TEX in Schools? Just Say Yes: The use of \TeX at the Faculty of Informatics, Masaryk University

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Abstract

Students at Masaryk University (MU) use \TeX for many purposes, such as writing theses, essays, and papers. It is also used by the staff for teaching electronic publishing and literate programming, for writing scientific papers, quizzes and teaching resources, and for generating documents and web pages from university databases by the university information system. \TeX and related technologies have been systematically supported and deployed at the Faculty of Informatics of MU (FI MU) for more than two decades. In this paper, we describe the \TeX-related support and projects that we have realized at various levels. These include the design of the Faculty’s visual identity, resources for teaching electronic publishing, and for database publishing directly from the University’s information system. We evaluate the outcomes, and consider some possible future deployments of \TeX-related technologies. With the data analytics of fithesis3 class support and its use at MU, we give arguments why the answer to the often-asked question in the title is in the affirmative, at least for computer science schools like ours and for authoring math publications.

1 Introduction — basic premises

\TeX was born at a university, in the Stanford Computer Science Department, but primarily for one project of its author. Should it be used and taught widely in schools? Such questions have often been asked and answered [22, 4, 19]. Under which premises and for what purposes should \TeX and its friends be used in schools? The most appropriate answer is that it depends on the type of school, on the tasks, and on the end users:

- \TeX as a programming (macro) language? Probably not.
- \TeX as an example of a literate programming paradigm? Maybe.
- \TeX as a low level typesetting tool? In some cases, it depends on the type of school.
- \TeX in the I\O\TeX format as a reusable scientific authoring markup tool? Probably yes.

Why not just hope that in the flow of getting words on a medium we play our humble role and hope we’re not forgotten but remembered as inspiration. (Hans Hagen, [7, p. 32])

2 History of \TeX at Czech schools — just a predilection or an objective good?

Let us start with some historical remarks.

1980s \TeX found its way to Czechoslovakia at the end of the eighties, and was probably first used by the dissidents when preparing books and booklets that were forbidden to be printed officially [5]. For this reason, Czech diacritics had to be added to Computer Modern fonts [47].

1990s Within a year of the Velvet Revolution, the Czechoslovak \TeX Users Group (\textsc{CSTUG}) was founded. With the vast majority of the individual and institutional members of \textsc{CSTUG} being part of academia, high schools and universities became natural hubs of \TeX know-how.

To put this into a historical context — Hàn Thé Thành (Figure 1) came from socialist Vietnam and started to learn Czech at a Czech school and subsequently enrolled in the FI MU. The first Internet ADSL 56 kbps line from Linz in Austria was rented by the consortium of Czech universities to share. And at 290 kB, \texttt{latex.tex} was easy to both search and edit even on a PC XT with 640 kB of memory and two floppy diskettes.

As \TeX began to gain momentum, a group of enthusiasts decided to organize a \TeX conference in Prague [48]. Thus, Euro\TeX 92 was born with about 300 participants from all over the world. \TeX started to be used for book and database publishing [40].
A new Czechoslovak variant of the Computer Modern fonts (csfonts) was created. Math journals started switching to \TeX. Czechoslovak Mathematical Journal, Applications of Mathematics, and Mathematica Bohemica in Prague, Archivum Mathematicum in Brno, and Mathematica Slovaca in Bratislava all used \TeX as their primary typesetting tool.

Thus the community was already starting to grow. Groups of mathematicians started to typeset their reviews for the German Zentralblatt Math journal, and (\LaTeX) \TeX courses started to find their way into schools, primarily as tools for typesetting mathematics. One such a course was even taught at TUG 1993 in Aston, UK.

At that time, the first author was working at the Institute of Computer Science, Masaryk University, and promoted the use of \TeX there. There was a series of popular articles about \TeX published in a university bulletin Zpravodaj MU and in CS TUG’s bulletin Zpravodaj CS TUG. MU became an institutional member of TUG. \TeX was actively supported and customized versions of \TeX supporting the Latin2 input encoding were created and compiled on shared \TeX installations within the university.

The first computer science faculty in the Czech Republic — the Faculty of Informatics, Masaryk University, Brno (FI MU) — was founded in 1994. Jiří Zlatuška, a proponent of \TeX, became its first dean. The faculty logo was designed by the first author as a ligature FI based on Escher’s Penrose triangle, as seen in Figure 2. The motto of the logo comes from Blaise Pascal’s Pensées: “The eternal silence of these infinite spaces terrifies me”.

\TeX became the mainstay of everyday life at the Faculty. There was a need to typeset timetables, e.g. for lecture rooms, for individuals and for study groups. \TeX has proven itself to be an ideal tool for the job (see Figure 3). \TeX has been used for the typesetting of almost all database outputs of the Faculty administration [26], including phone directories, course catalogues — as seen in Figure 4 — and study diplomas.

A course on electronic document preparation opened in 1994. It was designed as a blend of both the theory and practice [18] of document preparation. The course teaches students about how information is transferred from the mind of an author via a markup language (\LaTeX) to the reader’s mind. They are taught about the separation of form and content and about the particulars of both paper and digital output formats of PDF and (X)HTML. Since document development and program development have much in common, the students are taught to use versioning systems and automation tools such as make. As far as \TeX is concerned, the students learn both the practicalities, such as the typesetting of documents with an emphasis on theses, and the theory covering \TeX’s line-breaking and hyphenation algorithms.

Every effort was made to ensure the Faculty was a safe playground to experiment with \TeX toys and tools, for the benefit of all, and as part of the studies [27]. For students like Hàn Thế Thành, \TeX was the obvious choice for typesetting their essays and theses. Hàn Thế Thành picked \TeX and the recently designed PDF format as the topic of his Master’s thesis. \TeX has been extensively used by the staff for their academic output and most research publications have been prepared in \TeX. The Faculty’s technical report series has been designed in its own

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{logo.png}
\caption{The logo of the Faculty of Informatics: the ligature FI, as a symbol of quality typography, was implemented in METAFONT [49]. The optically scaled Computer Modern letters in the circular text were recursively joined using the ligature mechanism of METAFONT.}
\end{figure}
The syllabus of the Electronic publishing course typeset in Minion by \texttt{pdftex} as a part of the Yellow book of courses taught at FIMU in 2004.

 rate with Hermann Zapf’s Palatino as the faculty’s primary font.

To automate the typesetting of longer texts and database publishing, quality hyphenation was required. The results of the first author’s research \cite{45, 32} were reported at TUG 1995 (and elsewhere), where the first author met Donald Knuth and took the photo in Figure 5. Don was subsequently invited to Brno to receive his twentieth honorary doctorate.

When he arrived in Brno, Don saw his Computer Modern fonts on the timetables of public transport tram stops (see Figure 7). He was delighted to see the fruits of his ‘labour of love’ being used on the other side of the globe, both in theory and in practice. He mentioned this in his inaugural speech (Figure 6) when he became the first recipient of an honorary doctorate from FIMU.

In 1996, Hàn Thế Thành defended his masters thesis \cite{10}; the program called \texttt{tex2pdf} \cite{31} was presented to the \TeX{} community at the TUG 1996 conference in Dubna, Russia. The program caught the eye of the \TeX{} community and was subsequently renamed \texttt{pdftex} and its manual was drafted \cite{15}.

The new toy needed users willing to test it in day-to-day \TeX{} authoring work. We maintained faculty-wide installations for multiple operating systems that shared the same \texttt{texmf} trees; in addition, we kept historical \TeX{} Live installations and made them available via a module switching mechanism. Twenty years later, most \TeX{} Live versions of the past are still installed and ready to use; this makes it easy for authors to go back in time and retypeset decades-old material. Lowering the bar for starting with \TeX{}, by having the tools ready to use and a local community ready to help, made \TeX{} the go-to

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system for authoring long documents such as books or theses. The \texttt{fitthesis} \LaTeX{} class for typesetting theses was designed, installed and offered to the students. They were given a small booklet “Getting started with \TeX at FI” on enrollment day at the Faculty.

There were conferences being organized by the Faculty, e.g. Gödel in 1996, and a multiconference on the Mathematical Foundations of Computer Science (MFCS) in 1998. \TeX{} was used for typesetting all conference materials from a single \emph{textual} database; Figure 9 shows one example of this material. In the Seminar on Linux and \TeX{} (SLT) organized mainly by the students themselves, Linux and \TeX{} enthusiasts developed not only an interesting research program, but also the icons seen in Figures 8 and 10 drawn by Petra Rychlá.

The information system of the Faculty, also developed partly by the students [26], generated most of its output via a secure independent sandboxed \TeX{} installation. Data for the course catalogue were acquired from the teachers using web forms, then validated, converted to \LaTeX{}, and typeset. The DTD for the validation of the submitted data enabled the use of special entities \&TeX{} and \&LaTeX{}; \&. Hyphenation pattern were further improved [33] to minimize errors in automated workflows. Students were motivated to actively participate in \TeX{}-related projects. Mirka Misáková implemented Gutenberg-like justification in \METAFONT as a part of her thesis [21], Jan Pazdziora studied line and page breaking algorithms [25], and Pavel Janík studied digital font formats [16]. Most of \APST [50] was programmed in Brno by the MU alumnus, Karel Skoupý [30].
Figure 8: Icons for the Seminar on Linux and \texttt{\LaTeX} (SLT’98), drawn by Petra Rychlá.

Figure 9: A personalized invitation card typeset for the participants of the MFCS ’98 conference held at FI MU.

Figure 10: The logo of the Seminar on Linux and \texttt{\LaTeX}(SLT), drawn by Petra Rychlá.

2000s H\'an Th\'e Th\'anh consulted on further \texttt{pdftex} improvements [11] with Herman Zapf, and conducted several microtypographic experiments together with Hans Hagen who came to give a special course on Typographic Programming in Brno. In October 2000, H\'an Th\'e Th\'anh finished his dissertation [12], and left Brno after 11 years of study. He returned to Vietnam, secured his family financially and for a short while worked in Vietnamese academia [13, 14].

As the power of electronic documents and demand for them was increasing, new coursebooks and interactive teaching materials were created [6]. There was demand for animations in PDF [34], for the automation of multiple choice testing [36], and for interactive teaching materials in PDF and JavaScript [35]. \texttt{\LaTeX}’s notation was so common for the University math teachers that they demanded an extension of the interface for creating online quizzes that would enable them to directly input \texttt{\LaTeX} formulae using a special \texttt{<math>} and \texttt{</math>} element. Math formulae were rendered on the fly via a pipe of \texttt{\LaTeX} to \texttt{dvipng}. The software for the automated scanning and evaluation of test sheets generated by \texttt{\LaTeX} [9], an extended version of \texttt{patgen} called \texttt{opatgen} that enabled the direct use of UTF-8 patterns [2, 1, 39], and the software for producing animated PDFs in \texttt{pdftex} [8] may serve as examples of other \texttt{\LaTeX}-related tools that have been designed and developed by students and staff at FI. The reuse of textbook content authored in \texttt{\LaTeX} for multiple output devices was also requested. We have been able to show that, given that form and content are separated in the markup, several different outputs can be easily generated via \texttt{\LaTeX}, namely PDFs suitable for printing, PDFs suitable for reading on a screen, HTML for web-enabled devices, and XHTML/MathML for fully standards-compliant web-enabled devices [42] without the monstrous systems of large publishers. Our \texttt{\LaTeX}-based production system is used by most of journals delivering to the DML-CZ library [29, 43].

At the time when \texttt{\LaTeX} and Knuth became widely known, many software businesses started to move to Brno, which is now known as the Silicon Valley
of Central Europe. Consequently, a publisher based in Brno had the Art of Computer Programming (TAOCP) translated into Czech (by a FI MU alumnus) and retypeset from Knuth’s sources (Figure 11).

2010s  Leveraging their \TeX typesetting know-how, the students and alumni of FI MU joined several projects related to digital mathematical libraries, namely DML-CZ and EuDML. A \TeX-based workflow for journal publishing has been developed with an automated export of an archival version that would be stored in the digital library. The Archivum Mathematicum journal published by MU uses the tools and the workflow developed for DML-CZ [44, 38]. Several related tools have been developed: an efficient PDF recompression technique [41] and the \TeX math indexing and searching algorithm from the MiS project [20] deployed in EuDML [46]. As blind students needed to study math from TEX-authored textbooks, support for Czech Braille output has been prepared as part of a master thesis [17].

The creation of \TeX-related software has been supported by the dean’s research project program and offered as a topic for theses. The second author of this paper, supervised by the first author, created a new version of the fitthesis class [23] with fine-tuned support for all nine faculties of Masaryk University. Thousands of students across the university now author their theses in \LaTeX with the ability to discuss problems via a dedicated forum in the university information system. Students have also started to file pull requests to customize style options of other faculties, a sign of a growing faculty-local \TeX support community.

Another development was triggered by the inability of markdown to prevent the occurrence of Czech vowelless prepositions at the end of lines in FI MU senate minutes, which is a grave error according to Czech typography rules. The new markdown.tex macro package that enables the processing of markdown documents directly in \TeX solves this issue as a tiny side-effect [24].

The fruits of separating form and content were recently reaped when Masaryk University changed the visual style for their documents. Changes in the \TeX-based workflow were minimal and did not affect the authors much—a mulettter style file for preparing letters, and a thesis review document template were put on the Faculty’s GitLab server shortly after the new visual style was released and smoothed the transition significantly.

The use of \TeX at MU currently celebrates a quarter century of support and development, where students and staff have contributed significantly both to the questions and solutions in the digital typography world and especially within the 40-year-old \TeX family.

So, maybe instead of ambitious themes, the only theme that matters is: show what you did and how you did it. (Hans Hagen, [7, p.32])

3  Where we are now and what’s next — predictions

Nelson Beebe predicted the future of \TeX more than a decade ago [3]. The world we live in constantly changes, and while most predictions still hold, some have to be revisited. We have tried to evaluate the influence of the \TeX tools and predictions using statistical data about theses defended not only at FI MU, but across the entire university.

With the creation of the fitthesis3 \LaTeX class, the level of support for thesis writing entered a new era [23]. Templates in fitthesis3 were prepared for each of the nine faculties of Masaryk University. Writing a thesis is now just a few clicks away even if the author does not have a working local \TeX installation. Enchanted by the ease of the authoring process and the beauty of the resulting documents, it seems likely that many will install \TeX on their devices at some stage. Cloud \TeX environments enable much faster learning by example than before, and allow for
online consulting, commenting by supervisors, and collaborative debugging.

The portability, stability, reliability, and style uniformity enforced implicitly by visible markup, the ease of writing math, as well as the aesthetic and visual qualities of the output are the main benefits compared to WYSIWYG editor alternatives. This is attractive for students, as can be seen in Figure 12.

In parallel, a beamer theme fibeamer has been developed and made available in \LaTeX{} Live and cloud \LaTeX{} platforms to allow the students to prepare their presentations for thesis defense without having to bother about the visual style of their slides. This appears to be especially attractive for the students of the Faculty of Arts—see Figure 13.

Approximately 40,000 students study at Masaryk University and all theses defended are archived in the university information system. We have used heuristics to detect whether a thesis has been written in \LaTeX{} on a sample of 44,875 theses submitted at MU from 2010 through 2015. It is estimated that the number of theses written in \LaTeX{} across the entire University steadily increased from 5.67% in 2010 to 6.28% in 2014. Extrapolating this trend indicates that 100% of theses will be written in \LaTeX{} by 2783.

Theses written using \LaTeX{} had been awarded grade A statistically significantly more often and grades C and D statistically significantly less often than theses not written using \LaTeX{} [23]. The awarded grades are summarized in Table 1 and in Figure 14. There is clear evidence that theses written in \LaTeX{} received better grades than theses written using different tools. It remains to be shown that the grades students received for theses written in \LaTeX{} are consistently better than the grades the students received for their state exams—the hypothesis is that using \LaTeX{} helped the students reach grades that do not correspond to their ability to study in general.

To conclude, the main lessons learned from \LaTeX{} at MU are:

- Sustainable support for [thesis] writing in \LaTeX{} and incentives for community building by university are very important. There should ideally be a playground where students and faculty members can play and experiment together, work on joint projects, and have fun.
- Using \LaTeX{} in the daily agenda of the university is motivating, and is a win-win situation for both students and faculty members—the students learn new things while the faculty administration and teaching is effective and enjoyable.
- The \LaTeX{} typesetting kernel gives visually appealing results, often superior when compared to other alternatives, especially when math typesetting is needed, as in STEM education.
- Contrary to most WYSIWYG alternatives, the use of \LaTeX{} gives consistent results, is productive and efficient for database and automated publishing, and for long documents containing math. It is a safe choice, especially when there is official support.
- The separation of form and content and \LaTeX{} as a fixed point in document authoring is another benefit academics recognize in their ever-changing world: it allows reusing content in different portable forms and formats that appear over time.
- The usage of \LaTeX{} as a typesetting kernel in a university information system has paid off in decades of use.

Young, smart students who enjoy playing with \LaTeX{} document tools are constantly appearing, joining the community, and taking on ambitious new \LaTeX{}-related projects and challenges. This allows the retiring faculty members to take a well-earned rest.

References


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Figure 12: The cumulative number of views of the \texttt{fithesis3} document class in the online service of Overleaf.

Figure 13: The cumulative number of views of the \texttt{fbamer} beamer theme in the online service of Overleaf.

Figure 14: A box plot of the grades of theses written and defended during 2010–2015 at the Faculty of Informatics (FI MU), the Faculty of Science (Sci MU).
Table 1: The contingency table of the numbers of marks awarded to theses written and defended during 2010–2015 with Pearson’s goodness-of-fit measure \((E - O)^2 / E\) between the expected \(E\) and the observed \(O\) numbers of marks awarded to theses written using \(\text{T}_{\text{E}}\text{X}\).

<table>
<thead>
<tr>
<th>Grade</th>
<th>Without (\text{T}_{\text{E}}\text{X})</th>
<th>E(with (\text{T}_{\text{E}}\text{X}))</th>
<th>O(with (\text{T}_{\text{E}}\text{X}))</th>
<th>((E - O)^2 / E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>15,476</td>
<td>988</td>
<td>1,181</td>
<td>37.858</td>
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<tr>
<td>B</td>
<td>9,999</td>
<td>638</td>
<td>587</td>
<td>4.093</td>
</tr>
<tr>
<td>C</td>
<td>7,926</td>
<td>506</td>
<td>381</td>
<td>30.799</td>
</tr>
<tr>
<td>D</td>
<td>4,020</td>
<td>257</td>
<td>194</td>
<td>15.248</td>
</tr>
<tr>
<td>E</td>
<td>2,783</td>
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<td>128</td>
<td>13.853</td>
</tr>
<tr>
<td>F</td>
<td>1,979</td>
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<td>145</td>
<td>2.771</td>
</tr>
<tr>
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<td>42,183</td>
<td>2,692</td>
<td>2,692</td>
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