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## The First Alphabetical Treatises in the Renaissance

### Millard Meiss

Treatises on the design of the alphabet were an innovation of the early Renaissance and reflect that period's conception of a world ordered by numerical proportion and geometric shape. The interrelationship of the various men and their theories is discussed and illustrated. Although Felice Feliciano inaugurated these alphabetical treatises, Andrea Mantegna is shown to have had an important place (if not key role) in the revival of the roman letter.

A new form of didactic and theoretical writing appeared in the early Renaissance: treatises on the design of the alphabet, which is to say, of course, the roman alphabet. The first of these texts known to us was written by none other than Felice Feliciano, a friend of the painter Andrea Mantegna who recorded the chief events in a famous archaeological trip they made together to the Lago di Garda. Feliciano's treatise on the alphabet was followed by similar "*trattati delle lettere antiche*," one by Damiano Moille, printed at Parma ca.1480, another by Luca Pacioli, printed in Venice in 1509, and still another by Sigismondo de' Fanti, printed in Venice in 1514.<sup>1</sup> This species of literature was then adopted north of the Alps, appearing first as a section of Dürer's *Underweysung der Messung*, printed in 1525.

Treatises of this sort seem to be entirely novel; they were, at least, written without awareness of precedents in antiquity. They bear witness to the seriousness of the concern of Quattrocento artists and humanists with the creation of a new script, based on Roman example. They also testify to the desire of these innovators to describe, record, and communicate their intellectual and artistic conquests, contributing thereby to the advancement of contemporary culture, of whose progress they held such an unshakable conviction. The treatises reflect also the desire of these men to get at fundamental laws, even those underlying the shapes of letters. In fact the primary

motive of Feliciano, Moille, and Pacioli was to demonstrate the principles of proportionality in the *lettera antica formata*, as the formal script in the new style was called. Sigismondo de' Fanti says at the beginning of his discussion of the majuscules (Book IV) that he wishes to impart the principles of the letter “cum doctrina erecta,” and this *doctrina* is based on the premise, ultimately Greco-Roman itself, that “nature has ordered the things of this earthly microcosm according to their true and proper proportions.” Feliciano introduces his discussion of the first letter of the alphabet as follows (Fig. 7):

“According to ancient practice the letter is shaped from the circle and the square, the sum of whose forms rises to 52, from which is drawn the perfect number, which is 10. And thus the width (of the stroke) of your letter should be one-tenth of its height. In this way the letter has as much of the circle as of the square. . . .”<sup>2</sup>

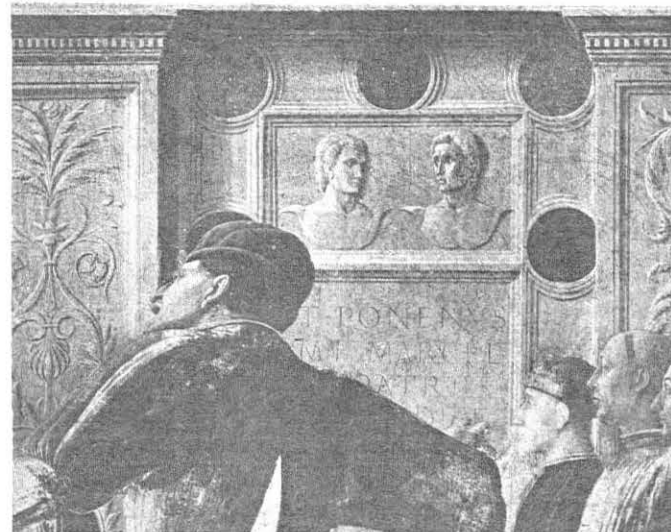
Thus in the very first account of the “exquisite *litere latine antiquarie*,” as Francesco Colonna describes them in the *Hypnerotomachia*, the premises conform to the mathematical mystique of the early Renaissance. It was not only the world and man and architecture and music that possessed beauty as the consequence of an inherent numerical proportionality, but the letters of the alphabet as well! In the passage quoted above, Feliciano probably had Vitruvius in mind. It was probably from Vitruvius that he derived the idea of the perfection of the number 10, which the Roman writer in turn admits having taken from the “ancients,” particularly Plato and the Pythagoreans.<sup>3</sup> These older writers, Vitruvius says, considered 10 perfect because of its relation to members of the body—fingers and toes—and also because it is equal to the sum of the *monades* ( $10 = 1 + 2 + 3 + 4$ ). The human body, Vitruvius adds, manifests a canon of proportion that is based on the ratio  $1 = 10$ . The figure may be divided longitudinally into 10 units, each of which is equal to the face from the chin to the top of the forehead.

It was, moreover, not only the idea of the perfection of 10 that Feliciano took from Vitruvius. In his treatise he proceeded to apply to capital letters the perfect forms of the square and the circle that, when applied by Vitruvius to man, had stirred the imagination of Ghiberti, Leonardo, and the entire Renaissance. In short, to the Vitruvian *homo ad quadratum et ad circulum* Feliciano and his successors



Figure 1. Mantegna, *Lettering on gesso*, Altarpiece, Verona, S. Zeno.

Figure 2. Mantegna, 1456–7, *Inscription on tablet, Padua, Eremitani, Martyrdom of St. Christopher* (detail).



STRABONIS LIBER SEXTVS



OST SILARIS  
HOSTIVM  
LVCANIA EST  
ET IVNONIS  
ARGIVAE TE  
PLVM QVOD

*ablatone constructum fuit prope ma stad quinquagm  
a polidonia hie cum enauigavit leucolia occurrit  
insula pui ad continentem huius cui sum nom e fire*

Figure 3. Mantegna, *Initial P*, Albi, Bibliothèque Rohegude MS 4, f. 117.

Figure 4. Mantegna, *Initial A*, Albi, Bibliothèque Rohegude MS 4, f. 183v.

STRABONIS LIBER NC



BSOLD  
LOPOI  
CIRCA  
QVAM  
AM C  
COET

*minimam ebrommetor id est ex perr*

STRABONIS LIBER VNDECIMVS



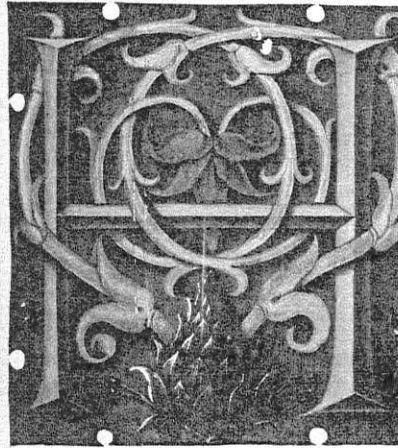
VROP AE  
CONTINE  
NS ASIA  
EST AD TA  
NAIM ILLI  
CONIVNC  
TA DE IPSA

*ioitur deinceps differendum: dnaturalel anoldum*

Figure 5. Mantegna, *Initial E*, Albi, Bibliothèque Rohegude MS 4, f. 230v.

Figure 6. Mantegna, *Initial H*, Albi, Bibliothèque Rohegude MS 4, f. 273.

STRABONIS LIBER XIII



ACTENVS  
PHRYGIAE  
TRACTVS  
TERMINE  
TVR VERVM  
PROPONTI  
DEM RVRSVS

*proxima q. clespo m. utimum repetentel oram eundem describe*

add the *littera ad quadratum et ad circulum*. The letters of the alphabet, like the human body, manifest a geometric as well as a numerical canon.

Feliciano's ideas and procedures were adopted and given a more philosophical explanation by Luca Pacioli, who wrote a half century later. In the *Divina proportione*, to which his little treatise on letters is appended, he says that "the ancients, after having considered the right arrangement of the human body, proportioned all their work, particularly the temples, in accordance with it. For in the human body they found the two main figures without which it is impossible to achieve anything, namely the perfect circle . . . and the square." Pacioli adds a metaphysical interpretation of these figures and of the shape of the body: ". . . from the human body derive all measures and their denominations and in it is to be found all and every ratio and proportion by which God reveals the innermost secrets of nature."<sup>4</sup> These secrets are evidently inherent also in the perfect capital letter (Fig. 24).

The man who, as far as we now know, inaugurated the Renaissance tradition of alphabetical treatises, Felice Feliciano, was an almost exact contemporary of Andrea Mantegna.<sup>5</sup> Famous as one of the first collectors of ancient inscriptions, and nicknamed "l'antiquario," he was also something of a poet, a printer, and towards the end of his life, an alchemist. He transcribed a biography of his Quattrocento predecessor in epigraphy, Ciriaco d'Ancona. Among painters he knew Marco Zoppo and Giovanni Bellini as well as Mantegna, and on one occasion he addressed to the latter a sonnet pleading for assistance in his poverty. We know that in 1464 he joined the excursion to the Lago di Garda; in 1474-5 he was in Venice and Ferrara; in 1476 he printed a Petrarch, *De viris illustribus*, at Pojano; and he died around 1480. In 1463 he dedicated a collection of inscriptions to Mantegna, "amicus incomparabilis," speaking warmly of their common passion for ancient culture, and praising the painter's learning and archaeological experience.<sup>6</sup> The most important of his epigraphical manuscripts, preserved in the Vatican Library, contains also the treatise on the alphabet (Figs. 7-12).<sup>7</sup>

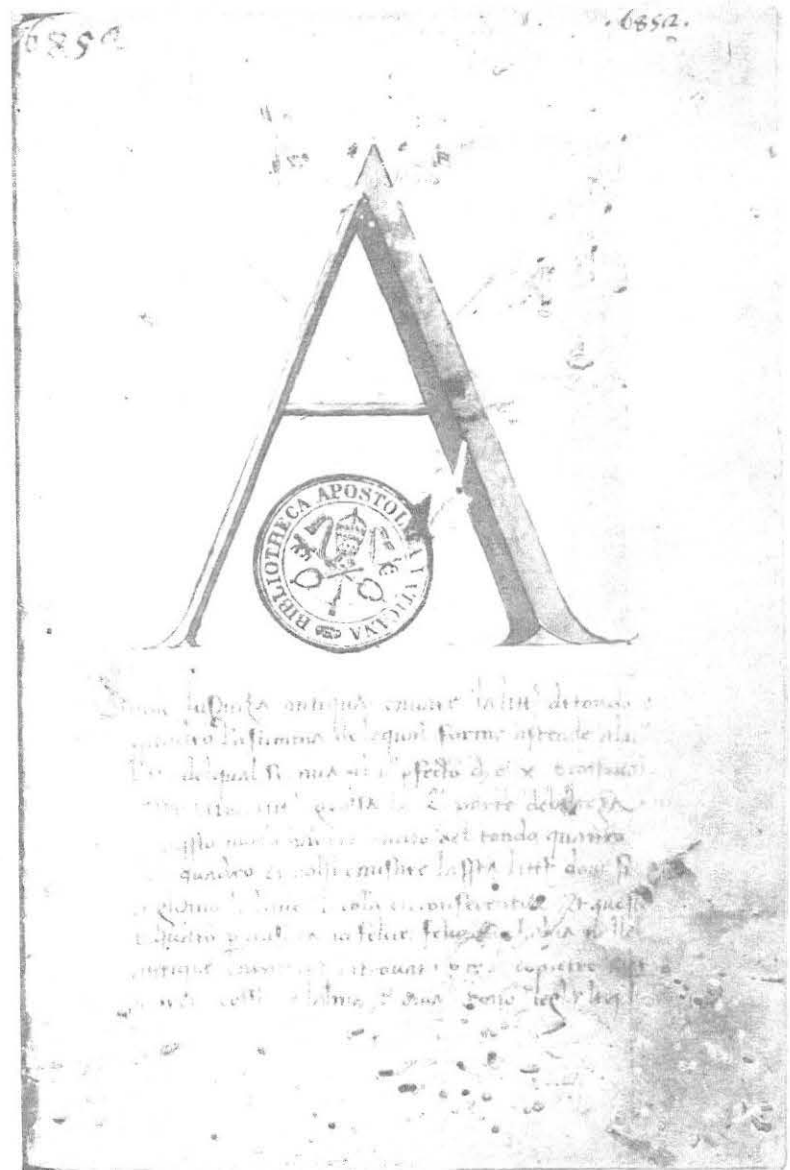


Figure 7. F. Feliciano, *A*, Rome, Biblioteca Vaticana, lat. 6852, f. 1.

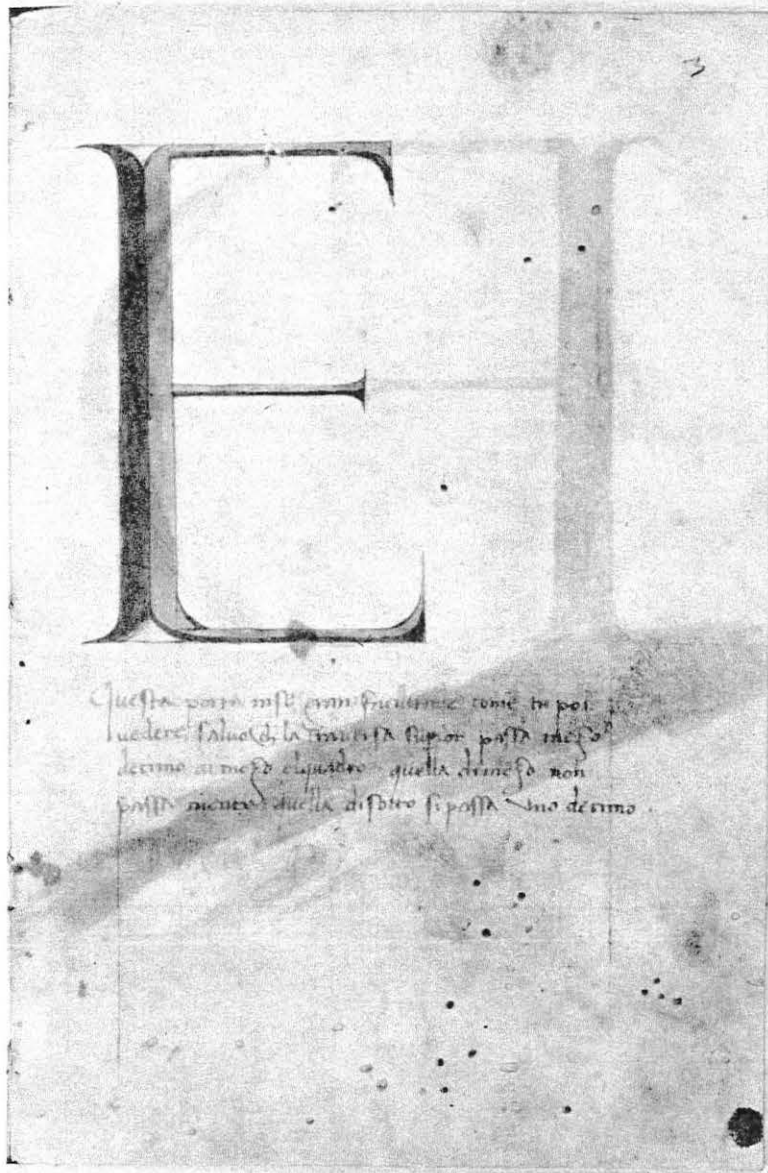


Figure 8. F. Feliciano, *E*, Rome, Biblioteca Vaticana, lat. 6852, f. 3.  
10

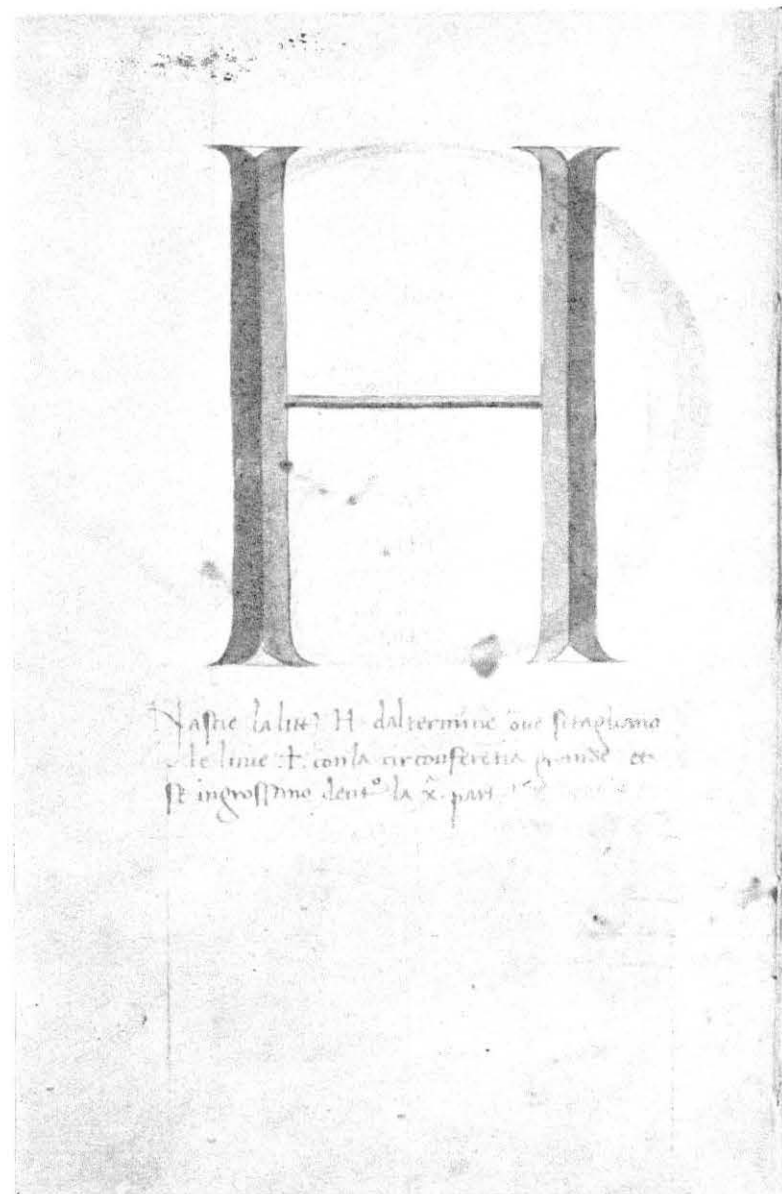


Figure 9. F. Feliciano, *H*, Rome, Biblioteca Vaticana, lat. 6852, f. 4v.  
11



Figure 10. F. Feliciano, *M*, Rome, Biblioteca Vaticana, lat. 6852, f. 6v.  
12

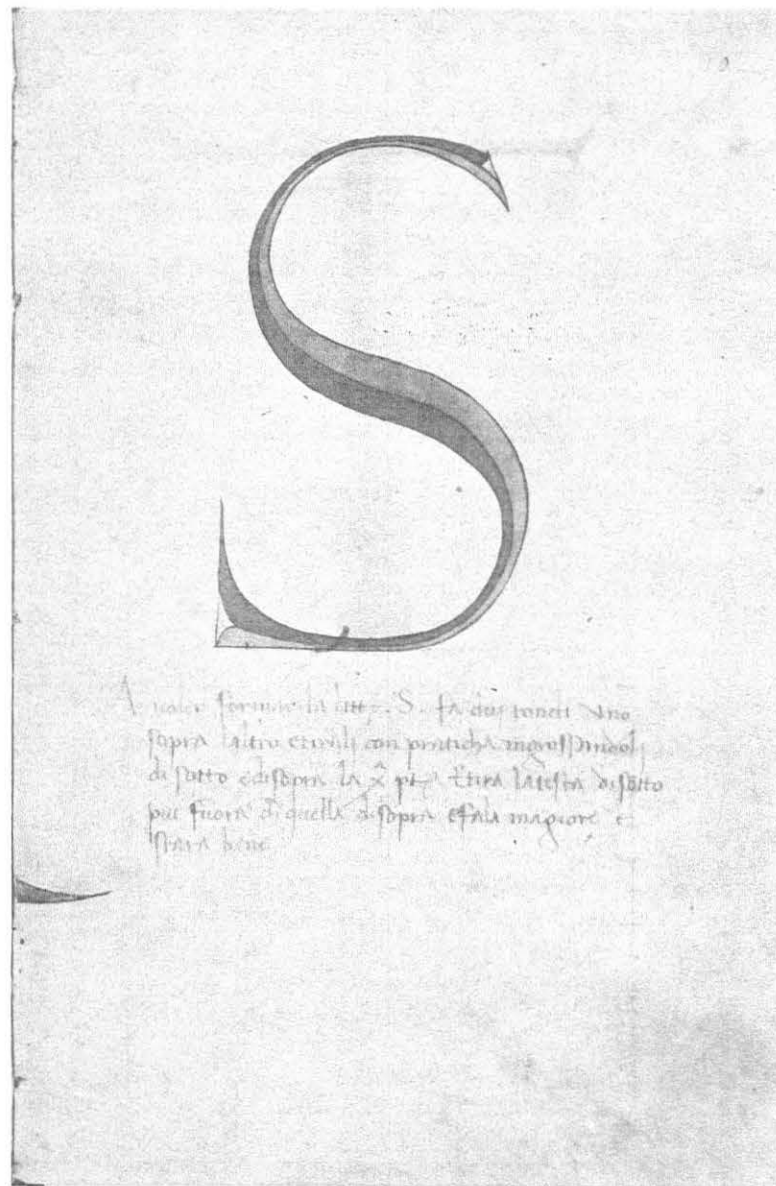


Figure 11. F. Feliciano, *S*, Rome, Biblioteca Vaticana, lat. 6852, f. 10.  
13

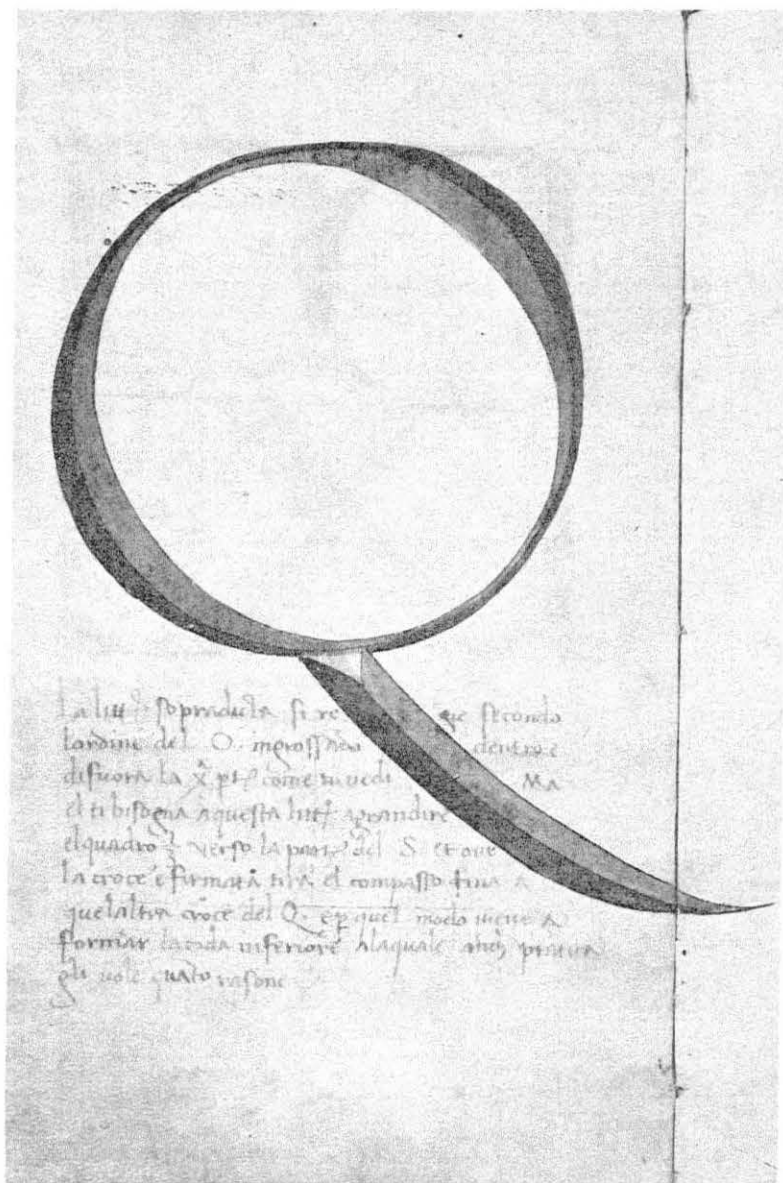


Figure 12. F. Feliciano, Q, Rome, Biblioteca Vaticana, lat. 6852, f. 9v.

Like the capital A discussed above, all of Feliciano's letters exhibit his conception of the perfect Vitruvian ratio,  $1 = 10$ . After giving an account of D, Feliciano adds: "Nota non te domenticar far tutte le littere grosse la parte X<sup>a</sup>." Although Feliciano's concern with proportion and geometry is essentially theoretical, it is occasionally bound up with practical and didactic purposes. Of the R he says: "La piu difficil parte di questa littera (e) la coda perche non vi si trova alchun tracto di compasso perfecto . . . e fassi la coda . . . per praticha piu che per rasone. . . ." R, not reducible to proper geometry, is a sort of second-class letter.

Close study of Feliciano's manuscript proves that he not only advocated geometric construction of the majuscule but applied his principles, in the case of many letters at least. Faint traces of circles, squares, and diagonals, as well as the central prick of the foot of the compass, may be seen on many folios. These geometric forms were drawn in the brownish ink used afterwards to outline the letters, and they were erased after the shapes of the letters had been determined. Geometry had, however, only a proximate meaning. Feliciano, for instance, preferred a narrow H and he produced it, even though it does not come near to filling the square with which he began.

The capitals in Feliciano's alphabet are prismatic, and in this respect they resemble the much more beautiful capitals in the initials of a manuscript of Strabo, *De Situ Orbis*, which can be dated 1459 (Figs. 3–6). These splendid letters approximate so closely the capitals in contemporary inscriptions by Andrea Mantegna (Figs. 1, 2) that they seem to me to have been designed by him and painted in his workshop.<sup>9</sup> If this is true, how are we to understand the relationship between Feliciano and Mantegna? Was the prismatic letter introduced earlier, in examples unknown to us, and then greatly refined by Mantegna? The known facts of its history seem to disprove this. Could Feliciano, professional antiquary, have been its creator? The problem is somewhat complicated by the fact that Pratilli has recently shown that the Vatican manuscript, contrary to general belief, is not dated, though some facts do point to ca. 1463, the year when it is commonly believed to have been finished.<sup>10</sup> We are therefore thrown back on internal evidence, and fortunately this seems clear and decisive.

Feliciano, first of all, was not an artist nor even a first-rate callig-

rapher. A Latin miscellany preserved in the Museo Correr at Venice provides abundant proof of that. Dated 1460, it contains the statement “scripto e miniato per mano di me felice feliciano da Verona. . . .”<sup>11</sup> We can be certain then—or, intellectuals being what they are, reasonably certain—that the initials in this manuscript were painted by Feliciano himself (Fig. 13). They are altogether conventional.<sup>12</sup> The letters themselves are not only without special distinction but are strikingly similar to those in the Vatican manuscript, so that we can assume that the latter also are specimens of Feliciano’s limited craft. They are scarcely comparable to those in the *Strabo*. The transversal in Feliciano’s H, for instance, is painfully thin, especially for a statuesque letter. The letters generally lack the entasis and other refinements of the *Strabo* letters, and while they are constructed in light and dark, these value changes are unpredictable and unsystematic. In the *Strabo* the light strikes the initials consistently from the upper left. Feliciano’s R is lighted from the right, while the H (Fig. 9) is lighted from within and the A (Fig. 7) from both sides. Surely Feliciano was applying, with limited comprehension, a principle initiated by the friend and colleague to whom he dedicated his treatise.

Given the friendship of Feliciano and Mantegna, as well as their known collaboration in the study of antiquity, we might suppose that the proportions of their letters would be the same. Such, however, is not the case. The *Strabo* capitals were perhaps laid out on a square and a circle (Figs. 16, 17), but their ratios do not conform to the prescriptions of Feliciano. When the latter tells us, in the passage quoted above, that the “width” of the letter A is  $\frac{1}{10}$  of its height, he undoubtedly refers to the ratio of width to height in the right shank (Fig. 7). The corresponding ratio in the *Strabo* is about 1 to 12 (Fig. 16). If we turn to other letters, H for example, we discover similar differences. Feliciano again stipulates a ratio of 1 to 10 for both the uprights (Fig. 9), whereas Mantegna, with equal consistency, again employed 1 to 12 for the more important right shank, while reducing the left—for the sake of a more active pattern—to about 1 to 16 (Fig. 17). Feliciano prescribes for E an upper transversal that passes the axis of the square by a half of a tenth, while the lower transversal passes it by one-tenth. In the *Strabo* the variation in the lengths (as well as the thicknesses) of the three transversals is greater. The lower



Figure 13. F. Feliciano, *Q*, Venice, Musco Correr MS 314, VI, 351, f. 12.

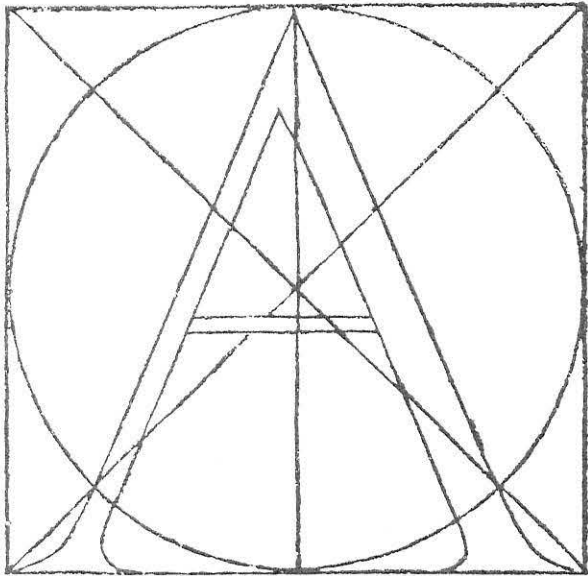
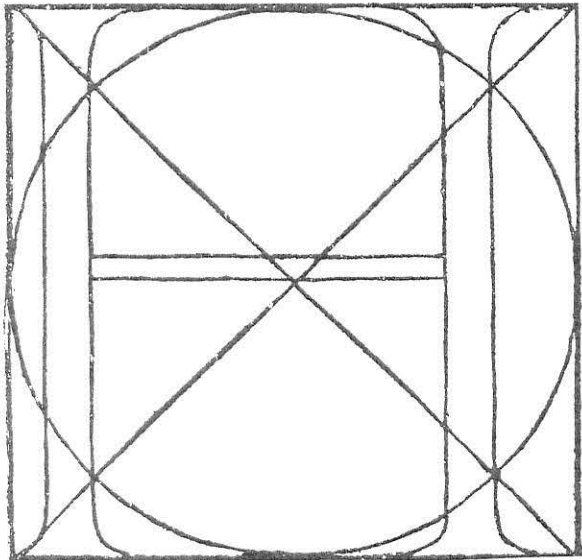


Figure 14. D. Moille, *A*, from *Alphabetum*, Parma, ca.1480.

Figure 15. D. Moille, *H*, from *Alphabetum*, Parma, ca.1480.



18

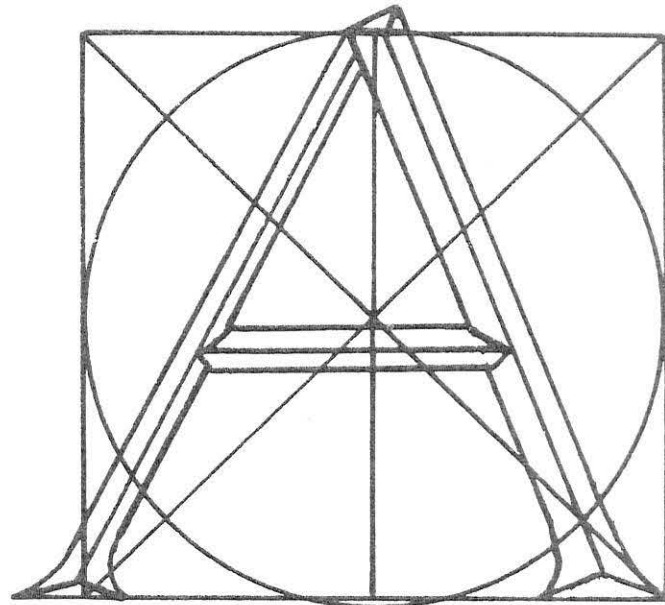
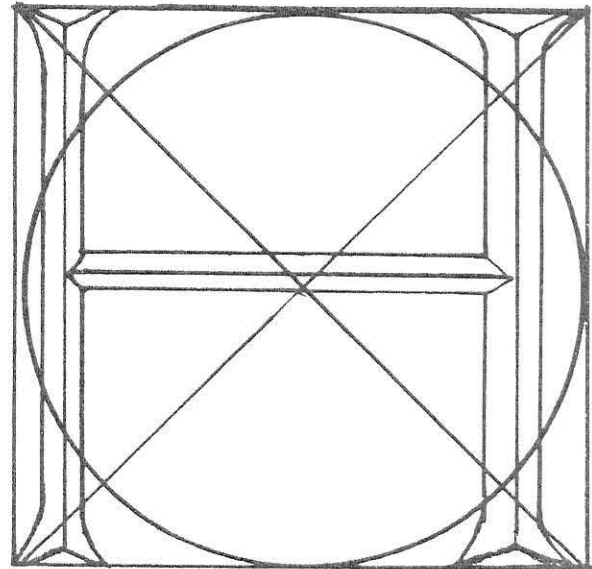


Figure 16. Diagram of Mantegna, *A*, Albi, MS 4, f. 183v.

Figure 17. Diagram of Mantegna, *H*, Albi, MS 4, f. 273.



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COMPARATIVE TABLE OF PROPORTIONS

	STRABO (MANTEGNA)	FELICIANO	MOILLE	PACIOLI
A				
width r. shank	ca. $\frac{1}{2}$ height	$\frac{1}{10}$ height	$\frac{1}{12}$ height	$\frac{1}{3}$ height
width l. shank	ca. $\frac{2}{3}$ width r.	ca. $\frac{1}{3}$ r.	$\frac{1}{4}$ width r.	$\frac{1}{4}$ width r.
width transversal	ca. $\frac{2}{3}$ width r.	ca. $\frac{1}{3}$ r.	$\frac{1}{4}$ width r.	$\frac{1}{3}$ width r.
location of transversal	below center	just below center	one thickness of r. leg below center	below crossing of diagonals
E				
width upright	ca. $\frac{1}{12}$ height	ca. $\frac{1}{6}$ height	$\frac{1}{12}$ height	$\frac{1}{6}$ height
width upper transversal	ca. $\frac{1}{3}$ width upright	ca. $\frac{2}{11}$ width upright	$\frac{1}{4}$ width upright	$\frac{1}{4}$ width upright
width middle transversal	ca. $\frac{2}{3}$ width upright	ca. $\frac{2}{11}$ width upright	$\frac{1}{2}$ width upright	$\frac{1}{3}$ width upright
width lower transversal	ca. $\frac{1}{4}$ width upright	ca. $\frac{1}{6}$ width upright	$\frac{1}{4}$ width upright	$\frac{1}{4}$ width upright
H				
width r. shank	ca. $\frac{1}{12}$ height	$\frac{1}{10}$ height	$\frac{1}{12}$ height	$\frac{1}{6}$ height
width l. shank	ca. $\frac{1}{10}$ height	$\frac{1}{10}$ height	$\frac{1}{12}$ height	$\frac{1}{6}$ height
width transversal	same as l. shank	ca. $\frac{2}{3}$ width upright	$\frac{1}{4}$ width upright	$\frac{1}{3}$ width upright
location of transversal	just above middle	just above middle	just above middle	passes through middle

Ratios derived from measurement of the initials are only approximate.

transversal is actually shorter than the upper, but it has a larger serif. The ratio of width to height in the upright is again about 1 to 12.

In his choice of a ratio of 1 to 12 Mantegna, like Feliciano, may have intended to conform to ancient authority, particularly Vitruvius. Actually this writer, in the same passage on proportion to which we have referred above, says that while many of the "ancients" held 10 to be the perfect number, others preferred 6. Twelve was an essential part of the numerical pattern that is inherent in 6, and it was called *diplosios*.

Measurement of initials like those in the *Strabo*, whose parts are merely a fraction of a centimeter wide, is of course only approximate, and our belief that Mantegna had in mind the ratio 1 = 12 therefore receives welcome support from the theory of Damiano Moille. This stationer, miniaturist, and calligrapher of Parma produced in that city around 1480 the first printed treatise on the design of the *littera antiqua* (Figs. 14, 15).<sup>13</sup> The little book, printed on only one side of the sheet and unbound—probably because it was intended only for craftsmen—combines a short description of each letter with a diagram that shows it inscribed within a circle and a square. The author prescribes for the ratio of the width of an upright to its height the same ratio that we supposed to be inherent in the *Strabo*. "The I," Moille says, "should be of a width that is the twelfth part of the height of the square, like all the other letters." In describing the A, Moille says that the right shank is  $\frac{1}{12}$  of its height, and then stipulates for the other shanks some of the ratios that, according to the ancients, contribute to the perfection of 6 ( $\frac{1}{2} = 3$ , and  $\frac{1}{3} = 2$ ). The width of the left shank is  $\frac{1}{2}$ , and the transversal is  $\frac{1}{3}$ , of the right shank. Such variations, lacking in Feliciano's A (Fig. 7), may be found in the *Strabo* (Fig. 16). Here, however, the relation of the transversal to the left shank is reversed, the transversal in the *Strabo* being larger than the left shank in the ratio of ca. 3 to 2.<sup>14</sup>

The comparative massiveness of the transversal of the A, together with its low position and the wide spread of the shanks, increases the weight and the monumental effect of the letter. These qualities characterize all the letters in the *Strabo*. The H, for instance, whose uniquely varied verticals we have already mentioned, is equally unique for its overall width (Fig. 17). It approaches closely a square, more closely at any rate than Moille's H, which leaves an unfilled

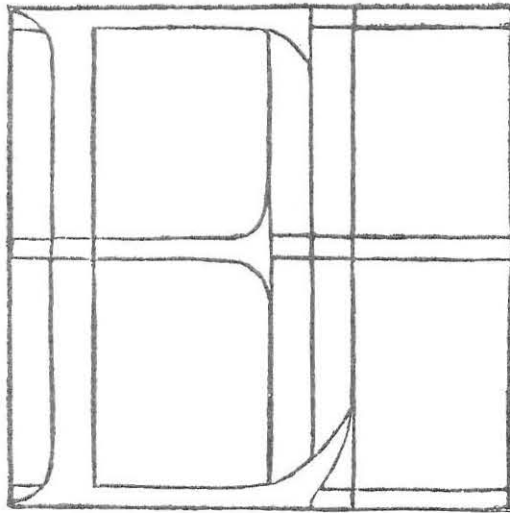


Figure 18. D. Moille, *E*, from *Alphabetum*, Parma, ca. 1480.

space at the right (Fig. 15). In Moille's constructions, as well as in those of Pacioli and other later writers, the letters frequently fail to fill the square or project a little beyond it. The ideal shape is only approximated. Geometry provides guidance without exerting strict control.

The relations of Feliciano and Moille with the *Strabo*, and with one another, are evidently quite complex. Only Feliciano adopts the letter in relief, but Moille's proportions are closer to Mantegna's. Luca Pacioli's connections with his predecessors are no less complex (Figs. 20, 21).<sup>15</sup> It has been argued that he knew both Feliciano and Moille, even though he didn't follow either very closely. And when one considers such aspects of the letters as the serifs, it is apparent that though Moille, like the Romans themselves, omits top serifs on M, Pacioli as well as Feliciano employs them.<sup>16</sup> At the same time Pacioli's letters, shaped in 1509 in the period of the High Renaissance, are squarer and bulkier than those of his predecessors. This change is reflected in his basic proportion of the width of the stroke to its height, which is no longer  $1=12$ , but  $1=9$ . The ratio of the smaller stroke to the larger—the transversal of H, for instance, to the uprights (Fig. 21), or the transversal of A to the right shank (Fig.

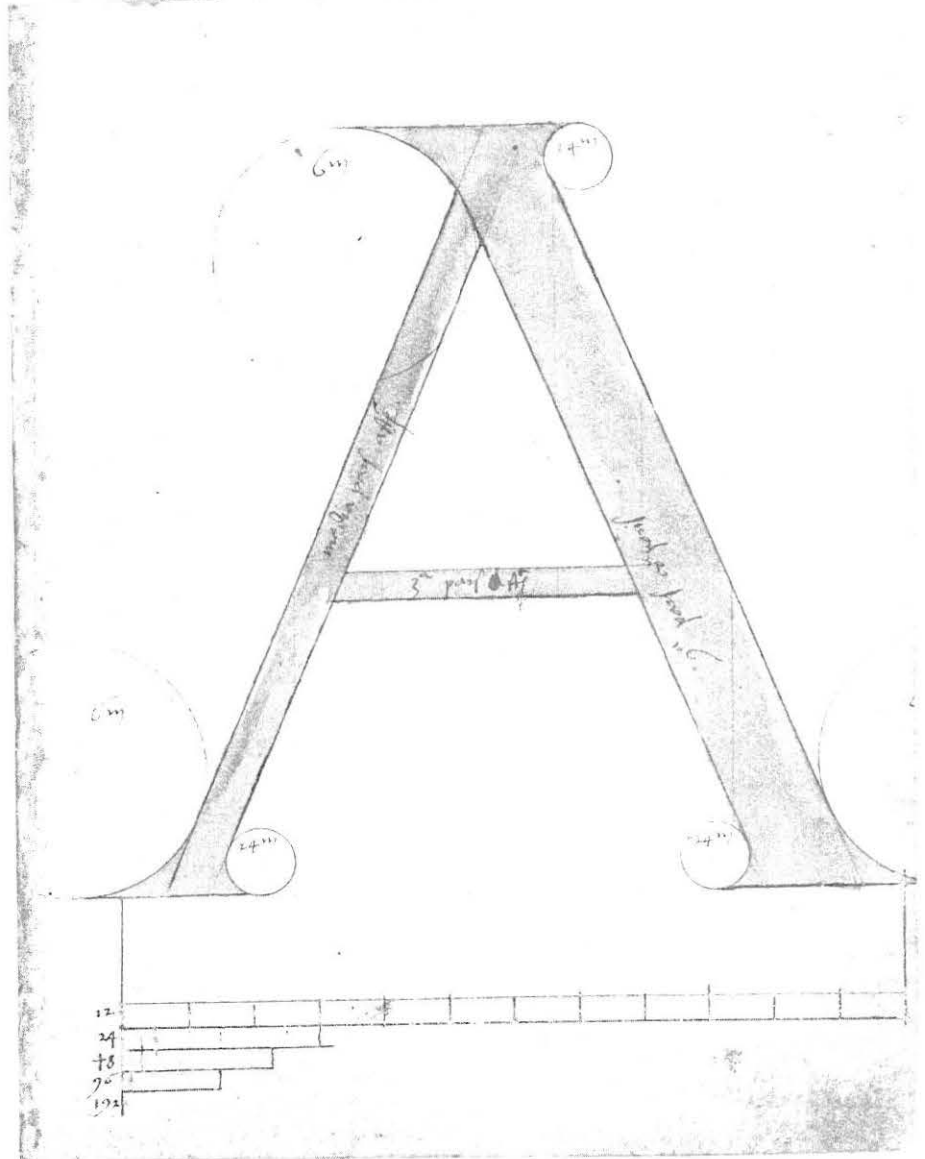


Figure 19. Italian late XV century, *A* from an alphabet, Chicago, Newberry Library.

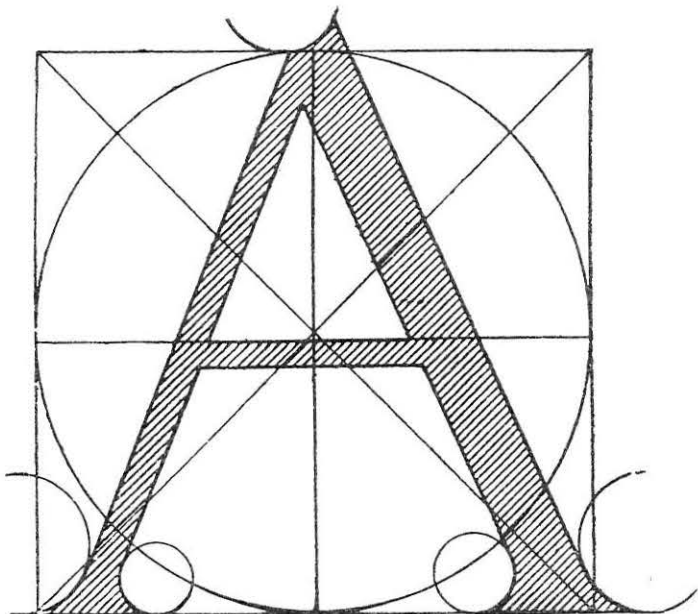
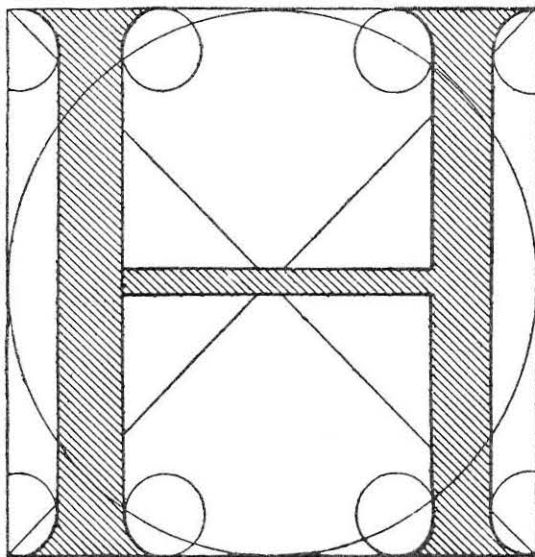


Figure 20. L. Pacioli, *A*, from *Divina Proportione*, Venice, 1509.

Figure 21. L. Pacioli, *H*, from *Divina Proportione*, Venice, 1509.



20)—is moreover often  $1=3$ . In all of this (1–3–9) we recognize not only a predilection for a certain shape but for a certain abstract proportion, namely the Platonic, as set forth in the *Timaeus*.

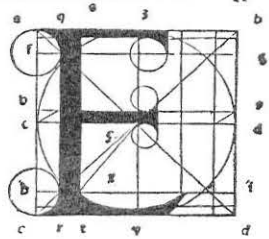
Pacioli is the last of the major early Italian theorists of the design of the alphabet. Sigismondo de' Fanti's book, published in Venice five years after Pacioli's, is notable chiefly as a full-fledged manual, giving precise and detailed instructions for the construction of the letters, which are illustrated by complex diagrams (Fig. 22).<sup>17</sup> It is a sign of the times that Fanti should discuss first not Roman capitals but Gothic minuscules. As we have observed elsewhere,<sup>18</sup> after the first wave of enthusiasm for the *littera antiqua* Gothic letters returned to favor, especially for religious texts.

But an account, however brief, of the first half century of the theory of the design of the alphabet cannot end with Pacioli, and much less with Fanti. For a highly significant contribution was made at this time, first apparently by the originator—whoever he was—of the ideas contained in a manuscript that belonged in the early sixteenth century to the Nürnberg physician and scholar, Hartmann Schedel. This manuscript, of which only the briefest notices have been published,<sup>19</sup> proposes three possible ratios for the letters:  $1=12$ ,  $1=10$ ,  $1=9$ , though  $1=10$  is favored. A similar concept of alternatives emerges in the thought of Albrecht Dürer, perhaps inspired by this anonymous text. Dürer in any event had been twice to Venice, and he was no doubt familiar with at least those alphabetical treatises that had been published, two of which had appeared in that city itself. Just as in his speculation about the human figure Dürer had come to recognize more than one beautiful form and one canon of proportion,<sup>20</sup> so in his account of roman capitals in the *Underweysung der Messung* he presented more than one perfect example of each letter. He offered for each letter the ratio  $1=9$  as well as  $1=10$ , and two or more shapes, recommending to the reader the use of the one "weliche dir am besten gefelt." Thus Dürer and his anonymous forerunner undermined the central concept of the earlier theorists—that of a single perfect form. Without abandoning geometry and numerical law they opened the door to multiformity and to individual taste.

But the idea of a perfect letter, possessing a fixed proportion, continued to haunt the sixteenth and seventeenth centuries. Indeed in

Q V A R T V S.

**A** littera. E. antiqua certamente e auarfe da le medefine circulantie & modi de la precedete nõ negamo. Quãdo adũque laſta naturale de qũta littera fera cũ le medefine portide del circulo. x. y. ſecũdo la qũta de. e. x. tãgẽdo lo diametro a. d. in. y. da li qũe puncto ſia la linea. y. z. ppendiculariter extẽdura fõ pra il diametro. a. d. per la. xi. de Euclide: & de dita lĩa la gamba iſe riore hauerai fabricatoe fe la ſupiore gãba uorai generare. Alhora dal pũcto. z. per la. xi. del Megareſe ſia la linea. z. &. ppendiculariter



fopra lo lato. c. d. ptraſi iſte cãdo. f. g. in. o. Et qũ il circulo paruo ſopra il centro. p. ſera deſcripto ſecũdo la qũta de. g. z. la quale e poſta eſſere æquale a li tri quarti de la larghezza de la pẽna cioe de. f. a. Et qũto fatto ſe la media aſta. A. C. B. D. eſtingere al cẽtro. e. cõmuõno ſera lineata il cui termino ſia la linea. E. F. diſtãte da la linea. u. z. p tri qũti de teſta. Hauerai alhora la mediale gãba de dita lĩa cũ doctũ na erecta. Et maxie qũ p gra de qũlla li ſerãno li dui paruiſſimi circuli ſecũdo la qũta de media teſta deſcripta. Se da poi li dui parui circuli

Figure 22. S. de' Fantii, *E*, from *Theorica et Practica de modo scribendi*, Venice, 1514.

Figure 23. A. Dürer, *A*, from *Underweysung der Messung*, Nürnberg, 1525.

zertũ eſte ſierung mit ſieben ream muen vñ außwert. c. p. vñ ſerũ. g. p. z. amũtẽpõ vñ vñ m der ſierung den. c. d. ſien puncto. i. f. em ſeben teſt hancũ vñ ſien den dũmũn ſien de buſlabũ von den. i. vberſich an der ſierung von den. ſoi. h. den beſeren ſien vber teſtãlſo das nẽ beder beo p ten auffen die zuen puncto. i. f. an nũen ſõ beder mitten ein dũmũn. aber der punct e hũmpũ oben in teſtã den buſlabũ. Zũmach auch das a. vñ der den ſierũ ſien. p. i. ſiſtãne. den ſien ſiẽ nach emũ dũmũn beo vñ der gũſeren beo. Dũmũn. laſt an den beoũn ſien oben ein mũdũnũ ſedũm vñ der ſien vber die ſierung außſteoẽ. vñ von den buſlabũ oben mit einẽ ſiẽ langũũ lũũ ab. alſo das die beoũn gegen den dũmũn ſien ſiẽ vñ ſiẽ vñ de buſlabũ ſien vñ an auf be den ſien auß. alſo das ſie der ſierung. e. c. d. nũen. das ſiẽ mit einẽ einſedũm deo halben. Dũ mũn. emũ ſien teſt von der ſierung ſien hab. aber nũen hancũ laſt den auß. den von der gũſeren beoũn deo ſien. be ſien dũmũn weo ſiẽ dũmũn. Dũmũn. iũ beoũn nũen mit einẽ einſedũm auß deo z. amũn deo b. emũ ſien beoũn ſien.

Item dũ. a. maãũ du auch oben mit der ſierung bla ab nũen vñ den buſlabũ auß beoũn ſien auß ſiẽ beoũn weo vñ den. das deo teſtã teſtã ſien werde. aber oben mũen die ſien ein wenig nũer ſiẽ anũen ſiẽ mũtẽ werden. Dũ ſiẽ breoũn meũung mũũ du dich gebãũen. vñ die du am ba ſien uẽ. vñ mit e. ſiẽ glẽnder vñ mũ. weo dũ. ſiẽ lab. a. oben vñ vñ den auß ſiẽ beoũn vñ. alſo ſiẽ du auch auß ſiẽ beoũn die buſlabũ deo ſien e. ſiẽ beoũn vñ. alſo du ſiẽ. x. n. aber deo. emũ meũn. amũn. weo du bemãch. ſien vñ. Item das. a. maãũ du noch ande. ſiẽ mã beoũn nũen. oben ſiẽ beoũn. ſiẽ anũen ſiẽ ſien oben nũer ſiẽ anũen. Dũmũn. mit den ſiẽ beoũn ſiẽ anũen vñ. vñ mãch. noch ſiẽ beoũn. alſo. du maãũ auch den ſien oben. hũmpũ ab ſiẽ beoũn vñ. ſien auß ſiẽ beoũn. Dũ dũ. ſiẽ lab. ſiẽ bemãch. auß ſiẽ anũen.

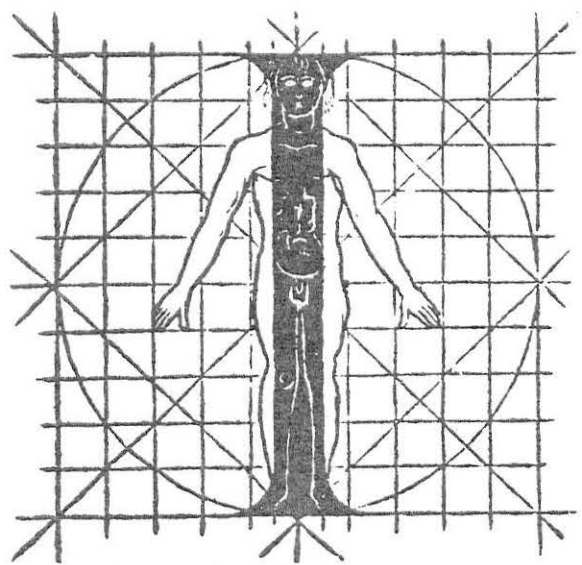
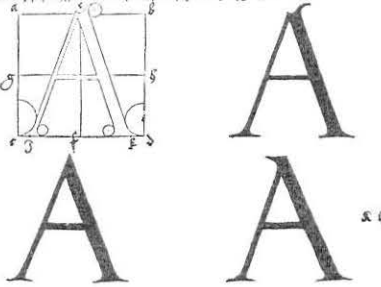


Figure 24. Geofroy Tory, *I*, from *Champ Fleury*, Paris, 1529.

Figure 25. N. Jaugeon, *L* and *M*, Drawing, Paris, Bibliothèque Nationale.

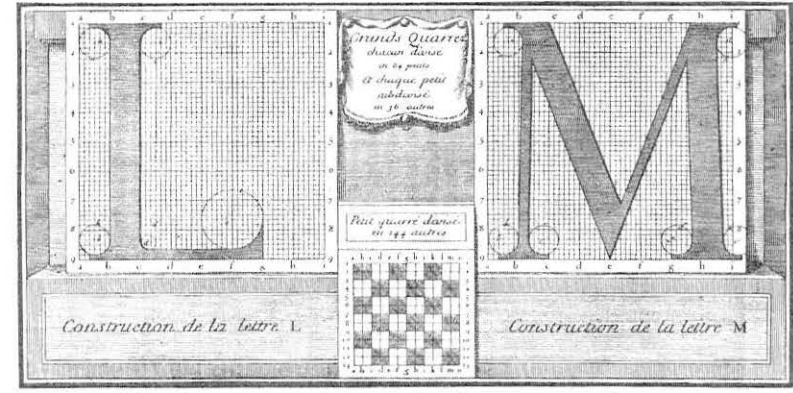


Figure 25. N. Jaugeon, *L* and *M*, Drawing, Paris, Bibliothèque Nationale.

France, where Italian criticism and theory were rigorously systematized, the mathematical determination of letters was raised to an astonishing level of precision. In 1692 the *Académie des Sciences*, composing a set of models of capitals for the engraver of the *Imprimerie Royale*, laid them out on a field subdivided into 2304 squares (Fig. 25). The story is not complete however without adding that the engraver, confronted with these laboriously contrived geometric patterns, absolutely refused to adhere to them, insisting that the eye was the sovereign creator and judge of form.<sup>21</sup> Mantegna and his contemporaries would probably not deny this, but they would not, at the same time, sense an inherent conflict. Even while invoking geometry as a guide to form they assumed its limits, and they knew intuitively how to make something living and personal of it.

This article is adapted from chapter IV in Millard Meiss, *Andrea Mantegna as Illuminator, an Episode in Renaissance Art, Humanism, and Diplomacy*. New York: Columbia University Press.

1. There is also a manuscript on letter design now in the Newberry Library, Chicago, formerly in the Ricketts Collection (Fig. 19). Measurements and brief instructions are written on or around the letters (Cf. F. W. Goudy, "The Roman Alphabet," in *Ars Typographica*, II, 1926, pp. 202–5, with an unfounded ascription to Leonardo—see below, note 15). I have been unable to find reproductions of another alphabet in the Bayerische Staatsbibliothek, Munich, Clm 451. See below, note 19.
2. "Suole lusanza antiqua cauare la littera di tondo e quadro, la summa de le qual forme ascende al numero LII, del qual si caua il numero perfecto che e. X. e cossi uol esser la tua littera grossa la X<sup>a</sup>. parte delalteza et per questo modo hauere tanto del tondo quanto del quadro . . ."
3. Vitruvius, Book III, chapter 1.
4. *Divina proportione*, ed. C. Winterberg, Vienna, 1889, pp. 129, 131. The two passages are quoted above in the English translation given by R. Wittkower, *Architectural Principles in the Age of Humanism*, London, 1949, p. 14.
5. He was born in 1431. The published accounts of the life and works of Feliciano evidently abound in error. A recent study by L. Pratilli, "Felice Feliciano alla luce dei suoi codici," in *Atti del Reale Istituto Veneto di Scienze, Lettere, ed Arti*, XCIX, 1939–40, pp. 33–105, makes real progress, but much remains to be done. See also G. Tiraboschi, *Storia della Letteratura Italiana*, ed. Milan, 1824, VI, I, p. 304, and S. Maffei, *Verona Illustrata*, Milan, 1825, III, p. 191 ff.
6. Ms. 269, Biblioteca Capitolare, Verona. The dedicatory preface is printed in Pratilli, *op. cit.*, p. 49.

7. Ms. lat. 6852. The text on the alphabet was printed by R. Schöne, "Felicio Feliciani Veronensis Opusculum ineditum," in *Ephemeris Epigraphica*, Rome, 1872, p. 255 ff. See also J. Poppelreuter, "Zu Felice Felicianos römischen Schriftformen," in *Repertorium für Kunstwissenschaft*, XXVII, 1904, pp. 57–60 (with the incorrect statement that the Vatican manuscript was finished in 1481), and R. Bertieri, "Gli Studi Italiani sull'Alfabeto nel Rinascimento," in *Gutenberg-Jahrbuch*, 1929, p. 269 ff. The letters E, M, S have not hitherto been reproduced.

W. R. Koehler has kindly informed me of a sort of Carolingian prelude to this Quattrocento concern with the measurement of roman script, described in a letter dated 836 of Lupus of Ferrières to Eginhard. "Praeterea scriptor regius Bertecandus dicitur antiquarum litterarum, dumtaxat (i.e. videlicet) earum quae maximae sunt, et unciales a quibusdam vocari existimantur, habere mensuram descriptam." (Cf. *Lettres de Servat Lup, Abbé de Ferrières*, ed. Desdevises, Paris, 1888, pp. 60–61.)

8. Drawings of all these letters were published by Schöne, *op. cit.* Pratilli, *op. cit.*, reproduces photographs of several.
9. The relationship of the *Strabo* capitals to Mantegna, and Mantegna's role in the revival of the Roman imperial majuscule—a major one, in the writer's opinion—are discussed in Meiss, *op. cit.*, pp. 52–67, and idem, "Toward a More Comprehensive Renaissance Palaeography," *Art Bulletin*, XLII, 1960, pp. 97–112.
10. The date 1481 on f. 17, taken by some students to be determining, is actually, according to Pratilli (*op. cit.*, p. 58) an addition.
11. Museo Correr, ms. 314. VI, 351, f. 5. Cf. Pratilli, *op. cit.*, p. 96.
12. A similar kind of interlace appears in the friezes of the Petrarch printed by Feliciano (cf. Pratilli, *op. cit.*, fig. 7).
13. Cf. the facsimile published by S. Morison, *A Newly Discovered Treatise on Classic Letter Design*, Paris, 1927. Damiano was born shortly after 1439 and died probably in 1500. Cf. also *Tesori delle Biblioteche d'Italia, Emilia e Romagna*, Milan, 1932, p. 542 and figs. 305–6.
14. The relationship is peculiar to the *Strabo*, and differentiates it from all the treatises, including Pacioli's.
15. The opinion, shared by Morison (*op. cit.*, p. 20), that Pacioli wrote his account of the alphabet in 1483, has been refuted by R. Bertieri, *op. cit.* Bertieri shows that this treatise was written expressly for the volume of the *Divina Proportione* published in 1509. Bertieri argues also that there is no substance in the old view that Pacioli's letters were drawn by Leonardo, and he suggests instead (with little evidence) Piero della Francesca. Bertieri also points out that there is no evidence for the attribution to Leonardo (even ultimately) of the alphabet now in the Newberry Library, Chicago (Fig. 19). On this see above, note 1.
16. On this point see Morison, *loc. cit.*
17. *Theorica et Practica de modo scribendi*, Venice, 1514.
18. Meiss, *op. cit.*, p. 64.
19. See G. Dehio, "Zur Geschichte der Buchstabenreform in der Renaissance," in *Repertorium für Kunstwissenschaft*, IV, 1881, pp. 269–79, and E. Crous, *Dürer und die Schrift*, Berlin, 1933, p. 11. The text for one letter has been published (by Dehio), but none of the letters themselves. Dehio proposed that the text was copied from a lost late fifteenth-century treatise, probably by Leonardo, and also was the source of the ideas of Pacioli, Dürer, and Feliciano, whose *ars litteraria* he dated after 1481.

It is to be hoped that this manuscript, apparently important, will soon be studied adequately. Crous, whose book became available to me only after my own was in galleys, gives a short account of the alphabetical treatises. His statements of fact are sometimes incorrect, as, for instance, about Moille's preferred ratio. He is the only writer who comments on the prismatic letter, wondering whether the innumerable examples in printed books of the 'nineties derive from Feliciano.

20. See E. Panofsky, *Albrecht Dürer*, Princeton, 1943, I, p. 266 ff. See also p. 258 for a discussion of Dürer's alphabet.

21. See S. Morison, *op. cit.*, p. 22. See also A. Christian, *Débuts de l'Imprimerie en France*, Paris, 1905, p. 83 and plate opposite p. 275. Already in 1529 Geofroy Tory utilized a more elaborate system of coordinates than his Italian predecessors, aiming at a more precise mathematical determination of the letters (Fig. 24). Cf. *Champ Fleury*, Paris, 1529 (ed. G. Cohen, Paris, 1931).

## Computer Recognition of Hand-printed Text

John H. Munson

This paper describes the procedures and results of a project aimed at the computer recognition of relatively unconstrained hand-printed texts. Scanning, feature-extraction, and character classification techniques are described. Novel approaches investigated include a feature-extracting preprocessor consisting entirely of local edge detectors, the use of multiple-valued confidence indicators both before and after classification, the combining of independent preprocessor-classifier systems in parallel to achieve improved character-recognition accuracy, and the use of application-oriented context analysis. Two large files of hand-printed data are described, and results concerning their legibility are given. An extensive bibliography in hand-printed character recognition is included.

### *Introduction and Background*

Among the many subject areas in the field of pattern recognition, the recognition of machine-printed and hand-printed alphanumeric characters has perhaps been the classic example to which people have referred in exemplifying the field. Interest in character recognition has long run high; an extensive literature in hand-printed character recognition alone dates back to at least 1955.<sup>1-36</sup>

In recent years the recognition of machine printing has become a commercial reality. Following the introduction of the highly controlled E13B magnetic font by the banking industry, several advances in optical character recognition (OCR) capability have been brought to the market-place. The trend of these advances is toward the acceptance of broader and less controlled classes of input: from single, stylized fonts to multi-font capability; from high-quality copy to ordinary inked-ribbon impressions, and even to multi-part carbons of surprisingly poor quality. Still, in contrast to hand printing, the approaches to OCR have been able to rely on the lack of gross