The colourful side of TEX

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The day it started…

First of all I would like to say thanks to all who helped me in my understanding and learning TEX. (My father, Ervin Fried, my husband, Lehel Juhász, friends, Gabriella Köves, Tamás Bori.)

It all happened in the late eighties. At that time Lehel worked as an editor at the publishing house of the Hungarian Academy of Sciences. One day he came home and with a smile on his face he said: I have something you are going to like. (You have to be aware that I started writing books right after I finished university — early eighties — and by this time I had been through two books.) This is, he said to me, a typesetting program. So what, I said, a typewriter can do it. But you can typeset mathematics symbols with it, he said. I can type mathematics on my typewriter, I said. But it looks nice!, he added. Now you are talking!, I said, but then I simply do not believe you.

Questions

Can you type a sum sign?, I asked. Yes, he said. Can you type integrals? Yes. Can you type matrices? Yes. Can you…, can you…, can you…, I kept asking. And the answer was always the same: yes, yes, yes.

After about a couple of hours I remembered something.

Just a few month before that I had problems about denoting arcs in a book. You know what I mean, taking an arc of a circle between the points A and B you would like to refer to this arc and denote it in a similar way as you denote a line segment, $\overline{AB}$, but with an arc above the letters. So I asked, can you typeset such an arc? No, he said. But I can typeset $\widehat{AB}$ or $\widetilde{AB}$. That is not good, I want to see an arc! Like $\overset{\frown}{AB}$. Just much nicer!

But how can you do such a thing?

And there is more! When simplifying fractions I need to cross out the numerator and the denominator. Then I have to write the new numerator and denominator above and below the fraction, respectively. You know, like

$$\frac{6}{8} = \frac{\overset{3}{\cancel{6}}}{\underset{4}{\cancel{8}}} = \frac{3}{4}.$$

But *how* can you do it?

And can you put a frame around a text? (You must not forget that at the time we only had plain TEX and no utilities.) You know, like $\boxed{A \neq B}$. Or rather $\boxed{\ A \neq B\ }$.

Yes, yes, but *how do you do it?*

Some answers

At the time when these questions arose we had no help at all. All we had was *The TEXbook* — and only I read English. For framing things we simply had to put them into a box then "wrap them into hrules and vrules".

```
\def\boxit#1#2#3\hfill\break
{\vbox{\hbox{\vrule\vbox{\hrule%
\kern#2\hbox{\kern#3#1\kern#3}
\kern#2\hrule}\vrule}}}
```

It did not take more than a couple of months to solve this problem. And refining took only another 2–3 years.

Now, crossing out the numerator and denominator of a fraction took somewhat more time. We had to wait until Eberhard Mattes created his version of TEX in 1990: emTEX.

Its `\special` feature gave us the freedom to create new graphic objects. With these we could solve some of our problems — similar to the framing problem.

We could define nodes:

```
\def\node#1{\special{em:point #1}}
```

We could draw lines between two nodes:

```
\def\line#1#2{\special{em:line #1,#2}}
```

Fractions could be "simplified graphically". We had only to measure the numerator and the denominator in TEX — by boxing it and then measuring the box itself — and then draw a line between the appropriate nodes.

And we could even import bitmap graphics into TEX. This was fairly important because we could not draw everything under emTEX.

And from this point on we could create drawings of polygons and lines. We could add letters and symbols to our drawings.

We only had to face one serious problem: how to position the nodes we want to use.

```
\def\put(#1,#2)#3{\vbox to0pt
{\vss\kern#2pt\kern#2pt\hbox
to0pt{\hss\kern#1pt\kern#1pt
\vbox{#3}\hss}\vss}}
```

did the trick for us. Notice that this is basically the same idea as the one we used in framing.

But we still could not draw arcs. So we still did not have the arc above *AB*.

It was about this time when we discovered a drawing utility for TEX: PICTEX.

It had wonderful features:

1) You could define a plot area to be used. The picture had height, depth, and width independent of our construction. Why is it important? Because an object that has no height, depth, and width is difficult to input into your TEX file. As soon as you have to position the picture and the text you are going to face problems.

If it has height, depth, and width you can handle it as a TEX object and so you can fit it into your text. True, it is still a hard job. (Of course it is easier if you just centerline the picture.)

2) You could draw circles and ellipses. What a joy! We could do elliptical arcs, circular arcs (that is, parts of ellipses and circles). Alas, still no arc above mathematical objects.

And what did we lose when switching to PICTEX? We had no nodes. That was a great loss so we started to use the two drawing programs at the same time.

PICTEX can be used under LATEX. But we got stuck in plain TEX. Forever, it appears ...

Demands of authors

Years have gone and we solved more and more problems concerning drawings. Seeing this, our authors have become greedier and greedier. Not only would they like us to create real drawings by computer (ones a graphic artist should do) but also, they would like to have colours added to their books.

Luckily, Lehel had his diploma in art, so he could create all kinds of drawings (only he didn't have time to draw, as he was busy "TEXing"). But we gave it a try. There were two things we tried:

1) Drawing, scanning, retouching and importing the drawing into TEX.

2) Drawing by a graphic program and importing the drawing into TEX.

(After these experiments we could import "anything" into TEX.)

We imported bitmap drawings as before. But the age of bitmap graphics was declining. We had to change to eps form. Luckily, we found Tomas Rokicki's epsf.sty file from 1989. (We started to use it many many years later — bitmaps did the trick for us for quite a while.)

The drawings were created in some graphic programs (like Illustrator, CorelDraw, etc.).

On the other hand, there was a need to do more mathematical objects, such as the graphs of functions and constructions.

We could not keep pace with the demands our authors set for us. emTEX and PICTEX were simply not enough.

But just around that time we found another software package perfect for our needs. This software was PSTricks by Timothy Van Zandt (from 1993). For using this we also needed a dvi → ps driver. Tomas Rokicki's "dvips" offered us the PostScript output.

What did we gain from it? Everything! It had all sorts of graphics abilities — all kinds of "PostTricks". We could embed PostScript code into the drawings! What joy we had!

A whole new world opened in front of our eyes with "posttricks" (pstricks).

More answers (fine tricks)

True, when doing constructions we had to face a new problem. Euclid's postulates give us the possibility

- to draw a line going through two given points: could be done.
- to open the compasses to a distance of two given points: not simple but could be done somehow.
- to draw a circle with a given diameter: not simple but could be done.

- to draw the intersection point (if any) of two lines: lacking!
- to draw the intersection points (if any) of two circles: lacking!

Our friend Tamás Bori gave us a hand. He created a utility with which we could construct the intersection points. We were drawing happily ever after...

No, we were not! We found that we could not draw in 3D. I am not a mathematician for nothing. I studied projective geometry. I know how to do the transformation on the 3D coordinates to create such a drawing. So we wrote and used the program. As curves were not given by their coordinates no curves could be drawn. (I have to mention that about a couple of years ago we found a 3D graphing program written by someone else.)

Programming TEX reminds me of a conversation I had with a colleague of mine: At the university everybody uses TEX and when I told him I write programs in TEX with variables and calculations and such, he was astonished. 'Can you really write a program in TEX?' Well, not all of us do it. But for creating an animation I have to have a variable to calculate the number of phases, to calculate the measurement of objects changing, to calculate the shades of colours to use. Because that's what animation is.

And we could draw functions dot-by-dot. And we could create animation.

And what is a presentation? Properly animated pages. So, we can create a presentation. As a matter of fact, we have done such a presentation — like the one at this conference.

Open questions

I want to draw your attention to an important point: these programs have been available from the mid 90's. I have not seen anybody else using them. I believe that we are offered too much and we can take too little. Each of us finds small bits of all the knowledge that had been created in connection with TEX. We, ourselves have created utilities, tools for TEX we never published. Imagine what a huge amount of knowledge there must be!

Still one question remains: *how can you put an arc above AB?!?*

Finally, I would like to say thanks to all those who posed questions to me to make me think about TEX problems (and solve them, most of the cases).