squares solution \hat{x} .

When the ambiguities of the first step are of poor precision and at the same time highly correlated, the ellipse or ellipsoid gets very elongated and narrow. As a consequence the discrete search may get computationally inefficient. For computational efficiency the quadratic form (7) can be integer transformed, so that the resulting ellipsoid becomes more sphere-like and the transformed ambiguities become less correlated [2-3].

Alternative integer estimators

Instead of the integer least-squares estimator one can also think of alternative integer estimators. Starting from the 'float' solution, such an estimator $\hat{x} = F(\hat{x})$ will consist of a mapping $F: R^n \rightarrow Z^n$ from the n -dimensional space of real numbers to the n -dimensional space of integers. Due to the discrete nature of Z^n , the map F will not be one-to-one. This implies that different real-valued ambiguity vectors will be mapped to the same integer vector. One can therefore assign a subset $S_{\hat{x}} \subset R^n$ to each integer vector $z \in Z^n$.

$$S_z = \{x \in R^n \mid z = F(x)\}, \quad z \in Z^n \tag{8}$$

The subset S_z contains all real-valued ambiguity vectors that will be mapped by F to the same integer vector $z \in Z^n$. This subset is referred to as the pull-in region of z ; it is the region in which all am-

biguity 'float' solutions are pulled to the same 'fixed' ambiguity vector z .

Since the pull-in regions define the integer estimator completely, one can define classes of integer estimators by imposing various conditions on the pull-in regions. One such class is given as follows [4].

An integer estimator is said to be *admissible* if

$$\begin{aligned} (i) & \bigcup_{z \in Z^n} S_z = R^n \\ (ii) & S_z \cap S_{z'} = \emptyset, \quad \forall z, z' \in Z^n, z \neq z' \\ (iii) & S_z = z + S_0, \quad \forall z \in Z^n \end{aligned} \tag{9}$$

This definition is motivated as follows. Each one of the above three conditions describe a property of which it seems reasonable that it is possessed by an arbitrary integer ambiguity estimator. The first condition states that the pull-in regions should not leave any gaps and the second that they should not overlap. The absence of gaps is needed in order to be able to map any 'float' solution $\hat{x} \in R^n$ to Z^n , while the absence of overlaps is needed to guarantee that the 'float' solution is mapped to just one integer vector. Note that the pull-in regions are allowed to have common boundaries. This is permitted if we assume to have zero probability that \hat{x} lies on one of the boundaries. This will be the case when the probability density function (PDF) of \hat{x} is continuous.

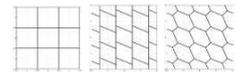


Figure 7 Two-dimensional pull-in regions of rounding, truncating, and integer least-squares.

The third and last condition follows from the requirement that $F(x+z) = F(x) + z, \forall x \in R^n, z \in Z^n$. Also this condition is a reasonable one to ask for: it states that when the 'float' solution is perturbed by $z \in Z^n$, the corresponding integer solution is perturbed by the same amount. This property allows one to apply the integer-on-integer technique $F(x+z) = z + F(x)$. It therefore allows one to work with the fractional parts of the entries of \hat{x} , instead of with its complete entries.

There exist various admissible integer estimators. The simplest integer map is the one that corresponds to integer rounding. In this case the integer vector is obtained from a rounding of each of the entries of \hat{x} to its nearest integer. Since component-wise rounding implies that each real-valued ambiguity estimate $\hat{x}_i = 1, \dots, n$, is mapped to its nearest integer, the absolute value of the difference between the two is at most $1/2$. The subsets $S_{z_{\pm}}$ that belong to this integer estimator are therefore given as

$$S_{z_{\pm}} = \left\{ \hat{x} \in R^n \mid |x_i - z_i| \leq \frac{1}{2}, \quad \forall z \in Z^n \right\} \tag{10}$$

The subset $S_{z_{\pm}}$ contains all n -dimensional ambiguity vectors that will be mapped by F to the same integer vector $z \in Z^n$. This subset is referred to as the pull-in region of z ; it is the region in which all am-

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ISSN 0028-9545

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Op het omslag

Brief van Goethedieck aan Serre van 2 april 1984. Zie bladzijde 42 voor een recensie van de omlaats in het Engels vertaalde correspondentie.

Agenda

Uitnodiging Events
Gefelove gegevens voor deze agenda door te geven aan onderstaand adres.
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maart 2004

9-12 maart
Buildings and Groups of Lie-Type
Minisymposium over semi-simples Liegroepen vanuit combinatorisch perspectief. Doцент: Bernhard Mühlhler (Universiteit Libre de Bruxelles).

15-19 maart
Mathematics with Industry
48ste Europese Strategiepro. Bedrijven leveren problemen aan de wiskundigen proberen op te lossen.

19 maart
Kangaroo
Westrij voor middelbare scholieren en voor leerlingen van groep 7 en 8 van de basisschool.

23 maart
John Bernoulli lezing
Prof. J.F. Barot de Moor (Katholieke Universiteit Leuven) verzorgt de Bernoulli lezing met het titel Systems biology: a new mathematical frontier

25-26 maart
Nationale rekendagen
Conferentie, gewijd aan het rekenonderwijs.

26 maart - 26 september
Goedheden met getallen
Epublie over de plaats en historie van getallen in de samenleving.

10-14 mei
Approximation Algorithms and Games on Networks
Minicursus op de doorsnede van de vakgebieden algoritme ontwerpen en speltheorie door prof. Eva Tardos (Cornell University, USA).

29 maart - 4 april
Weiskunde Conformal Invariance, Scaling Limits and Percolation
Organisatoren: Nina Gantert, Remco van der Hofstad

april 2004
Nederlands-Belgisch Mathematisch Congres
Gastprekers: Neil Sloane (AT&T), Bernard de Baets (Universiteit Gent) en Stef Tijss (Universiteit van Tilburg, Manjula Bhargava (Princeton University).

16-17 april
Kokema symposium
Symposium naar aanleiding van de honderdste geboortedag van J.F. Kokema.

20-23 april
Continuous and Discrete Random Spatial Processes
Organisatoren: J. van den Berg (CW), B. Bielewicz (UVA).

21 april
Kokema symposium
Symposium naar aanleiding van de honderdste geboortedag van J.F. Kokema.

25-26 maart
Nationale rekendagen
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15 mei
Symposium X historische kring reken- en wiskunde onderwijs
Organisatie: Freudenthalinstituut.

28 mei
Panama voorjaarsdag
Panama voorjaarsdag en IVOGWO jaarvergadering.

juni 2004
Lie groups in Analysis, Geometry and Mechanics
M81 Spring School 2004, AIO-cursus van drie weken.

9-11 juni
Onderwijs Research Dagen 2004

14-18 juni
Mod 7
Conferentie over het ontwerpen van statistische experimenten.

21-25 juni
18th European Conference for Mathematics in Industry
Internationale conferentie over wiskundig modeleren van industriële processen.

23-25 juni
Workshop HPOPT 2004
Internationale workshop over High Performance Optimization Techniques met thema: Optimization and Polynomials.

30 juni
MSOM Multi-Echelon Inventory Conference
Internationale conferentie georganiseerd door de afdeling Medische Statistiek van de Leiden University Medical Centre (LUMC).

1-2 juli
MSOM 2004 Conference
Optimization Techniques met thema: Optimization and Polynomials.

4-11 juli
ICME 10
10th International Congress on Mathematical Education

6-8 juli
Internationale Wiskunde Olympiade
De 48ste versie van het grootste internationale wiskundeonderzoek voor middelbare scholieren.

6-8 oktober
Woudschoten-conferentie
De 29-ste conferentie van de Nederlandse Vlaamse Nederlandse Wiskunde Gemeenschappen. Thema's van deze conferentie zijn: Computational electromagnetics en Geometrische Integratie voor ODEs en PDEs.

augustus - oktober 2004

15-19 augustus
International Society for Clinical Biostatistics 2004
Internationale conferentie georganiseerd door de afdeling Medische Statistiek van de Leiden University Medical Centre (LUMC).

23-26 augustus
Harmonic Analysis and Homogeneous Spaces
Workshop, gewijd aan harmonische analyse en haar toepassingen in de mathematische fysica, niet-communicatieve meetkunde en getaltheorie.

27 augustus
Special day in honour of Gerrit van Dijk
Special day in honour of Gerrit van Dijk on the occasion of his 85th birthday.

30 augustus - 3 september
Workshop Algebraic Cycles and Motives
Organisatoren: S.J. Edixhoven, J. Nagel, C. Peters.

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Nieuws

Nederlands-Belgisch Mathematics Congress
Het Koninklijk Wiskundig Genootschap en het Belgisch Wiskundig Genootschap houden dit jaar een gezamenlijk congres. Het congres vindt plaats op vrijdag 14 en zaterdag 15 april 2004 aan de Universiteit van Tilburg.

Er zijn drie hoofdvoorzitters. Sief Tijl (Universiteit van Tilburg) geeft een voorzitter over Nash-evenwichten, Bernard De Baets (Universiteit van Gent) spreekt over verzamelingen en Neil Sloane (AT&T) over zijn 'On-Line Encyclopedia of Integer Sequences'. Verder is er de tweedagelijkse Beeger lesing (getiteld) door Manjiv Bhargava (Princeton University), een speciale voordracht over palken in het casino door Ben van den Graaf (Universiteit van Tilburg) en een interactieve veiling (met een echte veiling) door Casper de Vries (Erasmus Universiteit Rotterdam). Daarnaast zijn er vijftien minisymposia, korte presentaties van promovendi en aangelegde voordrachten.

Voor het eerst is zaterdag een congresdag. De organisatie verwacht dat dit interessant kan zijn voor hbo- en vwo-docenten. Het programma houdt hiermee rekening en is er speciaal tafel-voor-destinatie op zaterdag.

Voor informatie, zie <http://www.uvt.nl/nmc2004>. *Wiml Hoovers*

Veertigste Mersenne-priemgetal gevonden
Het GIMPS-project (Great Internet Mersenne Prime Search) heeft op 2 december 2003 aangekondigd dat Michael Quaker (werkzaam bij de Michigan State University) het veertigste Mersenne-priemgetal $2^{29967631} - 1$ gevonden heeft. Het getal bestaat uit meer dan zes miljoen cijfers en staat daarmee het vorige record $2^{7680193} - 1$, dat gevonden was op 14 november 2003 en iets meer dan vier miljoen cijfers telde.

Het GIMPS-project wordt op dit moment gedragen in een wereldwijd virtueel netwerk van ongeveer 25.000 computers. Mersenne-priemgetallen zijn genoemd naar Marin Mersenne, een Franse geestelijke die in zijn dertiende-jaar geleiden als eerste getallen van het type $2^p - 1$ bestudeerde. (In die laatste formule is ook p , de exponent van 2, een priemgetal.) Bij het GIMPS-project wordt gebruik gemaakt van software ontwikkeld door George Woltman en Scott Kurowski, draaiend op 'gewone' PCs.

Informatie: <http://www.mersenne.org/2996601.htm> *Dick Klings*

Kokma Symposium
Op woensdag 21 april 2004 vindt op de Vrije Universiteit voor een breed publiek een symposium plaats naar aanleiding van de honderdste geboortedag van J. F. Kokma (1904-1964), voornaamste grondlegger van de beoefening van de wiskunde aan de VU. Kokma promoveerde op 4 juni 1930 bij Van der Graaf in Groningen. Op 30 oktober van hetzelfde jaar werd hij gewoon hoogleraar aan de VU. Voor de VU, die zich als universiteit naar moet maken, was Kokma een gouden greep. Hij was een goed wiskundige, die onder meer met Eddys samenwerkte. Zijn hoofdwerk is *Diophantische Approximatieën* uit 1936. Kokma was ook een doeltastend netwerker, die binnen het Mathematisch Centrum en bij de organisatie van het Internationale Mathematische Congres in Amsterdam een grote rol speelde. De hijs gaf ook nog uiterland colleges, daarbij het contact met zijn gebouwd vriendschapshand. 'W' is zo toch nog wel in de gids, meener 'K', sprak hij ooit.

Deze rubriek is een heriaal van wiskundige activiteiten in Nederland. Toekomstige artikelen worden aangekondigd en voor voorbije activiteiten wordt gewaardeerd.

WV is een aanleiding tot verlies in deze wereld gezonde?
Stuur dan uw bijdrage (€ 250 worden, ze mogelijk met illustratie) naar wiskundebestuur@vrijevrijheid.nl. De redactie behoudt zich het recht voor berichten te wijzigen of in te korten.

Seeuwal binnesteelten
Een proef is naar vergelijkbaar – voorbeeld van wiskundige kunst wordt gevormd door een vier meter hoog beeld van sneeuw dat voorstelt hoe een bol volgens de topologische regels der kunst binnesteelten kan worden gekleurd. Dat is mogelijk te wend in 1996 bevestigd (door Stephen Smal) en concrete ideeën over hoe dit gewaarschuigd kan worden stammen uit de jaren zeventig van de vorige eeuw.

Een team onder leiding van de wiskundige Stan Wagenvoort (Macalester College in St. Paul, Minnesota, VS) heeft vorige maand tijdens het 14th International Snow Sculpture Championship (Breckenridge, VS) het binnesteelten keren letterlijk in beeld gebracht. De creatie kreeg een eervolle vermelding als 'meest ambitieus beeldhouwwerk'.

De www.sciencenews.org/20030207/msthrk.asp *Geert Koesters*



Wintersymposium Wiskunde en muziek
Tijdens de Nationale Wiskunde Dagen te Noordwijkerhout is een nieuw symposium van het Koninklijk Wiskundig Genootschap met het thema Wiskunde en Muziek, dat plaatsvindt in de Aula van het Academiegebouw van de Universiteit Utrecht. Door de grote toeloo most organisator Matha Kamminga de dag een kwartier later dan gepland openen.

Er werden drie pikante lezingen gegeven. De eerste lezing over boventonen werd verzorgd door Jan van de Craats en was een groot succes. Hij illustreerde zijn lezing met experimenten aan de vleugel. De tweede lezing werd verzorgd door sionoloog burger Reuissen die een digitale presentatie hield over signaalwerking. Ook dit onderzoek werd uitstekend geïllustreerd met behulp van computerbeelden met bijpassende geluidseffecten.

Na de lunch was het de beurt aan Henkjan Honing die over zijn onderzoek naar de persoonlijke perceptie van het fenomeen ritme in de muziek vertelde. Dit ging op gemeentelijke wijze met vele vragen aan het publiek, zoals 'Kunt u dit ritme klappen?' Als laatste maakte Loek Dirkes, componist van filmmuziek, een aantal improvisaties gebaseerd op verschillende groepen boventonen. Het was een zeer interessante en uitstekend verzorgde dag. *Ben: websters.nl/na/kamminga/wintersymposium/wintersymposium.html*

Wiskundendernijswijzer
Tijdens de Nationale Wiskunde Dagen te Noordwijkerhout is een nieuwe website ten doop gehouden. Deze 'wiskundendernijswijzer' is het initiatief van de samenwerkende niet-commerciële wiskundendernijswijzers in Nederland, waaronder die van het Freudenthal Instituut, het APS, de Ned. Vereniging van Wiskundeleraars, het Koninklijk Wiskundig Genootschap, de Digitale School, Wilfridus, Pythagoras, Vierkant voor Wiskunde en Kennislink. De bedoeling is

om onder andere door overzichten per onderwerp en zoekmogelijkheden op meerdere websites tegelijk, de steeds groeiende hoeveelheid informatie en kwaliteitsmatiaal toegankelijk te maken, met name voor leerlingen en docenten.

Internetadres: www.wiskundendernijswijzer.nl *Geert Koesters*

Nieuw rekenonderwijs voor ouders ontbegrift
In het februari-nummer van het blad 'W' dat zich richt op ouders van opgroeiende kinderen, wordt aandacht besteed aan het veranderende rekenonderwijs op de basisschool. Verschillende deskundigen komen aan het woord over onderwerpen als vermenigvuldigen van breuken (taal: 'Welke beeling wilt nu precies wat hij deed als hij twee breuken vermenigvuldigde? Bijna niemand toet?'), het verwijderen van staartdelingen en het zogenaamde realistische reken- en wiskundendeelwisk.

Afgelopen van het ontbreken van kritische distantie bij de genterverende deskundigen geeft artikel een helder overzicht van de huidige stand van zaken op de basisschool. *Dirk Pix*

Expositie Museum Boerhaave in Liden
Museum Boerhaave te Liden exposeert van 26 maart tot en met 26 september demonstratiespellen en historische voorwerpen onder het thema *Goedheer met getallen*. Er zijn meerdere thema's getallen in de natuur, inhoud- en lengtematen, getallen in de astronomie, landmeetkunde en zeevaartkunde, mechanica en statistiek.

Onder de historische voorwerpen bevinden zich de differentiaalrekening van Babbage uit 1830, oude rekenkisten, rekenwielletjes, planetaria, stoeltellen en een Babylonisch tablet van 2000 jaar voor Christus. *Ben: www.museumboerhaave.nl/voorChristus*



Bessensap
Het evenement Bessensap, dat op dinsdag 18 mei plaats zal vinden in het Amsteddamse MEMO, brengt journalisten, redacteurs, voorlichters en medegedienste medewerkers bij elkaar onder het motto: wetenschap ontmoet pers, pers ontmoet wetenschap. Bessensap is inmiddels uitgegroeid tot een sfeervolle en interactieve gebeurtenis in de niche van wetenschap, media en samenleving. NMO verwacht veel publiek op en rond deze dag.

Ook mag tijdens Bessensap een aantal onderzoekers zich met actueel en journalistiek spannend onderzoek presenteren aan de media. Doel is om via heldere, krachtige en voor journalisten prikkelende presentaties steeds het laatste nieuws te bereikten. *Ben: e-mailadres: NMO*

toen student Kok glazig begon te kijken.

Dit het symposium zal ook het eerste exemplaar van het boek *Worsteling naar waarheid* van H. Blauwendraat worden gepresenteerd. Dit boek beschrijft de geschiedenis van het wiskunde- en informatica-onderwijs en onderzoek aan de Vrije Universiteit.

Aan het symposium werken onder meer mee: Hendrik Blauwendraat, Gerard Alberts, Rob Tjeldens en Cor Baaijen. Aankomst: 14.30 uur. Plaats: zaal Darcy Gebouw voor Natuurwetenschappen. Inlichtingen: T.Koesters@fsw.uvt.nl *Ivan Koestier*



Dezelfde de Lelie universiteit van gelukkig, presenteerde N.E. de Bruijn (rechts voorin) met het Koninklijk Wiskundig Genootschap, maar met de 60 bij functie (links van links) op de eerste rij, waart Koesters.

Nieuwe opzet tweede fase gepubliceerd en bijgesteld
Dinsdag 4 december heeft minister Van der Hoeven de eind-olnste toegezegde nieuwe opzet voor de profielen in havo/vwo aan de Tweede Kamer gezonden. Globaal is de opzet drie verplichte vakken per profiel, die vak te kiezen uit een beperkt cluster en één keuzevak in het vijfde deel.

Op 4 februari 2004 zijn de ouders met de invulling van het havo en het vwo ingediend na het overleg van de minister met de vaste commissie voor onderwijs van de tweede kamer. Het is opvallend dat het vak natuurkunde niet langer verplicht is bij het profiel Natuur en Gezondheid.

Voor het downloaden van de brief van de minister en voor een schema van de aanpassing, zie: www.tweedefase-inket.nl/soemladed/index.php *Geert Koesters*

Nieuwe profielen voor havo en vwo zijn een ramp
De rectores van de drie technische universiteiten J. Fokkema, R. van Santen en F. van Vught waarschueren in een brief in de RCT voor de gevolgen van het nieuwste plan van minister Verhoeven. Enige citaten:

"Begin december heeft minister Van der Hoeven haar nieuwste plan gepresenteerd voor aanpassing van de profielen in de Tweede Fase van het voortgezet onderwijs (de klassen 4 en 5 van het havo en de klassen 4, 5 en 6 van het vwo). Alleen al het feit dat die de derde keer was in 2003 dat de minister met een plan kwam, illustreert hoe complex deze profielwettelijke. En hoe onstabiel. Want zowel nu de lancering van het eerste plan, in januari 2003, als nu de bijstelling van juli waren de bezwaren niet van de lucht.

De minister roept het beeld op dat de baten/kosten munitie en weling aantrekkelijk zijn en dat het allemaal wat minder kan. De twee

natuurprofielen Natuur en Gezondheid (N en G) en Natuur en Techniek (Nen T) worden een stuk kleiner, er wordt, met name in het vwo, minder wiskunde, algemene natuurwetenschappen en natuurkunde gegeven, terwijl natuurkunde ook nog eens verder uit verplicht vak uit het N en G profiel.

De technische universiteiten zijn tegenstander van een verlichting van de belastingen in de twee natuurprofielen N en G en N en T. Zo'n verlichting staat op gespannen voet met de voorbereiding die het vwo moet bieden op een vervolgstudie, bijvoorbeeld aan een van de drie technische universiteiten.

De beide natuurprofielen zijn niet robuust genoeg en bereiden onvoldoende voor op bijvoorbeeld een technische vervolgstudie. Elk van de beide natuurprofielen moet vier verplichte, echte baten/vakken kennen. Alleen zo is er voldoende ruimte om het vwo (voorbereidend wetenschappelijk onderwijs) inderdaad te laten voorbereiden op een universitaire vervolgstudie met als doelen: voldoende diepgang, ruimte voor vernieuwing, ruimte om aansprekende contexten uit natuur, wetenschap en techniek aan te reiken en ruimte voor interdisciplinaire ontwikkelingen op de oriëntatie van de klassieke baten/vakken." *Ben: NR, Handelsblad, 3 februari*

Wiskundig onderzoek leidt tot nieuw muziekinstrument
Twee Canadese wiskundigen, Samuel Gaudet en Claude Gauthier hebben een nieuw muziekinstrument ontwikkeld – de fitoro.

Tijdens hun onderzoek het gebied van getaltheorie stuiten ze op een verzameling getallen met symmetrieën die mogelijkheden leken te hebben in de elektronica, en uiteindelijk was een nieuw instrument het resultaat. Het heeft de vorm van een (omgekeerde) Y en heeft zes netwerken van snares, die een hele serie geluiden kunnen voortbrengen, variërend van snaargetal tot het laden van herfokken.

Voor meer informatie, zie www.radio-canada.ca/regions/atlantico/7065/15000000/07065.2373.html *Geert Koesters*



Bedrijfswiskunde postief beoordeeld
De opleidingen bedrijfswiskunde van de Nederlandse hogescholen leveren maatschappelijke knaachten voor het bedrijfsleven en (semi-)overheidsinstellingen af. Dit concludert de onafhankelijke visitatiecommissie die, onder voorzitterschap van prof. dr. J. van de Craats, in 2003 vier hbo-opleidingen bedrijfswiskunde voor de eerste keer op hun kwaliteit heeft beoordeeld. De bevindingen zijn vastgelegd in het in december 2003 gepubliceerde visitatierapport *Amoyke en Inzicht*. Het bereep van bedrijfswiskunde is nieuw en erg tamelijk onbekend. Het overgrote deel van de hbo-studenten in de bedrijfswiskunde is min of meer toevallig tegen de opleiding aangeploet. Er blijkt dus geen effectieve werkgroepbeleid geweest te worden. Het volgende visitatierapport is te downloaden via de site van de hbo-rand onder publicaties, (sub)thema kwaliteitszorg. *Matha Kamminga*

Boekbesprekingen

Book Review



G. 't Hooft
Boeven en de Scheping.
Een Zoektocht naar het Alleenstaande
(de, heretieke en bijgewerkte druk)
Amsterdam, Prometheus Books, 2002
266 p., prijs € 24,95
ISBN 90-446-0145-8

Gerard 't Hooft, theoretisch fysicus, Nobelprijswinnaar, en onder meer een van degenen met de meeste affiniteit voor wiskunde, heeft in dit boek geprobeerd te schetsen wat de elementaire deeltjes-fysica is en ook hoe deze zich heeft ontwikkeld. Zijn boek is bedoeld voor een algemeen – Nederlands – publiek. Dit is alweer de 4e druk. 10 jaar nadat het uitkwam, en een aantal zeer recente ontwikkelingen zijn toegevoegd.

Het is te prijzen dat iemand van zijn kaliber aan het populair-nieuwsgaas maar vaak vond de niet-zonder de technische achtergrond toch nog mysterieus blijven, en ook allerlei niet altijd even soepel.

Hoewel 't Hooft veel wiskunde aanpakt en ook alweer wiskunde heeft geproefd, is zijn houding die van de theoretische fysicus, pragmatisch, zometert opportunistisch als het om rigorositeit gaat, en zeker niet die van een wiskundige die alleen maar bewijbare resultaten accepteert.

Voor wiskundigen is in het bijzonder beharrendend hoe hij herhaaldelijk waarschuwt om bij toepassing op de kleine letters (de precieze condities van een wiskundige stelling) te letten bij toepassing in de natuurkunde. Regelmatig blijkt het daardoor mogelijk om stellingen te omzeilen, en blijven bevragen die op wiskundige gronden voor onmogelijk gehouden werden toch waar.

Er komen vrij veel onderwerpen aan de orde, maar eigenlijk is de functie van dit boek meer om inspiratie voor verder studie op te doen, dan dat het een toegankelijke inleiding tot het vakgebied biedt. Vooral de beschrijving van de ontwikkelingen begin jaren zeventig, waar 't Hooft zijn belangrijkste bijdragen leverde, is instructief. De beschrijving van het 'staandendendendend' dat toen ontworpen werd, en dat alle krachten behalve de zwaartekracht goed beschrijft, vond ik het meest wakkervolle gedeelte.

Ook de beschrijving van zijn eigen rol en bijdragen biedt hier iets extra's. Hoe in Yang-Mills-theorieën het Higgsmechanisme ontstaan kan, en hoe het in de laatste jaren door anderen gepubliceerd, wat een interessante prioriteitsstrijd opleverde.

Latere ontwikkelingen zoals supersymmetrie, snaartheorie, M-theorie, en wat die moet zijn genoemd, maar daarvoor kan men eigenlijk beter terecht bij Brian Greene's *The Elegant Universe*. Deze theorieën worden vooral aangehouden door consistente-eisen, niet door observaties. Daardoor is het karakter van de elementaire-deeltjesfysica nogal veranderd, en voor buitenstaanders ziet het er anders steeds spectaculairer uit. De zekerheid omtrent een aantal fundamentele noties komt duidelijk naar voren. Ondanks sombere profetieën is de theorie van de *Bevindingen der Scheping* nog lang niet af. A. van Erven

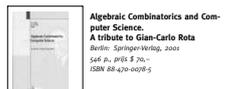
Alle in de vijfde serie van het MW verschenen boekbesprekingen zijn te vinden op onze webpagina. Tevens staat daar een lijst met de recente aangeboden congressen en evenementen onder de naam: Indus en prijs op zijn en van deze verslagen te bekijken, met dit dit binnen een maand na verschijnen van dit nummer (bij voorkeur per e-mail) op onderstaand adres.

Eindredactie: Hans Luyten en Hans Stegeman. Review Editors: MW - HCB 3.10 Dept. of Math. and Computer Science Technische Universiteit Eindhoven Postbus 512, 5600 MB Eindhoven Webpagina: www.math.tue.nl/nwv/ e-mail: nwv@math.tue.nl

retrospectief het vakgebied van de analytische meetkunde ontwikkelden. De boeken van De Witt vormen een bijzondere link tussen de antieke teksten en de meer moderne (Cartesiaanse) aanpak. Een cultuurhistorische context ontbreekt. Waarna de reconstructie van antieke teksten tot de tijdsbepaling behorende van Visse, Fermat, Stevius en Van Schooten wordt bijvoorbeeld niet duidelijk.

Voor teksten met het historisch belang van de boeken van De Witt is het een goede zaak dat ze op wereldwijde wijze beschikbaar zijn voor iedereen. Het is te prijzen dat de vertaling, inleiding en bespreking van *Geometriae Cartesianae* niet alleen vergoed, Middelen scholen in de boeven van het gymnasium, studenten kunnen en studenten van de lerarenopleiding wiskunde kunnen (delen van) deze tekst nu – onder begeleiding – bestuderen. Daarmee lijkt me minst goedkoop. Het boek van De Witt illustreert dat de hedendaagse wiskunde niet vanzelf spreekend, maar dat ze het resultaat is van een opeenvolgende ontwikkelingsproces.

Er zijn enkele bijdragen tussen het verschijnen van het eerste deel in 1997 en het tweede deel. Het moge duidelijk zijn dat mij betreft het resultaat het wachten waard is. Het is bijna jammer dat de ERMZ niet geen derde deel heeft. Groenendijk heeft de Nederlandse wiskundige gemeenschap een geweldig dienst bewezen. D. Bakker



Algebraic Combinatorics and Computer Science.
A Tribute to Gian-Carlo Rota
Birkh. Springer-Verlag, 2002
546 p., prijs \$ 70,-
ISBN 0-896-04009-5

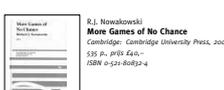
Gian-Carlo Rota was één van de meest veelzijdige wiskundigen van de twintigste eeuw. Hij begon zijn carrière in de operatormechanica, maar heeft vooral naam gemaakt binnen de combinatorische wiskunde (denk aan de Umbral Calculus en de reeks artikelen over de *Foundations of Combinatorial Theory*). Ook had hij uitgebreide kennis van en interesse op het gebied van algebra (met name invariantentheorie) en kansrekening. Rota kon zeer goed schrijven, zie bijv. voorbeeld zijn beruchte filipsrechner en eruditie boekrevisies in *Advances in Mathematics* of zijn fraaie overzichtartikelen. Naast zijn aanstelling als hoogleraar wiskunde aan de MIT was hij ook hoogleraar filosofie aan dezelfde instelling. Hij was zeer trots op deze tweede aanstelling.

Naast zijn grote visie op de wiskunde in het algemeen, was Rota bij velen bekend om zijn warme persoonlijkheid en generositeit in samenwerkingen met andere wiskundigen. Hij wist kollektief zijn manier van samenwerken aan te passen aan het niveau van de ander (of die nu PhD was of zeer ervaren onderzoeker). Daarnaast kon hij ook zeer scherp de waarheid zien en zonder terughoudendheid vertellen, wat hem natuurlijk niet altijd in dank werd gehouden. Een aardige wiskunde naar de vele aspecten van Rota goed naar voren komen is *www.rote.org*.

Hier is gezien het bovenstaande niet verwonderlijk dat, na het plotselinge overlijden van Rota in 1999, verschillende boeken en

speciale afleveringen van tijdschriften aan hem gewijd zijn. Het boek waaraan deze recensie gewijd is, is daar één van. De titel is enigzins misleidend, omdat het boek alleen bevat over allerlei wiskundige onderwerpen en geen artikelen over informatica. Het boek begint met een artikel van Crapo over verschillende onderwerpen die Rota had geresonneerd. Daarna komt Rota zelf aan het woord met zijn vier bijdragen, die zeer de moeite waard zijn en niet tot radenken geven. Gebeld in de stijl van Rota, die veel belang besteedde aan overzichtartikelen (zie bijvoorbeeld onderdeel 4 van Rota's *Ten Lectures on Just a Half Dozen Things*, te vinden op http://www.cira.cornell.edu/lectures/ten_lectures/) bevat het boek overzichtartikelen van Alperin over Catalangetallen en van Perrin over de combinatoriek van woorden. Vanzelfsprekend bevat het boek de nodige artikelen over Umbral Calculus, zowel toepassingen (circulante structuren matrices (Barnabei en Meo-fisico), het oplossen van recursies (Soto, Koelmeijer en Ulv reconstru) en invariantentheorie (Breni, Rogiani en Ito) als de verbanden van Umbral Calculus (Poisson kansverdelingen (Genati en Di Nardo) en het splitsen van alfabetten (Lacourts)). Van de overige artikelen noem ik slechts het artikel van Buchsbaum over Weyl modules, dat naast de nodige fraaie wiskunde ook aardige informatie geeft over de persoonlijke samenwerking met Rota.

Gezien de grote verscheidenheid aan artikelen (fowed qua onderwerp als qua niveau) is het moeilijk dit boek onder een bepaalde noemer te vangen of er een algemeen oordeel over te vellen. Voor de liefhebber van zware wiskunde zijn er in ieder geval allerlei interessante zaken te vinden. D. Buchholtz



R.J. Nowakowski
More Games of No Chance
Cambridge University Press, 2003
159 p., prijs £ 42,-
ISBN 0-521-80824-4

In juli 2000 werd de tweede *Combinatorial Games Theory Workshop* gehouden. De proceedings van deze workshop werden gepubliceerd als boek met de titel *More Games of No Chance*, alhoewel het boek hoofdzakelijk uit de eerste workshop in de serie. De bijdragen in het boek houden zich bezig met abstracte combinatorische spelletjes, strategische spelletjes voor twee spelers, waarbij steeds de spelers volledige informatie over de stelling hebben en kans geen rol speelt. Er zijn artikelen over bekende spelletjes als Schaken of Go, over minder bekende moderne spelletjes zoals Phutball en Amazons, en over spelletjes die louter interessanter zijn om te analyseren maar niet deel van de menselijke geschiedenis zijn, zoals een aantal dimensionaal spelletjes, zoals een interessant vraag bij dit soort spelletjes is bijvoorbeeld, gegeven een stand gedurende het spel, hoe de speler aan zet een winnende strategie heeft? Er zijn verschillende manieren om naar zo'n vraag te kijken, een analyse volgens de methodologie zoals in het klassieke boek *Winning Ways for their Money* Conway en Guy en analyse van de computatiele complexiteit van het probleem, of analyse en het doorzoeken van posities met behulp van een computer. In de ruim dertig artikelen in het boek komt elk van deze manieren aan bod.

Recent Trends in Combinatorics
Cambridge: Cambridge University Press, 2002
212 p., prijs £ 42,-
ISBN 0-521-80270-7

This is a collection of surveys and research papers on combinatorics and additive number theory, presented at a conference in Mátraháza, Hungary. The book is dedicated to the memory of the brilliant and versatile mathematician Paul Erdős.

The foreword gives a favour of Paul Erdős' somewhat unusual lifestyle and an outline of the importance of his work in combinatorics and other related fields.

The first article is a selection of some old and new problems and results written by Erdős which, in his opinion, have been underappreciated or neglected.

There is a very interesting paper by Noga Alon on the Combinatorial Nullstellensatz. Numerous applications in additive number theory and in graph theory are discussed and unified proofs are presented. As an example we mention the following theorem: for any prime p , any loopless graph G with average degree bigger than $2p - 2$ and maximum degree at most $2p - 1$ contains a p -regular subgraph.

An article by Peter Cameron and Paul Erdős on sum-free sets also deserves special attention. For any irrational real number α the set $S_\alpha = \{k \in \mathbb{N} : \{k\alpha\} < \alpha\}$ is introduced. The set S_α is sum-free, has density α and is also maximal. Furthermore the sets $S_\alpha(p) = S_\alpha \cap \{1, 2, \dots, p\}$ are investigated regarding the length of arithmetic progressions in them. B. Bollobás and O. Riordan write a long article on the Tutte polynomial for coloured graphs. Results on knots, links and Reidemeister moves are presented. At the end there is a collection of some challenging problems.

This book can be recommended to all those interested in combinatorics and cognate fields. C. de Vreugde

S. Hawking
Het Universum
(Wetenschap door R. Janssen, 'The Universe in a Nutshell')
Amsterdam: De Blik, 2002
223 p., prijs € 22,50
ISBN 90-5232-364-6

In het *Universum* behandelt Stephen Hawking de nieuwste inzichten in de kosmologie, de fysica van het ontstaan en de evolutie van het heelal. Het boek is geschreven voor leken, en is uitzonderlijk gefillustreerd.

In de kosmologie woont een belangrijke plaats ingenomen door de algemene relativiteitstheorie, die beschrijft hoe de zwaartekracht de ruimte en de tijd kromt. Als gevolg van deze vervorming kan men berekenen dat het heelal ooit ontstaan moet zijn in één punt, de Big Bang. Dat is ook precies waar de problemen ontstaan, door quantumfluctuaties is de relativiteitstheorie niet geldig voor kleine afstanden. Het grootste deel van het boek gaat over de verschillende, tot nog toe niet geheel succesvolle pogingen om een theorie te komen waarin quantummechanica en relativiteitstheorie verenigd worden.

In het eerste hoofdstuk wordt een overzicht gegeven van de algemene relativiteitstheorie. Vervolgens komen verschillende mo-

gelijkheden voor een verengde theorie aan bod, zoals supersymmetrie, snaartheorie, p-branen en M-theorie. Veel van deze ideeën veronderstellen dat ons heelal eigenlijk is ingebed in een hogedimensionale ruimte, die wij niet kunnen waarmaken. Ook 'imaginair tijd' speelt daarbij een rol, overigens zonder dat het erg duidelijk wordt bij hieronder moet worden verstaan. Daarnaast is er veel aandacht voor experimenten, die vaak verhelderend werken. De toezicht van de tijdruimte levert ook fascinerende voorbeelden op van casualiteit en de richting van de tijd, waarop het antwoord vaak nog onbekend is. Het boek bespreekt enkele van die problemen, bijvoorbeeld hoe de toekomst kunnen voorspellen (misschien, volgens Hawking, als er maar geen informatie verdwijnt in zwarte gaten), en of we terug kunnen naar het verleden en dat kunnen veranderen (ja, maar de kans is buitengewoon klein).

De auteur weet het onderwerp vlot te presenteren en is er in geslaagd het toegankelijk te maken voor een breed publiek. Dat brengt onvermijdelijk een zekere vaagheid met zich mee, waarbij de behandelde theorieën oppervlakkig beschreven worden zonder veel uitleg of argumentatie. Daardoor wordt de tekst helaas hier en daar moeilijk te begrijpen, en het lezer achter met vragen omtrent de precieze betekenis van de gebruikte bewoordingen. Dit wordt vergoed door een aantal sterrenfouten en onnauwkeurigheden, die overigens voor een studentende lezer in weinig zijn aan de verrijking. R. van Hoort

A.W. Groenendijk
Jan de Witt. Elementa Curvarum Linearum Liber Secundus
Amsterdam: CWI, 2003
313 p., prijs € 25,00
ISBN 90-6497-514-4

In 1997 publiceerde het CWI het eerste boek van de *Elementa Curvarum Linearum* van Jan de Witt (1625-1672). Het was vertaald en inleiding en commentaar voorzien door Albert Groenendijk. Nu is ook het tweede boek, van de *Elementa* beschikbaar.

De *Elementa* werden geschreven in de periode van de opkomst van de Cartesiaanse meetkunde. Het eerste deel van het werk van De Witt behandelt meer klassieke meetkundige verhandeling. In dit tweede deel doet de auteur zijn wat hij Descartes heeft opgevoerd. Dat betekent veel formules. Van diverse formules toont De Witt aan dat ze overeenstemmen met de klassieke rechte lijn, parabool, ellips en hyperbool. Enerzijds maken de formules de tekst van dit tweede boek, 'herkenbaarder' voor de hedendaagse lezer dan het eerste boek was. Anderzijds blijft het ook niet de ontkenbarheid het stempel van de zeventiende eeuw draagt. Dat blijkt bijvoorbeeld uit de vele woorden en schijnbaar noodloze moeilijkheidsverminderingen, die typografische afwijkingen (zoals het gebruik van π en in plaats van π^2), of de bijzondere wijze waarop factoren 'buiten haakjes' worden gebruikt. In de inleiding kent de wiskundige-historische achtergrond uitvoerig aan bod. Al met al is dit een boek dat voor een ieder geïnteresseerd in de theorie van meetkunde en eindige simpele groepen, zeer aan te raden is. R. Bakker

De onderwerpen die in het boek behandeld worden, zijn relatief technisch van aard. De auteurs hebben de daardoor opredende moeilijkheden van een breed gebied over de verschillende opvattingen door een helder Engels taalgebruik en door korte samenvattingen aan het begin van elk hoofdstuk te geven. Verder wordt de ontwikkeling van het boek teruggevoerd door de tijd. Al met al is dit een boek dat voor een ieder geïnteresseerd in de theorie van meetkunde en eindige simpele groepen, zeer aan te raden is. R. Bakker

R. Miron, D. Hiriart, H. Shimada, S.V. Sabau
The Geometry of Hamilton and Lagrange Spaces
(Fundamental Theories of Physics)
Dordrecht: Kluwer Academic Publishers, 2001
338 p., prijs € 42,-
ISBN 0-305-93946-7

According to the preface, this monograph is a continuation of the books by R. Miron, *The geometry of higher-order Lagrange spaces, Applications to Mechanics and Physics*, Kluwer (1997) and R. Miron and M. Anastassi, *The geometry of Lagrange spaces. Theory and applications*, Kluwer (1994), emphasizing Hamiltonian geometry. It can be considered as a very deep study of the tangent bundle to a manifold, the Lagrangian aspect, and its cotangent bundle, the Hamiltonian aspect and the Legendre duality connecting the two.

Very general Lagrange functions on the tangent bundle are allowed, the only condition apart from continuity being that when restricted to a single tangent space, its Hessian at any tangent vector different from zero is nondegenerate. In case the Lagrangian is positive, satisfies an appropriate homogeneity condition, and the above Hessians are positive definite, the square root of the Lagrangian defines a Finsler structure. Finsler structures by themselves are already a surprisingly rich generalization of Riemannian structures.

Lagrange spaces of higher order also exist, using big bundles of the underlying manifold (configuration space). It is a difficulty to define a dual to this in such a way that a reasonable Hamiltonian version exists, but R. Miron found a solution in the product over the base space of the jet bundle of one lower order with the cotangent space. The study of these higher order Hamilton spaces occupies about 110 pages.

The reader is assumed to have a good background in differential geometry. The relation switches between the 'physics' notation in terms of local coordinates and the abstract notation from differential geometry. I was very surprised by the richness of the subject, and I think the book is an important reference work for researchers who are interested in Analytical Mechanics and more generally in Lagrangians and Hamiltonians occurring anywhere in Physics. It is an inspiration to students and researchers in differential geometry. Somewhat striking is the use of the English. An interesting example is that when symmetric matrices are assumed to be positive definite they had better be positive definite, not just. Moreover there are many typographical errors. In some instances they make a definition unintelligible, and only through reading of the context can they find the reader out.

The book has a short but effective index and an extensive bibliography. R. Bakker

Experiences with micro-typographic extensions of pdfT_EX in practice

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February 21, 2005

Abstract

pdfT_EX provides two micro-typographic extensions: margin kerning (also known as character protrusion) and font expansion. Those extensions have been available for a while, however they are not used much yet, probably due to their complicated setup and not that visible benefits they bring. In this article I want to share some experiences, either good or bad, in using those extensions in practice, the tricky parts of them and how to get the best from what pdfT_EX offers without having to know all the low-level details and messy font issues.

1 Introduction

Font expansion and margin kerning have been introduced several times in various articles, so I won't go to any detailed description here. From a practical point of view, what those extensions bring is pretty simple:

1. Margin kerning makes the margins of text *look* smooth, by moving certain characters out to the margins by a small amount. The most common case is to move the hyphen character or punctuation marks, but applying this technique to certain letters also improves the result.
2. Font expansion can help to improve line-breaking. Typically, a text typeset using font expansion has:
 - (a) less hyphenations,
 - (b) less overfull and underfull boxes,
 - (c) more equal inter-word spacing ,
 - (d) reduced occurrence of “rivers”.

These benefits are most visible in difficult cases, like narrow-column typesetting, disabled hyphenation, or simply in automated typesetting when manual work needed to correct problematic cases should be minimized or totally avoided.

Margin kerning and font expansion have been implemented in the *hz* program by Hermann Zapf and URW; that's why I called them together *hz* extensions of pdfT_EX¹. For more detailed information on margin kerning and font expansion, including background and related works on *hz* extensions in other systems, please refer to [Thành 2001]. From now, by *hz* extensions I mean margin kerning and font expansion in pdfT_EX.

2 How to start using *hz* extensions

Similarly as in the case with T_EX primitives, the *hz* extensions as provided by pdfT_EX are not easy to use. They require the understanding how certain concepts in T_EX work at the very low-level, as well as the ability to set up some complicated font-related stuff. Thus the best way to start using *hz* extensions is via some available

¹The *hz* program is in fact a set of modules implementing certain micro-typographic improvements including margin kerning and font expansion. *hz* extensions of pdfT_EX are only a small subset of the modules in the *hz* program

interface. An article about how to start using *hz* extensions in practice will be published in TUGboat soon so I don't go into the details here. In short, given that we have pdfT_EX version at least 1.20a (1.21a is recommended at the time of writing this paper) and the L^AT_EX package `microtype` installed, it's enough to say

```
\usepackage{microtype}
```

to activate both margin kerning and font expansion. A recommended next step is to read the `microtype` manual to learn more about the options the package offers, as well as advice for new users.

3 Practical experiences

hz extensions have been used rarely in practice, due to the lack of an easy interface and the necessity of complex font setup as mentioned above. Also, those features are not completely mature yet. For those reasons, a collection of practical issues would be helpful for those interested in using *hz* extensions. Some of the issues described here may sound very technical, or very weird to those who have not tried to use *hz* extensions in pdfT_EX yet. If it is the case, simply skip the details you don't understand.

So far, the total number of people who have contacted me to discuss some issue concerning *hz* extensions is about ten. Some of them use *hz* for some occasional projects, some use *hz* for their regular work. Of course it doesn't have to mean that only ten people have been using *hz* extensions; it only means that at least ten people tried and had some trouble.

Recently, ConT_EXt and L^AT_EX (the `pdfcprot` and `microtype` package) make *hz* extensions easier to use and become more popular, especially margin kerning. The introduction of auto expansion is also a big step toward easy use of font expansion.

3.1 Using the auto expansion feature

To deploy font expansion, the expanded TFM fonts must be prepared ahead, using some utility as `fontinst`, `afm2tfm` or `METAFONT`. This is the most annoying part, even for experienced users. And usually this annoyance is doubled by the fact that most TFM's must be used with VF, hence the expanded VF's must be created as well.

From version 1.20a, pdfT_EX supports a feature called auto expansion, which allows TFM and VF to be expanded automatically in memory at run time. That means expanded TFM and VF are no longer required, which is a great relief. In order to use font expansion now, it's enough to upgrade pdfT_EX binaries, install the L^AT_EX `microtype` package, and that's it. No need to deal with expanded TFM's and VF's, map files or whatever. This feature makes things really simple. The implementation however is not that simple and it took some time to evolve and mature.

There is one catch in using virtual fonts with auto expansion: in virtual fonts accented characters are often drawn as composition of two glyphs, a base letter and an accent. Using auto expansion will cause the accent in such composed glyph to be misplaced by a small amount (0.01–0.1pt).

Now one may wonder whether auto expansion should be used in case all the expanded TFM's and VF's already exist (most likely because the user had to create them manually when auto expansion was not available yet). The answer is if DVI output is not considered (see the next issue) and only Type 1 fonts are being used, auto expansion should always be used. This is also the typical case.

3.2 Using *hz* extensions in DVI mode

hz extensions are available in both PDF and DVI mode. Using *hz* in DVI mode is much similar to PDF, although it requires some extra setup for `dvips` to process the expanded fonts. If only margin kerning is used, then there is no difference whether it is used in DVI or PDF mode.

The question is why one would want to use *hz* in DVI mode? There are some known reasons:

1. the output is smaller: in PDF mode pdfT_EX embeds many instances for a single expanded font, while `dvips` embeds only one;
2. the document requires PS processing, for example PStricks;
3. the user just doesn't need or like PDF, but wants *hz*.

The following (typical) example demonstrates how to make `dvips` process DVI files with font expansion enabled. It only makes sense to people who can already make some setup to use font expansion in PDF mode without auto expansion, which means that you must be able to create the expanded TFM's and VF's using `fontinst` or `afm2tfm` or some similar tool. The detailed instructions on how to do that is however out of scope of this article.

Assume that we have activated font expansion for font `cmr12` with stretch limit 20, shrink limit 20 and expansion step 5. To process the DVI file produced using this setup, we must update the map entry read by `dvips`. In my system, the entry for `cmr12` is

<code>cmr12</code>	<code>CMR12</code>	<code><cmr12.pfb</code>
--------------------	--------------------	----------------------------

Now it must be replaced by

<code>cmr12</code>	<code>CMR12</code>	<code><cmr12.pfb</code>	
<code>cmr12+5</code>	<code>CMR12</code>	<code>"1.005 ExtendFont"</code>	<code><cmr12.pfb</code>
<code>cmr12+10</code>	<code>CMR12</code>	<code>"1.010 ExtendFont"</code>	<code><cmr12.pfb</code>
<code>cmr12+15</code>	<code>CMR12</code>	<code>"1.015 ExtendFont"</code>	<code><cmr12.pfb</code>
<code>cmr12+20</code>	<code>CMR12</code>	<code>"1.020 ExtendFont"</code>	<code><cmr12.pfb</code>
<code>cmr12-5</code>	<code>CMR12</code>	<code>".995 ExtendFont"</code>	<code><cmr12.pfb</code>
<code>cmr12-10</code>	<code>CMR12</code>	<code>".990 ExtendFont"</code>	<code><cmr12.pfb</code>
<code>cmr12-15</code>	<code>CMR12</code>	<code>".985 ExtendFont"</code>	<code><cmr12.pfb</code>
<code>cmr12-20</code>	<code>CMR12</code>	<code>".980 ExtendFont"</code>	<code><cmr12.pfb</code>

Then `dvips` can process the DVI with expanded fonts just like any other DVI files.

The main disadvantage of DVI mode is, however, that the auto expansion feature of `pdfTEX` cannot be used. Or to be more precise, auto expansion can be activated in DVI mode and `pdfTEX` can create the DVI file with font expansion enabled. Such a DVI file however is pretty useless because DVI drivers cannot process that file, as they don't have access to the expanded TFM's and VF's (those exist in `pdfTEX` memory at run time only).

There have been requests to support auto expansion for use with `dvips`, by changing `pdfTEX` to write the expanded TFM's and VF's to disk as well as to update some map files. It is likely that this will never be implemented. The better way to do that is to change the script `TEX` (`pdfTEX`) calls to create missing TFM at run time (on `web2c`-based systems this is called `mktextfm`) to create all the required stuff on demand.

3.3 Margin kerning and non-character material

Margin kerning only works with characters. Sometime we need to protrude something that is not a character, for example some superscript (index), because such a thing would look bad when ending up at the margin without protrusion. The typical example is the index of footnote, which is typeset into an `hbox`.

There are two solutions to the above problem:

1. Make margin kerning work even with characters inside boxes. A patch has been made to check whether the ending element of a line is a box, and if so check the last element of that box, and so on, to ensure that the last character inside boxes will get protruded. This patch is still experimental at the time writing this article. Also beware that it is not enough just to have this patch and the right package loaded, because the default settings for margin kerning as provided by macro packages are suitable for normal text. Superscript text often has much smaller size than the normal text, so to get the right result the protrusion factors must be increased. Then it might cause conflicts in other places where the same font is used for normal text (for example in footnote text).
2. Append a "virtual character" immediately after the material we want to protrude into the right margin (or prepend in case of the left margin). Such a virtual character is not visible, has no dimension, but has non-zero protrusion factor so when ending up at the margin it will get protruded. Creating such a virtual character is quite easy using `fontinst`. There is also a script available to generate a virtual font with all blank characters for this purpose². This approach has been used several times in practice and is reliable. The drawback is that it requires some extra work in creating those virtual characters and inserting them into the right places.

²The script was made by Hartmut Henkel, however having read the draft version of this paper he suggested to distribute the font itself, so the font will be available at `pdftex.sarovar.org` soon.

3.4 Margin kerning does not work in some cases

Sometimes it happens that margin kerning doesn't work as expected, some characters are not protruded. There are usually two reasons:

1. Margin kerning is blocked by some invisible material around the relevant character; usually there is a workaround using macros.
2. It is a bug in pdfT_EX. If your pdfT_EX is older than 1.20b then upgrading pdfT_EX is the first thing to consider when encountering some problem with *hz* extensions. Margin kerning has been improved a lot from version 1.20b.

3.5 Using margin kerning and font expansion at the same time

Although this seems something evident, sometimes it doesn't work. The reason is most likely that you are using pdfT_EX version 1.20a, which has this bug.

3.6 Reasonable settings for font expansion

Font expansion must be used with care. While it gives more room for line-breaking, it can also destroy the whole text if the effect of font expansion becomes visible. Then the question is when font expansion becomes visible? This question has no definitive answer, as to trained eyes font expansion can be easily detected and hence annoying, while to others it has no effect. For most people the safe limit is 2% expansion, i. e. the stretch and shrink limit when expanding a font should not be more than 20 (see pdfT_EX manual for explanation of stretch and shrink limit).

The expansion step is usually set to 5. A too small value leads to large output size (more fonts embedded), while a too big value can lead to some surprises like unexpected overfull or underfull boxes. This is not a bug but a limitation in the way pdfT_EX implements font expansion.

4 Lessons learned

During the development of *hz* extensions, many decisions were made and not all of them were good. pdfT_EX started as an experimental project. Most decisions in the beginning were made rather for the purpose to examine the effect of *hz* extensions than for practical purpose. Then *hz* extensions started to be used in practice and certain things had to be changed to make life easier. Here are some lessons I learned concerning *hz* extensions:

1. The way margin kerning can be used without changing existing fonts seems to be the right decision. Settings for margin kerning should be part of fonts just like kerning between pairs of characters, from the viewpoint of clean design. Doing so however would lead to two problems:
 - (a) to use margin kerning, we need some kind of extended TFM;
 - (b) the settings cannot be changed easily.

These problems would make practical use of margin kerning impossible. Clean design is important but sometime backward compatibility and flexibility play a more significant role.

2. The concept of font expansion in pdfT_EX was quite general and flexible, which was good for experiments as we needed to study the effect of font expansion in as many cases as possible. From the experimental viewpoint the way font expansion was implemented is not that bad, but from practical viewpoint it is too cumbersome and hard to deploy. Hence for practical use, a less flexible mechanism which is easier to use but offers 80% of what font expansion can give is more needed. That's the reason why auto expansion has been introduced.

So was it a bad decision that pdfT_EX needed expanded TFM for font expansion? For experimental purpose it was a good decision, however it would be a mistake not to change it after the experiments have been done.

3. The user interface is as important as the implementation to end users. Without L^AT_EX or ConT_EXt support, *hz* extensions are pretty useless to most users.
4. Feedback and help from the pdfT_EX user community is vital for *hz* extensions to evolve and mature.

5 Recent changes

pdfT_EX version 0.14h is the last version of pdfT_EX released by me during my stay in Czech republic. Then I came back to Vietnam and didn't have time to work on pdfT_EX for about two years. During that time pdfT_EX was maintained by the pdfT_EX team (lead by Hans Hagen and Martin Schröder). Since March 2004 I came back to work on pdfT_EX development, and version 1.20a is the first release I participated in after the long break.

Here I would like to give a brief summary of some noticeable changes since version 1.20a, as I think that they might be of interest to pdfT_EX users or simply to those who don't use pdfT_EX but want to keep an eye on what is happening with pdfT_EX. Apart from those, there have been many small bug fixes and improvements but they are too technical to mention here.

1. *hz* extensions have been significantly improved; some serious bugs have been fixed and margin kerning has been extended to handle some special cases.
2. Auto font expansion has been introduced: expanded TFM's are no longer required to use font expansion.
3. The font expansion mechanism has been simplified: the font expand factor (the last argument of `\pdffontexpand`) is no longer supported. This parameter was used to simulate font expansion using letter spacing. Experiments have shown that this technique is not the way to go: it didn't improve much the result while it caused many troubles.
4. Support for the configuration file `pdftex.cfg` is gone; all parameters are set via primitives. Their values can be dumped to the format file. The only exception is `\pdfmapfile`: its value cannot be dumped to the format file, so when pdfT_EX starts the value of `\pdfmapfile` is always set to the default value "`pdftex.map`".
5. pdfT_EX uses the GNU libAVL library to speed up certain searchings.
6. Support for TrueType fonts has been improved, allowing referring to glyphs inside a TrueType font by their unicode index. `ttf2afm` also has been heavily revised.
7. There is a program called pdfxT_EX, which is a variant of pdfT_EX that contains experimental features. Those features may be moved to pdfT_EX when they seem to be useful and stable. At the moment the following extensions are available:
 - `\pdflastximagecolordepth` returns the last color depth of a bitmapped image;
 - `\pdfximage` supports a keyword `colorspace` following an object number representing a PDF ColorSpace object;
 - `\pdfstrcmp` compares two strings;
 - `\pdfescapestring` and `\pdflastescapedstring` provide a means to escape strings;
 - `\pdffirstlineheight`, `\pdflastlinedepth`, `\pdfeachlineheight` and `\pdfeachlinedepth` allow fixing line dimensions during paragraph building;
 - various extensions from Taco Hoekwater:
 - support for dimension unit `px`;
 - `\tagcode` primitive allowing read and write access to a character's `char_tag` info.
 - `\quitvmode` primitive quits vertical mode;

6 Pending requests and future development

In this section I would like to mention shortly some issues that have been discussed and the future plan of pdfT_EX.

PDF inclusion with annotations: when pdfT_EX includes a PDF figure, all the annotations (the PDF term for hyperlinks and the like) from the figure are lost. There is a patch for pdfT_EX version 1.10b by Andreas Matthias that copies annotations from included PDF figures. The patch was released during the period when I was not maintaining pdfT_EX and didn't get attention from other pdfT_EX maintainers either. I am aware of the patch but did not look into the code yet. If this becomes urgent or frequently asked then it should be re-considered.

Implement virtual fonts using Type 3 fonts: pdfT_EX supports virtual fonts in the same way like other DVI drivers does, i.e. it interprets the DVI commands from virtual fonts to draw characters. It means that accented characters from virtual fonts are often unsearchable – in fact there are no such letters in the PDF output but sequences of PDF commands drawing the base letter and the accent. There have been requests to make letters from virtual fonts searchable. One possible solution is to implement virtual fonts as Type3 fonts in PDF. This feature is something very handy to have, as it can allow other nice things as well. At the moment this feature is still being examined, and might be supported in the future if the effort required to implement it is not too much.

Support for subfont scheme for use with huge TrueType fonts: Subfont scheme is a trick to split huge TrueType fonts (usually used for Asian languages like Chinese, Japanese or Korean) into smaller pieces so that they can be used with 8-bit T_EX. pdfT_EX has some support for subfont scheme, but still very poor. At the moment this is being revised and should be improved in the near future.

Support for pdfsync: pdfsync is a package allowing synchronization between a PDF file created by pdfT_EX and its L^AT_EX source: the user clicks on some point in the PDF file and the editor “jumps” to the corresponding place in the source. The current implementation of pdfsync still has some unsolved issues, due to the lack of low-level support in pdfT_EX. We had some discussions with the pdfsync author and I plan to provide some hooks to support pdfsync.

7 Acknowledgments

Too many people helped pdfT_EX development in various ways, so it is impossible to thank all people here without missing someone. However, I would like to say thanks to a few people whose impact on pdfT_EX is most vital in the last years:

1. Hans Hagen for his testing, discussions, feature requests, feedbacks and encouragement;
2. Hartmut Henkel for his important contributions on pdfT_EX development and maintenance, especially in *hz* extensions;
3. Martin Schröder for his effort on keeping pdfT_EX in sync with latest sources of libraries and other pieces of T_EXLive and t_eT_EX; he is also responsible for official pdfT_EX releases;
4. and NTG and DANTE for financial support on this work.

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Newmath and Unicode

Johannes Küster*

Abstract

The “Newmath” project aims at defining and implementing new standard encodings for math fonts, and at the development of accompanying tools and packages. Switching math fonts should be made as easy as switching text fonts. The project stopped in 1998, as efforts were concentrated on the definition of Unicode codepoints for mathematics.

This article outlines my ideas for further development of Newmath. It deals mainly with the “encodings and fonts” part of the project. Originally the project aimed only at extending and reorganizing the encodings of existing math fonts, but its objectives should be widened now to Unicode math – to make all those mathematical characters accessible and usable in T_EX-based systems. The last section gives an outlook on Latin Modern Math fonts development.

Introduction

About 12 years ago, the Math Font Group¹ (MFG) started a project to define new standard encodings for T_EX math fonts, together with the development of fonts implementing this new standard and of accompanying tools and packages. The new encodings should bring an extension to 256 codepoints per font. They should become the standard for T_EX math fonts, ideally making it just as easy to switch between different math fonts as it has been achieved for text fonts. This whole project is called “Newmath”, short for New Math Font Setup (“newmath.sty” is the name of the principal L^AT_EX package implementing the new math font setup).

The development of Newmath stopped about 6 years ago, as it was decided (at the EuroT_EX conference in St. Malo in 1998) to concentrate efforts first on “Math into Unicode”, i.e. to identify all mathematical symbols in (reasonable) use and to get these symbols encoded in the Unicode standard. This goal has been achieved for quite a while now, mainly with Unicode 3.2 in 2002, but work on the Newmath encodings has not been resumed since (mainly because the people originally involved quit for other projects in the meantime).

Is further development of Newmath still interesting at all, despite Unicode and OpenType fonts? I think it is, for the reasons discussed below. But its initial objectives should be widened: to make all Unicode math characters accessible in T_EX in a standard way, but also to make math fonts easier to design or to adapt, and to make them more usable for other typesetting systems.

Current State of Newmath

Partial implementations of the new Math Font Encodings, information about the development of Newmath, links to articles, conference presentations, mailing list archives etc. can be found at the MFG homepage [1]. The development of Newmath stopped in 1998 with version 0.59a. The implementation was mainly done by Matthias Clasen with help from Ulrik Vieth.

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1 The Math Font Group is a joint venture of the L^AT_EX3 project and the T_EX Users Group Technical Working Group on Extended Math Font Encoding. For more information see the Math Font Group’s homepage [1].

Currently six encodings are defined:

- *Math Core* (MC) contains Math Italic, Greek Upright and Italic, basic delimiters and other “alphabetic” characters (i.e. most of the characters which are really dependent on the font design and/or which are most likely to pre-exist in a text font)
- *Math Symbol Principal* (MSP)² contains a Calligraphic (or Formal Script) alphabet, the most important mathematical symbols, and basic accents
- *Math Symbol 1* (MS1 or MSA) contains a Blackboard Bold (or “Doublestroke”) alphabet and additional mathematical symbols
- *Math Symbol 2* (MS2 or MSB) contains a Fraktur (or Blackletter) alphabet, some additional delimiters and accents, and an “Arrow Kit” (consisting of left and right arrow endings and repeatable middle parts (with negated and gapped versions), by which a great variety of different arrows at any desired length can be composed)
- *Math Extension Principal* (MXP)² contains text and display versions of big operators and integrals, wider version of basic accents (hat and tilde), the larger and extensible versions of the basic delimiters, larger root symbols, over- and underbrace parts, parts for extensible vertical arrows and bars
- *Math Extension 1* (MX1 or MXA) contains additional big operators and integrals, larger and extensible versions of delimiters, and wider accents (vector, bar, tie, etc.).

Each of the *Symbol* encodings contains a complete alphabet (A–Z, a–z, digits 0–9, dotless i and j) of a specific design for use in mathematical typesetting.

Compared with T_EX’s original “Math Extension” encoding, the new extension font encodings offer a much wider range of wide accents (9 sizes of each accent) and large delimiters (7 sizes instead of 4 for most delimiters, 14 for parentheses and non-extensible delimiters like angle brackets, plus extensible parts as necessary).

Unicode Math

Since version 3.2, Unicode assigns almost 2.000 codepoints for mathematical characters. Due to the way in which Unicode evolved, and as new versions should be backward compatible, these codepoints are scattered over many Unicode blocks (mainly over 15 blocks in fact, of which 7 blocks are devoted exclusively to math characters; another 15 blocks each contain a few characters for occasional use in mathematics).

Additional information about Unicode math is given in the Unicode Technical Report #25 [2] and in “Math-Class6.txt” [3], a file which classifies the Unicode math characters according to their usage and provides “a mapping to standard entity sets commonly used for SGML and MathML documents”. The classification is comparable to T_EX’s mathematical symbol classes, with the additional classes “diacritic” (which is not handled as a class by T_EX, but by `\mathaccent`) and “fence” (an unpaired delimiter or a delimiter-like separator; normally treated as `\mathrel` in T_EX).

Glyph Variants in Unicode. Some mathematical symbols did not get a codepoint of their own, instead they can be accessed as a combination of two Unicode codes (examples are shown below). This is the case for the negated version of many relators, for variants of negated relators (with a vertical negation slash instead of a slanted one), and for some symbols which are considered mere stylistic or typographic variants of another symbol.

These variants are shown in three tables in [2]: Table 2.5 there shows those relators with encoded negated form for which a variant with vertical stroke overlay can be realized by composition of base character and overlay; Table 2.6 shows those relators for which the negated form can only be realized by composition (i.e. the negated form is not encoded itself); and Table 2.7 shows all the currently defined glyph variants, which can be realized as a combination with “Variant Selector 1” U+FE00.

² Originally, the Math Symbol and Math Extension “Principal” encodings were named “Primary”; later this was changed to “Privilege”. As I think neither really conveys the intended meaning, I decided to change the name to “Principal”.

\notin	U+2209	\notin	U+2208, 20D2	NOT AN ELEMENT OF
\nlessgtr	U+2267, 0338	\nlessgtr	U+2267, 20D2	NEGATED GREATER-THAN OVER EQUAL TO
\leqneq	U+2268	\leqneq	U+2268, FE00	LESS-THAN BUT NOT EQUAL TO

Examples of Unicode variants and combinations: with U+20D2 “vertical line overlay”, with U+0338 “combining long solidus overlay” (with and without encoded negated version), and with U+FE00 “Variant Selector 1”

Future Additions to Unicode Math. Of course Unicode math can be and will be extended in the future. At the time of writing, the current version of Unicode is 4.1.0 (released March 2005). A few math characters were added in this version. Furthermore, the Unicode Pipeline Table [4] shows some mathematical characters which are currently under consideration for future inclusion in Unicode. Also newly discovered and newly invented symbols will be standardized in future version eventually, when they are “used by a considerable number of people.” Such possible extension have to be taken into account when designing new math font encodings for T_EX.

Reasons for Newmath

To see more clearly how Unicode math could be made usable for T_EX, and why Newmath could still be very helpful, let's see what Unicode does offer and what it does not.

Unicode offers a very large set of mathematical characters, with a standardized code referring to each character. But the backward-compatibility leads to a quite unordered way in which characters are presented within Unicode. This is not a problem for a computer program (e.g. for any automatic conversion program, workflow processes and the like), but it makes it difficult for users to search for a specific character, or for font designers to get an overview over all those math characters.

Unicode does not offer any sorting or ranking of mathematical symbols, nor much information about the importance, meaning or usage of most characters. Also Unicode encodes only base characters, thus leaving all typographic variants aside which are needed in proper mathematical composition. Now theoretically all those glyphs could be defined in one large OpenType font, by assigning glyphs in the Private Use Areas (PUA) of Unicode, and/or by defining those glyphs as alternate forms of their base glyph via OpenType features. Unfortunately, it is not very likely that a standard way of PUA usage will evolve for math fonts. Also, the currently defined OpenType features are hardly suitable or sufficient for math fonts.

So I see many reasons why Newmath is still interesting and could be useful, despite Unicode and OpenType, and despite any successor of TeX which will be Unicode and OpenType capable:

- Newmath offers a standard interface for T_EX (L^AT_EX, ConT_EXt).
Currently almost each set of math fonts comes with its own encodings, which makes font switching very cumbersome.
- Newmath will offer all the typographical variants needed.
This comprises most of the characters in extension fonts: larger and extensible delimiters, arrows and root symbols; text and display versions of big operators and integrals; wide accents. (This could be done in an OpenType font as well, of course.)
- Newmath will order, sort and rank mathematical characters.
This will give a much better overview than it is possible in Unicode, making it comparatively easy to find a specific character, to judge its importance, etc.
- Newmath could serve as a guideline to font designers.
Within Unicode, it is very hard for a font designer to identify the characters needed for mathematics, and to separate indispensable math characters from less important ones. In fact, most font designers will be abhorred by the prospect of designing 2000 additional characters, of which many will be seldom used.

Here Newmath could offer a clearly arranged and well-ordered set. For example is the math asterisk * (U+204E LOW ASTERISK) easily overlooked, as most fonts already contain an asterisk * (U+002A ASTERISK), but normally the latter is not suitable for math, which uses a larger version, six-pointed and vertically centered at the mathematical axis.

- Newmath could be used to classify math fonts.

Currently it is not easy to judge the usability of a specific math font, and to gain a quick overview of its glyph complement set. This could be made much easier by classifying the font according to the set of its supported Newmath encodings. For example, it should be quite easy then to see that a font has all the Unicode glyphs needed in Mathematical Logic.

Further Development of Newmath

For further development of Newmath, I see the following areas: *Encodings; macros; fonts; packages and tools; integration and interaction with other packages; additions and enhancements to T_EX's mathematical typesetting engine.*

I am mainly concerned with encodings, macros and fonts here, and my ideas for these areas are detailed in the sections below.

The development of “packages and tools” will, for a good part, go hand in hand with the development of macros (for L^AT_EX, ConT_EXt and plain T_EX). By “integration and interaction with other packages” I mean that Newmath should work with other math packages (e.g. `amsmath` or `nath` in L^AT_EX), but also that Newmath could borrow and integrate from other packages (e.g. macros in widespread use could be standardized). For possible “additions and enhancements to T_EX's mathematical typesetting engine”, see Ulrik Vieth's article [5]. Here I'm only dealing with these aspects in the way they influence possible encodings.

Of course I won't and can't do all the necessary work alone, so anyone who wishes to help and to contribute is invited to join the project. Also all steps in the development will be discussed on the Math Font Group's “math-font-discuss” mailing list (see [1] for information about the mailing list and how to join it).

Development of the Encodings

General Considerations. We have to take T_EX's restrictions into account: only 16 families of math fonts are allowed in one formula (practically, this means in one document in most cases). Therefore the additional encodings should be designed in a way that minimizes the loading of additional fonts.

In a TFM file, only 15 different non-zero heights and 15 non-zero depths are allowed. While one could cope with this for symbol fonts in most cases, it is a really troublesome restriction when it comes to extension fonts. This leads to the strange vertical placement of most glyphs in extension fonts, which hinders their usability outside of T_EX. But even within T_EX, it could become impossible to cope with for some fonts which differ in design from some of Computer Modern's assumptions.

These restrictions should be overcome by any successor of T_EX, maybe best with a new “math font metrics” format, but for the time being, the encodings should deal with them as good as possible.

But the encodings and macro packages should not be tied too closely to T_EX and the current situation; they have to be flexible enough to be extendable – to other typesetting traditions like those of traditional Russian mathematical typography, and to font sets which bring their own extensions and special macros, like the Math-Time Pro fonts.

The Existing Encodings. I consider *Math Core* as fairly stable. Maybe about 5 characters could be moved to another encoding.³ This would allow to include a few Roman characters like e, i, and maybe D (MathCore

³ For example, only italic variants of *f*, *ə*, and *t* are encoded here; moving these to an additional font-dependent encoding would allow to encode their upright variants there as well.

already contains “d”, and these single Roman letters are quite common in mathematical typography; inclusion in MathCore would allow kerning with Math Italic letters); but this may sacrifice compatibility with the old math font setup.

Both *Math Symbol Principal* and *Math Symbol One* are stable as well, maybe with one or two questionable characters in each one, and with about 40 yet unassigned codepoints in MS 1. The additional Unicode symbols supply some obvious candidates for inclusion here.

For *Math Symbol Two*, I think that the Fraktur digits are a misunderstanding (the “Fraktur digits” currently included here stem from the Euler fonts, but apparently these are intended as Euler Roman old-style digits; while proper Fraktur digits – clearly visually separate from Roman digits – just do not exist). So old-style (tabular⁴) digits should be put here, at least for math fonts which bring their own digits, like Euler. But in general, putting old-style digits here would make this encoding dependent on the text font used. A better way could be to put old-style digits in an additional, font-dependent encoding (alongside with additional letters and letterlike symbols which don’t find a place in MathCore).

The Arrow Kit could be moved to an encoding of its own, as many more arrow pieces could be added then (Unicode features many additional arrows; some of these are candidates for extensible arrows).

The case is different for the *extension fonts*: maybe the whole encodings should be overthrown, maybe we should sacrifice compatibility with older documents here in favour of a clearer layout. By putting e.g. root, accents, and over- and underbrace into one encoding, and putting delimiters and big operators into a second one, most glyphs could be brought to their natural position, which would ease the design and greatly improve the general usability of such fonts.

New Additional Encodings. For the remaining Unicode math characters (i.e. for the characters not yet encoded in Newmath), we have to design new, additional encodings. First, let’s see how many additional characters there are, and how many additional forms (like larger delimiters) we need. The following table gives a rough number for the additional characters in each class, with the number of additional codepoints needed in T_EX:

Arrows:	250	+ arrow kit pieces:	100
Binary Operators:	130		
Geometric Symbols:	100		
Miscellaneous Symbols:	30		
Ordinary Symbols:	90		
Punctuation:	15		
Relators:	230	+ negated variants:	100
Z Notation:	10		
Accents and Overlays:	30	+ in extension fonts:	90
Big Operators:	0	+ in extension fonts:	40
Delimiters:	45	+ in extension fonts:	450
Integrals:	25	+ in extension fonts:	50
<hr/>			
Total number of glyphs:	955	+ in symbol fonts:	200
		+ in extension fonts:	630

This would mean 4 or 5 additional symbol font encodings (possibly including 1 or 2 arrow kit encodings), and 3 or 4 additional extension font encodings.

To minimize the loading of additional fonts, and to offer clearly arranged font layouts (both to users and to font designers), we should sort and group the Unicode characters, according to importance, meaning, and area of use (within mathematics). For example, all symbols specific to one field of mathematics should be kept together in one encoding (e.g. logic, geometry, or z-notation symbols).

⁴ Many OpenType fonts come with (at least) four sets of digits: lining and old-style, each as proportional and as tabular. For math, tabular digits are used, where all the digits have the same width.

Most documents will only need a limited set of mathematical symbols, and well-designed encodings should make it possible to keep within T_EX's restriction to 16 math font families in most cases – without the need for mid-document changes of math encodings.

Unfortunately Unicode does not provide much information neither about the use of a specific character nor about its field of use, so many characters need some research before one could group them properly into an encoding.

Macros and Packages

Along with the new encodings, we do need standard macro names to access those glyphs. Again, any information about the meaning of a character is very helpful here, as then the macro could be named accordingly. For some characters, this is a rather straightforward task.

Ideally, these macro names should be the same in all T_EX based systems (especially in plain T_EX, L^AT_EX and ConT_EXt). Of course one has to develop a “Newmath” package (or file bundle) for each system, but these macro definitions will form the core of each such package and will essentially remain the same.

For L^AT_EX, the current version of Newmath already supplies the necessary files, so we just have to extend these accordingly. When Newmath development ceased in 1998, ConT_EXt was not very widespread yet, but now Newmath should of course support it (and vice versa).

T_EX's existing math macro names could be broadly categorized as

- descriptive (describing the shape, e.g. `\uparrow`)
- semantic (describing the meaning, e.g. `\sum`, `\times`)
- mixed (partly semantic, partly descriptive, e.g. `\otimes`).

Obviously Knuth employed the following scheme: any symbol with one fixed meaning gets a macro name according to its semantics (thus, `\sum` and not `\bigsigmaup` or whatever). Any symbol without fixed or with more-than-one meaning gets a macro name describing the shape. And the mixed names come in for symbols where the base symbol or a component of the symbol has a semantic name already, but where the meaning of the combined symbol is not clear or not fixed. Of course the new additional macro names should follow this scheme, using a semantic name whenever possible.

In addition, Newmath could be extended to gather macros in widespread use, which could be standardized by including them in Newmath packages. Examples of such macros are `\abs{...}` and `\norm{...}`. Supplying such a standardized set of (alternative) semantic macros could be very helpful to many users. In fact, by using well-chosen semantic macros, a T_EX source sometimes can be more readable than its pretty-printed output – and of course it greatly helps in conversion e.g. to Content MathML or OpenMath.

Latin Modern Math Fonts

Encodings, macro packages, and tools are only useful together with fonts. Freely available math fonts could be extended and reencoded, and commercial math fonts could be mapped to the new encodings via virtual fonts (but in most cases they will lack many of the additional glyphs). A good part of this work (on Computer Modern extension and on virtual fonts for other math fonts) has been done already in the last version of Newmath, of course based on the math fonts available at that time. For the future development, it doesn't seem to be a very useful approach to extend the Metafont sources of Computer Modern, as most users would want PostScript Type 1 or OpenType fonts. Instead, I think of extending the Latin Modern fonts.

The Latin Modern math fonts will be a set of freely available math fonts, for use with Latin Modern text fonts. I will design and develop these fonts (with the help of anybody who volunteers to work on these fonts). However I did not start to work on these fonts yet, so I can only give an account of my ideas and intentions here.

I will do the development in MetaType1, so the resulting fonts will be in Type 1 format and could be wrapped as (CFF flavoured) OpenType, too. In general, the design will follow Computer Modern math fonts, with 6 versions of each glyph: 2 weights (regular and boldface) times 3 optical sizes (5 / 7 / 10pt, or rather “Tiny”, “Caption”, “Regular”, as the fonts will be freely scalable of course). But the number of glyphs will be considerably extended, to comprise the complete set of Unicode math characters together with all characters defined in Newmath.

Neither the design nor the metrics of the fonts will be completely compatible with Computer Modern: the design should be more “of a piece” than with Computer Modern and its various extensions (just one example of such a mis-match: the 3 Hebrew letters Beth, Gimel, Daleth from the AMS fonts do not match the design of CM’s Aleph, they rather match the Euler fonts’ Aleph); and metrics will be changed as needed (e.g. many new kerning pairs will be possibly due to the extended encodings).

By default, these fonts will be encoded in the Newmath standard, thus offering a freely available implementation of the standard. But by the MetaType1 approach the fonts will be independent of any de-facto encoding – so one could rather easy adapt them to further Newmath development, to different encodings, or even to the requirements of other typesetting applications.

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Latin Modern fonts: how less means more

Bogusław Jackowski and Janusz M. Nowacki

Well, less is more . . .

Robert Browning, “Andrea del Sarto,” 1855.

1 Introduction

The Latin Modern project was launched during the 13th European and 10th Polish T_EX Conference, May 2002, Bachotek, Poland. The aim was to prepare a family of outline fonts, compatible with Computer Modern fonts ([8]), but, unlike CMs, equipped with a rich collection of diacritical characters.

At that time, two solutions to the problem existed: (1) Lars Engebretsen’s AE (Almost EC, [3]) family of virtual fonts, based on Computer Modern fonts in PostScript Type 1 format released by AMS; (2) Vladimir Volovich’s collection of PostScript Type 1 fonts, CM-Super ([15]). Engebretsen’s approach has an important drawback — virtual fonts can be used only with T_EX. From this point of view, Volovich’s CM-Super fonts would be a better choice. The fonts were produced by Péter Szabó’s T_EXtrace ([12]) which, in turn, is based on Martin Weber’s Autotrace ([16]). Volovich’s achievement is really impressive, nevertheless we would cast doubt upon the quality of the outlines of glyphs. This is perhaps the intrinsic drawback of the autotracing approach. Moreover, there is a problem with the size of the CM-Super package. It contains more than four hundred fonts; the size of the PFB files is almost 60 MB. Finally, it is not easy to repeat the process of the font generation if changes are needed, as manual tuning was involved. (A comprehensive discussion of alternative approaches can be found in [5], [6], and particularly [11].)

Finding the situation unsatisfactory, some representatives of European T_EX Users groups decided to prepare yet another family of fonts, Latin Modern, being in a way a continuation of Engebretsen’s approach, but going further: the aim was to comprise all existing Latin-based alphabets, not necessarily European. We were invited to lead the project, which we gladly accepted.

2 The initial stage of the LM project

Like Engebretsen, we decided to make use of the Computer Modern fonts in the PostScript Type 1 format, released by AMS. But being bent on working with human readable sources, we decided to employ our (anyway favourite) METAPOST-based program, METAT ([6], [7]). One of the modules of the METAT package is a converter from PostScript fonts to METAPOST sources. So, the first step was the conversion of PostScript Type 1 fonts to METAPOST sources that were to be manually adjusted.

The decision was not obvious at all. The main disadvantage of such an approach is the “freezing” of parameterization. As an alternative, we considered a conversion of METAFONT CM sources into METAT-conforming ones. It turned out, however, that this method, although practicable, would be time-consuming. Taking into account that our main goal was the extension of the *standard T_EX fonts* with diacritical characters, we abandoned eventually the idea of working with METAFONT sources, although access to the CM parameterization is provided (see section 4.1).

3 Interim stages of the LM project

The LM family of fonts has been developing evolutionary. Our main concern, as already mentioned, was the enhancement of the character set, but, as a result of pressure from users, the number of fonts also increased.

3.1 Serious matters and trifles

The number of glyphs per font grew from less than two hundred to more than six hundred. Also, the number of fonts grew. We started with 50 fonts (following Engebretsen); currently, the LM family contains 57 fonts. Among them are fonts that do not belong to the “Knuthian canon,” for example, the bold companion for `cmssq8` and `cmssqi8` (prepared by Pierre A. MacKay) — see [5], p. 67, for the complete list of LM fonts. The increase of the number of glyphs resulted of course in the rapid growth of the number of kern pairs.

The augmentation of the LM family of fonts was certainly the most important part of the whole enterprise. We wrote several tools (mostly `awk` scripts) that helped to control the herd of glyphs and interdependencies between them — it is unimaginably difficult to fiddle with dozens of thousands of glyphs and hundreds of thousands of kern pairs by hand.

As we pointed out in [5], the lion share of our time was spent on the struggle against tiny details and exceptions. We were not expected to come up with brand-new concepts. On the contrary, we had to comply with the established practice. This, as it turned out, necessitated looking closely into lots of various aspects.

One can call most of these problems trifles, but their amount, relating of course to the size of the project, created a real problem. Such “trifles” had to be carefully analysed and even if the result of the analysis was simply “let’s do nothing,” it took time. Listing all details would be impracticable, but we cannot resist to mention just a few in order to demonstrate how seemingly less important things may cause more trouble.

Latin Modern fonts: how less means more
Bogusław Jackowski, Janusz M. Nowacki

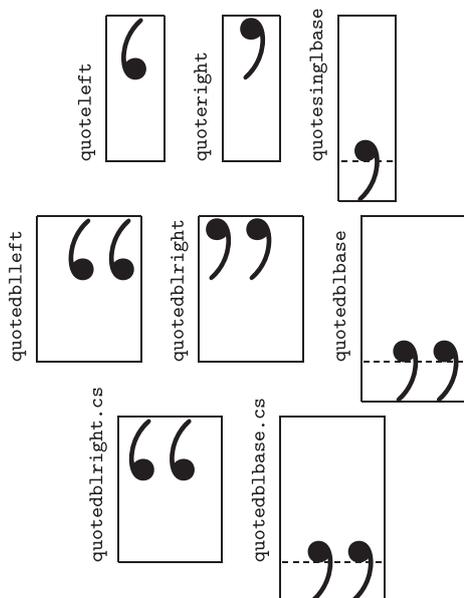


Figure 1: A seemingly innocuous asymmetry of double quotes turned out to be fairly bothersome; PostScript names of the glyphs have been used for the description.

3.2 Detail 1: asymmetry of double quotes

One of such problems turned out to be, somewhat unexpectedly, the asymmetry of double quotes (see figure 1). Observe that single quotes are positioned symmetrically, while double ones are not. This is the CM fonts heritage: the glyphs *quoteleft* (reverse apostrophe), *quoteright* (apostrophe), *quotedblleft* (opening quotes), and *quotedblright* (closing quotes) were designed by Donald E. Knuth ([8], p. 140–141 and p. 280–281), who decided to introduce asymmetry. But the glyph looking like an English opening quote is used in some languages, for example, Czech and German, as a closing one. Therefore, Czech T_EX users introduced a special glyph with differently asymmetric sidebearings (*quotedblright.cs* in figure 1) in their variant of CM fonts. In consequence, the character *quotedblbase* (used as an opening quote, for example, in Czech, German, and Polish) also inherited the asymmetry¹.

The proliferation of glyphs caused by the asymmetry of *quotedblleft* and *quotedblright* is of course a disadvantage because fonts needlessly swell. We decided, however, to inflate them even more: symmetric quotes were provided as an alternative. We believe that only the latter ones should be used, but because of the remnants of history, the problem cannot be resolved once forever — asymmetric quotes should be retained.

¹ For historical reasons, the glyphs *quotedblbase* and *quotedblbase.cs* slightly differ; the latter is placed asymmetrically also in typewriter fonts.

3.3 Detail 2: non-uniform width of accents

Typically, accents should have the same width. This is, however, not the case with CM fonts: *cedilla*, *dotaccent* and *ring* have widths different from the remaining accents, that is, *acute*, *breve*, *caron*, *circumflex*, *dieresis* (umlaut), *grave*, *Hungarian umlaut*, *macron*, and *tilde*, all of which have the same width of 1/2 em. We cannot say why *cedilla* and *dotaccent* are an exception. The idea behind the extraordinary width of *ring* can be easily understood if one inspects the code of the plain T_EX ([9]) macro `\AA` which typesets the symbol Å (*Aring*). The glyph *ring* is designed to align with the top of the letter *A*:

```
\def\AA{\leavevmode\setbox0\hbox{!}%
\dimen@ \ht0\advance\dimen@-1ex%
\rlap{\raise.67\dimen@\hbox{\char'27}}A}
```

It is tempting to have a unique width for all accents. But this would mean upward incompatibility, as the `\AA` macro would cease to work. On the other hand, it is not urgently needed, as *Aring* obviously belongs to the repertoire of LM glyphs. Perhaps the cure would be to introduce alternative accents and use the odd-sized ones only with T_EX, and only when compatibility is needed, for example, if the LM fonts are to be used as a replacement for CMs (see section 4.2). But, as we complained already in section 3.2, a supererogatory increase of the number of glyphs would be an obvious disadvantage.

The plain T_EX macro `\AA` is not the only one that heavily exploits the metric properties of CMs. The macros `\l` and `\L` (which define glyphs *lslash* and *Lslash*, respectively) also are defined in a CM-dependent manner. Both macros rely on the assumption that there is a special glyph in slot 32 (*suppress*; of course, the width of this “accent” glyph is different from a typical one) and that there are specific, unusually large kerns between this glyph and the letters *l* and *L*:

```
\def\l{\char321}
\def\L{\leavevmode\setbox0\hbox{L}%
\hbox to\wd0{\hss\char32L}}
```

For example, the respective kern amounts in **cmr10** are −2.78 pt and −3.19 pt, while other kerns are generally in the order of a fraction of a point.

There are two intrinsic problems with *suppress*: (1) it does appear in worldwide standards, such as *Unicode* ([14]) or *Adobe Glyph List* ([2]), although *lslash* and *Lslash* appear there (the *Unicode* standard uses the name *stroke* instead of *slash*); (2) according to ASCII, slot 32 should be occupied by the *space* glyph. The result is easy to predict: most non-T_EX fonts will not work properly with plain T_EX and most non-T_EX software will not work properly with standard T_EX fonts. . .

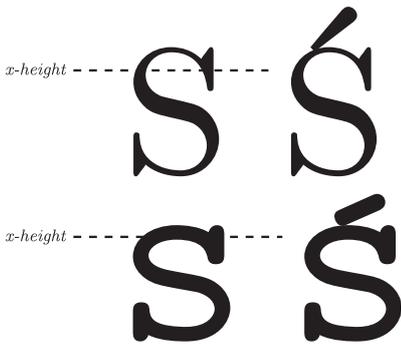


Figure 2: The lowercase letters in CM caps and small caps fonts, that is, `cmcsc10` (top) and `cmtcsc10` (bottom), are higher than the nominal *x-height*; this may befoul some typesetting programs which may assume that lowercase letters should be accented without an additional vertical shift of the accent — the potential disastrous results are shown to the right; T_EX rises an accent by the difference between the *ex* unit and the actual height of an accentee.

3.4 Detail 3: bogus x-height in small caps

One might expect that *x-height* (that is, the *ex* unit in T_EX) is approximately the height of the lowercase letter *x*. True, but it depends on the accuracy of approximation. The difference between the *x-height* and the height of the lowercase *x* is queerly large in CM caps and small caps (see figure 2). For example, in `cmcsc10` it reaches 0.83 pt. The answer to this riddle is simple: all roman fonts of the CM family have *exactly the same* value of *x-height*; in other words, `cmcsc10`'s *x-height* is the height of the `cmr10`'s lowercase *x*. This discrepancy is harmless, if not advantageous, for T_EX, but if the fonts are to be used outside the T_EX world, then one may expect weird results if a given system is capable of making composed characters. Nevertheless, we adopted the CM convention for the LM fonts in the hope that if a font is used in a different environment, all necessary characters that could potentially be composed will be already in it.

4 The present stage of the LM project

The project seems to be approaching a development plateau: in comparison with the state of the art reported in [5], the number of fonts was not changed, although the repertoire of characters has been augmented by approximately one hundred glyphs per font — now each font contains circa 650 glyphs. In particular, diacritical characters for Vietnamese and Navajo alphabets have been added — many thanks to Hàn Thế Thành, Karl Berry and Hans Hagen for their warm-hearted help.

As was mentioned, the LM family of fonts developed evolutionary. Everybody knows that evolution is capable to bring forth really bizarre creatures. So were

the METAT sources of the LM fonts after two years of evolution. Two years more — and we would be lost in them. Hence the decision to repeat the initial step: the METAT sources were once more generated from the now current LM fonts in PostScript Type 1 format. Of course, manual tuning was again necessary, as the structure of automatically generated sources is not always fit for a particular purpose. The newly generated sources turned out to be satisfactorily legible, so we decided to release them publicly. Thus, one of the project's main goals was reached.

4.1 Structure of the LM sources — an overview

The LM family of fonts consists of a few general purpose files and files containing specific data for every font (see the listing of a sample driver file below). The data for each font is split into five files that contain:

- metric data,
- PostScript-oriented data,
- encoding data,
- the definition of shapes of basic glyphs,
- the information about ligatures and kerns.

All these files are governed by a single driver that inputs them — see lines 5, 6, 7, 10, and 13 in the listing below:

```

1 % A driver file for lmb10 Latin Modern font
2 input fontbase;
3 vardef cm_pal = "cmb10" enddef;
4 input comm_mac; % common defs, CM params
5 input lmb10.mpm; % metric
6 input lmb10.mph; % PS-oriented header
7 input lmb10.mpe; % encoding
8 input comm_mph; % common header
9 beginfont
10 input lmb10.mpg; % ‘frozen’ glyphs
11 input comm_mpg; % common glyphs (diacritics)
12 if known generating:
13 input lmb10.mpl; % ligatures and kerns
14 fi
15 endfont

```

There is no parameterization in these files. All entities are defined using bare numbers. The files are assumed to be “frozen” and are not expected to be altered in the future, unless new basic characters are added or severe bugs are spotted. The exception is, of course, the encoding file (line 7) that can be modified as need be.

Each LM font is associated with its CM pal (line 3). The respective CM driver file is being read and its parameters are stored for further use; they are exploited, for example, in the file `comm_mpg.mp` (line 11) by the programs defining the characters depicted in figure 3.

The `comm_mpg.mp` file is actually a “pivot” of the LM fonts. Its main purpose is to define accented

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glyphs, that is, diacritical characters that can be defined as composites. But not only. The file begins with three peculiar inputs:

```
input gly_euro.mp;
input gly_guil.mp;
input gly_vspa.mp;
```

The files being input are exceptional as they do not define accented characters. They contain a parametric METAFONT-based code for the following glyphs: *euro* (`gly_euro.mp`), *guillemotleft*, *guillemotright*, *guilsingleft*, *guilsingright* (`gly_guil.mp`), and *visible space* (`gly_vspa.mp`). The selection of glyphs is more or less arbitrary. The glyphs could be “frozen” as well; however, we decided to leave them in order to demonstrate what the METAFONT code would look like after a manual conversion to the METAT jargon.

Next, the definitions of letters *i* and *j* come. If one is surprised, one shouldn't. After all, the letters *i* and *j* are simply *dotlessi* and *dotlessj* accented with *dotaccent*.

Then, the main part of the `comm_mpg.mp` file ensues. It reads as follows:

```
%% \vb\ - Aacute:\ - \PICT{Aacute}\ -
acc_glyph(_A)(_Aacute)(_Aacute);
%% \vb\ - aacute:\ - \PICT{aacute}\ -
acc_glyph(_a)(_aacute)(_aacute);
%% \vb\ - Abreve:\ - \PICT{Abreve}\ -
acc_glyph(_A)(_Breve)(_Abreve);
%% \vb\ - abreve:\ - \PICT{abreve}\ -
acc_glyph(_a)(_breve)(_abreve);
%% \vb\ - Abreveacute:\ - \PICT{Abreveacute}\ -
acc_glyph(_A)(_breveacute)(_Abreveacute);
...
```

The details of the code are unimportant—the reader is expected to understand what is going on here without arcane knowledge of the METAFONT language. We only mention that the persistently appearing macro `acc_glyph` automatically generates an accented character and that lines beginning with a double percent are meant for the preparing of proofs of a font.

The code looks a bit boring. Indeed, the majority of diacritical characters are composed using the macro `acc_glyph` which roughly corresponds to the T_EX `\accent` primitive. In particular, the Vietnamese diacritics are defined in this way (see [4] for the details concerning the Vietnamese alphabet).

Note that there are different accents for uppercase and lowercase letters, for example, *Acute* and *acute*. Note also that double accents in the LM fonts, such as *breveacute*, are not defined using the macro `acc_glyph`, that is, they are supposed to belong to the basic set of glyphs. They might have been defined as composed objects, but this would increase the com-



Figure 3: A group of diacritical characters in the LM fonts for which accents were positioned by hand. Note that although the suffix *caron* misleadingly appears in the glyph names, it is not an element of the respective glyphs.

plexity of the fonts (for example, *abreveacute* would depend on *a* and *breveacute* and the latter, in turn, would depend on *breve* and *acute*), which we wanted to avoid. Moreover, in some cases subtle adjustments were needed. Therefore, we decided to “freeze” the double accents, once they had been created.

There are, however, several glyphs that cannot be obtained in a simple manner (see figure 3). In the LM fonts, the following glyphs are specially programmed: *dcaron*, *gcommaaccent*, *Lcaron*, *lcaron*, *tcaron*, and *ydotbelow*. A punctilious reader may wish to examine the source code for the details of the implementation.

The final part of `comm_mpg.mp` defines duplicated glyphs, that is, glyphs of the same shape, but different names. For example, we decided to keep the glyphs named *Tcedilla* and *tcedilla* for historical reasons, although their proper names are *Tcommaaccent* and *tcommaaccent* (see [5], p. 70–71). Such duplication increases of course the size of a font, but not excessively. As already mentioned in [5] (p. 71), the duplication of a character adds only 30–40 bytes to a font. This is done by a METAT module which compresses PostScript Type 1 fonts. The module defines multiple occurrences of the same PostScript code as subroutines. In particular, whole characters can be defined as subroutines. This means that only the code that invokes these subroutines is to be added. Thus, the duplication of glyphs is moderately harmful which does not mean that it is always reasonable. In future, some of the duplicated glyphs might be deleted.

4.2 Using LM fonts with other t_fm files

Obviously, as shown in [5], full LM and CM font compatibility can not be expected, that is, LM metric files cannot be used instead of CM ones. Still, it is possible to use LM fonts as a replacement for a subset of CMs: one should use CM metric files, a few special encoding

files and a special font map file for the `dvips` driver. A typical line (broken here into two lines for technical reasons) from the relevant font map file for CM fonts looks as follows:

```
cmb10 LMRomanDemi10-Regular
"enccmm ReEncodeFont" <cmrm.enc <lmb10.pfb
```

This line says that T_EX should use the metric file `cmb10.tfm` for typesetting, while the `dvips` driver should embed files `lmb10.pfb` and `cmrm.enc` instead of respective files for the CM fonts. Because the dimensions of the glyphs occurring both in the LM and CM fonts are the same (within the accuracy of rounding errors) and glyph shapes are very similar to each other, a user should not notice any difference, unless there is a bug in the LM fonts.

We hope that this solution will prove sufficient in most of practical cases. Similar files are provided for the PL and CS fonts, that is, for the Polish and Czech variants of the CM fonts. At present, work is being done on the support for VNS, that is, the Vietnamese variant of the CM fonts.

4.3 LM fonts in the *OpenType* format

The PostScript Type 1 format is claimed to be obsolete since many years. Actually, all PostScript engines support Type 1 fonts and are expected to support them also in the future. Recently, however, the *OpenType* format becomes a worldwide-accepted standard (see, for example, [10]). We believe that the T_EX world should acquiesce to this. Therefore, we also prepared the collection of the LM fonts in the *OpenType* format.

The current release of the *OpenType* LM fonts should be considered experimental, although we gathered some experience during the preparation of the *OpenType* fonts for the *Antykwa Toruńska* family. We employed the *Adobe Font Development Kit for OpenType* (free but not open; see [1]) for the conversion from the PostScript Type 1 to *OpenType* format. An alternative could be *FontForge*, a marvellous openware font program by George Williams (see [17]). Currently, AFDKO better suits our purpose, but as *FontForge* is being constantly developed we hope to switch to it before long.

One of the most important innovations introduced in the *OpenType* format are so called *features*. These are tags that provide additional information about how to use the glyphs in a font. So far, five features have been built into the *OpenType* LM fonts:

- `csp` (*Capital Spacing*),
- `dlig` (*Discretionary Ligatures*),
- `frac` (*Fractions*),
- `liga` (*Standard Ligatures*),
- `onum` (*Old Style Numerals*).

The availability of these features depends upon application support, for example, the *Adobe InDesign* program under the control of the *Microsoft Windows 98* operating system offers all of them (see figure 4), while *Microsoft Word 2002* in the same system ignores *OpenType* features.

Perhaps the toughest problem is the grouping of LM fonts into subfamilies. The idea of a series of point sizes, as implemented by Knuth in the CM fonts, seems to be athwart the nowadays praxis. Nevertheless, we followed the Knuthian tradition — see figure 4. Feel warned, however, that the adopted grouping may likely change after consultations with experienced *OpenType* users.

5 Conclusions

As one can infer from the title of the paper, our aim was to obtain a product handy in use at the price of abandoning features that — as far as we perceive it — are only moderately usable.

Just two examples:

- There are some fonts in the CM family that we never happened to use: `cmff10` and `cmfi10`. We decided not to include such fonts into the LM family.
- We did not follow the idea underlying the EC fonts to provide a complete series of font sizes (our arguments are set forth in [5], p. 66), unlike Volovich with his CM-Super fonts.

It is for the users to judge whether the goal was achieved.

Actually, the LM family of fonts in many respects offers simultaneously less and more, not always unequivocally, for example:

- The number of fonts is less than in the CM family, but the repertoire of characters in each font is much larger.
- The LM parameterization is limited in comparison with the CM one, but we expect the potential modifications and augmentations of LMs to be easier, although the LM sources are much larger (6 MB after a compression) than the CM ones. Note that LM fonts take up much less space than the CM-Super ones (but reckoning with the uncompressed LM sources, the sizes become comparable).
- If the LM family would become a basic set of fonts for T_EX (which we hope for), then the national variants of the CM fonts (PL, CS, VNS) could be dismissed, which would introduce more order into the T_EX font distribution.
- The area of possible applications for the LM fonts is broader in comparison with the T_EX fonts available so far, because of the furnishing of the LM distribution with the *OpenType* format.

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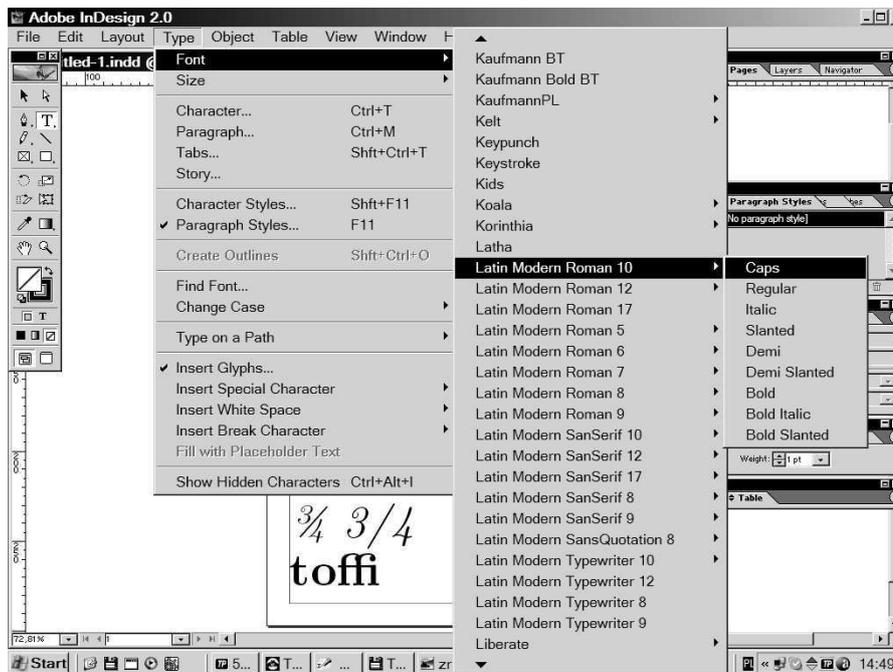


Figure 4: The *OpenType* LM family of fonts as seen by the *Adobe InDesign* program. Note that *Adobe Type Manager* used to accept subfamilies that contained at most four variants of a font, that is, normal, italic, bold, and bold italic. This is no longer the case with *OpenType* fonts — see the list displayed in the right part of the screen shot.

- Although the LM glyph repertoire is already fairly rich, it can and should be extended further: the next step will be perhaps the addition of glyphs specific for African Latin-based alphabets (cf. [13]). It is not within the scope of the project, however, to include Cyrillic and Greek alphabets.

There is, however, at least one case where more means a not wanted more: the significantly large repertoire of glyphs per font means that the one-to-one correspondence between an LM font and its metric no longer exists and that a multitude of font metric files can be generated for a given font. This abundance is not necessarily what we want. But as long as T_EX accepts 1-byte fonts only, the situation cannot be improved. This, however, is quite a different story.

The LM project is not finished yet. As all of us were taught by Donald E. Knuth, the debugging of software is a never-ending task and therefore software projects never end. But apart from fixing bugs, when the LM project reaches the stage of stability of metric data, we will consider the project essentially finished. Having legible sources, we are fairly optimistic — as far as we can assess, the LM project is rather more than less accomplished.

The current version, 0.98, of the LM fonts distribution is available either from CTAN or from `ftp://bop.eps.gda.pl/pub/lm`.

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6 Acknowledgements

The Latin Modern project is supported by European T_EX Users Groups, in particular by the German-speaking T_EX Users Group DANTE e.V., the French-speaking T_EX Users Group GUTENBERG, the Polish T_EX Users Group GUST, the Dutch-speaking T_EX Users Group NTG, and, last but not least, by TUG — very many thanks. We would like to express our gratitude also to Harald Harders for preparing and maintaining the web page “Wishes for Latin Modern” (<http://www.harald-harders.de/latex/lmodern.html>) and to Jurek Ludwichowski for his willingly offered help, not only during the preparation of this paper.

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Bibliography Styles Easier with MIBibT_EX

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Abstract

We emphasise and discuss some methodology about writing bibliography styles using the `nbst` language, part of MIBibT_EX. Most of the given tricks can also be applied to developing styles using XSLT, since `nbst` extends it closely. Last we show that the organisation of a bibliography style in several files allows modular decomposition.

Keywords: bibliographies, methodology, bibliography styles, multilingual features, BibT_EX, MIBibT_EX, `bst`, `nbst`, XML, XSLT.

Résumé

Nous dégageons et argumentons quelques méthodes d'écriture de styles bibliographiques au moyen du langage `nbst` de MIBibT_EX. La plupart des conseils donnés peuvent également s'appliquer au développement de styles en XSLT, le langage `nbst` en étant assez proche. Enfin, nous montrons en quoi l'organisation des divers fichiers d'un style bibliographique permet une décomposition modulaire.

Mots-clés : bibliographies, méthodologie, styles bibliographiques, multilinguisme, BibT_EX, MIBibT_EX, `bst`, `nbst`, XML, XSLT.

Zusammenfassung

Es werden einige Methoden dargelegt und untergesucht, um bibliographische Styles in der Sprache `nbst` zu schreiben. Da `nbst` mit XSLT nah verwandt ist, kann diese Anleitung auch für die Programmierung der Styles in XSLT helfen. Am Ende wird an der Aufteilung der bibliographischen Styles in einzelne Dateien gezeigt, dass eine modulare Dekomposition möglich ist.

Stichwörter: Bibliographien, Methodik, bibliographischen Styles, mehrsprachigen Funktionen, BibT_EX, MIBibT_EX, `bst`, `nbst`, XML, XSLT.

Introduction

This article aims to give some methodology about the development of *bibliography styles*, that is, specifications that rule the layout of *references* put in the ‘Bibliography’ section of a document, these references being built from *entries* located in bibliography data bases.

When we started the development of our program MIBibT_EX (for ‘MultiLingual BibT_EX’) [9], we were interested in going thoroughly into multilingual aspects for a bibliography processor belonging to the programs of T_EX’s family and especially, generat-

ing bibliographies as source files for the L^AT_EX word processor [22], like BibT_EX [26]. More precisely, we aimed to put into action an ‘extended’ BibT_EX with multilingual features comparable with L^AT_EX’s. Another example of such an extension is given by the `babelbib` package and the bibliography styles in interface with it [7].

As we explained in [12], we think that such organisation — adopted for MIBibT_EX’s first version [9] — leads to complicated bibliography styles, since the language `bst` [25], used within BibT_EX, is not modular: each style is a monolithic program put in

```

@INPROCEEDINGS{thys1997,
  AUTHOR = {first => Frank,
            last => Thys},
  TITLE = {Auf der {Spur} des
            {Vernichters}},
  BOOKTITLE = {Dinoland},
  EDITOR = {first => Wolfgang,
            last => Holbein},
  PAGES = {353--437},
  PUBLISHER = {Bastei L\"{u}bbe},
  ADDRESS = {Bergisch Gladbach},
  YEAR = 1997,
  MONTH = aug,
  LANGUAGE = german}

```

Figure 1: Entry using MIBibT_EX's syntax.

only a single file, so if we would like to add multi-lingual features, we have to extend each style separately. This point and others decided us to develop a new language, so-called **nbst**, for ‘new bibliography styles’, close to XSLT¹, the language of transformations for XML² documents. We think that such a choice is good, since XML becomes a central formalism for document interchange. In particular, using **nbst** eases the production of bibliographies for XML documents: for instance, documents written using XSL-FO³ [37], a language for describing high-quality print outputs, or DocBook [38], a system for writing structured documents.

We explain in [17] why MIBibT_EX does not use XSLT itself, after converting bibliography (.bib) files into an XML-like format, as programs like BibteXML [6] or BIB2XML [27] do. However, if we agree to consider an XSLT-like language for bibliography styles, we have to rewrite most of the bibliography styles of BibT_EX, if we want to provide some continuity with this program. There exists a way to import **bst** functions into an **nbst** program [11], nevertheless it is obvious that complete rewriting is preferable, in order to take as much advantage as possible of this programming paradigm. We put some methodology into action to rewrite BibT_EX's bibliography styles, we are giving these methods hereafter.

We begin with a small example, in order to illustrate the expressive power of **nbst**. Second we show how to design the layout of a reference. We consider a particular case: the @INPROCEEDINGS entry type of BibT_EX—for an article in a conference proceedings or a story in an anthology—but our

```

<inproceedings id="thys1997" language="german">
  <author>
    <name>
      <personname>
        <first>Frank</first><last>Thys</last>
      </personname>
    </name>
  </author>
  <title>
    Auf der <asitis>Spur</asitis> des
    <asitis>Vernichters</asitis>
  </title>
  <booktitle>Dinoland</booktitle>
  <editor>
    <name>
      <personname>
        <first>Wolfgang</first>
        <last>Holbein</last>
      </personname>
    </name>
  </editor>
  <publisher>Bastei Lübbe</publisher>
  <year>1997</year>
  <month><aug/></month>
  <address>Bergisch Gladbach</address>
  <pages>
    <firstpage>353</firstpage>
    <lastpage>457</lastpage>
  </pages>
</inproceedings>

```

Figure 2: The entry of Figure 1 as an XML tree.

method is easily adaptable to any entry type. Then we implement our specification. Last, we show how to organise the different items of a bibliography and give some advice about the decomposition of an **nbst** program into several files. A succinct comparison between **bst** and **nbst** statements is given as an annexe, followed by some complements about writing external functions using Scheme—the language used for developing MIBibT_EX [15]—close to the expression language used as part of DSSSL⁴ [18], the language of stylesheets of SGML⁵ [8].

What knowledge is required to read this article? A basic one about XML, XPath—the language used to address parts of an XML document—and XSLT is sufficient to just understand the examples given hereafter. Good introductions to them are [29, 30, 34], the ‘official’ references about XPath and XSLT, issued by the W3C⁶, are [36, 35]. Concerning

¹eXtensible Stylesheet Language Transformations.

²eXtensible Markup Language.

³eXtensible Stylesheet Language — Formatting Objects.

⁴Document Style Semantics and Specification Language.

⁵Standard Generalized Markup Language, the ancestor of XML. Now it has just historical interest.

⁶World Wide Web Consortium.

```
<!ELEMENT pages (onepage+ |
    (firstpage,(ff | lastpage)) |
    pages-verbatim)>
<!ELEMENT onepage %INTEGER;>
<!ELEMENT firstpage %INTEGER;>
<!ELEMENT lastpage %INTEGER;>
<!ELEMENT ff EMPTY>
<!ELEMENT pages-verbatim (#PCDATA)>
<!-- Strictly speaking, '%INTEGER;' is a parameter
entity (cf. [29, pp. 163–164]) standing for parsed
character data ('#PCDATA'). But we use it for
sake of readability, whenever the content of a
text node is an integer, because DTDs'
formalism does not know this type. 'ff' is for
an unspecified number of following pages.
-->
```

Figure 3: Excerpt from our DTD: specification of pages from a journal or book.

MIBibT_EX more precisely, all its elements and functions used within path expressions are described in [13]. On another point, we think that developing new functions in Scheme by MIBibT_EX's end-users is only needed for very specific applications, so referring to an introductory book such as [32] is sufficient to understand the given examples. MIBibT_EX has been developed using the fifth revision of this language [19].

A small example

Let us consider the bibliographical entry given in Figure 1. Even if it roughly looks like a BibT_EX entry, we can notice the use of syntactic features specific to MIBibT_EX: a LANGUAGE field⁷, some keywords for introducing the different parts of a person name: 'first', 'last'. All these syntactic features are described precisely in [13].

If this entry is cited throughout a document, the corresponding bibliographical reference, to be put at the 'References' section, looks like:

- [1] Frank Thys. Auf der Spur des Vernichters. In Wolfgang Holbein, editor, *Dinoland*, pp. 353–437, Bergisch Gladbach, August 1997. Bastei Lübbe.

We got this result by using 'old' BibT_EX, operating on an 'old' bibliography (.bib) file. The bibliography style used above is plain.bst, that is, items are labelled by numbers, and first names are not

⁷Also used in conjunction with the mlbib package [23] or the natbib package [7], but in MIBibT_EX, the corresponding values need not to be surrounded by braces or double-quote characters.

```
FUNCTION {multi.page.check}
{ 't := % t is given the value of the PAGES field,
    % popped from the stack.
#0 'multiresult := % I.e., multiresult ← false.
{ multiresult not % While multiresult is
  t empty$ not % false and t non-empty,
  and % do
}
{ t #1 #1 substring$ % compare t's first
  duplicate$ "-" = % character with
  swap$ duplicate$ "," = % '-', ',', '+';
  swap$ "+" =
  or or
  % if success, update multiresult;
  { #1 'multiresult := }
  % if not, update t by removing its head:
  { t #2 global.max$ substring$ 't := }
  if$
}
while$
multiresult % pushed result.
}
```

Figure 4: How BibT_EX detects that several page numbers are given.

abbreviated. This reference is supposed to be put at the end of a document written in English. If a German-speaking plain bibliography style—e.g., dtk.bst, used for the articles of the journal of the DANTE⁸ group, *Die T_EXnische Komödie*—is chosen, that results in:

- [1] Frank Thys: *Auf der Spur des Vernichters*; in *Dinoland* (Hg. Wolfgang Holbein); S. 353–437; Bergisch Gladbach; Aug. 1997; Bastei Lübbe.

so the stylistic differences between these two examples—for example, '.' after the author's name in English, ':' in German and French—shows that the layout of such references is language-dependent, in the sense that it is influenced by 'national' traditions.

When MIBibT_EX parses the entry of Figure 1, the entry is processed as if it was the XML tree given in Figure 2; in fact, it results in the SXML⁹ representation of such an XML tree. We can notice that this choice allows us to structure information given in some fields, for example, person names, in the AUTHOR and EDITOR fields, but also the first and last pages of a story belonging to an anthology, in the

⁸Deutschsprachige Anwendervereinigung T_EX e.V.

⁹Scheme implementation of XML, described in [20]. See [15] for more details about its use within MIBibT_EX's implementation.

```

<nbst:template match="pages">
  <nbst:param name="beginning"/>
  <nbst:param name="ending"/>
  <nbst:value-of select="$beginning"/>
  <nbst:variable name="onpage-elements" select="onpage">
  <nbst:choose>
    <nbst:when test="$onpage-elements">
      <nbst:choose>
        <nbst:when test="count($one-page-elements) = 1"><nbst:text>\bblp</nbst:text></nbst:when>
        <nbst:otherwise><nbst:text>\bblpp</nbst:text></nbst:otherwise>
      </nbst:choose>
      <nbst:apply-templates select="$onpage-elements[1]"/>
    </nbst:when>
    <!-- Otherwise, firstpage element, followed by either the ff or a last page. -->
    <nbst:otherwise><nbst:apply-templates/></nbst:otherwise>
  </nbst:choose>
  <nbst:value-of select="$ending"/>
</nbst:template>

<nbst:template match="onpage">
  <nbst:param name="first-time" select="true()"/>
  <nbst:variable name="following" select="following-sibling::onpage">
  <nbst:choose>
    <nbst:when test="$first-time"><nbst:call-template name="tie-number"/></nbst:when>
    <nbst:otherwise><nbst:value-of select="."/></nbst:otherwise>
  </nbst:choose>
  <nbst:if test="$following">
    <nbst:text>, </nbst:text>
    <nbst:apply-templates select="$following[1]">
      <nbst:with-param name="first-time" select="false()"/>
    </nbst:apply-templates>
  </nbst:if>
</nbst:template>

<nbst:template match="firstpage | pages-verbatim"> <!-- Putting a non-breaking space character -->
  <nbst:call-template name="tie-number"/> <!-- before a small number. -->
</nbst:template>

<nbst:template match="ff">
  <nbst:text> \bblff</nbst:text>
</nbst:template>

```

Figure 5: Putting page numbers down in nbst.

PAGES field. Such XML trees are conformant to a DTD¹⁰, an excerpt from which being given in Figure 3. Syntactically, the PAGES field of MIBibT_EX allows the specification of:

- a single page: {353},
- a range of pages: {353--457},
- the first page of an unspecified number of consecutive ones: {353+},
- some enumerated pages: {353,439,519},

¹⁰Document Type Definition. A DTD defines a document markup model [29, Ch. 5]. The DTD we use is a revised version of what is given in [10].

- otherwise, the value associated with this field is kept *verbatim* and becomes the content of the `pages-verbatim` element: this content will appear as it is within any predefined bibliography style.

The bibliography styles of BibT_EX deal with these different syntactic forms, as it can be seen in Figure 4, but this style of programming seems to us to be some *hack*.

Figure 5 shows how page numbers can be processed using nbst. Many tags and attributes are the same than in XSLT, except for the namespace used as a prefix, which is obviously different. We explain

Entity reference	Character	How to produce it in L ^A T _E X	Numeric entity
&	&	\&	&
'	'		'
&emdash;	—	---	—
&endash;	-	--	–
&eol;	¶ ^a	\newline	

>	>		>
<	<		<
&nobsp; ^b		~	
"	"		"

^a“¶” is a typographic sign for the end-of-line character [2, § 2.85]. In `nbst`, this entity is used to begin a new line within generated files.

^bNon-breaking space character.

Table 1: Entities usable in `nbst`.

later what the parameters `beginning` and `ending` are precisely, but intuitively, we can guess that they are strings to be put before and after the page numbers. Let us notice the use of *variables*—names that may be bound to values—and of *path expressions* in `match` and `select` attributes’ values. Using the `following-sibling` axis allows us to reach the subtrees at the right of the current node and sharing the same parent node, that is particularly useful to implement loops, in the sense of ‘classical’ programming languages. Putting some enumerated pages would be done this way if we express it using a ‘classical’ algorithm:

```
write(tie-number(first(one-page-elements))) ;
loop
  one-page-elements ← rest(one-page-elements) ;
  exit when one-page-elements = ∅ ;
  write(" , ") ; write(first(one-page-elements)) ;
end loop ;
```

Figure 5 shows how this algorithm is put into action by means of a recursive template, matching the first element of page numbers not written yet. This technique is very common in XSLT for iterative algorithms.

Let us focus on the texts generated when these templates are invoked, more precisely, on the content of the `nbst:text` tags: we notice the use of additional L^AT_EX commands, for example, `\bblp` (resp. `\bblpp`) for one (resp. several) pages. These names originate from bibliography styles generated by the `makebst` program [3] in interface with the `babel` package [24, Ch. 9], and are language-dependent. For example, the `\bblp` command is expanded in ‘p.’ for ‘page’ in English and French, in ‘S.’ for ‘Seite’ in German. How to organise them is shown in [14, § 2].

```
<nbst:template match="lastpage">
  <nbst:value-of
    select="concat('&endash;',.)/">
</nbst:template>

<nbst:template match="lastpage"
  language="french">
  <nbst:value-of select="concat('-',.)/">
</nbst:template>
```

Figure 6: Default and language-dependent templates.

Special characters can be denoted by entity references, like in XML [29, pp. 48–49]. MIBibT_EX knows more predefined character entities than XML—e.g., ‘&endash;’, used in Figure 6—they are summarised in Table 1: for each, we give its name, the corresponding character, the way to produce it in L^AT_EX if this character is special¹¹, the decimal number coding it w.r.t. Unicode [33].

Now let us introduce the main difference between XSLT and `nbst`. When a range of pages is to be given, an *en-dash* character¹² should be put between the first and last page numbers. More precisely, this is the convention for most European languages, including English. But in documents written in French, this character tends to be replaced by a single minus character (‘-’). In our style, this character is put by the template processing the last page number. Figure 6 gives two version of this template: a default version, without the `language`, and another version, suitable for the French language. This `language` attribute does not exist in XSLT; in `nbst`, a template with it has higher priority than the same template without.

Style for an entry type

As we can read in [24, § 13.6.3], introducing small changes in a bibliography style written using the `bst` language is quite easy. Writing the whole of a style is a worthwhile exercise: we have to know what has been pushed onto the stack handled by BibT_EX, what we can pop from it, possibly after applying the `duplicate$` function when this value is needed afterwards by the program. This language is not modular, we have to take care of such questions from a

¹¹MIBibT_EX uses it only when the `mode` attribute of the `nbst:output` element (cf. Figure 12) is `LaTeX`. For example, the element:

```
<nbst:text>The Bull & the Spear</nbst:text>
produces ‘The Bull & the Spear’ (resp. ‘The Bull & the Spear’) if the mode is LaTeX (resp. text).
```

¹²That is, a dash as wide as the ‘n’ letter.

```

<inproceedings> ::=
  "\bibitem{" <id> "}¶" <authors> <title> <in-eds-booktitle> [", " <volume-number-series>]
  [", " <pages>] <date-etc> ["¶\newblock " <note> "."] "¶¶" ;
<authors>      ::= <name-list> ".¶\newblock " ;
<editors>      ::= <name-list> ", \bbled, "          if |<name-list>| = 1 |
                  <name-list> ", \bbleds, "         if |<name-list>| > 1 ;
<name-list>    ::= <name> {" , " <name>} [", \bbland\ " <name> | " \bbletal"] ;
<title>       ::= change-case(t)(<string>) ".¶\newblock " ;
<booktitle>   ::= "\emph{" <string> "}";
<in-eds-booktitle> ::= "\capitalize\bblin " [<editors>] <booktitle> ;
<volume-number-series> ::= "\bblvol" <tie-number><volume> " \bblof \emph{" <series> "} " |
                          "\bblno" <tie-number><number> " \bblin " <series> ;
<pages>       ::= "\bblp" <tie-number(s)>          if |<tie-number(s)>| = 1 |
                  "\bblpp" <tie-number(s)>        if |<tie-number(s)>| > 1 ;
<tie-number(s)> ::= <non-breaking-space-character> <number(s)> if <number(s)> < 3 |
                  " " <number(s)>                  if <number(s)> ≥ 3 ;
<date-etc>    ::= [", " <address> ", "] <date> [". " <org-pub>] ". " |
                  [". " <org-pub>] ", " <date>
<org-pub>     ::= [<organisation> ", "] <publisher> ;

```

‘[...]’ is for the number of elements of a list, ‘...’ for the length of a string. Cf. Table 1 about the ‘¶’ sign.

Figure 7: How to put information about a story included into an anthology.

function to another, and the use of only global variables reinforces this monolithic way of programming. So, the best method for rewriting a style wholly is to express it using a grammar, according to a *reverse engineering*¹³ approach. That is, studying *bst* styles in order to deduce such a grammar. Of course, such modelling can also be done from documents giving rules for bibliographies’ layout, such as [1, § 10] or [2, §§ 15 & 16].

Figure 7 gives all the possible texts for references generated by BibT_EX, using a ‘plain’ style and derived from entries being @INPROCEEDINGS type. We do not consider cross-referencing ([22, § B.1.4], [24, § 13.2.5]), not implemented yet in MIBibT_EX. These possible texts are expressed with a formalism close to EBNF¹⁴, that is:

- for each non-terminal symbol, enclosed like an XML tag, the expression following the ‘:=’ sign

¹³According to the terminology used in Software Engineering:

- **re-engineering** consists of transforming a program written using an ‘old’ language into a new program in a more modern language: for example, deriving a C program from source files written in FORTRAN;
- **reverse engineering** is the process of analysing software in order to recover its design of specification.

As stated in [31, Ch. 34], reverse engineering is part of software re-engineering process, in the sense that allows better understanding of a system.

¹⁴Extended Backus-Naur Form. Readers unfamiliar with this formalism can refer to [4] for an introduction. DTD syntax originate from it.

and terminated by ‘;’ states how it can be expanded;

- the ‘|’ sign means an alternative, ‘[...]’ is for an optional part, ‘{...}’ for zero or more occurrences of its content;
- expressions enclosed by two double quote characters are texts to be put: let us recall that they are part of L^AT_EX input.

Since this grammar does not model texts to be parsed, but texts to be generated, we do not have to be conformant with conditions related to parsing, as that would be the case for a language to be interpreted or compiled. In fact, most of our non-terminal symbols are fields’ names of MIBibT_EX (e.g., <title>) or simple types (e.g., <string>). There is some language abuse — for example, the use of functions (e.g., **change-case**¹⁵) — but we think that such a specification is precise and gives a good overview of the texts to be generated.

So, we are given precise information about the order in which fields’ values should be placed. As specified in the file *plain.bst*, we keep the occurrences of the `\newblock` command, used when the bibliography is to be ‘open’ — by means of the `openbib` option of the `\documentclass` command — that is, each block starting on a new line [24, § 12.2.1]. On another point, some keywords, hard-wired in this file, are replaced by multilingual commands of L^AT_EX. By the way, let us remark that we are able

¹⁵Analogous to the namesake function in BibT_EX [25].

```

<nbst:template match="inproceedings">
  <nbst:call-template name="common-pre"/>
  <nbst:variable name="comma-space"
    select="', '"/>
  <nbst:apply-templates select="author"/>
  <nbst:apply-templates select="title"
    mode="inproc"/>
  <nbst:call-template name="in-eds-booktitle"/>
  <nbst:call-template
    name="volume-number-series">
    <nbst:with-param name="beginning"
      select="$comma-space"/>
  </nbst:call-template>
  <nbst:variable name="pages">
    <nbst:apply-templates select="pages">
      <nbst:with-param name="beginning"
        select="$comma-space"/>
    </nbst:apply-templates>
  </nbst:variable>
  <nbst:call-template name="date-etc">
    <nbst:with-param name="previous"
      select="$pages"/>
  </nbst:call-template>
  <nbst:apply-templates select="note">
    <nbst:with-param
      name="beginning"
      select="'\&eol;\newblock '"/>
    <nbst:with-param name="ending"
      select="'. '"/>
  </nbst:apply-templates>
  <nbst:call-templates name="common-post"/>
</nbst:template>

```

Figure 8: Building a reference from an `inproceedings` element: program using `nbst`.

to capitalise the result of such a command when it begins a sentence, by means of the `\capitalize` command¹⁶. As far as possible, we consider that a sign of punctuation terminates the written form of a field—for example, the list of authors, ended with a period—but it is not always possible: as another example, the specification of page numbers may be followed by a comma if there is an address, by a period if there is an organisation name. In such a case, the sign of punctuation is specified before the non-terminal symbol it opens in Figure 7.

¹⁶This command is not predefined in L^AT_EX, it can be defined as follows:

```

\def\capitalize#1{%
  \def\Capitalize##1{\uppercase{##1}}%
  \expandafter\Capitalize#1}

```

cf. [21] for more details about `\expandafter` and the definitions of T_EX commands.

```

<nbst:template match="title" mode="inproc">
  <nbst:apply-templates match=".">
    <nbst:with-param name="emf"
      select="false()"/>
    <nbst:with-param name="retain-capitals"
      select="false()"/>
  </nbst:apply-templates>
</nbst:template>

```

Figure 9: Putting titles down.

Now the role of the two template parameters `beginning` and `ending`, occurring in Figure 5 is explained. Their use is systematic, as it can be seen in Figure 8, that ‘implements’ our specification. More generally, we can notice that writing this template matching `inproceedings` elements is direct, once we got a grammar for such references. If we consider Figure 7, the layout for an element (e.g., `<author>`) is implemented by a template with a `match` attribute; if we implement a non-terminal symbol grouping the layout of several elements (e.g., `<in-eds-booktitle>`), a named template does that. The named template `common-pre` opens a reference, by putting the `\bibitem` command [24, § 12.1.2], whereas the `common-post` template closes it. Both may be used to insert multilingual directives, for example, the `otherlanguage` environment of the `babel` package [24, § 9.2.1].

Let us mention a last point about signs of punctuation: several consecutive ones may conflict. In practice, such a case occurs when a period is to be put after a string ending with an exclamation or question mark, or with a period belonging to an abbreviation. B_IB_T_EX solves this case by means of its function `add.period$` [25], provided that the string has not been popped yet. In XSLT and `nbst`, a string is output by means of the `value-of` element, unless it is processed within a template that becomes the content of a variable. Thereby the result of this template can be memoized and reused later. Let us look at Figure 8: the string result of invoking the template matching the `pages` element becomes the value of the `pages` variable, which is passed to the named templates `date-etc`.

Refining the way to process `title` elements, let us remark that it depends on the entry type: within the bibliography style `plain.nbst`, they are put down using italic characters for an entry type being type `@BOOK`, written using roman characters without quotation marks if this type is `@INPROCEEDINGS`. In this last case, we process such an element with a

```

<nbst:template match="title">
  <nbst:param name="emf" select="true()"/>
  <nbst:param name="quotedbf" select="false()"/>
  <nbst:param name="retain-capitals" select="true()"/>
  <nbst:param name="ending" select="'.&eol;\newblock'"/>
  <nbst:if test="$quotedbf"><nbst:text>\begin{bblquotedtitle}</nbst:text></nbst:if>
  <nbst:if test="$emf"><nbst:text>\emph{</nbst:text></nbst:if>
  <nbst:variable name="title-put">
    <nbst;choose>
      <nbst:when test="$retain-capitals"><nbst:apply-templates/></nbst:when>
      <nbst:otherwise>
        <nbst:apply-templates select="node()[1]">
          <nbst:with-param name="retain-capitals" select="false()"/>
          <nbst:with-param name="no-left-lowercase" select="true()"/>
        </nbst:apply-templates>
        <nbst:apply-templates select="node()[position() &gt; 1]">
          <nbst:with-param name="retain-capitals" select="false()"/>
        </nbst:apply-templates>
      </nbst:otherwise>
    </nbst:choose>
  </nbst:variable>
  <nbst:value-of select="$title-put"/>
  <nbst:if test="$emf"><nbst:text></nbst:text></nbst:if>
  <nbst:if test="$quotedbf"><nbst:text>\end{bblquotedtitle}</nbst:text></nbst:if>
  <nbst:call-template name="adjoin-sign">
    <nbst:with-param name="the-string" select="$title-put"/>
    <nbst:with-param name="ending" select="$ending"/>
  </nbst:call-template>
</nbst:template>

```

Figure 10: Putting titles down (*continued*).

mode attribute, as shown in Figure 9. The template matching `title` elements without any mode — cf. Figure 10 — allows us to define parameters for ruling the layout and give them default values used when we display the title of a book:

- `emf`: if true, use italic characters;
- `quotedbf`: if true, use language-dependent quotation marks, provided by the `bblquotedtitle` environment (cf. [14, § 2]);
- `retain-capitals`: if false, converting the title to lowercase except at the beginning;
- `ending`: the string to be put after the title. The named template `adjoin-sign` prevents conflict between the last character of the title and the value of `ending`.

As shown in Figure 9, this template with the `mode` attribute set to `inproc` only consists of passing suitable values to the general template of Figure 10. Processing titles according to this `inproc` mode can be redefined for the French language, using French quotation marks, or the German language, using italic characters, as written in Figure 11.

Core of a style

When MIBibT_EX builds an XML-like tree with all the entries to be processed, this tree is rooted by an element so-called `mlbiblio`. Figure 12 gives the root element of our ‘new plain’ bibliography style and shows how to process all the entries. Opening the `thebibliography` environment [24, § 12.1.2] is done by the named template `put-preamble`, which may put additional L^AT_EX definitions, especially those included in BIBT_EX’s preambles [24, § 13.2.4]. Symmetrically, the `putpostamble` template closes the bibliography.

We can also see how entries are sorted before they are dispatched according to their type. Like the namesake element of XSLT, the first occurrence specifies the primary sort key, the second occurrence the secondary sort key, used for elements left unsorted, and so on. The first occurrence could have been specified by:

```
select="author/name[1]/personname/last"
```

that is, sorting entries w.r.t. the family name of the first author, but that would discard organisation

```

<nbst:template match="title" mode="inproc"
  language="french">
  <nbst:apply-templates match=".">
  <nbst:with-param name="emf"
    select="false()"/>
  <nbst:with-param name="quotedbf"
    select="true()"/>
  </nbst:apply-templates>
</nbst:template>

<nbst:template match="title" mode="inproc"
  language="german">
  <nbst:apply-templates match=".">
  <nbst:with-param
    name="ending"
    select="';&eol;\newblock'"/>
  </nbst:apply-templates>
</nbst:template>

```

Figure 11: Putting titles down w.r.t. French and German styles.

names as authors. The solution we put in Figure 12 consists of concatenating three strings related to the first author, two of them being always empty:

- the family name, if this name is for a person,
- the sort key of an organisation name, if given,
- the organisation name itself, if the sort key has not been given.

For first authors that are organisation names, only the first occurrence of the `nbst:sort` element is of interest, the others do nothing. When sorting entries w.r.t. names is finished, we sort w.r.t. years, then months. This last sort order can seem to be some *hack* since it uses the interface with Scheme functions (cf. § B), but let us recall that programming such a sort order is very difficult in `bst` and unused in practice. However, we think that our successive `nbst:sort` elements are clearer than the `presort`, `sortify` and `purify$` functions used within bibliography styles written in `bst`.

Splitting a style into several files

As abovementioned, the `bst` language is not modular, and all the definitions for a particular style must be stored in the same file, what is a drawback since several styles share the same definitions. That complicates the maintenance of bibliography styles if some definitions need some enrichment. Besides, it is difficult, when we are studying a style, to determine what is specific or common to other styles. The `nbst` language includes:

- an `nbst:include` element, to import definitions explicitly from another `nbst` file;

- *implicit importations*, described in [14, § 3.1].

Hereafter, we show how to spread out the templates we are writing over different files, in order to take as much advantage as possible of implicit importations of `nbst`. Let us recall that we are developing a new version of the ‘plain’ bibliography style, that is, the master file is `plain.nbst`.

- The `global.nbst` can be viewed as MIBIB_T_EX’s initial library of definitions using `nbst`: it includes general named templates such as:

`adjoin-sign` `date-etc` `tie-number`

as well as template matching the following elements:

<code>address</code>	<code>one-page</code>
<code>booktitle</code>	<code>organization</code>
<code>ff</code>	<code>pages</code>
<code>firstpage</code>	<code>pages-verbatim</code>
<code>lastpage</code>	<code>publisher</code>
<code>note</code>	<code>title</code>

Putting more templates in this file may seem to be of interest, but let us recall that in `nbst`, imported templates have the same priority than other elements¹⁷: so ‘global’ elements cannot be redefined¹⁸, unless adding a `language` or `mode` attribute to the redefinition.

- Of course, the `plain.nbst` file—the master file for this bibliography style—must include its root (`nbst:bst`) element and the ‘main’ template matching an `mlbiblio` element, given in Figure 12. The following named templates, related to references’ labels, should be included in this file, too:

`common-post` `put-postamble`
`common-pre` `put-preamble`

The layout of the following element depends on the bibliography style, so the corresponding templates have to be stored in the `plain.nbst` file:

`author` `inproceedings` `series`
`editor` `number` `volume`

as well as the named templates, for the same reason:

`in-eds-booktitle` `volume-number-series`
`org-pub`

- The ‘French’ definition of the template matching a `lastpage` element (cf. Figure 6) is general for French-speaking styles, not directly related to ‘plain’ styles, so we place it onto the

¹⁷This is not the case in `XSLT` if the `xsl:import` element is used.

¹⁸More exactly, if there is conflict between templates, it is unpredictable to know which will be run.

```

<nbst:bst version="1.3" id="plain" xmlns:nbst="http://lifc.univ-fcomte.fr/~hufflen/mlbibtex">
  <nbst:output method="LaTeX" encoding="ISO-8859-1"/>
  <!-- This encoding allows accented letters of Western European Languages [5, Table C.4]. -->
  <nbst:template match="mlbiblio">
    <nbst:call-template name="put-preamble">
      <nbst:with-param name="longest-label" select="count(*)"/>
    </nbst:call-template>
    <nbst:apply-templates>
      <nbst:sort select="concat(author/name[1]/personname/last,
                               author/name[1]/othername/@sortingkey,
                               author/name[1]/othername[not(@sortingkey)])"/>
      <nbst:sort select="author/name[1]/personname/first"/>
      <nbst:sort select="author/name[1]/personname/von"/>
      <nbst:sort select="author/name[1]/personname/junior"/>
      <nbst:sort select="year" data-type="number"/>
      <nbst:sort select="call(month-position,month)" data-type="number"/>
    </nbst:apply-templates>
    <nbst:call-template name="put-postamble"/>
  </nbst:template>
  ...
</nbst:bst>

```

Figure 12: Root element for a program in `nbst` — Organising all the entries to generate references.

-french.nbst file, that is, the file grouping the general definitions for the French language.

- On the contrary, the French and German re-definitions of the template matching `title` elements in `inproc` mode (cf. Figure 11) belong both to the ‘plain’ bibliography style so they should be put into the files `plain-french.nbst` and `plain-german.nbst`.

Conclusion

We think that when a new tool or a new programming language is developed, its conceptor(s) should provide methodology and advice about it. Often teachers of programming languages notice that students may program badly in a good language. Let us go back to `BIBTEX`, we personally missed — in the past, a long time before we decided to develop `MIBIBTEX` — a didactic introduction to the `bst` language like [28]. Likewise, an overview for writers of `LATEX` extensions such as [24, Appendix A] was missing for a long time.

In this article, we have not shown all the features of `MIBIBTEX`. For example, we have not gone thoroughly into multilingual features — in order to show that our approach was mostly suitable for designing styles using `XSLT`, too — and ‘new plain’ style was implicitly supposed to be language-dependent [13], that is, each reference is expressed using the

language’s entry. In fact, our goal was to show that `nbst` allowed us to write bibliography styles in elegant manner, provided that we are given a precise specification of what to put. So we are able to build a solid basis for a style, and people could easily enrich it with new language-dependent templates by using `MIBIBTEX`’s implicit importation.

Now we are rewriting predefined bibliography styles of `BIBTEX`. Most of them have already been redesigned, but this work is not finished yet at the time we finish writing this article. We hope that these explanations would help people enrich these new styles, especially in order to adapt them to other languages.

Acknowledgements

Thanks to Volker R. W. Schaa, who proof-read the German translation of the abstract.

A bst vs nbst

A precise comparison between `bst` and `nbst` is difficult, since these two languages belong to very different programming paradigms. The former is based on handling a stack (see [28] for a didactic introduction to this aspect), the latter encourages rule-based programming. They do not belong to the same time, either: the former has been influenced by assembly

bst expression	“Equivalent” expression in nbst	Kind ^a
$\mathcal{I}_1 \mathcal{I}_2 >$	$\mathcal{I}_1^{\natural} \ \> \ \mathcal{I}_2^{\natural}$	<i>P</i>
$\mathcal{I}_1 \mathcal{I}_2 <$	$\mathcal{I}_1^{\natural} \ \< \ \mathcal{I}_2^{\natural}$	<i>P</i>
$\mathcal{I}_1 \mathcal{I}_2 =$	$\mathcal{I}_1^{\natural} = \mathcal{I}_2^{\natural}$	<i>P</i>
$\mathcal{S}_1 \mathcal{S}_2 =$	$\mathcal{S}_1^{\natural} = \mathcal{S}_2^{\natural}$	<i>P</i>
$\mathcal{I}_1 \mathcal{I}_2 +$	$\mathcal{I}_1^{\natural} + \mathcal{I}_2^{\natural}$	<i>P</i>
$\mathcal{I}_1 \mathcal{I}_2 -$	$\mathcal{I}_1^{\natural} - \mathcal{I}_2^{\natural}$	<i>P</i>
$\mathcal{S}_1 \mathcal{S}_2 *$	<code>concat($\mathcal{S}_1^{\natural}, \mathcal{S}_2^{\natural}$)</code>	<i>P</i>
\mathcal{S} add.period\$	<code><nbst:call-template name="adjoin-sign"> <nbst:with-param name="the-string" select="S[⋈]" /> <nbst:with-param name="ending" select="'. '"/> </nbst:call-template></code>	<i>E^b</i>
\mathcal{S} "t" change.case\$	<code>concat(substring($\mathcal{S}^{\natural}, 1, 1$), lowercase(substring($\mathcal{S}^{\natural}, 2$)))</code>	<i>P^c</i>
\mathcal{S} "l" change.case\$	<code>lowercase(\mathcal{S}^{\natural})</code>	<i>P</i>
\mathcal{S} "u" change.case\$	<code>uppercase(\mathcal{S}^{\natural})</code>	<i>P</i>
\mathcal{S} chr.to.int\$	<code>(char->integer \mathcal{S}^{\natural})</code>	<i>S</i>
cite\$	<code>@id</code>	<i>P</i>
\mathcal{L} empty\$	<code>not(string(\mathcal{L}^{\natural}))</code>	<i>P</i>
$\mathcal{I} \mathcal{F}_1 \mathcal{F}_2$ if\$	<code><nbst:choose> <nbst:when test="I[⋈] &gt; 0">F₁[⋈]</nbst:when> <nbst:otherwise>F₂[⋈]</nbst:otherwise> </nbst:choose></code>	<i>E</i>
\mathcal{I} int.to.chr\$	<code>(integer->char \mathcal{I}^{\natural})</code>	<i>S</i>
\mathcal{I} int.to.str\$	<code>string(\mathcal{I}^{\natural})</code>	<i>P</i>
\mathcal{L} missing\$	<code>not(\mathcal{L}^{\natural})</code>	<i>P</i>
newline\$	<code><nbst:text>&eol;</nbst:text> or <nbst:value-of select="'\&eol;'/></code>	<i>E</i>
\mathcal{S} num.names\$	<code>count(name) if name(\mathcal{S}^{\natural}) ∈ {author, editor}</code>	<i>P</i>
preamble\$	<code>@preamble</code>	<i>P</i>
\mathcal{S} purify\$	<code>call(bst-purify, \mathcal{S}^{\natural})</code>	<i>P^d</i>
quote\$	<code><nbst:text>&quot;</nbst:text> or <nbst:value-of select="'\&quot;'/></code>	<i>E</i>
$\mathcal{S} \mathcal{I}_1 \mathcal{I}_2$ substring\$	<code>substring($\mathcal{S}^{\natural}, \mathcal{I}_1^{\natural}, \mathcal{I}_2^{\natural}$) if $\mathcal{I}_1 > 0$ <code>substring($\mathcal{S}^{\natural}, \text{string-length}(\mathcal{S}^{\natural}) + \mathcal{I}_1^{\natural} - \mathcal{I}_2^{\natural} + 2, \mathcal{I}_2^{\natural}$) if $\mathcal{I}_1 < 0$</code></code>	<i>P^c</i>
\mathcal{S} text.length\$	<code>string-length(\mathcal{S}^{\natural})</code>	<i>P</i>
$\mathcal{S} \mathcal{I}$ text.prefix\$	<code>substring($\mathcal{S}^{\natural}, 1, \mathcal{I}^{\natural}$)</code>	<i>P^c</i>
type\$	<code>name()</code>	<i>P</i>
\mathcal{S} warning\$	<code><nbst:warning>\mathcal{S}^{\natural}</nbst:warning></code>	<i>E</i>
\mathcal{S} width\$	<code>(tex-width \mathcal{S}^{\natural})</code>	<i>S^e</i>
\mathcal{S} write\$	<code><nbst:value-of select="S[⋈]" /></code>	<i>E</i>

^aQualifies the given expression in nbst: ‘E’ is for ‘element’, ‘P’ for ‘path expression’, ‘S’ for ‘Scheme expression’.

^bThe `adjoin-sign` is included in MIB_BT_EX’s initial library.

^cLet us recall that indexing strings is one-based in XPath and nbst, whereas it is zero-based in Scheme.

^dThis Scheme function is given in Figure 13. Useless in practice (see Figure 8)!

^eNot implemented yet (always returns "0").

Table 2: Translation of most bst statements given in [24, Table 13.8]

languages, the latter has taken advantage of a modern language, suitable for handling documents and designed for a large purpose.

Some statements of `bst` are not really translatable into `nbst`: for example, the assignment (`:=`), because `nbst` is like a purely functional language, in the sense that a variable — or a parameter — cannot be changed, once it has been given a value. On

the other hand, `nbst` allows recursive templates, like in XSLT, what is useful for iterative programming (cf. Figure 5) and replaces the `while$` function of `bst`.

The `call.type$` function of `bst` does not have a direct equivalent, either: such an operation is performed by pattern-matching by means of the `match` attribute of suitable `nbst:template` elements. The

```
(define (bst-purify string-0)
  (let thru ((index (- (string-length string-0) 1))
            ;; Current index, we are going backward. The second argument allows us to accumulate retained
            ;; characters in a list, we begin with an empty list:
            (accumulator '()))
    (if (negative? index)
        ;; The string has been processed, we convert the list of accumulated characters into a string:
        (list->string accumulator)
        (thru (- index 1) (let ((current-char (string-ref string-0 index)))
                          ;; Discarding it if it is not alphanumeric:
                          (if (or (char-alphabetic? current-char) (char-numeric? current-char))
                              (cons current-char accumulator)
                              accumulator))))))
```

Figure 13: Scheme function implementing the `bst-purify` function.

`format.name` function is replaced by handling path expressions like in XPath for subtrees for authors and editors.

Table 2 is an attempt to express the relationship between `bst` statements and corresponding realisations in `nbst`. In fact, it emphasises which statements are easily translatable, which are not. This table does not include `bst` functions such as `:=`, `while`, `call.type`, `skip`. Likewise, we did not put `bst` functions directly related to `BIBTEX`'s stack management: `duplicate`, `stack`, `swap`, `top`.

For the other `bst` functions, we make precise its operands: \mathcal{I} is for an integer, \mathcal{S} for a string, \mathcal{L} for any value, \mathcal{F} for a function. When several operands are the same type, we use indices. We use the `'..b'` notation to mean 'the translation of an operand in `nbst`': for example, the `if` function of `bst` pops three values from the stack, the translation of the first should be used inside the value of a `test` attribute, the others should be translated into `nbst` elements put as contents of an `nbst:if` element.

As it can be seen in Table 2, the direct translation of some statements needs to call functions directly written in Scheme: we put them for sake of completeness, but in practice, most of these functions are useless when a style is wholly rewritten using `nbst` (cf. § B). Last, let us remark that in the path expressions given in this table—`@id` and `@preamble`—the current node is supposed to be the node for an entry (`inproceedings`, `book`, ...)

B Interface with Scheme

Path expressions used within `nbst` include calls to external functions written in Scheme and returning strings. The syntax is:

```
call(function-name, arg1, ..., argn)
```

where *function-name* is the function's name, applied to `arg1`, ..., `argn` ($n \in \mathbb{N}$). Now we got some experience in writing bibliography styles, and as far as we know, there are three reasons for using such functions within bibliography style files:

- functions related to `TEX`'s features: for example, returning the width of a string, expressed in `TEX`'s units (cf. Table 2), as another example, searching `LATEX` source files: for instance, we have to do that in order to know the document's language¹⁹;
- operations that would be tedious with the functions of XPath's library: an example appearing in Table 2 is the `bst-purify` function;
- functions used to sort entries: e.g., the function `month-position`, that allows the sort of month names according to the chronological order, used in the template given in Figure 8.

In Figure 13, we give the exact equivalent for the `purify` function of `bst`, in order to give some idea about how to deal with strings in Scheme. Let us remark that this operation—used in `BIBTEX` to build strings to be sorted lexicographically—is useless practically since it is better to use successive `nbst:sort` elements as we show in Figure 12.

In addition to the `bst-purify` function, we give a second example written in Scheme in Figure 14: the `month-position` function, used to sort month names, as shown in Figure 12. As abovementioned, this way may be thought as *ad hoc* method, nevertheless, let us remark that such a sort is not provided by 'old' `BIBTEX`.

¹⁹See [16] for more details about this problem. `MIBIBTEX` also searches auxiliary (`.aux`) files produced by `LATEX`, but not whilst a bibliography style is applied.

```

(define month-position
  (let ((month-name-list
        '("jan" "feb" "mar" "apr" "may" "jun" "jul" "aug" "sep" "oct" "nov" "dec")))
    (lambda (string-0)
      (let thru ((month-name-list-0 month-name-list)
                 (current-position 0))
        (if (or (null? month-name-list-0)
                ;; This way, elements with a non-recognised or empty month name will be put after those with
                ;; an actual month name after the sorting operation.
                (string=? (car month-name-list-0) string-0))
            (number->string current-position) ; Final result as a string.
            (thru (cdr month-name-list-0) (+ current-position 1)))))))

```

Figure 14: Scheme function used to sort month names by sorting corresponding positions.

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The T_EX Wrapper Structure: a basic T_EX document model implemented in iT_EXMac

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February 25, 2005

1 Introduction

This presentation primarily concerns the high level user interface of the T_EX typesetting system. In general, people find it difficult to work with T_EX due to the powerful syntax, numerous auxiliary files created or managed, and the user interface that has very little in common with standard word processors. Moreover, sharing T_EX documents with colleagues is often delicate as soon as some non standard L^AT_EX is involved or, more frequently, there are some significant differences in the computer configurations. The purpose of this article is to lay the foundation for the T_EX Wrapper Structure, which aims to help the user solve this kind of problems.

We first explain what could be the desiderata for a T_EX document object model, then we give a precise description of the T_EX Wrapper Structure, discussing the various solutions and the final choice. Finally, the concrete implementation used by iT_EXMac¹ demonstrates an example of user interface.

An appendix briefly presents the latest developments concerning PDF synchronization which is a MacOS X specific feature of great interest for the whole T_EX community.

2 A T_EX Document Model

2.1 *De facto* document model

A document model aims to describe the storage and use of a certain kind of data: a simple document model might be a linear text, which is an ordered list of 8 bit numbers following the ASCII rules and stored in one flat file. More complex document structures are used either to describe data contents, for example Adobe's Portable Document Format, or to store them, for example old MacOS operating sytemes use a hierarchical file system with resource forks to allow file to store structured data. Regarding these two points among others, T_EX is very specific mainly because it does not pose *a priori* any document model, letting the end user use its own *de facto* model. The question is to identify what core structure should have a T_EX document model, that should be shared by quite all documents including the ones already existing.

Actually, a *self contained T_EX document* is a series of files gathering data as various as images, linear text, formatted text, macro packages (L^AT_EX style), code libraries (libjpeg...), engines (T_EX, MetaPost) and their calling options. Of course this makes really huge documents, such that common parts are naturally eliminated, hoping that they will be available everywhere and every time one will ever need them. This results in some kind of *weak T_EX document model* which has proved to be efficient, except in some rare situations where the syntax was broken by some package update, and less rare ones where engine options have been forgotten... Far-sighted T_EX users carefully keep the various log files coming from typesetting because of the versioning information they contain. It is extremely helpful when fixing update problems, but still relies on non negligible human expertise where one could reasonably expect full computer assistance. When a strategy is available to record version information, it will be added to the T_EX Wrapper Structure.

Generally speaking, a T_EX document is composed of different kind of graphical objects, from linear text to pictures, possibly splitted into different files. There is no real problem concerning the various graphical data

¹iT_EXMac, one of the open source T_EX front-ends on MacOS X, was presented during EuroT_EX 2003 and TUG2004. Further information at <http://itexmac.sourceforge.net>

formats but the same does not hold for T_EX source files. Any T_EX user knows that a source document is not correct as long as it has not successfully passed T_EX digestive process. More experienced users are perfectly aware of the problems that can appear when using certain combinations of macro packages. All this makes the data part of a T_EX Document Model very difficult to define *a priori* in a complete and explicit description. This design, being as open as possible, is a real advantage because it provides quite unlimited document types. But at the same time, it does not take into account the document preparation stage and does not provide any help to the user in his real life struggle for document elaboration.

2.2 The meta information

For that purpose, advanced T_EX dedicated editors have designed their proper strategy to assist the user with extraneous information not really necessary but missing when absent: the meta information. For example syntax attributes highlighting (marking T_EX tokens, comments and other stuff with special colors) is a clever use of the information actually available as is in a source file. This can be improved by some syntax checking, that could mark bad commands just like the spell checker marks the misspelled words. For this to work efficiently in a real time context, we must collect the macros defined in the context and cache the whole dictionary list to improve access. Similarly, parsing the document contents for sectioning commands provides the user with a map that improves the overall sight and the navigation inside the document. All this is more or less filtering or interpreting the existing information to make it more accessible. Moreover, editors are free to add their own information if they think it is relevant. We can see that in fact, real T_EX users may need more information that actually available in a T_EX document, and T_EX does not care about this kind of meta information. The T_EX Wrapper Structure will mainly consider this point.

2.3 The document storage

As we must preserve actual T_EX documents in a backward compatibility issue, we are only concerned with the document storage, more precisely the location where the different files are stored. Some of them must be located in definite folders, according to the T_EX environment (in general following the T_EX Directory Structure rules), while the user is absolutely free to name others. For them, some weak naming rules could help in their organization, without limiting their use. For example, people generally gather their graphic files in folders named images, graphics, pictures or whatsoever but there is not yet a widely spread strategy to become part of a T_EX document model. Moreover, we must admit the use of different naming strategies to best fit the numerous situations one can imagine, for example, a unique image directory is certainly not advisable when the document is expected to contain thousands of logically organized images. Finally, the only naming rules we can safely state concerns the meta information and will be addressed by the T_EX Wrapper Structure.

3 The T_EX Wrapper Structure

We define the core T_EX Wrapper Structure gathering information useful to any editor or utility, then we detail the T_EX project concept and we briefly describe the concrete implementation developed in iT_EXMac. This is a weak T_EX document model given through a series of compliance rules, only assuming an underlying hierarchical file system. We also assume that all the document files but the standard macro packages are collected in one enclosing directory, but *a priori* different documents can share the same directory.

3.1 The core T_EX Wrapper Structure

The only purpose of the core structure is to separate the document data, which is necessary, from the meta information, which is supplemental. Actually, the meta information is stored either in the very T_EX source file (for example the %& first line trick to code for the format, the first commented line for T_EXEXEC, emacs local variables to code for the string encoding, AUC T_EX local variables in the file trailer), or an external file (the .aux L^AT_EX file, the Auto/ directory where AUC T_EX caches its style attributes, the T_EXniCenter projects) and each tool defines its own strategy without really taking care of one another. It is not yet the point to define a unique and complete set of meta information, but we are concerned with the storage location of the meta information. For practical reasons, it appears that some information such like the string encoding and the language should live near the document they are referring to, but other information including the list of project files and the root document identifier should live in a shared data base. If we consider all the tools of the T_EX typesetting

system, the simplest solution from the user point of view, is to collect the whole meta information into one central dedicated location. That way, no more meaningful comment will pollute the T_EX source thus preserving the meta information from hazardous manipulations and preventing an innocuous T_EX comment to become suddenly active while a utility has silently put some implicit information in it.

Finally, I strongly recommend not to use T_EX comments anymore for anything else than commenting, except when conforming to a publicly available and widely accepted syntax rule.

3.2 The T_EX project paradigm

With emacs' AUCT_EX mode and T_EXniCenter we already mentioned, the old DirectT_EX pro is another example of editor that stores meta information in an external file. We propose to collect this information in one dedicated directory. So, a T_EX project is just a directory named *document.texp* ("**texp**" stands for T_EX Project) where shared or private meta information should be stored. The possible interference with already existing T_EX documents is quite void because the **texp** extension is not yet used, this ensures a full backward compatibility.

To define the mapping linking projects to files, the T_EX project is expected to maintain a list, either explicit or implicit, of all the files it is meant to manage. But conversely, it is not strictly necessary for the T_EX source files to know the project they belong to (as for AUCT_EX) because this information can be retrieved easily if we impose that T_EX projects only manage files at the same level of below themselves in the file system hierarchy. Then, given a file path, we just have to scan the file hierarchy up to the root for T_EX projects and only keep the appropriate ones.

The contents of the T_EX project directory *document.texp* is described in the sequel. The user is not expected to view nor edit this data, so the format primarily concerns the programmers. More precisely, it is a balance between a flat XML file and an atomic directory structure, both suitable for information hierarchically organized. The "/" character is used as path separator.

Key	Class	Contents
isa	String	Required with value: info
version	Number	Not yet used but reserved
files	Dictionary	The paths of the files involved in the project wrapped in a files dictionary described in table 2. It is an indirection table suitable for file name management. Optional.
properties	Dictionary	Attributes of the above files wrapped in a properties dictionary described in table 3, this is where string encoding and spelling key are recorded. Optional.
main	String	The <i>fileKey</i> of the main file, if relevant, where <i>fileKey</i> is one of the keys of the files dictionary. The main file is the one to be typeset or processed. Optional.

Table 1: **info** dictionary description where the T_EX project maintains the list of known files, their properties and the main file identifier.

- *document.texp/Info.plist* is an XML property list for a general purpose meta information wrapped in an **info** dictionary described in table 1 and subsequent tables. This is optional.

We make use of the XML property list data format storage as publicly available at

<http://www.apple.com/DTDs/PropertyList-1.0.dtd>

It is indeed MacOS X centric but two PERL modules are available on CPAN to parse such XML files: *Mac-PropertyList*² and *Mac-PropertyListFilter*³. Moreover, this can be changed in forthcoming versions without causing any harm from the user point of view.

²<http://search.cpan.org/~bdfey/Mac-PropertyList-0.9/>

³<http://search.cpan.org/~jgoff/Mac-PropertyListFilter-0.02/>

Key	Class	Contents
<i>fileKey</i>	String	The path of the file identified by the string <i>fileKey</i> , relative to the directory containing the T _E X project. Each file key is unique. While the file name is subject to changes, the file key will never change: the latter is a strongly reliable file identifier. In general, no two different keys should correspond to the same path.

Table 2: **files** dictionary description: an indirection table particularly suitable for file name management.

Key	Class	Contents
<i>fileKey</i>	Dictionary	Language, encoding, spelling information and other attributes wrapped in an attributes dictionary described in table 4. <i>fileKey</i> is one of the keys of the files dictionary.

Table 3: **properties** dictionary description: to each key identifying a file is associated a dictionary of attributes.

Key	Class	Contents
isa	String	Required with value: attributes
version	Number	Not yet used but reserved
language	String	According to latest ISO 639. Optional.
codeset	String	According to ISO 3166 and the IANA Assigned Character Set Names. If absent the standard C++ locale library module is used to retrieve the codeset from the language . Optional.
eol	String	When non void and consistent, the string used as end of line marker. Optional.
spelling	String	One of the <i>spellingKeys</i> meaning that the property list at <i>document.tex/spellingKeys.spelling</i> contains the list of known words of the present file wrapped in a spelling dictionary described in table 5. Optional.

Table 4: **attributes** dictionary description

Key	Class	Contents
isa	String	Required with value: spelling
version	Number	Not yet used but reserved
words	Array	The array of known words

Table 5: **spelling** dictionary description for the list of known words.

- *document.tex/frontends* A directory dedicated to front-ends where they store private meta information.
- *document.tex/frontends/name* A private file or directory dedicated to the front-end identified by *name*. The further contents definition is left under the front-end responsibility. The directory at

document.tex/frontends/iTeXMac

is reserved for iT_EXMac private use, maybe AUCT_EX can move its `Auto/` directory into

`document.texp/frontends/AucTeX`

and T_EXniCenter can use

`document.texp/frontends/TeXniCenter.`

This cooperative design is based on a strong separation of private meta informations from each other front-end, it prevents corruption and allows better recovery in case of error. Moreover, synchronization problems that may appear when two different utilities access the same flat file do not occur.

- `document.texp/users` is a directory dedicated to users and should not contain any front-end specific data. This is optional and reserved for further user.
- `document.texp/users/name` is a directory dedicated to the user identified by *name* (not its login name). Not yet defined, but private and preferably crypted.
- `document.texp/spellingKey.spelling` is an XML property list for lists of known words wrapped in a **spelling** dictionary defined in table 5 and uniquely identified by *spellingKey*. This format is stronger than a simple comma separated list of words. This is optional.

We assume that a text document is multilingual and can have different spelling contexts, all of them being defined by a language with a dictionary and a list of known words. At this time, MacOS X programming interface does not allow to have more than one spelling context per open file, and the same might hold for other operating systems. So, each file is expected to have only one spelling context defined by a language and a spelling key, both defined in the **properties** dictionary (see the description in table 3). Then, a multilingual document will be splitted into files according to the language and the list of known words.

Notice that there is no pre definite correlation between a language and a list of known words. And this design is certainly not the best we can elaborate, but it appears to be sufficiently efficient.

3.3 The T_EX Wrapper Structure implemented in iT_EXMac

The graphical user interface developed in iT_EXMac takes benefit of the T_EX Wrapper Structure. Private informations are cached to improve the user experience: window size and positions recording are the classical examples. Also, meta information about the engine and options used to typeset the document are stored, they are used to launch the appropriate utility with appropriate arguments assuming a teT_EX like distribution is available. This should be shared once the latest T_EX live is well established.

Technically, iT_EXMac uses a set of private, built-in shell scripts to typeset documents. If this is not suitable, customized ones are used instead, possibly on a per document basis, but no warning is given then. No security problem has been reported yet, most certainly because such documents are not shared.

Notice that iT_EXMac declares both `texp` and `texd` as document wrapper extensions to MacOS X, which means that `document.texp` and `document.texd` folders are seen by other applications just like other single file documents, their contents being hidden at first glance. Using another file extension for the T_EX document will prevent this MacOS X feature without losing the benefit of the T_EX Wrapper Structure and its T_EX project.

4 Appendix: The pdfsync Feature

During the document preparation using the T_EX typesetting system, the correspondence between the output and the original description code in the input is of frequent use, unfortunately it is not straightforward. Some commercial T_EX frontends (Visual T_EX⁴ and T_EXtures⁵) introduced a workaround. Then L^AT_EX users could access the same features with a less-efficient implementation through the use of `srcltx.sty`, which added source specials in the DVI file. The command line option `-src-specials` now delegates that task to the T_EX typesetting engine.

iT_EXMac fully supports this synchronization allowing to jump from the DVI file to the `.tex` source and back. Moreover, Piero d'Ancona and the author have extended this feature from the `.tex` to the `.pdf` output.

⁴<http://www.micropress-inc.com/>

⁵<http://www.bluesky.com/>

While typesetting a *document.tex* file with L^AT_EX for example, the `pdfsync` package writes extra geometry information in an auxiliary file named *document.pdfsync*, subsequently used by the front ends to link line numbers in source documents with locations in pages of output PDF documents. i_TE_XMac, T_EXShop⁶ and T_EXniscope⁷ both support `pdfsync`.

The official `pdfsync` web site where file specifications and more complete explanations will be found at:

<http://iTeXMac.sourceforge.net/pdfsync.html>

Unfortunately, the various `pdfsync` files for Plain, L^AT_EX or ConT_EXt are not completely safe. Some compatibility problems with existing macro packages may occur. Moreover, sometimes `pdfsync` actually influences the final layout; in a case like that, it should only be used in the document preparation stage.

Notice that the `pdfsync` approach is different from Heiko Oberdiek's `vpe.sty`.

⁶<http://www.uoregon.edu/~koch/texshop>

⁷<http://docenti.ing.unipi.it/~d9615/homepage/mac.html>

The `bigfoot` bundle for critical editions*

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February 27, 2005

Abstract

The L^AT_EX package `bigfoot` and supporting packages solve many of today’s problems occurring in the contexts of single and multiple blocks of footnotes, and more. The main application is with philological works and publications, but simpler problems can be solved painlessly as well without exercising all of the package’s complexities. For other problems not yet tackled in this area, a solid framework is provided.

1 Introduction

Footnotes in T_EX are a problematic area. One reason is that T_EX’s insertion mechanism is far too basic to cope with more complicated usage patterns. Insertions are not subjected to the usual optimization methods of T_EX, but instead are fitted on the page with a greedy algorithm at the time they are encountered. At that time, they may also be split or floated to the next page. A split does not take into account any mandatory following material on the vertical list: infinite values of `\widowpenalty` coupled with footnotes anchored in the next to last line will not be split at the correct point, and thus will have to get moved over to the next page.

Another deficiency is that when splitting a footnote, shrinkability is considered by T_EX while doing the split, fitting more material on the page. However, at the time of the page break decision, the information about the shrinkability used for the insertion split gets lost, and consequently the page can appear overfull.

Since T_EX does not even get the cases right for which it was designed, more complicated footnote schemes like those for critical editions have to be implemented mostly manually.

The `bigfoot` addresses a number of deficiencies and replaces the normal footnote mechanism.

2 Features

So what are the features that `bigfoot` provides?

- Multiple footnote apparatus¹ are possible.²
- Footnotes can be nested.³
- Footnotes are numbered in the order they appear on the page, and numbering may start from 1[†] on each page. In each apparatus, the footnotes are arranged in numerical order identical to page order. This does not sound exciting at all until you consider the implications of footnotes being nested: if the main text has some footnote⁴ and then the publisher comments the main text with a footnote,^a the logical order of footnotes (in which they appear in the source text) would have been to let footnote e appear before footnote a. The footnotes instead will be reordered to page order.⁵
- Footnotes may contain `\verbatim` commands⁶ and similar, and they will just work as expected. This is achieved in a manner similar to the `\footnote` command of plain T_EX.
- Footnotes can be broken across pages.⁷

¹ An apparatus is one block of contiguous footnotes forming a logical and physical unit. Separate apparatus^b can be independently broken to the next page.

² Actually, `manyfoot` already provides this functionality^c but it fails to address a number of intricacies inherent to this sort of setup, a few of which follow.

³ You can anchor footnotes for some apparatus in the main text^d.

[†] or whatever the first footnote symbol happened to be

⁴ such as shown in this example footnote^e

⁵ The style file `perpage` has been extended with additional functionality for reordering such numbers.

⁶ even stuff like `\verb-\iffalse-`

⁷ While this does not sound like something excitingly new, it must be noted that T_EX does not do a satisfactory job at splitting insertions, the underlying mechanism for split footnotes. In particular, T_EX only manages to find a split when no material whatsoever is added to the page after the occurrence of the split footnote. This might include another footnote in a different apparatus, or simply a line tied to the current line with an infinite penalty, for example because of a respective setting of `\widowpenalty`. In contrast, `bigfoot` breaks footnotes properly in such circumstances, and it uses a backtracking algorithm (with

^a This is a subsequent comment to the main text. ^b Yes, this is the correct plural form. ^c and is loaded by `bigfoot`

^d or any apparatus preceding it on the page

^e which happens to have a comment attached to it. Notice that `bigfoot` will prefer to leave this smaller footnote block intact, as breaking it will not help fitting the above footnote block on the page.

*and a lot of other footnote applications

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- When footnotes are broken across pages, the color stack is maintained properly. Color is handled in L^AT_EX with the help of specials that switch the color (and, in the case of dvips, restoring it afterwards with the help of a color stack). Restarting the footnote on the next page with the proper color is something that has never worked in L^AT_EX. Now it simply does.
- Footnotes may be set in a compact form in one running paragraph.⁸
- Split footnotes will not get jumbled in the presence of floats. **bigfoot** is not afflicted by this bug in L^AT_EX's output routine since it does not delegate the task of splitting footnotes to T_EX in the first place. While the faulty output routine of L^AT_EX may still jumble the order of footnotes in that par-

early pruning of branches that can't beat the current optimum) for finding the best split positions for several footnote apparatus in parallel. The fill level of the page is taken into account as well as the costs of the individual splits. A split footnote is penalized with a penalty of 10000 (which is pretty similar to what T_EX itself does when dealing with footnotes), so that in general T_EX will tend to avoid splitting more than a single footnote whenever possible. One complication is that if the parts broken to the next page contain footnotes themselves, those have to be moved to the next page completely and adapted to the numbering of footnotes there^a. This rather intricate and complicated mechanism leads to results that look simple and natural.

⁸ While **manyfoot** and **fnpara** also offer this arrangement, **bigfoot** offers a superior solution in several respects:

- The line breaking can be chosen much more flexibly: with appropriate customization, it is possible to fine-tune quite well when and where stuff will be placed in the same line, and when starting a new line will be preferred.
- In-paragraph footnotes can be broken across pages automatically, just like normal footnotes. They will only be broken after the last footnote in the block has started.
- Pages will not become over- or underfull because of mis-estimating of the size of in-paragraph footnotes. Also the total width of such footnotes is not restricted to `\maxdimen` (which sounds generous at something like 6 m or 19 ft, until you realize that a few pages of text suffice to burst that limit, and a few pages of text are reached easily with longer variants of the main text). While T_EX will accumulate boxes exceeding this size without problem, it panics at its own audacity if you actually ask about the total width of the acquired material. While one may still not have material exceeding a total *vertical* size of `\maxdimen` accumulate in one footnote block, one would usually need a few dozen pages for that, and so *this* limitation is much less noisome than the corresponding restriction on the horizontal size.
- The decision of whether to make a footnote in-paragraph or standalone can be changed for each footnote apparatus at any time, including on mid-page. In fact, you can make this decision for each footnote separately. Since display math requires vertical mode footnotes, this is convenient.
- **bigfoot** will make a good-faith effort to adapt the normal footnote layout provided by the document class with the `\@makefnmark` and `\@makefntext` macros to in-paragraph footnotes.

^a which can be completely different!

ticular case (when one footnote gets held over as an insertion ‘floated’ at infinite cost), **bigfoot** will sort the jumbled footnotes back into order before processing them.

- Each footnote apparatus can have its own private variant of `\@makefntext` and a few other macros and parameters responsible for formatting a footnote block. The default is to use what the class provides, but special versions can be defined, for example,

```
\FootnoteSpecific{variants}%
\long\def\@makefntext#1{...
```

for the footnote block called “variants”.

3 Drawbacks

What about current drawbacks?

- ε -T_EX is used throughout. After it became clear that the implementation of the package would not be possible without using some of ε -T_EX's features, its features were extensively employed: rewriting the package to get along without ε -T_EX would be very hard, even if you came up with ideas for those cases where I could find no other solution. Free T_EX distributions have come with ε -T_EX for a long time by now (in fact, ε -T_EX is now the recommended engine for L^AT_EX, and actually used as the default in the latest T_EX Live), but proprietary variants may lack ε -T_EX support. The same holds for quite a few Ω versions.
- The licence is not the LPPL, but the GPL. In my book, I consider this an advantage: the functionality of the package is quite important, and it is in its infancy yet. I would not like to encourage a market of proprietary offsprings directly competing with it. While with sufficient financial incentive I might feel confident enough to have the means to reimplement whatever noteworthy extension somebody else might come up with, at the current time I prefer this way of ensuring that the free development does not fall behind and that there is no incentive to turn to developers with no qualms about creating proprietary versions.
- **bigfoot** requires twice as many box registers⁹ as **manyfoot**: one set in the form of an insertion for each footnote apparatus, one set as mere boxes.
- It can't handle more footnotes in a single block per page than the group nesting limit of T_EX, and

⁹ Since ε -T_EX has an ample supply of box registers (32767 instead of 256), this is not really much of an additional limitation.

that is usually hardwired at 255.[†]

- Since it meddles considerably with the output routine’s workings, interoperation with other packages doing the same might be problematic. Considerable effort has been spent on minimizing possibly bad interactions, but the results might not always be satisfactory and, at the very least, might depend on the load order of packages.
- It slows things down. This is not much of a concern, and usually the package is astonishingly fast.
- The complexity of the package makes it more likely for things to go wrong in new ways.¹⁰

4 Additional new packages

The bundle provides some more packages: `perpage` is used for the sort of renumbering games mentioned before, and `suffix` is used for defining augmented commands.

As an example of use for those packages we had previously a few examples where numbers like 7[‡] and 255[§] were given footnotes, and in order not to confuse this with powers as the following 666¹¹ is in danger of, we have switched to per-page numbering of footnotes with symbols for that purpose. The source code simply uses

```
like~7\footnote'{a lucky number}
```

namely a variant footnote command. How is that achieved? Just with

```
\newcounter{footalt}
\def\thefootalt{\fnsymbol{footalt}}
\MakeSortedPerPage[2]{footalt}
\WithSuffix\def\footnotedefault' {%
  \refstepcounter{footalt}%
  \Footnote{\thefootalt}}
```

A new counter is created, its printed representation is set to footnote symbols, the counter is made to start from 2 on each page (since symbol 1[¶] is a bit ugly), and then a variant of `\footnotedefault` is defined which will step the given counter and use it as a footnote mark.¹²

If you find yourself running out of insertions, `etex` offers the `\reserveinserts` command.

[†] This limit seems sufficient at first glance, but one could use the various mechanisms available in connection with in-paragraph footnotes to make sure that a footnote will be broken across the page at a point closely related to the main text’s breakpoint (for example, if you are doing an interlinear translation in a footnote). In that case, this limit might become problematic.

¹⁰ Most of those problems should arise under requirements that could not possibly be met without the package, so this would be reason for improving rather than not using the package.

[‡] a lucky number [§] well, almost as lucky

¹¹ strange, yes? [¶] which is *

¹² `manyfoot` defines a two-argument command `\Footnote` that

That’s all. One can define several suffixes, the resulting commands are robust¹³, and one can use arguments and other stuff. For example,

```
\WithSuffix\long\def\footnotedefault
  [#1]{#2}{...}
```

would augment the macro `\footnotedefault` by a variant accepting an optional argument.

5 Some internals

5.1 Basic operation

The package uses most of the interfaces of `manyfoot` for its operation. While it uses TeX’s insertions for managing the page content, the material collected in those insertions is in a pretty raw state and its size is always overestimated.¹⁴ The actual material that goes onto the finished page is generated from the insertions at `\output` time.

Material that is put into insertions is prewrapped into boxes without intervening glue.¹⁵ The box dimensions are also somewhat special: while the total height (height+depth) corresponds to the actual size of the footnote, the depth contains a unique id that identifies the last footnote in each box (of which there usually is just one, unless we are dealing with the remnants of an in-paragraph footnote apparatus broken across pages). The width is set to a sort key that is used for rearranging the various footnotes into an order corresponding to their order of appearance on the page.

The boxes are sorted by unboxing them and then calling the comparatively simple sorting routine (a straight insertion sort):

```
\def\FN@sortlist{%
  \setbox\z@\lastbox
  \ifvoid\z@ \else
    \FN@sortlist \FN@sortlistii
  \fi}

\def\FN@sortlistii{%
  \setbox\zw@\lastbox
  \ifvoid\zw@\else
    \ifdim\wd\zw@<\wd\z@
      {\FN@sortlistii}%
    \fi
    \nointerlineskip \box\zw@
  \fi
  \nointerlineskip \box\z@}
```

takes a footnote mark and corresponding footnote text.

¹³ as long as their suffixes are so as well

¹⁴ `bigfoot` simply sets each footnote, even those that should be typeset with others in one block, separately in its own paragraph for estimating its size, which should be a safe upper limit for the size a footnote can take when set in a paragraph with others.

¹⁵ That way, there is never a legal breakpoint in an insertion.

and then all consecutive runs of hboxes are joined into vboxes. The desirability of breaking between two in-paragraph footnotes depends on their respective size, on whether this would save lines when typesetting, on whether a footnote apparatus can be shrunk by more than a certain factor in this manner, and whether the ratio of allowable joints between footnotes¹⁶ to the number of footnotes exceeds a certain ratio.¹⁷ The criteria are configurable per apparatus or globally.

There are some footnotes where a vertical arrangement is mandatory,¹⁸ and the footnote must not be set into a hbox to start with. This is the case, for example, for footnotes containing display math. Placing a + sign before the opening brace of the footnote text will achieve that, and similarly a - sign can be used for switching in an otherwise vertically arranged footnote apparatus to horizontal arrangement.

`bigfoot` hooks into the output routine and does its accounting work before the main output routine gets a chance to get called. This work involves sorting the various contributions to a single insertion, joining together all in-paragraph footnotes into a single paragraph, measuring the resulting boxes, and gathering more material from the page in case that this produces an underfull box. Since the insertions `bigfoot` uses are unsplittable, this will often lead to an overfull box. In that case, the various footnote blocks get split to an optimum size before the real output routine gets called, and if this results in an underfull box again, more material gets called in again.

5.2 Dissecting `\@makefn`

The footnote layout of document classes is given by `\@makefn`. This macro receives one argument, the body of the footnote. We'll now discuss several problems we want to tackle in the context of using `\@makefn` for implementing the layout prescribed by the class file.

5.2.1 Robust footnotes

One problem with L^AT_EX's footnotes is that they scan their arguments prematurely. We want them to behave more like those of plain T_EX, to forestall complaints when `\verb` and its catcode mongering cousins fail to work in footnotes. The trick is to have the

¹⁶ where both footnotes around the breakpoint are considered potentially horizontal material

¹⁷ A footnote apparatus in which there are just few horizontally arranged footnotes would appear inconsistent.

¹⁸ like footnotes containing

- list environments
- display math like

$$\sum_{n=1}^{\infty} \frac{(-1)^n}{n} = \log \frac{1}{2}$$

macro argument of the `\footnote` macro not really be a macro argument, but the content of an `\hbox` or `\vbox` command, and have subsequent code do its work with `\aftergroup`, once the command finishes.

This means that we have to cut `\@makefn` into parts before and after its argument. It turns out that cutting the part before it starts processing its argument is rather easy:

```
\@makefn \iffalse \fi
```

will do that. It executes and expands `\@makefn` until it comes to the point where it would process its argument, which happens to be `\iffalse`, and then kills the rest of `\@makefn`. At least as long as the argument #1 does not happen to be in itself inside of a conditional, in which case bad things will happen. Very bad things. But a pretty thorough sampling of `\@makefn` variants on T_EX Live did not turn up such code.

Much more problematic is getting hold of the second part of `\@makefn`. It turns out that about 95% of the variations out there in different class files will work with

```
\expandafter \iffalse \@makefn \fi
```

which looks rather similar to the above. Unfortunately, it is not quite equivalent, since in the upper code, `\@makefn` is cut into two once it has been expanded up to its macro parameter, whereas in the lower version it is cut into two before any parts of it get expanded. If any of the closing braces that follow #1 in the definition of `\@makefn` happen to belong to the argument of a macro starting before #1, they will cause spurious closing groups.

Getting the closing part at the end of the footnote without any remaining macro braces is more tricky, inefficient and error prone. One possibility is starting another instance of `\@makefn` inside of a box to be discarded later. Then as its macro argument you use code that will repeatedly be closing opened groups until the outer group level is reached again and the box can be discarded. ε -T_EX's grouping status macros (`\currentgrouplevel` and `\currentgroup`) make it possible to know how to close the current group and whether it is the last involved one. After everything that has been opened has been discarded again, the remaining tokens in the input stream should form a perfect complement to the tokens that the initial `\iffalse` trick has discarded at the start of the footnote.

One other mechanism probably worth playing with is the use of alignment templates, since they provide a natural way of having T_EX switch input contexts across groups. The best approach in that regard would seem to parse the content of the footnote within a `\noalign` group of a `\valign`, but that still suffers from the problem that no automatic discretionary hyphens are generated for explicit hyphens.

But since most of the the `\@makefntext` variants out in the field are covered with the simple variant (basically, this is the case for all definitions that do not use #1 within a macro argument itself), `bigfoot` for now has not added any of the more complicated versions. The group discarding trick might perhaps be made available with a separate package option at a later time, if there is sufficient demand for it.

But it may be easier in most cases simply to rewrite the culprits: after all, `\@makefntext` is rarely complicated. Most notably, the `\@makefntext` of the `ltugboat` class is so ridiculously contorted that the automated analysis of it fails. (It has been replaced with an equivalent for this article.)

5.2.2 `\@makefntext` in ‘para’ footnotes

is really a bit out of place: the ‘para’ footnote style sets all footnotes within one continuous running paragraph, a manner of operation quite different from the original intent of `\@makefntext`. Single footnotes are first collected in horizontal mode, and at `\output` time the relevant footnotes making it to the current page are pasted together. This has several problems: for one, `\@makefntext` will set paragraph breaking parameters. We need these at the time that we assemble the footnotes into one paragraph. But `\@makefntext` also generates the footnote mark, so we need to call it for each footnote.

So even when we set `\@thefnmark`¹⁹ equal to an empty string at footnote assembly time, the assembled footnote mark will likely take up some additional space. This is not the end of our worries: while the formatting will be right for standard footnotes, it does not cater for ‘para’ footnotes. If we want to have a reasonably looking turnout, here are the conditions we have to meet:

1. At the beginning of the footnote block, or if a footnote starts right after a line break, the specified formatting should be used.
2. Within the line, we shall keep the spacing between footnote mark and footnote text correct. However, most styles right-justify the footnote mark within a box of fixed size. If we keep this sort of formatting, we will end up with a large space before short footnote marks, and a small one before longer marks. Since the amount of whitespace inside of a line should not be so large as to cause unsightly white holes, nor so small to make the footnote mark confused to be a part of the preceding footnote, we want a fixed spacing before the footnote mark.

The solution to these problems is to do a few measurements: we measure the width that an empty footnote

¹⁹ the mark as displayed in the footnote

mark would cause in the footnote box (and start our assembled footnotes with a negative space compensating that), and we typeset the footnote mark once on its own with `\@makefntext`, fishing with `\unskip` and `\lastbox` for the footnote mark box and resetting it to its natural size (which will kill the particular justification prevalent in the majority of class files doing justification). The difference in box size gets recorded separately until the time that the footnote gets set, and then the interfootnote glue is calculated accordingly.²⁰

5.2.3 Maintaining the color stack

is not nice.²¹

What is the color stack, anyway? L^AT_EX’s `color` package provides color selection commands that will change the current text color until the end of the group, where it will be restored.

The involved macros are

`\color@begin@group` is called at the start of each ‘movable’ box: material that does not necessarily appear right away. Without color support loaded, this does nothing. With color support loaded, it is usually equal to `\begingroup`.

`\color@end@group` is the corresponding macro at the end of ‘movable’ boxen. Any color restoration initiated with `\aftergroup` in the box will happen right here, still within the scope of the box, instead of outside where it would not move with the box.

`\set@color` will be called for setting the current color. It will also use `\aftergroup` in order to insert a call to `\reset@color` when the group ends.

`\reset@color` will restore the current color to what it was before the current group.

How will the color be restored? We have two different models:

dvips restores colors by making use of a color stack: `dvips` can ‘push’ a new color onto the stack, and pop the previous color back. Consequently, `\reset@color` inserts a special that tells `dvips` to pop the stack once.

pdftex instead restores colors by reinstating the color stored in `\current@color` after closing the group.²²

It is clear that the `pdftex` model is insufficient to even keep the color of the main text across page breaks,

²⁰ A few classes work with `\parshape` or `\hangindent`, either directly or with a `list` environment, and this is also taken into consideration as far as possible.

²¹ The main philosophy for work on the color stack has been summarized well by David Carlisle: “It’s not my fault.”

²² Of course this means that if we are at the end of a movable

since on the next page there is no special after the page break that could switch back to the text color after the page footer²³ from the last page and headers from the current page have been placed with a default color.²⁴

But in the context of footnotes, the problem is severely exacerbated: a footnote can be broken right in the middle of a sequence of color changes. The technically sound solution would be to switch to a different color stack for each footnote block. Since `dvips` does not offer multiple color stacks (and `pdftex` does not even offer a single one), we have to revert to trickery.

At each color change, the complete state of the color stack gets recorded in a mark. When the footnote is broken, we use the information in the mark in order to unwind the color stack to the state on the page before the footnote was entered. When the footnote is continued on the next page, the unwound color stack is reinstated again. Whenever `\color@begin@group` is called, the whole recording and restoration business is stopped (since a new context has been started), the record of the color stack essentially restored to empty, and only resumed when the corresponding group has ended.

In order to keep these proceedings fit for consumption by the general public, the reader is referred to the actual code for further details.

6 Outlook

At the time this article was written, quite a few tasks remained to be done. Further improvements in the footnote breaking decisions and their scoring metrics are needed. Flushing footnotes out in the middle of the page for short successive works would be nice. Amending footnotes with marginals (including line numbers) in a manner consistent with the main text would seem desirable. Additional footnote arrangements apart from the existing basic two styles should be easily implementable on top of the general scoring and breaking mechanisms.

7 Conclusion

It is hoped and expected that this bundle will become a basic building block for critical typesetting applications. While there are other packages available for that purpose, `bigfoot` (with its companions) offers the following important features:

- It is completely layout-neutral: while most solutions for critical typesetting are provided in the

box, the restored color will be that at the time the box was assembled, not at the time it was used.

²³ and footnotes

²⁴ Heiko Oberdiek's `pdfcolmk` package tries to deal with that particular problem.

form of document classes, `bigfoot` does not make layout decisions but instead just uses the layout provided by a base class.

- Footnote arrangement and balancing is vastly superior to and more flexible than any of the available solutions.
- Color works.
- The interfaces for creating new functionality focused around footnotes are reasonably simple.

At the time this article was written, not all interfaces have yet been cast into stone. However, `bigfoot` can be mostly used as an upwards-compatible drop-in replacement of `manyfoot`.

One can define a `plain` footnote style in the manner of `manyfoot`, and then the default footnotes will get replaced by this footnote style. In fact, if one does not redefine the `plain` style, `bigfoot` will do so itself. Thus just loading it without any further action on behalf of the user will cater for the most common problems in connection with footnotes.

At the current point of time, still problems remain to be tackled: the accounting of page space and page splits was modeled after T_EX's insertion mechanism and suffers from the same problem with regard to shrinkability, so in this paper, shrinkability has been removed from footnotes, a bad temporary hack. Page breaks currently are calculated by looping inside of the output routine instead of restarting it. In consequence, the headlines are not correct when material gets pushed to the next page. In a similar vein, floats like tables and figures might appear too soon. This will get solved with the next iteration of the package, after which a regular release should be possible.

It is not entirely clear how to deal satisfactorily with floats: if the first page size calculation results in a float being moved to the next page, and then it is determined that enough space on the current page is available for placing the float, doing so will significantly *reduce* the available space for the main text.

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(developer site and CVS instructions)
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EuroT_EX 2006: A Hungarian T_EX Rhapsody

Announcement and Call for Papers

The 16th EuroT_EX meeting, “A Hungarian T_EX Rhapsody”, will be held in Debrecen, Hungary, between July 5 and 8, 2006. M_AT_EX (the Hungarian T_EX User Group) together with the University of Debrecen have committed to undertake the conference affairs, and now announce the call for papers. This will be the first international T_EX conference held in Hungary.

For more information about EuroT_EX 2006, please visit <http://www.matexhu.org>.

Dates

- March 1, 2006 — Deadline for abstracts of presentations;
e-mail: eurotex2006@matexhu.org.
- June 1, 2006 — Deadline for preprints of papers, for distribution at the conference.
- July 5–8, 2006 — Conference.
- July 25, 2006 — Deadline for final versions of papers; the proceedings will be published as an issue of *TUGboat*.

Topics

Topics include but are not limited to: ■ T_EX and so many friends, for automated typesetting
■ Typography (digital or otherwise) ■ Font design and technologies
■ Publishing (electronic or otherwise) ■ (Re)discovery of the European book tradition

Location

The place of the conference is Debrecen, Hungary. Debrecen is a town of universities known as the Calvinist Rome. It is near the biggest Hungarian National Park, Hortobágy, and a famous spa in Hajdúszoboszló.

There will be also free time to give you the opportunity to taste the many types of Hungarian wines, and get to know the tasty special Hungarian dishes. Hungary is a sunny country during summer, an ideal place for making excursions. There are several cultural programs in both Debrecen and Budapest, including jazz and classical music festivals, exhibitions and performances. And we especially invite you to bring your musical instruments to create our own festival!

