

# Contents

<b>Introduction</b>	<b>1</b>
Explorations . . . . .	3
The Letter and Its Parts . . . . .	3
Letterpress Typesetting . . . . .	7
Digital Typesetting . . . . .	11
Font Formats . . . . .	14
Between Characters and Glyphs: the Problems of the Electronic Document . . . . .	15
The Structure of the Book and Ways to Use It . . . . .	17
How to Read This Book . . . . .	23
How to Contact Us . . . . .	25
<b>1 Before Unicode</b>	<b>27</b>
FIELDATA . . . . .	29
ASCII . . . . .	29
EBCDIC . . . . .	31
ISO 2022 . . . . .	33
ISO 8859 . . . . .	35
ISO 8859-1 (Latin-1) and ISO 8859-15 (Latin-9) . . . . .	36
ISO 8859-2 (Latin-2) and ISO 8859-16 (Latin-10) . . . . .	38
ISO 8859-3 (Latin-3) and ISO 8859-9 (Latin-5) . . . . .	39
ISO 8859-4 (Latin-4), ISO 8859-10 (Latin-6), and ISO 8859-13 (Latin-7) . . . . .	40
ISO 8859-5, 6, 7, 8, 11 . . . . .	41
ISO 8859-14 (Latin-8) . . . . .	42
	<i>vii</i>

The Far East . . . . .	42
Microsoft's code pages . . . . .	45
Apple's encodings . . . . .	47
Electronic mail . . . . .	48
The Web . . . . .	51
<b>2 Characters, glyphs, bytes: An introduction to Unicode</b>	<b>53</b>
Philosophical issues: characters and glyphs . . . . .	54
First principles . . . . .	58
Technical issues: characters and bytes . . . . .	62
Character encoding forms . . . . .	64
General organization of Unicode: planes and blocks . . . . .	70
The BMP (Basic Multilingual Plane) . . . . .	70
Higher planes . . . . .	83
Scripts proposed for addition . . . . .	89
<b>3 Properties of Unicode characters</b>	<b>95</b>
Basic properties . . . . .	96
Name . . . . .	96
Block and script . . . . .	96
Age . . . . .	97
General category . . . . .	98
Other general properties . . . . .	105
Spaces . . . . .	106
Alphabetic characters . . . . .	106
Noncharacters . . . . .	106
Ignorable characters . . . . .	107
Deprecated characters . . . . .	107
Logical-order exceptions . . . . .	107
Soft-dotted letters . . . . .	108
Mathematical characters . . . . .	108
Quotation marks . . . . .	109
Dashes . . . . .	109
Hyphens . . . . .	109

---

Terminal punctuation . . . . .	109
Diacritics . . . . .	109
Extenders . . . . .	110
Join control . . . . .	110
The Unicode 1 name and ISO's comments . . . . .	110
Properties that pertain to case . . . . .	111
Uppercase letters . . . . .	111
Lowercase letters . . . . .	112
Simple lowercase/uppercase/titlecase mappings . . . . .	112
Special lowercase/uppercase/titlecase mappings . . . . .	112
Case folding . . . . .	113
Rendering properties . . . . .	114
The Arabic and Syriac scripts . . . . .	114
Managing grapheme clusters . . . . .	116
Numeric properties . . . . .	118
Identifiers . . . . .	119
Reading a Unicode block . . . . .	120
<b>4 Normalization, bidirectionality, and East Asian characters</b>	<b>127</b>
Decompositions and Normalizations . . . . .	127
Combining Characters . . . . .	127
Composition and Decomposition . . . . .	130
Normalization Forms . . . . .	131
The Bidirectional Algorithm . . . . .	133
Typography in both directions . . . . .	134
Unicode and Bidirectionality . . . . .	138
The Algorithm, Step by Step . . . . .	142
East Asian Scripts . . . . .	146
Ideographs of Chinese Origin . . . . .	147
The Syllabic Korean Hangul Script . . . . .	155

---

<b>5</b>	<b><i>Using Unicode</i></b>	<b>159</b>
	Interactive Tools for Entering Unicode Characters . . . . .	160
	Under Mac OS X . . . . .	160
	Under Windows XP . . . . .	161
	Under X Window . . . . .	163
	Virtual Keyboards . . . . .	164
	Useful Concepts Related to Virtual Keyboards . . . . .	167
	Under Mac OS X . . . . .	168
	Under Windows . . . . .	175
	Under X Window . . . . .	181
	Conversion of Text from One Encoding to Another . . . . .	183
	The <i>recode</i> Utility . . . . .	184
<b>6</b>	<b><i>Font Management on the Macintosh</i></b>	<b>187</b>
	The Situation under Mac OS 9 . . . . .	188
	The situation under Mac OS X . . . . .	191
	Font-Management Tools . . . . .	194
	Tools for Verification and Maintenance . . . . .	194
	<i>ATM</i> : the “Smoother” of Fonts . . . . .	196
	<i>ATR</i> : classification of fonts by family . . . . .	199
	Font Managers . . . . .	200
	Font Servers . . . . .	204
	Tools for Font Conversion . . . . .	205
	<i>TransType Pro</i> . . . . .	205
	<i>dfontifier</i> . . . . .	206
	<i>FontFlasher</i> , the “Kobayashi Maru” of Fonts . . . . .	207
<b>7</b>	<b><i>Font Management under Windows</i></b>	<b>209</b>
	Tools for Managing Fonts . . . . .	212
	The Extension of Font Properties . . . . .	212
	Tools for Verification and Maintenance . . . . .	213
	<i>ATM</i> : the “Smoother” of Fonts . . . . .	215
	Font Managers . . . . .	216
	Font Servers . . . . .	218
	Tools for Font Conversion . . . . .	219

---

<b>8</b>	<b><i>Font Management under X Window</i></b>	<b>221</b>
	Special Characteristics of X Window . . . . .	221
	Logical Description of a Font under X . . . . .	222
	Installing fonts under X . . . . .	226
	Installing Bitmap Fonts . . . . .	228
	Installing PostScript Type 1 or TrueType Fonts . . . . .	229
	Tools for Managing Fonts under X . . . . .	231
	Tools for Converting Fonts under X . . . . .	232
	The GNU Font Tools . . . . .	232
	George Williams's Tools . . . . .	233
	Various other tools . . . . .	233
	Converting Bitmap Fonts under Unix . . . . .	233
<b>9</b>	<b><i>Fonts in T<sub>E</sub>X and Ω, their installation and use</i></b>	<b>235</b>
	Using Fonts in T <sub>E</sub> X . . . . .	235
	Introduction to T <sub>E</sub> X . . . . .	236
	The High Level: Basic $\LaTeX$ Commands and NFSS . . . . .	240
	The Low Level: T <sub>E</sub> X and DVI . . . . .	259
	“Après-T <sub>E</sub> X”: Confronting the Real World . . . . .	263
	Installing Fonts for T <sub>E</sub> X . . . . .	274
	The Tool <i>afm2tfm</i> . . . . .	275
	Basic Use of the Tool <i>fontinst</i> . . . . .	277
	Multiple Master fonts . . . . .	283
	Customizing T <sub>E</sub> X Fonts for the User's Needs . . . . .	285
	How to Configure a Virtual Font . . . . .	285
	Conclusions and Glimpses at the Future . . . . .	312
<b>10</b>	<b><i>Fonts and Web Pages</i></b>	<b>315</b>
	(X)HTML, CSS, and Fonts . . . . .	318
	The Standard HTML Tags . . . . .	318
	CSS (version 3) . . . . .	319
	Tools for Downloading Fonts from the Web . . . . .	332
	<i>TrueDoc</i> , by Bitstream . . . . .	333
	<i>Font Embedding</i> , by Microsoft . . . . .	336

GlyphGate, by em2 Solutions . . . . .	340
The SVG Format . . . . .	345
Fundamental Concepts of XML . . . . .	345
And what about SVG? . . . . .	350
Font Selection under SVG . . . . .	351
Alternate Glyphs . . . . .	353
SVG Fonts . . . . .	355
Conclusion . . . . .	365
<b>11 The History and Classifications of Latin Typefaces</b>	<b>367</b>
The Typographical Big Bang of the Fifteenth Century, and the Fabulous Destiny of the Carolingian Script . . . . .	367
From Venice to Paris, by Way of Rome . . . . .	371
New Scripts Emerge in Germany . . . . .	381
The Wild Adventure of Textura in England . . . . .	382
The Sun King Makes Waves . . . . .	384
England Takes the Lead in Typographic Innovation . . . . .	386
Didot and Bodoni Revolutionize Typefaces . . . . .	390
The German “Sturm und Drang” . . . . .	393
The Nineteenth Century, Era of Industrialization . . . . .	394
The Pre-war Period: Experimentation and a Return to Roots . . . . .	397
The Post-war Period . . . . .	403
Suggested Reading . . . . .	407
The Vox/ATypI Classification of Typefaces . . . . .	408
La classification Alessandrini des caractères: le Codex 80 . . . . .	411
IBM’s Classification of Fonts . . . . .	416
Class 0: No Classification . . . . .	416
Class 1: Old-Style Serifs . . . . .	416
Class 2: Transitional Serifs . . . . .	418
Class 3: Modern Serifs . . . . .	418
Class 4: Clarendon Serifs . . . . .	419
Class 5: Slab Serifs . . . . .	420
Class 7: Free-Form Serifs . . . . .	420
Class 8: Sans Serif . . . . .	421

---

Class 9: Ornamentals . . . . .	422
Class 10: Scripts . . . . .	422
Class 12: Symbolic . . . . .	423
The Panose-1 Classification . . . . .	424
Parameter 1: Family Kind . . . . .	425
Parameter 2: Serif Style . . . . .	425
Parameter 3: Weight . . . . .	427
Parameter 4: Proportion . . . . .	428
Parameter 5: Contrast . . . . .	430
Parameter 6: Stroke Variation . . . . .	431
Parameter 7: Arm Style and Termination of Open Curves . . . . .	433
Parameter 8: Slant and Shape of the Letter . . . . .	435
Parameter 9: Midlines and Apexes . . . . .	436
Parameter 10: X-height and Behavior of Uppercase Letters Relative to Accents . . . . .	438
<b>12 Editing and Creating Fonts</b> . . . . .	<b>441</b>
Software for Editing/Creating Fonts . . . . .	442
General Principles . . . . .	444
FontLab . . . . .	446
The Font Window . . . . .	446
Opening and Saving a Font . . . . .	452
The General-Information Window . . . . .	454
The Glyph Window . . . . .	459
The Metrics Window . . . . .	465
Multiple Master Fonts . . . . .	468
Driving FontLab with Python Scripts . . . . .	472
FontForge . . . . .	488
The Font-Table Window . . . . .	489
Opening/Saving a Font . . . . .	490
The General-Information Window . . . . .	491
The Glyph Window . . . . .	492
The Metrics Window . . . . .	495

---

What About Vertical Typesetting? . . . . .	497
CID Fonts . . . . .	498
Autotracing . . . . .	499
<i>potrace</i> . . . . .	500
<i>ScanFont</i> . . . . .	501
<b>13 Optimizing a rasterization</b> . . . . .	<b>505</b>
PostScript Hints . . . . .	507
Global PostScript Hints . . . . .	507
Individual PostScript Hints . . . . .	512
TrueType Instructions . . . . .	518
Managing Instructions in FontLab . . . . .	520
Managing Instructions under <i>VTT</i> . . . . .	529
Managing Instructions under FontForge . . . . .	546
<b>14 Enriching Fonts: Advanced Typography</b> . . . . .	<b>549</b>
Introduction . . . . .	549
Managing OpenType Tables in FontLab . . . . .	555
Feature Definition Language . . . . .	556
FontLab's User Interface . . . . .	565
Managing OpenType Tables in VOLT . . . . .	569
Managing OpenType Tables in FontForge . . . . .	576
Anchors . . . . .	577
Noncontextual Substitutions . . . . .	579
Noncontextual Positionings . . . . .	580
Contextual Substitutions and Positionings . . . . .	582
Managing AAT Tables in FontForge . . . . .	586
Features and selectors . . . . .	588
Managing AAT's Finite Automata in FontForge . . . . .	589



<b>A</b>	<b><i>Bitmap Font Formats</i></b>	<b>599</b>
A.1	The Macintosh World . . . . .	599
A.1.1	The FONT Format . . . . .	599
A.1.2	The NFNT Format . . . . .	601
A.1.3	Color . . . . .	601
A.2	The DOS World . . . . .	601
A.2.1	The CPI Format . . . . .	601
A.3	The Windows World . . . . .	602
A.3.1	The FNT Format . . . . .	602
A.3.2	The FON Format . . . . .	604
A.4	The Unix World . . . . .	604
A.4.1	The PSF Format of Linux . . . . .	604
A.4.2	The BDF Format . . . . .	606
A.4.3	The HBF Format . . . . .	609
A.4.4	The SNE, PCE, and ABF Formats . . . . .	610
A.4.5	The RAW and CP Formats . . . . .	611
A.5	The T <sub>E</sub> X World . . . . .	611
A.5.1	The PXL and CHR Formats . . . . .	612
A.5.2	The GF Format . . . . .	613
A.5.3	The PK Format . . . . .	617
A.5.4	Fonts or Images? Both! . . . . .	620
A.6	Other Less Common Bitmap Formats . . . . .	621
A.7	Whoever Can Do More Can Also Do Less . . . . .	621
<b>B</b>	<b><i>T<sub>E</sub>X and <math>\Omega</math> Font Formats</i></b>	<b>623</b>
B.1	TFM . . . . .	623
B.1.1	Global Declarations . . . . .	625
B.1.2	Font Parameters . . . . .	625
B.1.3	Kerning Pairs and Ligatures . . . . .	626
B.1.4	The Metric Properties of Glyphs . . . . .	631
B.2	OFM . . . . .	632
B.3	VF . . . . .	633
B.4	OVF . . . . .	634

<b>C</b>	<b><i>PostScript Font Formats</i></b>	<b>635</b>
C.1	Introduction to the PostScript Language . . . . .	635
C.1.1	Syntax . . . . .	636
C.1.2	The System of Coordinates . . . . .	637
C.1.3	The current transformation matrix . . . . .	637
C.1.4	Paths . . . . .	639
C.1.5	Shapes . . . . .	641
C.1.6	Bitmap Images . . . . .	642
C.1.7	Managing the Stack, Tables, and Dictionaries . . . . .	643
C.1.8	Font Management and Typesetting . . . . .	645
C.1.9	The Image Model and the Graphics State . . . . .	646
C.1.10	Structured Comments (DSCs) . . . . .	647
C.2	Type 3 Fonts . . . . .	650
C.3	Type 1 Fonts . . . . .	655
C.3.1	Before We Begin: the Format of the File that Contains the Font	656
C.3.2	The Public Dictionary . . . . .	657
C.3.3	Encodings for Type 1 Fonts . . . . .	659
C.3.4	The Private Dictionary . . . . .	661
C.3.5	Glyph Descriptions . . . . .	665
C.3.6	Individual Hints . . . . .	666
C.3.7	AFM Files . . . . .	672
C.4	Multiple Master Fonts . . . . .	677
C.4.1	Using Multiple Master Fonts in the PostScript Language . . . .	681
C.4.2	The AMFM file . . . . .	681
C.5	Type 42 Fonts . . . . .	682
C.6	Type 0, or OCF, Fonts . . . . .	684
C.6.1	Character Mapping . . . . .	684
C.6.2	The ACFM File . . . . .	686
C.7	CID Fonts (Types 9–11, 32) . . . . .	687
C.7.1	<i>CIDFont</i> . . . . .	688
C.7.2	<i>CMap</i> . . . . .	692
C.7.3	Rearrangement of a CID font . . . . .	694
C.7.4	The AFM File for the CID Font . . . . .	696

C.7.5	Using a CID Font . . . . .	696
C.8	Type 2/CFF Fonts . . . . .	697
C.8.1	The Compact Font Format . . . . .	697
C.8.2	The <i>charstrings</i> of Type 2 . . . . .	700
<b>D</b>	<b><i>The TrueType, OpenType, and AAT Font Formats</i></b>	<b>705</b>
D.1	TTX: TrueType Fonts Represented in XML . . . . .	706
D.2	TrueType Collections . . . . .	709
D.3	General Overview of TrueType Tables . . . . .	709
D.4	The Kernel of the TrueType Tables . . . . .	713
D.4.1	The GlyphOrder Table . . . . .	713
D.4.2	The cmap Table . . . . .	714
D.4.3	The head Table . . . . .	716
D.4.4	The Tables hhea and hmtx . . . . .	717
D.4.5	The maxp Table . . . . .	719
D.4.6	The name Table . . . . .	720
D.4.7	The OS/2 Table . . . . .	722
D.4.8	The post Table . . . . .	726
D.5	The Tables That Pertain to TrueType-Style Glyph Descriptions . . . . .	728
D.5.1	The loca Table . . . . .	728
D.5.2	The glyf Table . . . . .	728
D.5.3	The Tables fpgm, prep, and cvt . . . . .	730
D.6	The TrueType Tables That Affect PostScript-Style Glyph Descriptions . . . . .	731
D.6.1	The Table CFF . . . . .	731
D.6.2	The Table VORG . . . . .	731
D.7	Bitmap Management . . . . .	732
D.7.1	The Tables EBLC and EBDT (Alias bloc and bdat) . . . . .	732
D.7.2	The EBSC Table . . . . .	739
D.7.3	The bhed Table . . . . .	740
D.8	Some Other Optional Tables . . . . .	740
D.8.1	The DSIG Table . . . . .	740
D.8.2	The gasp Table . . . . .	741
D.8.3	The Tables hdmx and LTSH . . . . .	741

D.8.4	The kern Table . . . . .	743
D.8.5	The VDMX Table . . . . .	748
D.8.6	The Tables vhea and vmtx . . . . .	749
D.8.7	The PCLT Table . . . . .	750
D.9	The OpenType Advanced Typographic Tables . . . . .	751
D.9.1	Important concepts . . . . .	751
D.9.2	The BASE Table . . . . .	754
D.9.3	The GPOS Table . . . . .	758
D.9.4	The GSUB Table . . . . .	781
D.9.5	The JSTF Table . . . . .	796
D.9.6	The GDEF Table . . . . .	803
D.10	Predefined Features, Languages, and Scripts . . . . .	806
D.10.1	Predefined Languages and Scripts . . . . .	806
D.10.2	Predefined Features . . . . .	815
D.11	General AAT Tables . . . . .	822
D.11.1	The acnt Table . . . . .	823
D.11.2	The bsln Table . . . . .	823
D.11.3	The fdsc Table . . . . .	826
D.11.4	The fmtx Table . . . . .	826
D.11.5	The feat Table . . . . .	827
D.11.6	The lcar Table . . . . .	838
D.11.7	The opbd Table . . . . .	840
D.11.8	The prop Table . . . . .	841
D.11.9	The trak Table . . . . .	842
D.11.10	The Zapf Table . . . . .	844
D.12	The AAT Tables for Font Variation . . . . .	848
D.12.1	The fvar Table . . . . .	848
D.12.2	The avar Table . . . . .	850
D.12.3	The gvar Table . . . . .	851
D.12.4	The cvar Table . . . . .	855
D.13	AAT Tables with Finite Automata . . . . .	856
D.13.1	Finite Automata . . . . .	856
D.13.2	The morx Table (Formerly mort) . . . . .	862
D.13.3	The just Table . . . . .	872

---

<b>E</b>	<b><i>TrueType Instructions</i></b>	<b>879</b>
E.1	Basic Concepts . . . . .	881
E.1.1	Interpreter's Stack, Instruction Stream . . . . .	881
E.1.2	Reference Points . . . . .	881
E.1.3	Freedom and Projection Vectors . . . . .	881
E.1.4	Table of Control Vectors and Storage Area . . . . .	882
E.1.5	Touched and Untouched Points . . . . .	882
E.1.6	Minimum Distance and Cut-In . . . . .	882
E.1.7	Twilight Zone and Zone Pointers . . . . .	882
E.2	Instructions . . . . .	883
E.2.1	Instructions for Managing the Stack and Storage Area . . . . .	883
E.2.2	Managing Vectors, Zones, and Reference Points . . . . .	884
E.2.3	Moving Points . . . . .	885
E.2.4	$\delta$ Instructions . . . . .	889
E.2.5	Tests and Logical and Arithmetic Functions . . . . .	890
E.2.6	Definitions of Subroutines and New Instructions . . . . .	891
E.3	Some Examples . . . . .	892
E.3.1	The 'T' in the Font <i>Courier</i> . . . . .	892
E.3.2	The 'O' from the Font <i>Verdana</i> . . . . .	899
<b>F</b>	<b><i>METAFONT and Its Derivatives</i></b>	<b>905</b>
F.1	The METAFONT Programming Language . . . . .	906
F.1.1	Basic Concepts . . . . .	906
F.1.2	The Basics: Drawing and Filling . . . . .	908
F.1.3	More Advanced Concepts: Pen Strokes and Parameterization . . . . .	917
F.1.4	Optimizing the Rasterization . . . . .	930
F.2	The <i>Computer Modern</i> Family of Fonts . . . . .	935
F.2.1	General Structure . . . . .	935
F.2.2	Extensions . . . . .	944
F.3	<i>MetaFog</i> . . . . .	945
F.4	METATYPE1 and <i>Antykwa Półtawskiego</i> . . . . .	947
F.4.1	Installing and Using METATYPE1 . . . . .	947
F.4.2	Syntactic Differences from METAFONT . . . . .	948
F.4.3	<i>Antykwa Półtawskiego</i> . . . . .	956

<b>G Bézier Curves</b>	<b>961</b>
G.1 History . . . . .	961
G.2 Bézier Curves . . . . .	961
G.2.1 Definition and Interesting Properties . . . . .	963
G.2.2 de Casteljau's Algorithm . . . . .	964
G.2.3 Subdivision of Bézier Curves . . . . .	965
 <b>General Index</b>	 <b>991</b>
 <b>Index of Persons</b>	 <b>1013</b>