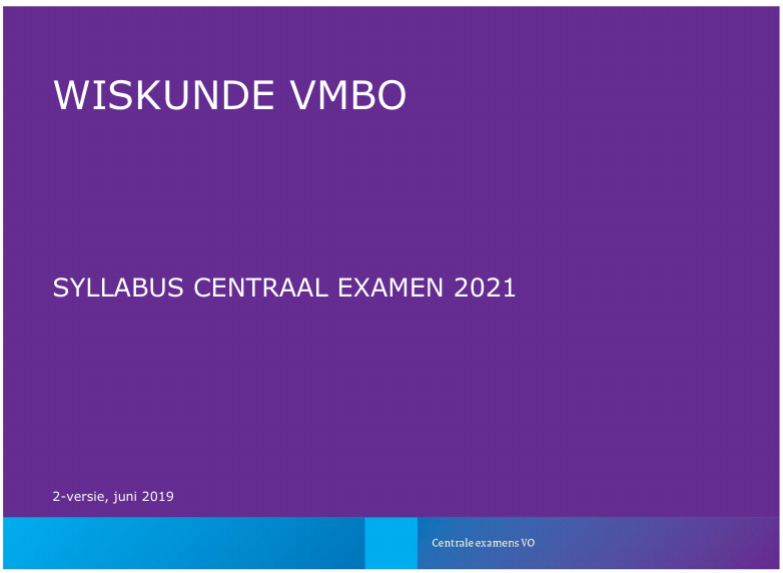
Dutch Government Math rendering

End 2021 and beginning 2022 Mikael Sundqvist and I spent quite some time on an upgrade of the math engine. Because TEX itself is frozen that was done in LuaMetaTEX, which is our follow up on LuaTEX. That effort was all about consistency, avoiding side effects, optimized spacing and line breaks, compensating for issues in OpenType math fonts, interfaces and more. The TEX engine already does a good job on math, if only because it's one of the reasons for its existence and when looking at the way it's done one always needs to keep in mind the limitations of those days: memory, performance, font technology, etc. But with the arrival of OpenType math and after many years of working with TEX we took the opportunity to discuss and improve math typesetting in ConTEXt using new features of LuaMetaTEX.

When one spends so much time on something that is sort of a niche application (math) a valid question is “Who will benefit from it?”. Decades of observing TEX usage has made clear that it's mostly for users who like to make their document look nice. I'm not sure if publishers still care, as they outsource composition and often demand usage of word processors or visual markup tools. Even academic usage in for instance reports, course materials and thesis is questionable because not every TEX user cares for an non-voluntary usage of some program just for the sake of getting something on paper.

So, in the end all that effort on an upgraded engine is for the happy few who love to see things done right. Because ConTEXt has some focus on educational usage it is no surprise that I occasionally run into a document that targets education and also has some math. In this case I will show some usage of math in a document that describes what school kids have to learn. We're talking vocational education so one can imagine that a lot of attention is paid to lowering the boundaries, easing understanding, and being consistent in presenting the learning objectives. Alas.



This 34 page document is published by the Dutch government as can be derived from the logo shown next. And, as is usual today in documents, a reference to the website is there too, and (also as usual) it's likely some bitmap clip of some web page. We will see that the two lions in the banner don't represent the TEX lion here.

Now that we made clear that we're dealing with an official document, we can have a closer look at the math. From the examples here it will be clear that programs like TEX are wasted here and that such documents should never be used to determine the specifications of a typesetting program. There was a time that such a document would be in a typewriter font with handwritten formulas and I bet that it would look way better than what we will see here. It might even be easier to produce because I don't want to imagine what effort it takes to get this crappy output. The snippets shown are just selections from the document exported in png format. We keep the order of occurrence and scale a bit so that we can see clearly what we have.

$$\textit{totale prijs} = \textit{aantal personen} \times \textit{prijs}_{\textit{koffie}} + \textit{aantal personen} \times \textit{prijs}_{\textit{gebak}}$$
$$\textit{totale prijs} = \textit{aantal personen} \times (\textit{prijs}_{\textit{koffie}} + \textit{prijs}_{\boldsymbol{\textit{gebak}}})$$

In this example we see a verbose example of a formula, which it itself is quite okay. It is however puzzling why in the second line the subscript text is in bold. The first line has some curious spacing, so it is definitely not done in so called math mode (assuming that the used word processor has that concept at all). A sans serif font is used so given that this is an example for school kids, one can wonder if the times ($\times$) is experienced different from an x (x), and we will see x's being used later. For the record, a math font setup has many variants: $\mathrm{x}+\mathbf{x}+x+\boldsymbol{x}+\mathsf{x}+\mathbf{x}+x+\boldsymbol{x}+\mathtt{x}+\mathbf{x}+\mathrm{x}+\mathrm{x} = \cdots$.

We stick a bit with verbose math and give another example. Let us be tolerant with respect to the interline spacing and just look at the math: we suddenly get a serif font here but definitely with a weight that does not really match the sans, so it is unlikely that a proper OpenType math font, with matching alphabets, has been used here so let's from now on assume that those responsible for rendering are unaware of the existence of such fonts. We can always blame the application.

$$\textit{hoeveelheid bloed} = \frac{1}{13} \times \textit{gewicht}\ (\textit{hoeveelheid bloed}\ \text{in liters en}\ \textit{gewicht}\ \text{in kg})$$

The next snippet shows an 'x' and as long as it is in an italic shape it will be different from the times symbol, but unfortunately in this document we see an interesting mix of upright, italic, sans and serif characters being used. At this point we probably no longer need to wonder why students in that segment of education have problems with math and why it is not that popular.

$$\text{verticale lijn } x = a$$

An example of a different 'x' comes next. Also watch the somewhat out of proportion radical compared to the 'x'. In TEX one really has to bend rules to get that. One cannot select the root symbol so it might as well be some overlayed bitmap.

$$y = \sqrt{x}$$

We stay with the ‘x’ and get a slightly different italic serif this time. It is combined with a sans serif ‘y’ and upright somewhat bold ‘a’. Again, for this to be done in TEX one needs to exercise some effort because normally all come out in a math italic font. Spacing fractions is not always trivial especially when you see different ones alongside but consistency is nevertheless important.

$$y = \frac{\mathrm{a}}{x}$$

That the ‘x’ brings some artistic freedom is clear, but at least we have two similar shapes here. I'm not sure how one can explain to a student that this time we use an upright sans. It's probably all about the ‘x’ being smaller and raised.

$$y^{x}$$

It is possible to have all symbols in italic, as is seen from the next snippet. Spacing could be a bit better but at least there is some consistency here.

$$h = 2t - 9$$

However, when one reads on this shows up:

$$y = \frac{1500}{x}$$

We do have two (this time serif) italic ordinary characters ‘x’ and ‘y’ but the number ‘1500’ made of digits is somewhat large and probably is typeset as an independent quantity.

As a welcome distraction we now show a table. The alignment in the first column is peculiar. As with much in this document it looks like there has been no proofreading at all. The numbers in the other cells are not (right) aligned and sit high in the cells and of course frames around the cells are used. A student might wonder if there is a difference between three and five dots. No mater how one abuses TEX, the commands that produce dots always produce the same amount: it's a proper glyph (shape)!

Afstand (in km)	1	2	5	10	20	...
Prijs (in euro’s)	9,10	10,20	13,50	19	.....	.....

Sometimes two successive lines indicate some concept (I guess) but that is no reason for this rendering. I cannot imagine that students are supposed to interpret such formulas depending on the inconsistent mix of fonts and weights being used. (In the following case using opp could have saved some space.)

$$\begin{aligned} \mathit{inhoud}_{\boldsymbol{\mathit{kegel}}} &= \frac{1}{3} \times \mathit{opp\ grondvlak} \times \mathit{hoogte} \\ \mathit{inhoud}_{\mathit{kegel}} &= \frac{\mathit{oppervlakte\ grondvlak} \times \mathit{hoogte}}{3} \end{aligned}$$

Here comes another beauty, a mix of digit '0' (or is it the letter 'O') and a degrees '°' symbol (I assume). In a decent (OpenType) math font the script symbols can have a shape optimized for the smaller size so one can't know I guess.

$$(0\ ^{o})$$

It is time again for a larger blob of text. Do you recognize the symbol pi (π) (it's not an 'n' but it comes close)? And what about the superscript digits '2' and '3' that also get special spacing? Weren't the digits upright in previous examples? The fractions look like some small image squeezed in with a non proportional scale.

$$\begin{aligned}
&\textit{omtrek cirkel} = \pi \times \textit{diameter}\\
&\textit{oppervlakte cirkel} = \pi \times \textit{straal}^{2}\\
&\textit{inhoud prisma} = \textit{oppervlakte grondvlak} \times \textit{hoogte}\\
&\textit{inhoud cilinder} = \textit{oppervlakte grondvlak} \times \textit{hoogte}\\
&\textit{inhoud kegel} = \frac{1}{3} \times \textit{oppervlakte grondvlak} \times \textit{hoogte}\\
&\textit{inhoud piramide} = \frac{1}{3} \times \textit{oppervlakte grondvlak} \times \textit{hoogte}\\
&\textit{inhoud bol} = \frac{4}{3} \times \pi \times \textit{straal}^{3}
\end{aligned}$$

By now you get the picture, so we show a few more in one go:

$$y = ax + b \qquad \boldsymbol{y = b\,g^{t}} \qquad \boldsymbol{y = a\,x^{n} + b}$$

In TEX there is a concept of a math axis, but not in the next example, and again one can wonder if the 'a' and 'x' come from the same font. I did not bother to disassemble the pdf. In TEX you can mess up the spacing too, but I get the impression that the 'x' is way below what a strut would enforce.

$$y = \frac{a}{x}$$

We started with a radical symbol that was somewhat high relative to what went under it. But it can't be worse than this. Not only do we have a squeezed radical symbol, the whole assembly also moved below the baseline: that takes some effort.

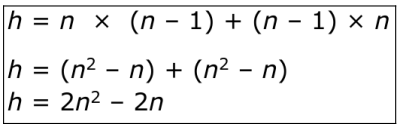
$$y = \sqrt{x}$$

It is not uncommon to see some upright words in math formulas, think of sine and cosine operators, often used in conjunction with parentheses $\sin(x)$. But the inverse operator in the next example is special: it is not only in bold, but also negated. And it seems not to be an issue to show it combined with an upright bold 'y' raised to the power bold 'y' in spite of a previous also upright regular variant. If in this case calculator operations are meant, a more appropriate font or symbol should have been used.

$$y^{x} \text{ en } \mathbf{INV\text{-}\ y^{x}}$$

At some point one gets accustomed to this kind of rendering and maybe when that happens those who are supposed to (proof) read this will not notice anything weird and inconsistent in the larger clip below:

Not only are all ‘x’ and ‘y’ letters different, so are the digits and equal signs. It is hard to imagine that the thousands of readers of a document like this who have an education in math don't find this amusing. Personally it makes me sad. How can we expect students to pay attention to anything they have to produce if this kind of crap comes from the government. There was a time when such official documents were typeset by the state publisher that employed famous typesetters and proper printers. Even when much got delegated to departments responsible for communication that used typewriters with these math specific symbol bulbs there was professional pride involved. One can only wonder about the quality criteria that get applied today. There is simply no excuse for this and also not for the interline and inter atom spacing in the next one:



But maybe spacing has some meaning that I don't grasp because I cannot imagine that proof reading did not catch the next snippet, one that also uses very thin underlining:

Maybe documents like this don't get proofread. In fact, maybe they are not even (supposed to be) read. Maybe it's just some outsourced effort that ends up on a website and leaves the actual content to the teachers. Maybe one only has to look at some exams and drill and practice for what is in there. Maybe no one really cares.

rijnummer	1	2	3	4	.....	10
aantal zitplaatsen	18	21	24	27	.....	45

The table above actually starts the document and again proves that no one checked it, because I cannot imagine anyone not noticing the line breaks in the pre-last cells where the (this time) eight dots would have fit quite well.

So, what conclusion can we draw from this? First of all that there is a total lack of attention to how something looks and feels and thereby is perceived. Personally I am not willing to even consider this a serious document at all. If textual consistency is lacking then for sure the content is also not consistent and checked. And I did not even discuss the text, punctuation, spacing, usage of quotes and excessive use of frames around pages. We can only hope that documents like these get lost over time so that no one can wonder how badly typesetting has evolved since the middle ages.

It also reveals to me that working on TEX is really dedicated to users who do care and not to this kind of institutionalized math usage. But above all, it makes me aware of the fact that it is no wonder that math is unpopular among kids. If it looks like crap, it must be crap. We really should make math look 'cool' and 'super' these days and only using these buzz words when talking to kids is not enough! The good news is that after many decades TEX users can still produce nicely looking documents with plenty of math.

Like: $y = \sqrt{x+4}$ and $y = \frac{a}{x}$ and y^x and $h = 2t - 9$ and $y = \frac{1500}{x}$ and $y = ax^n + b$ and $\mathrm{inv}(-y^x)$ and $0°$ as well as: $\mathrm{inhoud}_{\mathrm{kegel}} = \frac{1}{3} \times \mathrm{oppervlakte\ grondvlak} \times \mathrm{hoogte}$, or: $\mathit{inhoud}_{\mathit{kegel}} = \frac{\mathit{oppervlakte\ grondvlak} \times \mathit{hoogte}}{3}$.

And you can mix in some colors, emoji, graphics and still be consistent. If you don't pay attention to your readers, don't expect your readers to pay attention to what you bring to the table. And, once you know how to use TEX it's pretty easy and even saves time, because even getting a handful of formulas as bad as seen here takes time.

If you still wonder why we should care about these matters, imagine that you need new tires for a car and get it back with four differently sized ones. How would driving that car feel to you and would you be willing to keep that configuration for the time it takes to wear them off? Given that math (and teaching it) is pretty much about consistency, I suppose that when the rendering of math as shown here doesn't disturb you, you will also happily keep those different tires.

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