The Art, Science, and Engineering of Typography

‹ Programming › 2026

Didier Verna ‹ didier@didierverna.net ›

March 19

didierverna.net

@didierverna

didier.verna

in/didierverna

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0

Build 2026-03-19 16:54:08+01:00

The Art, Science, and ~~Engineering~~Craftsmanship of Typography

‹ Programming › 2026

Didier Verna ‹ didier@didierverna.net ›

Classes, Styles, Conflicts: the Biological Realm of LaTeX. *TUG 2010*.
Biological Realms in Computer Science. *Onward! 2011*.

didierverna.net

@didierverna

didier.verna

in/didierverna

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0

Build 2026-03-19 16:54:08+01:00

Plan

Writing

Printing

The Digital Transition

Conscientious Typography

Future

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Plan

Writing

Printing

The Digital Transition

Conscientious Typography

Future

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Proto-Writing *vs.* Writing

- **Proto-writing**: → end of 4th millennium B.C.
  - Meaning independent from spoken tongue
  - No grammar
  - Limited expression of thought
- **Writing**: end of 4th millennium B.C. →
  - Introduction of a phonetic component
  - ⚠ Does not necessarily mean alphabet

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Non-Alphabetic Systems (Isolates)

Sumerian

Source: Wikimedia Commons

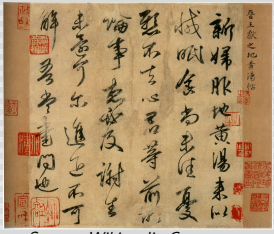
- 3200 B.C.
- Mesopotamia
- Oldest written language known
- Cuneiform

Hieroglyphs

Source: Wikimedia Commons

- 3200 B.C.
- 👉 Not (only) logograms

Hanzu (漢字)



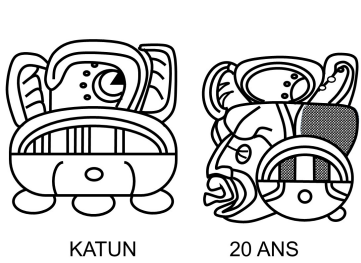
Source: Wikimedia Commons

- 1300 B.C.
- Oldest writing system still in use
- 2nd most used system in the world
- 👉 Not (only) ideograms

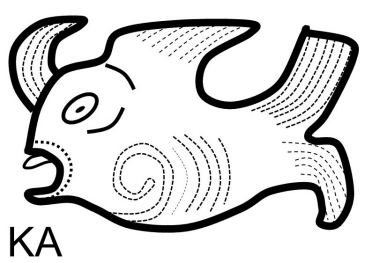
Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Maya

- 3rd century B.C.
- Logosyllabic writing system



Source: Wikimedia Commons



Source: Wikimedia Commons

Source: Wikimedia Commons

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

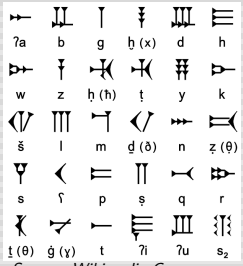
Alphabetic Systems: “abjads” (consonantic)

Protosinaïtic

Source: Wikimedia Commons

- From hieroglyphs
- Common ancestor

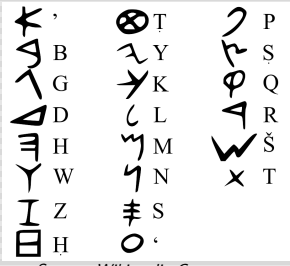
Ougaritic



Source: Wikimedia Commons

- 13th century B.C.
- Cuneiform
- Alphabetic order

Phœnician



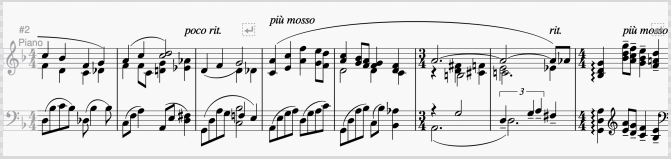
Source: Wikimedia Commons

- 10th century B.C.
- Ancestor of Greek

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Volumen (horizontal) & Rotulus (vertical)

- 3000 B.C.
- Potentially long
- Small columns
- Disadvantage: linear reading
- Rebirth
  - Web (vertical, plus hyperlinks)
  - Music (horizontal scroll)



Tora, Köln (source:Wikimedia Commons)

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Codex

- Bound manuscript (wood → parchment)
- 1st century (Rome), apogee 5th century
- 👉 Reading paradigm shift

Source: Wikimedia Commons

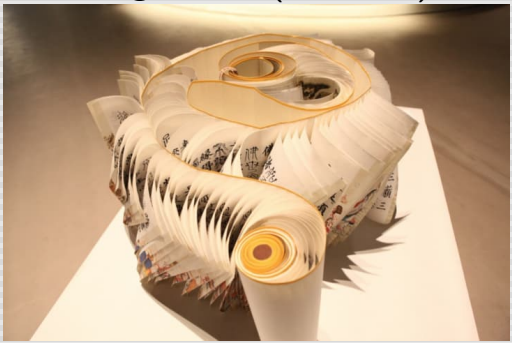
Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

The Art of Binding

Accordion / Fan (Concertina)

Orihon (折本) (source:Wikimedia Commons)

Dragon Scale (Whilrwind)



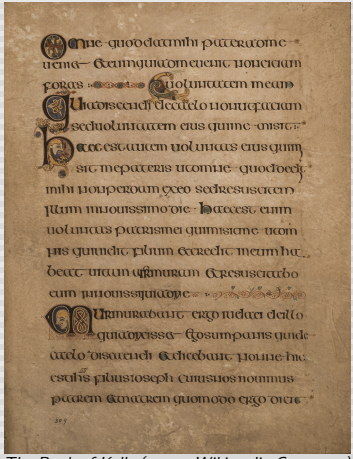
Courtesy of Sin Sin Fine Art

Video

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

From Codex to Book

- Readability
  - Separation between words: 7th century
  - Ponctuation: Middle Ages
  - Minuscule writing: 9th century
    Uncial → *Carolingian Minuscule*
  - Paragraph mark (Capitulum): 11th century
- Organization
  - Table of contents: Middle Ages
  - Index: 13th century
  - Pagination / numbering: 1470
  - Title page: 1475

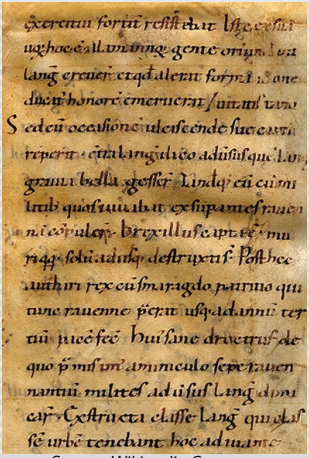


The Book of Kells (source:Wikimedia Commons)

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

From Codex to Book

- Readability
  - Separation between words: 7th century
  - Ponctuation: Middle Ages
  - Minuscule writing: 9th century
    Uncial → *Carolingian Minuscule*
  - Paragraph mark (Capitulum): 11th century
- Organization
  - Table of contents: Middle Ages
  - Index: 13th century
  - Pagination / numbering: 1470
  - Title page: 1475

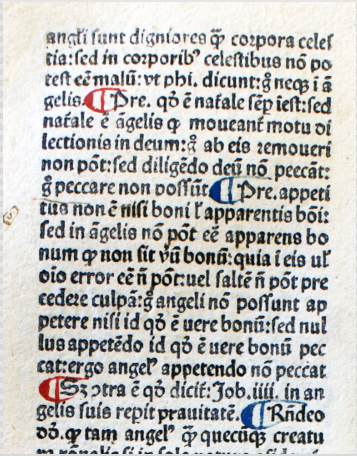


Source: *Wikimedia Commons*

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

From Codex to Book

- Readability
  - Separation between words: 7th century
  - Ponctuation: Middle Ages
  - Minuscule writing: 9th century
    Uncial → Carolingian Minuscule
  - Paragraph mark (Capitulum): 11th century
- Organization
  - Table of contents: Middle Ages
  - Index: 13th century
  - Pagination / numbering: 1470
  - Title page: 1475



Summa theologica, Venise (source:Wikimedia Commons)

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Plan

Writing

Printing

The Digital Transition

Conscientious Typography

Future

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Xylography & Bloc Printing

- Ink → tissue (Han dynasty, 220) / paper
- Spreads rapidly to Japan & Korea
- Similar techniques: central Asia (12th century), Europe (14th century)

Diamond Sutra, 9th century (source:Wikimedia Commons)

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Movable Type

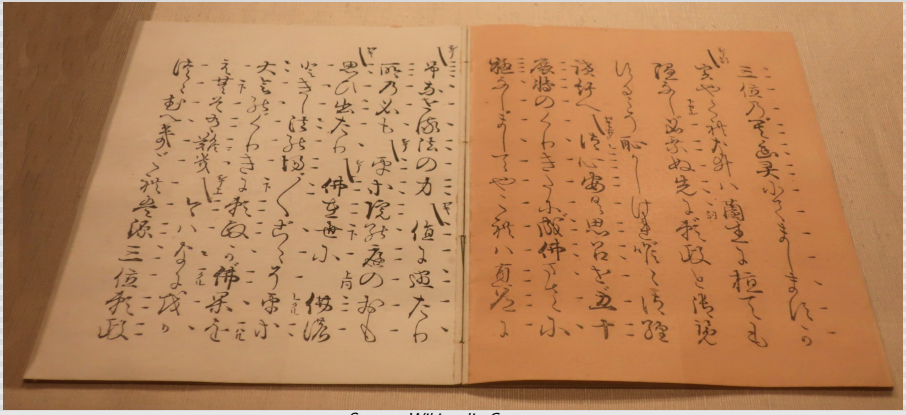
- 1040, Song dynasty
- Ceramic, wood, bronze
- ⚠ **But takes centuries to spread**
  - Cheap workforce
  - Number of characters
  - Ligatures
- 1439: Gutenberg, Mainz (Germany)
- ⚠ Breaking: Procopius Waldvogel (France) may have predated Gutenberg

Jikji, Korea, 1377 (source:Wikimedia Commons)

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Saga-bon (嵯峨本)

- Booklet of Nô theater (1608)
- Semi-cursive writing form (“Renmen Taï”)
- Ligatures of 2 to 4 characters, 2100 characters / 16% used only once



Source: Wikimedia Commons

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

The “B42” (1455)

Source: Wikimedia Commons

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0

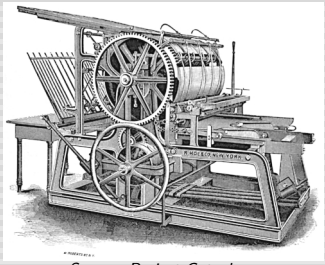
Presses

Flat-Bed

Source: Wikimedia Commons

- Gutenberg press
- Crucial invention

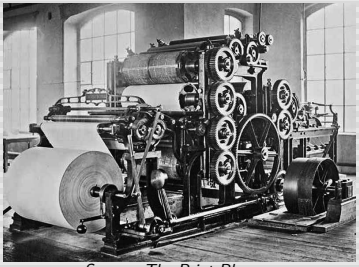
Cylinder



Source: Project Gutenberg

- 1780 (France)
- Round on flat
- *Wharfdale Stop Cylinder Press*

Rotary



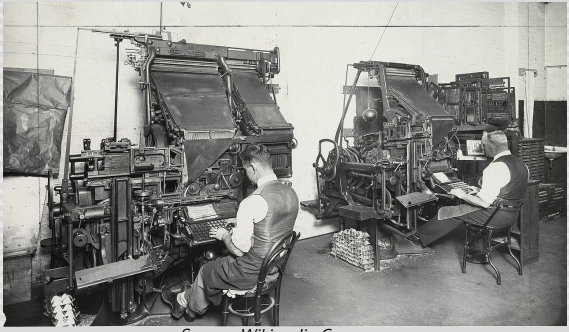
Source: The Print Blog

- 1832 (Times: 1853)
- Round on round

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Funny Machines: Linotype (Line o' Type)

- Late 19th century – 1980
- "Hot Metal", partial automation of the compositor's job



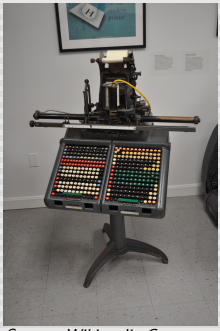
Source: Wikimedia Commons

Video

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

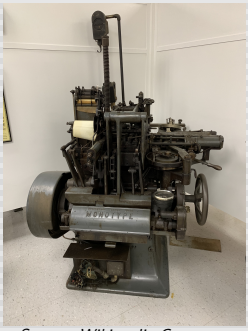
Funny Machines: Monotype

- Late 19th century
- Two machines communicating via punched paper rolls



Source: Wikimedia Commons

Keyboard



Source: Wikimedia Commons

Caster

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Funny Machines: Lumitype

- French invention (1946)
- Photocomposition “cold”, algorithmic justification

Source: Wikimedia Commons

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

The End. The Beginning.

- *The Last Punch Cutter*
- *Farewell, Etaoin Shrdlu*

  Last hot metal impression of the NY Times (July 1st 1978)

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Plan

Writing

Printing

The Digital Transition

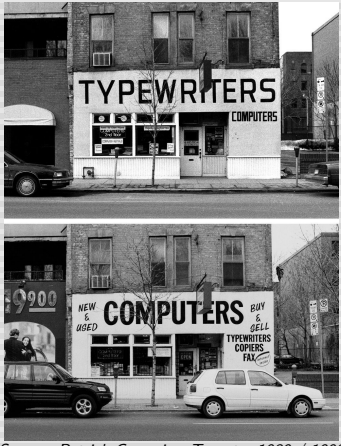
Conscientious Typography

Future

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Transition

- 1900: Manuscript letters & Printed books
- 1950: Typewriters & Comms (ads, signage, *etc.*)
- **Transition factors**
  - Keyboards (Linotype, typewriters)
  - Encoding (Monotype)
  - Algorithms (Lumitype)
- **Convergence factors**
  - 1960: Time sharing systems → interactive typesetting
  - 1980: PC & laser printing → display/print unification
  - Collaborations
    - Academy / industry (SIGGRAPH, ATypI, …)
    - Scientists / typographers (Knuth & Zapf, …)

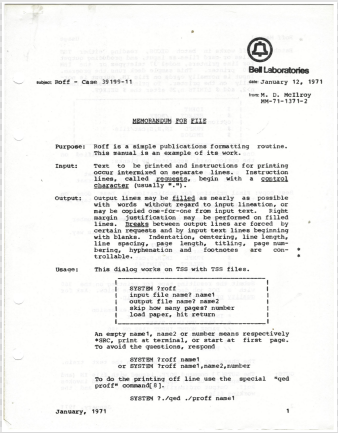


Source: Patrick Cummins, Toronto, 1989 / 1998

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Challenges

- New
  - Digital fonts & typesetting algorithms
    Craftsmanship → Science
  - Typographer ≠ Computer scientist
- Antagonistic
  - Quality: craftsmanship & science for art
    TEX & METAFONT
  - Quantity: mass production
    Financial & commercial concerns



Bell Laboratories

subject: Roff - Case 35195-11

date: January 12, 1971

from: M. D. McIlroy
MM-71-1371-2

MEMORANDUM FOR FILE

Purpose: Roff is a simple publications formatting routine. This manual is an example of its work.

Input: Text to be printed and instructions for printing occur intermixed on separate lines. Instruction lines, called requests, begin with a control character (usually ".").

Output: Output lines may be filled as nearly as possible with words without regard to input lineation, or may be copied one-for-one from input text. Right margin justification may be performed on filled lines. Breaks between output lines are forced by certain requests and by input text lines beginning with blanks. Indentation, centering, line length, line spacing, page length, titling, page numbering, hyphenation and footnotes are controllable.

Usage: This dialog works on TSS with TSS files.

```
SYSTEM ?roff
input file name? name1
output file name? name2
skip how many pages? number
load paper, hit return
```

An empty name1, name2 or number means respectively *SRC, print at terminal, or start at first page. To avoid the questions, respond

```
SYSTEM ?roff name1
```

or SYSTEM ?roff name1,name2,number

To do the printing off line use the special "qed proff" command[8];

```
SYSTEM ?./qed ./proff name1
```

January, 1971 1

Source: Douglas McIlroy's BCPL Roff Manual

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Current Situation 😭

- Automation
  Complete dehumanization
- Externalization (Divide and Conquer)
  Service providers, compartmentalization, loss of global view
- “Home Print Shop” phenomenon
  Race to the bottom

Observation

Hundreds of typographical defects in almost every book from almost every major professional publisher today.

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Plan

Writing

Printing

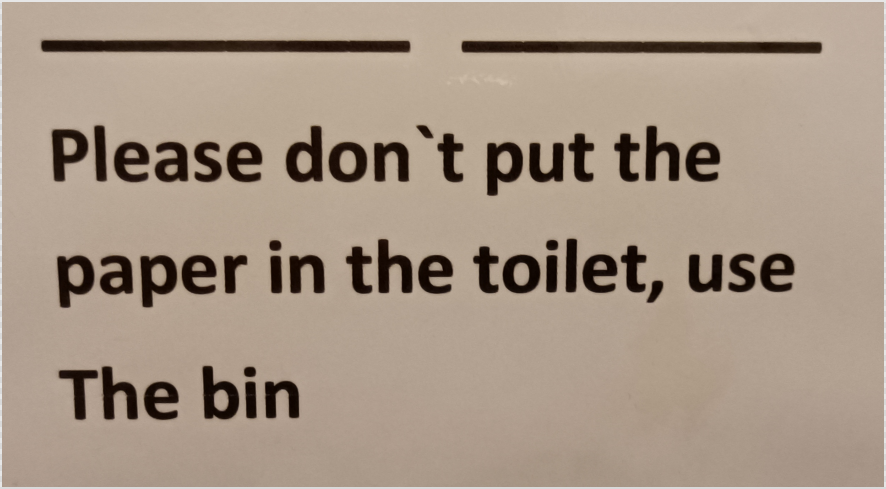
The Digital Transition

Conscientious Typography

Future

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Hall of Shame

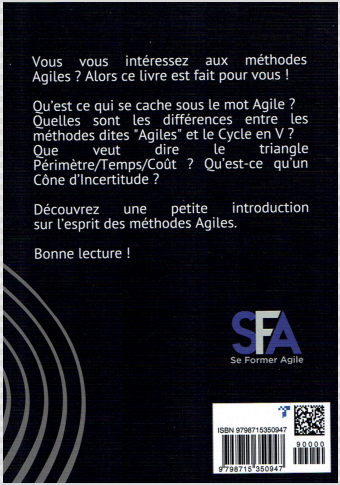


Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0

Hall of Shame

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0

Hall of Shame



Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0

Typographic Quality

- **Legibility:** perception
- **Readability:** understanding
- **Aesthetics:** emotion

👎 The Crystal Goblet, or Printing Should Be Invisible (Warde, 1956)

💡 Printing should be enticing, but discreet

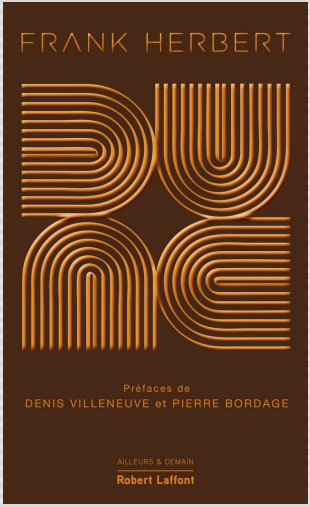
Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Typographic Quality

- **Legibility:** perception
- **Readability:** understanding
- **Aesthetics:** emotion

👎 The Crystal Goblet, or Printing Should Be Invisible (Warde, 1956)

💡 Printing should be enticing, but discreet



Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Typographic Quality

- **Legibility:** perception
- **Readability:** understanding
- **Aesthetics:** emotion

👎 The Crystal
Invisible (Wa

> **James Felici (2012)**
>
> Good typography is the result of caring about small details, sometimes very small details. To do it well, you have to be willing to be thought a bit obsessive.

💡 Printing should be enticing, but discreet

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Typographic Quality

- **Legibility:** perception
- **Readability:** understanding
- **Aesthetics:** emotion

Jan Tschichold (2018)

The typographer must serve his text and the reader anonymously. The awareness of serving a small number of optically receptive readers is usually the only reward the typographer receives.

- The Crystal
  Invisible (Wa
- Printing should be enticing, but discreet

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

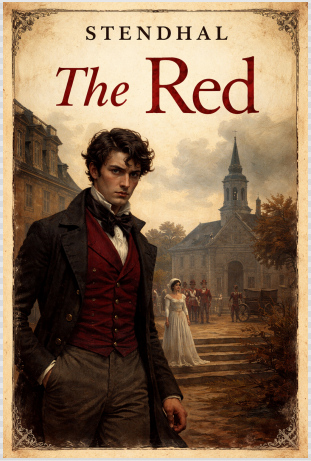
The Form / Meaning Overlap

- “You can always reformulate”
  Don Knuth's advice
- Linefeed gone bad

Tomorrow, we'll discuss fighting with Mike Tyson.	*Tomorrow, we'll discuss fighting with Mike Tyson.*

- Hyphenation gone bad

That's it. I resign.	*That's it. I re-sign.*
I'm getting unionized.	*I'm getting un-ionized.*
A meeting with co-workers.	*A meeting with cow-orkers.*



Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

The Form / Meaning Overlap

- “You can always reformulate”
  Don Knuth's advice
- Linefeed gone bad

Tomorrow, we'll discu
with Mike Tyson.

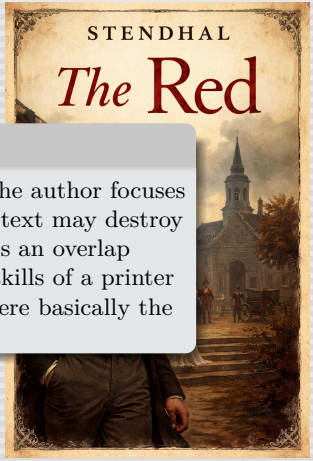
- Hyphenation

That's it. I resign.

I'm getting unionized.	*I'm getting un-ionized.*
A meeting with co-workers.	*A meeting with cow-orkers.*

Bernard Shaw (2015)

An author spoils the printer's work because the author focuses on the contents, and his modifications to the text may destroy the typographic color. In other words, there is an overlap between the form and the contents. [...] The skills of a printer can only truly be asserted on the classics, where basically the text is immutable.



Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Micro-Interruption

- Temporary rupture of the reading flow
- **Voluntary**: serves the text
  - General organization (chapters → paragraphs), *etc.*
  - Punctuation, *etc.*
- **Necessary**: must be carefully chosen
  - New page / line, *etc.*
  - Notes, figures, *etc.*
- **Accidental**: actual defects
  - Everything else…
  - Consecutive interruptions – even worse!

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

What To Do?

- Conscientious typography is **simple** (in theory): move the text!
- Conscientious typography is **hard** (in practice)
  - Form / meaning overlap
  - Plethora of techniques (burden of choice)

    Breakpoint desirability, hyphenation, kerning, expansion, tracking, protrusion, etc.
  - Butterfly effect
  - Chaotic behavior

One has to know the rules

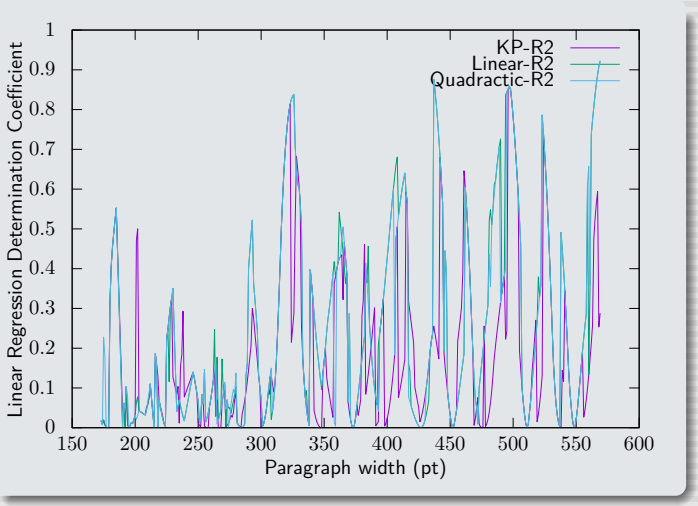
This is exactly why "typographer" is a profession (and should remain so)

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

What To Do?

- Conscientious
- Conscientious
  - Form / n
  - Plethora
    Breakpoin
  - Butterfly
  - Chaotic l

- One has to k
  This is exactly



Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Plan

Writing

Printing

The Digital Transition

Conscientious Typography

Future

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

An (Un)Solved Problem

- Breaking paragraphs into lines.
  Donald E. Knuth and Michael F. Plass. Software: Practice and Experience, 11(11):1119 – 1184, ***1981****. doi: 10.1002/spe.4380111102.*
- Micro-typographic extensions to the TEX typesetting system.
  H.T. Thành. TUGboat, 21(4), ***2000****.*
- Global Multiple Objective Line Breaking.
  Alex Holkner. PhD thesis, School of Computer Science and Information Technology, RMIT University, Melbourne, Australia, October ***2006****.*

😐 No (recent) experimental data or behavioral analysis

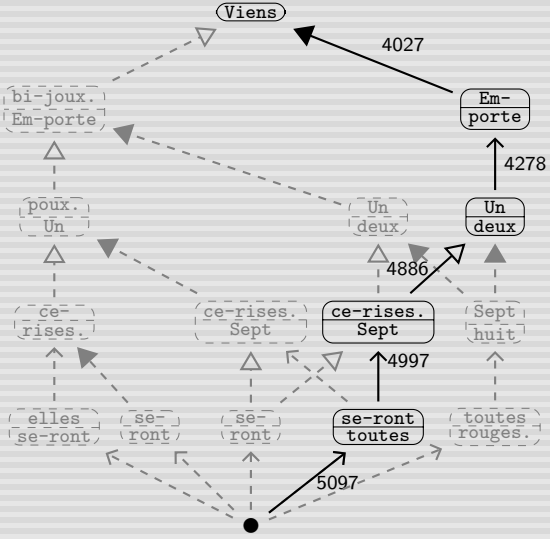
😐 Most current work is about type design

👉 Need better understanding of text behavior

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Shortest Path + Dynamic Programming Optimization

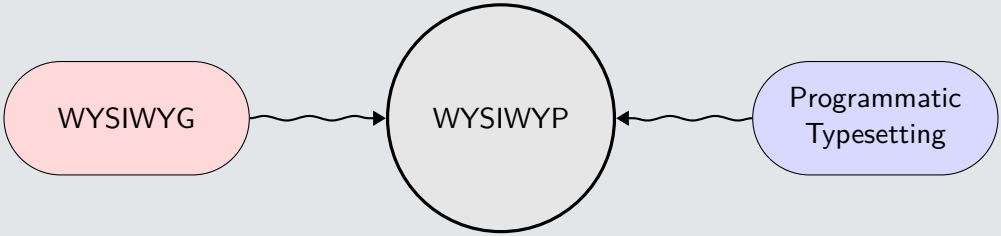
Viens mon chou sur mes ge-noux avec tes jou-joux et tes bi-joux. Em-porte des cailloux pour lan-cer sur les hi-boux pleins de poux. Un deux trois nous irons au bois. Quat' cinq six cueillir des ce-rises. Sept huit neuf dans mon pa-nier neuf. Dix onze douze elles se-ront toutes rouges.



Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

The WYSIWYP Paradigm

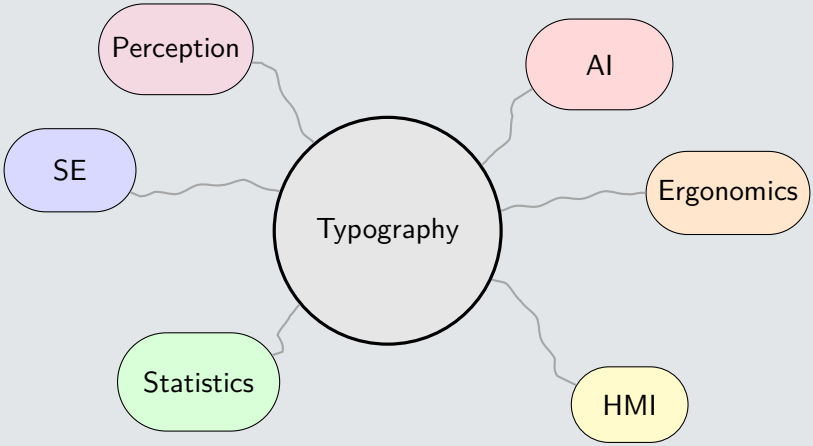
What You See Is What You Program



Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0

A Broad Application Domain

Interested? Please help! 😉



Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00

Plan

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0

Thank You!

- The Art, Science, and Craftsmanship of Typography
  Slides for an 18 hours lecture (currently in French).
- Towards More Homogeneous Paragraphs.
  ACM Symposium on Document Engineering, 2025.
- Similarity Problems in Paragraph Justification: an Extension to the Knuth-Plass Algorithm.
  ACM Symposium on Document Engineering, 2024.
- Interactive and Real-Time Typesetting for Demonstration and Experimentation: ETAP
  TUGboat, 44 (2):242–248, 2023.
- ETAP: Experimental Typesetting Algorithms Platform
  15th European Lisp Symposium, pp. 48–52, 2022.
- ETAP, `github/didierverna/etap`.

Copyright © 2026 Didier Verna ‹ didier@didierverna.net ›, CC BY-NC-ND 4.0 Build 2026-03-19 16:54:08+01:00