Towards a Digital Matematics Library: from DML-CZ to EuDML

Petr Sojka

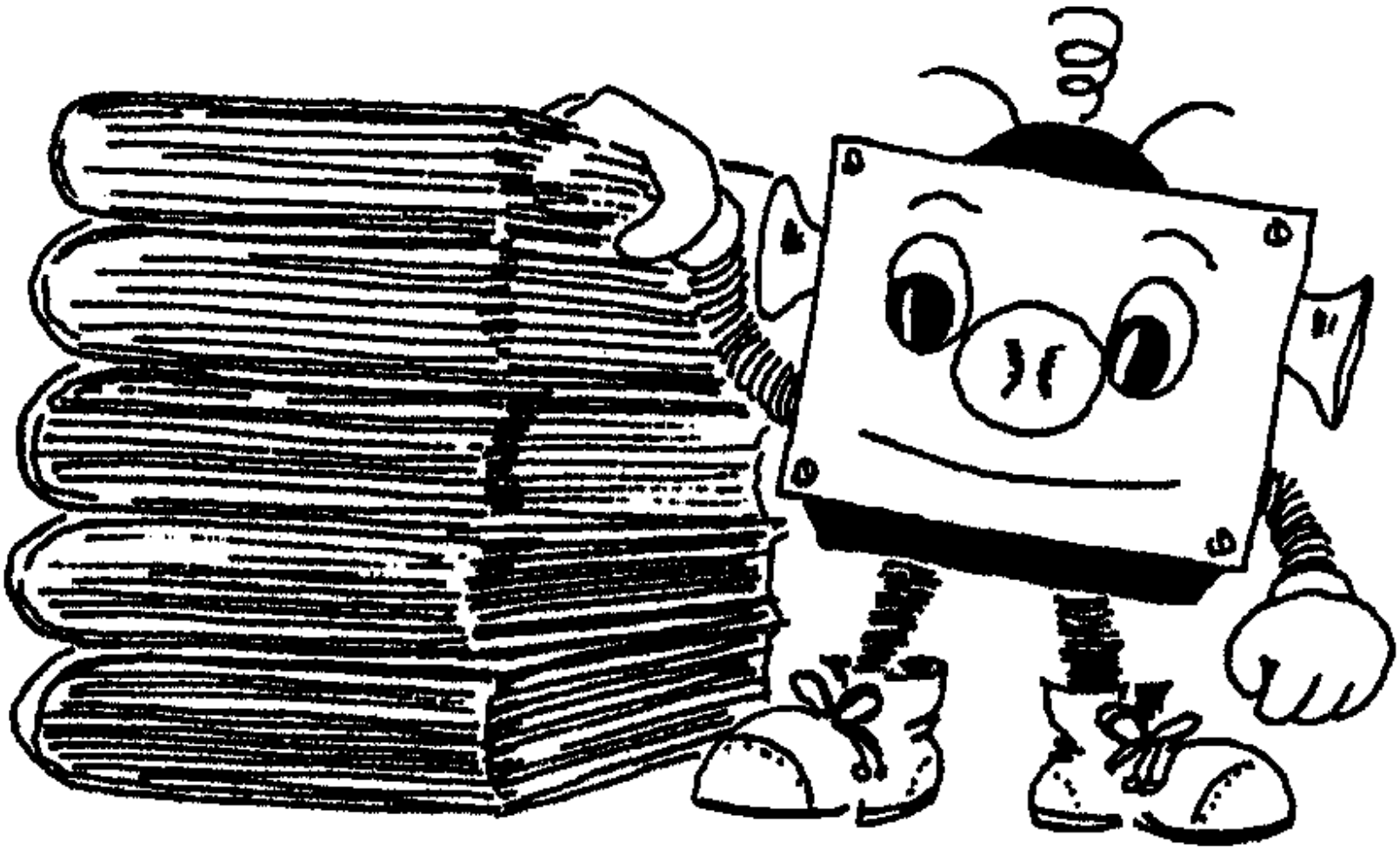
<sojka@fi.muni.cz> (FI MU, Brno)

FI MU, Brno, CZ, Informatics Colloquium, May 4th, 2010, 2 p.m.

EuDML

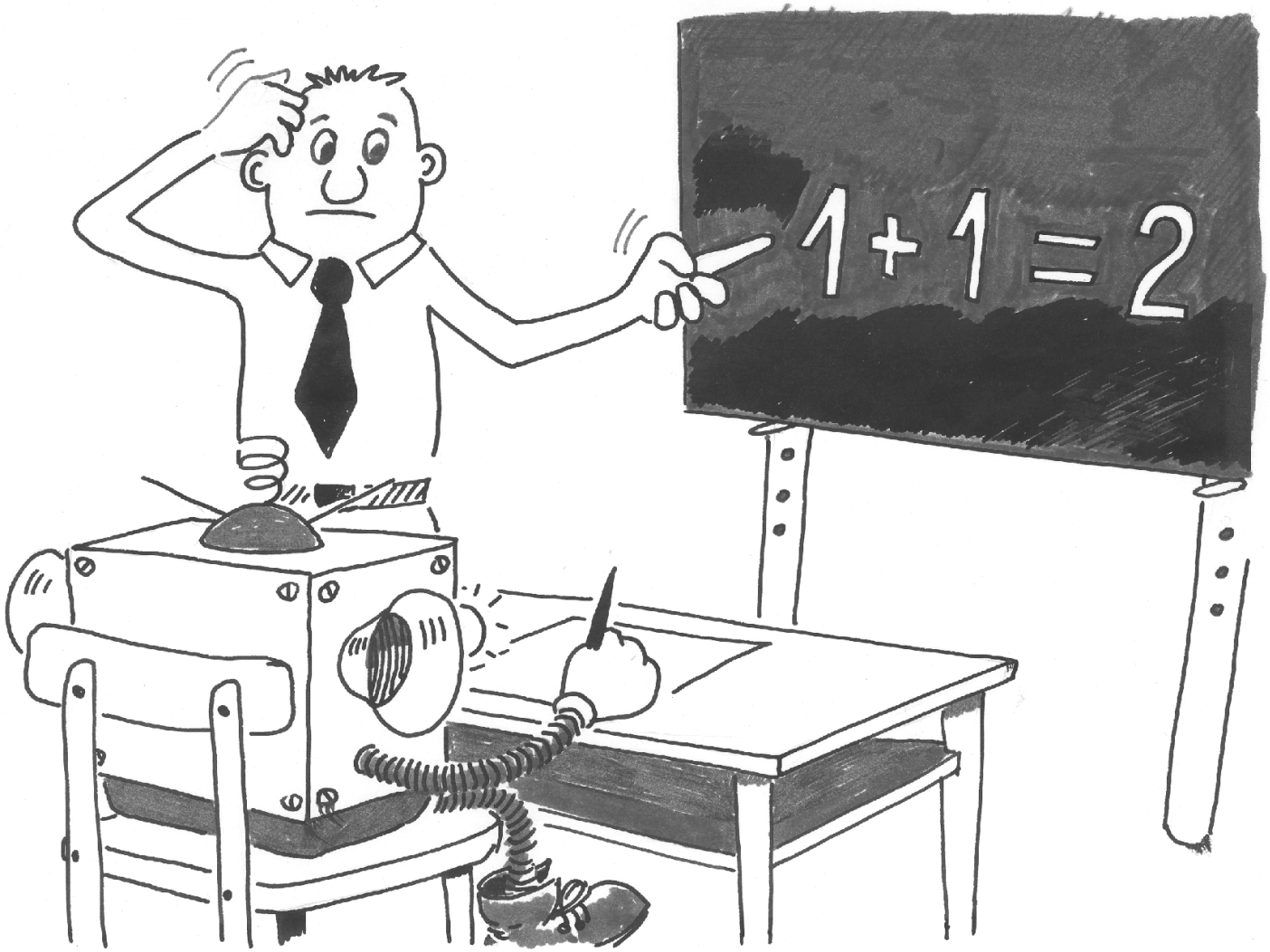
The EUROPEAN DIGITAL MATHEMATICS LIBRARY

From paper to digital processing

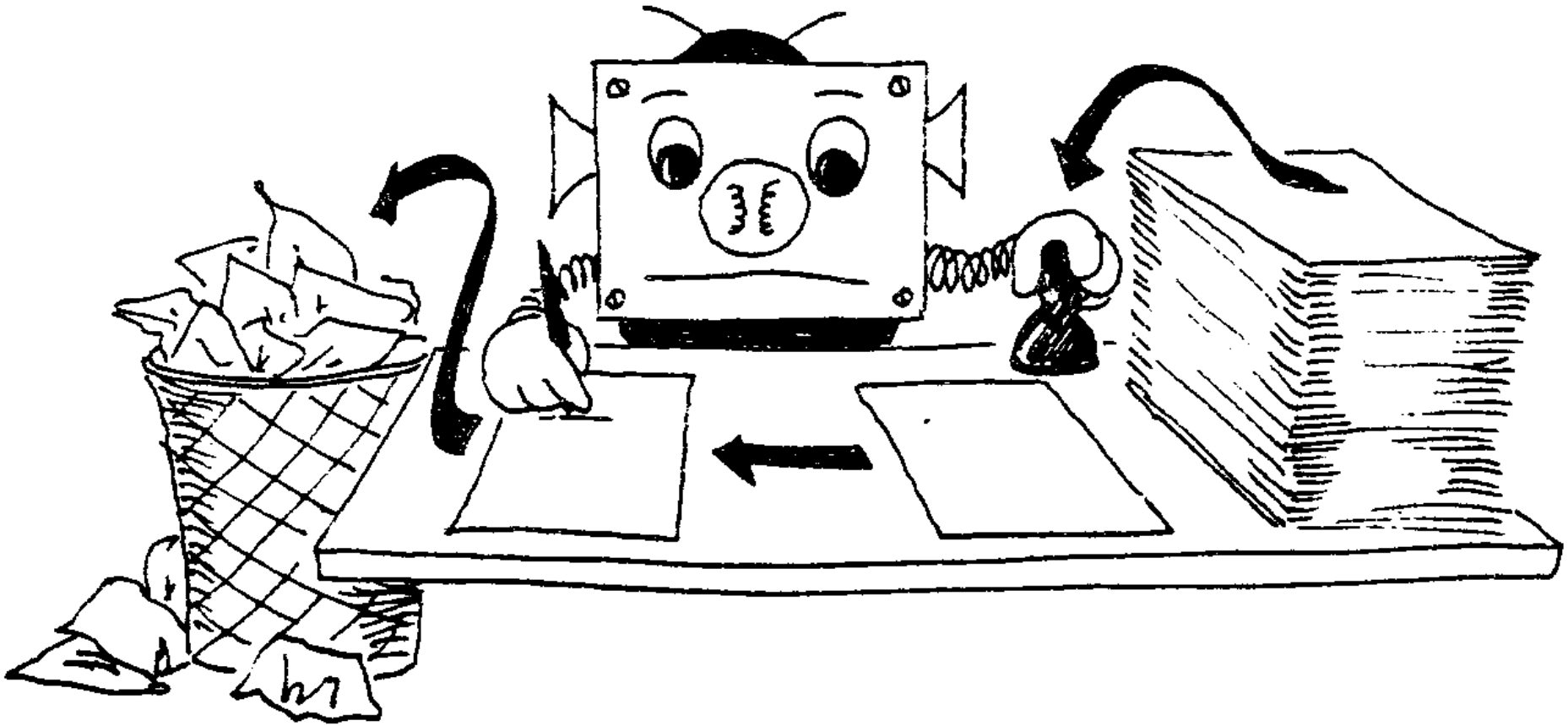


Information overload

Information overload in mathematics

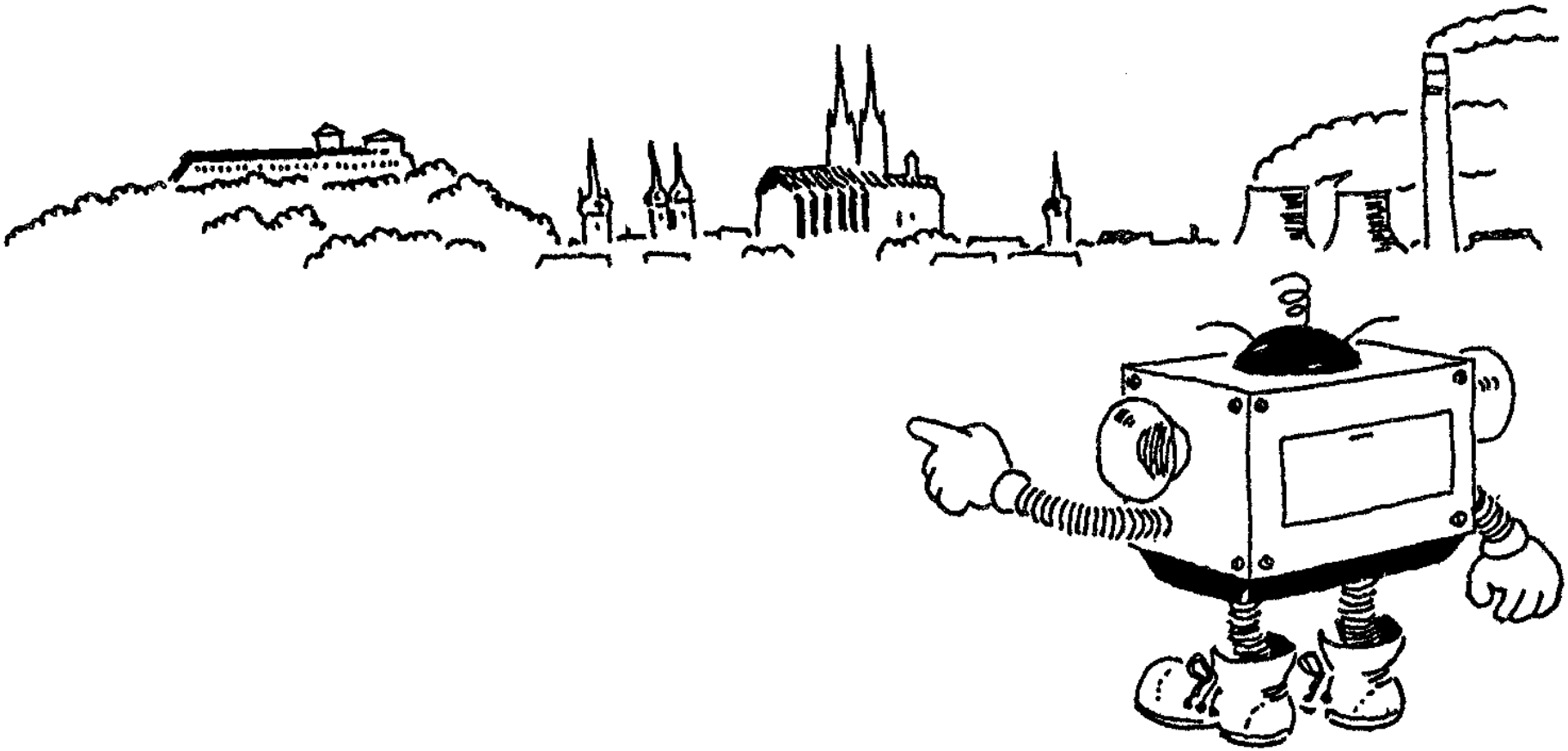


Document engineering—from paper to digital workflow

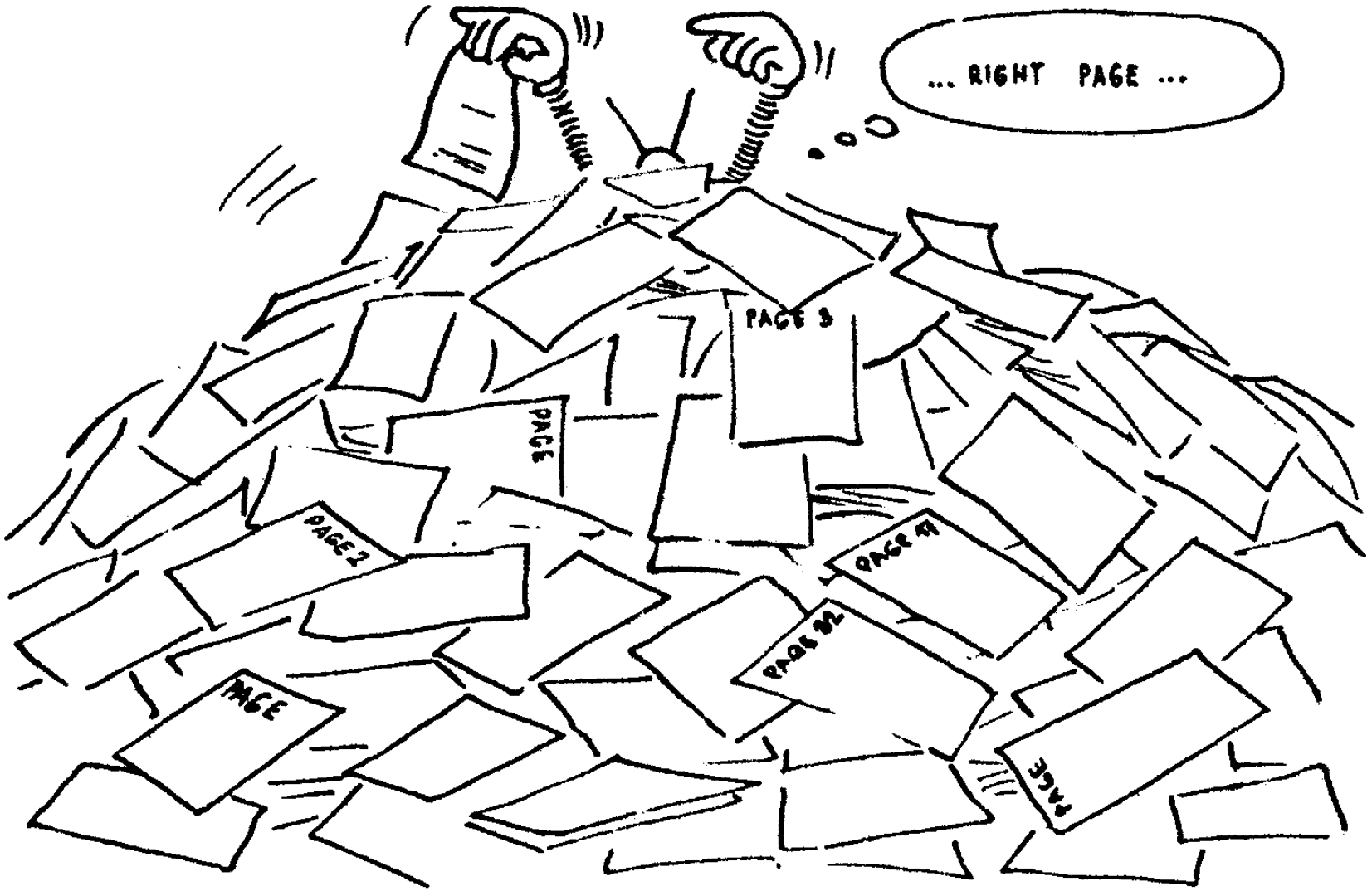


Document engineering—digitization, digital library development

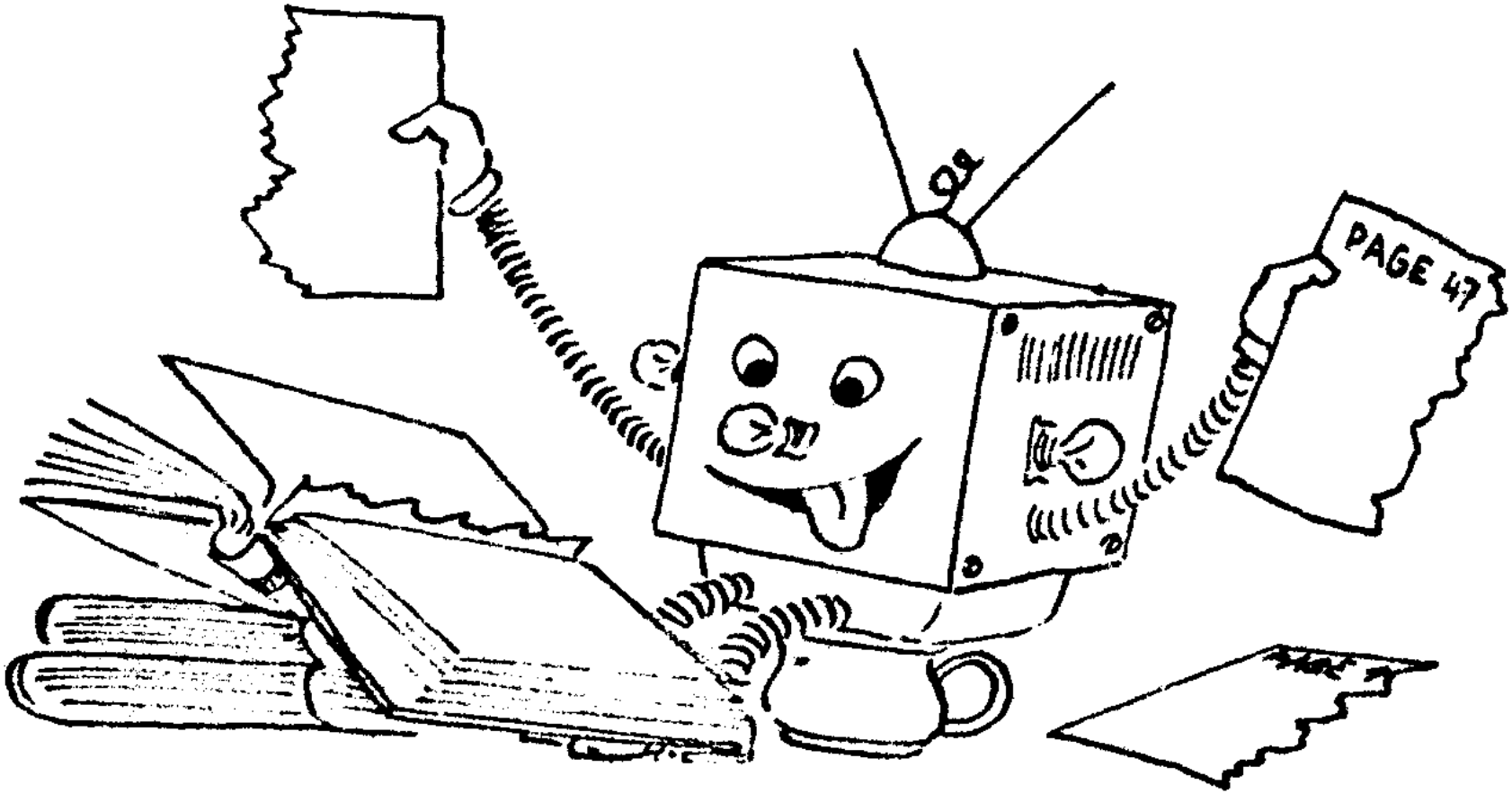
Bottom up processing—local (Brno, CZ) document engineering



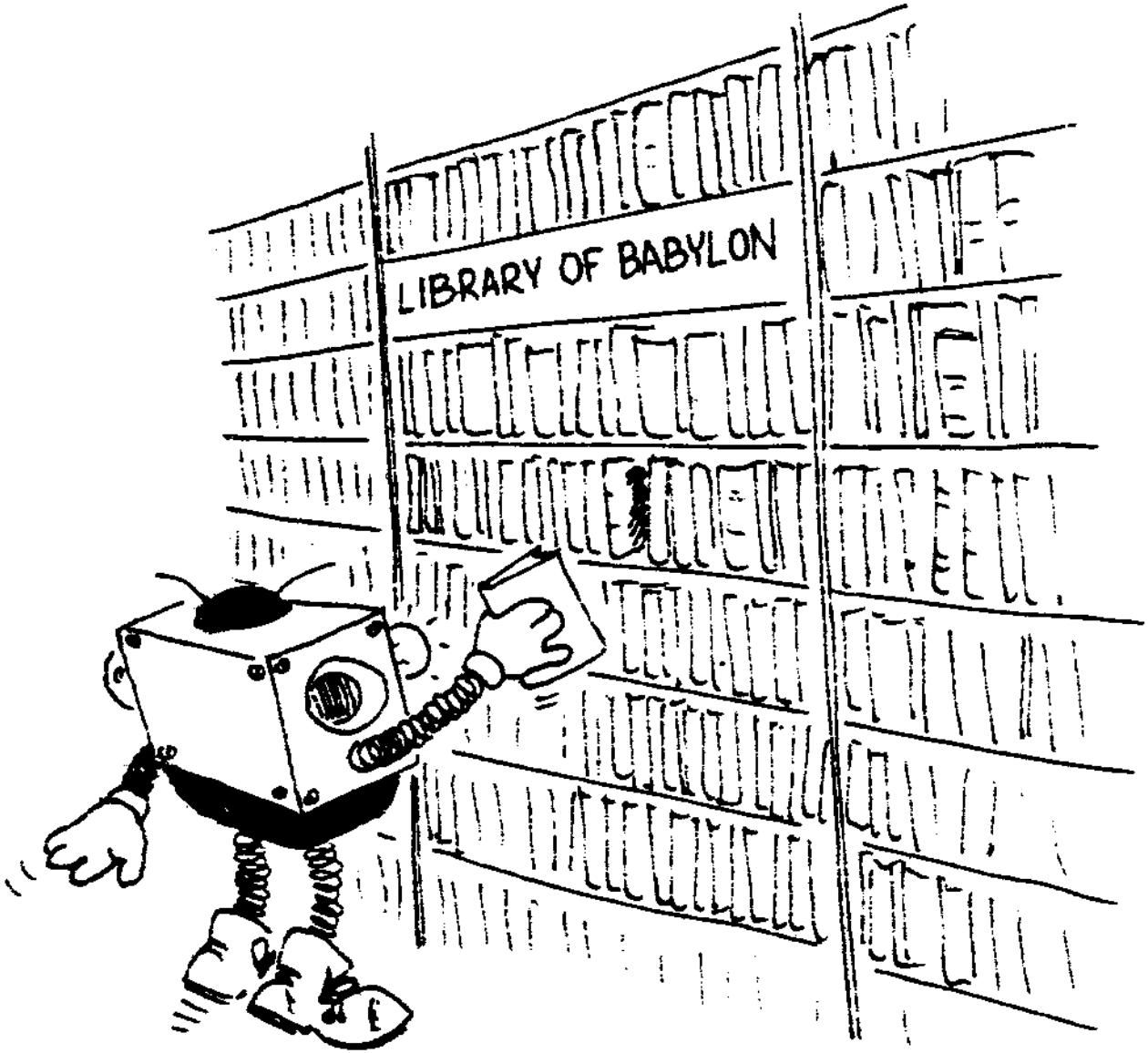
DML-CZ document engineering—data processing



DML-CZ document engineering—tools

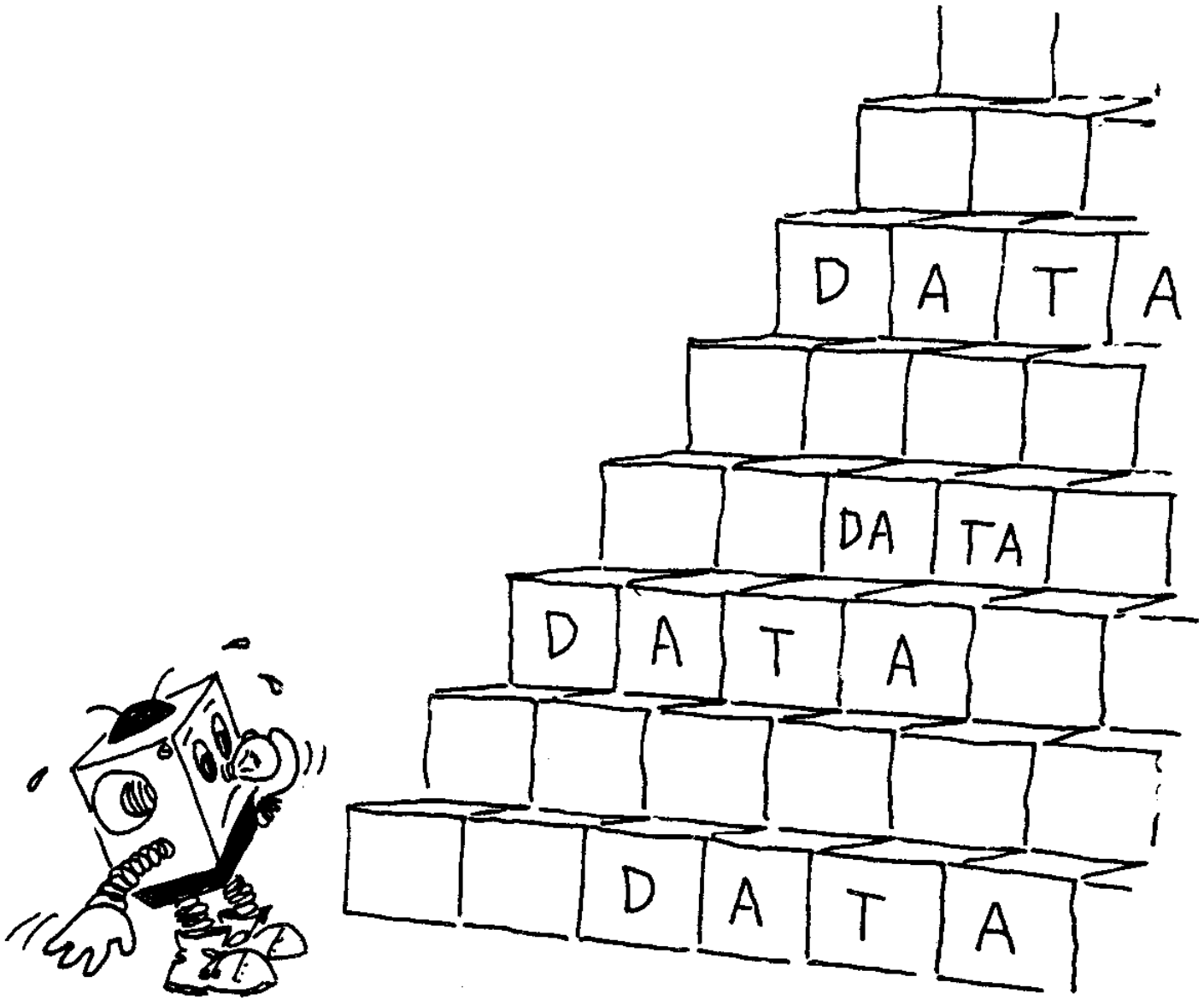


Bottom up DML processing towards EU or worldwide scale

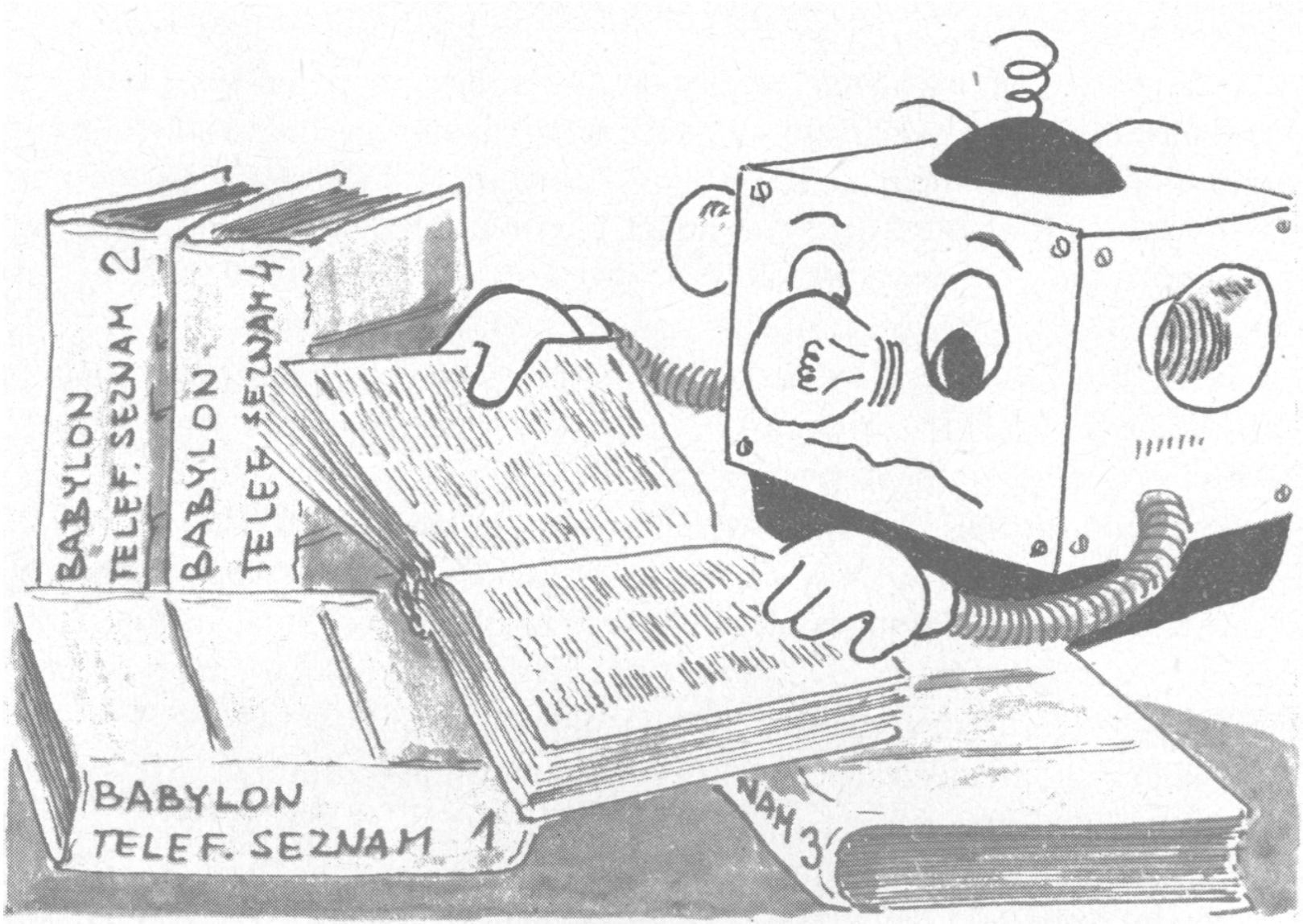


European Digital Mathematics Library

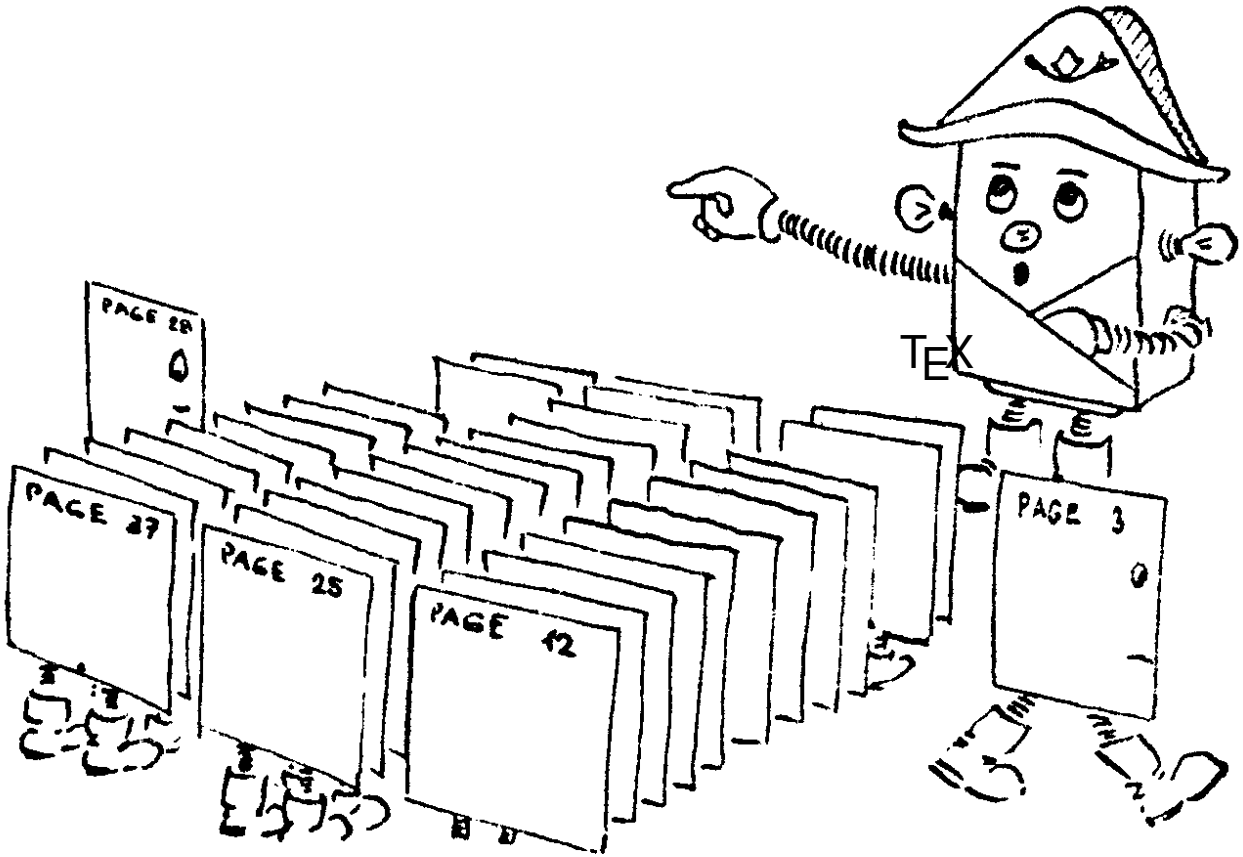
EuDML—from data collection to virtual digital library



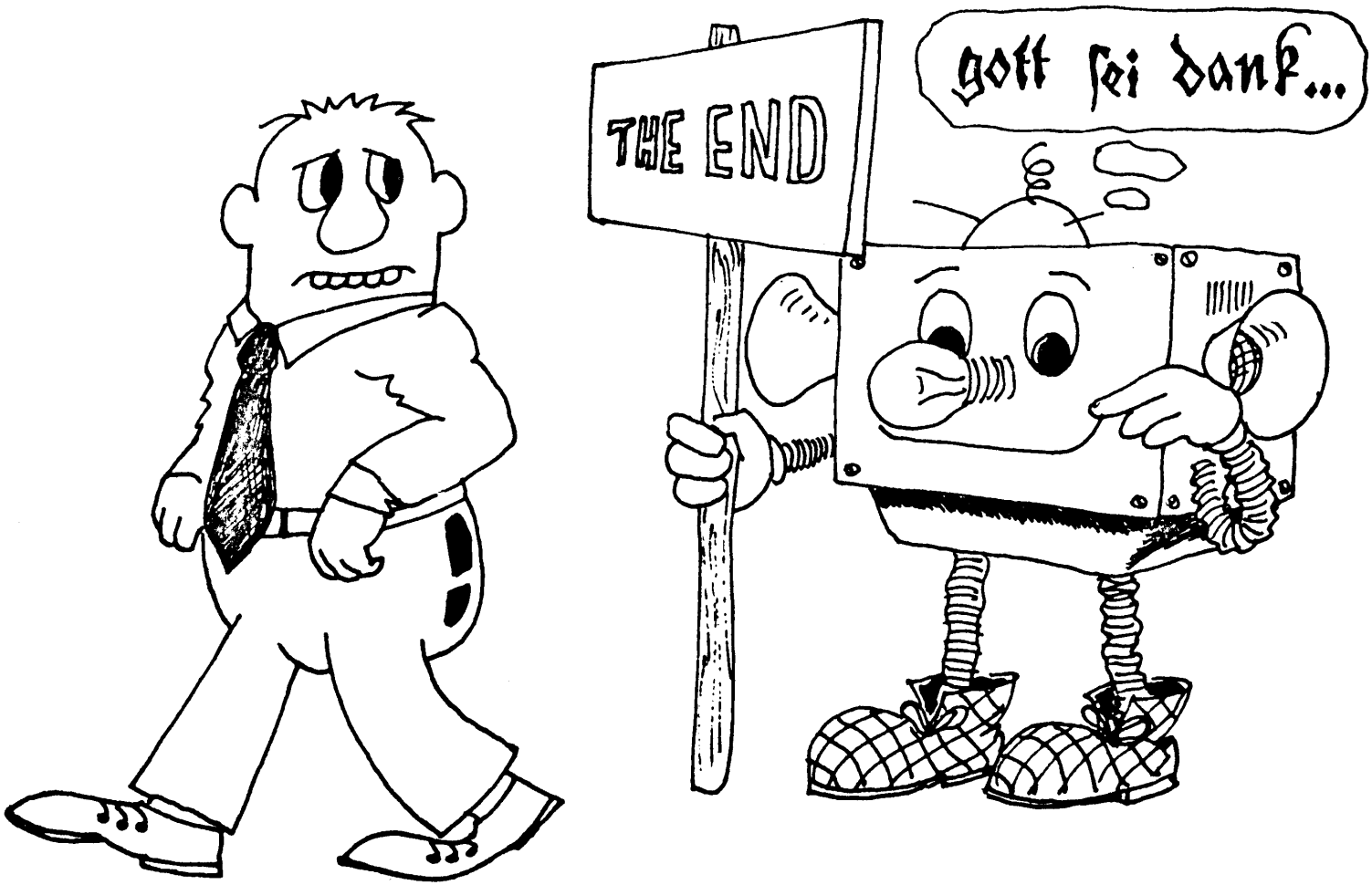
EuDML document engineering—scalable tools development



Yes, you can!



End of talk overview



Vision of WDML/EuDML

At the beginning there was a vision of all mathematical knowledge, *peer reviewed and verified* (100,000,000 pages) on one spot and in the digital form.

It starts to happen, but slowly: three year EU project EuDML (programme EU CIP-ICT-PSP, type Pilot B) from February 2010 (MU and MU AV).

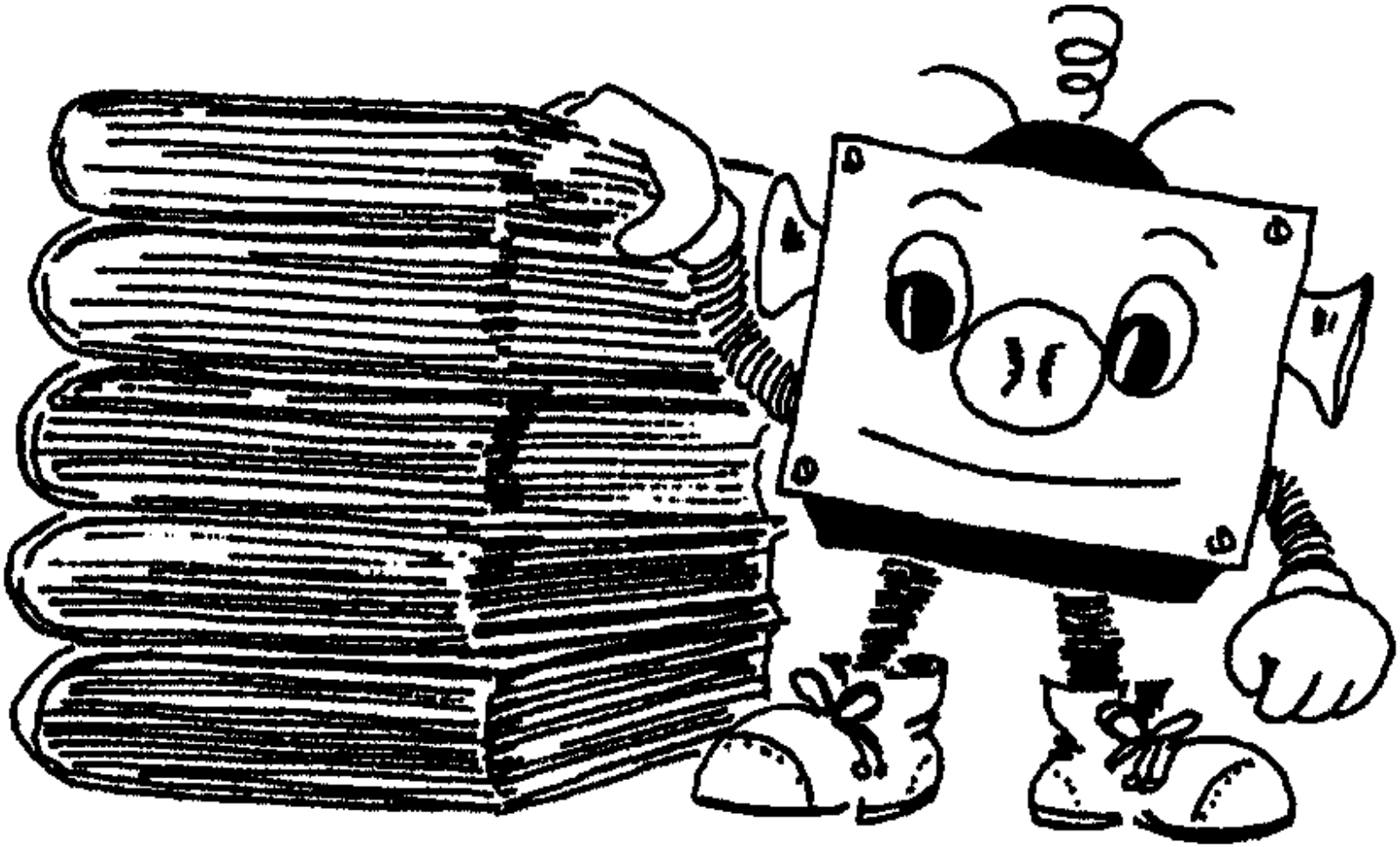
EuDML

The EUROPEAN DIGITAL MATHEMATICS LIBRARY

The strategy:

- to master the technology, develop tools and offer them;
- concept of *moving wall* to motivate and engage commercial publishers.
- to collect (bottom up) [virtual] *digital library*, 'one-stop shop' and achieve critical mass in the domain $\longrightarrow$ 'me too' effect then.

From paper to digital processing, from local to the whole



Bottom up

As a basis serve current DML repositories as DML-CZ or NUMDAM, DML-PL, DML-PT, RusDML,…(from local repositories bottom-up to build the final thing).

Example of DML-CZ: up and running digital mathematic library with nearly 30,000 papers. For more, see (who, what, browse, browse similar, how to search).

Live project—all comments to DML-CZ welcome!

DML-CZ: main facts

- Czech Academy of Sciences grant (program Information Society) 2005–2009, *full* (retro)digitization of 50,000 pages of mathematical literature per year, 8M CZK in total.
- Research part: **1)** gradual enhancement of the digital material by 'knowledge enhancing' filters on markup-rich XML data. **2)** New methods for (semantic) text processing tested on the available data. **3)** The design of the work-flow aiming at mathematical knowledge stored in digital library.
- IPR part: sharing/delivery (economic models for knowledge sharing due to interests of content owners/publishers).

DML-CZ: who?

Four contractors (all from Czech Republic):

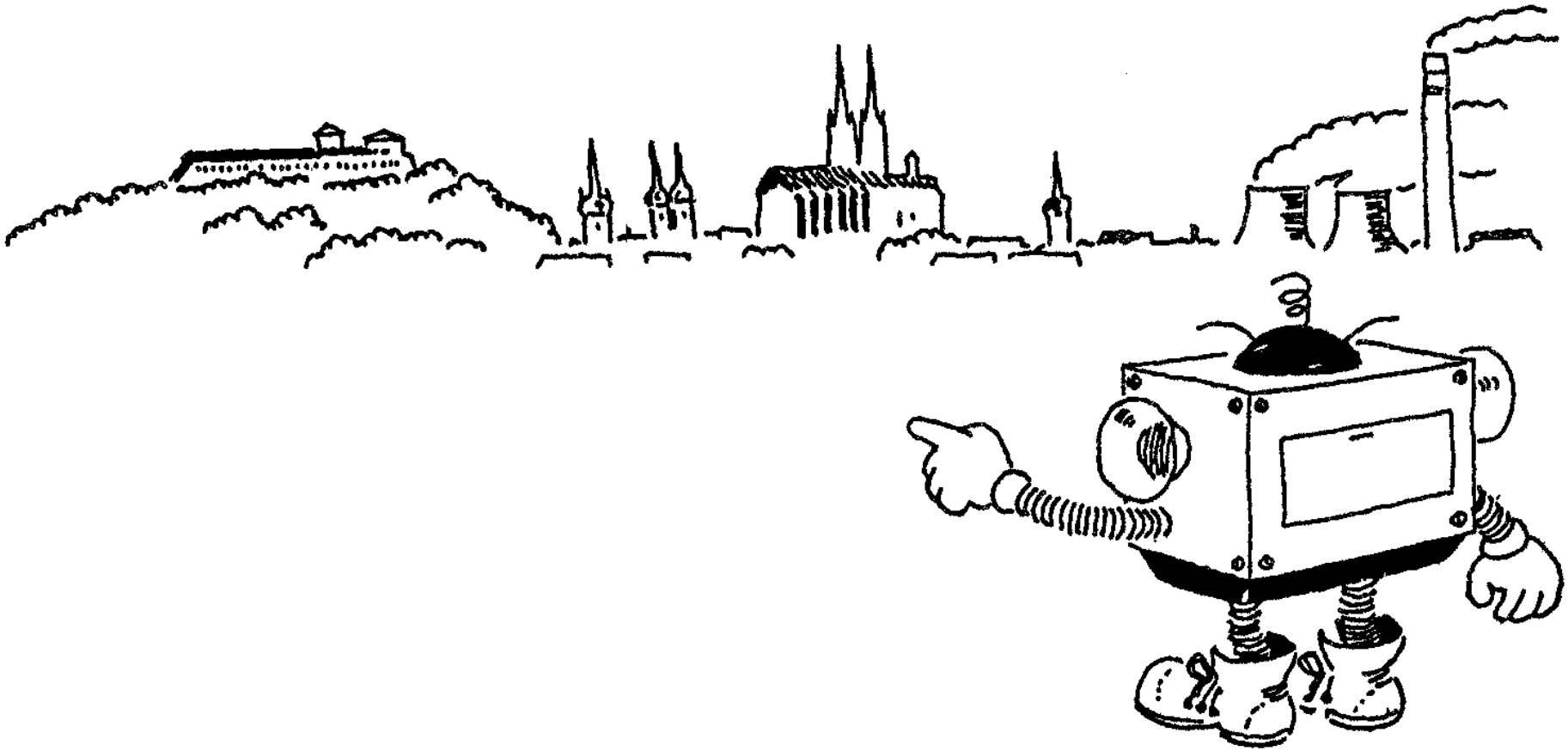
① **Czech Academy of Sciences, Prague** Jiří Rákosník, head of the project, responsibility for material selection, copyright negotiations.

② **Masaryk University, Brno** Petr Sojka (FI) formats and tools, technical coordination, information retrieval, indexing.
Mirek Bartošek (Institute of Computer Science), content management system, metadata Q/A, long-term archiving.

③ **Charles University, Prague** Jiří Veselý, Oldřich Ulrych, selection and preparation of materials for digitization, metadata cleanup.

④ **Library of Academy of Sciences, Prague** Martin Lhoták, document scanning in Jenštejn.

Bottom up processing—local (Brno, CZ) document engineering



Take care!

Information overload—what is there in DML-CZ?

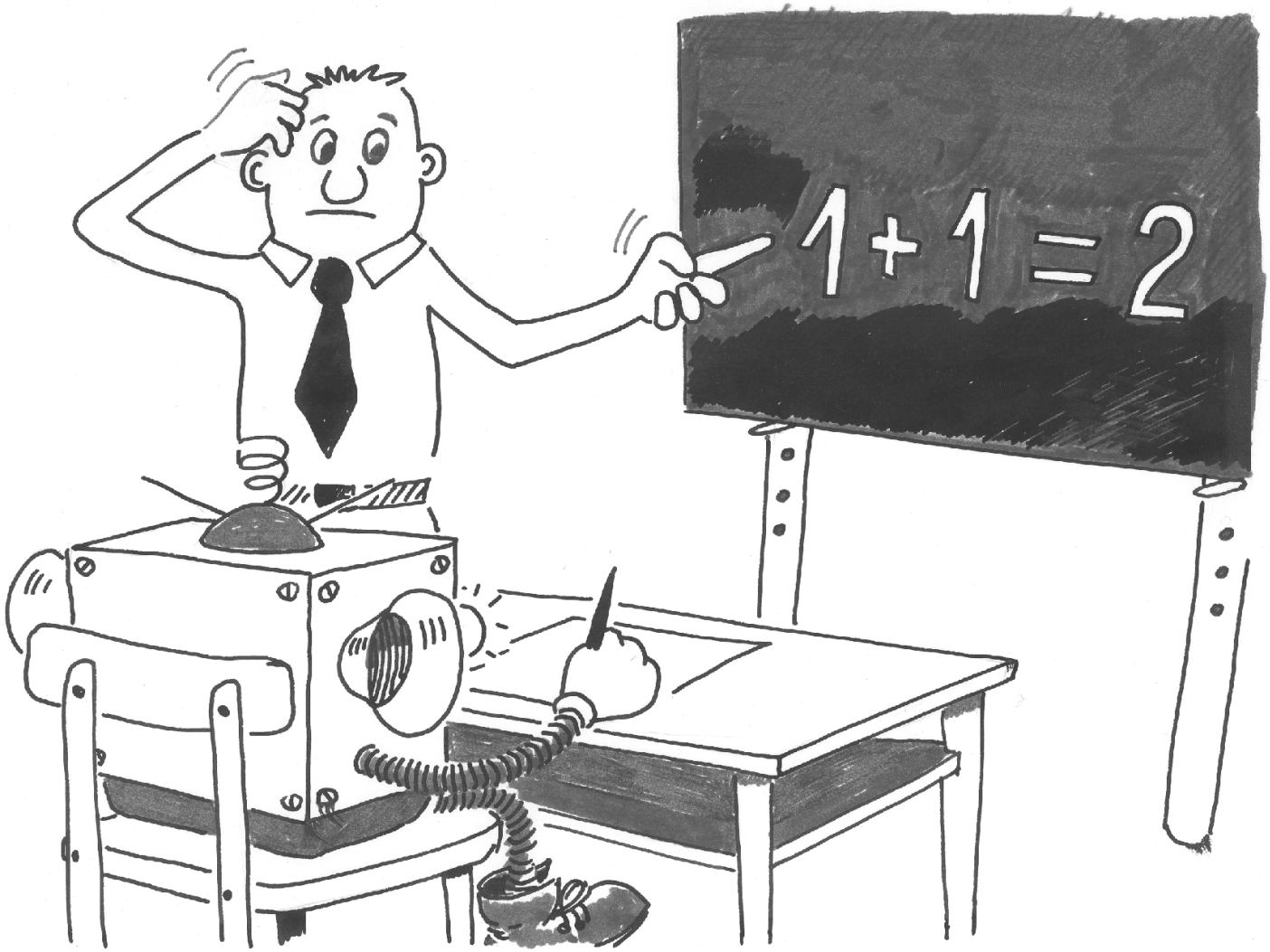
The approach used in DML-CZ

A succesfully built repository (e.g. set of *workflows*) needs a *coordinated* effort of *librarians*, *IT specialists* and representatives of users – *content specialists*.

Design, technical and *political decisions* behind building the *Czech Digital Mathematics Library DML-CZ* (<http://dml.cz>) in the context of other succesfull thematical community projects (PubMed Central, ADS, SCOAP3 and planned EuDML) have been solved. (No wheel reinvention.)

Our framework integrates workflow for the articles scanned from a paper (*math OCR*), for documents from retro-born digital period (data available in some type of electronic form) and for born-digital ones.

Math handling poses challenges—math OCR, math indexing,...



DML-CZ – data: scientific math published in Czech and Slovak

Proof. Let $\hat{K}$ be a cube, $\hat{K} \subset \hat{G}$; put $K = \varphi^{-1}(\hat{K})$. According to theorem 50 we have $K \in \mathfrak{A}$ and it follows from theorem 24 that

$$P(K, v) = \int_K f(x)\,\mathrm{d}x\,. \tag{89}$$

The functional determinant T of the mapping $\psi = \varphi^{-1}$ fulfils the relation $T(\varphi(x))\,.\,\det M(x) = 1$, so that

$$\int_K f(x)\,\mathrm{d}x = \int_{\hat{K}} f(\psi(y))\,.\,|T(y)|\,\mathrm{d}y = \int_{\hat{K}} \hat{f}(y)\,\mathrm{d}y\,. \tag{90}$$

From theorem 50 (and relation (86)) we see that $P(K, v) = P(\hat{K}, \hat{v})$; relations (89), (90) show therefore that $P(\hat{K}, \hat{v}) = \int_{\hat{K}} \hat{f}(y)\,\mathrm{d}y$, which completes the proof.

Remark. The reader may compare this paper with [6].

REFERENCES

[1] *V. Jarník:* Diferenciální počet, Praha 1953.
[2] *V. Jarník:* Integrální počet II, Praha 1955.
[3] *J. Mařík:* Vrcholy jednotkové koule v prostoru funkcionál na daném polouspořádaném prostoru, Časopis pro pěst. mat., *79* (1954), 3—40.
[4] *Ян Маржик* (Jan Mařík): Представление функционала в виде интеграла, Чехословацкий мат. журнал, *5* (80), 1955, 467—487.
[5] *J. Mařík:* Plošný integrál, Časopis pro pěst. mat., *81* (1956), 79—82.
[6] *Ян Маржик* (Jan Mařík): Заметка к теории поверхностного интеграла, Чехословацкий мат. журнал, *6* (81), 1956, 387—400.
[7] *S. Saks:* Theory of the integral, New York.

Резюме

ПОВЕРХНОСТНЫЙ ИНТЕГРАЛ

ЯН МАРЖИК (Jan Mařík), Прага.

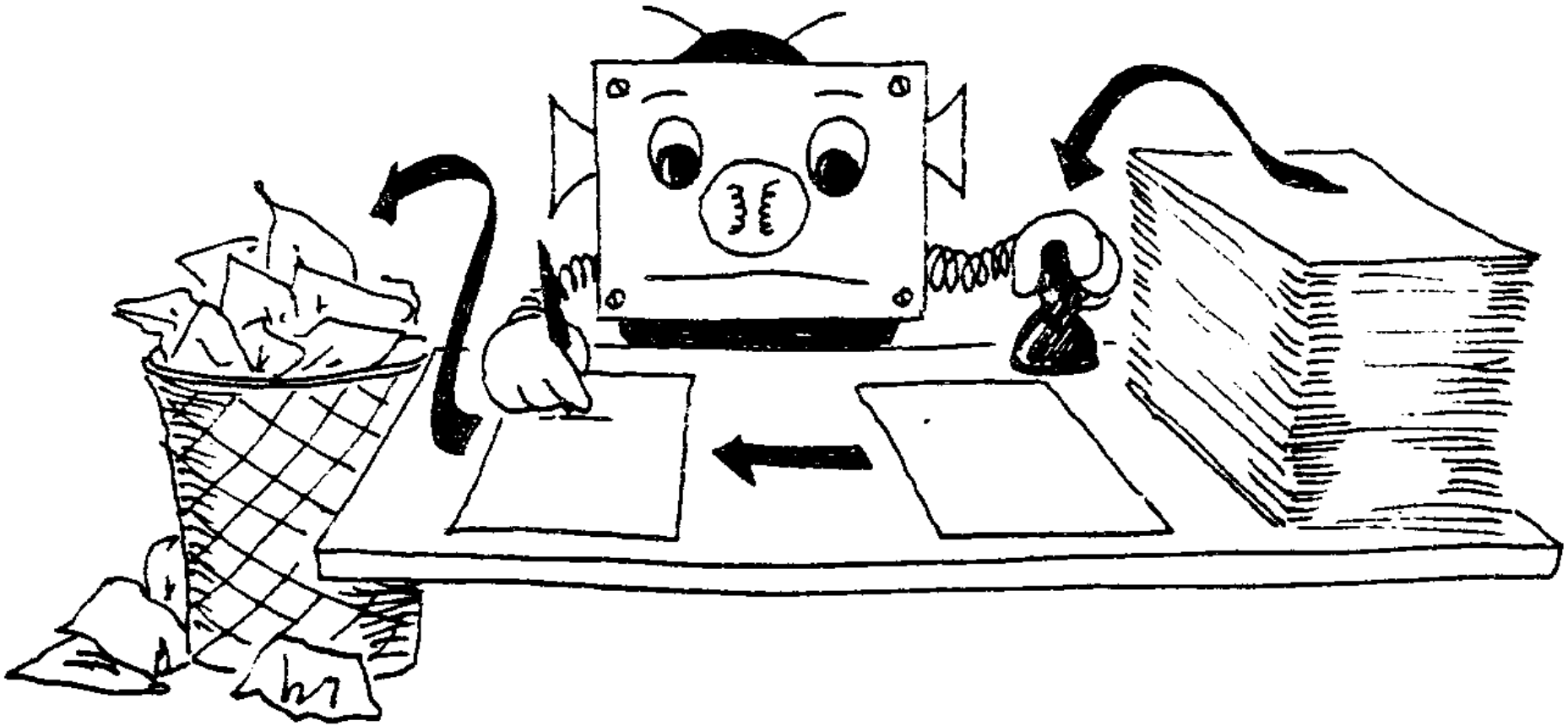
(Поступило в редакцию 10/X 1955 г.)

Пусть m — натуральное число; пусть E_m — m-мерное евклидово пространство. Для всякого ограниченного измеримого множества $A \subset E_m$ положим $\|A\| = \sup \int_A \sum_{i=1}^{m} \frac{\partial v_i(x)}{\partial x_i}\,\mathrm{d}x$, где $v_1, \ldots, v_m$ — многочлены такие, что $\sum_{i=1}^{m} v_i^2(x) \leqq 1$ для всех $x \in A$. Пусть $\mathfrak{A}$ — система всех ограниченных измеримых множеств A, для которых $\|A\| < \infty$. Теорема 18 тогда утверждает: *Пусть* $A \in \mathfrak{A}$; *пусть* D — *граница множества* A. *Тогда на системе* $\mathfrak{B}$ *всех борелевских подмножеств множества* D *существует мера* p *и на*

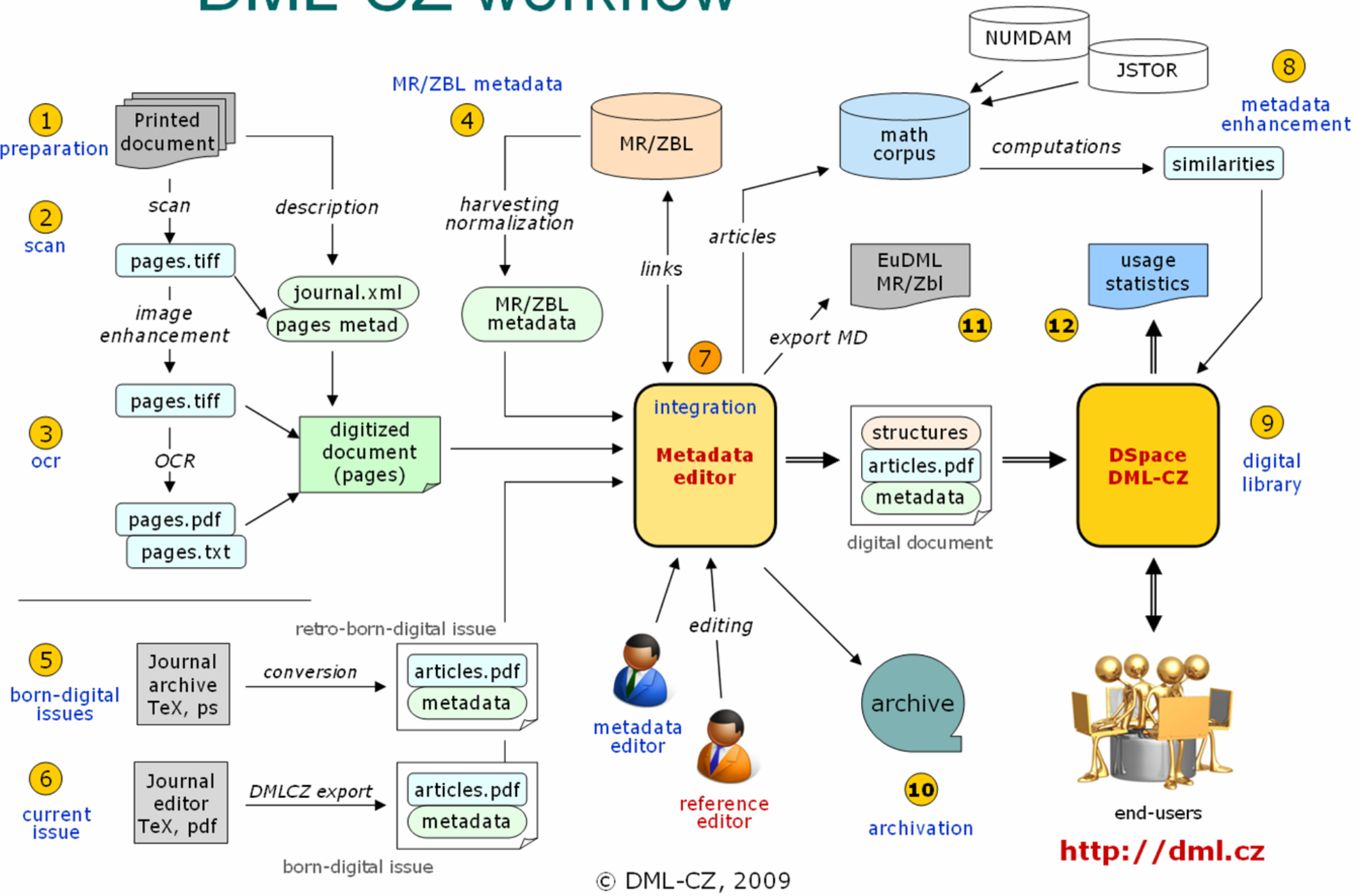
ИОСИФ ВИССАРИОНОВИЧ СТАЛИН

1879—1953

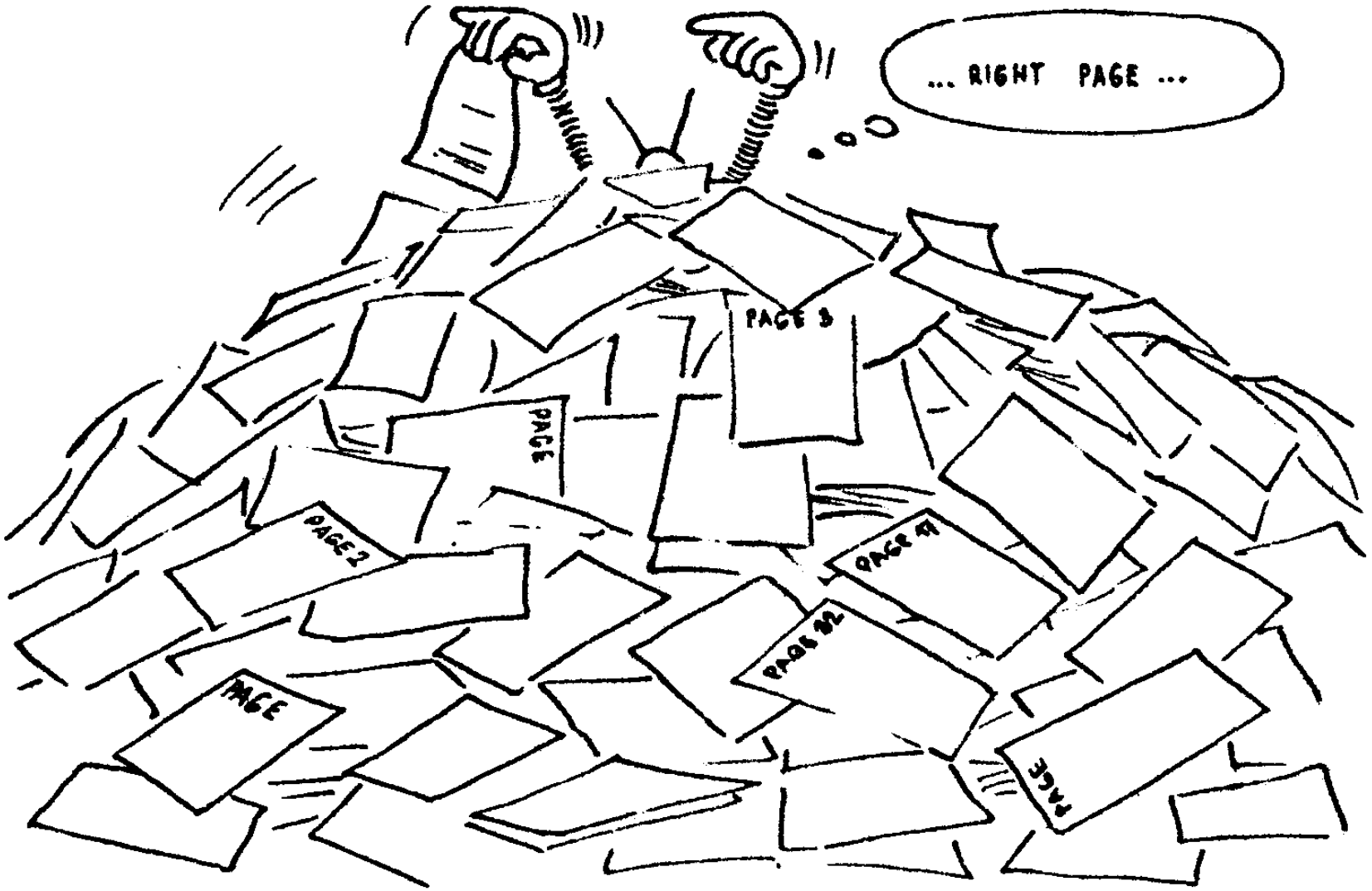
Document engineering—from paper to digital *workflow*



DML-CZ workflow



DML-CZ document engineering—data processing



DML-CZ now serves about *275,000 pages of math papers*.

Problems of *migration of existing workflows (born-digital, retro-digital) into the repository*. negotiations with Google Scholar towards better visibility, indexing and search, and problems of copyright and sustainability issues, visualization, space and processing demands,….

Document engineering—digitization, digital library development

MU expertize in [meta]data processing

Data heterogenity, plethora of formats, validation and conversions:

retro-digital period: scanning, geometrical transformations (BookRestorer), OCR (FineReader, InftyReader), two-layer PDF

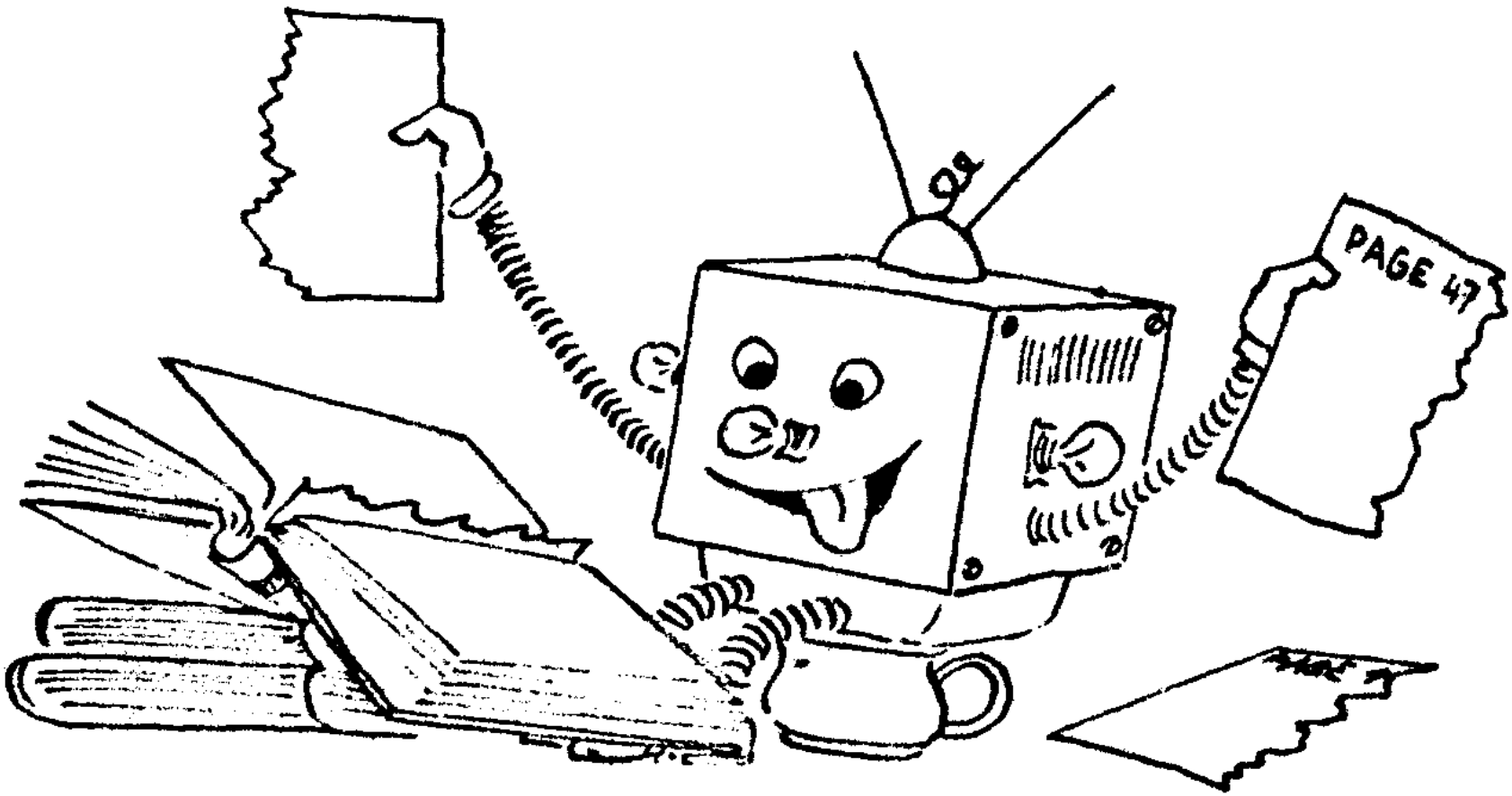
retro-born-digital period: not complete .tex or .dvi data, bad formats, bitmap fonts of low resolution

born-digital period: typesetting by TEX with export of [meta]data into digital library

world of authors: LATEX, TEX notation of mathematics

world of applications/data exchange: XML, MathML

DML-CZ document engineering—tools and challenges



Typesetting of papers and cover pages

- XeLaTeX, Charis SIL (many alphabets and characters in author names, cyrillic,...)
- `\usepackage{pdfpages}` or `pdftk` (annotations).
- TeX source generated from XML metadata (XSLT a perl), after validation of metadata full regeneration automatic (pipe of 7+ steps) `meta.xml` → `item.xml` → `item.tex` → `item.pdf` → ...

meta.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<article>
   <number>1</number>
   <status>completed</status>
  <title lang="fre">Sur quelques applications des dispersions
  <title lang="eng">On some applications of cetral dispersions
  <author id="BoruvO" order="1">Borůvka, Otakar</author>
   <language>fre</language>
   <msc>34C10</msc>
   <idMR>MR0197823</idMR>
   <idZBL>Zbl 0151.10804</idZBL>
   <idUlrych>19650001</idUlrych>
   <category>math</category>
   <range>7-26</range>
   <range_pages>1-20</range_pages>
   <access>true</access>
</article>
```

item.tex

```
\newlength{\vsx} \vsx=148mm
\newlength{\vsy} \vsy=205mm
\newcommand\toptitle{Archivum Mathematicum}
\newcommand\maintitle{Sur quelques applications des dispersion
\newcommand\mainauthors{Otakar Borůvka}
\newcommand\PURL{http://dml.cz/dmlcz/104576}
\documentclass{dmlcz}
\begin{document}
\copyrightholders{$\copyright$ Masaryk University, 1965}
\bibtoks{\textit{Archivum Mathematicum},
Vol. 1 (1965), No. 1, 1--20}

\dmltitlepage
\dmlpage{../page/0007}{121mm}{193mm}
\dmlpage{../page/0008}{118mm}{189mm}
\dmlpage{../page/0009}{118mm}{186mm}
...
\end{document}
```

Verified and proven technologies (in DML-CZ)

- scanned image processing and transformations (with BookRestorer) (BP Pulkrábek).
- mathematical optical character recognition: OCR (DP Panák, Mudrák, BP Vystrčil).
- digital signature of PDF: pdfsign (BP Peter Bočák).
- web-based long distance metadata editing: web application metadata editor (ÚVT MU Mirek Bartošek, Martin Šárfy, Vlasta Krejčíř, Petr Kovář); to be localized by Miha Filej for EuDML.
- optimization of PDF: pdfopt (from ghostscript), pdfsizeopt.py (by Peter Szabó).
- similarity article computations (research with Radim Řehůřek), demo.

Verified and proven technologies (cont.)

- retroborn paper automated classification by MSC (Radim Řehůřek).
- data vizualization, browsing: adaptation of Visual Browser (DP Zuzana Nevěřilová), will be offered for EuDML GUI.
- PDF recompression using JBIG2: application based on jbig2enc/leptonica (BP Radim Hatlapatka), offered for EuDML.
- math retrieval: math formula indexing and search (DP Vítězslav Dostál, BP Martin Liška, BP Peter Mravec) – possibly to offer for EuDML.
- citation linking: CiteCrawl (BP Lukáš Lalinský)

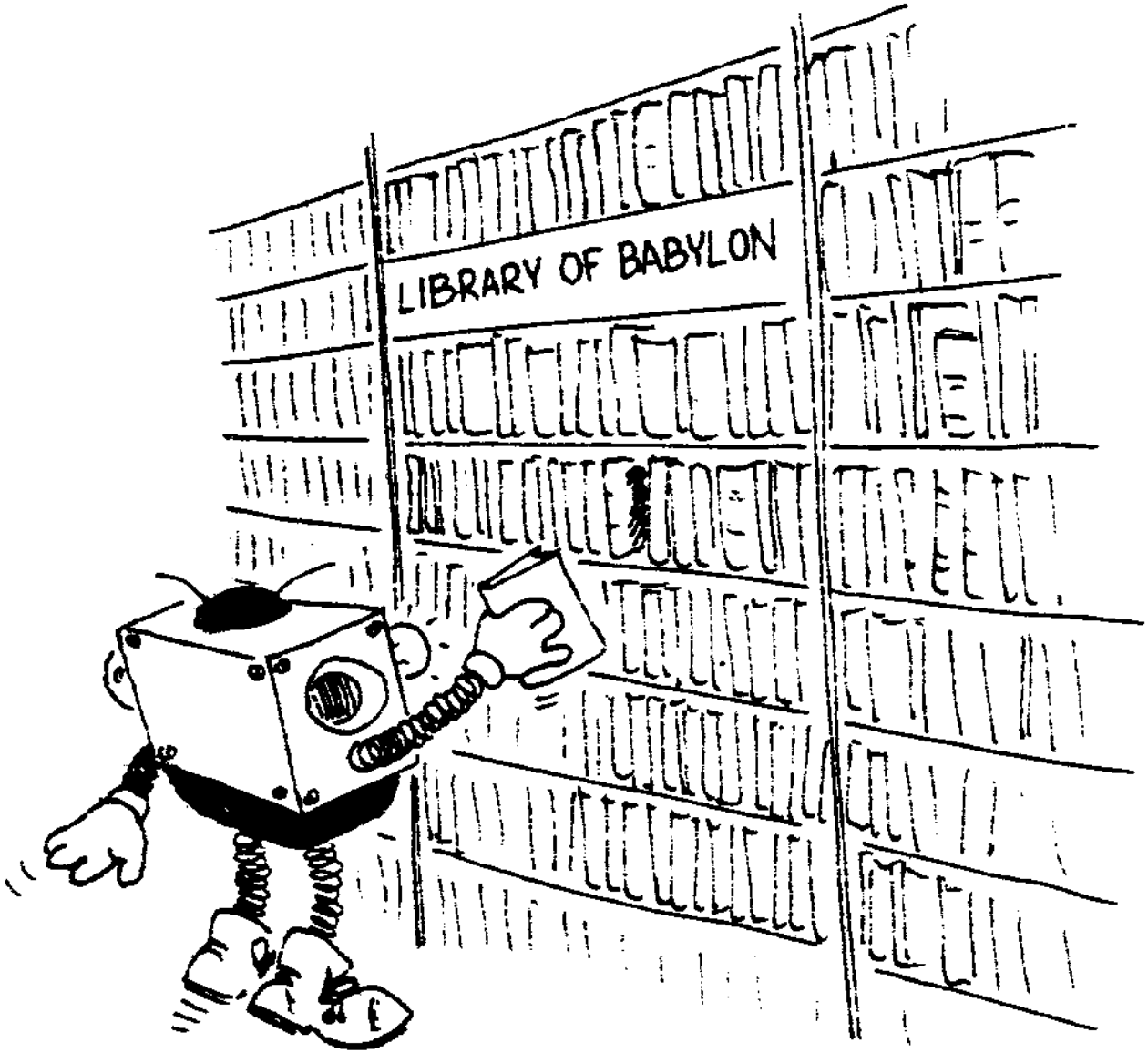
Verified and proven technologies (cont.)

- born-digital publishing system [for Archivum Mathematicum and other 4 journals] and conversions (BP&DP Michal Růžička), offered for EuDML.
- retro-born-digital paper conversions and enhancements (Michal Růžička), dtto.

open areas/challenges: multilingual retrieval?. MathML indexing using manatee/bonito?, math common sense?

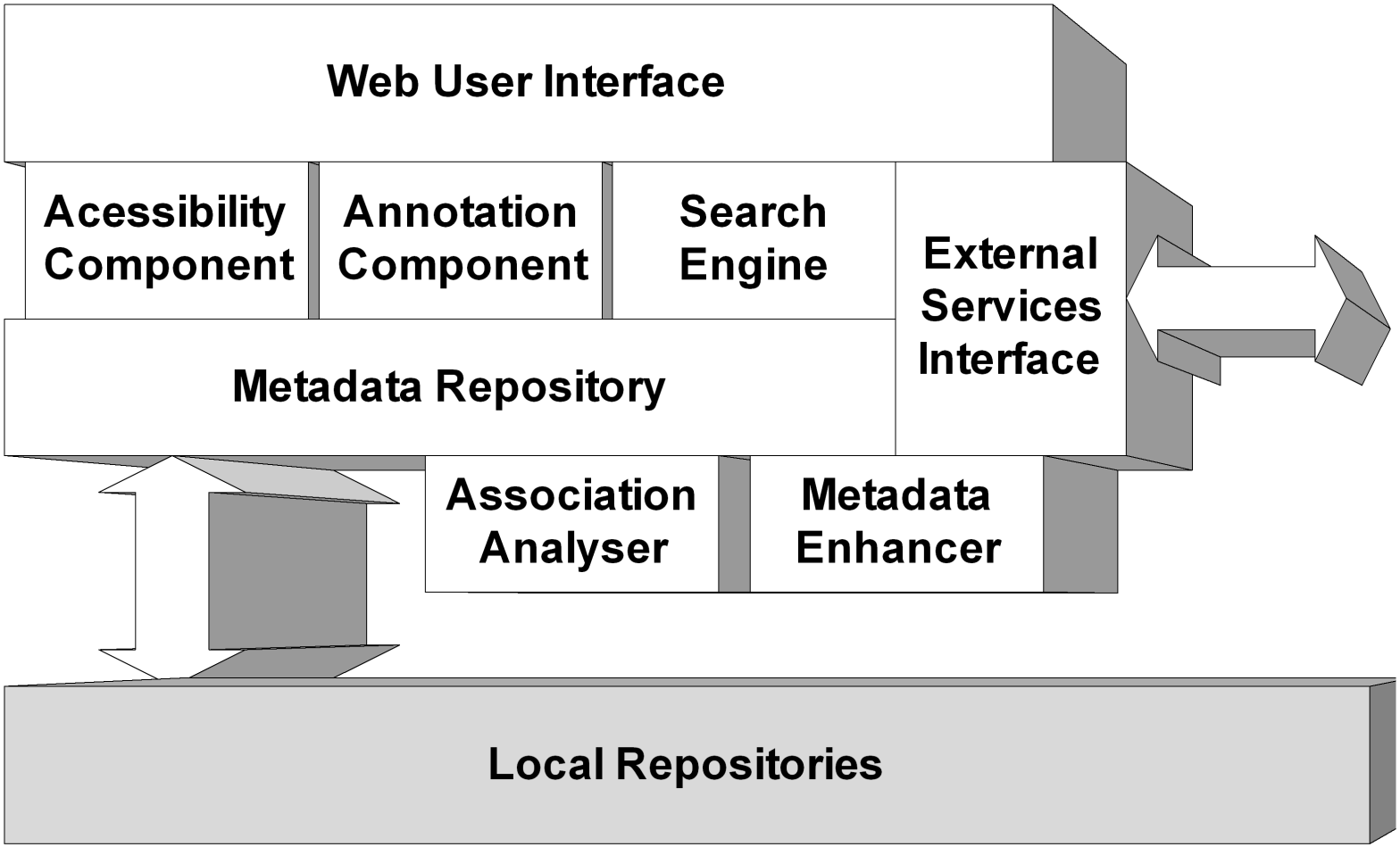
cooperation [problems above, `fixfont`, citation crawling, math OCR a indexing (BP/DP/PhD)] “wanted!” to develop, enhance and offer for EUDML.

Bottom up processing towards EU or worldwide scale



EuDML as a virtual library portal

EuDML will be a *virtual* library based on data from smaller data providers, DLs and publishers:



European Digital Mathematics Library

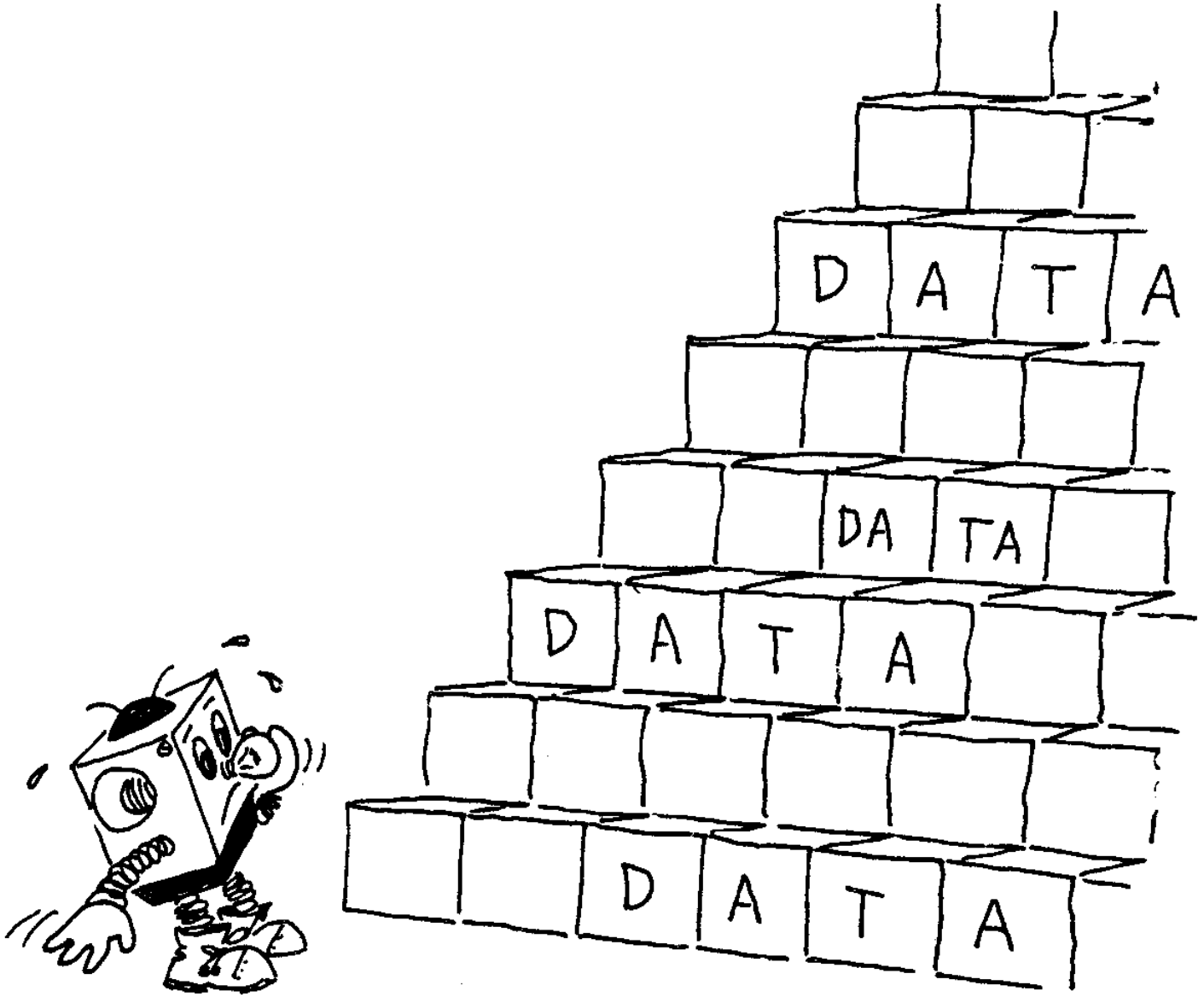
EuDML – data: legacy scientific math

- By 2013, EuDML should integrate *12 repositories*, have content from *200 integrated collections* (journals, book series, conference proceedings,…), more than *160,000 digital items* (papers, book chapters), *500,000 links between database objects*.
- It should be ‘live’ DL, having more than *1,000 users* contributing annotations, and more than *10,000 annotation* by 2013.
- Concept of *moving wall*: legacy data even from commercial publishers.

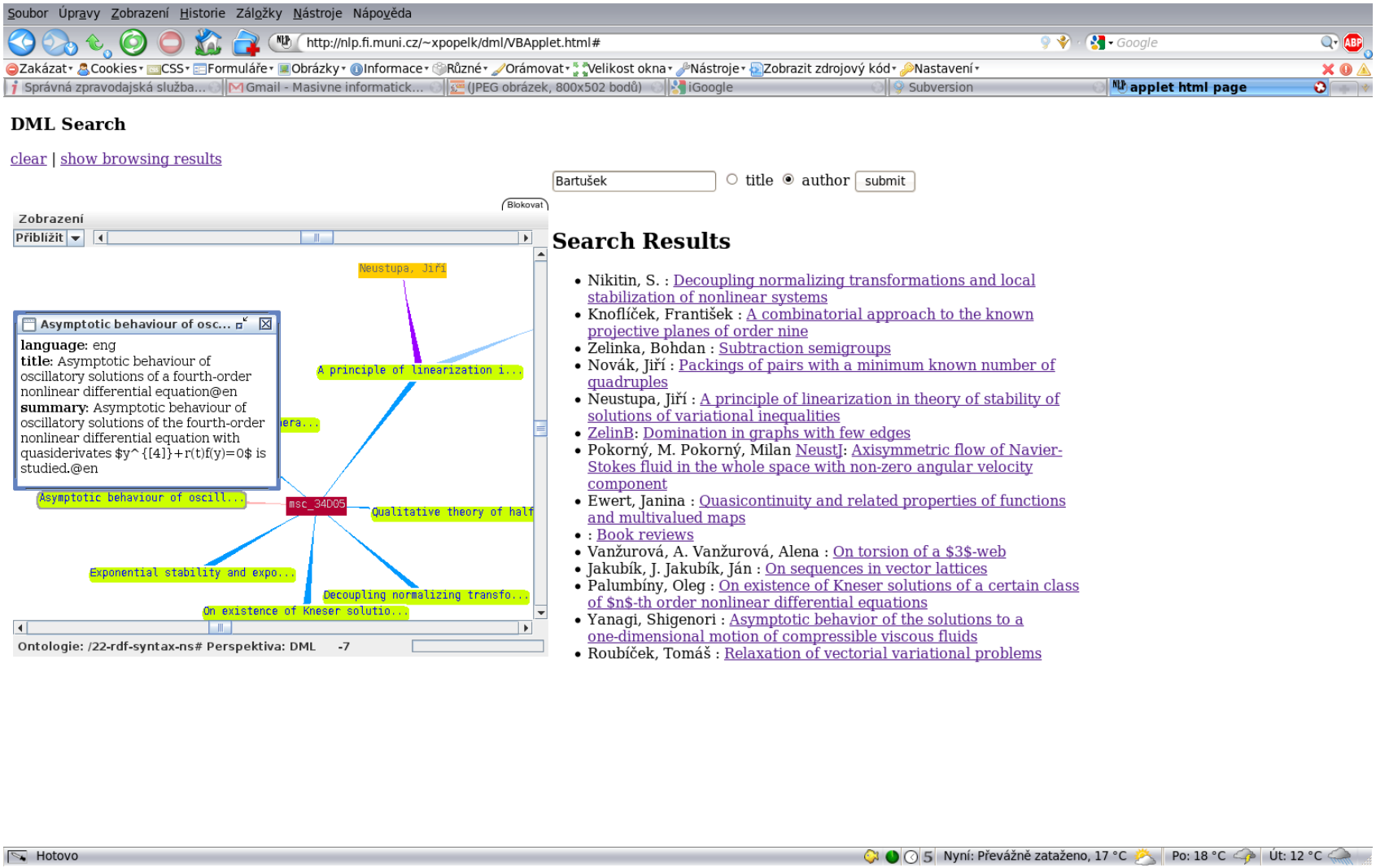
But how to actually implement it?

Experience from project partners from current digital library development.

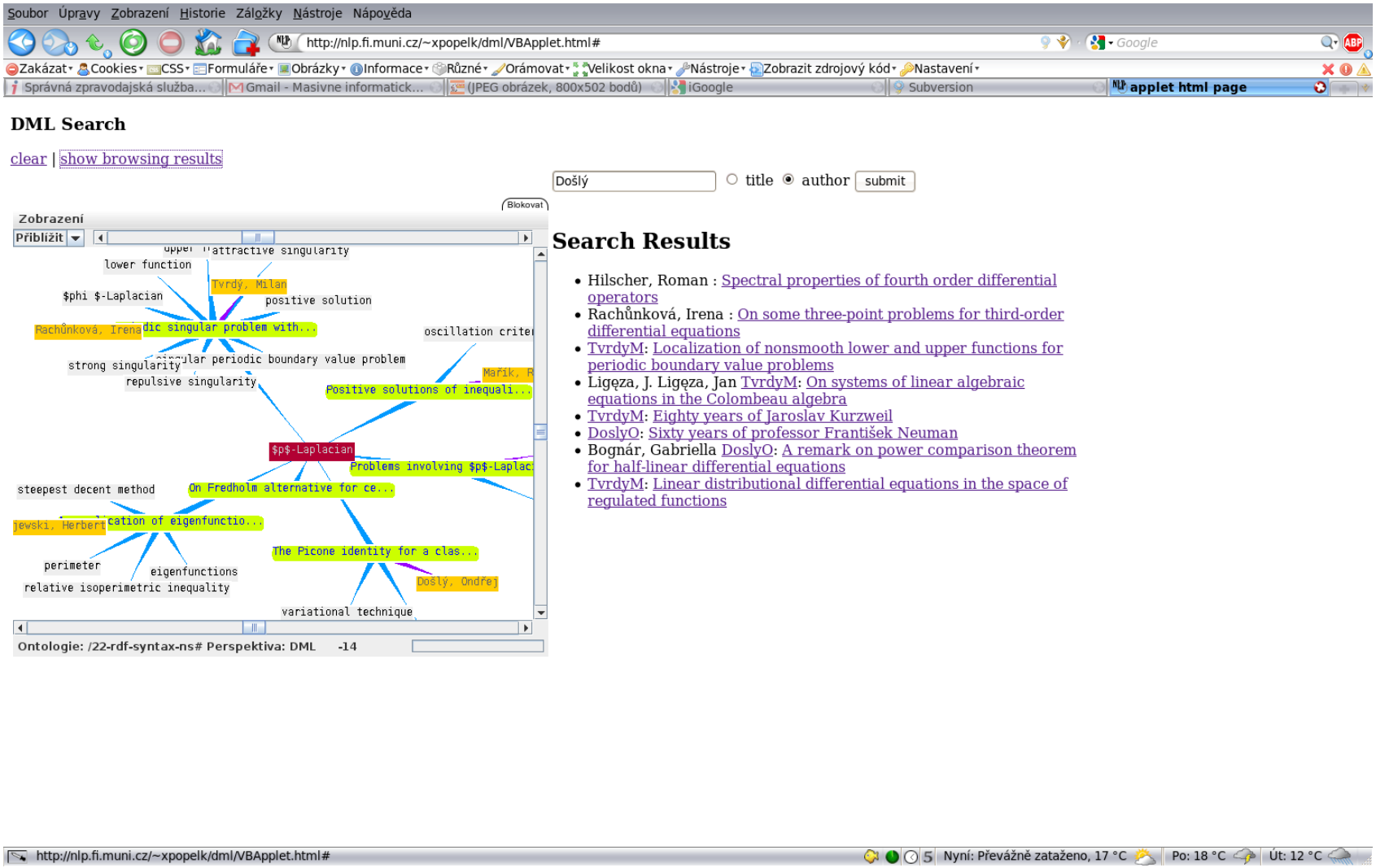
EuDML—from data collection to virtual digital library



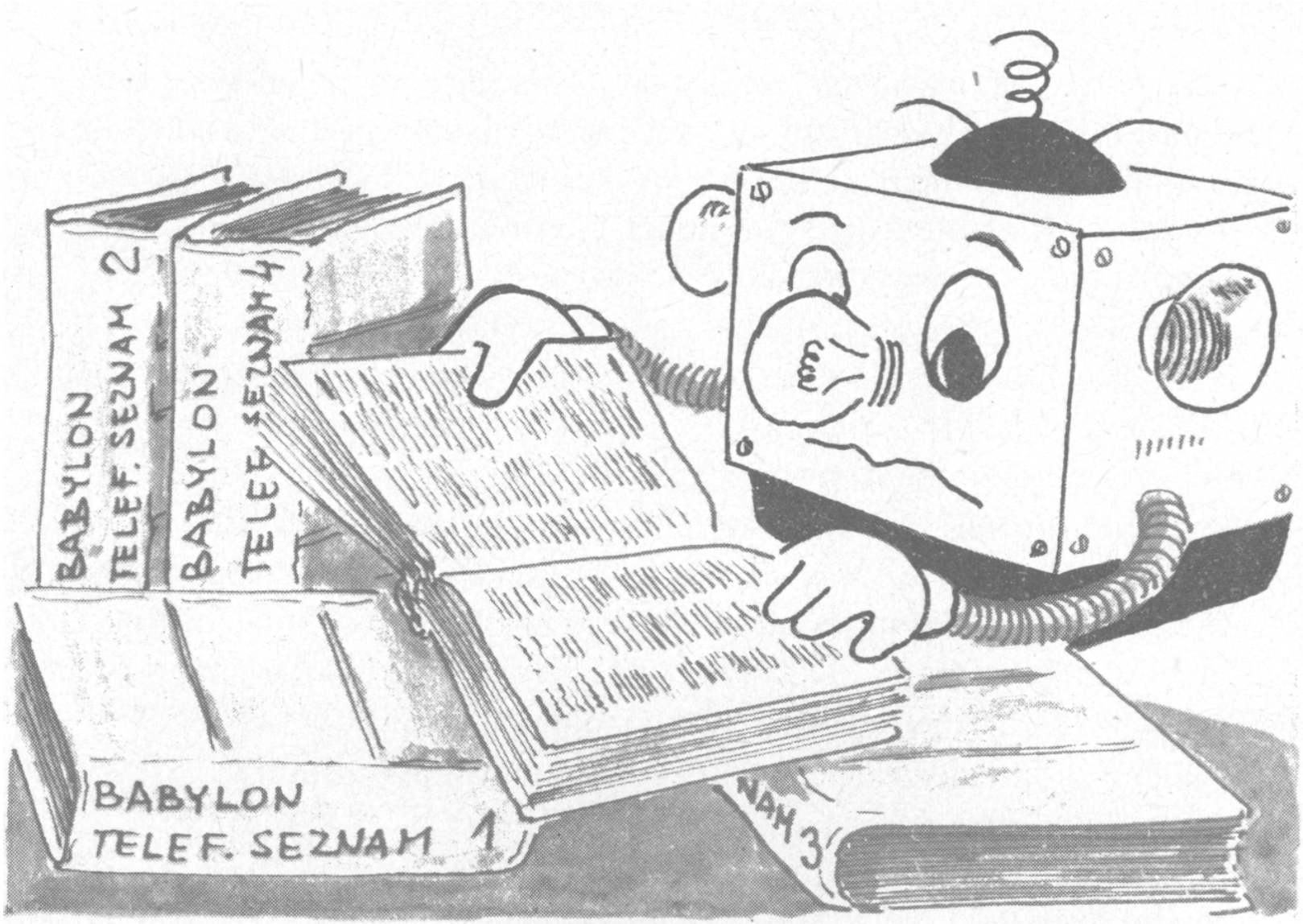
MU: alternative GUI—vizualisation research



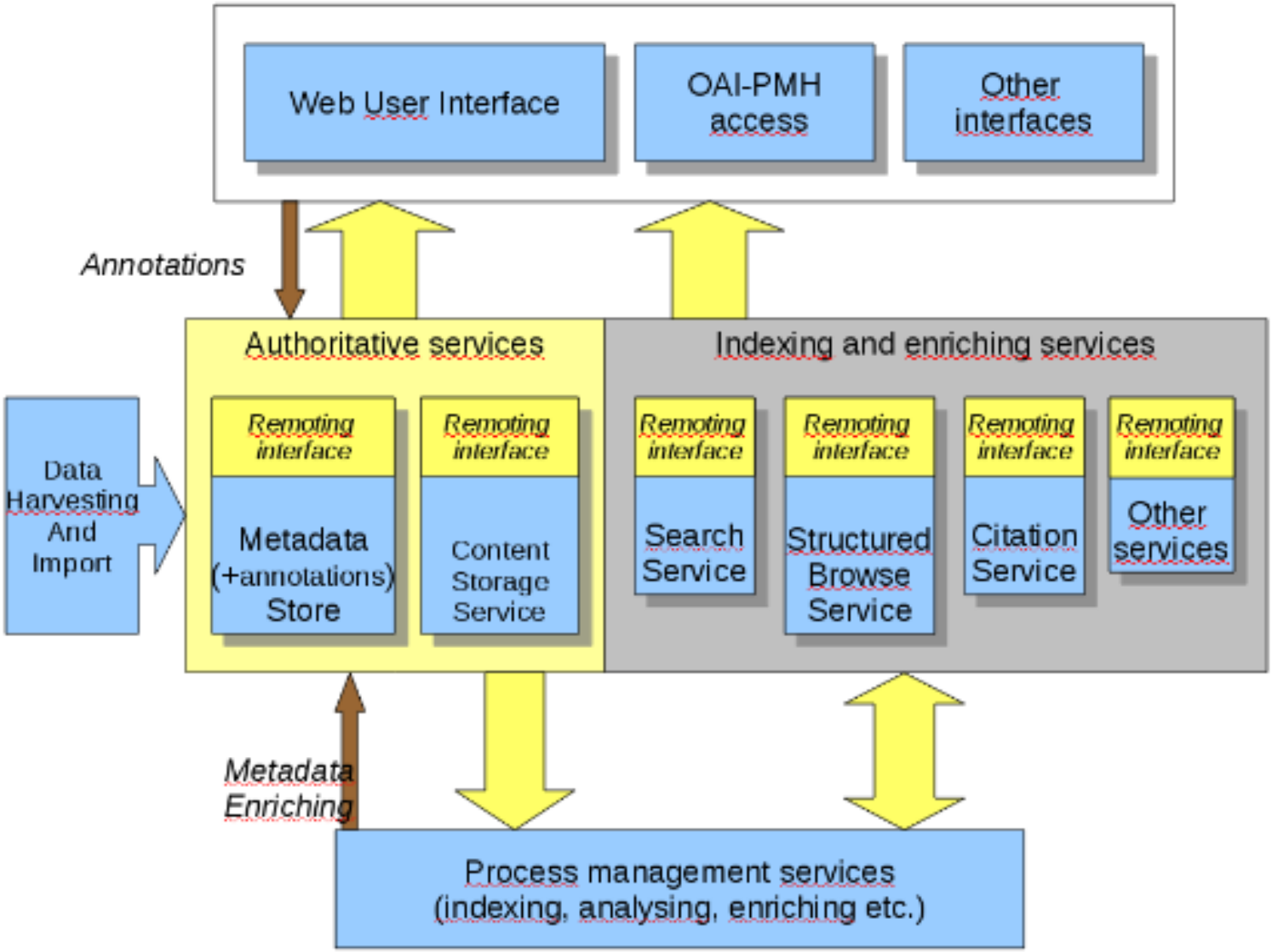
MU: Visual Browser dvelopment (DML-CZ)



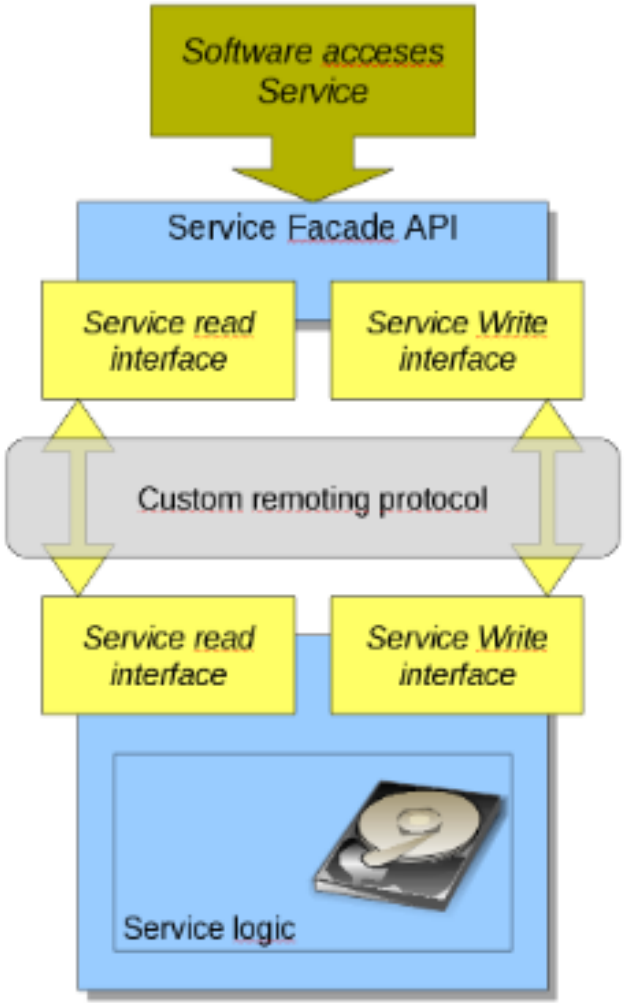
EuDML document engineering—scalable tools development



EuDML service based architecture



EuDML service based architecture II



based on existing YADDA (used in Driver, Driver II) and REPOX (used in EuropeanaLocal, Telplus) projects – both are verified and mature platforms (implemented in Java)

math specifics needed to develop (TEX to MathML converter, math OCR, math in metadata support,…

MU offers: Metadata editor and other tools and expertize, mainly to be used in *WP7 Metadata Enhancements*

PDF Re-compression

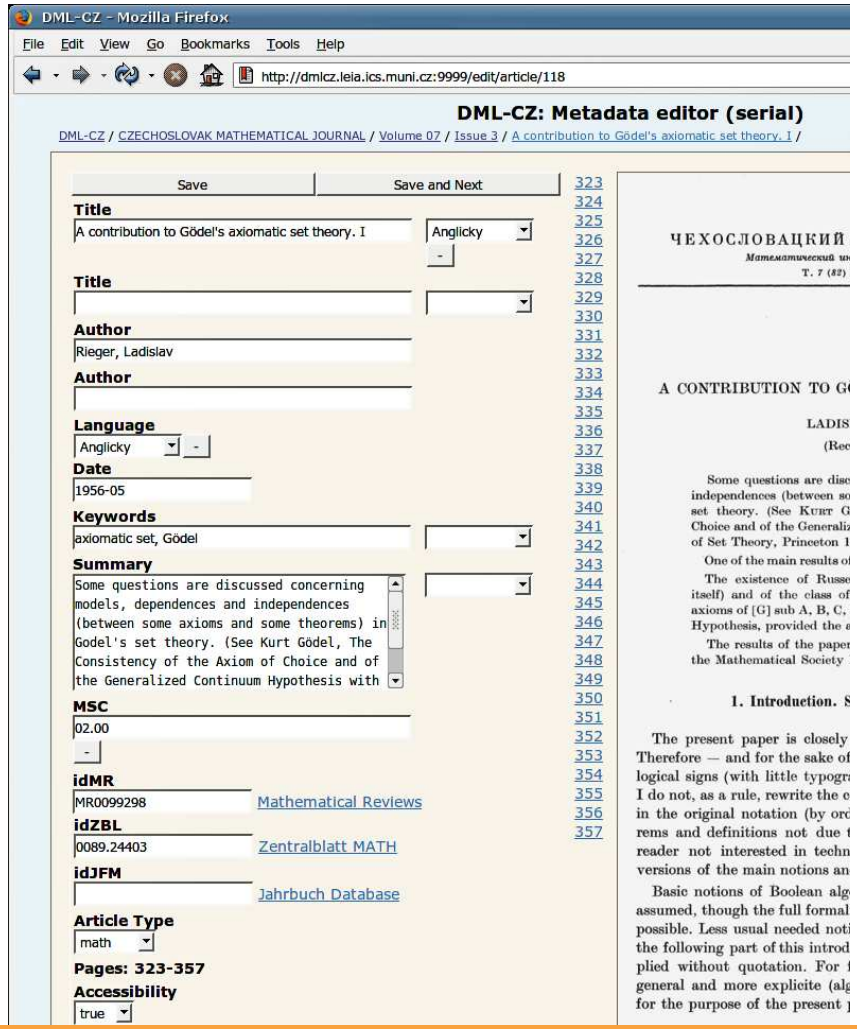
New tools developed (with Radim Hatlapatka) to re-compress [bitonal] PDF files:

	Original PDF	After using PDF re-compressor	After using pdfsizeopt.py	After both
Size of whole PDF	100%	74.61%	50.02%	40.23%
Size of image and other objects	69.46%	37.14%	45.14%	35.36%

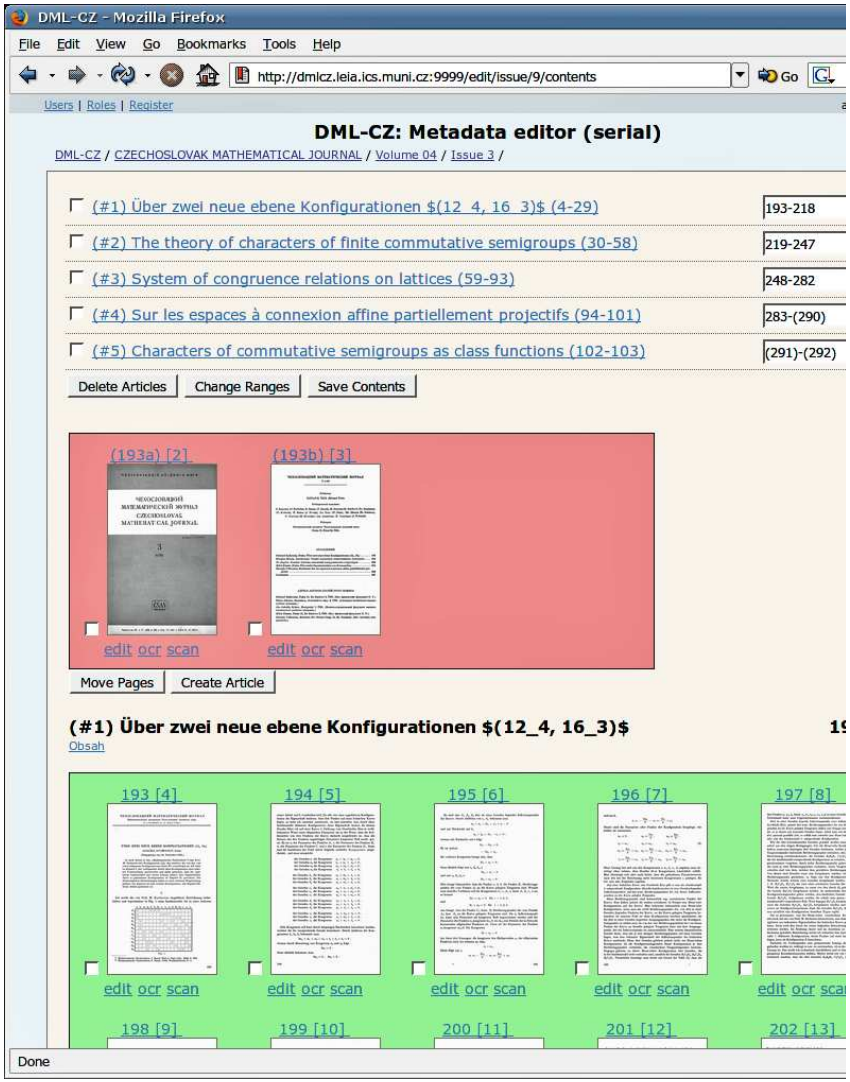
May be used for any PDF 1.4 (since Acrobat 5 released in 2001) file—JBIG2 compression.

Metadata Editor http://editor.dml.cz

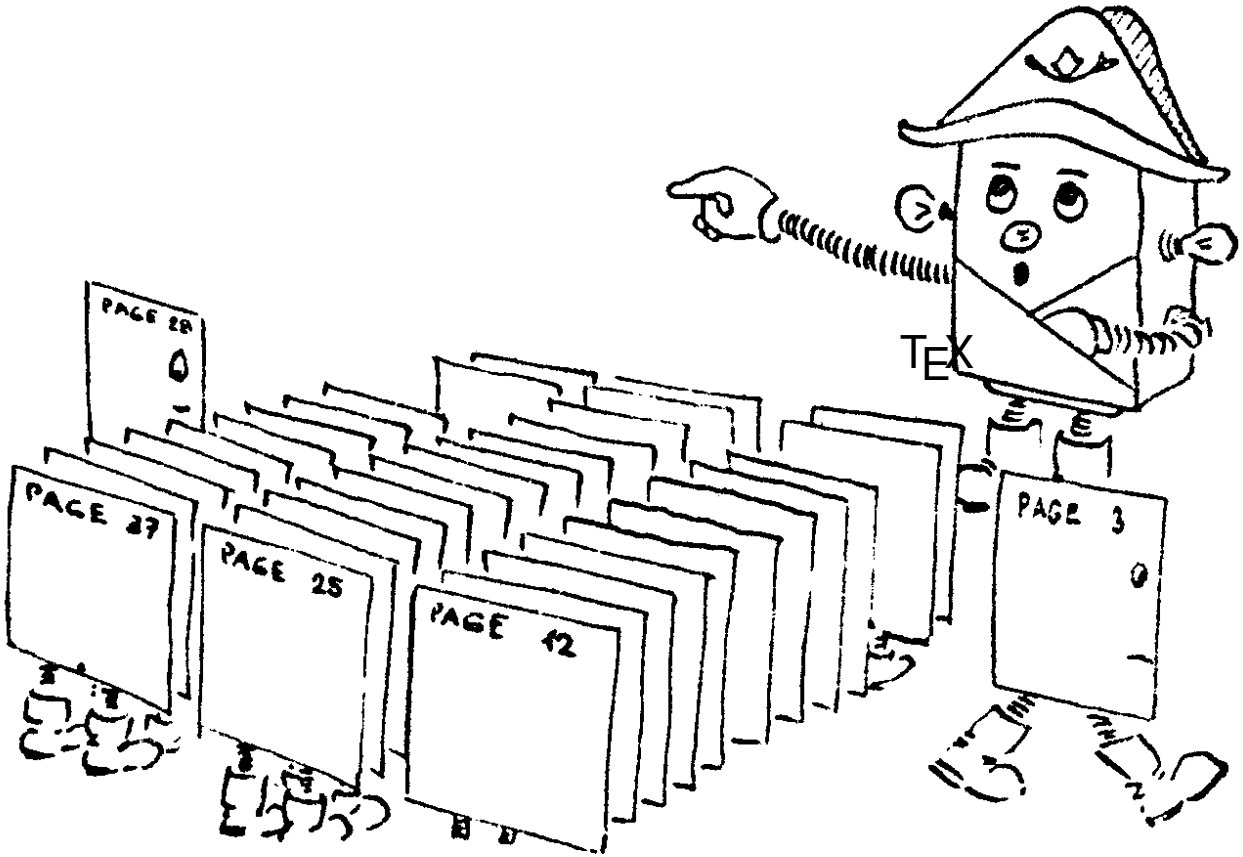
Web-based client-server tool, developed (ICS MU) from scratch (Ruby) for [meta]data import, editing, validation and checking.



Metadata Editor localization (Miha Filej)



Yes, you can!



Summary

EuDML: work in progress, based on DML-CZ experience and tools developed at FI and ICS during last 6 years.

Current activities: WP4&5 meeting in Warsaw, 4+ papers for forthcoming DML 2010 workshop (deadline today ;-), accepted paper at LREC 2010 (with Radim Řehůřek)…

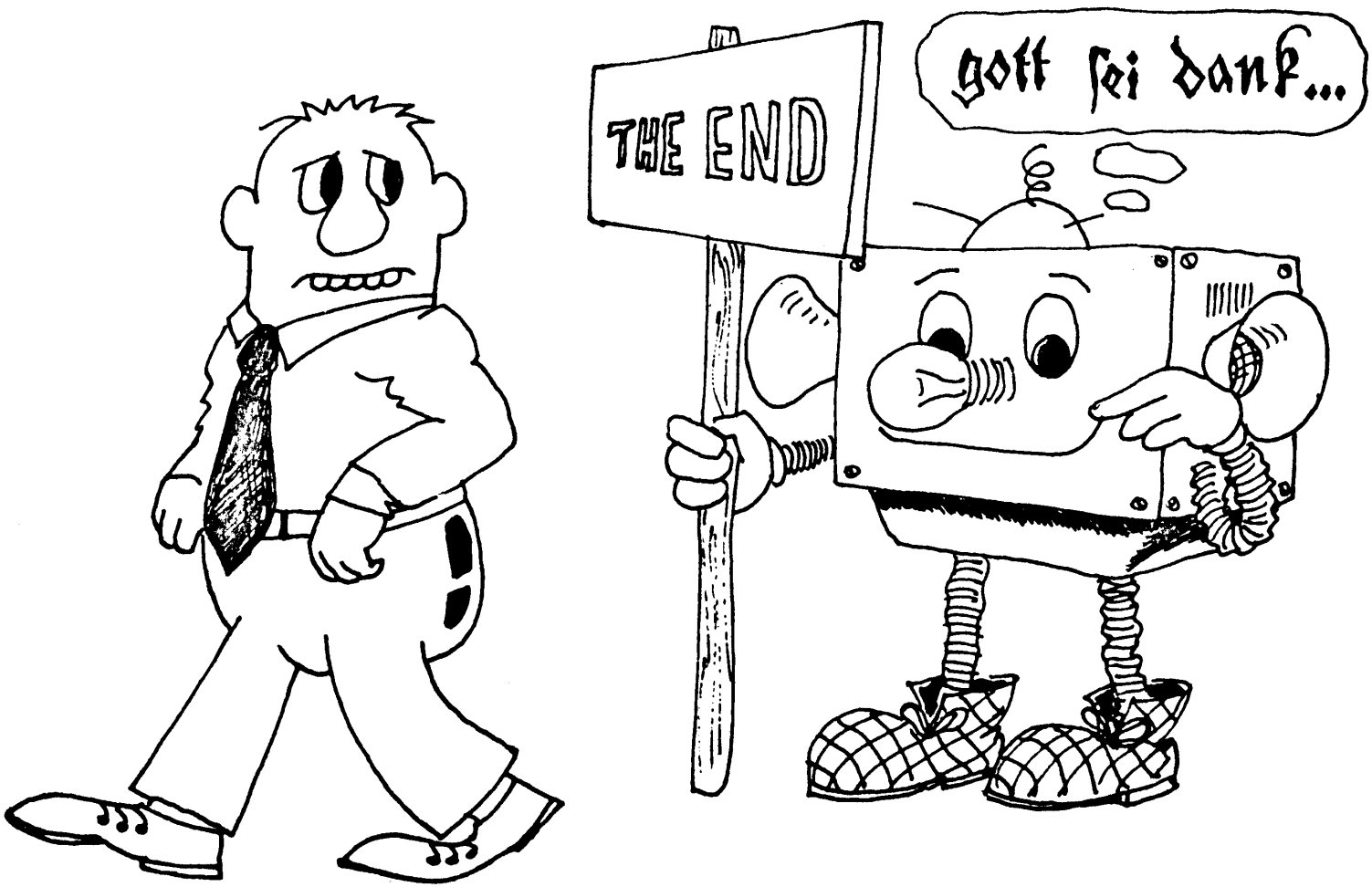
Next activities: EuDML general meeting in Paris in July (c/o CICM 2010, DML 2010), WP7 technical meeting, tool implementation.

DML 2010 organization: <http://www.fi.muni.cz/ sojka/dml-2010.html>

Working meetings at MU every Wednesday, 2pm.

Comments, cooperation offers welcome!

End of the talk



Questions?

References, links

DML-CZ team.
Materials about DML-CZ, project publications [online, cit. 2010-05-4].
<http://project.dml.cz/documents.html>.

EuDML team.
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