

中 国 传 统 文 化 双 语 读 本

Four Great Inventions

# 四大发明

教育部基础教育课程教材发展中心编

◎中文 王 毅

◎英文 柯文礼





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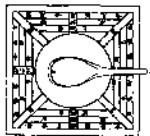
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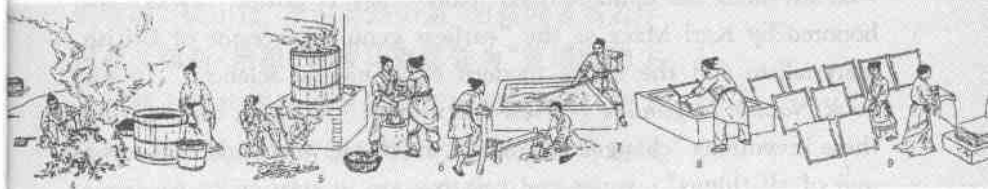
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## 四大发明



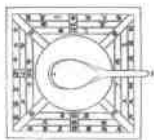
Four Great Inventions

When it comes to scientific and technological achievements made in ancient China, we first think of the "Four Great Inventions"—papermaking technology, the art of printing, the compass and gunpowder, which played an immeasurable role in the history of mankind. Francis Bacon, the famous British philosopher, who advanced his opinion that "Knowledge is power", was once honored by Karl Marx as the "earliest genuine ancestor of British materialism and the entire modern experimental science." In his book *Novum Organum* ("New Instrument"), Bacon believes that these inventions "changed the face of the whole world and the *status quo* of all things": paper and printing are in relation to academic pursuit, gunpowder to the war, and the compass to navigation. In his book *Application of Machines, Physical Power and Science*, Karl Marx also points out "Gunpowder, the compass and printing are the three inventions that heralded the advent of the bourgeois society. Gunpowder blew up the cavalier stratum to pieces in its explosion, the compass opened the world market and paved the way for the establishment of colonies, and printing became the tool of Protestants. In short, they became the means of scientific rejuvenation, and the most powerful lever that created the prerequisites for spiritual development."

The Four Great Inventions are the everlasting pride of the Chinese nation. But how were the inventions made? How clever, lucky, and marvelous those people were who made the inventions! But what we should know more is that these inventions were successfully made only when certain conditions and necessities were available. These inventions did not come because of the sudden

谈到中国古代的科技成就,我们首先想到的就是“四大发明”。造纸术、印刷术、指南针、火药这“四大发明”,在人类历史上产生的作用是无法估量的。提出过“知识就是力量”的英国著名哲学家弗兰西斯·培根,曾被马克思誉为“英国唯物主义和整个现代实验科学的真正始祖”,他在《新工具》一书中就认为这些发明“改变了全世界的面貌和一切事物的状态”:纸和印刷术是在学术方面,火药是在战争方面,指南针则是在航海方面。马克思本人在《机器、自然力和科学的应用》中也指出:“火药、指南针、印刷术,这是预告资产阶级社会到来的三大发明。火药把骑士阶层炸得粉碎,指南针打开了世界市场并建立了殖民地,而印刷术则变成了新教的工具,总的来说,变成科学复兴的手段,变成对精神发展创造必要前提的最强大的杠杆。”

四大发明,是中华民族永远的骄傲。然而,它们是怎样发明出来的?把它们发明出来的那些人多么聪明、多么幸运、多么了不起啊!但是,我们更应该知道的是:它们之所以能够被发明出来,是具备了一定的条件和必然性。它们并不是一些天





impulse and pure contingency of some talents or exceptional personages. In essence, these inventions were a gradual process, a demonstration of the collective wisdom and talent of a national group, and an outcome facilitated by the specific demand of a society or an age. In this way they came to pass and gradually developed from an embryonic stage to maturity, the way a small tree steadily grows to full size. There is no imagining that out of nothing and in the final form, a certain person at a certain place and on a certain day suddenly made paper, printed the book, made available gunpowder that was flammable or could explode, and invented the compass that pointed to the magnetic north for people in a magic way. Herein are imbedded many interesting stories and particulars.

才或者特殊人物灵机一动、纯粹偶然地发明了出来。在本质上,这些发明都是一个渐进的过程,是一个民族群体的智慧和才华的显示,是一个社会、一个时代的特定要求所促成的,这样它们才能够被发明,并从萌芽状态逐渐生长成熟,就如同小树逐渐长大成材一样。我们不可能设想,某一天,某个地方,某个人,突然就无中生有地、一锤定音式地造出来了纸、印出来了书、有了可以燃烧或者是爆炸的火药、用指南针神奇地给人们指出了方向。这里面有不少有趣的细节和故事。



# I. From Tortoise Shells to “Marquis Cai’s Paper”

## 1. Information Dissemination and Writing Media

It is generally agreed that we are now in an information age, yet such major inventions can be found in the mode of human’s intelligence transmission, if counted in accordance with the rough sequence of man’s evolution and the development of his ability. The first invention is language, which seems to be the most natural thing, but in no circumstances should it be made light of. Should primitive humans have failed to invent the mode of disseminating information with sound instantaneously and within a short distance, nothing could be mentioned about all that followed. The second invention is writing, which recorded language and thought. What was recorded could be kept, and disseminated beyond time and space, and the fatal drawback of language that disappeared instantly without the availability of a recorder could be overcome.

Then followed the paper. Where could literal information find a settled place without any writing media? Of course, such media could be clay tablets from the palisades, tortoise shells and animal bones, metals, leathers or silks. But the cheapest and finest, and the handiest for use were sheets of paper, which truly enabled written messages to be stored in huge quantity and disseminated on a large scale. Following the invention of paper came printing technology. The appearance of printing enabled writing to turn from a time-and-energy-consuming and low – efficient manual job to a scale operation or even a mechanized operation, thus both heightening the exactitude of disseminating information and greatly

## 一、从甲骨到“蔡侯纸”

### 1. 信息传播与书写材料

大家都说,我们现在已经是处在一个信息时代里,然而,按照人类进化和能力发展的大致顺序来数一数,我们人类信息传递方式有这样一些重大的发明。首先是语言,它似乎是最为自然的东西,但千万不要小看了它,如果原始人类没有发明出这种瞬时间短距离的以声音来传播信息的方式,后面的一切都无从谈起。其次是文字,它把语言和思想记录下来,可以保存,可以做一种超时空的传播,克服了在没有录音机的情况下语言转瞬即逝的致命弱点。

接下来就是纸了。没有书写材料的话,文字信息在什么东西上安身呢?当然,这种东西可以是岩壁泥板,可以是龟甲兽骨,也可以是金属、皮革或者是丝帛。但是,最物美价廉、最方便好用的却是纸张,正是有了纸张,才真正使得文字信息能够大量保存和大范围传播。在纸张的发明之后就是印刷术。印刷术的出现使得文字的书写由费时费力、效率不高的手工转向了规模化乃至于机械化,既提高了传播文字信息的准确性,更大大



improving the efficiency of character writing.

The following items fall into the category of modern society: telecommunications—electrophone and radio telephone, telegram, television, movies, and satellite telecommunication networks, which enable writing, language, sound and image to transmit to a long distance and at a great speed; electronic computer and Internet—whose storage and processing of writing, language, sound and image and whose interactive and high-speed dissemination on a large scale and in a big area led to an information revolution.

If the invention of language and writing was the natural outcome of evolution and development of the various nations in different places of the world (of course, there are some nations and tribes that up to now have only language without writing), then the appearance of paper and printing perhaps did not come so naturally, for they required some other important causes and conditions. Now let us first see the process of the invention of papermaking technology.

As is mentioned above, after the invention of writing by mankind, media for recording the writing were required. We may even say that writing and the media for its recording must have appeared synchronically, only different nations chose media available in line with their local conditions. Egypt and Babylon were civilized ancient states in the world, where clay tablets were once used as writing media. Scholars from the Roman Empire on the Mediterranean Sea had used papyrus and sheepskin for writing. Rock, marble, iron, pottery, wood, wax and so on had been the early writing media of some nations in the world.

In the Yin-Shang Period (c. 16—11 centuries B. C.) in China, there were oracle bone inscriptions and inscriptions on ancient bronze objects, which were engraved on tortoise shells, animals bones and bronze objects. It can be easily imagined that their writing and use must have been quite inconvenient. From the Warring States Period (475—211 B. C.) to the Qin (221—206 B. C.) and Han (206 B. C. —



提高了文字书写的效率。

下面的这些东西就都属于现代社会了：电讯通讯——有线和无线电话、电报、电视、电影和卫星通讯网，使文字、语言、声音和图像长距离快速传播；电子计算机和互联网——对文字、语言和声音图像的存贮和处理，以及大规模、大范围的高速互动传播，导致信息革命。

如果说，语言和文字的发明，是世界各地各个民族进化发展较为自然的结果的话——当然，有些民族和部落直到今天也还是只有语言而没有文字；那么，纸张和印刷的出现，或许就不那么“自然而然”了，它们更需要一些其他的重要原因和条件。我们先来看看造纸术的发明过程。

前面已经说过，人类在发明文字之后，就需要有记载文字的材料，我们甚至可以说，文字和记载文字的材料必定是同步出现的，只是不同的民族因地制宜地选择了自己所能得到的材料。古埃及和巴比伦都是世界文明古国，它们曾经是用泥板来作书写材料；地中海沿岸罗马帝国的学者们曾经用埃及产的莎草片和羊皮板来书写，岩石、大理石、铁、陶器、木头、蜡等等，都曾是世界一些民族早期的书写材料。

在我们中国，殷商时期有甲骨文和钟鼎文，它们是刻在龟甲、兽骨和青铜器上面的，其书写和使用的不便可想而知。从战国到秦汉，这时的



A.D. 220) dynasties, writing media more easily available, greater in quantity and more convenient in use began to be applied—writing on bamboo slips, wooden tablets, and fine silks. Were these writing media, nevertheless, still quite clumsy, inconvenient and unpopular? In the Chinese language there are two idioms, *xue fu wu che* (meaning: to have read five cartloads of books—be very learned) and *wei bian san jue* (meaning: Confucius studied the *Book of Change* so much that the leather straps binding the bamboo strips wore out three times.). In those days, the books of bamboo strips a learned person read were so many that five carts were needed to contain them and the leather straps stringing the bamboo strips would break due to longtime wear. It can be imagined how cumbersome and inconvenient for use such writing media were. Fine silks and their kind had no such shortcomings and were called “paper” at that time in order to distinguish them from bamboo slips. As far as the meaning of the word is concerned, “paper” was originally meant to describe plant fibers as clean and white as natural silk, and their surface as smooth as whetstone. But such “paper” was small in quantity and its price was high, and therefore it was not an ideal writing medium.

## 2. Drift Wadding and Cai Lun's Making of Paper

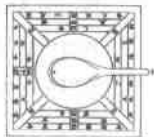
So it was that the appearance of paper was a revolution of writing media. Viewed from its source of technology, papermaking technology drew inspiration from the byproduct called “drift wadding” produced in the process of silkworm breeding and throwing. China was the earliest country in the world in making use of natural silk and, for a rather long time, the only country of its kind. In the ruins of Qianshanyang of Wuxing, Zhejiang Province of 5 thousand years or so ago was excavated a section of silk ribbon and a small piece of thin, tough silk, in addition to some ramie cloth. Raw silk can be reeled off from cocoons and pongee be woven



书写就开始使用一些更容易得到、数量更大、使用起来也更为方便的材料了——文字被书写在竹简、木牍、缣帛上。但是，这些书写材料不是仍然很笨重、很不方便、很不大众化吗？我们中国有两个成语，“学富五车”和“韦编三绝”，写在竹简上的书，竟然要用车来拉，而翻阅的时间一长，串起一根根竹简的皮绳也会磨损而断，可以想象，这样的书写材料是如何笨重、如何不便于使用了。缣帛之类的东西，没有这样的缺点，它们当时就被叫作“纸”，以区别于竹简。就字义而言，“纸”的本意就是形容植物纤维净白如蚕丝，表面又平滑如砥石。但这种“纸”数量又少，价钱又高，也不是理想的书写材料。

## 2. 漂絮与蔡伦造纸

所以，纸的出现，是书写材料的一次革命。从技术方面的源头来看，造纸术受到了养蚕制丝过程中“漂絮”这种副产品的启发。中国是世界上最早利用蚕丝的国家，并且在相当长的一段时间内，是唯一这样的国家。在距今约五千年左右的浙江吴兴钱山漾遗址中，除了发现苎布外，还出土了一段丝带和一小块绢片。蚕结的茧，质量高的可以抽丝织绸；而那些质量较差、不能直接抽





if they are of fine quality; those cocoons that are of poor quality and from which raw silk cannot be reeled off can be made into silk floss. The process is as follows: first cut through the cocoons and make them soft by soaking in water, then put them on the woven bamboo mat to be beaten repeatedly, and finally they become soft silk floss which is called drift wadding. After the drift wadding is taken away, a layer of silk fiber still remains on the woven bamboo mat. Thus the accumulated silk fiber becomes a sheet when it is torn off after it is allowed to dry and cool off.

The handicraft industry of using inferior cocoons to make silk floss was quite popular during the period between the Qin Dynasty and the Han Dynasty. The "drift wadding" mother whom Han Xin (Han Hsin, ? —196 B.C., a famous minister and general of Liu Bang or Liu Pang, 256—195 B.C., Emperor Gaozu, founder of the Western Han Dynasty) met before he gained power and position probably earned a living on this business. The thin layer of fiber torn off from the woven bamboo mat was light-colored. Though it could not truly be used as paper due to its lack of fiber knots and close adhesion, it should have been quite natural that people conceived of the idea of writing on it and, further, gained enlightenment from it on the method of manufacture. Cocoons were after all expensive and small in quantity. People would think of using ramie, hemp and the kind, which were less expensive and more easily available, as raw materials. By using this method media for writing could be manufactured.

In 1957, remnants of ancient paper of the second century B.C. were unearthed at Baqiao, in the eastern suburbs of Xi'an. They assumed yellowing and had been broken into fragments, the biggest piece being 10 sq. cm. and the smaller ones three to four sq. cm. After identification, they proved to have been made of fibers of hemp and a small quantity of ramie. In spite of the fact that they were primitive in manufacturing technique, rough in texture and were not handy for writing, they were the paper the world had ever