THE *YIJING* – THE PHILOSOPHICAL FOUNDATION OF THE BINARY SYSTEM

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Abstract

This paper focuses on the philosophical foundation of the binary system, which was first published by G. W. LEIBNIZ in 1703. In our work we have traced its origins back to ancient China and found parallels with the Yijing, one of the "Five Classics" of the Chinese culture. After an introduction to yin-yang thought, we portray the Yijing's role developing from an ancient divination manual into the foundation of the binary system, which is still highly important in modern computer science. The philosophical interpretation gives an overview of PLATO'S Theory of Ideas and focuses on the origin of "mental realities" including mathematical findings. With his hypothesis Plato has introduced myth into philosophy and metaphysics. The final part of the paper deals with the relevance of the binary system's background to a topical issue: Can computers fully match human intelligence?

1. Introduction

The use of computers and computer-controlled machines has become a standard in our modern world. For the majority of us it is quite natural to use the familiar decimal system for the in- and output of numeral data. We also know, however, that it is the binary system on which the processing of these data "inside" the machine is based. As students and as teachers we often are too much concerned with basic operations, conversion methods, floating point notations, etc. considering the historical background of the binary system irrelevant. In practice, the work of computer scientists most often consists of transforming the demands imposed by the ideas and concepts coming from process- or domain level into logical applications that can be processed. To me, the historical background of the binary system is interesting also from an epistemological point of view and suitable enough to be pointed out as an example for possible similar developments. In addition, this work wants to give an impression in which way the principles of the Far Eastern culture – in this case the yin-yang principle – can be applied successfully even in our Western culture due to the particular intellectual achievements of individual scientists.

2. Ancient Chinese Philosophy

The thirst for knowledge is the driving force behind scientific research. An alert mind regards the problems of everyday life as a challenge and attempts to find solutions. In China, literature, philosophy and science are believed to be based on the insight that the quest for knowledge contains the sum of all the human experiences possible. The creativity of Chinese science accounts for some of the most brilliant inventions which had a great impact on the world and still influence everyday life, e.g. the compass, gunpowder, silk and the calendar system. Paper and printing also had been used in ancient China long before they were known in the Western world (cf. [7], p. 23).

The beginning of the Han dynasty (206 B.C.–220 A.D.) was an era that saw the appearance of many famous philosophers, poets and writers. At that time, two major philosophical traditions marked the Chinese mentality: Confucianism is the philosophy of the upper classes and supports an agnostic attitude. Taoism, on the other hand, has its roots in the lower social classes and reflects an attitude largely based on religious values. The influence of Buddhism, which arrived from India in the first century A.D. and eventually became China's "third tradition", proved to be of fundamental importance to China's later history. Taoism is an existential philosophy emphasizing individual understanding of the cosmic process, while the teachings of KONG ZI (lat.: Confucius) can be regarded as the basis of social ethics regulating both public and private life. *"Buddhism is for the mind, Taoism is for the body and Confucianism is for the society."* [Translation by author.] This frequently cited quote, ascribed to Emperor XIAO ZONG (1163-1189), is still valid today, after more than 800 years.

In ancient China, like in every culture, cosmogony and cosmology were closely related (cf. [12], p. 14). As a result of the philosophical schools' endeavours to find the golden mean, the harmony of man and cosmos as well as of man and nature came to be regarded as an ideal. Myth and cult also had a great impact on all phases of human life. In the first historically attested dynasty, the Shang dynasty (1523-1028 B.C.), divination e.g. with oracle bones already played a crucial role in politics as well as in religion [3]. Nature was considered to be primarily about changes and transformations. Even the ancient Book of Changes was based on the idea that two opposed principles – yin and yang – could be applied to any existent thing. The Yin-Yang School, often identified as the quintessential "Chinese way of thinking", represents a worldview, according to which human action is directly linked with the cosmos. The world is not explained and structured by means of causal connections but by means of grouping, coincidences and correspondences.

2.1. Yijing – The Book of Changes

The Yijing (I Ching), or Book of Changes as it is often referred to, is one of the "Five Classics" of the Chinese culture (Table 1). As regards their contents, these texts very likely date from the time before the great scholar CONFUCIUS (551-479 B.C.) (cf. [5], p. 58). The Yijing is said to be a composition of the mythical emperor FUXI, who lived and ruled around 3000 B.C., and it may well be that it is the oldest preserved document of philosophical thought that we know (cf. [14], p. 98). It probably had more impact on China's cultural development than any other book in the Chinese culture. For a long time it served as a manual for divination. Over the centuries an enormous number of commentaries and remarks have been added. In his introduction to RICHARD WILHELM's *I Ging* [16] WOLFGANG BAUER notes, *"Since this book has universal qualities, every word about it is too much and too little at the same time."* [Translation by author.] All the worldviews and scientific approaches later emerging in China have tried to harmonize their teachings with the principles of the Yijing.

Symbol	Name	Description
易經	Yijing	The Book of Changes
書經	Shujing	The Book of History
詩經	Shijing	The Book of Songs
禮記	Liji	The Book of the Rites
春秋	Chunqiu	The Spring and Autumn Annals

Table 1: The „Five Classics“ of the Chinese Culture

Even CONFUCIUS is said to have studied the Yijing intensively. However, he turned away from the complex metaphysical references. Instead, he put the emphasis on the aspects of earthly harmony and the individual happiness resulting from it. According to Chinese tradition, CONFUCIUS wrote four of the ten commentaries on the Yijing, known as the ten "Wing Commentaries". During the Han dynasty his philosophical views on the state and his secular ethic became a political and moral ideal, which continued to be the foundation of China's official state ideology until 1912. Begun already several centuries before the Han dynasty, the discussion of the dualistic yin-and-yang theory – yin as the female, dark, negative principle, which combines with yang, the male, light, positive principle to form harmony – was intensified. These philosophical speculations, along with the theories about the qualities and effects of the five agents (wood, fire, soil/earth, metal, and water) eventually resulted in an increasingly complex system of cosmological explanations (Yin-Yang School). Under the Han these theories were finally developed into a kind of overall science. Due to the influence of Western learning, attention was gradually directed also to the origins of the Yijing. Some of the theories resulting from these examinations are interesting because they already revealed the text's complex character.

2.2. The Structure and the Symbolism of the Yijing

The core of the Yijing is a set of eight simple symbols, the so-called Eight Trigrams (Ba Gua). Each of them is composed of three differently arranged horizontal lines, where each line is either divided (broken, or "yin") or undivided (solid, or "yang"). Each Trigram represents a force of nature and at the same time symbolizes a certain element of human life (Table 2). The combination of two Trigrams, an upper and a lower one, produces a Hexagram. A total number of 64 different combinations, i.e. Hexagrams, are possible – each composed of the two basic symbols yin (the female, receptive principle) and yang (the male, creative principle). These 64 Hexagrams are explained and interpreted in the Yijing: Each Hexagram is listed with its name, its Chinese character, with a short general statement and a picture with accompanying text that explains the Hexagram in an illustrative language. Furthermore, every single line of a Hexagram is commented by a respective line statement. These commentaries are very abstract and focus on the symbolism of the employed lines and the way they are arranged. The ten "Wing Commentaries" give additional information about the Hexagrams' names and their texts and interpret the Hexagrams and their statements in a lexicological, symbolistic and moral-philosophical way.

Trigram	Name	Quality	Element	Family
☰	Qian, the Creative	strong	Heaven	Father
☷	Kun, the Receptive	devoted	Earth	Mother
☳	Zhen, the Arousing	active	Thunder	Youngest Son
☵	Kan, the Dark	dangerous	Water	Middle Son
☶	Gen, the Keeping Still	quiet	Mountain	Eldest Son
☴	Xun, the Gentle	penetrating	Wind, Wood	Youngest Daughter
☲	Li, the Clinging	shining	Fire	Middle Daughter
☱	Dui, the Joyous	happy	Lake	Eldest Daughter

Table 2: The Eight Trigrams of the Yijing

The great philosopher Wang Pi (226-249 A.D.) is considered to have discovered the true nature of the Yijing. He found out that the uniform “dynamic order”, which he regarded as the principle the world is based on, as well as the “ideas” into which this order is split, are represented by the Hexagrams, their names and statements. However, these symbolic representations must not be mistaken for the actual “ideas”. In his commentary on the Yijing Wang Pi wrote, *“Symbols represent ideas, and words describe symbols. Once you have grasped the symbols, you can forget about the words, and once you have grasped the ideas, you can forget about the symbols. By clinging to the symbols, however, you will never grasp the ideas.”* (Cf. [16], p.8; Translation by author).

2.3. Interpretations

The abstract nature of the Yijing’s texts and commentaries made room for occult prognostication, numerological and cosmological speculation as well as for political and moral philosophizing. For the Chinese the Yijing was a compendium of immense wisdom primarily used for divination, accessible only to someone who is familiar with its complex world of symbols and their hidden meanings. The examination of the Hexagrams and the relationships between them focused primarily on the different possibilities of combining the divided and undivided lines and disregarded the content of the pictures. This resulted in a number of theories, which stated that the Yijing contained a complex hidden system of magical squares and mathematical statements. A key characteristic of this system is that the 64 basic states are not fixed and rigid but regarded as flexible and steadily changing, which can be expressed by exchanging one or more yin-lines for yang-lines and vice versa.

The Swiss doctor and psychiatrist Carl Gustav Jung (1875-1961) is considered the founder of Analytical Psychology. In his essay *Synchronizität als ein Prinzip akausaler Zusammenhänge* [8]

[Synchronicity: An Acausal Connecting Principle (1952)] he wrote, *"Unlike the Western mind, which is brought up in the tradition of ancient Greece, Chinese thinking does not intend to grasp the details for their own sake but aims to view them as parts of a whole."* [Translation by author.] What JUNG refers to is the principle of emergence. A system or a property is emergent when it can no longer be described as the simple sum of its parts or the sum of the parts' properties. For emergent properties to arise, a higher degree of complexity on a superior system level is necessary (cf. [2], p. 277 ff. and [4], p. 69 ff.). It is easy to understand, for instance, that a macromolecule is more complex than an atom, that a cell is more complex than a molecule, an organism is more complex than a cell, and a group is more complex than an organism. In these examples, the respective higher system level actually consists of an aggregation of the lower levels' elements. However, this aggregation alone is not a sufficient explanation, additional structural patterns and processes become apparent. These are directly related to the conditions that influence and determine the functioning of the whole and can therefore only be understood if regarded under the aspect of the whole (cf. [17], p. 13). Referring to the Yijing JUNG is convinced that an assessment consequently has to be based on the irrational functions of our consciousness, such as intuition and emotion. The interpretations then are an expression of the inner, unconscious knowledge meeting a particular state of consciousness.

3. LEIBNIZ and the Binary System

In the 17th century the Yijing experienced a revival in China and became also known in Europe. GOTTFRIED W. LEIBNIZ (1646-1716) was the first important European philosopher who recognized the greatness and merits of this highly developed foreign culture (cf. [14], p. 129). In his work *Novissima Sinica*, a collection of documents on China published in 1697, he claimed that the occidental and the Chinese culture complemented each other. According to LEIBNIZ, the Chinese culture was superior in the fields of ethics and politics, while the Western culture was superior in the abstract theoretical fields of logic, metaphysics and mathematics. In his correspondence with Father JOACHIM BOUVET (1650-1730), a Jesuit who lived and worked in China, LEIBNIZ learned about the Neo-Confucian SHAO YONG (1011-1070). SHAO YONG had arranged the 64 Hexagrams in a precise, deductive system. Interested in numerology, he was convinced that the divine order of the universe could be expressed by numerical relations (cf. [5], p. 79). It is very likely that SHAO YONG's work prompted LEIBNIZ to develop his famous binary system. Although there had been other attempts before, LEIBNIZ' *Explication de l'Arithmétique Binaire* (Picture 1) dating from 1703 is generally regarded as the origin of the binary system (cf. [1], p.72). In this work he gave a detailed explanation how to carry out the four basic arithmetical operations in the binary system. His focus of interest was primarily on theoretical numerical studies and he found out that the eight Trigrams of the Yijing are actually based on only two different types of lines, i.e. on a dual system: The divided lines (yin) correlate with "0" (even) and the undivided lines (yang) with "1" (odd). In the binary system the eight Trigrams can therefore be regarded as three-digit numerals, the 64 Hexagrams as six-digit numerals. Although these sequences represent the values 0 to 63 in a binary code, there is no evidence that SHAO YONG already used this numeral system for arithmetical operations such as addition or subtraction (cf. [11], p. 59 ff.)

3.1. The Binary System

Unlike the widely used decimal system, which is based on the values 0 to 9 (Table 3), the dual or binary system is based on the two values 0 and 1 (cf. [18]). Recalling the Yijing's structure – 2 (2^1) basic symbols, 8 (2^3) Trigrams, 64 (2^6) Hexagrams – the similarities to LEIBNIZ' binary system quickly become apparent. LEIBNIZ' appreciation of China and its culture may well be largely due to his enthusiasm for this particular way of thinking.

Sometimes, the binary number system is considered the most fundamental incarnation of computer science, and strings of zeros and ones comprise the foundation of all the software and all the data in digital computers. The most important advantage of the binary system is that its practical implementation is easy to realize as regards hardware requirements. There is hardly anything in computer science as basic as the binary number system. A computer based on the decimal system would be much more complex and difficult to realize than the computers used today. The fact that the binary system needs longer numeral sequences to represent high numbers than e.g. the decimal system is irrelevant. In practice, "L" (Low) and "H" (High) are often used instead of "0" and "1". This refers to the electro-mechanical and/or electronic implementation with L being the low, or negative, voltage and H being the high, or positive, voltage. Instead of "binary digit", referring to 0 or 1, the expression "bit" is commonly used.

Form of Representation	
Dual	**Decimal**
Basis 2	**Basis 10**
0	0
1	1
10	2
11	3
100	4
101	5
110	6
111	7
1000	8
1001	9

Table 3: Dual and Decimal System

„*Wer zuerst bis zwei zu zählen verstand, sah,*
wenn ihm auch selbst das Fortzählen noch schwer ward,
doch die Möglichkeit einer unendlichen Fortzählung
nach denselben Gesetzen."
Novalis (cf. [1]).

TABLE DES NOMBRES.

0 0 0 0 0 0	0
0 0 0 0 0 1	1
0 0 0 0 1 0	2
0 0 0 0 1 1	3
0 0 0 1 0 0	4
0 0 0 1 0 1	5
0 0 0 1 1 0	6
0 0 0 1 1 1	7
0 0 1 0 0 0	8
0 0 1 0 0 1	9
0 0 1 0 1 0	10
0 0 1 0 1 1	11
0 0 1 1 0 0	12
0 0 1 1 0 1	13
0 0 1 1 1 0	14
0 0 1 1 1 1	15
0 1 0 0 0 0	16
0 1 0 0 0 1	17
0 1 0 0 1 0	18
0 1 0 0 1 1	19
0 1 0 1 0 0	20
0 1 0 1 0 1	21
0 1 0 1 1 0	22
0 1 0 1 1 1	23
0 1 1 0 0 0	24
0 1 1 0 0 1	25
0 1 1 0 1 0	26
0 1 1 0 1 1	27
0 1 1 1 0 0	28
0 1 1 1 0 1	29
0 1 1 1 1 0	30
0 1 1 1 1 1	31
1 0 0 0 0 0	32
&c.	&c.

bres entiers au-dessous du double du plus haut degré. Car icy, c'est comme si on disoit, par exemple, que 111 ou 7 est la somme de quatre, de deux & d'un. Et que 1101 ou 13 est la somme de huit, quatre & un. Cette proprieté sert aux Essayeurs pour peser toutes sortes de masses avec peu de poids, & pourroit servir dans les monnoyes pour donner plusieurs valeurs avec peu de pieces.

100	4
10	2
1	1
111	7

1000	8
100	4
1	1
1101	13

Cette expression des Nombres étant établie, sert à faire tres-facilement toutes sortes d'operations.

Pour l'*Addition* par exemple. ☽

110	6	101	5	1110	14
111	7	1011	11	10001	17
1101	13	10000	16	11111	31

Pour la *Soustraction*.

1101	13	10000	16	11111	31
111	7	1011	11	10001	17
110	6	101	5	1110	14

Pour la *Multiplication*. ⊙

11	3	101	5	101	5
11	3	11	3	101	5
11		101		101	
11		101		1010	
1001	9	1111	15	11001	25

Pour la *Division*.

15	1111	101	5
3	11		

Et toutes ces operations sont si aisées, qu'on n'a jamais besoin de rien essayer ni deviner, comme il faut faire dans la division ordinaire. On n'a point besoin non-plus de rien apprendre par cœur icy, comme il faut faire dans le calcul ordinaire, où il faut sçavoir, par exemple, que 6 & 7 pris ensemble font 13; & que 5 multiplié par 3 donne 15, suivant la Table *d'une fois un est un*, qu'on appelle Pythagorique. Mais icy tout cela se trouve & se prouve de source, comme l'on voit dans les exemples precedens sous les signes ☽ & ⊙.

Picture 1: A Page of a Reprint of *Explication de l'Arithmétique Binaire* (1703)

4. Philosophical Interpretations

Each of the Yijing's 64 Hexagrams represents a description of a particular state or process. The commentary not only gives detailed information about the significance of these different states, it also gives some advice how to act in order to produce an effect beneficial to the situation. The symbolism of the Yijing is grasped intuitively, whereas understanding the 0's and 1's of the binary system requires logical thinking. Since the binary system is based on reliable, predictable principles, it can be applied in information technology. How can this fact be interpreted from a philosophical point of view? Well, even in ancient Greece mathematics and philosophy were studied separately. PLATO (427-347 B.C.), for instance, distinguished between philosophical knowledge (intelligence), which consists in the apprehension of the original concepts and ideas, and mathematical knowledge, which uses concepts as starting points but requires that some postulates be accepted unquestioned. However, he regarded both as intellective knowledge because they refer to the intelligible world, i.e. the world of reality, which is made up of the unchanging products of human reason. We can therefore argue that LEIBNIZ as well as other mathematicians very likely gained their knowledge by means of reason and by using concepts, i.e. mental representations of ideas.

The term "idea" has been a key word in the more than two thousand years of Western philosophy. PLATO established the classical idealistic worldview, according to which the everlasting Ideas and mental realities (the intelligible world) have absolute priority over the world of things, items and bodies (the sensible world) (cf. [5], p. 323). Our knowledge and judgments gained by reason are therefore not relative or variable but objective and universal. What PLATO referred to with the term "Idea" (or "Form") can be best translated as "archetype" or "original model" (cf. [14], p. 191). According to him, these Ideas are actual realities; they are absolute, unconditioned and eternal. His Theory of Ideas is based on the assumption that the Ideas are genuinely incorporated in the human mind and lead us through the world independently of our thoughts. He assumed the existence of a metaphysical world, the "World of Ideas", that is superior to our empirical knowledge and experience and that can only be reached by intuitive contemplation. This World of Ideas is identical with the eternal, unchanging being (cf. [5], p. 321). To understand what PLATO meant by that let us think of something abstract, e.g. a mathematical object. The Italian doctor and mathematician GERONIMO CARDANO (1501-1576) was the first to employ imaginary numbers by extracting the square roots of negative numbers that actually do not exist. Originally intended as a mere "trick" to solve a mathematical problem, it quickly became evident that this was a rich source of new possibilities and findings, including the discovery of the Mandelbrot Set in the 20th century (cf. [14], p. 191). Following PLATO's Theory of Ideas it could be argued that scientists like CARDANO, EULER, CAUCHY, GAUß and RIEMANN did not discover something new that had not existed before. On the contrary, it had already been there in the non-material world of ideas before mathematicians knew about it. We can gain knowledge of the "World of Ideas"; however, this is only possible through reason. This epistemological approach (classical ontology) is based on the belief that there is a world which exists independently of human thinking and speech and therefore stretches beyond the limits of human consciousness.

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In late 19th century China the Yijing was increasingly taken as a proof that the much-admired Western way of thinking had always been inherent in the Chinese culture. The thesis of the Chinese scholar HU SHIH on logic in ancient China, dating from 1917, is an example: HU SHIH attempted to prove that the "images" of the Yijing were identical with the "ideas" of the Western philosophy and that by their interplay they represented the system of a Confucian logic (cf. [16], p. 11).

5. What can we learn from the history of the Binary System?

The difference observed between the highly semantic Chinese symbols and the totally abstract formal methods of LEIBNIZ raises a philosophical question which is related to a contemporary trend in the field of artificial intelligence [6] and its approach to real world problems: The (seeming) preference of effectiveness over meaning, of formal logic (just discovered) over meaningful symbols (thousands of years old), of syntax over semantics, of computation over representation – or vice versa[10]. Following the thought through logically, we may also raise the question of the preference of machines over man. One of the most controversial questions related to this issue is whether a computer can be programmed with a "mental matrix" equivalent to a mathematician's?

An influential as well as controversial philosophical contribution to this question is JOHN R. SEARLE's famous thought experiment "The Chinese Room Argument" [13]: A man who does not know Chinese is locked in a room with boxes of Chinese symbols as well as instructions for manipulating these symbols. From outside he is then given data in Chinese characters and asked to produce meaningful replies. By following the instructions the man is able to do so, although he does neither understand the questions nor the answers he produces. The man does exactly what a computer would do – he applies rules given from outside. Therefore, the answers come from a larger system or entity, *not* from the man. Obviously, a computer would not understand the messages either. In this work, SEARLE argues against the proposition that computers can think like people do. Moreover, it can be regarded as a counter-attack on the increasing trend of preferring computation to representation. LEIBNIZ got syntax from semantics, but is the man in the Chinese Room able to do so? The codebook (formal logic) enables the man to understand coded messages (semantics). The man alone may not understand, but the man plus the formal instruction do. The paradox of the Chinese Room argument is that it is not an argument at all. What it is trying to say, if we like, is that the man in the Chinese Room is able to understand the Chinese symbols. SEARLE's argument is intended to show that while suitably programmed computers may appear to converse in natural language, they are not capable of understanding language, even in principle. His thought experiment emphasizes the fact that computers merely use syntactic rules to manipulate symbol strings, but have no understanding of meaning or semantics. *"A computer does not know that it is manipulating 1's and 0's. A computer does not recognize that its binary data strings have a certain form, and thus that certain rules may be applied to them"*.[1] Compared to the arguments of the Chinese Room, LEIBNIZ has found the codebook, i.e. the formal logic, for applying the Yijing in the field of mathematics.

Just as important from a historical point of view is the "Leibniz' Mill" [9], beside ALAN M. TURING's "Paper Machine" [10], [15] the most important antecedent to SEARLE's argument. Like in the Chinese Room experiment, LEIBNIZ asks us to imagine a physical system, i.e. a machine, which behaves in such a way that it supposedly thinks and has experiences. Today many researchers agree that modern computers' programs are purely formal (syntactic), while human minds have mental contents (semantics). Although computers may be able to manipulate syntax to produce appropriate responses to "real world input" such as natural language, they do not understand the sentences nor do they associate meanings with the words. We may choose to interpret voltages (high and low) as binary numerals and the voltage changes as syntactic operations, but a computer does not interpret its operations as syntactic or any other way. Computation, or syntax, is "observer-relative" and not an intrinsic feature of reality.

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[1] Stanford Encyclopedia of Philosophy, retrieved from *http://plato.stanford.edu/entries/chinese-room/* (2007-03-07)

6. Conclusion

The idea of two opposed yet interacting principles is the main characteristic of ancient Chinese thought. The active and the passive principle are found in almost every philosophical school as yang and yin, li and ki, mind and matter. Whether the Yijing is regarded as a divination manual or as a scientific theory – the fact is it has influenced the Eastern as well as the Western culture for many centuries. With its non-causal, structuralist way of thinking it is more than the sum of its parts and allows everyone to find their own individual interpretation. However, it is also an example of philosophical thought becoming the basis of exact science. The subjective experience of thinking itself is a phenomenon, which can only be experienced in thinking. The personal experience thus gained must not be seen as an emotional accessory of logic. On the contrary, it is crucial for deciding whether thinking finally leads to a result or not.

Maybe the discovery of the binary system is not LEIBNIZ' most important contribution. Usually his name is associated with the differential calculus. However, since his binary system has played a crucial role in the development of computers, a closer look at the likely connection of his considerations with ancient Chinese philosophy to me seemed not only interesting but also highly relevant in the context of modern computer science.

7. References

[1] BLIEBERGER, J.; KLASEK, J.; REDLEIN, A.; SCHILDT, G.-H., Informatik. Springer Verlag, 3. Auflage, Wien 1996.

[2] CHROUST, G., Emergent Properties in Software Systems. In: Christian Hofer und Gerhard Chroust (Hrsg.): 10 th Interdisciplinary Information Management Talks. Verlag Trauner, Linz, 2002.

[3] FISCHER, T., Das chinesische Entsprechungsdenken und seine Analogie in der Synchronizitätslehre von C.G. Jung und in der Quantenphysik. Chinesische Medizin, Vol. 14 (2), Urban & Vogel, München 1999.

[4] FLIEDER, K., Prägnanz in HCI-Design: Towards a Pattern Language. In Andreas Holzinger und Karl-Heinz Weidmann (Hrsg.), Empowering Software Quality: How can Usability reach these Goals? OCG Bd. 198, 2005.

[5] GRABNER-HAIDER, A., Philosophie der Weltkulturen – Die Weltdeutungen und die Theorien der Wahrheit. Matrixverlag, Wiesbaden 2006.

[6] HOFSTADTER, D. R., Gödel Escher Bach: ein Endloses Geflochtenes Band. Dtv, München, 10. Auflage, 2004.

[7] JONTES, G., China – Verborgene Schätze: Grabfunde der Han-Dynastie. Ausstellungskatalog, Kunsthalle Leoben 1998.

[8] JUNG, C. G., Synchronizität, Akausalität und Okkultismus. Dtv, 3. Auflage, München 1994.

[9] LODGE, B; BOBRO, M., Stepping back inside Leibniz' Mill. Monist, Vol. 80, 1998.

[10] NAUR, P., Computing versus Human Thinking. Comm. ACM, Vol. 50 (1), 2007.

[11] RYAN, J. A., Leibniz' Binary System and Shao Yong's Yijing. Philosophy East and West, Vol. 46 (1), 1996.

[12] SCHMIDT-GLINTZER, H., Das alte China. Verlag C.H. Beck, 3. Auflage, München 2002.

[13] SEARLE, J. R., Minds, Brains and Programs. The Behavioral and Brain Sciences, Vol. 3 (3), 1980.

[14] STÖRIG, H. J., Kleine Weltgeschichte der Philosophie. Fischer Taschenbuch, 4. Auflage, Frankfurt 2003.

[15] TURING, A., Computing machinery and intelligence. Mind LIX, Vol. 236, 1950.

[16] WILHELM, R., I Ging – Text und Materialien. Diederichs gelbe Reihe, 23. Auflage, Kreuzlingen 1999.

[17] WILLKE, H., Einführung in das systemische Wissensmanagement. Carl Auer Verlag, Heidelberg 2004.

[18] WITT, K.-U., Algebraische Grundlagen der Informatik. Vieweg Verlag, Braunschweig/Wiesbaden 2001.