

The Structures of the Mexican *Tonalamatl*

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It is a great pleasure to participate in this *homenaje* for Doctora Beatriz de la Fuente and to signal the great respect and affection I have for her. For over three decades she has been the dominant force in Pre-Columbian art in Mexico, shaping the way the study of ancient Mexican art has grown. She has exerted a powerful influence on the field in the United States and Europe as well. My art historical colleagues and I owe her a great debt for all she has done for Pre-Columbian art history. Personally, Doña Beatriz has represented an ideal to follow: she is always elegant, always kind, and always generous. More than anyone else, she has mentored and encouraged women scholars both in Mexico and the United States to succeed. If in the United States we think of George Kubler as the father of Pre-Columbian art history, we think of Beatriz de la Fuente as the queen.

The paper offered here pertains to one of Doña Beatriz's long term interests: her interest in aesthetic structure. Structure is central to her unsurpassed studies of Olmec and Toltec sculpture. And although my own work pertains to the Aztecs, Mixtecs, and other participants in the Mixteca-Puebla Horizon Style, I share her desire to investigate the organizational relationships between formal elements, and to understand how ancient Mexican artists structured their visual codes.

In particular I have been interested in the graphic or pictorial writing system of Late Postclassic central Mexico, especially the area encompassed and dominated by the Aztec empire. This pictorial system, which I call Mexican pictography or Aztec pictography,¹ is composed of glyphic elements and figural images that work together to convey information. Fragments of this writing system

¹ Hanns Prem (1992: 53) divided Aztec writing into two components, "narrative pictography" and "hieroglyphic writing." I use the terms "Mexican pictography" and "Aztec pictography" to embrace both glyph and figure, which interact

within a single system of pictorial record keeping. This system is part of the larger "Mixteca-Puebla Horizon Style" phenomena.

appear on monumental stone sculpture, such as the Stone of Tizoc or the Dedication Stone for the Templo Mayor, where glyphic appellatives and dates interact with figural pictography to commemorate events important to the Aztec state. The system is best preserved and understood, however, in the central Mexican pictorial codices, which record the mythical and historical past, outline social and economic relationships, and set down the tenets of Postclassic ideology. The Aztecs and their neighbors did not write alphabetically in letters, words, and sentences; they did not even write phonetically with hieroglyphs, as did the Maya. Instead they wrote purely in images (Boone 1994). The elements of their graphic vocabulary appear as figural representations, icons, and symbols. Their syntax is fundamentally spatial, where meaning is created and directed by structure and by the principles of sequence, proximity, inclusion, and exclusion. In this and other respects, Mexican pictography is similar to other graphic systems, such as those that are today employed so efficiently in business, philosophy, science, and mathematics.

Mexican pictography has much to tell us about graphic systems and image writing in general. It represents a kind of figural writing that developed as an alternative to hieroglyphic expression. The Postclassic central Mexicans knew about Maya hieroglyphic writing, but they did not adopt hieroglyphic writing for themselves to any great extent; instead they developed a specialized pictography. By studying Aztec or Mexican pictography, I believe we can gain new perspectives on image writing in general. And by analyzing some of the other, non-Mexican, forms of image writing, I believe we can appreciate the special features of the Mexican system even more.

Graphic systems compose one of the major forms of communication. Graphic language informs through sight, for it is a language of the eye. In contrast, spoken language is a language for the ear; and both languages have a linear, one-directional quality, in that one must hear a speech or read text from the beginning to the end. In contrast, graphic images have the desirable quality of revealing at a single moment a complete entity. One can see the whole and then allow the details to reveal the complexities of the different parts. As a means of analyzing

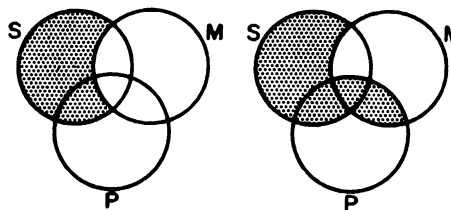
figure 1

Algebraic formula for “the momentum (or energy) imparted by the gravitational field to the matter per unit,” from Albert Einstein’s general theory of relativity.

$$\frac{1}{2} \sum_{\mu\nu} \sqrt{-g} \cdot \frac{\partial g_{\mu\nu}}{\partial x_{\sigma}} \Theta_{\mu\nu}$$

figure 2

Venn Circles used to express relationships such as “no S is M.”



and describing information and conveying ideas, graphic systems are the most efficient way we have of communicating relationships among variables.

Algebraic notation, for example, has become the language of mathematics and physics because ordinary prose can not express these kinds of complex relations efficiently (Drake 1986: 136-139, 154; Rotman 1993: X; 1995). Instead, the algebraic formula records knowledge by organizing icons and symbols spatially on a surface; meaning is achieved by their order, position, relative size, orientation, and repetition (fig. 1).

In some realms of logic, the logic diagram is used because it can express relationships more sharply than prose. Venn Circles, for example, were developed by the late-nineteenth-century logician John Venn to explain Boolean class algebra and to picture the structure of class logic (Gardner 1982: 29-31, 39). In fig. 2 the three intersecting circles show relationships like “no S is M,” or “some of S is P and some of S is MP.” As Martin Gardner (1982: 28-29) points out, “In logic, a good diagram has several virtues. Many individuals think with far greater ease when they can visualize an argument pictorially, and a diagram often makes clear to them a matter which they might have difficulty grasping in verbal or algebraic form.”²

² See also Allwein and Barwise (1996: vii-viii); Kress and van Leeuwen (1996: 53).

figure 3
Model for DNA.

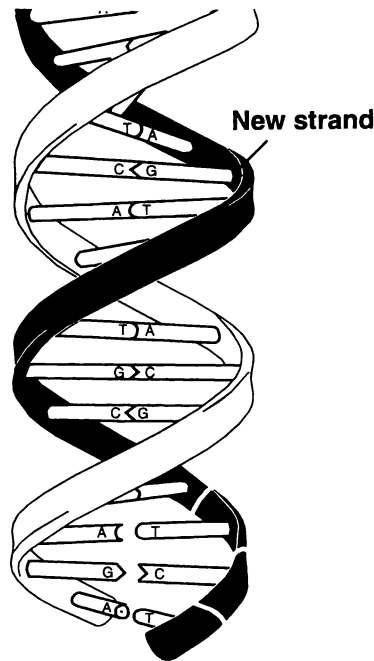


figure 4
List of most popular restaurants in New Orleans.

1. Commander's Palace
2. Galatoire's
3. Bayona
4. Brigtsen's
5. Grill Room
6. Ruth's Chris
7. Clancy's
8. Emeril's
9. Brennan's
10. Antoine's
11. Gabrielle
12. Upperline
13. Mr. B's Bistro
14. Crozier's
15. La Crêpe Nanou

In physics, chemistry, and biology, the model or diagram has proved fundamental, because “structure is generally more effectively depicted than described” (Drake 1986: 153). Our understanding of DNA, for example, rests on the physical modeling of DNA as a double helix around a central axis. It was this model that allowed James Watson and Francis Crick in 1953 to explain the structure of DNA (fig. 3); and their theory of DNA structure was the model itself (Watson and Crick 1953a, 1953b).

Because of the efficacy and power of images, world communication is becoming increasingly visual. The popularity of film and television and the increased use of computers rather than typewriters mean that more and more messages are received as images rather than as words. By analyzing the vocabulary and grammar of some of these modern graphic systems, I believe we can better understand the conventions and structure of Mexican image writing.³ And by

³ See Boone (n.d.) for a further exploration of these systems.

examining Mexican pictography, I believe we can better understand graphic systems in general.

In the past I have analyzed the pictorial writing system used by the Aztecs, Mixtecs, and their neighbors to record history (Boone 2000), but in this essay I want to concentrate on the pictographic writing in the central Mexican *tonalamatl* or divinatory book. The *tonalamatl* differs greatly from the historical codices, for it is much more diagrammatic. The religious and divinatory codices do not usually present narratives as do the histories; instead, they record units of the divinatory calendar along with their governing forces. In a purely abstract sense, their purpose is to record discrete elements and to organize these elements in a way that explains the relationships between the different parts. In this sense, the *tonalamatls* share the purpose of many graphics that support chemistry, logic, and statistical analysis, which is to specify elements, to show how they are organized, and to explain the relationships between them. They have much in common with the kind of conceptual diagramming found in chemistry and logic, and with tabular and list graphics otherwise found in statistical analysis.

When an Aztec child was born, her parents took her to a calendar priest to have her fate read and her calendar name assigned. The priest cracked the stiff pages of the *tonalamatl*, consulted many different almanacs contained therein, and pronounced the child's fate (see Sahagún 1959-82, bk. 6: 198). Thereafter, through the child's life, she would consult the calendar priests or day-keepers for guidance at major life events, such as marriage, and for lesser moments, such as planting and harvesting, gathering and hunting, going to the market, and making a journey (Durán 1971: 396-397; Las Casas 1967, 2: 411; Mendieta 1971: 108, 126; Sahagún 1959-82, bk. 2: 40; bk. 5: 152; bk. 9: 9; bk. 10: 42). The larger society relied on the calendar priests and the divinatory books to guide them also in war, commerce, and political life (Durán 1971: 397; 1994: 475; Lockhart 1993: 269). In Mesoamerica everything that happened and everything that mattered was governed by the divinatory forces attached to the calendar.

The extant *tonalamatls* each contain between one and 31 almanacs that associate different units of time with their supernatural beings and forces. About

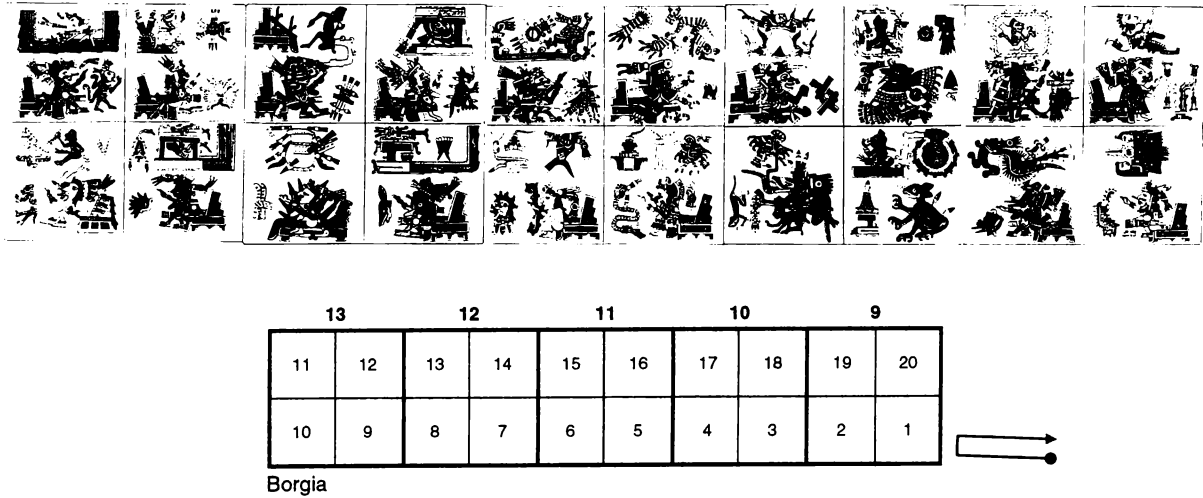
half the almanacs pair the 20 day signs with their mantic elements, and about half cover all 260 days of the divinatory cycle or *tonalpohualli*, usually by grouping the days into 20 *trecenas*. Only a few treat the 13 numerical coefficients.

Meaning is created by organizing the day signs and the gods and forces that govern them in ways that establish systems of correspondence. Figural images are the basic message-carrying units, but their message is controlled by the structure of their arrangement. In this way the almanacs employ structure, space, sequence, proximity, and the properties of inclusion and exclusion to convey meaning. The 100 or so extant almanacs employ three basic organizational schemes for linking time to its influences. The three structures are the list, the table, and the diagram. It can be useful, as we proceed, to compare modern examples of these structures with the ancient Mexican ones.

The simplest way to relate one series of things to another series of things is in a list, and in a list where there is a clear one-to-one correspondence between the elements put into association. A very simple modern list is this list of top restaurants in the city of New Orleans (Zagat 2000: 11) (fig. 4). The numbers next to the restaurants' names indicate their favored status, and thereby characterize the restaurants as having a certain quality. The symbol that represents number 1 signifies a value judgment or a belief that Commander's Palace was the best restaurant in the city. The symbol that represents number 10 conveys a different value judgment, one that ranked Antoine's as less popular. Those with local knowledge will interpret this to mean that the once-celebrated Antoine's has declined over the years, although it was still celebrated enough to remain within the top ten. Spatially, the elements are related as a sequence that reads from top to bottom; each number, and thus each position in the sequence, symbolizes a different valuation. The virtues of a list are that it brings several different kinds of information together (here it is the ranking number and the restaurant) and presents these correspondences as discrete units.

Mixteca-Puebla manuscript painters employed the list to relate the 20 day signs to their governing forces. On *Codex Borgia* 9-13, for example, the 20 day signs

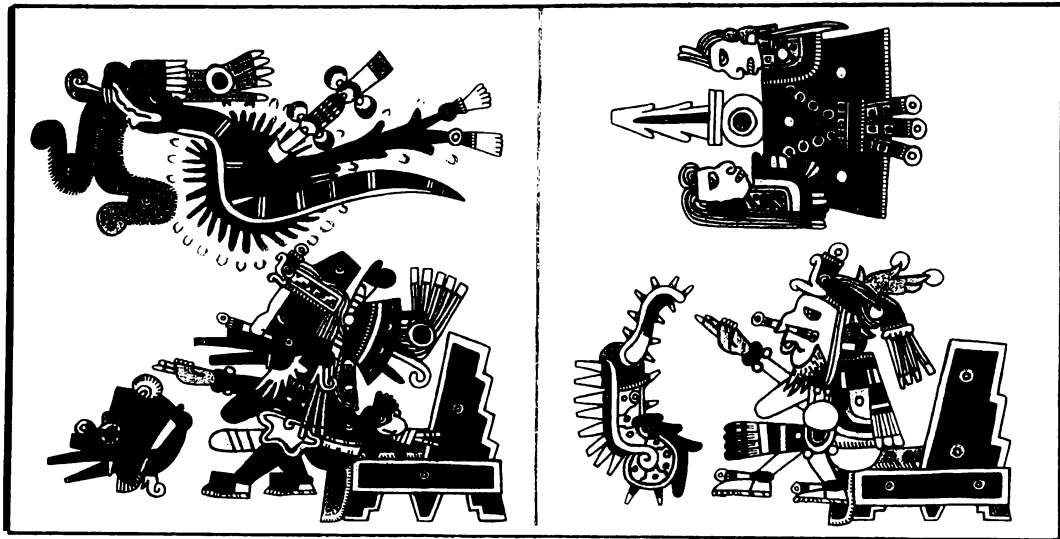
figure 5
Pictorial list of the 20 day signs and their associations.



follow each other in two registers over five pages (fig. 5).⁴ Each day sign has its own cell (called *calli* or “house” in Nahuatl), and the divinatory elements associated with it are located in the cell along with the day sign. The day signs are listed sequentially beginning in the lower right with Crocodile and running left along the bottom register to Lizard. The list then continues to the upper register with Monkey and reads to the right until it finishes with Flower. A certain circularity is implied because the sequence spatially turns back on itself, so that after the last day sign (Flower), the first (Crocodile) appears again. Unlike the list of restaurants, the sequencing of this list does not imply a valuation from best to worst. Instead, the almanac’s principal goal is to show the continuing sequence of the days and to link each day sign with its specific mantic elements. The cell achieves this by physically enclosing the elements and thereby relating them unambiguously.

4 For readings of the mantic forces, see Anders and Jansen (1993: 343-354), and Anders, Jansen, and Reyes García (1993: 91-104); Seler (1963, 1: 63-162).

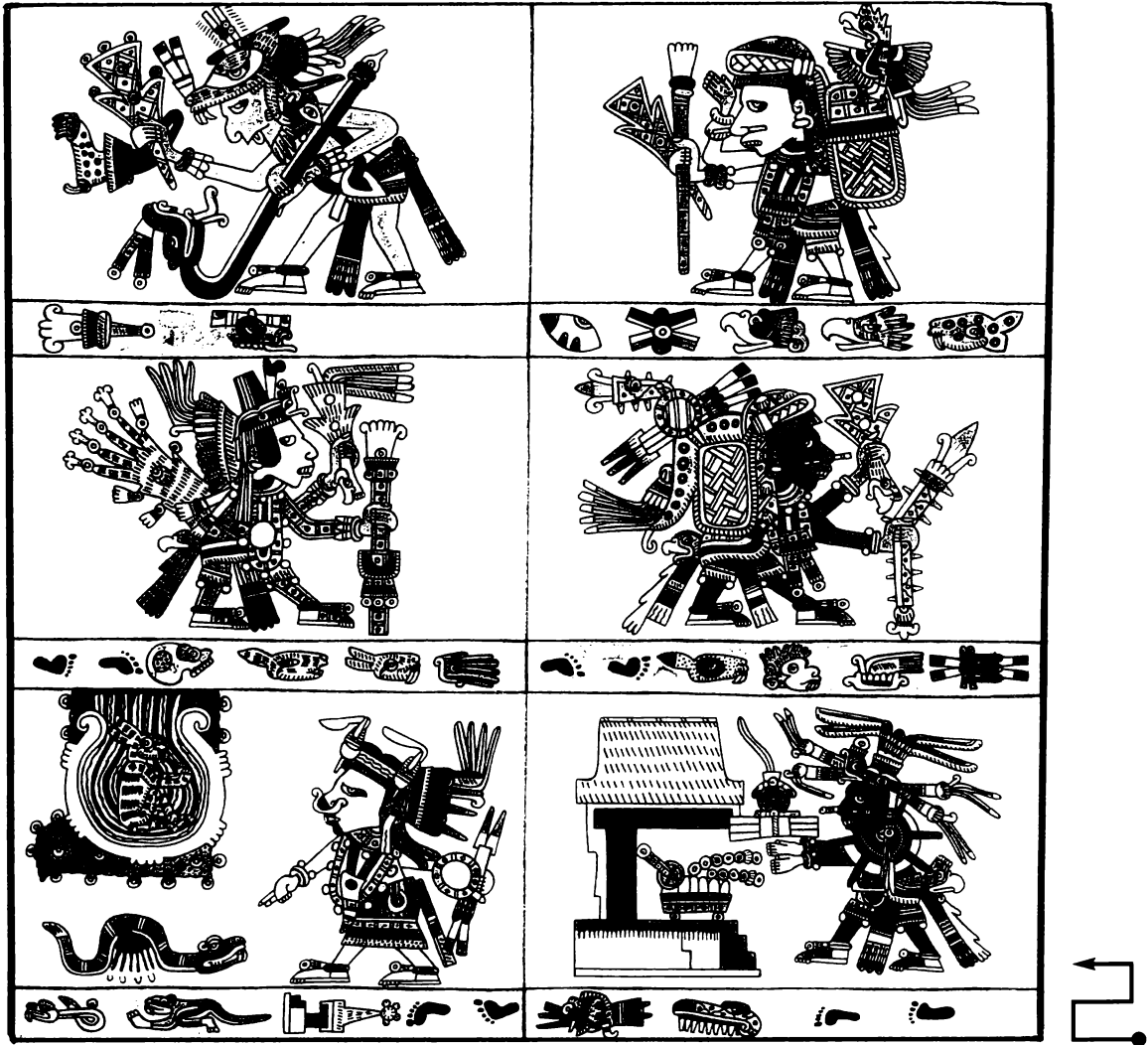
figure 6
The day signs Crocodile and Wind with their
mantic associations.



It is very clear, for example, that Crocodile is associated with the creator god Tonacatecuhtli (seated on the throne) and with the generative forces of the first procreating couple, who face each other under a precious cape of turquoise and jade (fig. 6). The next day Wind is clearly tied to Quetzalcoatl in his manifestation as Ehecatl the wind god, who sits on a throne. That day is also associated with the sacrifice of a coral snake, who emits dark supernatural forces from his mouth (as breath or speech) while he is dramatically pierced by an arrow, his blood spurting forth. This serpent appears elsewhere in a variety of contexts, most of which evoke Quetzalcoatl's office as the quintessential priest. Within the cells space does not itself carry meaning, because the figures simply appear *with* one another but do not interact spatially. Instead, the red lines forming the cells serve to *include* the pertinent elements and to *exclude* all others, so that the relationship of each part to the other is clear.

A variation of the basic list is the grouped list, where several day signs are grouped together with the same mantic unit. Such a grouped list is painted on *Codex Borgia 55*, where the 20 day signs are associated with a series of 6 travel-

figure 7
A grouped list relating the 20 day signs to eight travelers.



ing or walking supernaturals (fig. 7); the almanac is thought to signal the fate of one taking a journey (Anders, Jansen, and Reyes García 1993: 297). The almanac begins in the lower right with Crocodile and runs left, right, and left up the three registers, finishing with Flower in the upper left. The principal of adjacency links the grouped day signs to the traveler just above them. The first two days signs

figure 8
Wine vintage table for 1985 through 1998. Vintages of 1987, 1991, and 1993 are excluded because the table's preparer considered those vintages generally poor.

	'85	'86	'88	'89	'90	'92	'94	'95	'96	'97	'98
Whites											
<i>French</i>											
Alsace	25	20	23	28	28	24	28	26	24	25	24
Burgundy	24	25	19	27	22	23	22	27	28	25	24
Loire Valley	—	—	—	26	25	18	22	24	26	23	22
Champagne	28	25	24	26	28	—	—	24	26	24	—
Sauternes	22	28	29	25	26	—	18	22	23	24	—
<i>California</i>											
Chardonnay	—	—	—	—	—	24	22	26	22	26	26
Reds											
<i>French</i>											
Bordeaux	26	27	25	28	29	18	24	25	24	23	23
Burgundy	24	—	23	27	29	23	23	25	26	24	24
Rhône	26	20	26	28	27	15	23	24	22	24	23
Beaujolais	—	—	—	—	—	—	21	24	22	24	23
<i>California</i>											
Cab./Merlot	26	26	—	21	28	26	27	25	24	25	26
Zinfandel	—	—	—	—	—	21	23	21	22	24	25
<i>Italian</i>											
Tuscany	27	—	24	—	26	—	—	25	19	28	25
Piedmont	25	—	25	27	27	—	—	23	25	28	25

(Crocodile and Wind) come near the path of the sun god Tonatiuh; the next three days signs belong to Tlazolteotl; the next four belong to a turquoise-covered Quetzalcoatl, who exudes preciousness, and so forth.

These lists of the 20 day signs are repeatable, and when lists repeat themselves, they are most efficiently presented as a table, which is the second mode for organizing the almanacs. A modern example is a table that rates wines according to their region or variety and their vintage (Zagat 2000: 124) (fig. 8). In this table the wine regions and varieties are listed vertically on the left, and the years of their harvest are listed horizontally along the top. These two perpendicular lists combine to form a table that interweaves both region and year. Here, as in all tables, the framework of horizontal and vertical axes allows one easily to compare information from line to line and column to column. The unbordered cells

in each line are all from the same region, being linked to the words on the left, and the cells in each column are identified with the same year, being tied to the numerals listed on the top. Other numbers appear within the cells in order to assign values to the unique intersections of lines and columns. These numbers rate the wines on a scale of 0 to 30. We note that high numbers below the column of '89 show 1989 to have been a very good year for all white wines, but the 19 under '88 in the Burgundy line warns that white Burgundies suffered that year. The table, as a graphic system, divides up space into horizontals and verticals, and it conveys meaning according to where icons or elements are located within the grid. Each cell relates to the other cells in its register or column, and each register and column is in turn qualified by the words and letters at the margins.

Mixteca-Puebla scribes used a similar table format for their great “in extenso” almanacs, where so much different information had to be organized and presented (figs. 9, 10).⁵ These large almanacs are called in extenso because they picture all 260 days of the cycle. They come at the beginning of the *Codices Borgia*, *Cospi*, and *Vaticanus B* and are clearly of major importance. In them, the day signs are sequentially listed in five horizontal registers which span eight pages or four two-page spreads. Each entire register contains 52 days (a fifth of the *tonalpohualli*), and each two-page spread contains 13 days (or a *trecena*). In the *Codex Borgia* the day signs begin in the lower right and read right to left for each register, so that the sequence flows like lines of a prose text.⁶ Above and below the registers are elements, figures, and scenes that give meaning to the day signs. The red grid lines create both the horizontal registers and the vertical columns that separate the day signs and elements. The days take their meanings from their columnar axes and share the fates at the top and bottom. In the first column, for example, Crocodile, Reed, Serpent, Movement, and Water share the association

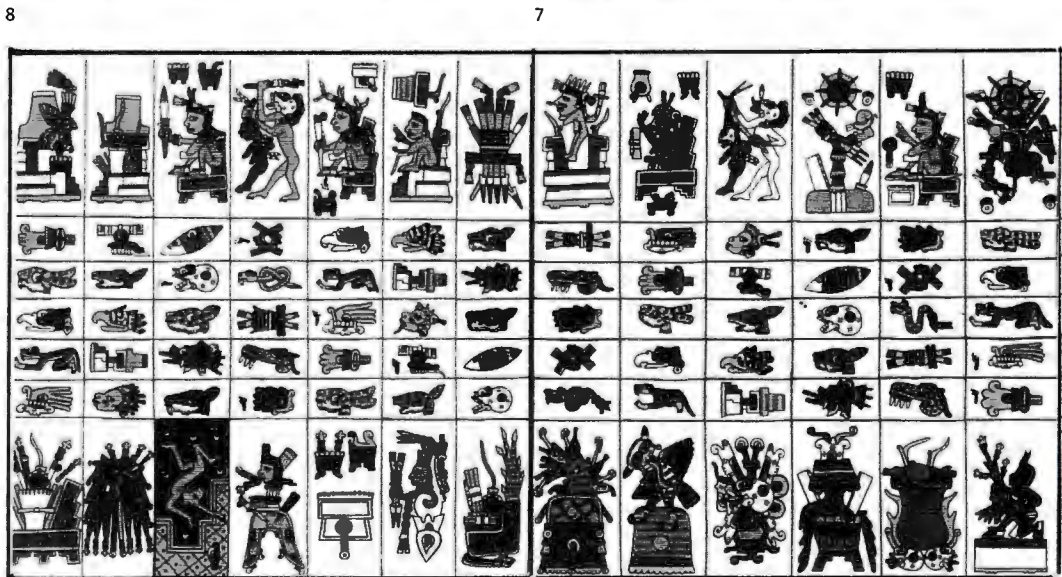
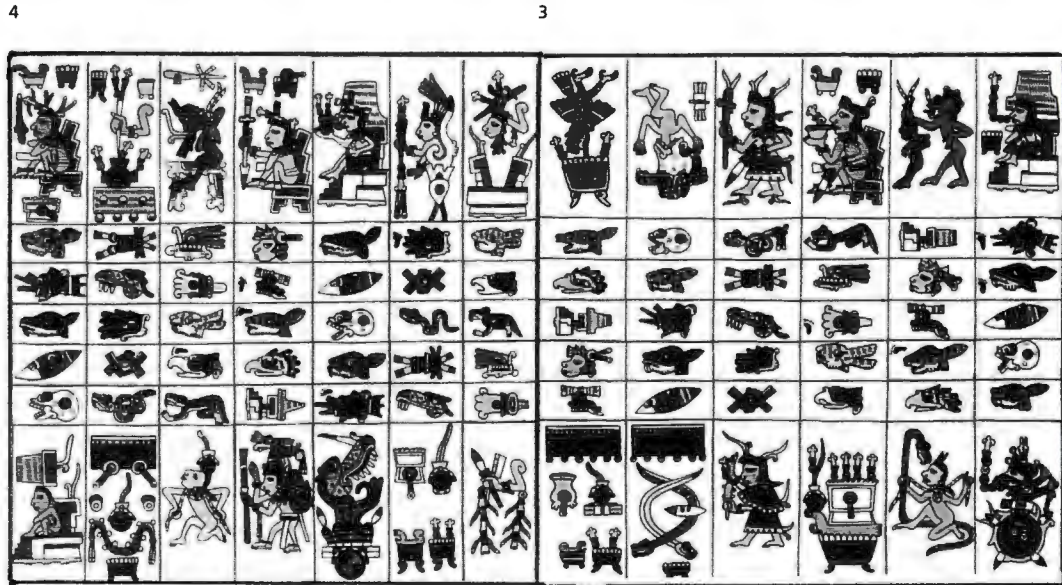
5 The term “in extenso” was coined by Nowotny (1961: 229). For readings of these in extenso almanacs, see Anders and Jansen (1993: 169-184); Anders, Jansen, and Reyes García

(1993: 75-90); Anders, Jansen, and van der Loo (1994: 123-235); Seler (1963, 1: 11-62).

6 The *Cospi* and *Vaticanus B* read left to right, bottom to top.

figure 9

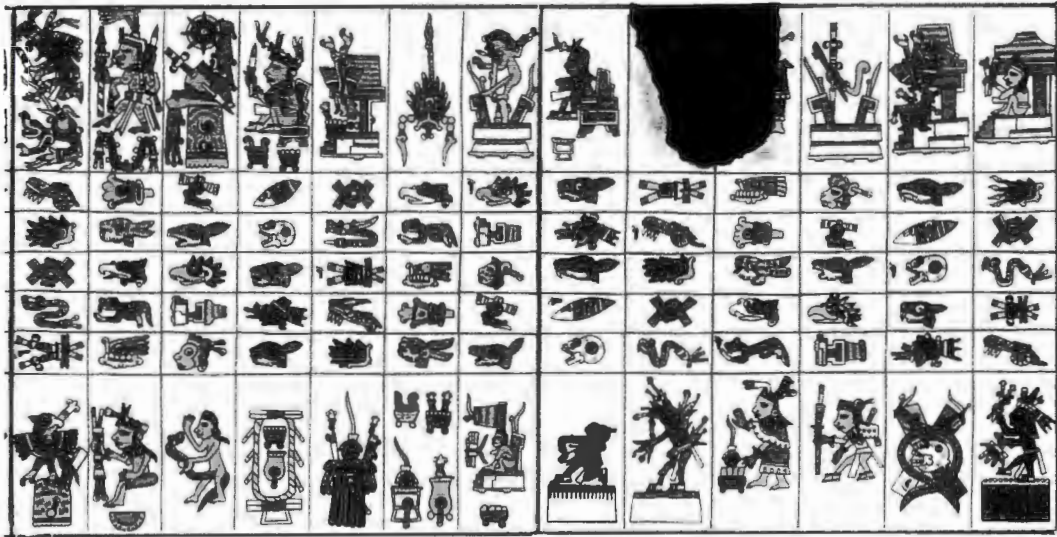
In extenso almanac relating the 260 days
in the *tonalpohualli* with prognosticatory scenes
at the top and bottom.



8	7	6	5	4	3	2	1					

2

1



6

5

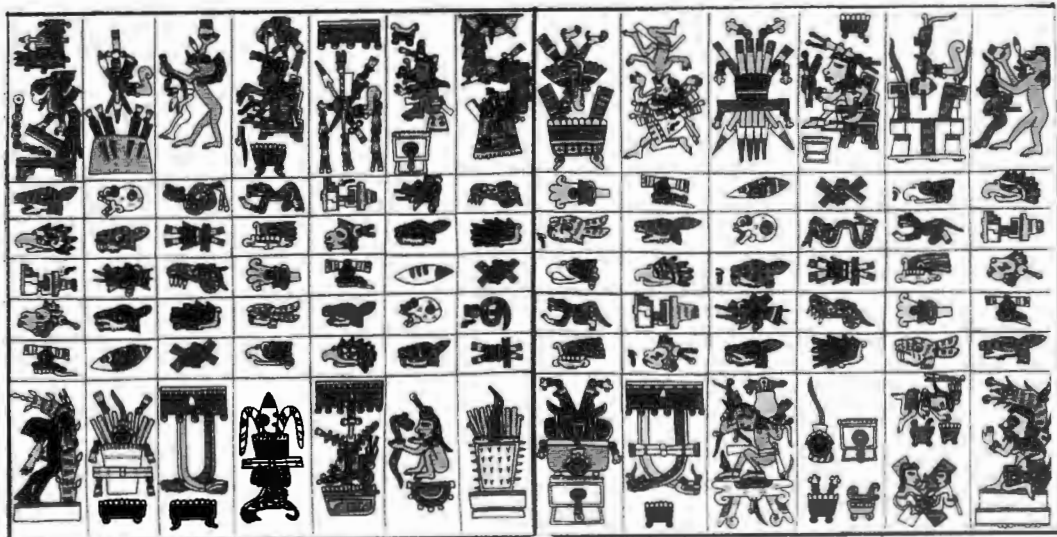
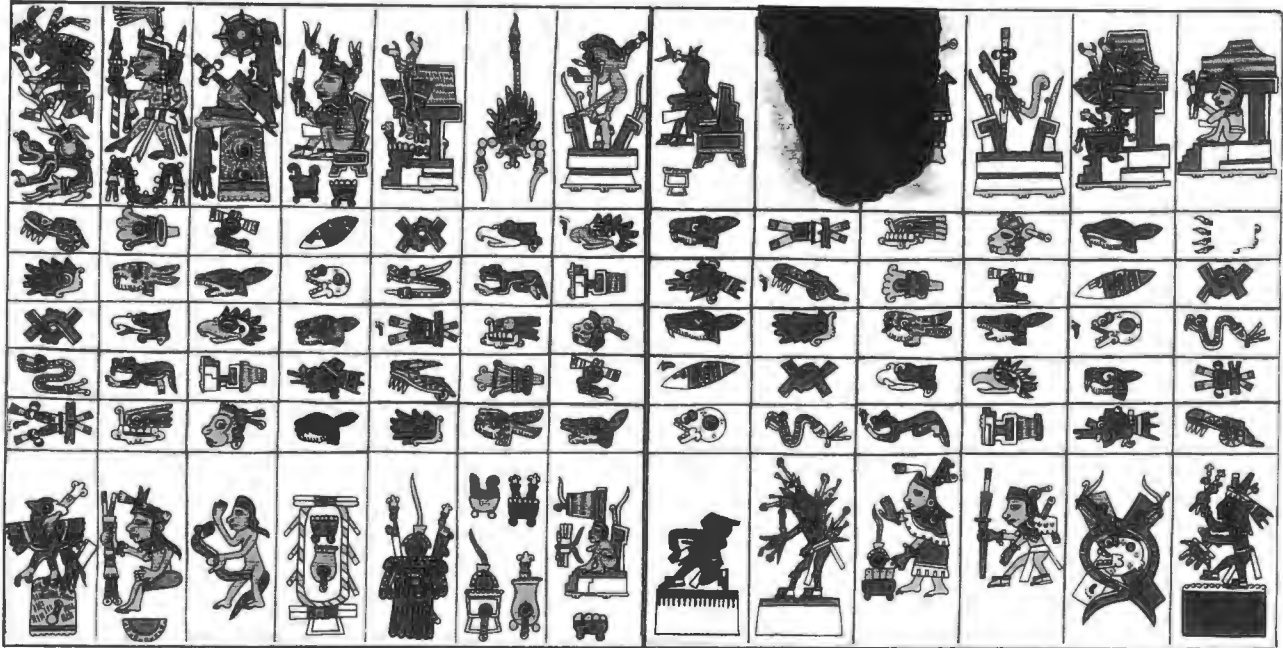


figure 10
The first two pages of the *Borgia* in extenso almanac.

2

1



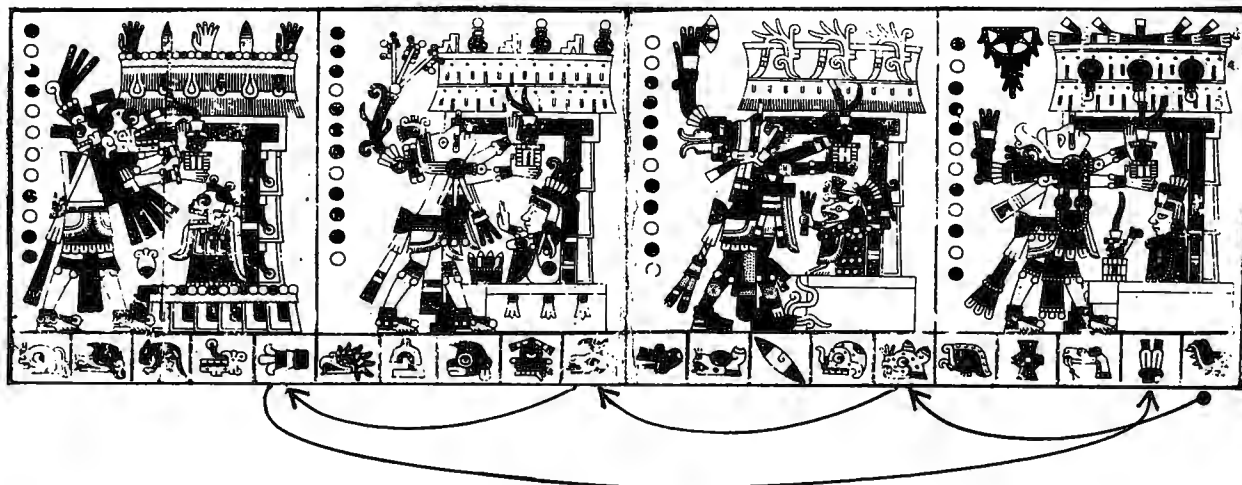
13	12	11	10	9	8	7	6	5	4	3	2	1



2

1

figure 11
 A compressed table relating the 20 *trecenas*
 with four scenes of supernaturals or deity impersonators
 making offerings before temples.



with the man seated in a temple holding bloodletting instruments at the top, and below with the priest who holds similar instruments and an incense pouch. These are surely days for ritual bloodletting.

The horizontal registers are not assigned specific mantic associations, although the reader would know that each register represents a fifth of the cycle and that each 2-page spread represents the 13 days of a *trecena*. The reader would know without it being specified that the numbers 1 through 13 are automatically attached to these days. The first column on the right page carries the implicit number 1, the second column 2, the third column 3, and so forth. As the reader opens the almanac to other pages, correspondences are noted between the mantic elements associated with the different positions. The auguries for position 2, for example, might be similar. Although there is a great deal of variation in the fates from column to column, some themes and elements also tend to reappear in certain positions.

This table uses the cell, here more fully developed as a grid, to separate and unite the days and fates. Spatial location functions within the columns to relate the days to the elements below and above, and space implicitly links columns in

the same relative position from *trecena* to *trecena*. The table, more so than the simpler list, shows patterns and multi-directional relationships.

A variation on the table is the compressed table, which repeats and cycles within itself. As I have found no adequate modern example, the compressed table may be a particularly Mesoamerican structure. Nearly a fourth of all almanacs are grouped tables. In such almanacs, each mantic unit has several groups of signs associated with it. Usually the first sign of each group is represented, and the others are replaced by disks, which I call spacers. These spacers stand in for the missing day signs. The lower register of *Codex Fejérváry-Mayer* 33-34 is a good example (fig. 11). It, like most other compressed tables, involves all 260 days of the *tonalpohualli*, grouped into the 20 *trecenas*. Thus the almanac concerns itself more with the 20 *trecenas* than with all the individual days. The *trecenas* are identified by their initial day-signs, Crocodile, Jaguar, etc., and the other twelve days are signaled by spacers; here they are listed in a column on the left side of the scene.

On *Codex Fejérváry-Mayer* 33b-34b the 20 *trecenas* are associated with four scenes of a priest or deity impersonator making an offering before a temple and cult figure (Anders, Jansen, and Pérez Jiménez 1994: 273-276; Seler 1901-02: 171-180). The first *trecena*, Crocodile, pertains to the first scene, the second *trecena* (Jaguar) to the second scene, the third (Deer) to the third scene, and the fourth (Flower) to the fourth scene; then the fifth *trecena* (Reed) returns to the first scene, to set up the progression all over again: sixth (Death), seventh (Rain), eighth (Grass), and so forth. One moves from scene to scene, and by the time all 20 *trecenas* are counted out, one has passed through the almanac five times. This grouped list gathers the days together as they are gathered in the in extenso almanac just discussed (*Borgia* 1-8), but whereas the in extenso almanac presents all the days of each *trecena* across a two-page spread, here each *trecena* is abbreviated and grouped with a single scene. A value of the grouped table is that it gives the mantic associations for many temporal units in a very small space.

This kind of almanac unifies the *tonalpohualli* by presenting it as a set of repeating cycles. The *trecenas* are purposefully grouped; we note that every 4th

figure 12
Structural diagram of benzene molecule.

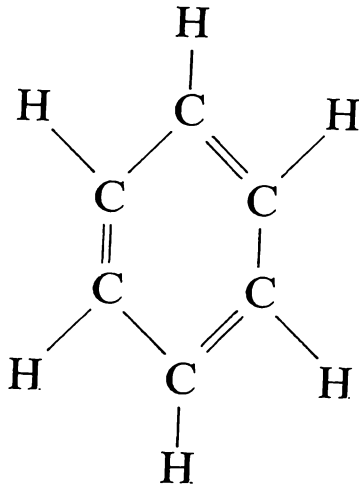
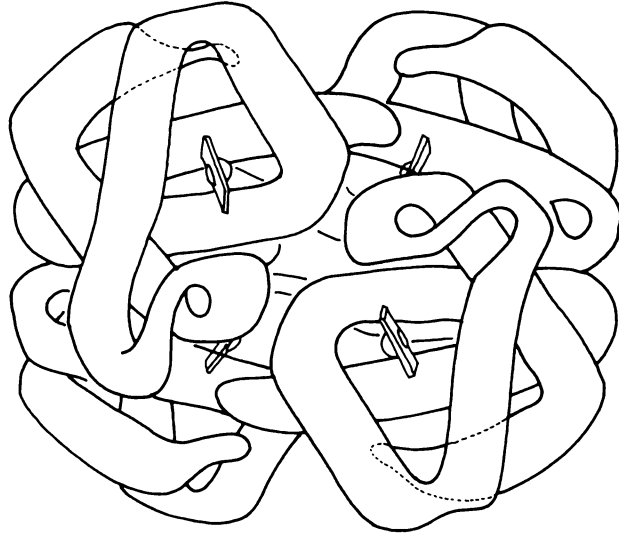


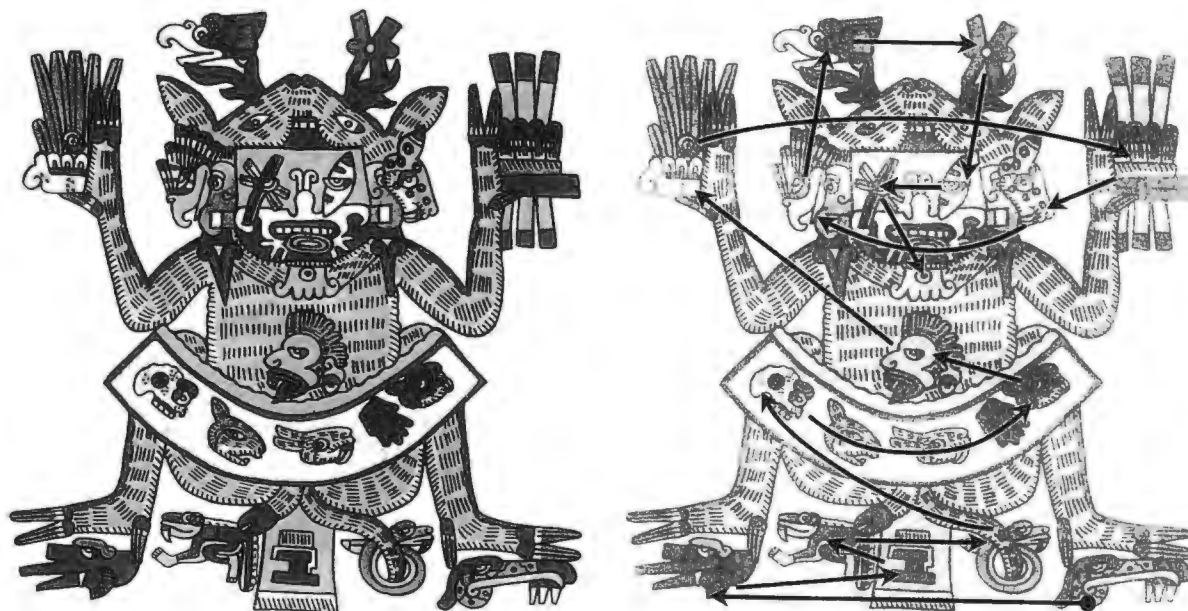
figure 13
Model of hemoglobin concentrates on its quaternary structure and the shapes and intertwining spatial relationships of the four subunits.



trecena is positioned together, so that the first, fourth, ninth, thirteenth, and seventeenth *trecenas* are all related as kindred units that pertain to the first scene. Likewise with the second, fifth, tenth, fourteenth, and eighteenth, and so forth. This grouping is a major part of the system of correspondences being recorded.

The third basic structure for almanacs is the diagram. As a graphic form, the diagram excels at presenting structure and expressing relationships between the parts. The diagram is today an especially powerful tool in the sciences, particularly in chemistry, which is dominated by problems of structures and the relationships of many discrete parts to each other (Drake 1986: 150). The structural diagram for the molecule of benzene, for example, records the hexagonal arrangement of its six carbon and six hydrogen atoms, as well as the different bonds between these atoms (Atkins 1987: 8; Drake 1986: 151) (fig. 12). Vastly more complex molecules, however, need different models. For example, hemoglobin, the oxygen transporter in our blood, has some 10,000 atoms, arranged along four intricately folded polypeptide chains (two alpha chains and two beta chains), packed together in a tetrahedral arrangement (Dickerson and Geis 1983:

figure 14
Diagram of the 20 day signs as they relate
to different parts of the body of a deer.

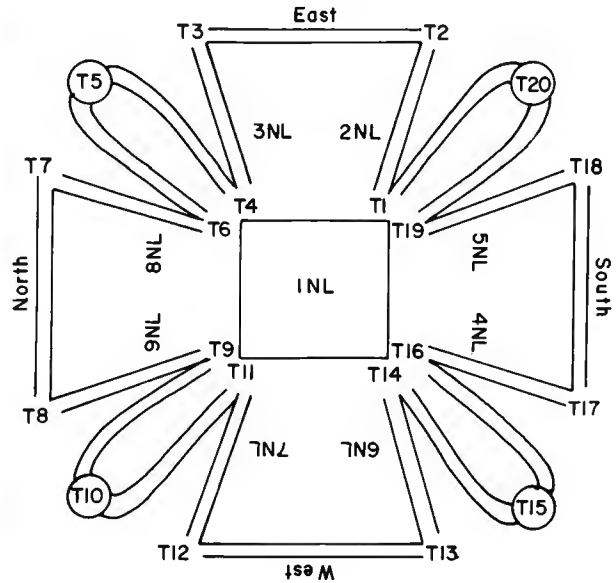
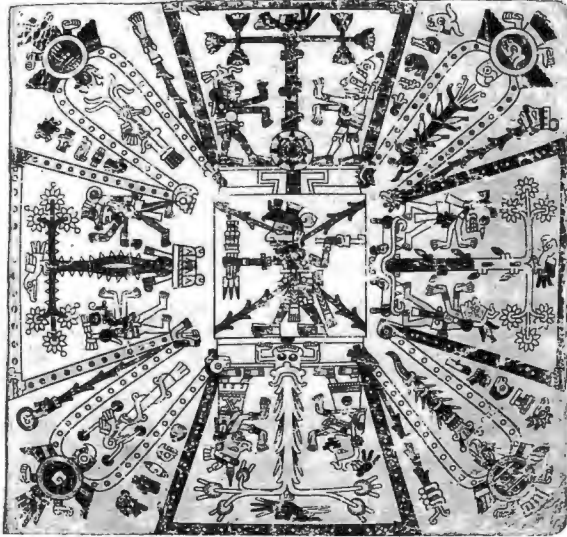


7; Perutz 1964: 64; Stryer 1988: 150-151). Chemists interested in the overall structure of hemoglobin represent the chains as ribbons or cords, which clarifies their folding pattern and their complex internal symmetry (fig. 13). These models, like other chemical models, were created to record structure and show spatially how the major parts are related within the whole.

Mixteca-Puebla artists employed the diagram for the same reasons: to depict structure and relate the parts to each other and the whole. In the divinatory codices, diagrammatic almanacs are structurally based on a shape or image that expresses a conceptual truth, and the day signs or other temporal units are then located on or around this image. In such diagrammatic almanacs, the red cells and grids are usually absent, which means that the principles of inclusion and exclusion that operate with lists and tables are not utilized. Instead of red lines that unite and separate elements, space functions actively to associate or disassociate the various components. Location, proximity, and relative position become important.

figure 15

Diagram of the 260 days of the *tonalpohualli*, organized as 20 *trecenas*, as they relate to the four directions and the Nine Lords of the Night.



On *Codex Borgia* 53, the 20 day signs are distributed over the body of a deerskin, of the kind the Aztecs and their neighbors used for divination (Anders and Jansen 1993: 359-362; Anders, Jansen, and Reyes García 1993: 285-288; Seler 1963, 2: 111-112) (fig. 14). The deer is splayed out, and on his face is the mask of Macuilxochitl, god of dance, song, and feasting, who also carries solar connections. The days begin in the lower right with Crocodile below the deer's foot, and they continue to zigzag back and forth up the deer skin. The second day (Wind) is below the other foot on the left, then House on the loincloth between the two legs, then to the left with Lizard at the penis, and to the right with Serpent at the deer's tail. From there the count moves into the abdomen, where a curved panel represents the animal's innards (Death, Deer, Rabbit, Water, and Dog), followed by Monkey at the navel. Then the succession rises to the upper body, back and forth, to end with Flower at the mouth, no doubt signaling flowery speech, or precious, sacred utterance. Many of these associations between day sign and body part are commonly seen in the almanacs and make perfect sense

even to us. The Crocodile earth monster is usually at the foot, close to the earth. The Serpent visually fits the tail very well, and House (with its domestic associations) is often linked to the loincloth. Lizard is often linked to sexuality, and what better association for the tongue than the Flower of eloquent speech. The succession of the day signs creates an active circuit that moves back and forth across the body; it juxtaposes the right and the left and thereby establishes pairings and center points.

This *Codex Borgia* deerskin almanac is a relatively simple diagram. A more complex one is the cosmic diagram of *Fejérváry-Mayer* page 1 (fig. 15). Around a central figure of Xiuhtecuhtli, the lord of the year and of time, the painter arranged the 260 days of the ritual calendar in a multi-colored ribbon that defines a Formée Cross. The cross' broad arms are oriented toward the four cardinal directions, with East at the top. Each direction has its own cosmic tree and bird and the two lords who govern there.⁷ Narrower loops between the arms are oriented toward the intercardinal points; they have their own birds, plants, and forces. The 260 days flow along this ribbon of time in 20 groups of 13 days, the *trecenas*. Each *trecena* is represented by the first day sign of the period followed by 12 disks that serve as spacers standing in for the other 12 days. Beginning with the first day (Crocodile), the count reads counterclockwise around the cross. The first five *trecenas* are associated with the East and Northeast, the second five with the North and Northwest, the third five with West and Southwest, and the fourth five with South and Southeast.

Each arm of the cross, and thus each direction, has its own color: red in the East, yellow in the North, blue in the West, and green in the South. Within the frame of each appear the two lords, the directional tree, and the bird that are associated with that direction. These nine lords—two in each direction and Xiuhtecuhtli (lord of fire and the year) in the center—are the Nine Lords of the Night, who in other

7 These identifications generally follow Seler (1901-02: 5-3) and/or Nowotny (1961: pl. 45A, 225-227); see also Anders, Jansen, and Pérez Jiménez (1994: 149-184)

contexts influence the fates of the days in sequence. The intercardinal loops have their own plants and animals, and they are topped with birds flying toward the center. Within the birds' bodies, circles around the day signs Rabbit, Reed, Flint, and House distinguish these day signs also as yearbearers. Next to these intercardinal birds but lower toward the center are the dismembered body parts of Tezcatlipoca (god of rulership and divination), which release blood that flows toward Xiuhtecuhtli in the center, as if the body of the god of divination were nourishing the lord of time at the center. A second set of *trecena* day-signs along the intercardinal loops associates the *trecenas* with the directions in yet another pattern.

In this one complex and masterful presentation the painter uses the regular passage of the *tonalpohualli* to recreate the physical space of the cosmos with its cardinal directions, cosmic trees, birds, and the lords who rule those directions. As it passes, time moves from one part of the cosmos to another, absorbing the mantic meaning associated with each direction. Thus, the ribbon of time describes the cosmos as a physical and geographical entity; at the same time the physicality of the cosmos inscribes time with mantic meaning. This single diagram, interpreted as a temporal and spatial map of the cosmos, shows how inextricably time is linked to space in the central Mexican mind.

These three kinds of visual presentations—the list, the table, and the diagram—use space in different ways to achieve meaning. They also rely differentially on the principles of inclusion and exclusion, and adjacency, proximity, and distance. The list links specific calendrical units with individual images either by including both elements in the same cell or by locating them in adjacent cells. Fully elaborated tables, like the *in extenso* almanacs, rely on these same principles of inclusion and adjacency, but they employ space more actively in order to link registers and columns. In diagrammatic almanacs, space, or more specifically, spatial proximity, is paramount. A calendrical unit takes meaning according to its location vis-à-vis a mantic image. Thus, these structural forms impart their own nuances and layers of meaning onto the almanacs. They signal to the diviner a multitude of relationships and associations that he or she must take into consideration in drawing out the most appropriate reading for the situation.

Shaped by different structures, the pictorial almanacs yield rich and multi-valent interpretations. And they do so with an economy that is particular to the realm of graphic communication. The calendar priests saw at a glance the associations and correspondences of the days and mantic elements (both subtle and direct), and these they weighed and judged in order to fashion their thick interpretations.

If we were to replace these pictorial almanacs with prose texts, we would need very many words and phrases to explain all the elements exactly and to specify the intricacies of their relationships. The prose text would tend to privilege one interpretation over the others and thereby limit and harden the message into a partial truth. This would constrict any interpretation. Instead, the painted text presents the individual elements within an organized arrangement, which allows the diviner to see correspondences and associations, to weigh them, and then to reach the most ideologically satisfactory interpretation. Graphic writing systems like these central Mexican almanacs codify knowledge by depicting the structures of cosmic and social reality.

Bibliography

- Allwein, Gerard and John Barwise, eds.
1996 *Logical Reasoning with Diagrams*.
Oxford and New York: Oxford University Press.
- Anders, Ferdinand and Maarten Jansen
1993 *Manual del adivino. Libro explicativo del llamado Códice Vaticano B*. Accompanied by a facsimile of the codex. Graz: Akademische Druck- u. Verlagsanstalt; Madrid: Sociedad Estatal Quinto Centenario; Mexico, Fondo de Cultura Económica.
- Anders, Ferdinand, Maarten Jansen and Gabina Aurora Pérez Jiménez
1994 *El libro de Tezcatlipoca, Señor del Tiempo. Libro explicativo del llamado Códice Fejérváry-Mayer*. Accompanied by a facsimile of the codex. Graz: Akademische Druck- u. Verlagsanstalt; Mexico, Fondo de Cultura Económica.
- Anders, Ferdinand, Maarten Jansen and Luis Reyes García
1993 *Los templos del cielo y de la oscuridad: oráculos y liturgia. Libro explicativo del llamado Códice Borgia*. Accompanied by a facsimile of the codex. Graz: Akademische Druck- u. Verlagsanstalt; Madrid: Sociedad Estatal Quinto Centenario; Mexico, Fondo de Cultura Económica.
- Anders, Ferdinand, Maarten Jansen and Peter van der Loo
1994 *Calendario de pronósticos y ofrendas. Libro explicativo del llamado Códice Cospi*. Accompanied by a facsimile of the codex. Graz: Akademische Druck- u. Verlagsanstalt; Mexico, Fondo de Cultura Económica.
- Atkins, P. W.
1987 *Molecules*. New York: Scientific American Library.
- Boone, Elizabeth Hill
1994 Introduction: Writing and Recording Knowledge. In *Writing without Words: Alternative Literacies in Mesoamerica and the Andes*, edited by Elizabeth H. Boone and Walter D. Mignolo, pp. 3-26. Durham, North Carolina: Duke University Press.
2000 *Stories in Red and Black: Pictorial Histories of the Aztecs and Mixtecs*. Austin: University of Texas Press.
n.d. "Beyond Writing." In *The First Writing*, edited by Stephen Houston. Cambridge: Cambridge University Press, forthcoming.
- Codex Borgia*
1993 *The Codex Borgia: A Full-color Restoration of the Ancient Mexican Manuscript*, by Gisele Díaz and Alan Rodgers, with a new introduction and commentary by Bruce E. Byland. New York: Dover.
- Codex Fejérváry-Mayer*
1971 *Codex Fejérváry-Mayer 12-14 M, City of Liverpool Museums*. Introduction by Cottie A. Burland. Graz: Akademische Druck- u. Verlagsanstalt.
- Dickerson, Richard E. and Irving Geis
1983 *Hemoglobin: Structure, Function, Evolution and Pathology*. Menlo Park, California: Benjamin/Cummins.

- Drake, Stillman
1986 "Literacy and Scientific Notation". In *Toward a New Understanding of Literacy*, edited by Merald E. Wrolstad and Dennis F. Fisher, pp. 135-155. New York: Praeger.
- Durán, Diego
1971 *Book of the Gods and Rites and the Ancient Calendar*, translated and edited by Fernando Horcasitas and Doris Heyden. Norman: University of Oklahoma Press.
1994 *The History of the Indies of New Spain*, translated by Doris Heyden. Norman: University of Oklahoma Press.
- Einstein, Albert
1996 *The Collected Papers of Albert Einstein, Vol. 4: The Swiss Years: Writings, 1912-1914*, translated by Anna Beck. Princeton: Princeton University Press.
- Gardner, Martin
1982 *Logic Machines and Diagrams*. 2nd ed. Chicago: University of Chicago Press.
- Kress, Gunther, and Theo van Leeuwen
1996 *Reading Images: The Grammar of Visual Design*. London and New York: Routledge.
- Las Casas, Bartolomé de
1967 *Apologética historia sumaria*. 2 vols. Edited by Edmundo O'Gorman. Mexico, UNAM, Instituto de Investigaciones Históricas.
- Lockhart, James
1993 *We People Here: Nahuatl Accounts of the Conquest of Mexico*. Berkeley and Los Angeles: University of California Press.
- Mendieta, Gerónimo de
1971 *Historia eclesiástica indiana*, edited by Joaquín García Icazbalceta. Facsimile of the 1870 edition. Mexico: Porrúa.
- Nowotny, Karl Anton
1961 *Tlacuilolli: Die mexicanischen Bilderhandschriften, Stil und Inhalt, mit einem Katalog der codex-Borgia-Gruppe*. Berlin: Verlag Begr. Mann.
- Pauling, Linus C.
1967 *The Chemical Bond*. Ithaca, New York: Cornell University Press.
- Perutz, Max F.
1964 "The Hemoglobin Molecule". *Scientific American* 211, 5: pp. 64-76.
- Prem, Hanns
1992 "Aztec Writing". In *Handbook of Middle American Indians, Supplement 5, Epigraphy*, edited by Victoria R. Bricker, pp. 53-69. Austin: University of Texas Press.
- Rotman, Brian
1993 *Taking God out of Mathematics and Putting the Body Back in: An Essay in Corporeal Semiotics*. Stanford: Stanford University Press.
1995 "Thinking Dia-Grams: Mathematics, Writing, and Virtual Reality". *South Atlantic Quarterly* 94, 2: pp. 389-415.

- Sahagún, Bernardino de
1959-82 *Codex Florentine: The General History of the Things of New Spain*, translated and edited by Arthur J. O. Anderson and Charles Dibble. 12 books. Santa Fe: School of American Research and the University of Utah.
- Seler, Eduard
1901-02 *Codex Fejérváry-Mayer. An Old Mexican Picture Manuscript in the Liverpool Free Public Museums (12014/M). Published at the Expense of His Excellency the Duke of Loubat*. Berlin and London: T. and A. Constable. German edition is 1901.
1963 *Comentarios al Códice Borgia*. 2 vols. and facsimile. Mexico: Fondo de Cultura Económica.
- Stryer, Lubert
1988 *Biochemistry*. 3rd edition. San Francisco: W. H. Freeman.
- Watson, James D. and F. H. C. Crick
1953a "Molecular Structure of Nucleic Acid: A Structure for Deoxyribose Nucleic Acid". *Nature* 171: pp. 737-738.
1953b "Genetic Implications of the Structure of Deoxyribonucleic Acid". *Nature* 171: pp. 964-967.
- Zagat
2002 *Zagat Survey 2000: New Orleans Restaurants*, edited by Sharon Litwin and Pat Denechaud. New York: Zagat Survey.