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 do not often include canals.

Canals are waterways made by people for the transportation of irrigation water, people, manufactured goods, and/or agricultural and mineral commodities. Canals, except for a few currently famous ones like the Suez Canal or the Panama Canal that serve ocean-going vessels, 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 for the industrial revolution that brought us into the modern world.

Canals, along with rivers, were the primary communication highways for centuries, well into the 19th-century, but faded in importance after the growth of railroads, full throttle by 1850, and automobiles, only since 1920. Superseded by modern modes, the use of canals faded, as did understanding of their historical importance. A few canals are still in use as working industrial routes; prominent among these are China's Grand Canal--the Jing–Hang Grand Canal (京杭大运河); between Hangzhou and Beijing--Germany's Kiel Canal in Schleswig-Holstein, and the USA's New York State Canal System (formerly known as the New York State Barge Canal connecting New York City with Lakes Erie, Ontario, and Champlain. Several historic canal routes continue to be maintained largely as tourist draws and/or historic sites. Among these are the Baltic Sea Canal, connecting the White Sea with the Baltic; the Gota Canal across Sweden; extensive canal networks in England and France; and city-wide canal systems in places like Copenhagen and Amsterdam. Many of these date from the 19th-century,

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 few decades. But ancient China's contributions to the modern world remain little known.

In his discussion of "Inventions and the Diffusion of Technology", for the UNESCO ***History of Humanity*** compendium Richard Bullier cites the underlying belief in "European Exceptionalism", the prevailing myth that Europeans created the modern world. Bullier points out that "invention was abundant on a worldwide scale" and describes many vectors of diffusion, including trade, population shifts, and wealthy rulers importing foreign specialists. (Bullier, p 77) Largely forgotten or ignored is the fact that most of the technology that made canals so efficient, in their glory days originated in China centuries ago.

During the 16th Century, Europeans believed that the three greatest inventions in human history (printing, gunpowder, and the compass, as listed by Francis Bacon in his *Instauratio Magna*) were European. Beginning only in the 19^{th} century did Europeans begin to acknowledge that all three of the technologies first appeared in China. And not only did these technologies first appear in China, they originated in China, and they were invented in China. Many of history's critical technologies first appeared in China, originated in China, and were invented by the Chinese. These include the ship rudder, paper, cast iron, the wheelbarrow,, and the summit-level canal.

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, east, 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 often in caravans along the route, but it was rare for any individual to complete the entire journey. Admiral Zheng He's15^{th}-century Ming Dynasty maritime expeditions—seven voyages in all, from1405 to 1433 CE—were grand expeditions—diplomatic, military, and commercial—through the South China Sea and into the Indian Ocean. But after 1433, successor regimes turned away from foreign interaction. Perhaps centuries of Chinese culture infused with and guided by the ancient teachings of Confucius are part of the reason for Chinese close-mindedness, conservatism, and the resulting isolation.

> [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 within three great river drainages flowing to the sea from the west; the Yellow River (Huang He, **黄河**) on the north, so-called because of all the silt it carries flowing east from central Asia, the Yangtze (Yangzi, Changjiang, **长江**) in the center, and the Pearl River (Zhŭjiang, **珠江**) system on the south, the least of the three. Among the world's rivers, the Yangtze ranks fourth in length, the Yellow sixth. However, by volume, the semi-tropical Pearl system, several rivers that share a delta, is larger than the Yellow.

Chinese contributions to world civilization are immense. Among the inventions and other cultural advances credited to China are the domestication of rice, soybeans, and pigs, the smelting of iron, and the making of porcelain, noodles, gunpowder, silk fabric, mechanical clocks, kites, wheelbarrows, tea, and paper, which led to the origin of movable type printing and paper money. Among the ocean-navigation innovations credited to the Chinese are the sternpost-mounted rudder and the magnetic compass. Of particular interest for this study are specific inland water transportation technological innovations, including those associated with transport canals, including contour routing, water source capture, water-conservation methods such as clay lining ("puddling"), spade snouts, turning basins, dikes, gates, spillways, weirs, and double weirs used as pound-locks.

Canals

Canals, artificial waterways constructed by people, are some of the earliest water control technologies, known to the ancients in Egypt, Mesopotamia, as well as in China and elsewhere (Hadfield, 1986, p. 16). A canal is an artificial channel for irrigation, drainage, flood control, and/or navigation (travel and transport). Because of its potential for changing the extent of political and economic command, navigation is the primary focus of this analysis. Canals are distinguished from natural watercourses by containing slack, water with little, or no, current. Inland navigation began on natural watercourses (rivers and lakes) and has extended over the centuries through the human creation of canals and channels, including improved ("canalized") rivers, where obstructions have been removed and dams inserted. Estimates on the efficiency of canal transportation vary, but often are touted to be fifty to over one hundred times that of the horse-drawn wagon (Needham, 1971, p. 216). The great efficiency of canals is due to the lack of friction: heavy loads floating on water can be moved great distances by sail, oar, polling, or by tugging from human or domesticated animal (horse, mule) power along adjacent towpaths, often built atop dikes that retain water in the canal.

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 element of the Industrial Revolution, which, not incidentally, coincided with the "Canal Age" in Europe, the years between 1760 and 1840. British canals made possible the general supply of coal, as well as iron-ore, which powered industry. Not only coal and iron ore, but stone, copper ore, lime, sand, manure, and agricultural produce, which in earlier times could not be shipped due to the prohibitive cost of transport. With canals, commodities move freely and efficiently, floating on systems of slack waterways. Britain's canal system—rendered obsolete and unnecessary by railways after 1840—remains a greatly-reduced vestige, kept for historical preservation, quaint scenery, and pleasure cruising. Commercial shipments ended in the 1960s.

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) engineered technology to control water flow, and (4) labor adequate for construction, maintenance, and operation. The canal itself must be securely connected to sufficient water sources to overcome drought but separated from those same water sources to minimize damage from flooding. Canals are expensive—in both labor and capital—to construct, to operate, and to maintain. Absent strong and well-organized administration, canals deteriorate rapidly—through siltation, leakage, collapsed walls, broken technology, or breached dikes, for example—and fall into disuse,

Water Control in China

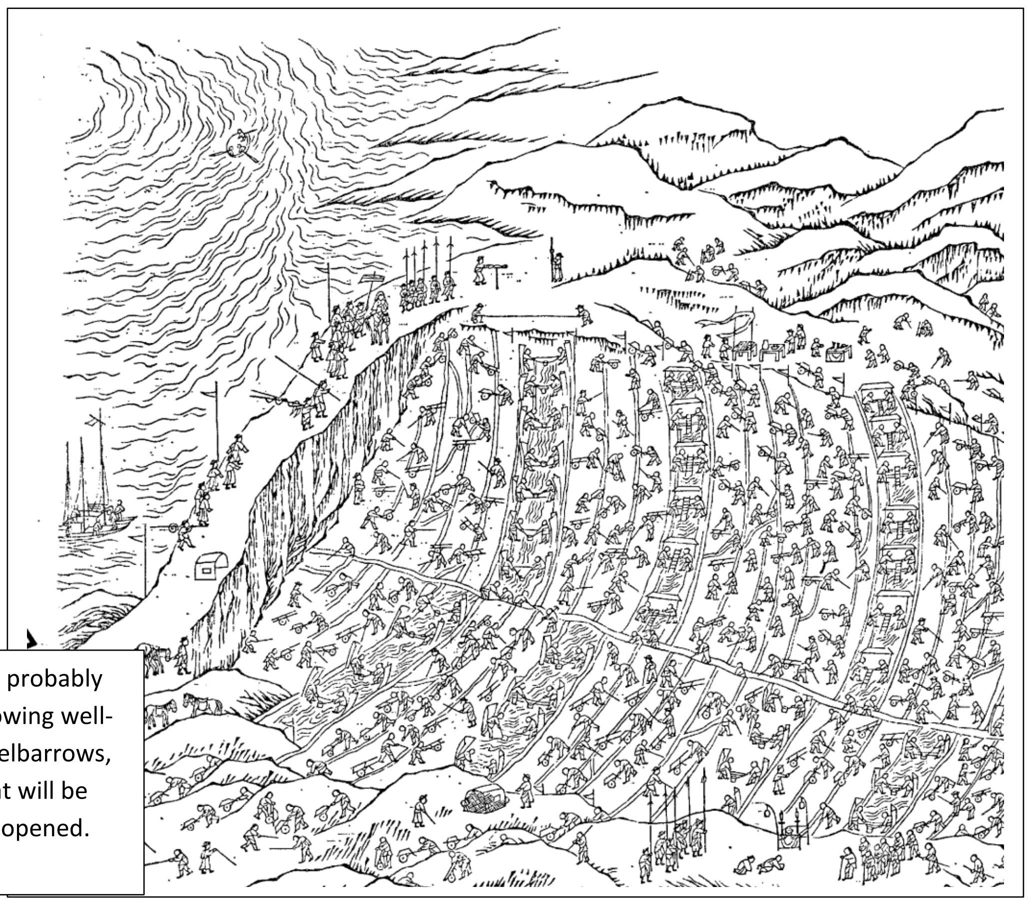
The control of watercourses has been central through 5,000 years of Chinese history. In Chinese legend, for example, Yu the Great, first emperor of the Xia Dynasty, even before his coronation, was famous for winning control over the waters after the Great Flood, which, tradition holds, lasted from 2085 to 2072 BCE [Buchanan, p 96]. Unlike his predecessors, whose efforts to battle nature had failed at preventing flooding, Yu is legendary for having worked with nature, using dikes and deepening riverbeds (Needham, 1971, p249). Yu's 'controls' were diversions, human-dug channels that carried floodwaters away rather than relying on dams to stop flooding, which had repeatedly failed to stop catastrophic flooding. The Yellow River (Hwang He), in particular, sometimes called Zhongguo de Bei'ai [去 趣 觑]– "China's Sorrow," is subject to disastrous flooding [Lewis, p. 7]]. It flows through 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 riverbed and adjacent flood-plains.

Over the centuries, higher and higher dikes have been necessary to keep the river to its course. Floods, if and when they eventually break through the dikes, inundate huge areas left lower by the rising riverbed [Embry, p. 13]. As recently as 1931, unseasonable summer storms filled the upland lakes, and, on August 26 of that year, when the wind suddenly shifted, dikes collapsed at a town called Gaoyou (高邮), 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 by the weather again in 2003, but now higher, stronger and 100 yards wide, they held.

The oldest Chinese canal on record is said to be the Han Kou (Hangou, **邗沟**, Han Canal, or "Canal of the Wild Geese"), connecting the Yangtze River and the Huaihe River, said to have been ordered constructed by Fuchai, king of the Wu Kingdom, during the late years of the Spring and Autumn Period (770-476 BCE), although alternative dates for its construction point to the early years of the Warring States Period, 475-221 BCE (Needham, 1971, p269).

The Han Gou eventually became part of the Grand Canal, also known as the Jing–Hang Grand Canal (**京杭大运河).** Beginning with the Han Gou, segments linked to create the Grand Canal were completed around 605 CE by the Sui dynasty (581 - 618 CE). [D'Arcy-Brown, p. 5]. One estimate is that some 294 million cubic yards of earth were 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 CE), 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 -



A Chinese canal-digging project, probably at Chung-mau around 1840, showing well-organized chain-measures, wheelbarrows, guards, and the neck of land that will be washed away when the canal is opened. (Needham, 1971, p 262)

1368 CE) and Ming (1368–1644) dynasties, the Grand Canal linked their northern capital (Beijing) to southern China, some 2,000 kilometers, 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, and valuable minerals such as alum and jadeite. Also carried north were products from the tropics including sugar, licorice, 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 seven feet to eleven feet were maintained by seventy-five sluices built across the canal. Plank sluices, which could be fully or partially closed by a gate made from separate planks were introduced around 605-618 CE. Boats were hauled upstream through the waterfalls over differences of elevation of twenty feet to thirty feet by windlasses, or by gangs of men (trackers) with ropes. The canal was wider than one hundred feet in many places, but sometimes only fifty feet. The banks were frequently protected by stone, the waterway spanned by stone bridges. Boats were moved mainly by sail, poling, or oars, and pulled upstream through gaps and rapids, by trackers—human laborers.

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 were shipped on the Grand Canal each year. During the later years of the Qing dynasty (1644 - 1911), however, especially 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. China's Grand Canal—now reduced to some 1,700 kilometers in length—is still heavily used in the Yangtze delta. About 100,000 river vessels transit on the canal each year. They carry some 260 million tons of cargo, mostly bulk commodities such as construction materials—sand, gravel, and bricks—and coal. These are heavy durables, for which barge transportation is the most economical.

The centralized bureaucracies of the various Chinese dynasties established and maintained the vast national networks of canals and canalized rivers, providing flood-control, irrigation, and transportation. And the vast network of canals and canalized rivers sustained the dynasties through agricultural production and the efficient collection of taxes and tribute, primarily the shipment of grain.

Unification of China by the Qin

Nearly 3000 years have passed since the beginnings, in what is now northern China, of the Qin state. For centuries, the Qin was just one of seven rival city-states in the area (present-day Gansu and Shaanxi). But after more than six centuries of intermittent war, the Qin emerged victorious, conquering and unifying the various city-states in the region. "Qin", pronounced "Ch'in", became known as the land of the Chin, the origin of the word "China". There is much more to the story of how the Qin state, and China's first emperor, unified and created the whole of China, and the critical role of a transportation canal, the Língqú 灵渠 Magic Transport Canal,

Chinese history is sometimes said to begin with the Zhou state, which pre-dates the Qin and was in existence from about 1140 to 236 BCE. 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 their homelands 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 BCE). Perhaps with the future of his offspring in mind, the merchant Lu Buwei arranged for the prince (in line to become the future king) 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 BCE in Hanan. The prince, believing the baby to be his own, named him Ying Zheng. Upon the death of his supposed father, in 246 BCE, 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 fighting 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 third-century BCE had been loose confederations of city-states under the control of hereditary fiefdoms. But while hereditary feudal lords squabbled for power among themselves, the Qin (pronounced and sometimes known as "Ch'in") had different ideas about how to create and consolidate power. Beginning in 246 BCE, 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 titleholders). 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 (present-day) central Shaanxi 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 Min River water into the Chengdu Plain [Keay, p. 84]—date from even earlier decades. 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 (and laborers), reportedly in the hundreds of thousands. 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 roadbuilding, 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 mere weaponry or location, but from adoption of "legalist" political philosophies—reliance on formal structures of government institutions—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 BCE), Zhou (228 BCE), and Wei (225) in the Yellow River basin, the Yen (226 BCE) to the northeast, Chu (223 BCE) along the middle Yangtze River and finally the Qi (221 BCE) 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." Furthermore, the conqueror Zhou Zheng, ruling over all, took the god-like title, ***Shi Huangdi***, roughly translated in English as "Emperor". Thus, the new emperor claimed authority 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 China.

Qin Shi Huangdi, from an 18th-century album of emperor portraits. (Wikipedia)

The Qin established governance through a tightly administered bureaucracy, an innovation that resulted in centralized control over a vast region. Qin-decreed bureaucracy, harsh administration of stringent law, replaced a feudal system of semi-autonomous local (often hereditary) authority allied only through mutual promises of service and loyalty. Centralized governance, run by a previously unimaginably organized corps of civil service (Joseph Needham, 1986, p10) was to have lasting implications for the Chinese landscape in general and the Língqú 灵渠 Magic Transport Canal in particular.

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 Lingnan region occupied by Yue ethnic groups, including the Minyue in the present-day Fujian area and the Nanyue. The major city was P'an-yü (later known as Canton and now 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. Without the newly imposed centralized control and accompanying bureaucracy, the canal never would have come into being at such an obscure and remote location.

The place chosen for the envisioned 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 a few kilometers. Xing'an County is administered as part of the prefecture-level city of Guilin. The canal is nestled between the Dupang Mountains and the Yuecheng Mountains. To the southeast, a marine mountain system running through Dupang Mountain gives birth to the Xiang River (Xiangjiang), which is part of the Yangtze River system. To the Northwest are the Yuecheng Mountains, giving birth to the Li River (Lijiang) of the Pearl River system. The valley between the two mountains has become known as the "Xiang-Gui Corridor," historically important and highly contested as an important passage between north and south China, even before the canal was created.

The region's elevation is about 700 meters, its latitude about 25^0 30' North (similar to Miami, Florida, USA). The region has a mid-latitude continental climate, with warm wet summers, relatively dry cool winters, and some 180 cm (70 inches) of annual rainfall. The drainage area of the Xiang River above Xing'an is on the order of 1,000 square kilometers. Xiang River flow is plentiful, except during the winter months. Minor snowfall is ordinarily confined to the month of January. Freezing temperatures are rare and of short duration.

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, Dou Canal, and Xing'an Canal, The Mandarin character "ling" translates to a number of English words, including having a spiritual or mystical nature, or, for a person, smart or clever. Simon Winchester refers to it as the "Miracle Canal" (Winchester, 1996, p151), Needham starts by calling it the "Ling Chhü" Canal (1971, p. 266), using the canal's English pronunciation) then uses the designation "Magic Transport Canal".(p299+ff). In his 1986 book on ***World Canals***, Charles Hadfield calls it the "Magic Canal" (p22). For the purposes of this analysis, we will use the name Língqú 灵渠 Magic Transport Canal. In the history of world civilization, the Língqú 灵渠 Magic Transport Canal was the first contour canal re-directing the flow of water across a "saddle" of land, thus connecting two river systems through a mountain pass,

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

> The great historian Sima Qian, who lived from about 140 B.C to 86 BCE, 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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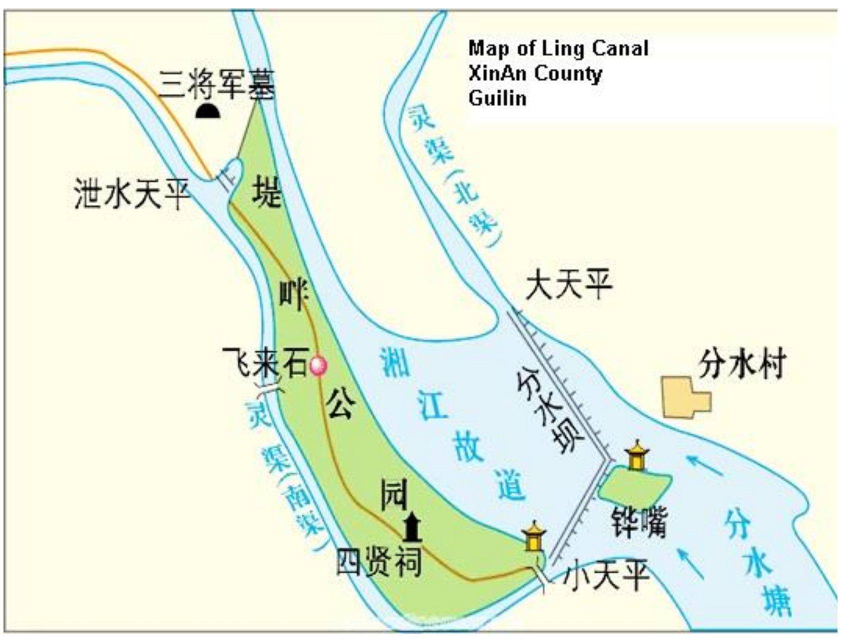
> Joseph Needham (1971, p299) cites two additional ancient references to the canal, the *Book of the Huainan* from about 139 BCE, and a biography dating from 132 BCE of an individual concerned with grain transport. Needham also reports that the Língqú was in

good working order during much of the Early Han period, especially between 140 and 87 BCE, reaching a peak about 111 BCE when Han Wu Di was campaigning against the Yue to the south. Needham reports evidence of another time of heavy use around CE 40 with the expedition against Annam.

The essence of the Língqú 灵渠 Magic Transport Canal creation is that it was critical to the origin and unification of all the lands that became China, named China because of the Qin conquest. The Língqú 灵渠 Magic Transport Canal facilitated the transportation of troops and supplies absolutely necessary to carry out Qin Shi Huang’s attempted takeover of the south.

According to China’s Confucius Institute, what started as a military transport link 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 two hundred boats passed through the canal.   Because hilly terrain made road construction difficult, water transportation remained important in the southern regions of China for centuries.

Project Details



In this illustration, the Xiang River flows (to the north) from the bottom, with the ploughshare and balancing dikes directing water into the Lingqu Canal, which flows to the left (west).

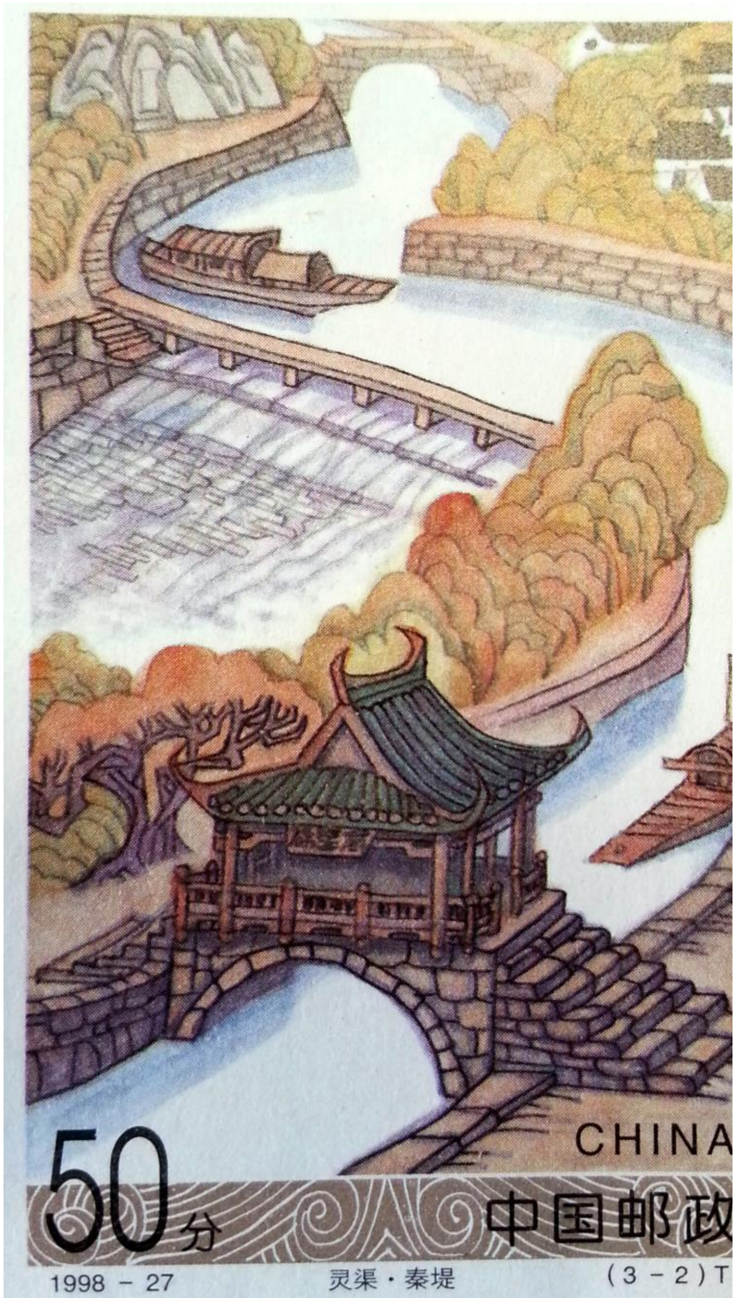
Emperor Shi Huangdi’s chief engineer was Shi Lu. Shi Lu directed that water flowing north be diverted from the Xiang River into a canal dug on a relatively level grade through the saddle, first to the northwest through the present-day town of Xing’an and then on west and southwest to the Li River, a total of some 35 kilometers. At its beginning, a lateral canal (parallel to the river) had to be dug and diked alongside the Xiang 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 tributary 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-kilometer canal then be dug to join them.

The work of digging, moving earth, and building dikes no doubt required thousands of laborers—most of them the emperor's soldiers—and untold injuries and deaths. Iron tools made the digging possible. An early Chinese invention, the wheelbarrow, may have been employed, also, although the earliest documentation of wheelbarrow technology (a Han Dynasty mural) dates from three centuries later. A major feature of the project, credited to Shi Lu, and an innovation at the time, is an elaborate method of diverting the 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 divider known as a "ploughshare" (or "spade-snout"), and two sections of low dam (balancing weirs) crossing the river, set at a 105 degree angle to one another, sometimes called the "large balance" (380 meters long) and "small balance" (124 meters long). The "ploughshare" is about six meters high, seventy-four meters long and about twenty-three meters wide at its widest.

The "ploughshare" and balancing weirs Lu Gwei-djen in this first of three 1998 PRC LIngqu Canal commemorative stamps. The Xiang River flows from the top, divided by the ploughshare, directing waters into the Lingqu to the right.

The "ploughshare" diverts about 30 percent of the river's flow into a western channel which flows 2.4 kilometers northwest to where the canal leaves the vicinity of the Xiang River. A dike along the hillside keeps the canal waters separated from the river. In addition to the low dams, two spillways (weirs) along the 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 do not do damage to the canal or its inhabitants. It is called 天平 '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 dike's length is forty-two meters, the dike's upper breadth is sixty-three meters, its lower breadth is 11.5 meters. The dike is made of huge rocks, topped with rectangular rocks stacked in a parallel layered fashion called "fish scale", the name coming from its appearance resembling the scales of a fish." (Translation by Xu Peiru)

Vessels were sailed, polled, oared, or hauled manually. To travel on the canal required barges and other canal boats to pass closely by the side-weir spillway where, at times, significant volumes of water were returned to the Xiang River. Passing by the *Feilei Shi* spillway was a particularly exciting event, as described by Zhou Qufei in *Ling Wai Dai Da* (Information on What is Beyond the Passes) from 1178 CE (Needham, 1971,page 213):



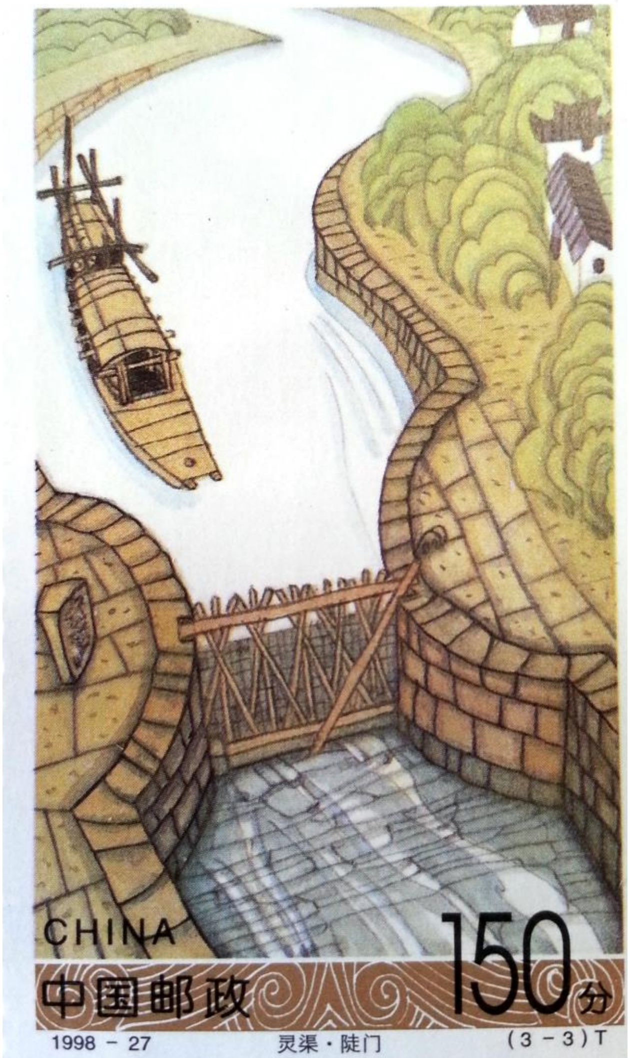
The first spillway as shown in the second of three 1998 PRC LIngqu

"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."

The canal's elevations are about 210 meters at its Xing'an origin and about 180 meters where it empties into the Li River, a vertical difference of about thirty meters, resulting in an average slope of less than one meter per kilometer.

According to Needham, the original canal had eighteen flash-lock gates (1971, p305) More than a thousand years later, travelers gave accounts of thirty-six gates controlling water flow, the doubling of the numbers strongly indicative of pound locks.

The flash lock, or "steep-gate", was another innovation incorporated into the original Língqú 灵渠 Magic Transport Canal. The "steep-gate"—a form of sluice gate—partially blocked the canal and was used to confine water, backing it up 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. Originally the "steep-gate" sluices were probably used as "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. Removing the diagonal key beam would collapse the gate, releasing the flow, with barges riding through on the surge of water. The surge past, upstream barges hauled through, the gate would be re-assembled in the slack water, and the upper reach would again fill. 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.



A "flash-lock" gate is illustrated in this, the third of three 1998 PRC LIngqu Canal commemorative stamps

Ramps may also have been employed, utilizing winches or human labor to pull barges over the dikes between differing elevations of the canal.

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 the river and the Bei Qu flowing north toward the Yangtze. The canal made it possible for barges and junks to move north, via river current, sailing, poling, and towing, from Guangzhou (Canton) on the South China Sea via the Pearl, Xi, and Li Rivers crossing the watershed over the saddle via the Língqú 灵渠 Magic Transport Canal and on to the Xiang River, down the Xiang to the Yangtze, down the Yangtze to the east, and thence north again via the Grand Canal to the Yellow River system and all the way to the administrative center at Beijing. And in the opposite direction, as well.

The Língqú 灵渠 Magic Transport Canal, damaged by flooding and deteriorated by neglect, fell into disrepair and was renovated many times over the centuries. But unlike the Grand Canal, which has been relocated, improved, remodeled and revamped countless times, much of the original design and materials of the original The Língqú 灵渠 Magic Transport Canal, remain in the present day. The most recent renovation, of the historic canal's first three kilometers, was completed in 2007, for the Xing'an Lingqu Dike Tourism Scenic Area (National Park).

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 them 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. Instead of a struggle against the current to open flash-lock gates, the gates at either end of pound-locks open easily, as there is no difference in water-level when the gates are operated. 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, there 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 CE, on the Grand Canal, more than 1,000 years after the establishment of the Língqú 灵渠 Magic Transport Canal, but some three hundred years prior to any such technology in Europe. The 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 CE [adapted from Needham, 1971, 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 let 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 CE Zhou Qufei record cited previously [Needham, 1971, 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 Zhou Qufei's apparent attribution of the pound-lock to the 219 BCE Língqú 灵渠 Magic Transport Canal engineer Shi Lu has thus far not been corroborated.

If not the first, the Língqú 灵渠 Magic Transport Canal, it is likely one of the first locations using the "pound lock", perhaps as early as the in the tenth century. The Chinese invention of the pound-lock was vital to the network of European canals that facilitated the industrial revolution, technology likely transmitted to Europe via silk-road traders, merchants, and/or ocean-going navigators of the day, as told by Hanson (p. 5).

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 Magic Transport Canal, where a change in elevation was necessary. Double slipways are 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—during times of drought, for example. 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. Indeed, the massive toil of human labor is what brought about the civil works underpinning all of Chinese civilization through the centuries, as it has for all civilizations (including America's 19th-century transcontinental railroad, build largely by Chinese labor).

Although no records of initial 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 CE) who put the greatest effort into expansion of the Grand Canal over six years of concentrated labor from 605 to 610 CE, 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 or disease, or were beaten to death by the overseers when they were not able to 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 laborers needed: shoals-men for dredging, lock-keepers to operate the locks, slipway-haulers, barge-pullers ("trackers") wherever needed, banks-men to nurture the trees and groundcover that stabilize the banks, beacon-men to mark out the channels, ponds-men to keep the reservoirs clean and deep, weir-adjusters to assure the water-flow is "balanced", and springs-men to keep water sources free from obstructions. Among the bureaucrats required: A director-general with superintendents for each section, secretaries to oversee the most difficult segments, commissioners to see that traffic runs smoothly, records-keepers to identify, certify, and document each boat and barge. 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, citizens were enlisted to assist with the movement of the barge traffic itself. Barge haulers, "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 barges and junks against the current or through rapids on the stretches where sails were impractical. Working almost naked, each strapped a towing board to a hawser (rope) 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 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 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 in 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.

Simon Winchester retells the story of a British merchant's 1898 struggle to get a "small teak steam launch" up the Yangtze through the Three Gorges to Chongqing, requiring the assistance of three hundred trackers to pull the vessel through the river's rapids (Winchester, 1996, p 257). Winchester also relates changes described by an elderly lifelong Yangtze River resident who said that "when he was a young man all the upstream boats would have been hauled by trackers, teams of naked men harnessed by bamboo hawsers and struggling along the broken shores or in the crouch-high galleries that ran along the cliff walls." (p267) Winchester also describes an outdated Three Gorges tourism brochure showing pictures:

> ". . . of nude men with well-muscled buttocks and backs, lashed together with braided ropes, bending in their scores to haul a ship up and over a raging whirlpool. Some were in the water, their skin glistening like silver. Others, with the bamboo-fiber ropes bent over their backs, hauled from on land, their feet clamped onto the rocks, their arms loose and their fingertips touching the earth, their heads low, their eyes staring fixedly at the ground. On board the ship, a trackers' master beat a drum, and one could almost hear the singing and the grunts as, foot by painful foot, the army of men drew the huge wooden vessel onward against the rushing might of the stream." (p279)

In his 1956 short novel ***A Single Pebble***, John Hersey (who spent his childhood in China) describes the lives of early-twentieth-century Yangtze-river trackers, headed by the book's protagonist, an unusually capable tracker who went by the name "Old Pebble". Pulling a freight-ladened junk upstream through rapids, the twenty-or so trackers who are part of the junk's crew, are joined by some three hundred temporary trackers at the biggest rapids:

> "I was watching the trackers. These laborers fascinated me, and I had the habit of sitting by the hour observing them, while they scrambled from rock to rock on the riverbank straining frightfully at their halters and dividing their heavy work evenly between them, or while they moved slowly, step by chanted step, along a level towing bund, or while they crept lynx-footed along a ledge on the wall of one of the gorges, hauling the clumsy junk against the powerful current. Their work

had a long tradition behind it, as the fluted places on obstructing boulders proved, across the rocks where tow ropes had dragged for so many centuries that they had warn grooves—stone filed away by braided bamboo! The trackers, doing the work of animals, sustained their hard hours by listening to antique melodies and fantasies which the head tracker constantly sang as he, too, tugged at the top end of the towline. They marked time for his songs with a repeated unison cry at the moment when all of them together planted each footstep: "Ayah!" . . . Ayah! . . ." This rhythmic work-cry had an indescribable poignant sound . . ."

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."

Boat Tracker Scene from *Third Sister Liu*

The classic 1960 Chinese film "Third Sister Liu", set some centuries in the mythical past, includes a brief scene depicting trackers hauling a sailing vessel up the Li River.

In 21st-century China, with the growth of highway and rail

Boat Tracker Memorial, Shennong Stream, China transportation, boat tracking has all but disappeared. Virtually all canal traffic is now motorized. Tracking currently exists (rarely) as performance for tourism, where it once flourished along Yangtze tributaries in the Three Gorges area, including the Shennong Stream (神农溪), Badong County. Many vestiges of the practice—including towpaths, some cut into rock cliffs, and rope scars—remain visible in China river and canal landscapes.

Summit-Canals

Summit-crossing canal technology first appeared in China, originated in China, and was invented by the Chinese. It was pioneered by Shi Lu's Lingqu, and then applied to the Grand Canal's connection between the Yellow and Huai rivers.

The technology originating in these Chinese canals was taken to Europe in the later Middle Ages, probably by traders and travelers such as Marco Polo or the great Chinese admiral Zheng He. Or perhaps via the Silk Road which went through Qin Shi Huang's old capitol Xi'an. Xi'an is and has been for centuries, a bustling city with canals on the Hwang Ho, China's Yellow River, upstream from the Grand Canal.

Marco Polo, a native of Venice, was certainly familiar with canals. Marco Polo provided Europeans with superlative descriptions of Chinese canals, especially those he visited and may have travelled on in the vicinity of Hangzhou, in the 13th century.

Applied to European rivers and landscapes, Chinese technology spread, and was incorporated into--and thus enabled—the waterworks that became known collectively as the "Canal Age", providing the transportation network necessary for the Industrial Revolution, the industrialization that created our modern world.

The construction, operation, and maintenance of summit transportation canals are extremely expensive in both labor and capital. Summit canals are worth the expenditures if and when they greatly reduce the costs of transportation; with the addition of flood-control and irrigation benefits, if any. In addition, prerequisites for such a huge investments, are powerful governments and social stability. The Lingqu, built for military and commodity shipment, led the way, conceptually, for transportation canals built and operated to facilitate the movement of bulk commodities—principally iron ore and coal—that facilitated the industrial revolution.

It is no coincidence that a majority (19 of 29) of the world's summit-crossing transportation canals—all built using Lingqu technology—were constructed during the industrial revolution, generally specified as the eighty years between 1760 and 1840. Only four were built prior. They were used to carry the bulk commodities that went into the production of steel, namely coal and iron ore, which were made into the inventions and manufactures of the industrial revolution,

Thus, in the magic of the Lingqu and its immediate environment can be found the early seeds of industrial revolution, the portent of our modern world.

<u>Summit Transportation Canals of the World</u> (Compiled from Wikipedia)

<u>Canal, (Location, Completion Year)); Length; Summit Elevation</u>

Lingqu Magic Transport Canal (China, 214 BCE) 36km, 210 meters

Grand Canal (China, 609 CE) 1,776 km; 42 meters

Canal de Braire (France, 1642) 57 km; 110 meters

Canal du Midi (France, 1681) 240 km; 190 meters

Newry Canal (N. Ireland, 1741, abandoned since 1949) 47 km; 24 meters

Leeds and Liverpool Canal (England, 1774) 204km; 148 meters

Trent and Mersey Canal (England, 1777) 150 km; 124 meters

Thames and Severn Canal (England, 1789) 46 km; 110 meters

Forth and Clyde Canal Scotland, 1790) 56 km; 46 meters

Oxford Canal (England, 1790) 126 km; 120 meters

Canal du Centre (France, 1792) 112 km; 304 meters

Crinan Canal (Scotland, 1801) 14 km, 20 meters

Rochdale Canal (England, 1804) 51 km; 180 meters

Grand Union Canal (England, 1805, numerous links and dates) 221 km, 120 meters

Kennet and Avon Canal (England, 1810) 140 km; 140 meters

Huddersfield Narrow Canal (England, 1811) 32 km; 196 meters

Caledonian Canal (Scotland, 1822) 100 km; 33 meters

Erie Canal (USA, 1825) 565 km; 174 meters

Morris Canal (USA, 1829, closed since 1924) 172 km; 279 meters

Göta Canal (Sweden, 1832) 190 km; 92 meters

Rideau Canal (Canada, 1832) 202 km; 123 meters

Canal du Rhône au Rhin (France, 1833) 237 km; 340 meters

[Ludwig Canal (Germany, 1840, replaced by Main-Danube Canal) 171 km; 406 meters]

Canal de l'Oise à l'Aisne (France. 1890) 48 km; 65 meters

Kiel Canal (Germany, 1895) 98 km; 161 meters

Augustów Canal (Poland, 1839) 101 km; 54 meters

Panama Canal (Panama, 1914) 82 km; 26 meters

White Sea–Baltic Canal (Russia, 1933) 227 km; 102 meters

Volga–Baltic Waterway (Russia, 1964) 368 km; 113 meters

Main-Danube Canal (Germany, 1992) 171 km; 406 meters

Main-Danube Canal

A summit-canal across Europe, connecting the Atlantic Ocean with the Black Sea, attempted three times, was successfully completed in 1992. The route attaches the Main and Rhine river waters flowing north to the Atlantic with the Danube River waters flowing south to the Black Sea using a summit-level canal through mountain passes near Nurnberg Germany. The general concept is the same as pioneered by China's Lingqu Magic Canal. The original idea, the *Fosa Carolina*, was built under Charlemagne during the 8^{th} century CE and soon abandoned. A second attempt, the *Ludwig Donau Main Kanal* built under Bavaria's King Ludwig of Bavaria between 1836 and 1846, was too narrow and shallow to carry much.

Following significant damage from the World Wars, it was abandoned in 1950. The completed canal, the Rhine-Main-Danube Canal (also known as the RMD, the Main-Danube Canal or Europa Canal) is 171 kilometers in length, 4 meters deep, crosses its summit at 406 meters elevation (almost twice the Lingqu's 214-meter summit elevation), contains 16 locks, and uses waters from the Lech, Altmühl, and Regnitz Rivers in addition to the headwaters of the Main and Danube. Water conservation is a major concern: the canal incorporates a summit impoundment, an artificial lake for additional storage, side-tanks at the locks, and significant pumping to re-use water within the canal. The cultural impact of the Main-Danube Canal is reminiscent of the changes brought by the Lingqu—the European Union was established in 1993, one year following the completion of the Main-Danube Canal.

Panama Canal

The most famous of the world's summit canals is the Panama Canal which crosses Central America connecting the Atlantic and Pacific Oceans, completed in 1914. The Panama Canal crosses a summit of 26 meters over its 82-kilometer length, presently with a minimum depth of about 15 meters and a width of about 49 meters. The Panama Canal also employs the summit-canal concept pioneered by the Lingqu, using the waters of artificial lakes to supply six locks, three up and three down in each direction.

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 BCE until 210 B.C, brought tremendous cultural and intellectual growth, but much tyranny and destruction. In addition to the Língqú 灵渠 Magic Transport 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 principal beneficiaries of all that the Qin had built. The Han maintained power and territory for more than four hundred 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 eEmperor) could master nature [Marks, p. 27].

Over the centuries, the Língqú 灵渠 Magic Transport 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 the point of almost 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.

Língqú 灵渠 Magic Transport Canal along Water Street in Xing'an, 2013. *(Author's photo)*

The Lingqu Canal has been relatively unknown until the last several decades, although it should be famous as one of the premier World Cultural Heritage Sites.

In his book ***Canals*** (1959)**,** for example, Fon Boardman offers many details on early Mesopotamian, Greek, and Egyptian canals, mentioning the Lingqu only in part of one sentence, "In 215 B.C. the Ling Ch'u canal was finished, ..."

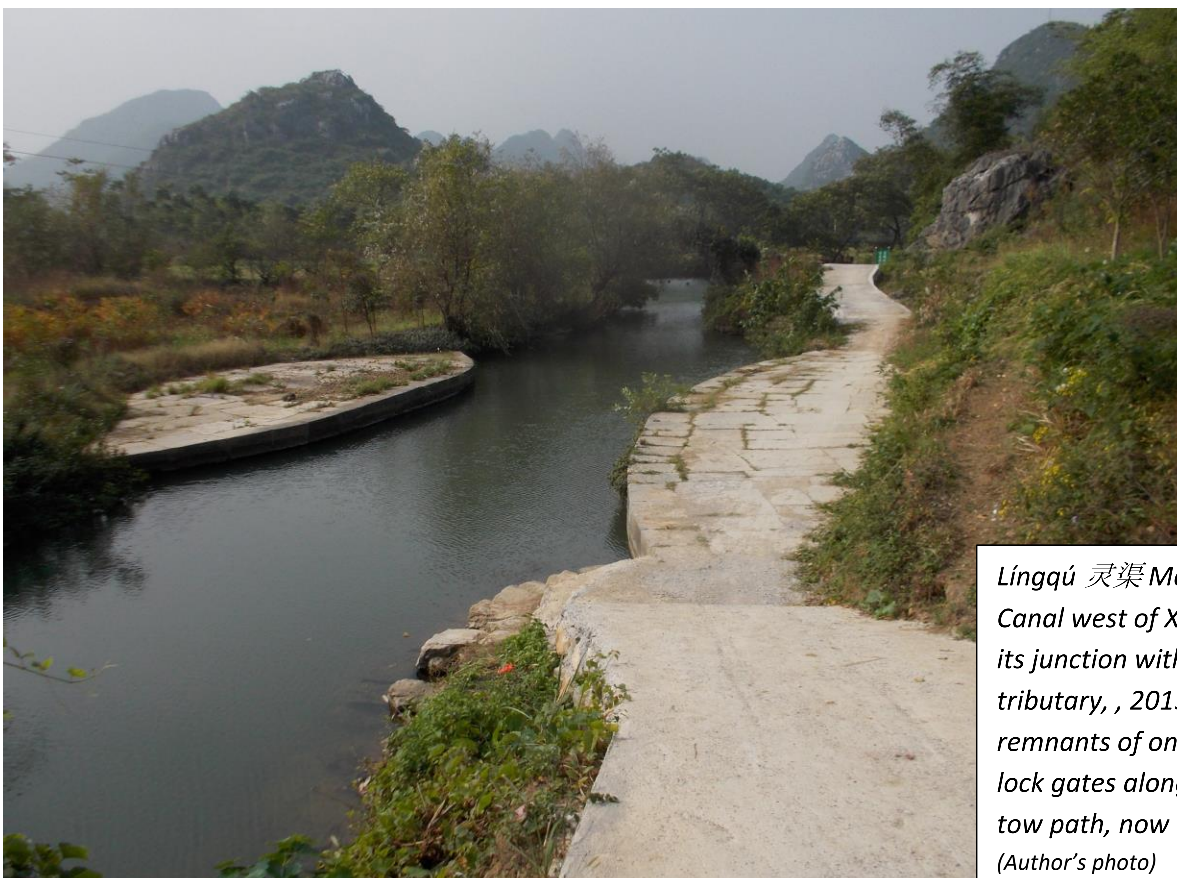
In Charles Hadfield's 430-page ***World Canals: Inland Navigation Past and Present*** (1986), the only mention of the Lingqu is on page 23—two sentences—"In 219 BC came the 'Magic Canal' built in Guangxi. Linking the upper reaches of two rivers by way of an interconnecting saddle, it is the oldest contour transport canal known,"' Hadfield also gives a nod to Chinese "strong central government that could maintain a consistent development policy; competent administrators and technically advanced engineers."

The 4,640-page UNESCO ***History of Humanity*** (published in seven volumes, 1994-2008) contains brief descriptions of ancient waterworks for agricultural irrigation, and flood control, but little on canal transportation and no mention of the Lingqu.

In Jonathan Fenby's ***The Seventy Wonders of China*** **(**2007), the Lingqu is completely omitted.

The American) National Geographic's 656-page compendium ***Ultimate Visual History of the World*** (2021), states only that during the classical age of China "Work was also begun on a national road network and an extension of existing canals." (p. 245).

So, what is the significance of the innovations first manifest in the Língqú 灵渠 Magic Transport Canal? We do not 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, manufactured products, and passengers, we forget that canals were the miracle transportation technologies for hundreds of years. The Língqú 灵渠 Magic Transport 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). (For more information on the Língqú 灵渠 Magic Transport Canal's UNESCO submission, please see https://whc.unesco.org/en/tentativelists/5814/).



Língqú 灵渠 Magic Transport Canal west of Xing'an near its junction with the Li River tributary, , 2013, showing remnants of one of the 35 lock gates along with the tow path, now a bicycle path. *(Author's photo)*

Like most canals, the Língqú 灵渠 Magic Transport 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 comprehensive renovation, done primarily for preservation of the historical resource, was completed in April 2007. Renovations and repairs continue, under the auspices of the Xing'an Lingqu Dike Tourism Scenic Area.

And through all the repairs and renovations the essentials of the Língqú 灵渠 Magic Transport Canal remain. The original third- century-BCE 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 Magic Transport Canal remains the foremost lasting monument to Shi Huangdi, ancient unification among the warring states, and the creation of China. It is one of the most important ancient landmarks in the history of world civilization.

The Língqú 灵渠 Magic Transport Canal Memorial in Xing'an.

The present-day town of Xing'an, fifty or so kilometers north of Guilin, is the home of the, the Lingqu Canal Scenic Area, a national-level AAAA scenic site (and UNESCO tentative World Heritage Site). The tourist-and-education area includes preservation of the canal's ancient headwater technologies, a new museum, and the first few kilometers of the canal, flowing slowly west through Xing'an's Water Street. Water Street is an ancient-replica commercial zone, where the clear waters of the Xiang River are used to wash vegetables.

(Author's photo)

About two kilometers west of Water Street is a memorial to the designers and builders of the Língqú 灵渠 Magic Transport Canal, The memorial is a large sculpture depicting many of the labors and laborers that created the canal, all overseen by China's First Emperor himself, Shi Huangdi. It was ***Shi Huangdi*** who ordered the canal's construction and used the canal to "unify" China, sending troops and supplies south to conquer the Yue peoples of the Pearl River valley and delta.

Preserving the Cultural Heritage Site of the Língqú 灵渠 Magic Transport Canal

China's Grand Canal has been recognized and listed as a World Heritage Site only recently by the United Nations Education, Scientific and Cultural Organization (UNESCO)—in 2016. The at least equally-significant Língqú 灵渠 Magic Transport Canal has languished on the UNESCO "Tentative List" since 2013. Despite the commemorative statuary in Xing'an, the three kilometers of the canal preserved in a National Park ("Lingqu Canal Scenic Spot"), Xing'an's thriving Water Street's traditional canal-side marketplace, and the critical importance of the canal in Chinese and World history, the Língqú 灵渠 Magic Transport Canal, is not well known. More famous internationally are the Great Wall and the Terra-cotta Warriors (both works by the builder of the Língqú 灵渠 Magic Transport Canal, China's first emperor, ***Shi Huangdi.*** The town of Xing'an is actually more famous, in Chima, as the location of "Merryland", a popular theme park with a golf course.

The importance of China's Grand Canal has also been largely overlooked until recently. It has taken some time and effort to transform the Grand Canal, in Hangzhou, from "an old piece of infrastructure" into "an officially recognized cultural heritage site", as Shu-wei Tsai points out in a year 2020 University of California Berkeley PhD dissertation. Tsai calls the transformation "heritagization", beyond mere heritage preservation, as a city develops new social and cultural aspirations and experiences from exploring and embracing the past. The same transformation is needed in Xing'an. Heritage resources—the Língqú 灵渠 Magic Transport Canal and its associated landscapes—could be a focus of worldwide recognition, as well as the basis of much greater tourism and educational development.

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