The Língqú 灵渠 Magic Transport Canal:
Landmark in the History of World Civilization

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Canals, Civilization, and China

When we think of transportation modes in the modern world, we don't often include canals.

Canals, save for a few of the famous like the Suez or the Panama, are mostly obsolete, replaced by railroads and highways. But transportation canals, in their day, were critical—critical to communication, critical to unification of large regions, critical for supplying the raw materials of the industrial revolution that brought us the modern world. Canals, along with rivers, were the primary communication highways for centuries, well into the 19th-century, and faded in importance only after the growth of railroads, full throttle by 1850, and automobiles, only since 1920. Superseded, the use of canals, as well as their historical importance, faded. A few canals continue to be maintained as tourist draws, fewer still are used as working industrial routes.

Largely forgotten, also, is the fact that most of the technology that made canals so efficient originated in China centuries ago.

In addition to being one of the world's great civilizations, with a history of nearly 30 centuries, modern China is the world's most populous nation, currently the fastest-growing of the world's economic regions, and projected to be the largest of the world's national economies within a decade. But ancient China's contributions to the modern world are little known.

Among the great civilizations, China has always been relatively isolated from the rest of the world. Vast distances, deserts, mountain ranges, and dense jungles separated ancient China from the civilizations of Europe, the Mediterranean, the Middle East, and the Indian subcontinent. Vast oceans and the world's highest mountains separated ancient China from the peoples to their south and west. Even though the "Silk Road" was known to be a connection for trade between the east and west through central Asia, it was far from a highway. Trade goods travelled in abundance, moved by traders from place to place along the route, but it was rare for any individual to complete the entire journey.

> NOTE: China's historical isolation led to the development of language characteristics so different from those of the west that translating sounds with western alphabets are imprecise at best, leading to a number of different western versions of Chinese words and phrases. I have attempted to use the most common spelling translations, noting occasional alternate spellings or names in parentheses, with the original Chinese characters, where appropriate.

Most of modern China is contained in three great river drainages, the Yellow River (Huang He) to the north, so-called because of all the silt it carries flowing east from more central Asia, the Yangtze (Chang Jiang) in the center, and the Pearl River (Xi or Zhu Jiang) system to the south, the least of the three. Among the world's rivers, the Yangtze ranks fourth in length, the Yellow

sixth. However, the volume of the Pearl system, several rivers that share a delta, is actually larger than that of the Yellow.

Chinese contributions to world civilization are immense. Among the inventions and other cultural advances credited to China are gunpowder, the magnetic compass, silk fabric, tea, and paper, which lead to paper money and printing. Of particular interest for this study are specific water transportation technologies, including those associated with the contour canal, including spade snouts, spillways, weirs, and double weirs used as pound-locks.

Water Control in China

The control of watercourses has been central in 5,000 years of Chinese history. In Chinese legend, for example, Yu the Great, first emperor of the Xia Dynasty, even before his coronation, was famous for winning control over the waters after the Great Flood, which, tradition holds, lasted from 2085 to 2072 B.C. [Buchanan, p 96] Yu's 'controls' were diversions, using canals to direct the flows of floodwaters rather than dykes and dams, which repeatedly had failed to stop flooding. The Yellow River (Hwang He), in particular, sometimes called Zhongguo de Bei'ai [去 趣 覷]– "China's Sorrow," is subject to disastrous flooding [Lewis, p. 7]]. It flows through the easily-eroded loess-soil regions of northwest China, collecting silt that is deposited when the current slows as it arrives in the flatlands of the east. Silt deposits continually build up the river bed; over the centuries, higher and higher dykes are needed to keep the river to its course. Floods, when they eventually break through the dykes, inundate huge areas left lower by the rising riverbed [Embry, p. 13]. As recently as 1931, unseasonable summer storms filled the lakes, and, on August 26 of that year, when the wind suddenly shifted, dikes collapsed at a town called Gaoyou, and the lakes emptied, filling 10,000 square miles of densely-populated farmland, drowning 200,000 people. [D'Arcy-Brown, p. 139]. The dikes were tested again in 2003, but now higher, stronger and 100 yards wide, they held.

Canals, artificial waterways constructed by people, are some of the earliest water control technologies, known to the ancients in Egypt, Mesopotamia, as well as China and elsewhere. A canal is an artificial channel for irrigation, drainage, flood control, and/or navigation, but navigation, because of its potential for changing the "reach" of political and economic control, is our primary concern. Canals are distinguished from natural watercourses by containing slack, water with little, or no, obvious current. Inland navigation can take place on natural watercourses (rivers and lakes), canals, or channels of an intermediate nature, such as improved rivers.

As testament to the importance of canals in human history, the remarkable network of broad and narrow canals and improved rivers in Britain is often credited as an essential part of the Industrial Revolution, which coincided with the "Canal Age" in Europe, 1760-1840. British canals made possible the general supply of coal which powered industry. Not only coal, but stone, iron and copper ores, lime, sand, manure, and agricultural produce, which earlier could not support the cost of transport, moved freely. Britain's canal system was rendered unnecessary by railways after 1840 and remains a system only for pleasure cruising. Commercial shipments ended in the 1960's.

The four most important requirements for a canal are: (1) an adequate supply of water, especially important at the summit, (2) control of leakage, (3) engineering, and (4) labor adequate for construction, maintenance, and operation. The canal itself must be securely separated from natural waters to minimize the effects of drought and flooding.

The oldest Chinese canal on record is said to be the Han Gou (Hong Gou or Han Canal), connecting the Yangtze River and the Huaihe River, said to have been ordered constructed by Fu Chai, king of the Wu Kingdom, during the late years of the Spring and Autumn Period (770-476BC), although alternative dates for its construction point to 361 BC during the Warring States Period (475-221 BC).

The Han Gou eventually became part of the Grand Canal, also known as the Yun-Ho. Beginning with the Han Gou, connections linked to create the Grand Canal were completed around 605 AD by the Sui dynasty (581 - 618 AD). [D'Arcy-Brown, p. 5]. One estimate is that some 294 million cubic yards of earth was excavated [D'Arcy-Brown, p. 9].

The goal of canal construction was to ship agricultural commodities through the empire, and ultimately to the capitals chosen by the various dynasties. For the Sui dynasty, the canal linked their western capital, Luoyang, to the rich agricultural regions of the lower Yangtze. The capital of the Tang dynasty (618 - 907 AD), Chang'an (now Xi'an) was further west along a tributary of the Yellow River, also linked to the Grand Canal. For the Yuan/Mongol (1279 - 1368 AD) and Ming (1368–1644) dynasties, the Grand Canal linked their northern capital (Beijing) some 2,000 kilometers to southern China, enabling rice grown in southern China to supply the wheat-growing regions of the north. Other commodities carried along the canal included porcelains, damasks, satins and silks, precious metals and ornaments, carved ivories, pearls, wines, paper, tung oil, ironware, alum, jadeite and other valuable minerals. Also carried north were products from the tropics including sugar, liquorice, bananas, tea, hardwoods, bamboo, and incense, as well as products heading south including cotton, wheat, soy, peanuts, sesame oil, pears, almonds, and walnuts.

Depths of 7 feet to 11 feet were maintained by 75 sluices built across the canal. Plank sluices, that could be fully or partially closed by a gate made from separate planks were introduced around 605-618 AD. Boats were hauled upstream through the waterfalls over differences of elevation of 20 feet to 30 feet by windlasses, or by gangs of men (trackers) with ropes. The canal was wider than 100 feet in many places, but sometimes only 50 feet. The banks were frequently protected by stone, with stone bridges built across it. Boats were moved mainly by sail, poling, or oars, and pulled by trackers, human labor, through difficult passages.

The density of canals was highest south of the Yangtze. Between Yangzhou, on the Yangtze, south to Hangzhou, every commercial settlement was beside the canal or an extension of the canal, linked to the others in a complex economic and social system where wealth was dependent upon canal trade. Notable among Grand Canal cities, Suzhou has been among China's wealthiest cities for many centuries. At its peak during the 15th and 16th centuries, some 400,000 tons of grain shipped on the Grand Canal each year. During the later years if the Qing dynasty (1644 - 1911), however, after its route was cut by the 1855 change in the course of the Yellow River and its use reduced by railroad, highway, and ocean transport, the Grand Canal fell

into disrepair and sections were abandoned. The Grand Canal is now some 1,700 kilometers in length and still heavily used in the Yangtze delta. About 100,000 river vessels transit on the canal each year, carrying about 260 million tons, mostly bulk commodities such as construction material and fuel, durable commodities for which water transportation is the most economical.

Unification of China by the Qin

Nearly 3000 years have passed since the beginnings, in what is now northern China, of the Qin state, the one of many rival city-states that eventually, after more than six centuries, came to conquer and unify the varieties of cultures in the region. Chinese history is sometimes said to begin with the Zhou state, which pre-dates the Qin by some 250 years, and was in existence from ca. 1140 to 236 B.C. when it was conquered by the Qin.

Both of the earliest Chinese civilizations, the Zhou and the Qin, originated in the populous areas of the Yellow River. The Qin emerged from along the Wei River, a major tributary of the Yellow River.

There exists a legend about how China's first emperor came to power. The legend is that a rich merchant named Lu Buwei befriended a powerful prince of the Qin State during the latter years of the Eastern Zhou Dynasty (770-256 B.C.). Perhaps with the future of his offspring in mind, the merchant Lu Buwei arranged for the prince to meet and fall in love with his lovely wife Zhao Ji, who, unbeknown to the prince, had just gotten pregnant. Zhao Ji became the prince's concubine, and soon gave birth to Lu Buwei's child in 259 B.C. in Hanan. The prince, believing the baby to be his own, named him Ying Zheng. Upon the death of his supposed father, in 246 B.C., Ying Zheng became king of the Qin state. The young king was 13 years old when he took the throne, so his prime minister (and probable real father) Lu Buwei acted as regent for the first eight years of his reign. At the time, seven warring states were vying for control of the land, as well as each other. The leaders of the Qi, Yan, Zhao, Han, Wei, Chu and Qin states had been dukes under the Zhou Dynasty, but had each proclaimed himself king as the Zhou leadership collapsed. This so-called "Warring States Period" was the precursor to the first unification in Chinese history.

During the Warring States Period, political and military competition flourished. Tribal kings raced against each other to raise and outfit the largest armies and deploy the largest workforces to build defenses (and transportation works). Sun Tzu's famous text, *The Art of War*, dates from the Warring States Period. Successful leaders were able to bring new lands into cultivation through drainage and irrigation and to utilize iron in the manufacture of weaponry, swords and shields, as well as farm tools to increase their populations and revenues [Embry, p. 41].

The powerful Zhou and other kingdoms of the early 3rd-century B.C. had been loose confederations of city-states under the control of hereditary fiefs. But with these hereditary fiefdoms squabbling, the Qin (sometimes known as the "Chin") had different ideas about how to create power. Beginning in 246 B.C., Qin leader Zhou Zheng developed an ever-stronger system of centralized control—division of the area he controlled, for example, into territories administered by officials appointed by him (rather than by inherited titles). With their new powers, the Qin began re-making their world to further increase their power. For example, they

opened new areas to cultivation. In the first year of Zhou Zheng's reign, a Qin-built twenty-mile irrigation canal changed an alkaline plain in central Shanxi into fertile farmland. The new farmland was a major contribution to Qin wealth. [Marks, p. 19] A successful Qin irrigation canal system at what is now Dujiangyan [Marks, p. 31] and the irrigation works of Li Bing, diverting the Min River into the Chngdu Plain [Keay, p. 84] date from decades earlier. These and other accomplishments convinced the Qin that water control promoted political power.

Other social transformations imposed, invented, or strengthened, by the Qin included standardized measures of length, weight, and volume, as well as the imposition of land taxes and military personnel levies, which allowed the creation of massive armies of infantry, reportedly in the hundreds of thousands of soldiers. In addition to paying taxes, peasants were obligated to provide annual labor services on public projects.

As stated by Pearl S. Buck in her book *China Past and Present* (1972, p. 27), "The Chinese people are opinionated, irrepressible, imaginative, resourceful, brilliant, and uncontrollable without force." The armies of forced laborers thus amassed by the Qin made possible the gigantic public works including systems of roads and canals. (The wheelbarrow, a basic tool of manual labor, especially in canal- and road-building, was in use in China for at least for ten centuries before it was known in the West. [Buchanan, p. 479])

Qin state had transformed itself from a relatively small backward peripheral polity to the most powerful political force East Asia had ever seen, founding an imperial system that would last more than 2,000 years. Qin power came not from weaponry or location, but from adoption of Legalist political philosophies, a comprehensively repressive system. (Yates, p. 104) While traditional Confucianists talked of benevolence and righteousness, the new Legalists stressed power, administration, and law.

Ranks in society were clearly defined, with privileges, such as land, numbers of servants and their ranks, precisely stated. Severe punishments were specified with groups and families responsible for the behavior of each member. These measures turned the Qin into a well-organized centralized state, governed by a loyal bureaucracy selected on the basis of merit. (Haw, p. 70)

The newly-powerful Qin went on to conquer each of the other six so-called warring states—the Han (230 B.C.), Zhou (228 B.C.), and Wei (225) in the Yellow River basin, the Yen (226 B.C.) to the northeast, Chu (223 B.C.) along the middle Yangtze River and finally the Qi (221 B.C.) at the Yellow River mouth. The Qin, immediately upon conquest and unification of each new area, imposed their systems of uniform weights, measures and money throughout, to facilitate the collection of taxes. To extend their control, they standardized writing and character usage. They also standardized transportation technology, such as axle-width, thus encouraging regional trade.

Qin ("Chin") thus accomplished the first unification of the region that came to be known as the land of the Chin, "China," and, Zhou Zheng, ruling over all of it, took a god-like title (Shi Huangdi), inferiorly translated in English as "Emperor". Thus the new emperor claimed jurisdiction over not only the people, but the mountains and rivers, indeed all the land and water,

a powerful deity indeed. Shi Huangdi (also spelled "Qinshihuang"), became the first emperor of China and is still known as the founder of ancient China.

Having conquered the Yangtze delta, and with an organization designed for conquering territory, the Qin Emperor continued his conquests. To the south lay lands that the Emperor had not yet conquered. The major city was P'an-yü (later known as Canton and presently Guangzhou), largest port in what is now coastal south China, center of the pearl trade, and port of entry for goods from Southeast Asia. His two-river-basin empire achieved through the transformation of Chinese culture into a vast machine of conquest, Emperor Shi Huangdi soon began looking to the south for additional lands and cultures to add to the Qin Empire.

In his effort to conquer and control southern China, the Emperor sent a force said to be 500,000 soldiers to attack the Hundred Yue Tribes of the south.

Origins of the Língqú 灵渠 Magic Transport Canal

As part of his invasion and control strategy, to carry and supply troops, the Emperor devised a scheme to join the great river basins of the Pearl and the Yangtze with a canal that would connect tributaries of each of the great rivers. The tributaries chosen were the Li River, also known as the Gui River, which waters flow south through present-day Guilin, and on into the Pearl, and the larger Xiang River, also known as the Hsiang River, which flows north into the Yangtze system. The place chosen for the canal was in the so-called "Five Ridges" area of present-day Guangdong and Guanxi provinces near the present-day town of Xing'an, where a low saddle in the hills separates the two rivers by just five kilometers or so. The canal, once called the Qinzao Canal and re-named during the Tang Dynasty (618-907), is now known as the Língqú (Língqú 灵渠) or "Magic Transport" Canal. According to local authorities, it has also gone by the names Quig Zao Canal and Xing'an Canal. For the purposes of this history, we will use the name Língqú 灵渠 Magic Transport Canal. In the history of world civilization, it was the first contour canal connecting two river systems.

Construction began in 223 BC and the canal was in use by 214 BC. The nominal date of construction of the canal is often given as 219 B.C. Several sources are cited to establish these dates:

> The great historian Sima Qian, who lived from about 140 B.C to 86 B.C., tells us that: "[the emperor Shi Huangdi] sent the Commanders (Zhao) Tuo and Tu Zhu to lead forces of fighting-men on boats with deck-castles to the south to conquer the countries of the hundred tribes of Yue. He also ordered the Superintendent to cut a canal so that supplies of grain could be sent forward far into the region of Yue." *UNESCO Courier, Oct 1988
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> Joseph Needham cites two additional ancient references to the canal, the *Book of the Huainan* from about 139 B.C., and a biography dating from 132 B.C. of an individual concerned with grain transport. [*The Shorter Science and Civilization in China*, p212] Needham also reports that the Língqú was in good working order during much of the Early Han period, especially between 140 and 87 B.C., reaching a peak about 111 B.C. when

Han Wu Di was campaigning against the Yue to the south. Needham reports evidence of another time of heavy use around AD 40 with the expedition against Annam.

According to China's Confucius Institute, what started as a military transport line turned into a busy trade route. Through the ensuing dynasties, the Língqú 灵渠 Magic Transport Canal was improved, and boats as big as 22-meters by 2.8 meters carried cargoes of up to 17.5 tons [tonnes, one tonne equaling 2,240 pounds] between the natural watercourses. On the busiest days, as many as 200 boats passed through the canal. Because hilly terrain made road construction difficult, water transportation was remained important in the southern regions of China for centuries.

Project Details

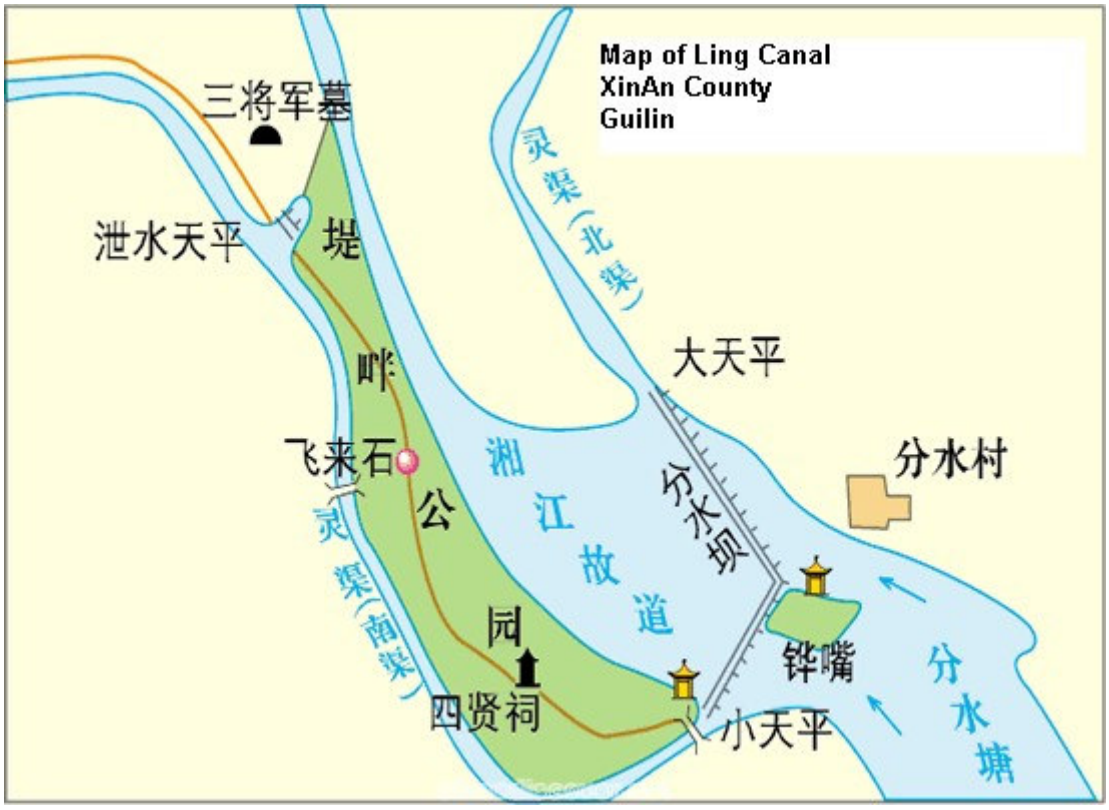
Emperor Shi Huangdi's chief engineer was Shi Lu. Shi Lu directed that water flowing north be diverted from the Xiang River into a canal dug on a relatively level grade through the saddle, first to the northwest through the present-day town of Xing'an and then on west and southwest to the Li River, a total of some 32 kilometers. A lateral canal had to be dug alongside the Xiang (Hsiang) River for 2.4 kilometers at a more even gradient than the river itself, and, at the other end, some 22 kilometers of the Li River had to be canalized in order to regulate it and make navigation possible. Only with the two rivers "tamed" at either end could a 5-kilometre canal then be dug to join them. To complete the transportation route, a short canal some 2.4 kilometers long, the Bei Qu, was dug on the east side of the Xiang River, providing a smooth waterway bypassing rapids and shallows of the Xiang River, both flowing north toward the Yangtze. The canal made it possible for barges and junks to move, via river current, sailing, poling, and towing, from Guangzhou (Canton) on the South China Sea north via the Pearl, Xi, and Li Rivers crossing the watershed through the Língqú 灵渠 Magic Transport Canal to the Xiang River, down the Xiang to the Yangtze, and thence via the Grand Canal to the Yellow River system all the way to the administrative center at Beijing, and in the opposite direction, as well.

Much of the original design, renovated many times over the centuries, remains in the present day. The most recent renovation, of the historic canal's first three kilometers, was completed in 2007.

A major feature of the project, credited to Shi Lu, and an innovation at the time, is an elaborate method of diverting a nearly-constant flow of water from the Xiang River into the canal while preventing flooding that would destroy the canal. This was accomplished using a spade-shaped dam known as a "ploughshare", two sections of low dam in the middle of the river, set at a 105 degree angle to one another. The "ploughshare" is about six meters high, 74 meters long and about 23 meters wide.

The "ploughshare" diverts about 30 percent of the river's flow into a western channel which flows 2.4 kilometers north to where the canal leaves the vicinity of the Xiang River. Two dykes further fortify the low dams, keeping the canal waters separate from the river. In addition, spillways (weirs) along the east and north side of the channel re-direct excess flow back into the Xiang River, maintaining a depth of 1.5 meters in the gently-flowing canal, which averages some 4.5 meters wide. According to Needham, the first spillway is called the Feilei Shi ("the stones

that came flying of themselves"), the second is named the Yishui Tianping ("water-emitting balance"). An information sign at the canal itself identifies the spillway as "one of the important parts" of the Língqú 灵渠 Magic Transport Canal. "It drains excess water back to the Xiang River to ensure the floods don't do damage to the canal or its inhabitants. It is called 'Tian Ping' because its function is to balance the flow of water. ('Tian' is sky, meaning nature; 'Ping' is balance.) The Tian Ping drain balance dyke's length is 42 meters, the dyke's upper breadth is 63 meters, its lower breadth is 11.5 meters. The dyke is made of huge rocks, topped with rectangular rocks stacked in a parallel fashion called fish scale, the name coming from its appearance resembling the scales of a fish." (Translation courtesy of Peiru Xu)



To travel on the canal required barges and other canal boats to pass closely by the spillways where, at times, significant volumes of water were returned to the Xiang River. Bypassing the spillways was a particularly exciting event, as described by Zhou Qufei in *Ling Wai Dai Da* (Information on What is Beyond the Passes) from 1178 AD (Needham, page 213): "Passengers are sometimes scared out of their wits, for about 2 li from the intake where the 'spade snout' divides the waters . . . there is another spillway. . . . Without this spillway, the raging force of the spring freshets could damage the retaining wall and the water would never reach the south. But by its aid, the violence of the waters is abated, the embankment is unbroken, and the water of the canal flows smoothly on."

Another innovation for the Língqú 灵渠 Magic Transport Canal was also employed—a form of sluice gate, it partially blocked the canal and was used to confine water to maintain sufficient depth along the canal. Retaining water in the canal was something of a daunting task because of

the differing levels of river elevations at either end of the canal, the intake on the Xiang end is about six meters higher than the outlet at the Li. Originally the sluices were probably used as a "flash locks", to allow barges to travel along the canal on temporary surges of water. Indeed, an alternative translation for the term is "dipping gate," which brings to mind the picture of the barricade being lowered into the waters of the canal. Each sluice or gate was used, in turn, to block the canal, temporarily raising the water level, with barges collecting on the higher water behind the sluice. When the sluice was released or "dipped", barges rode through on the surge of water. The mechanism for rapid release of the sluice gate, using a collapsible log superstructure holding a fabric-coated wood-lattice framework, was another ingenious Chinese innovation.

Origins of the Pound-Lock

At some time in the succeeding centuries, the sluice gates/flash locks were built close enough together to be used in tandem—with coordinated opening-and-closing—to limit the flow of water along the canal, while at the same time providing the depth necessary to float barges and carry the barges from level-to level across the terrain. The closely-spaced gates thus created an impoundment of water, and the double-gates are now known as a "pound lock". The operation of the gates consists of coordinating their opening and closing such that water released by the upper gate is retained by the lower gate, allowing the up-stream movement of barges through the open upper gate. Instead of a wholesale surge of water over a large section of canal, the pound lock accomplishes the same vertical movement of vessels with much smaller, carefully-controlled, volumes of water. The lock chambers were made as small as practicable, to conserve water, thus limiting the size of boats that could be used. Also to conserve water, the rise of the locks was made as uniform as possible. Indeed, without the pound lock to conserve water, their simply would not be enough water to operate most canals.

According to Needham, the first reliable record of such a double gated pound-lock dates from the year 984 AD, on the Grand Canal, more than 1,000 years after the establishment of the Língqú 灵渠 Magic Transport Canal, but some 300 years prior to any such technology in Europe. Invention/discovery of the pound lock is traditionally credited to the Grand Canal project engineer, Chiao Wei-yo.

A description of pound-locks in China, not along the Língqú 灵渠 MagicTransport Canal, but with reference to the Grand Canal, comes from the Japanese monk Jöjin in 1072 AD [adapted from Needham, page 247]: "Weather fine. At the 5am our boat cast off. By 11am we got to Yanguan xian, arriving at the Chang'an double-slipway. About 1pm the magistrate came, and we took tea at the Chang'an rest house. About 3pm two of the lock gates were opened (in succession), in order to le the boat through. When it had passed through, the stop-logs were dragged back so as to close (the middle gate), and then the stop-logs of the third lock gate were lifted out to open it, and the boat was let through. The surface of the succeeding part of the canal was a little more than 1.5 meters lower. After each gate was opened, the upper section (water level) fell and the water level became equal, whereupon the boat proceeded through."

The same 1178 AD Zhou Qufei record cited previously [Needham, p. 216] contains the following description of the Língqú 灵渠 Magic Transport Canal: "In the canal there are 36 lock-gates. As each vessel enters one of these lock gates [the people] immediately restore it to

its locked position and wait while water accumulates (within the lock), so that by this means the ship gradually progresses. In such a way they are able to follow the mountainside and move upwards. On the descent, it is like water flowing down the stepped groove of a roof, and thus there is communication for the boats between north and south. I myself have seen (I am happy to say) the historic traces of the work of (Shi) Lu." This seems to be a description of pound-locks in operation, although the attribution to the 219 B.C. engineer Shi Lu for the Língqú 灵渠 Magic Transport Canal has thus far not been corroborated.

To further complicate the issue of documenting the development of sluices, flash locks, and pound locks, the technology known as the "double-slipway" was in common use at various times along canals, including the Língqú 灵渠 MagicTransport Canal, where a change in elevation was necessary. Double-slipways are nothing more than two-sided ramps, facilitating the manual hauling of vessels up one side and down the other between sections of waterway. Double slipways are expedient methods of moving vessels along, and were probably used whenever and wherever a sluice-gate or flash lock was not in operation. Double-slipways are decidedly inferior technology, requiring large numbers of laborers, exposing the cargoes to pilferage, and resulting in frequent damage to the vessels. However, they did what they had to do to keep commerce (and taxes) flowing.

The Labor Force: Trackers

No historical account of canal-building in China would be complete without discussion of the massive amounts of human labor that went into the construction, maintenance, and operation of the canal system.

Although no records of construction have been found for the Língqú 灵渠 Magic Transport Canal, records or legendary stories exist for similar projects. For example, Emperor Yangdi of the Sui dynasty (589-618 AD) who put the greatest effort into expansion of the Grand Canal over six years of concentrated labor from 605 to 610 AD, is said to have conscripted several million peasant workers, ages 15 to 50, to further his plan. Any found to be hiding were executed. Fully half of these workers died of starvation, fatigue and disease, or were beaten to death by the overseers when they were not able to adequately perform the work [D'Arcy-Brown, p. 5].

After construction, a huge workforce continues to be required to operate a complex canal system of most any length. Among the bureaucrats required: A director-general with superintendents for each section, secretaries to oversee the most difficult stretches, commissioners to see that traffic runs smoothly, shoalsmen for dredging, lock-keepers to operate the locks, slipway haulers where needed, banksmen to nurture the trees that stabilized the banks, beacon-men to mark out the channels, pondsmen to keep the reservoirs clean and deep, springs-men to keep water sources free from obstructions. As examples of bureaucracy that accompany canals, barges were standardized and monitored, with strict, complex rules governing their cargoes and timetables [D'Arcy-Brown, p. 157].

In addition to building and maintaining the canal, the citizenry was enlisted to assist with the movement of the barge traffic itself. Barge laborers, known as "trackers", were little more than slaves. Trackers were integral to Chinese canal transportation for millennia. From the

recollections of the descendants of trackers, we learn that men did the work of draught animals. The qianfu ("前俯", literally "bend forward") were the trackers, who lived and died hauling junks on the stretches where sails were impractical. Working almost naked, each strapped a towing board to a hawser thrown out from the barge. Placing the board flat across his chest, on a signal from the barge, he, along with his comrades, would "lean forward," heaving along to a hypnotic work song, a Chinese shanty, one of which has been transcribed as "hoyalla, hoya, hoya, hoya, hoy-waudi-hoya, hoyolla hoya, hoya, hoya, hoy-waudi-hoya . . ." [D'Arcy-Brown, p. 117]. There might be a hundred or more qianfu for a large grain barge. A driver walked behind, encouraging slackers with a swift lash. Hauling for perhaps hours in this fashion, they might make a mile an hour.

Several descriptions of China river and canal trackers appear in historic and modern literature:

The 1836 book *An Historical and Descriptive Account of China* by Hugh Murray, et al (Edinburg: Oliver and Boyd, Tweedledale Court, made available through Google e-Books) includes the observation that

> ". . . boats were dragged up the opposing stream by the efforts of numerous laborers, whom their tyrannical masters compelled to toil in this service; and if their efforts slacken through fatigue, 'there is one who follows, and never leaves beating them till they go or die.' "

The 1855 book *Pictorial History of China and India Comprising a Description of those Countries and Their Inhabitants*, edited by Robert Sears (Published by Robert Sears, New York and made available through Google eBooks) contains the observation

> "The boats on the canals and many of the rivers have to be tracked, or drawn along by ropes, and this labor, which in most countries is done by horses, is in China performed by men; so that, either on land or water, the number of laborers employed in the transit of merchandise is immense. The tracking of government barges is a sort of tax on the people, who are usually pressed into this service by order of the magistrates, on whom the duty devolves of seeing that each district furnishes a certain number of men for that purpose, even the wealthiest farmers not being exempt, except on finding substitutes, whom they must pay. The system of impressing men to serve as trackers seems to be productive of much misery. So hateful is the service, that people strive in every way to avoid it. When Lord Macartney's embassy traversed China, those who had tracked the vessels throughout the day generally deserted by night. They knew the difficulty which the officers would have in getting others to relieve them; and they knew also that till others were procured, their own services would be required. To supply their places, very harsh measures were commonly resorted to: the officers used to dispatch their soldiers to the nearest village, where the inhabitants, taken surprise, would be forced out of their beds to join the yachts. Scarcely a night occurred in which some poor wretches did not suffer the lashes of the soldiers for attempting to escape, or for pleading the excuse of old age or infirmity. It was painful to behold the deplorable condition of some of these poor creatures; several were half naked, and appeared to be wasting and languishing for want of food."

On an 1868 journey up the Yangtze, following a stop at Ichang, the French missionary and naturalist Père Armand David recorded (Bishop, page 128):

> . . . "Many new boatmen joined the boat the next morning, each carrying his makeshift bed and a tiny bundle."
>
> "As they made their way to the Ichang Gorge, the road or towpath became increasingly difficult for the men hauling the boat. Three or four men, leaning forward shoulder to shoulder, with wooden frames across their chests to which were attached long ropes connected to the mast, hauled the heavy load. They climbed and jumped like monkeys to surmount the tricky parts."
>
> "[Père] David sat bolt upright from reading his Breviary. The crack was like a rifle-shot. At the bow of the boat stood two chiourme [slave-labor bosses], each holding a huge whip in his hand. David could not believe his eyes as he saw the two raise their right arms and then bring the whips cracking across the backs of the haulers, dripping with rain and sweat and now blood.
>
> 'Hey,' shouted David, as he stood up in anger. You can't do things like that. Stop it.' The chiourme glared down at David and showed their disapproval by lashing the hauliers again and then again for good measure. The Chinese could often be cruel and heartless.
>
> Father Provôt pulled David back to his seat. He explained that this was the custom of the country, justified by the exceptional difficulties caused by the ravines and gorges. The hauliers did not complain.
>
> The atmosphere became dark and foreboding as the high, overhanging mountains constricted the mighty river from a width of several miles ion places to a mere 200 yards at the entrance to the gorges. Hauling was no longer possible and the men clambered aboard. The wind caught the newly erected sails and they glided slowly and with difficulty between the rock faces. . . ."
>
> "The wind presently fell and the boat was rowed on silent waters, resembling a subterranean river. . . . The sheer rock faces resounded to the incessant singing of the rowers."
>
> "Beyond Wushan they had to stop again, to await their turn to be hauled up the short but very steep Hsia-ma-t'an rapids. When their turn came it took more than eighty men more than half an hour to move the boat just 15 feet."

Trackers, in their characteristic garb, make a brief appearance in Mao Dun's classic 1932 Grand Canal short tragedy "Spring Silkworms" (p. 110): "Straining down the road [that skirted the canal], the men towing the fast junk wore only thin tunics, open in front. They were bent far forward, pulling, pulling, pulling, great beads of sweat dripping from their brows." The description is a metaphor for the hard life of Chinese peasantry through the ages.

The well-known world travel-writer Paul Theroux, in his 1984 book *Sailing through China*, writes:

> ”It was near Chang Shou [on the Yangtze River], about noon that first day, that I saw a sailing junk being steered to the bank, and the sail struck, and five men leaping onto the shore with tow-lines around their waists. They ran ahead, then jerked like dogs on a leash, and immediately began towing the junk against the current. These are trackers. They are mentioned by the earliest travelers on the Yangtze. They strain, leaning forward, and almost imperceptibly the sixty-foot junk begins to move upstream. There is no level towpath. The trackers are rock-climbers: they scamper from boulder to boulder, moving higher until the boulder gives out, and then dropping down pulling and climbing until there is a reach on the river where the junk can sail again.” Theroux goes on to point out that “The only difference—but it is a fairly large one—between trackers long-ago and trackers today is that they are no longer whipped.”

In 21st-century China, with the growth of highway and rail transportation, boat tracking has all but disappeared. Virtually all canal traffic is now motorized. Tracking currently exists primarily as demonstration in tourism, where is flourishes along Yangtze tributaries in the Three Gorges area, including the Shennong Stream (神农溪) of Badong County. Many vestiges of the practice, including towpaths, some cut into rock cliffs, and rope scars, remain visible in China river landscapes.

Cultural Heritage and the Língqú 灵渠 MagicTransport Canal

The Qin Empire was short-lived. Megalomaniac Emperor Shi Huangdi, who ruled for 32 years, from 246 B.C. until 210 B.C, brought tremendous cultural and intellectual growth, but much tyranny and destruction. In addition to the Língqú 灵渠 MagicTransport Canal, he was responsible for constructing large sections of the Great Wall of China on the far north of his empire, as well as the well-known terra-cotta warriors in Xi’an. But Shi Huangdi’s reign was so hated that three years after his death, his son, the “Second Emperor” was put to death along with all members of the imperial family (Paludan, p. 9). Once the warring states had all been conquered, and Shi Huangdi had passed from the scene, the Qin were not successful at transitioning to peaceful administration. The Han dynasty eventually materialized out of the chaos of civil war. And thus the vision of world empire was left to the Han, who became the principle beneficiaries of all that the Qin had built. The Han maintained power and territory for more than 400 years by employing many of the Qin policies and procedures, altered to fit the conditions of a lasting empire.

The institutions the Qin had used to concentrate power changed China’s future forever, making governing stability dependent upon the strength and character of the leader [Embry, p. 63]. In addition, successful control of water to serve the needs of people gave confidence to the Chinese that they (or at least the Emperor) could master nature [Marks, p. 27].

Over the centuries, the Língqú 灵渠 MagicTransport Canal had come to be considered a sacred waterway, with a dragon as its governing spirit. With the coming of railroads and all-weather highways in the 1930s, however, usage of the canal declined to nothing by the 1970s, according to Lui Jinix of the Língqú Historical Cultural Research Society. A modern railway bridge goes right over the old canal route, which is still used for irrigation of adjacent gardens and orchards.

So what is the significance of the innovations first manifest in the Língqú 灵渠 MagicTransport Canal? We don't often see canals as the huge transportation innovations they were in their day. We are so accustomed to rail, highway, "steamship" and air transportation for the movement of our commodities and manufactured products, we forget that canals were the miracle technologies for hundreds of years. The Língqú 灵渠 MagicTransport Canal, world's first contour canal connecting two river systems, was listed for national key cultural relic protection in 1988 and is currently on the tentative list for designation as a world heritage site by the United Nations Educational, Scientific and Cultural Organization (UNESCO).

Like most canals, the Língqú 灵渠 MagicTransport Canal has needed frequent and extensive maintenance and repairs. Extensive renovations were carried out by the Eastern Han (25-220) and Tang (618-907) dynasties. Records of renovations from the Qing Dynasty (1644-1911), carved in stone, are on display at the canal, the Língqú Scenic Spot, in Xing'an. The most recent renovation, done primarily for preservation of the historical resource, was completed in April, 2007.

But through all the repairs and renovations the essentials of the canal remain. The original third-century-B.C. creation of Shi Huangdi and Shi Lu remain visible in the landscape in and west of the town of Xing'an in present-day Guanxi Province. At least five essential ancient artifacts remain. They are the ploughshare (spade snout) that separates the waters of the Xiang River, the two low dams that direct river water into the two canals (the Língqú to the west and the Bei qu to the east), the two balancing sluices that return excess waters to the Xiang River, and, of course, the route of the canal itself–along-the-contour, all 32 kilometer of it, connecting the Xiang River with the Li River.

The Língqú 灵渠 MagicTransport Canal remains the foremost lasting monument to Shi Huangdi and the unification of China. It is one of the most important ancient landmarks in the history of world civilization.

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