

## **Chinese Technology** (Techniques, Methods, Equipment)

**Introduction** Chinese society created a stable, high-functioning and integrated economy in the bronze and iron ages. As was true of all early societies, its foundation was a thriving and well-managed agricultural sector. Farming sustained massive populations, provided a reliable basis for taxation and enjoyed domestic micro-economic trading zones. It produced excess in most years, which allowed for large segments of society to specialize in sectors other than farming. Chinese growers were extremely capable and worked in concert with the government to build and manage infrastructure projects that all used to their advantage and in which all took great pride. Even though ancient and post-classical Chinese dynasties occupied a geographic space that encompassed half the territory of contemporary China, the sheer size and scope of the world's largest population worked as an advantage most of the time. When unified and well-led, the Chinese economy was a powerhouse and dwarfed all nations around it. When economic fortunes reversed, however, that same population suffered on a similarly grand scale. For most of Chinese history, other East Asian peoples watched the Chinese economy carefully and traded on terms that emperors dictated. At the beginning of the 19<sup>th</sup> century, however, conditions changed worldwide and China entered a 150 year period of economic contraction and humiliation. It had missed the industrial revolution. For much of that time, hunger was a specter haunting large segments of the population. In the past four decades, the Chinese economy has expanded dramatically. Hunger has been vanquished and China has reclaimed its place among the economic giants of the world. Though not wealthy on a per-capita basis, China's emerging middle class alone (approximately 400 million people) dwarfs the entire population of every other nation except India. The future looks bright.

### **PREHISTORY—The Neolithic age (10,000 BCE-2000 BCE)**

**Hunting and Gathering** Neolithic era Chinese did not engage in agriculture early in the period. They gathered berries, roots, nuts, and other readily available foodstuffs based on the season. Chestnuts, in particular, have been found in archaeological digs. These and other such items could be stored to help them get through a winter that was longer and colder (as the last glaciers melted) for most of the period than is the case today. In addition to foodstuffs that could be gathered, hunting provided the protein needed to sustain most of the population. Early in the period, large game such as bear, deer, and wild boar were regular food items for inland people groups. For groups near to the coast and to fresh water sources, fishing was the primary source of protein. Later in the period, smaller game such as squirrels, rabbits, and birds of all varieties were trapped and/or hunted.

**Agriculture and Rice.** In the middle and late neolithic periods, Chinese society began the most important transformation in its history: the adoption of agriculture and animal husbandry. It is hard to overstate the importance of wet rice cultivation because it revolutionized the early culture of the lower Yangzi River valley and then went on to become the single most important staple for the majority of humanity. There is no universal consensus among scholars on the genesis of rice cultivation. Some scholars argue for southeast Asia, some argue for south Asia and still others the Yangzi River valley. Indeed, it has become a point of national pride to find evidence of the first cultivation. Regardless, in a 5000 year period between the 10<sup>th</sup> and 5<sup>th</sup> millennium BCE, rice shifted from growing wild in the Yangzi River valley to being cultivated by humans. This event had monumental effects for human settlements. Instead of moving from time to time when seasons changed or when resources dwindled, neolithic Chinese shifted to live long-term in settlements and villages, some of which grew quite large. Society was ordered around the cultivation, storage, distribution and protection of this most important foodstuff. When successfully implemented, rice cultivation provided a stable, reliable source of excess calories, which in turn allowed for population increases. A larger population required more social structure, the careful control of resources and the development of local government. Human dwellings had to be fairly close to rice paddies, water and irrigation infrastructure, but higher and far enough away from water to avoid the danger of occasional flooding. Village dwellings were also grouped around rice storage buildings so that they could be controlled and protected and food easily distributed. Villagers had to learn how to get along with those who were not necessarily members of the same family or clan.

**Millet.** For northern China, millet became one of the most important early important crops. It grew wild in north China in the early neolithic period and was among the first grains to be domesticated. Residue found in archaeological digs indicate that it existed as early as 6500 BCE in the Yangshao culture (located at the intersection of the Wei River Valley at the bend of the Yellow River).

**Animals.** Animal husbandry also emerged during the late neolithic period. Humans domesticated wild boar, giving us the pigs we know today. Wild chickens, though likely not native to China, were domesticated and appear in the archaeological record in China as early as 5400 BCE. Cows, horses and oxen provided milk, cheese, protein, labor and transportation. Dogs sounded the alarm when enemies approached and fought off predators near settlements.

**Technology.** In order to cultivate rice, paddies had to be created. Paddies had to be flooded during the transplantation stage of development for a period of several weeks. This required the landscape to be transformed as well because paddies must be relatively flat and ringed by small dykes, a condition that does not exist in a state of nature. Shovels, hoes and other earth moving tools were necessary to prepare the land. Canals, ditches and other irrigation infrastructure had to be tied in to rivers and creeks. Finally, sluice gates and a drainage mechanism had to be in place in order to remove water from the paddies at the appropriate time. Millstones helped grind hard to digest whole grain millet and other grains. In short, wet rice agriculture created the conditions which placed a premium on the development of tools, weapons and other implements that facilitated farming, storage and fighting. Those cultures that produced artisans who could cast bronze, and later iron, were able to out compete their neighbors. The slow abandonment of stone and wooden implements and the adoption of metal tools brought humanity new models for society and civilization.

### **BRONZE AGE (2000 BCE-600 BCE)**

**Agriculture.** The economy of Bronze Age China was largely agrarian. Many peasants were serfs or subsistence farmers and barely grew enough food to pay their taxes and survive from season to season. Unlike some of the other Bronze Age cultures, bronze implements were slow to be introduced into the daily life of peasants (and equally slow to be used for military purposes). The reason for this is unknown. Nonetheless, some bronze tools have been unearthed in archaeological sites. This indicates that though peasants were able to scratch a living out of the earth, their ability to produce food in excess was likely limited.

**Diet.** In contrast to conventional wisdom, the Chinese diet in the early and middle Bronze Age was not based only on rice. Instead, crops more suited to cultivation on the north China plain were grown including millet, early varieties of wheat, hemp, barely and the like. There is also evidence of the consumption of livestock such as pork and beef. In the southern areas of China where moisture is much more abundant, wet rice agriculture was in use as early as the 4500 BCE. However, it was not introduced into northern China until the late Shang period. Wet rice agriculture is very labor intensive, but good producers were able to grow more than was necessary for consumption by one family. Calories were therefore beginning to be produced in excess in the late Bronze Age, allowing for additional members of society to specialize in pursuits other than agriculture and for a rise in population. As a result, cities grew dramatically larger and more important. Vestiges of pre-wet rice agriculture can be seen in the regional cuisine of contemporary China. For example, the cuisine of north China still shows evidence of more reliance on grains other than rice.

### **IRON AGE (1000 BCE-500 CE)**

**Technology.** The economy of Iron Age China was largely agrarian. That is not to say that there were not advances in technology which made the lives of working peasants, artisans and laborers much more productive than their ancestors. Indeed, the Chinese economy benefited immensely from the shift from Bronze Age technology to Iron Age technology. Iron implements made possible the expansion of agriculture into marginal lands which had previously not been under cultivation. It was possible in the late Warring Kingdoms period (475 BCE-221 BCE) for your average peasant to possess iron hoes, scythes, plows, axes and more, all of which were utilized in agriculture. Iron was also used in carts used to transport goods and in yokes to harness oxen both on the roads and in the fields. In addition, iron was used for shovels to dig irrigation ditches, in dredging equipment and the like. Finally, iron cooking utensils became widespread during the Iron Age. Because of advances in agriculture, populations increased dramatically. There were also more people shifting from subsistence farming to other endeavors where they were allowed to specialize in skilled professions and become masons, smithies, farriers, carpenters, coopers, and the like. Others became educators, philosophers, clergy, accountants, bookkeepers and bureaucrats. Still others were dedicated to the art of war and became fletchers, swordsmiths, bowmen, professional soldiers, foundrymen, etc. Many of these professions had existed in the Bronze Age, but in much smaller numbers. Their proliferation in the Iron Age made possible the classical age of human history.

## POST-CLASSICAL PERIOD (500 CE-1500 CE)

**Grand Engineering Projects .** In post-classical China, the Sui (589-618) and Tang (618-907) Dynasties are well known for supporting massive and important infrastructure projects. Some, such as the Grand Canal reshaped the economy of China. The Grand Canal ran north to south linking several major river systems, the Qiantang River near Hangzhou in the south, Yangtze River a little further north, the Yellow River in Shandong province and finally the Hai River near Beijing in the north. It spans 6 modern provinces and is more than 1100 miles long, the longest man made river in the world. Portions of it are still in use today for transporting commerce. The Grand Canal was so important to the economy of China for more than a thousand years and was such a monumental feat of engineering in the post-classical world that it has been designated a UNESCO World Heritage by the United Nations alongside such sites as the Great Pyramids of Egypt, the Acropolis in Greece and the Forbidden City. This waterway was so important that if it silted over, which it did from time to time after Yellow River floods, emperors are well known for throwing enormous resources at dredging projects for fear of losing the Mandate of Heaven. In time of war, disabling the Grand Canal which your enemy was using to transport supplies could lead to victory. This project was started in antiquity, but was completed under the Sui. It is one of the reasons that the economy under the Tang grew so fast and was so strong.

**Technology.** The southern areas of post-classical China produced far more rice and other food stuffs than could be consumed in the region. This was facilitated because the crown supported the dispersal of knowledge of advances in agriculture such as crop and field rotation, the use of fertilizers and the like. Irrigation and flood control projects both in the south and the north were high priorities. The Tang are known for rebuilding the system of roads that had been left to decay since antiquity. In addition, the Tang took seriously the problem of security and sought to end enduring problems with banditry and the like. They built post-stations along the most important roads and waterways to maintain law and order. The basis for taxation was land and not goods produced on the land. This simplified the tax system and made land-owners, not peasants, largely responsible to the authorities. All of these things contributed to a thriving economy.

## EARLY MODERN PERIOD (1500-1800 CE)

**Agriculture.** The economy of early modern China functioned very well in the reign of the Emperor Kangxi (1667-1722) and early in the reign of the Emperor Qianlong (1735-1796). There was a well-established system with peasants and agriculture being the engine of the economy and there was a high-functioning administrative class. Advances in infrastructure in the early Ming period (1368-1644) and the will to maintain engineering marvels such as the Grand Canal and the Yellow River dikes meant that irrigation and the transportation of bulk commodities by barge were available to facilitate agricultural and economic development. Advances in rice production were significant and the economy grew quickly. Indeed it was transformed in other ways as well. The early modern period saw the importation of important food stuffs from the new world: potatoes, peanuts and corn via the Spanish-controlled Philippines. Many of these food-stuffs were grown in soil that was not conducive to the growing of rice or other traditional Chinese foods. This had the effect of bringing marginal land under cultivation. These calorie-rich items allowed the Chinese population to explode. I might add that these newly productive fields could also be taxed as well. By the end of the reign of the Emperor Qianlong, the population of China had risen to approximately 300 million. Of course, it also freed increasingly larger percentages of the population from subsistence farming and allowed for increased specialization in the economy.

**Technology and Industry.** In order to meet world demand for fine porcelain, small producers ramped up production dramatically. Whereas in earlier periods very small cottage-industries had been sufficient to meet demand, these were greatly expanded in the 18<sup>th</sup> century. Large factories began to be built which harnessed the power of the waterwheel and other forms of energy. Advances in metallurgy made gears and pulleys stronger and more durable, allowing for the production process to dominate entire villages. Though the Chinese were not among the world leaders in the development of the steam engine, they were producing on a massive scale. It is clear that the Chinese economy in the 18<sup>th</sup> century was undergoing a fundamental change which can best be described as early industrialization.

## The 19<sup>th</sup> CENTURY

**Technology and Agriculture.** In the early decades of the 19<sup>th</sup> century, agriculture continued to advance. The Chinese economy was showing signs of early industrialization. Rapid advances in technology applied to the agricultural sector resulted in reliable sources of excess calories for many years. Rice, wheat and other grains allowed the population to increase rapidly. Much of the land, however, was under stress from over-farming and there simply wasn't enough additional land not under cultivation which could be made productive. In other words, Chinese agriculture reached a high point in the first decades of the 19<sup>th</sup> century. The horrors of the Taiping Rebellion (1850-1864) changed the agricultural dynamic dramatically. First, much of the most productive agricultural land in China (in the Yangtze River Valley) was the sight of some of the fiercest fighting. Second, other areas that were under the actual control of the Taiping could not contribute excess food stuffs. Third, several catastrophic floods, primarily along the Yellow River, created an environment in which there was a deficit in calories. Indeed, there was widespread hunger in the immediate post-Taiping years. In the last decades of the 19<sup>th</sup> century, agriculture suffered from the myriad of miseries that accompanied the slow devolution of government: banditry, excessive and arbitrary taxation, breakdown of irrigation and transportation infrastructure and the general lack of government support. Nonetheless, the peasantry continued to do fairly well on a micro-level unless that was a localized drought or flood. Somehow, the population continued to grow.

## Early 20<sup>th</sup> CENTURY (1900-1950)

**Agriculture.** The Chinese system of agriculture had suffered from decades of neglect by the turn of the 20<sup>th</sup> century. Essential infrastructure had not been maintained. Irrigation systems and flood control, in particular, were in serious disrepair. Many Chinese peasants were just getting by season to season. Any small disruption in the annual cycle yielded hardship and hunger. The threat of famine was persistent for the peasantry. China could often not feed itself. During the warlord era (the late teens and much of the 20s), there was no law and order and taxes were extracted at a high rate and at arbitrary times. During the decade of Guomindang rule, conditions moderated in some areas and some advances in agriculture were possible. But in other areas there was famine.

**Technology.** It would be accurate to say that there were real advances in agriculture in China in some areas during the first half of the 20<sup>th</sup> century. In particular, a number of schools opened with the express purpose of teaching new techniques and of applying new technology. Some, such as China Agricultural University (founded in 1905), Nanjing Agricultural University (founded in 1914) and Anhui Agricultural University (founded in 1928), became quite influential and promoted advances in wet-rice agriculture, animal husbandry and dry-land farming. Indeed, these institutions survived the ravages of civil war, foreign invasion and the Cultural Revolution—and still exist today. Nonetheless, China didn't become reliably self-sufficient in agriculture until after the Cultural Revolution.

## Late 20<sup>th</sup> Century

**The Great Leap Forward.** In 1958, Mao had grown frustrated with China's efforts at rapid industrialization. He wanted faster, exponential growth. The CCP then adopted an extremely ambitious plan known as the Great Leap Forward. In this 5-year plan, the Chinese were to create heavy industry on a massive scale. They were to do this by applying all of China's considerable revolutionary energy to the task. It would become the sacred duty of all Chinese to implement the plan. China's leadership hoped to catch up with the Soviet Union by 1962 in the production of the most important element of industrialization: steel. Factories were to be built wherever possible. Raw materials were to be provided on a massive scale by the state to factories. And workers were removed from agricultural production and put to work in the steel mills. Where it was not possible to build a factory, hard-core workers still felt it was their duty to produce steel. This led to bizarre efforts up to and including back-yard cauldrons being employed in the production of severely sub-standard and unsafe steel. Much of the steel produced during this period was worthless. But they met their quota. In addition, the Great Leap Forward also required society to be completely communized. Communal kitchens were provided for workers and families, and child care was provided. In theory, this freed women, retired workers, older children and all members of society to also engage in productive labor for the state. Many went out into the fields to farm or did jobs not suited to their capabilities. As might be expected, shortages in agriculture began to appear. But the government had moved emergency granary supplies to areas not affected by the lack of food. Serious hunger and malnutrition began to be felt as early as 1959. Soon thereafter, there was a famine unlike anything seen in China for a century. In the

famines associated with the Great Leap Forward, approximately 20 million people starved. Mao's attempt at social and economic engineering had proved a catastrophic failure.

**Technology.** In the period beginning with Deng Xiaoping's economic liberalization in the late 1970s, vast transfers of technology took place. The Chinese government first began the very expensive process of sending vast numbers of students abroad to study in the world's finest universities. After returning, Chinese scientists and engineers began to work for the government and also entered the emerging private sector. As more and more multi-national conglomerates relocated manufacturing to China in the 1980s, consumer electronics and the technological know-how that accompanied this process, created the conditions for the rapid development of the Chinese electronics industry. Now, domestic Chinese industrial giants such as Huawei, Lenovo, Tencent and China Aerospace Science and Technology are among the most dynamic and influential in the worldwide tech industry. Though the most cutting-edge technological discoveries still often take place elsewhere, Chinese technology and knowledge industries are poised to take their place as peers among other nations.

### **Readings**

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