Chinese Hexagrams, Trigrams, and the Binary System

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The old Chinese "Classic of Changes," called *I-ching*, was primarily intended as a book of divination, yet it has provided a basis for philosophy and religion in East Asia for more than two thousand years. It has long had a special appeal for Western scholars, who have studied it to try to understand the thinking of the Chinese people since ancient times. In recent years this book has also attracted wide attention in the Western world, and many new translations of it have recently appeared in Europe and America.[1]

Originally intended as a collection of omens to determine the results of future activities, this book has again become popular for fortune-telling. The main text of the *I-ching* consists of sixty-four predictions, each identified by a symbol called a hexagram.[2] A hexagram is a linear figure composed of six straight whole or broken lines. Complete sets of these are pictured in Figures 2 and 5.

In ancient times, a hexagram was obtained by throwing down stalks of a plant called milfoil or yarrow, in a rather complicated ritual, but in recent centuries, the Chinese have cast down six coins –"heads" representing the solid lines, while "tails" indicated the broken ones–to produce a full six-line figure. One variety of the coin method was highly recommended by the renowned Swiss psychologist C. G. Jung, and this system is now widely used in the West.[2] Though Chinese and Western scholars have given much attention to the meanings of the predictions indicated by the hexagrams, they have paid little attention to the hexagrams as such.

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[1] The best-known and most convenient translations are those of James Legge, *The Yi King*, in Max Muller, ed., *Sacred Books of the East* vol. 5, (New York: Scribners, 1899), and Hellmut Wilhelm, *The I Ching or Book of Changes*, translated into English by Cary F. Baynes, Bollingen Series 19 (Princeton University Press, Princeton N.J., 1983). Hereafter the latter will be cited as Wilhelm/Baynes. A useful outline of the format of the *I-ching* and its predictions is also given in Joseph Needham, *Science and Civilization in China* vol. 2 (Cambridge: Cambridge University Press, 1956): 314–21.

[2] The process of divination by yarrow stalks is described in Wilhelm/Baynes, 721–723. Jung's method of divination with six coins is briefly described in ibid., 723–724.

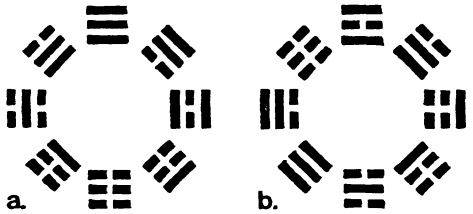

FIGURE 1. **The two traditional trigram circles.**
a. ascribed to Fu Hsi.
b. attributed to King Wen (Wen Wang).

The hexagrams were probably first devised by combining pairs of trigrams. These are three-line symbols—also made up of whole or broken lines—in a set of eight known in China as the *pa-kua*. They are usually presented in either of two circles: one ascribed to a legendary sage named Fu Hsi, said to have lived in the third millennium B.C., and the second attributed to King Wen of Chou, toward the end of the second millennium B.C.[3] See Figure 1.

We may never know precisely how or when the trigrams were invented. They belonged in the esoteric lore of ancient China that was mostly kept hidden until the Sung dynasty (A.D. 960–1279).[4] By that time, any memory of their origin had long since been forgotten.

Classical Chinese writings give little information about the formation of trigrams and hexagrams. They simply claim that the Supreme Unity produced the Two Principles: Yang and Yin, symbolized by one whole and one broken line, respectively. (Yang was the male principle, representing light, warmth, and activity; while Yin was the female principle which stood for shadow, coolness, and passivity.[5]) These two produced a set of four whole or broken lines in pairs, to represent Great Yang and Lesser Yang, Great Yin and Lesser Yin. From those, in turn, came the Eight Trigrams, and these produced the Sixty-four Hexagrams.[6] Also, the eminent Han dynasty historian Szu-ma Ch'ien, in his *Shih-chi* (ca.100 B.C.), said that while Wen Wang (King Wen of Chou) was a

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[3] See S. Cammann, "The Eight Trigrams: Variants and Their Uses," *History of Religions* 29, no. 4, (May 1990): 301–317.

[4] Until the Sung dynasty, the trigrams were only publicly known in the form of an aberrant circle from the Wen Wang set—used for special purposes. This matter is more fully discussed in my coming article "The Origin of the Trigram Circles in Ancient China," scheduled to appear in the *Bulletin of the Museum of Far Eastern Antiquities* 63 (Stockholm, 1991).

[5] The Chinese concept of the duality of Yang and Yin played a large part in Old Chinese scientific and mathematical thinking, as well as in Chinese philosophy and religion, into recent times. For some examples of its place in Chinese life and culture, see S. Cammann, "Symbolic Expressions of Yin-Yang Philosophy," in *Chinese Ideas about Nature and Society: Studies in Honour of Derk Bodde*, edited by Charles LeBlanc & Susan Blader (Hong Kong: Hong Kong University Press,1987): 101–116.

[6] This tradition is presented in the *Ta Chuan* Appendix to the *I-ching*. See Legge, *Yi King*, 373, and also his comments, 375.

prisoner of the Shang in the eleventh century B.C., he probably made the hexagrams from the trigrams.[7]

However, some eminent Western scholars have disregarded the traditional Chinese view and proposed that the hexagrams preceded the trigrams.[8] As it seemed odd to suggest that simple forms had derived from the more complex, I disregarded those recent theories and undertook to analyze several sets of hexagrams. The results of my study are presented here.

I

The ancient Chinese in the Shang dynasty (1765?–1027 B.C.) tried to foretell future events by consulting "oracle bones." They examined cracks on the shoulder bones of animals (scapulimancy) and on the under-shells of tortoises (plastronimancy), after working on them with a heated metal drill until they cracked, then made predictions from these.

That method of divination was later replaced by the divination with the sticks of milfoil or yarrow, and the latter has traditionally been considered an invention of the Chou dynasty (1027–256 B.C.). However, some Chinese archaeologists recently discovered that the people of the later Shang, before the Chou conquest, had also sought to foretell the future with sticks of milfoil or yarrow. They found too that the diviners of the late Shang and early Chou had recorded the results of milfoil divination by using numbers in sets of three, six, and five.[9] (Many Chinese people at the present time still practice divination with five coins, and the process is recorded in their traditional almanacs.)

Two of these archaeologists have claimed that the sets of three and six numbers—usually written vertically—might have been forerunners of the trigrams and hexagrams used in later divination. They also pointed out that the sets of five numbers were sometimes recorded in figures composed of five whole or broken lines (the latter broken into three parts instead of two) written either vertically or horizontally, and they suggested that these might have influenced the creation of the trigrams.[10] However, no actual trigrams or hexagrams have yet been recovered from that early time. If they were used at all, they might have been written on perishable materials such as cloth or birchbark.

Although the ultimate origin of the trigrams is still unresolved, that subject does not directly concern us here. We are primarily studying the way in which the trigrams were used to form sets of hexagrams. My research has revealed that the people of Old China had at least three sets

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[7] *Shih-chi* (*Szu-pu-pei-yao* edition) ch. 4, 5a.

[8] See Henri Maspero, *La Chine antique* (Paris: Bossard,1927): 444, and Joseph Needham, *Science and Civ.* 2, 343.

[9] Chang Ya-ch'u and Liu Yü,"Observations about Milfoil Divination based on Shang and Zhou *Bagua* Numerical Symbols," tr. Edward L. Shaughnessy, *Early China* 7 (1981–82): 46–55. The original article was in *Kao gu* 1981, 2, 155–163.

[10] See the chart in ibid., 48.

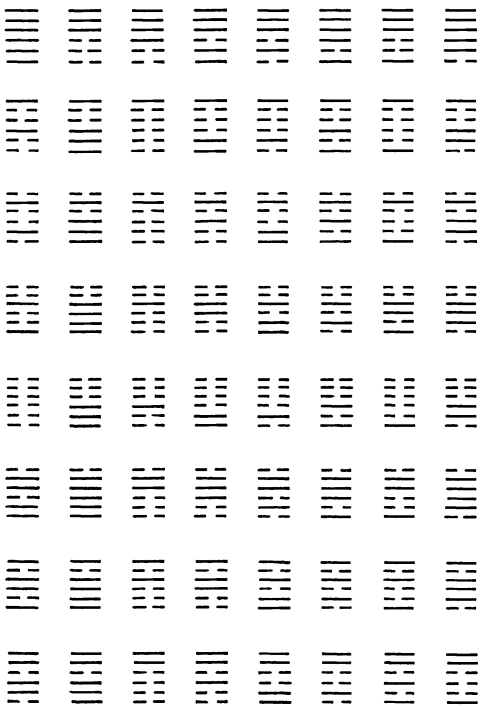

FIGURE 2. **The earliest known hexagram set found in the earliest copy of the *I-ching*, buried in 169 B.C.**

of hexagrams which clearly indicate that they were constructed by pairing trigrams.

The first of these hexagram sets is shown in Figure 2. This was found in the earliest surviving copy of the *I-ching*, recovered in 1973 from an Early Han tomb at Ma-wang-tui, near Changsha.[11] This book was buried in 169 B.C., and it may have already been quite old when it was placed in the tomb.

Analyzing this hexagram set, I found it had apparently been made by using two sequences of trigrams, taken from a trigram set that considered the individual trigrams as members of a family, according to an ancient system shown in Figure 3c.[12] This system postulated a father

[11] See Shaughnessy, *The Composition of the "Zhouyi,"* (Ann Arbor: University Microfilms International, 1983): 168–174, for comments about this hexagram set found in the earliest extant copy of the *I-ching*. *Zhouyi* [or *Chou-i*] was another name for the *I-ching*. See also ibid., note 81, 324–25, and a table with this hexagram set on 169–70.

[12] Another family system (the second, shown in Figure 3b) is recorded in a later appendix to the *I-ching*, probably written in the Han dynasty (B.C. 206–220 A.D.), though it has traditionally been ascribed to Confucius; but that was differently arranged. This family system is mentioned in the *Shuo-kua* appendix to the *I-ching*: in Legge, *Yi-King*, 429–432. My research on the development of the two traditional trigram circles has revealed that the Chinese had possessed a still earlier family system (the first, in Figure 3a). So the system being discussed in the text above (shown in Figure 3b) was the third

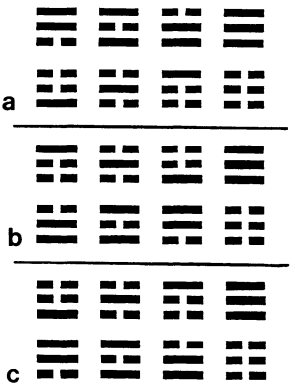

FIGURE 3. **The three family systems for arranging trigrams (read from right to left).**
a. Early system used to make the early Fu Hsi trigram circle.
b. System described in an appendix to the *I-ching*.
c. System used to make the earliest hexagram set.

with three sons (for Yang), and a mother with three daughters (for Yin), thus it symbolized a harmonious balance of the active and the passive forces in the universe.[13]

Some ancient scholar apparently chose two sequences from this family system to make a set of hexagrams in eight groups, with eight in each group. For his first sequence, he appears to have taken the trigrams from the top (male) line of this family system, moving horizontally from right to left, followed by the lower (female) line, in the same order. Then he simply doubled each of these trigrams to make the first hexagram for each of the eight groups. After that, he made the tops for the seven other hexagrams in each row, by simply repeating the trigram that he had doubled to make the first hexagram in that particular row.

For his second sequence, he apparently took in succession each vertical pair of trigrams in this system: father and mother, eldest son and eldest daughter, middle son and middle daughter, youngest son and youngest daughter, again working from right to left. Then he used these to make the bottom halves for the seven other hexagrams in each row. In each case, he passed over the trigram that he had doubled to make the first hexagram for that row, then set down the rest of the sequence in consecutive order. The finished set is shown in Figure 2.[14]

It seems remotely possible that this particular hexagram set may reflect a distant memory of the way in which the first hexagrams had been constructed, at a much earlier time. Otherwise, this early *I-ching*

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one. The three "family systems" came to light in the course of my research for the coming article cited in note 4. Only the second family set had previously been recognized.

[13] For the importance of Yang and Yin in Chinese thought, see note 4 above.

[14] A brief preliminary description of the method used for–making this set of hexagrams appeared in S. Cammann, "Early Chinese Symbols of Duality," *History of Religions*, (1985): 249–250.

ordering of the hexagrams may just have been a unique experiment, as no other examples of it have yet been found. Its primary significance here lies in that the entire set was apparently assembled in a simple yet ingenious method of combining trigrams from a previously unrecognized family system, which I have also found was used in ancient China for other purposes.

If the hexagrams were originally arranged in a systematic pattern like the one just discussed, the order of the familiar hexagram set traditionally ascribed to King Wen of Chou—found in the later texts of the *I-ching*—must have been badly jumbled later,[15] for it seems very clumsy.

It looks as though the only way of organizing this Wen Wang set had been to take the hexagrams in pairs. It has the eight symmetric hexagrams standing alone as opposed couples, the solid lines of the first contrasting with the broken lines of the second. The other twenty-eight pairs simply show one hexagram as the inverse of the other; the second being the first one turned upside down. The organizer does not appear to have used any consistent method for placing each pair in the larger group.

Some scholars have assumed that certain pairs of hexagrams in this Wen Wang set may have been placed together because the meanings read from their respective lines appeared to be either complementary or contrasting.[16] But in most cases the opposing shapes in each pair of hexagrams merely suggest possible yin-yang symbolism, with no related meanings.

In short, the arrangement of these Wen Wang hexagrams in the *I-ching*—like the irregular order of their predictions—seems quite haphazard. This irregularity is not necessarily a sign of a primitive state of development; it could be the result of deliberate rearrangement at a later time, intended to make the *I-ching* seem more mysterious.[17]

The second traditional ordering of the hexagrams (shown in the outer ring of Figure 1) is found in the circle ascribed to Fu Hsi. People have not fully appreciated this ingenious hexagram circle, as they have failed to understand its construction. Since they customarily regarded each hexagram as a unit, it did not occur to them that these particular examples could possibly be paired trigrams. However, close examination reveals that this hexagram set must indeed have been made by using pairs of trigrams drawn from the standard Fu Hsi trigram circle (pictured in Figure 1a). My research has shown that the Chinese possessed an earlier Fu Hsi trigram circle, with its trigrams arranged according to an older

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[15] The set of hexagrams ascribed to King Wen is presented in Legge, *Yi King*, plate 1; and, with further explanation, in Needham, *Science and Civ.* 2, 314–320.

[16] See Shaughnessy, "Composition of the *Zhouyi*," 171–74, and his chapter 4.

[17] Arthur Waley, "The Book of Changes," *Bulletin of the Museum of Far Eastern Antiquities* 5 (1934): 121, remarked that the text of the *I-ching* was probably cut up and shuffled a good many times before it reached its present order. Other scholars—Chinese and Western—have suggested that the Wen Wang hexagrams should be more systematically re-arranged. One attempt to do this was made by Stephen McKenna and Victor Mair, "A Reordering of the Hexagrams," *Philosophy East and West* 29 (1979): 429–436.

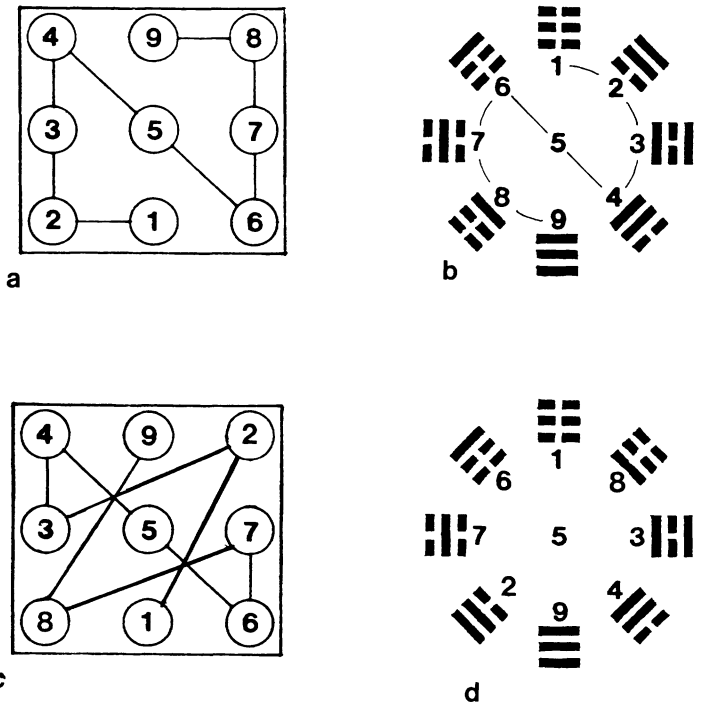

FIGURE 4. **a. The early form of the Lo-shu.**
b. An early form of the Fu Hsi trigram circle.
c. Final form of the Lo-shu (a magic square).
d. Last form of the Fu Hsi circle (later rotated).

family system (Fig. 3a); but later someone exchanged two of its trigrams, destroying this family system and breaking the consecutive order of its trigrams. This change appears to have been made so the trigram circle would still conform with a complementary diagram called the *Lo-shu*, after a change had been made in that.[18] See Figure 4.

In Old Chinese tradition the Lo-shu, being square in shape, was a symbol of the square Earth; while the circle of Fu Hsi trigrams, complementing it, represented the round Sky or Heaven. Being associated together, individual trigrams in the circle complemented opposing numbers on the Lo-shu, so each pair of numbers from the two diagrams would equal 10. Therefore, when two of the Lo-shu's numbers were exchanged to make that diagram into a magic square,[19] the two tri-

[18] The interrelation between the Fu Hsi trigram circle and the Lo-shu diagram is fully discussed in my coming article on origin of the trigrams, mentioned in note 4 above.

[19] For a long time the Lo-shu was not a true magic square. It was simply revered as a symbol of the Earth. For the numerous meanings and associations of the Lo-shu in its final form as a magic square, see S.Cammann, "The Magic Square of Three in Old Chinese Philosophy and Religion," *History of Religions* 1, no.1 (1961): 37-80.

FIGURE 5. **The Fu Hsi hexagram circle, enclosing the final Fu Hsi trigram circle.**

grams corresponding to those numbers also had to change places, to keep the numbers equal and the two plans fully complementary.

This exchange of two trigrams had some significant results. For example, the person who set out to make the Fu Hsi hexagram circle was working sometime after the changes, so he did not have either the consecutive trigram sequence or a family system to provide models. Lacking those guides, he apparently just drew two sequences of trigrams from the final Fu Hsi trigram circle and took pairs from these to combine into hexagrams.

He seems to have obtained his first sequence by starting at the top of the trigram circle, and going down its left side to pick up the first four trigrams, then he went back to the top and, beginning with the first trigram on the right, he went down the right side to the bottom to get the last four. Then he wrote this entire sequence four times down the left side of a larger circle, returned to the top, and wrote it again four times down the right side.

To obtain the bottoms for the hexagrams, it appears that he then drew another sequence of trigrams from the same trigram circle. Beginning again at the top, he went counterclockwise around the trigram circle, taking each trigram in its turn. Then, taking this second sequence, he moved counter-clockwise around the inside of the larger circle, writing the sequence eight times in succession to make the bottom halves for all the hexagrams. As we view the present, standard form of this Fu Hsi hexagram circle (shown in Figure 5), it would appear that the designer had begun both sequences with the principal yang trigram from the top of the Fu Hsi trigram circle. But, since that circle and the hexagram one were both symmetrical, he might just as well have started with an

inverted circle having the principal yin trigram at the top, then continued the construction in the same way.

Actually he probably did begin with the principal yin trigram. For he must have been working sometime in the period between the end of the Chou dynasty and the beginning of the Sung, during which time the Fu Hsi trigram circle had been turned upside down to serve as a celestial complement to the Lo-shu (as shown in Figure 4c and d). In that case, the principal yin trigram would have been standing at the top; and it was standard procedure for a Chinese scholar to begin at the top of a pattern and work to the left. Later, when the Fu Hsi trigram circle was rotated to put the chief yang trigram for South at the top, someone would have also rotated this hexagram circle so it assumed its present position, shown in Figure 1c.[20]

A third hexagram circle, in which the individual hexagrams were made by pairing the trigrams, appears in a sixteenth century book on the *I-ching*, by Lai Chih-te.[21]

At first glance, this resembles the Fu Hsi hexagram circle. For the lower halves of all its hexagrams were made by using eight repetitions of each trigram from a counter clockwise circuit of the Fu Hsi trigram circle, just like the bases for the hexagrams in the Fu Hsi hexagram circle. However, the tops for the hexagrams in this last set were differently constructed.

To make these tops, the compiler apparently took the same sequence of trigrams that he had used for the bases, then he wrote this sequence eight times around a larger circle, beginning at the top. However, he manipulated the sequence differently each time, so that no two of the eight segments were exactly the same. To describe this more specifically: apparently he started at the top and moved counterclockwise, first writing the entire sequence, beginning with the chief yang trigram. Then he began again with the last trigram in the first set; and he commenced every succeeding set by repeating the last trigram from the previous one. He continued writing these varying segments around the circle in the same direction, until he returned to the chief yang trigram at the top.

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[20] As long as the Chinese considered the Fu Hsi trigram circle as a symbol of the sky, over the Lo-shu which served as a symbol of the Earth, they had to invert it. Because they thought directions in the sky were opposite to those on Earth. The reason for their thinking this can be seen by holding a mirror (representing the trigram circle) above a compass dial (representing the Lo-shu), facing north; in the mirror's reflection, North and South will have changed places, while East and West keep their original positions.

In later times, when the connection between the Fu Hsi trigram circle and the Lo-shu were forgotten, they simply rotated that trigram circle as well as the hexagram circle derived from it, to put the main Yang trigram and the principal yang hexagram at the top of the respective circles. South, the chief Yang direction was always placed at the top on Old Chinese maps and charts.

[21] Lai Chih-te, *I-ching Lai-chu t'u-chieh* (original title, in 1599, *Chou-i chi-chu*), (Taipei: Sung-li Press, 1971) last *chuan*, 26 (a double page not numbered). Here, two of the hexagrams are miswritten; but other editions show this circle badly garbled, with many more errors.

We can assume that the compiler must have made a careful study of the Fu Hsi trigram and hexagram circles—both readily available—then based his own circle upon those; for this is scarcely more than a later derivative from the two Fu Hsi circles. I include it here mainly because the upper halves of its hexagrams illustrate an unusual experiment, revealing yet another technique for making hexagrams by pairing trigrams.

Still other methods for using pairs of trigrams to make hexagrams could have been employed, and Chinese sages may have tried some of those too. With all the possibilities for pairing trigrams, and three good examples of this out of four sets, it seems definite that the sixty-four hexagrams were devised in this manner not developed independently.

II

Let us now return to the Fu Hsi hexagram circle in Figure 5 for a closer examination. Note that in this circle—as in the trigram circle from which it stemmed—all the bottom lines on the left side are solid, hence considered as yang; while those on the right side are broken, and thus considered yin. The people of Old China would have thought that this represented a balance of the contrasting forces in a harmonious universe, because to them each circle symbolized the universe in microcosm. Also, on the hexagram circle, the top lines on either side of its central axis are alternately solid or broken, again suggesting a harmonious balance of yang and yin. Finally, each circle demonstrates another less obvious effect that later aroused much interest among Western scholars.

We have noted that the final Fu Hsi trigram circle had its original, regular order disrupted by the exchange of two of its trigrams to conform with an exchange of two numbers on the Lo-shu diagram. So the hexagram circle, having been modeled upon that trigram circle, shared the same altered order. This readjustment automatically—with no deliberate intention—caused both the trigram and the hexagram circles to look as though each had been constructed by using a binary system of notation.

This effect was first noticed by Fr. Joachim Bouvet, a French Jesuit who was living in Peking during the late seventeenth and early eighteenth centuries.[22] In 1701, he received a letter from Gottfried Wilhelm von Leibniz, in which the latter described the binary or "dyadic" arithmetic which he had discovered some years before.[23] Bouvet had been

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[22] Fr. Joachim Bouvet (1656–1730) was sent to China with the exalted title of *Mathématicien du Roi*, to try to gain converts through demonstrations of European Science. He was assigned to the Court in Peking, where he served for a time as tutor to the children of the K'ang-hsi Emperor. For details of his life, see Joseph Dehergne, *Répertoire des Jesuits de Chine de 1552 à 1800* (Rome: Institutum Historicum SI, 1972): 30–31.

[23] Baron Gottfried Wilhelm von Leibniz (1646–1716) had first announced his discovery of binary arithmetic in 1669. This particular letter to Bouvet, was sent on February 15th, 1701, and it must have taken seven months to reach China. Leibniz had previously described his binary theory to Fr. Claudio Grimaldi S.J., another missionary in Peking,

studying a current edition of the *I-ching* and was much interested in its trigram and hexagram circles ascribed to Fu Hsi. After receiving and digesting Leibniz's letter, he immediately recognized that both circles could be read as examples of the latter's binary system.

Leibniz's binary system used only 0 and 1. He began it with 1, and each additional 1 doubled the value, giving 2, 4, 8, 16, etc. Bouvet, took the solid lines of each trigram or hexagram as ones and the broken lines as zeros. He started at the bottom of each circle and went up its right side to the top, then he descended diagonally down to the bottom, and continued up the left side to the top, reading the successive lines of each hexagram from the outside in. Doing this, he found that the numbers represented by the lines of the trigram in the trigram circle ran consecutively from zero to seven, while the numbers indicated by the lines of the hexagrams in the hexagram circle ran from zero to sixty-three.[24]

Replying to Leibniz on 4 November 1701, Bouvet reported his find and, as an example of a larger application of the binary theory, he enclosed a copy of the hexagram circle ascribed to Fu Hsi.[25] He explained to Leibniz that Fu Hsi had been a "philosopher prince" of great intellect, respected by the Chinese as the ancient sage who had been their first ruler, had taught them writing and mathematics, and had given them laws.[26]

Although Bouvet was honored as a foremost scientist in his time,[27] his thinking was still tainted by the ideas of contemporary European pseudo-scientists regarding magic powers associated with ancient

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so Bouvet admitted he had already heard about it. However he did not think to apply it until he learned about it directly from Leibniz.

[24] To read the Fu Hsi trigram and hexagram circles as examples of binary notation, remember that a broken line has no value; a first solid line (on the outside) equals 1, a second solid line (in the middle) equals 2, and the third solid line (on the inside) equals 4. Starting with the full yin trigram at the bottom of the Fu Hsi trigram circle, and following the S-shaped course up to the full yang trigram – taking each one from the outside in – the successive trigrams would read: 000 = 0, 001 = 1, 020 = 2, 021 = 3, 400 = 4, 401 = 5, 420 = 6, 421 = 7. The hexagram circle would be read in the same way, passing in an S-curve from 000000 at the bottom to 1,2,4,8,16,321 = 63 at the top.

Apropos of this, see Olivier Roy, *Leibniz et la Chine* (Paris: Libraire Philosophique J. Vrin, 1972): 64. M. Roy understood the binary system in the Fu Hsi trigram circle, but in the hexagram circle he failed to find the binary sequence from 0 to 63; so he wrongly stated that the hexagram circle lacked an arithmetic progression which the Chinese would have made if they viewed the circle as Leibniz saw it.

[25] This letter from Bouvet to Leibniz appears (with some deletions) in Louis Dutens ed., *Gottfried Wilhelm de Leibniz, Opera Omnia* (Geneva: Frères de Tournes, 1768): 4, Part 1, 152–164. Most of the Bouvet-Leibniz correspondence is kept in a file called *Leibnizbriefe* in the Niedersächsisches Landesbibliothek in Hanover. This letter is discussed in Daniel E. Mungello, *Leibniz and Confucius: The Search for Accord*, (Honolulu: University of Hawaii Press, 1977): 49. The original hexagram circle sent with it is reproduced in ibid., 50.

[26] See Bouvet's letter, Dutens, vol. 4, Part 1, 153. Here he spoke of "Fohi [Fu Hsi], who by the skill of a consummate science . . . knew how to encompass in two general and magical symbols [0 and 1] the principle of all the sciences and of true wisdom . . . and has constructed this circular diagram [the hexagram circle] . . . to calculate and know exactly all the periodic movements of the celestial bodies and to give clear knowledge of the changes which by their means occur continually and successively in nature."

[27] Bouvet's title (mentioned in note 22 above) indicates that his superior abilities were recognized by Louis XIV.

"Masters" who were believed to have possessed secret lore. Thus, he told Leibniz about a concept which he said was prevalent among learned men of the time (obviously European scholars), to the effect that Fu Hsi had perhaps never set foot in China, but had been one of the Ancient Masters at the dawn of human history, like Zoroaster, Hermes Trismegistus, and Enoch.[28] In fact, Bouvet proposed that "Fu Hsi" might have been Hermes Trismegistus himself, and he included a philological analysis of the Chinese characters for the name Fu Hsi which he assumed would show an identity with Hermes Trismegistus.[29] Whoever Fu Hsi might have been, Bouvet felt that he had possessed forgotten wisdom, which he would now be able to uncover by means of this new key to the "ancient alphabet" provided by the binary system.[30]

His ambition was not a selfish one. He was not trying to gain occult powers just for himself. Though he worked as a scientist and a teacher of science, Bouvet was always mindful of his obligations as a missionary. He hoped that after he had regained the ancient knowledge he could give back to the Chinese this ancient heritage, and thereby gain their confidence so they might more readily become converts to Christianity.

Though Leibniz in his youth had been interested in the Rosicrucians, he was now too rational-minded to pay any attention to astrology or other aspects of the occult, so he disregarded Bouvet's statements about a supposed identity between Fu Hsi and Hermes Trismegistus. But he was naturally impressed to hear that a great genius of Ancient China had used the binary system to make diagrams with trigrams and hexagrams. Thus he wrote an account of his system and Bouvet's discovery of its ancient application, which was published in France in 1703.[31]

In this article Leibniz gave full credit to Bouvet for detecting the presence of the binary method in the trigram and hexagram circles, and to Fu Hsi for his original use of the system. Then, in several subsequent letters to other learned Europeans of that time, he again expressed his belief that the binary or dyadic system of numbering was not his own invention, but merely a rediscovery of Fu Hsi's principles.[32]

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[28] See Bouvet's letter, op. cit. 157–158. In the seventeenth century scientists were still often involved with alchemy and other aspects of Magic. And, as in the previous century, followers of Magic believed in ancient "Masters" thought to possess secrets of knowledge, wisdom and power. Among these, they often invoked Zoroaster, as the first of the Persian magi, Hermes Trismegistos (the Greek name for the Egyptian god Thoth) as the reputed author of the "Hermetic writings" dealing with astrology and other "occult sciences," and Enoch, who in the Hebrew tradition was seventh in descent from Adam and the supposed author of several books that incorporated astrology and prophetic lore.

[29] Ibid., 158.

[30] Ibid., 154 et passim, and in a second letter which Bouvet wrote to Leibniz in 1702, before receiving Leibniz's reply to the letter announcing his discovery. This is given in Dutens, vol. 4, Part 1, 365 ff. Bouvet failed to answer Leibniz's enthusiastic reply to his announcement and five more letters from him, so Leibniz reluctantly dropped the correspondence.

[31] G. W. Leibniz,"Explication de l'arithmétique binaire," *Mémoires de l'Academie Royale des Sciences*, année 1703, (Paris, 1705): 85–89.

[32] See Donald P. Lach,"Leibniz and China," *Journal of the History of Ideas* 6 (1945): 446.

In a final letter, written shortly before his death in 1716, Leibniz explained to another savant that the hexagrams actually represented a binary arithmetic which Fu Hsi had apparently possessed, and which he himself had rediscovered some thousands of years later; and once again he gave credit to Bouvet for recognizing the identity between his system and the symbols of Fu Hsi.[33]

Though Fr. Bouvet indeed deserves credit for detecting the presence of the binary system in the trigram and hexagram circles that Chinese tradition ascribed to Fu Hsi, his conclusion that the circles were made by that process was not valid in terms of Old Chinese thought and culture.

The philosophers of Old China were extremely symbol-minded, and they considered the trigram and hexagram circles as important symbols to them. But those sequences—0 to 7, and 0 to 63—would have had no significance at all for them. The sages in ancient times associated the Fu Hsi trigrams with eight numbers (1 to 4 and 6 to 9), as these numbers had been applied to those trigrams to make the trigram circle conform with the Lo-shu. Moreover, the Chinese in general have customarily thought in terms of sets of eight, just as Westerners commonly reckon things in dozens. Furthermore, the zero came to China late, in the T'ang dynasty (A.D. 618–906), and it had no symbolic value there. Also, when the Chinese sages used the circles for divination or other purposes, they always read the lines of each trigram or hexagram from the bottom up (from inside the circle outward), not from the outside in, as Bouvet read them. Lastly, Bouvet's concept of the legendary Fu Hsi as a source of infinite wisdom was just as fanciful as his ascription of magic powers to Hermes Trismegistus, since both of these figures were mythical.

In short, it now seems clear that Chinese scholars created both of the circles ascribed to Fu Hsi in two, much easier, separate ways—each in full accord with their own culture and beliefs, and were not aware that they had happened upon the binary system. Yet, because of Leibniz's well-deserved fame, and his modest deference to Fu Hsi, later scholars in the West assumed that some ancient Chinese sage had actually created both of the "Fu Hsi circles" with the binary system. Many still believe that, though most of them no longer think that the mythical Fu Hsi had anything to do with it.[34]

A general skepticism regarding Old Chinese traditions has caused Chinese scholars after the Sung, as well as some modern Western writers including Joseph Needham, to claim that the hexagram circle ascribed to Fu Hsi was actually invented by Shao Yung in the Sung dynasty.[35] However, that was precisely the time when the old hidden

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[33] Leibniz's final manuscript appears (with some slight omissions) in Dutens, *Leibniz, Opera Omnia* 4, Pt. 1, 169–210. See esp. 208. This important letter was translated into English with introduction and commentary, by Henry Rosemont, Jr. and Daniel J. Cook, as "Discourse on the Natural Theology of the Chinese," in *Monograph No. 4 of the Society for Asian and Comparative Philosophy* (Honolulu: University of Hawaii, 1977).

[34] See text below, and note 38.

[35] See Needham, *Science and Civ.* 2, 341.

lore was beginning to emerge. Moreover, Shao Yung's biography in the Sung Dynastic History states that he received from Li Chih-tsai the diagrams and symbols of the Ho-t'u and the Lo-shu as well as Fu Hsi's trigrams and hexagrams. It also remarks that Li's transmissions had a very remote origin.[36]

Thus, the Fu Hsi hexagram set could have been created at any time after the old Chinese sages produced the familiar Fu Hsi trigram circle by exchanging two trigrams on an earlier circle. The evolution of the Fu Hsi trigram circle was probably completed more than a thousand years before the Sung. In the second century A.D., the philosopher Cheng Hsüan (A.D. 127–200) described the Lo-shu in its final form. But that had evolved together with the Fu Hsi trigram circle so long before that he had no knowledge of their former connection. Therefore, he wrongly associated the Lo-shu with the other trigram circle (the one ascribed to King Wen), failing to realize that this second circle had undergone a similar, though entirely separate evolution with another very ancient diagram, the Ho-t'u.[37] Since the final development of the Fu Hsi trigram circle with the Lo-shu—and that of the Wen Wang trigram circle with the Ho-t'u—had apparently been forgotten by Cheng Hsüan's time, it seems evident that the Fu Hsi trigram circle must have attained its final form long before the second century A.D.

Therefore this trigram circle must have been known to scholars in esoteric circles for many centuries before it became public in the Sung. That gave a long span of time in which someone could have produced from it the Fu Hsi hexagram circle. This could have been done long before the Sung dynasty; but that early period was still a time of esoteric secrecy, so we may never know exactly when it happened.

One might well imagine that the untenable theory of very early Chinese knowledge and use of the binary arithmetic would have quietly dropped out of Western thinking. Yet, in this very century, when the work of Norbert Wiener and the English engineer Wynn-Williams produced thinking machines that operated on a binary system, the whole topic resurfaced. In 1968 a German writer even wrote an article discussing "the five-thousand year history of the binary number system" between its discovery by Fu Hsi and Wiener's employment of it in computers.[38]

Now that we know that the two Fu Hsi circles must have first been developed purely by accident, it is time to give Leibniz his due. He deserves full credit for discovering the binary arithmetic, which—together with his early calculating machine—helped to inspire the modern geniuses who invented the computer, and thereby initiated the present world-changing Computer Revolution.

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[36] *Sung-shih* ch.427, 17a.

[37] Cheng Hsüan's comments on the *I-wei ch'ien-k'un tso-tu*, in *Ts'ung-shu chi-ch'eng ch'u-pien* (Shanghai: Commercial Press, 1937): 668, 19.

[38] See Gottfried Wilhelm Leibniz, *Zwei Briefe über der binare Zahlsystem und die chinesische Philosophie*, (Stuttgart: Bessler-Presse, 1968), esp. 155–158, its "Afterword" [*Nachwort*] by Jean Wesner. This is entitled "Zur Funftausendjahrige Geschichte des Binaren Zahlsystem: Fu-Hi—G.W.Leibniz—Norman Wiener."