

Writing the first L^AT_EX-Book

Walter Gander, ETH Zurich

June 10, 2010

Abstract

In 1984 I wanted to write a German text-book called “Computermathematik” using the typesetting system T_EX developed by Don Knuth, which I have always admired and which I have been aware of since my first sabbatical year in Stanford in 1977. Mark Kent, a graduate student at Stanford in 1984, pointed out to me that Leslie Lamport had just finished a new typesetting system called L^AT_EX which I might want to use instead. I did and in Fall 1984 I had finished the (at least I think) first book written in L^AT_EX. In this historical talk I will present some reminiscences how the book was produced.

1 First Encounter with T_EX

In 1977/78 I spent a year at Stanford as postdoc writing my Habilitation. It was still the time where technical typists were writing papers or books for their professors. I was very lucky to have had my Stanford Report typed by Phyllis Winkler, the technical typist of Don Knuth, probably the best in Stanford. I gave her my hand-written manuscript and she typed it very efficiently using an electric typewriter. An excerpt is shown in Figure 1.

One day in the printer room, when I was retrieving some program output, I was really amazed to see a page of a printed book coming out of the printer. I could not really understand what this was, the only thing I could imagine was a photocopy of a page of a mathematical book. However, no, it was not that – it was some T_EX-output which Don had sent to the printer.

I returned home to Switzerland in Fall 1978 and continued my job as professor at the University of Applied Sciences in Buchs in the Rhine-Valley.

Finally (P2E) and (P3E) will be the corresponding problems with equality sign in the constraint.

The solution of (P1) is a stationary point of the Lagrange function (with the Lagrange multiplier λ)

$$L(\underline{x}, \lambda) = \|\underline{Ax} - \underline{b}\|^2 + \lambda \{ \|\underline{Cx} - \underline{d}\|^2 - \alpha^2 \}$$

and therefore a solution of $\frac{\partial L}{\partial \underline{x}} = \underline{0}$ and $\frac{\partial L}{\partial \lambda} = 0$, which are the "normal equations":

$$(\underline{A}^T \underline{A} + \lambda \underline{C}^T \underline{C}) \underline{x} = \underline{A}^T \underline{b} + \lambda \underline{C}^T \underline{d} \quad (1.3)$$

$$\|\underline{Cx} - \underline{d}\|^2 = \alpha^2 \quad . \quad (1.4)$$

If the matrix $\underline{A}^T \underline{A} + \lambda \underline{C}^T \underline{C}$ is nonsingular, then we can define

$$f(\lambda) := \|\underline{C} \underline{x}(\lambda) - \underline{d}\|^2 \quad (1.5)$$

where $\underline{x}(\lambda)$ is the solution of (1.3). We will call f the "length

Figure 1: Mathematical Typing: State of the Art 1977 in Stanford

From Stanford I began to receive beautifully printed mathematical documents, not typeset in the traditional way but generated with \TeX . One of those early ones was the PhD thesis of Nick Trefethen (see Figure 2)

2 Writing the book

A few years later I was due for a sabbatical and I decided to use it to write a German textbook with the title "Computermathematik" which would teach algorithms written in Pascal, mostly focussed on topics in numerical analysis. Of course I was determined to learn \TeX and write my book using this new text-processing system.

So I went with my two daughters of 9 and 11 years and a suitcase full of hand written notes to Stanford. My wife Heidi had just started a new job and had to stay in Switzerland but would visit us in the vacations.

At the beginning I had to learn to use the computer (a UNIX VAX) on which \TeX was installed. Mark Kent, a graduate student in the Computer Science Department, working in Numerical Analysis with Gene Golub, helped me a lot to get me going. I learned to use the Emacs editor to write \TeX source files. When Mark realized that I was going to write a book he pointed

This amounts to two real equations to be satisfied.

Denote by $\Gamma_1, \dots, \Gamma_m$ the distinct connected components of P , numbered in counterclockwise order. For each $\ell \geq 2$, impose one more complex condition: if z_{k_ℓ} is the last vertex of Γ_ℓ in the counterclockwise direction, then (real equations $3, 4, \dots, 2m$)

$$w_{k_\ell} - w_c = C \int_0^{z_{k_\ell}} \prod_{j=1}^N \left(1 - \frac{z'}{z_j}\right)^{-\beta_j} dz'. \quad (2.4b)$$

Finally, $N - 2m - 1$ conditions of side length are imposed. For each pair (z_k, z_{k+1}) beginning at $k = 1$ and moving counterclockwise, where both vertices are finite, we require (real equations $2m + 1, \dots, N - 1$)

$$|w_{k+1} - w_k| = \left| C \int_{z_k}^{z_{k+1}} \prod_{j=1}^N \left(1 - \frac{z'}{z_j}\right)^{-\beta_j} dz' \right| \quad (2.4c)$$

Figure 2: Part of Nick Trefethen's PhD Thesis

out to me that just a few weeks earlier Leslie Lamport had published a manual in which he described his system \LaTeX , a collection of \TeX macros which would help a book writer a lot since it would take him to a higher book-producing abstraction level. Simply write `\chapter{ }` and forget about the actual size of fonts, distance to text, numbering etc. It sounded good to me and since I had to learn anyway either \TeX or \LaTeX I decided to go for \LaTeX .

The first chapter I started to write was Chapter 4 of the book with the title "Polynome". This was already quite a challenge. Showing how to divide a polynomial by some factor in the form that one would write it up when doing it by hand is quite demanding for a \LaTeX -beginner. The first page of this chapter is displayed in Figure 3.

Including graphics was not yet as convenient as it is today. Nowadays we use `\includegraphics` to include all possible graphical material in various formats. In 1984 I used basic graphic commands provided by \LaTeX to, for example, produce Figure 4:

Kapitel 4 Polynome

Eine häufig verwendete Klasse von Funktionen bilden die *Polynome*.

Definition 4.1 Seien a_0, a_1, \dots, a_n mit $a_n \neq 0$ gegebene Zahlen. Es ist dann

$$P_n(x) = a_0 + a_1x + \dots + a_nx^n$$

ein Polynom vom Grade n . Die Zahlen a_i heissen die *Koeffizienten* von P_n .

4.1 Division durch einen Linearfaktor

Oft stellt sich die Aufgabe, ein Polynom $P_n(x)$ durch den Linearfaktor $(x - z)$ zu dividieren. Man erhält dabei ein Polynom vom Grade $n - 1$ und, falls die Division nicht aufgeht, eine Zahl r als Rest:

$$\frac{P_n(x)}{x - z} = P_{n-1}(x) + \frac{r}{x - z} \tag{4.1}$$

Beispiel 4.1 $P_3(x) = 3x^3 + x^2 - 5x + 1, z = 2$

$$\begin{array}{r} (3x^3 + x^2 - 5x + 1) : (x - 2) = \overbrace{3x^2 + 7x + 9}^{P_2(x)} \\ -3x^3 + 6x^2 \\ \hline 7x^2 - 5x \\ -7x^2 + 14x \\ \hline 9x + 1 \\ -9x + 18 \\ \hline 19 = r \end{array} \tag{4.2}$$

Somit lautet für dieses Beispiel die Gleichung (4.1)

$$\frac{3x^3 + x^2 - 5x + 1}{x - 2} = 3x^2 + 7x + 9 + \frac{19}{x - 2}$$

91

```
\chapter{Polynome}
Eine häufig verwendete Klasse von Funktionen bilden die {\em
~{Polynome}}.

\defi \it Seien $a_0, a_1, \ldots, a_n$ mit $a_n \ne 0$ gegebene
Zahlen. Es ist dann
\l
P_n(x) = a_0 + a_1 x + \cdots + a_n x^n
\l
ein Polynom vom Grade $n$. Die Zahlen $a_i$ heissen die Koeffizienten
von $P_n$.
\section{Division durch einen Linearfaktor}
Oft stellt sich die Aufgabe, ein Polynom $P_n(x)$ durch den {\em
~{Linearfaktor}} $(x-z)$ zu dividieren. Man erh\u{alt} dabei ein
Polynom vom Grade $n-1$ und, falls die Division nicht aufgeht, eine
Zahl $r$ als Rest:
\begin{equation}
\label{44.2}
\frac{P_n(x)}{x-z} = P_{n-1}(x) + \frac{r}{x-z}
\end{equation}

\begin{bsep} \label{41}
$P_3(x) = 3x^3 + x^2 - 5x + 1$, $z=2$
\end{bsep}
\medskip

\begin{equation} \label{44.*}
\arraycolsep 2pt
\begin{array}{r}
(3x^3 + x^2 - 5x + 1) : (x-2) = \underbrace{3x^2 + 7x + 9}_{P_2(x)} \\
-3x^3 + 6x^2 \\
\hline
7x^2 - 5x \\
-7x^2 + 14x \\
\hline
9x + 1 \\
-9x + 18 \\
\hline
19 = r
\end{array}
\end{equation}

Somit lautet f\u{ur} dieses Beispiel die Gleichung (\ref{44.2})
\l \frac{3x^3 + x^2 - 5x + 1}{x-2} = 3x^2 + 7x + 9 + \frac{19}{x-2}. \l
```

Figure 3: First page typeset

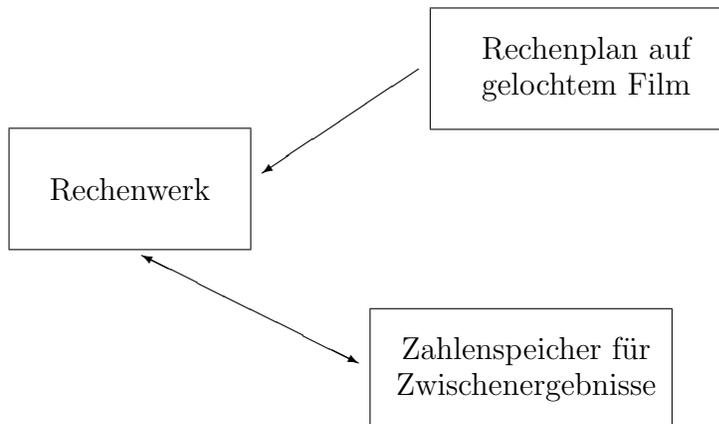


Figure 4: Erste Computer

```

\begin{figure}[htb]
  \begin{center}
    {\setlength{\unitlength}{8mm}}
    \begin{picture}(13,7)(0,0)
      \put(0,3){\framebox(4,2){Rechenwerk}}
      \put(4,2){\vector(2,-1){1.8}}
      \put(4,2){\vector(-2,1){1.8}}
      \put(6,0){\framebox(5,2){
        \shortstack{Zahlenspeicher f\"ur\\
          Zwischenergebnisse}}}
      \put(7,5){\framebox(5,2){
        \shortstack{Rechenplan auf\\
          gelochtem Film}}}
      \put(6.8,6){\vector(-3,-2){2.6}}
    \end{picture}
  }
  \end{center}
  \caption{Erste Computer} \label{1F1}
\end{figure}

```

Again today the situation has completely changed. We have tools to convert formats, *e.g.* from eps to pdf and tools for graphical construction, most notably METAPOST.

Another challenge was to typeset Pascal programs. Today most of us do not bother too much. We simply use `\verbatim` or `\verbatiminput` to include programs. I had the idea to write the reserved words like **begin**, **end**, **for**, etc in boldface and to indent always by three spaces after a **begin** or when using for-loops or if-statements. Of course I did not want to retype the Pascal programs, this would be too much a source of errors. So I finally asked Leslie Lamport by e-mail what he would recommend. He suggested using the tabbing environment. My Pascal programs were written with capitalized reserved words. As an example consider the Pascal function to compute a square-root:

```
FUNCTION quadratwurzel(a:real):real;
VAR xneu,xalt:real;
BEGIN
  xneu:=(1+a)/2;
  REPEAT
    xalt:=xneu; xneu:=(xalt+a/xalt)/2
  UNTIL xneu>=xalt;
  quadratwurzel:=xneu
END;
```

A pragmatic way was to replace a capitalized reserve word like `BEGIN` by `\BEGIN` where I had defined `\newcommand{\BEGIN}{\bf begin }+`. The characters `\+` would cause the next line to be indented in the tabbing environment. More changes like writing `$` to use math-mode and re-indenting I did by hand using Emacs. Defining the \LaTeX -command

```
\newcommand{\SETTABS}
{123\=456\=789\=123\=456\=789\=123\=456\=789\=123\=\kill
 \>\>\>\+\+\+}
```

and using Emacs I transformed it to

```
\begin{alg} \label{3wurzel} \it
\begin{tabbing} \SETTABS \\\
\FUNCTION quadratwurzel(a:real):real;\\
\VAR xneu, xalt : real ; \\\
\BEGIN \\\
  $ xneu := (1+a)/2;$ \\\
  \REPEAT \\\
```

```

    $xalt:=xneu; xneu:=(xalt+a/xalt)/2$ \\
\< \- \UNTIL $xneu \ge xalt;$\\
    quadratwurzel := xneu \\
\END
\end{tabbing}
\end{alg}

```

After processing with \LaTeX the result looked quite satisfactory:

```

function quadratwurzel(a:real):real;
var xneu, xalt : real ;
begin
    xneu := (1 + a)/2;
    repeat
        xalt := xneu; xneu := (xalt + a/xalt)/2
    until xneu ≥ xalt;
    quadratwurzel := xneu
end

```

I typed the whole summer, the children were busy attending Escondido School on campus. In summer vacations Heidi came to visit us and look after our daughters. Finally in Fall the book was finished. Voy and Gio Wiederhold invited us all to a party at their house to celebrate this event. Don Knuth was also with us and said: “Finally it is proved that \LaTeX is useful!”

3 Book Revision

The book was written. But of course I still needed to proofread it carefully. Back in Switzerland I offered the book to publishers for German textbooks among them Birkhäuser in Switzerland, Springer and Oldenburg in Germany. All the publishers were amazed about the quality of typing and all of them accepted the book and made me an offer. For patriotic reasons I then chose Birkhäuser.

When proofreading I found of course typos and other minor things which needed to be fixed. There was no way to process \LaTeX in Switzerland, I did not even know of a \TeX installation. So I decided to fly back in the winter

break at beginning of January 1985 to do the changes in Stanford and print the final camera ready version of the book on the best available printer, the AlphaType machine in the basement. This rather expensive way of doing changes was the only possibility that I had at that time. Switzerland was not yet connected to the Internet. So I spent a week in Stanford, produced a new corrected version of the book and wanted to print the final copy for the publisher. However, I did not succeed because the AlphaType printer was down. I discussed with Mark Kent what to do and we decided that I would return to Switzerland and that he would print the book when the printer was operating again and send me the manuscript by ordinary mail. Indeed this worked fine, two weeks later I received a beautifully typed manuscript.

Looking it through I was terrified: at some place the page break was different than what I had printed in Stanford before. One table was moved and there was a half page empty. Fix it and have Mark printed it again using this expensive printer and paper? I finally decided for a pragmatic solution. I took a scissor and glue and copy pasted the few pages by hand as I expected them to look in my first output.

What was the reason for this new page-break? Well in my absence Leslie Lamport made some small changes \LaTeX and installed a new version. We did not notice this and thus the different page break occurred.

4 Epilogue

I had to write a second volume of my book which includes the solutions of all exercises which are mostly programming assignment. I bought a desktop computer Olivetti M24 for some \$ 6'000 with a 10 MB Hard-disk. There was a company called Micro- \TeX who had ported \TeX on a IBM PC. I bought their floppy disk and installed \TeX on my Olivetti. It used up half of my disk-space! \LaTeX was not available. So I wrote in 1985 my solution book using plain \TeX on my own PC at home. Printing on the dot matrix printer did not look so nice as with Dover and furthermore was terribly slow. When the book was finished, I looked around to find a \TeX installation in Switzerland. I found one in the Institute of Astronomy at ETH. Professor Jan Olof Stenflo was one of the first to have \TeX and \LaTeX installed in Switzerland. So I processed the final version of the second book written in plain \TeX on his computer in Switzerland.

The first \LaTeX book is no longer in print, it had a second edition in 1992.

The publisher Birkhäuser has returned the copyrights to me. So I decided to give the book for free distribution to Google. This seems to be a very long procedure. Therefore I also made it available on <http://www.educ.ethz.ch/unt/um/inf/ad/cm>.

I wanted to produce a pdf file of the book for the web page. Now the amazing result: without any major changes the book compiled using `pdflatex`!! I do not know of any other typesetting system that is as stable over more than 25 years.