PHOEBE FU
JOHN CHAPMAN
BRENDA VALE

UNIVERSITY OF AUCKLAND

Timber in Ancient China

Wood work and wood processing as recorded in the ancient texts

The Chinese building is a highly "organic" structure. It is an indigenous growth that was conceived and born in the remote prehistoric past, reached its "adolescence" in the Han dynasty (around the beginning of the Christian era, matured into full glory and vigour in the Tang dynasty (seventh and eighth centuries), mellowed with grace and elegance in the Song dynasty (eleventh and twelfth centuries), then stared to show signs of old age, feebleness and rigidity from the beginning of the Ming dynasty (fifteenth century).

S.C Liang *in the preface to* A Pictorial
History of Chinese Architecture

INTRODUCTION

Timber was used extensively in traditional Chinese architecture, but the process by which the tree became the building material was often not fully documented. Many considered timber as a suitable building material because as the living drew their sustenance from the ground so the trees also grew from the ground. Therefore timber was seen as the material to accommodate the living. In contrast, the materials derived from the ground, such as clay bricks or stone were considered the building material for the dead. Trees intended for building were considered immensely valuable to the sovereign and the wealthy. Historically the use of large timber in building was always associated with power or social status. Since the scale of the constructions and the number of craftsmen involved were enormous, a standardized approach to building became inevitable –and this led to the compilation of "building standards".

Only a few treatises –such as the *Yinzaofashi* -"State Building Standards" [1] (□□□□), recorded the specification of various types of construction work and a standardized approach to architectural member sizes. Scholars were employed by the sovereign to undertake the task of treatise writing; the treatise was not intended to teach the principles of architecture to members of the department staff but to instruct them in managing construction accounts (Glahn 1981, p.135). The scholars would not be concerned with how timber came to be usable as this was considered the concern of labourers or craftsmen. Wood processing and its application in traditional Chinese architecture have instead, been recorded in historical documents throughout various dynasties. Therefore, in order to understand how timber was treated in ancient China, one must refer to various ancient texts and archaeological findings.

The first mortise and tenon joint discovered in China was made during the Neolithic period (6000 - 2000 BC), when stone, bone tools as well as knives made out of shells were used for wood work. This means this joint bas been in use for at least four thousand years. A Neolithic *gan-lan*[2] (□□) type of timber structure discovered in Zhe-jiang (□□) region used timber for poles, columns and rafters. It also had timber floor planks. These members were jointed together by mortise and tenon joints, and then the members were tied together by ropes (Xiao 1992, p. 421). From it early application, it seemed that the people had a basic understanding of the mortise and tenon joint; therefore it was not surprising that the technique was refined throughout the years and formed the jointing of the unique and complicated bracket system (Glahn 1981, p. 123) which became a crucial element in forming the identity of Chinese architecture.

[1] The oldest existing Chinese technical manual on construction, it was compiled with Jie Li (1065 -1110) in 1100, published by the Song sovereign in 1103 and enforced in 1104. Guo, Q. (2002).
[2] A house elevated above the ground by stilts to avoid attack from poisonous animals or moisture.

During the Shang period (ca. 1600-1046 B. C.) Bronze tools such as the axe, knife, and saw were used, enabling advancement in the refinement of wood work. In terms of evidence for such refinement, "The garden of Explanations"[3] (□□) spoke of the Shang palaces being highly decorated[4] with carvings (Zhao and Liu 1985, p. 601) and a coffin cover from the same period was discovered in the Ho-nan state (□□) Zheng prefecture (□□), which was decorated with relief carving of tigers.

From "The commentary (or tradition) of Zuo"[5] (□□), comes the phrase: "When timbers are found in mountains, the type of work to be carried out is judged by the timber found" ("□□□, □□□□") (Zuoqiu, Wang et al. 1990, p. 46). This phrase indicates that before felling the trees, the ancient Chinese people observed and measured the trees, and only specific trees were chosen to be felled for building purposes.

Palatial architecture required huge amounts of building material. The sovereign allocated soldiers and prisoners to undertake the acquisition of building materials, but the majority of the acquisition was done by force in various areas of China. The enforced extraction of building material was large in quantity and extensive in kind. The materials that were plundered from state to state included bricks for city walls, large structural timber, unrefined paint, and tung oil[6] (□□). It was noted that in the year 1607 B.C, the amount of Nan mu (□□) timber extorted from Si Chuan (□□) state reached 4700 pieces. On one hand this kind of extortion reflected the extremely high standards required in the selection and the processing of the timber, on the other hand it also reflected high degrees of extravagance in the selection and usage of timber.

FEUDAL CHINA

During the Western Zhou (1066 - 771 BC) or Eastern Zhou(770 - 256BC) Chinese society entered the feudal stage, and this was to last for 2500 years until it was shaken by the opium war in the 1830s. During the feudal period, using human labour to increase the production of building material was very common, but the process of obtaining building material was extremely dangerous and exhausting, whether it was tree felling in the deep forests, transportation of building material to various parts of China, or the excavation of clay for bricks. The men worked day and night and many, literally worked to death. For those who were assigned to go into the mountains to fell timber they "entered the mountain by the thousand, but leaving with only half of the number, plagued with illnesses and exhaustion, half of the men die" ("□□□□, □□□□, □□□□, □□□□") (Xiao 1992, p. 420).

Ancient texts such as *Liji* -"Records of Ritual matters • Monthly rituals"[7] (□□ • □□) and *Huainanzi* -"The Masters of Huainan"[8] (□□□) prescribed the suitable seasons in which the felling of timber should occur; from *Liji* it was said that "felling of timber is forbidden in the first month of spring [February][9], … During [November], the day is short, then timber should be felled to draw bamboo arrows" ("□□□□□□□□, … □□□□, □□□, □□□□□□") (Xu and An 1999, p. 84 -87). And from *Huainanz*, it was said that "before the grass and leaves fall, the axes does not enter the forests on the mountains" (□□□□, □□□□□□) (Xiao 1992, p. 421). These phrases summarized the experiences which the ancient people had regarding the felling of timber. The advantages of felling timber in winter were that the coldness prevented rot caused by insects or fungi, fungal infection in the air would be low during winter, and therefore the surface of the timber can be dried before it was exposed to infection. Infection rate would also be slower because of the low growth rate of any fungi in cold environments (Findlay 1953, p. 134). The ends of the logs may dry out gradually in the cold, so that the deep splitting and cracking which may form during hot seasons could be avoided. Transportation and tree

[3] Compiled by Xiang Liu (□□ d. 5B.C), it was a collection of historical stories and anecdotes, and contained twenty themes concerning government and social behaviour.

[4] □□□□

[5] Originally stated to have been written by Qiuming Zuo □□□, a contemporary of Confucius, in fact it was Xin Liu □□ (? – 23A.D) that discovered the ancient text during the Han period and it was suggested that he might have manipulated the text in order to please emperor Mang (Theobald, Ulrich. *Chunqiu* □□ "The Spring and Autumn Annals", www.Chinaknowledge.com. 06/2004). *Zuozhuan* was a commentary on the Chunqiu (□□) Annals, but it has significant difference; it covered a longer period -until 463 B.C and it was considered more readable than the *Chunqiu* classic. The classic outlined the internal states of Lu (□) and short reports of inter-state relationships with other feudal states. It also recorded the natural disasters during the period 722 to 481 B.C. Therefore in history this period was called the *Chunqiu* period.

[6] Light brown and semi translucent viscous liquid, used as a paint to seal the surface of timber to prevent it from being affected by moisture.

[7] "Liji" (□□) was one of four (others were Yili (□□), Zhouli (□□), and Da dai Liji(□□□□)) extant collections of ritual matters of the Zhou Dynasty (1122-221 B.C). The first person who studied Liji was Xiang Liu (Legge, James. Liji □ □"Records of Ritual Matters", www.chinaknowledge.de 06/2004).

[8] An Liu (□□ d. 122B.C) was one of the many princes of the Han period (206 B.C -220 A.D). He commissioned Daoist scholars and let them compile a book of their interpretation of how human life and the cosmos worked. It was a research into the true Dao, where Dao meant "The Way".

[9] □□□□ i.e. The first lunar month which is the same as □□□□□. The Chinese year starts from the first month of winter of the current year and ends at the first month of winter of the coming year. It is commonly know that the first month of the Chinese year □□ and is called Zheng yui (□□).

felling was also made easier during winter, as the frost facilitates the works of extraction by consolidating soft ground and muddy tracks. Felling in winter was preferred by people because it was not the planting season, which meant the people had more time to spare in terms of gathering building materials and preparing to build.

Iron tools were used for felling timber, according to *Zhou li* -"Rites of the Zhou • Overseer of Public Work"[10] (□□ • □□□). During the Spring and Autumn period, tools called "zhu" (□) [11] and "ke-fu"(□□)were used, the text also stated that the "ke" (□), which was the shaft of the axe, should be 3 "chi" (□)[12] (Lin and Wang 1972, p. 476 -477).

Following the advancing development of iron refinement, tools were improved to counter hard timber. *Houweishu* – "Book of Later Wei"[13] (□□□) noted "those who make men cut hard timber, must choose a good axe on their behalf. The hard timber from high mountains has the complexity of intertwining and overlapping texture planted within …unless using sharp, strong and precise instruments, there is no way to manipulate it." (□□□□□□□, □□□□□□. □□□□□, □□□□□□□□□… □□□□□, □□□□.) The phase "unless sharp, strong and precise" indicated that iron tools were already used for felling timber at the time.

TYPES OF TIMBER USED

As the demand for timber as a building material increased, the number of trees available gradually decreased. Texts written before Han period (206 -220 C.E) indicate that people were already aware of tree planting management and its association with power. In *Shiji* –"Records of the Grand Scribe • Biography of Profiteers"[14] (□□•□□□□), it was recorded that "In the Shu Han[15] and Jiang ling[16] areas were planted thousands of Ju (□ -orange) trees, between Huai bei (□□ –the north of the Huai river) and south of Chang shan (□□) thousands of Qiu (□-tallow) trees were planted… the owners of the trees were considered *qianhuhou's*[17] euqal." ("□□□□□□□□, □□□□□□□□□□□□□□□… □□□□□□□□□□."") (Wang and Sima 1988, p. 2726 -2727). In *Qi-Ming-Yao-Shu* -"Survival techniques for the common people" [18] (□□□□), it was written that "Chinese white popular has its nature extreme and its strength running straight, made for building material, it will withstand turning forces, even at its end…, to be used as roof rafter when it is five years old, when it is ten years old, it is to be used for ridge beam" ("□□□□□□, □□□□, □□□□, □□□□…, □□□□□□, □□□□□□"). The text indicated that during the Northern Wei period (386 -534 A.D), people managed the planting and felling of trees for building. In *Tian-Gong-Kai-Wu* "Making things feasible by Heaven-approved work"[19] (□□□□), the book mentioned the selection of timber for boat building: "Use a straight fir tree for the mast, if it is not long enough, join shorter ones together to make up the length, on its surface, used iron girdles 1/3 decimetre apart to surround the entire length of the tree… the ridge and fang-wall should be made of phoebe nanmu, oak, camphor wood, elm, pine, or ash… any timber can be used for planks. Elm, lang mu, or oak should be used to make the rudder. The door securing stick should be made with chou mu or lang mu. The prow/bow made of fir, Kuai mu or catalpa…" ("□□□□□□, □□□□□, □□□□□□□□… □□□□□□□, □□, □□, □□, □□, □□ (□□□□□□, □□□□), □□□□□□. □□□□□, □□, □□. □□□□□□, □□. □□□□, □□, □□. □□□□□") (Song and Zhong 1978, p. 143 -174). When it came to building material, it was noted that the wood most commonly used for construction in traditional Chinese building was white cedar and that it has four times the tensile strength of steel and its resistance to compression is about six times of concrete (Glahn 1981, p. 132) . It appeared that the selection of timber for its use was not random but very specific. Oak (□□), Nan mu (□□) or Camphor trees (□□) were used to make the dou-gong (brackets). Cedar (□□) was used to make circular eave rafters

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[10] *Kaogongji* was found *in Zhoulil* (□□). *Zhouli* consisted of a list of the officials that Zhou kings supposedly employed to run the empire. The hundreds and thousands of offices were divided into six groups according to heaven, earth and the seasons. It formed the foundation of the later six ministries. *Kaogongji* belonged to the *Dong guan* - "Winter Ministry" (□□) group.

[11] □=□

[12] 1chi = 1/3 metre. 3 chi = 1 metre.

[13] Compiled by Shou Wei (□□) during the Northern Qi period (550-577)

[14] Shiji was the first documentation of the history of China. It was written by Tan Sima (□□□ d. 110 BC) and his son Qian Sima (□□□ 145 -86 B.C); both were *taishi* (□□-court astrologers) during the Han period (206 B.C -220 A.D).

[15] During the Three Kingdoms period (220-280 A.D.), China was split into Three Kingdoms; Wei (□), Wu (□) and Shu (□) kingdom. Shu kingdom was also referred to as Shu han.

[16] Referring to Chang jiang jin ling (□□□□) region which was Wu kingdom's territory. It is today's Nan jing (□□) region.

[17] Qianhuhou (□□□) meant lordship during the feudal period, each governs a thousand "*hu"*, there were 200 people in every "*hu"*, and therefore the lordship governs over 200,000 people.

[18]Written by Jia Si Sai (□□□) during the North Wei period (386-534), it was regarded by Darwin as "an ancient Chinese encyclopaedia" in the first chapter of "The origin of Species". In the title, *Qimin* meant "common people" and *yaoshu* meant "ways of survival". The ancient book was about agricultural and other techniques in 10 volumes, and it was exported to Japan during the Tang period (618 -907)

[19] Written by Yingxing Song (□□□) during the Ming period (1368-1644), it was a book about technique and agriculture. It is interesting to note that Song believed even an academic should know how things worked, which was contrary to the trends of the time, when the academics or well educated were more concerned with ancient teachings rather than documenting how things worked.

(□□), roof planks (□□), and the flying rafter which was placed above the eaves rafter (□□). Nan mu was used for rafter, pillar and around the doors and windows (Zhao 2001, p. 42).

HANDLING TIMBER

Transportation of timber was a very difficult task. It was usually done with channelling, animal labour, human labour, and transporting on water. The channelling method involved digging channels from the mountain down to a storage point. The men would fell the timber in winter and place the logs in the channels, and when the rain came or the snow melted, the water helped the men to take the timber down to the storage point. Using animals such as bulls was a common method; with heavy timber; the bull would haul at the front, while men pushed from the rear. The timbers used for palatial buildings were not usually found in their own state. They were usually taken from other states; it was recorded that it would take two thousand[20] men to drag one pole. The channels cut from the high points of the mountain may have led to a river; the felled timbers were "flushed" down to the river bed. In *Yijin* –"The book of changes"[21] (□□) it was mentioned that "one by one the sandalwood was felled… placed on the river bed" ("□□□□□, □□□□□"), and then it would travel by water to reach the planned destination. The timbers were grouped, and one raft would take two groups. The grouping of the timbers depended on the diameter of the timber felled, size of the river or lake, and the travelling time. Usually there were fifty pieces of timber per group. On top of the raft a plank shelter was built. A light boat would guide the navigation or the raft would be left to drift on water and led or controlled by men from the banks. (Xiao 1992, p. 421)

The measurement of timber was done by a soft ruler made by a strip of bamboo[22]. The ruler being flexible resembled the modern day tape measure. Measuring units were inscribed on the surface of the bamboo. The unit that was usually used to measure the length of the timber was called "bu" (□); every "bu" is three "chi" (□)[23]. The timber was categorized into two groups, "zheng mu" (□□) literally meaning straight wood and "jiao mu"(□□) literally meaning foot wood. The straight wood was timber fit for building purposes, and the foot timber referred to flawed wood. Cavities, damaged wood, rot, timber being too pointy, too short or curvy was considered flawed.

Timber intended for building was advised to be treated before further processing. In *Huainanzi • Renjianxun*[24] –"The Masters of Huainan • Principles of man's world" (□□□ • □□□) it was said that "… when the timber is untreated and upon which paint is applied, trouble can be anticipated. If one paints over untreated timber, the success is temporary and failure will definitely occur" ("… □□□, □□□□□□□, □□□□□□, □□□, □□□")(Xiao 1992, p. 422). The text advised against the use of untreated timber in buildings, and the "trouble" and "failure" mentioned may refer to deformation of timber and rot caused by insects. There were two types of traditional drying process used in the Si Chuan (□□) and Yun Nan (□□) province. The first was drying the timber by natural ventilation. Usually this was done at the storage point; the logs were piled up on a grid scaffold, and placed on top of stones. The timbers were arranged to face the sun or were placed on the high point of the site. The scaffold allowed air to pass between the logs. If the ground was wet, then drainage had to be provided. Management of the usage of the timber was also necessary, so that the older timbers would be used first to make room for the storage of new timbers. The second drying method was man induced, the timber being placed in a pit and smoked. The size of the pit was roughly seven meters long , four meters wide and three meters deep (Xiao 1992, p. 422). The floor and the walls of the pit were lined with bricks, and above the bricks on the floor was a layer a saw dust. After the timber was placed, a cover was then placed over the pit, with holes in it to allow the smoke to escape. The saw dust was then set to burn. Observation of the smoke colour was required, the normal colour was whitish, and if the smoke became darker there would be the risk of burnt logs. To counter over burning, water was sprayed on the bottom of the pit to control the flames. The timbers that were dried by hot smoke had less chance of cracking, deforming or developing rot at an early stage. This method, although some considered it crude in modern terms was still used in the southern states of America, it was referred to as smoke or Arkansas kiln drying. The form of the kiln, interestingly enough, resembles that of the *gan-lan* structure aforementioned. Instead of placing the logs in a pit, the kiln consisted of a platform set on posts and was boarded in on three sides. It was noted that pine was the principle type that was dried this way (Koehler, Thelen et al. 1926, p. 72). The logs were piled on the platform and a fire lit underneath it. The logs eventually became blackened by the smoke except where they cross, but the discoloration is dressed off later. It seemed that the ancient Chinese people shared the same concerns of modern forestry; it was sensible to have the timber seasoned because it made the wood: stable, stronger, lighter, resistant to decay, take preservatives if required, take paints and polishes if necessary and combust easily if it was intended to be used as firewood (Bateson 1952, p. 5).

APPROACHES TO TIMBER: ATTITUDES AND TOOLS

[20] "…□□□□□□, □□□□…" From " □□□□" : □□□□□
[21] One of the five Confucian classics.
[22] It is called Zhu-mieh (□□)
[23] See footnote 9.
[24] See footnote 5.

The ancient text from the Spring and Autumn period *Kaogongji* –"Overseer of Public Work"[25] (□□□), mentioned seven categories[26] of timber workers, including those dealing with the wheel, carriage, arches, cottages, carpentry, vehicles, and inscribers. This showed that specialized wood working was specific to various fields. *Guangzi • Haiwang* [27](□□ • □□) prescribed that "those who called for emperor's work, must be equipped with an axe, a saw, an awl and a chisel" (□□□□□□, □□□□, □□,□□, □□) –all tools still in use today. *Kaogongji*[28] (□□□) also mentioned that the crafting of the timber was not all the same, that one must "review the differences of the material and make the appropriate decision regarding its use" (□□□□) (Lin and Wang 1972, p. 419 -421) of the timber before commencing work. It also pointed out that "beauty comes from the material and technique in the work" (□□□, □□□). Some ancient texts mention the use of curved tools. In *Shouwen*[29] (□□) a character dictionary, it was said that "*Ji jue*" (□□) was a curved knife (Zang, Wang et al. 2002, p. 277), and in *Ganquanfu*[30] (□□□) it was explained that "ji" was a curved knife and "jue" was a curved chisel.

In the *Yinzaofashi* -"State Building Standards" (□□□□), it was prescribed that the major architectural member be extracted from the timber and the left over timber used for secondary elements. Using a large piece of timber to make smaller secondary elements was forbidden[31]. It also prescribed that if the timbers to be used were slanted, damaged or tapered off to a spike, then the timbers should be joined "foot to foot" to make up the length[32]. All wastage should be avoided, for example, in the making of a column, if the timber was not big enough, then several smaller pieces should be assembled to form the single column. The technique was called "*he zhu gu mao*" (□□□□), and the combination included two pieces, three pieces or four pieces. The pieces were connected by hidden dove tenons (□□), *zuan-xie*(□□) literally meaning the gathering of small timbers, *gai-ju* (□□), and shown dove tenons (□□□). The connections must have been very precise otherwise settlement would cause different pieces to move out of line. These techniques must be the forerunner of modern glu-laminated timbers. A major advantage of "*he zhu gu mao*" was that the number of knots can be reduced and thus producing a stronger structural member.

During the Ming period (907-946) the people started to own private assets. Many owned timber yards and workshops in reaction to the expansion of the wood processing industry. Accoding to *Mingshi • Shihuozhi*- "Ming history • Record of food and trade" (□□ • □□□), the number of carpenters who resided or worked on shift within the capital was close to forty thousand, and the number of carpenters solely responsible for sawing timber was close to ten thousand (Xiao 1992, p. 423). New tools or new versions of tools were introduced as a result of the flourishing carpentry trade. *Tian-Gong-Kai-Wu*[33] recorded the use of a variety of carpentry tools. Two types of axes were mentioned –*qian gang*[34] (□□) and *bao gang*[35] (□□), the types of awl mentioned were snake head awl (□□□), chicken heart awl (□□□), twisting awl (□□) and hitting awl (□□). Long saws were used to *pao* (rip) the timber, shorter saws were used for sectioning; it was also mentioned that the saw with the finest teeth was used to cut bamboo pieces. Planes were also mentioned in *Tian-Gong-Kai-Wu;* however it did not describe the various forms. According to Frampton and Kudo the Chinese block plane operated with a pushing action in which both hands would grasp handles on either side of the plane (Frampton, Kudo et al. 1997). The planes which *Tian-Gong-Kai-Wu* noted was the hammer plane (□□), which was used to make cylindrical forms. According to Hong, this might be similar to a pushing plane (□□), in which the body of the plane may be fixed at a spot and was turned upside down to expose the mouth; the wood piece was held by hand, and was passed along the mouth repeatedly so that a cylindrical form may be achieved that way (Hong 2003, p. 8). The *qixian* plane (□□□) was used for fine wood work and the centipede plane (□□□) was used to smooth out the surface the boards. There were flat head chisels (□□□) and chisels used to chisel holes called *wan zuo*[36] (□□) (Song and Zhong 1978, p. 187 -189).

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[25] See footnote 10.

[26] □□□□, □□(wheel makers), □□(carriage makers), □□(bow makers), □□ (weapon makers), □□ (city wall builders), □□ (tool makers), □□ (makers of drinking vessels and racks for hanging musical instruments) (Lin, Y. and Y. Wang, 1972, p. 424 -488)

[27] Written by Zhong Guan (□□), it was a political and economic tract. Guan was the minister of the state of Qi (□) during the Autumn and Spring period (403 -221 B.C). It is interesting to note that Guan was the first to recognize that the economic strength of a state would lead to military strength. He also tried to enhance his power by introducing a system of rewards and punishment to make the official fully useful to the emperor. His writings showed his rigid control over the population.

[28] See footnote 10.

□ Shouwen jie zi (□□□□) was written by Shen Xu (□□) of later Han period (206 B.C 220 A.D). It was a dictionary that was intended to clarify what was proper Chinese. It was known at the time that people invented their own characters which were not considered "proper" characters.

[30] Written by Xiong Yang (□□), the ancient poem takes the form of three hundred stanzas.

[31] "□□□□□□, □□□□□□□□□□□□□□□□□□".

[32] "□□□□□□□□□□□□, □□□□□".

[33] See footnote 19

[34] Literally meaning " Inlay steel"

[35] Literally meaning "Surround or wrap steel"

[36] Literally meaning "gouge chisel"

CONCLUSION

The historical texts not only showed how timber was processed but also the various details the scholars prescribed for handling timber. "The commentary of Zuo"[37], "Ritual matters"[38] and "Rites of the Zhou –overseer of Public Work" [39] advocated suitable attitudes and seasons to the felling of timber and principles to the approach of the material. Texts such as "Overseer of Public Work" and "Ming history • shihuozhi"[40] noted the types of tools used and the "Book of later Wei" mentioned the quality expected of the tools if they were to encounter hard wood. In "Overseer of Public Work" it appeared that even the scholars understood the importance of tools to the craftsman and labourers, as they prescribed a list of tools for those called for the emperor's work. Shapes of tools were also described in the character dictionary –*Shouwen*[41].

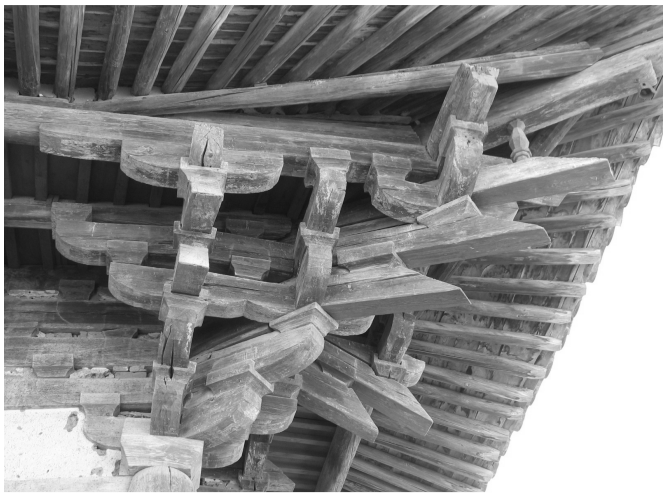
The Cultural context in which the timber was applied was mentioned in some old texts. "The garden of Explanations"[42] outlined woodwork in relation to the social context of the period and the degree of power associated with owning trees was recorded in "Records of the Grand Scribe"[43]. Texts such as "Survival techniques for the common people" and "Making things feasible by Heaven-approved work" indicated that the application of timber for building purposes related directly with its natural properties and that the selection of timber and its application was very specific.

The process following the felling of timber was also documented in various ancient texts. In "The book of changes" it noted the transportation of timber by water - the pieces of sandalwood were placed on the river bank after they had been cut. The failure that could be anticipated by building with green timber was noted in "the Masters of Huainan • Principles of man's world"[44] , and this indicated that timber was treated before it was applied. According to "Overseer of public Work" the craftsmen were categorized by specialization which was similar to the western tradition.

The ancient texts from various dynasties documented many complicated aspects of timber in Ancient China. It is only through these texts that it is possible to understand the complexity involved in timber handling, it was indeed a tremendous exercise that concerned both the imperial court and the rest of the people. The ancient texts also demonstrated that concerns about the use of timber in China in the past are very similar to those of the present. The care with which timber was produced and its controlled usage showed that it was treated as a valuable resource.

The timber pagoda at Ying Province was completed in the year 1056. It is octagonal in plan view. It is composed of five stories (entirely of wood) and is approximately 67 metres above ground level. The external of the pagoda showed a subtle taper of the structure from the base to the top.

[37] See footnote 5
[38] See footnote 7
[39] See footnote 10
[40] See footnote 33
[41] See footnote 29
[42] See footnote 3
[43] See footnote 14
[44] See footnote 24



The Fo-guang Temple was built in the year 857. It is the oldest temple structure in China. The bracket set is located at the corner of the temple.

The Shan-sheng Temple was built in the year 1143, enormous diagonal brackets are placed above the column ties. The ties showed signs of dressed smoked timber.

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