# *TEXT AND ITS CULTURAL INTERPRETATION*

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## SCIENTIFIC AND TECHNICAL THOUGHT OF OLD CHINA IN "MENG XI BI TAN"

Among many other Chinese scholars the great Song scientist-encyclopaedist Shen Kuo (Shen Gua, 1032—1096) stands detached — thanks to vast circle of scientific interests and thanks to the contribution he made to the treasury of Chinese culture. The large-scale figure of Shen Kuo has long since become the object of intent study; tens of works are written about his work and art; the achievements of Shen Kuo in rather diverse fields of knowledge are quite great and varied. Some number of works remained after Shen Kuo, among which great importance is ascribed to his collection of *biji* "Meng xi bi tan" ("Notebooks from the Mengxi Garden"). Rather valuable evidences relating to the level of scientific-technical thought of China of the 11th century are contained here. And the news of which are described in modern science with the epithet of "for the first time" particularly by Shen Kuo. Below is given the translation of some of those important evidences, supplied with necessary annotations.

( 4 4 )

A concave mirror reflects objects — but all turned upside down. It is because between [the mirror and an object] there is a "limit". The school of arithmetic calls it a "stopping point". It is similar to being on a boat and rowing with a scull and the prop [for the scull] becomes [such] a "limit". That's the way a black kite flies in the sky, and his shadow runs after it [along the ground] — but if a small window is placed between them and there would be a chink in it, then the black kite and the shadow will be diametrically opposite to each other: the kite to the east and the shadow to the west then, the kite to the west and the shadow to the east. And then if one were [to look] at the shadow, which has passed through the window chink and laid itself onto structures — then it will also be turned upside down, exactly as in the concave mirror.

If one were to bring his finger close to the cavity in the concave mirror, then its reflection would be a correct one; but as soon as one move [the finger] away a little — and one can't make out anything, take it a little further away — and [the finger] is upside down. The distance from where nothing can be made out is that very "limit" — as is the case with the window chink and scull prop; [it] is like *yaogu*, suspended at the belt of a drum, where both ends are equivalent and in the middle there is a crosspiece is narrowed, and when one raises his arm [for a beat], its shadow jumps down, the arms goes down — but the shadow jumps up; it is rather evident.

The cavity in the concave mirror — if the sun reflection can be caught by it, then its beams will be directed inward — but take the mirror one-two *cong*s aside, the beams will gather together in one spot at the size of a sesame seed and each unit [in it] will ignite itself. This will be similar to the narrowest spot of the drum suspended at the belt.

But is it indeed characteristic only of objects? It's the same for people: rare are such people for whom there is no "limit". Take a look from a short [distance] — benefit and harm alternate each other, truth and lie oppose each other; from afar — a man makes an enemy for himself out of himself and turns his enemy into himself. Not to seek to remove this "limit" and to desire to see things not turned upside down at that — oh, so hard!

In "You yang za zu" it says: "The sails of a seagoing craft is like a shadow of a pagoda turned upside down". Absurd words. A shadow turns only if [the light] passes through the window chink — such is the immutable order of things.

**Annotations.** That which I hereby translated as "limit", judging by descriptions and illustrations given by Shen Kuo, is nothing short of the point of light focus, known in China back in the 4th century BCE. In this excerpt Shen Kuo identified its location by two quite original methods for his time: by means of moving his finger away from the centre of concaved mirror until no reflection is seen, and by means of increasing the distance from such mirror to some combustible material until the sun light concentrated by the mirror ignites mentioned material (and inflaming optical effect was known to the Chinese back in the 6th century BCE). Thus, in the field of medieval optics Shen Kuo in the 11th century achieved that which European science did only in the 13th century.

*Yaogu* drum — is a traditional musical instrument, which was fastened at the belt with the help of belt / rope; looked like two cones joined at the peaks.

"You yang za zu" ("Miscellaneous Morsels from Youyang") is a collection of works belonging to the pen of Duan Cheng-shi of Tang dynasty (803—863) and is a distinctive encyclopaedia of miracle and wonder, a rather motley one at that too.

(299)

The art of erecting buildings [found in the book] that goes by the name of "Mu jing" ("The Canon of a Tree"). They say that its author is Yu Hao. In structures [he] distinguishes three levels: the top one — from roof timbers and up; the middle one — from ceiling and up; the bottom one — everything is below steps. The length of the ceiling joist and the height of the comb strictly depend on each other. If the length of the joist is eight *chi*s, and the comb projects for about three *chi*s and five *cong*s, then it means that the structure proportions are followed. This is what [Yu Hao] calls the top level. The number of *chi*s in the height of a column must be met with the same number of *chi*s in the foundation — these are the proportions. If columns are one *zhang* and one *chi* high, then the roots of the steps must be four *chi*s and five *cong*s. There are clear rules for all main details of the carcass, and this what [Yu Hao] calls the middle level. Steps could be steep, flat and sloping. In the palace the measure of things in this realm is a monarchic sedan chair in the palace. When they are raised from bottom up, the pole in the front is lowered, for as long as the arms [of carrier] make it possible, the pole is raised in the back for as much as shoulder's makes it possible — these are steep steps. If the front pole is level with ribs and the back pole is level with shoulders — it then is a sloping path. If the front pole is carried with arms down and the back pole is level with shoulders — it then is a flat path. This is what [Yu Hao] calls the bottom level. There are three *juan*s in his book. In construction works in recent years this book is always used as a highly important manual, and in former times "Mu jing" was rarely used. Under Song its significance was understood; it is based on experience of a great master!

**Annotations.** The treatise "Mu jing", as it is known, has long been lost; as a matter of fact, though, we do not even know whether a work with this title ever existed. At least we have two written testimonies at our disposal that testify of a Song work and these testimonies belong to Ouyang Xiu (1007—1072) and Shen Kuo. And of these two, only by the given excerpt we can judge, if of the content of "Mu jing", then at least of the views of its presumed author on contemporary (in relation to him) architecture. Yu Hao himself was apparently a commoner of natural gifts, and Xia Nai, a modern researcher, doubts whether Yu Hao was literate at all. Indeed, even the name of this popular carpenter is given in different ways in various sources (喻皓, 喻浩, 預皓), which at least testifies to the notion that evidently neither Shen Kuo nor Ouyang Xiu had the autograph with his signature. The same Xia Nai suggests that "Mu jing", as a certain text, was probably written (if such fact indeed took place) from the words of Yu Hao, but the manuscript itself did not contain the name of the author, since he was unable to sign (Xia Nai, "'Meng xi bi tan' zhongde Yu Hao 'Mu jing'" ("The treatise 'Mu jing' by Yu Hao from 'Meng xi bi tan' by Shen Kuo"), *Kao gu* I—VI (1982), p. 74). It could be an anonymous Song treatise, which rumours linked to the name of famous carpenter.

(307)

Book printing from boards under Tang was not yet widespread. It was initiated by Feng Dao, who printed five canons; and after him classic works [were printed] — all of them from boards. During the reign of Jing-li, Bi Sheng, a man of unofficial position, made movable type. His method was as follows: he took sticky clay and cut in it characters as thin as the edge of a coin. Each character formed, as it were, a single type. He baked them in the fire to make them hard. He had previously prepared an iron plate and he had covered his plate with a mixture of pine resin, wax, and paper ashes. When he wished to print, he took an iron frame and set it on the iron plate. In this he placed the types, set close together. When the frame was full, the whole made one solid block of type. [Bi Sheng] then placed it near the fire to warm it. When the paste [at the back] was slightly melted, he took a smooth board and pressed it over the surface, so that the block of type became as even as a whetstone. If two-three copies were printed, then it became too laborious; but if there were couple of hundreds or a thousand that needed to be printed, then it becomes quite reasonable.

Usually [Bi Sheng] used two iron [letter] plates: one was printed from, and unto the other one letters were set, and when the stamp on the first one ran out, the second one was already ready to be used. With such method, printing was quite rapid.

For each character there were several types, and for certain common characters there were twenty or more types each, in order to be prepared for the repetition of characters on the same page. When the characters were

not in use he had them arranged with paper [labels], one label for each rhyme-group, and kept them in [individual] wooden cases. If a rare type has come across, which he did not come across with previously, it was cut out and fired right away, so that it could be used at once.

[Bi Sheng] did not make letters out of wood, because it can be thin and coarse, and it absorbs moisture, which causes the surface [of composition] to be uneven. Besides, [wood] sticks to the mixture — can't tear it off! — not in the way clay does, which when you take it to the fire and give the [fastening] mixture some time to soften, knock with your hand in it and signs fall off on their own with no track of the mixture.

[When Bi] Sheng died, his letters went to my relatives and they are still kept as a great treasure.

**Annotations.** Feng Dao (882—954) was a minister under a number of governments of the Five Dynasties Period (907—979). Based on his report in 932 the government of the Later Tang began working on preparations for printing Confucian canonical works and commentaries to them from boards; for a long time the invention of book printing was linked to his name. A committee made up of authoritative scholars was formed for the purpose of text verification. Tian Min, who at that time was the head of capital education inspection in Guozijian, was appointed the head of this committee. For twenty one years this publication was worked on; four dynasties changed in the course of this time. And finally in 953 the printing was complete. Nevertheless, the person of Feng Dao in various sources is given in different ways.

The years of Jing-li — 1041—1048.

In fact, if Shen Kuo with his curiosity and truly scientific thoroughness did not happen to be at the right place at the right time, we might have never learned anything about the invention of Bi Sheng (990?—1051?). Historically speaking, it turned out that since this inventive person of natural gifts Bi Sheng did not leave any works behind — and it was Shen Kuo who in great detail described his invention in "Meng Xi Bi Tan" — for a long time this printing method with the help of movable type was particularly linked to the name of Shen Kuo. In fact it was called — "Shen Cong-rong fa", that is "the method of Shen Cong-rong". Shen Kuo himself, however, never took the credit for this innovation. And yet a native of South-Song by the name of Zhou Bi-da (1126—1204) in his own collection of *biji* "Yu tang za ji" ("Notes of the Jade Hall"), in the excerpt, dated from 1193, wrote that "he recently used the method of Shen Cong-rong", and having thus printed twenty eight excerpts from his *biji* collection, he gave them away to his friends. It is also known that the earliest text in the world, printed with the help of mobile type and reaching our days, is dated from 1103: these are the pages of sutra, found in the excavations in North-Song Buddhist stupa in the town of Wenzhou (Zhejiang Province). It should also be noted that in spite of certain technological advantages, the book-printing method invented by Bi Sheng did not receive any wide application and was ranked among the category of wonders.

( 4 3 7 )

Experts make a needle out of magnetic stone, and it is capable of pointing to the south, but is inclined to the east a little, not quite [looking at] the south. [If] one were to place [such needle] on the water surface, then it rocks very much, but [if] on a fingernail or a cup edge — then it is fully capable of pointing, but is turning really fast; but, since [the surface is] smooth and slippery, it falls easily — not as it is in the case when it is suspended by a thread, that is the very best [method].

The essence of this method is in pulling one thread from a freshly made silk cloth and with the help of [a piece of] wax of a size of not larger than a mustard seed fasten it in the middle of the needle. Suspend the needle in a windless place and it will always point to the south.

Among [magnetic needles] there some that are made in such a way that they point to the north. I have all kinds at home: some point to the south, some to the north. Those that point to the north are like cypresses reaching for the west.

Why it happens remains a mystery.

**Annotations.** Like cypresses reaching for the west — in accordance with ancient legends all trees reach for the east because that is where the sun rises, and only cypresses persistently bend themselves towards the west, which in itself does not correspond to botanical reality; Shen Kuo uses this comparison exclusively for the sake of illustrating his reasoning.

The history of magnetic compass in China takes its roots in great antiquity and was always linked with geomancy. However beginning in the 9th century the state of things has changed: since that time in particular we know of reliable information that magnetic compass was widely used by Chinese seafarers. But in Song times a compass was invented made up of a magnetized steel plate in the form of a fish, which was placed in the cup of water — this orientation method was described in the text in "Wu jing jing yao" ("The Most Important of Military Canons") of Zeng Gong-liang (999—1078), dating from 1044. It needs to be added that the first systematic description of magnetic compass, reaching our times, belongs namely to Shen Kuo, and so does the mention of magnetic variation, where the hand does not point to the south quite accurately (although in reality, the discovery of magnetic variation dates to much earlier times, i. e. to the 7th—10th centuries); whereas in Europe the dip angle was discovered only in 1492 by Columbus.