

66 MOZI, LETTER TO
ZHU XI, AND
COMPLETE RECORD
OF MILITARY
MATTERS

NEW WAYS OF DOING THINGS

INVENTIONS AND TECHNOLOGY

Wheelbarrows, kites, paper—everyone is familiar with them. When you think of a wheelbarrow, what comes to mind? Gardening or construction work, most likely. Kites probably make you imagine colorful paper or plastic constructions that you fly on the beach or in an open field. And paper is so common that most people hardly

think about it, but when they do, it's usually because they're using some for homework or an art project.

But if you were to mention these same items—wheelbarrows, kites, paper—to a person in the Han dynasty of ancient China, that person might assume that you were thinking about warfare.

We're so accustomed to seeing these things used in certain ways that it's difficult to imagine how useful they would be in a military setting. But what is a wheelbarrow, after all? An inexpensive wheeled vehicle that can be powered by a single person to



南方獨
推車圖

Ancient Chinese people can be credited with many useful inventions, including the wheelbarrow. They also wrote about their inventions so that others could re-create them. This illustration of a merchant transporting his goods comes from a 17th-century book on technology called The Lord of Heaven Invents Things.



move heavy things over uneven ground. The huge Chinese armies were constantly in need of food, clothing, medical equipment, and ammunition. Wheelbarrows were an efficient way to carry heavy and bulky supplies (and even people) over land that was often too rocky and mountainous for larger wheeled vehicles. The first images of these useful vehicles appeared in Chinese tomb decorations around 100 CE, but they had probably been in use since at least the first century BCE.

An ancient Chinese wheelbarrow wasn't always a simple cart with handles and a single wheel in front. There were many variations in their construction, especially in the size and placement of the wheels, which could be large or small, and which could rely on one central wheel in front or in the center. The Chinese adapted the form for different terrains. One ingenious inventor even thought of manufacturing wheelbarrows with sails attached. They could reach speeds of up to 40 miles per hour over land or ice.

Kites are so fragile that their military use would be limited today. But when you realize that kites were the first heavier-than-air aircraft known to the world, possibilities begin to open up. Kites may have been used to help far-flung soldiers communicate in a battle. A combination of colors and shapes of kites could serve as a code to send a message. The *Mozi* says that a general “constructed a bird from bamboo and wood and when it was completed he flew it. It stayed up for three days.” Although nobody knows exactly how the kites were used, it's unlikely that these serious

Many people were involved in silk production. In small, home-based workshops, women were often important in sericulture (the making of silk). In this picture, women feed the worms on the right, while men on the left sort the cocoons.

“ Mozi, *Mozi*, about 400 BCE

**FIBER: GOOD FOR
DIETS AND PAPER**

Paper is made of dissolved cellulose (plant fiber, like the strings in celery) that has been dried in a flat sheet. To make paper, the Chinese would mash or chop up fibrous plants or rags and soak or boil them in a solution to loosen the fibers from the rest of the plant structure. They would fish out the fibers and mix them with something such as flour to make them hold together, and then spread them on a screen or press them into a mold.

66 Lu You, a letter to Zhu Xi, about 1200 CE

66 Mao Yuanyi, *Complete Record of Military Matters*, about 1625 CE

warriors were just passing the time between battles. They must have had some warlike function in mind.

Materials for making kites were available in China. Silk is light and strong, and it was ideal for both the fabric of the kite's body and the string that tethered it. Bamboo, which grows in China, is a wood that is light and strong as well as flexible, making it perfect to form a kite's structure.

Today, many people make kites out of paper, which was invented in China by at least the second century BCE. The ancient Chinese used paper in many of the same ways we use it today: for kites, for writing and painting, as toilet paper, as wallpaper, for blowing noses. But would you believe armor was made of paper?

In the 1960s there was a brief fad for paper clothing in much of the United States and Europe. The people who wore these throwaway clothes might have been surprised to learn that the Chinese people of long ago used paper clothing. It wasn't disposable, like the more modern version, and in fact its owners prized it for its warmth and softness. Many centuries later, a poet praised a paper blanket, saying, "It is whiter than fox fur and softer than cotton." Multiple layers of paper can be extremely tough, too—just try to poke a hole in a phone book if you don't believe that. Eventually, Chinese soldiers wore armor made of pleated paper. They valued it because it was strong and light as well as protective. The Chinese used paper armor for hundreds of years. In about 1625, Mao Yuanyi said, "The best choice for foot soldiers is paper armor, mixed with a variety of silk and cloth."

These inventions and others spread through Asia and eventually throughout the world. Some were thought of independently in other parts of the world as well, often long after a Chinese inventor came up with them. Many of these inventions reached other lands through traders. Travel on China's many rivers was a relatively inexpensive and rapid way to trade goods. Whoever had the fastest, strongest, most reliable means of shipping could earn a lot of money, so inventors had an incentive to come up with ways to improve ships.



Getting your ship headed in the right direction was always a challenge. Early boats had no mechanism for steering. If you can't steer, you have to either wait for the river current and the wind to go the way you want or find a way to work against these forces. Oarsmen can steer by rowing harder and faster on one side than the other, but this uses a lot of energy that could otherwise be channeled into making the boat go forward. A model boat made of pottery, found in a tomb from the first century CE, shows a great innovation: a rudder, which would make steering much easier and would conserve energy.

The position of the sails also makes a difference in the boat's speed and handling. If the sails are fixed in a forward-facing position, the boat can go only in the direction the wind is blowing. But something important changes when sails are placed along the length of the boat, and the bottom of the boat comes down into a ridge. Then the force of the wind against the sail can push the boat forward, even when the wind isn't blowing in the same direction that the boat needs to go. The Chinese pioneered this arrangement, known as fore-and-aft rigging, by at least the second century CE. By the third century CE, a text mentions four-masted boats rigged fore and aft.

It would seem logical to mention the early Chinese invention of the compass here, since today the most common use of this instrument is in navigation. But as it turns out, although the Chinese did find compasses helpful for

Using ingenious devices such as the rudder to steer the boat accurately, the Chinese sailed far away from their home. They went around the southern tip of Africa and some scholars think they even went as far as North or South America.

**OR MAYBE THERE
WAS A LOT OF RAIN
THAT WEEK?**

People sometimes used omens to make a political point. In 185 CE devastating floods left thousands of people homeless. Ancient scholars argued that floods were a *yin* (female) force and they occurred because an empress was running the state.

Any piece of iron or steel can be turned into a compass needle. On this compass from the Warring States period, a magnetized spoon would swivel until its handle pointed south.



making maps and for finding their way, they used them mostly in an entirely different sphere of life. People believed that everything in the universe, large and small, was part of a pattern. Someone who knew what to look for could tell what would happen to individuals by studying natural events, which sometimes were more obvious than human nature. People can disguise what they're feeling, after all, but it's hard to hide an earthquake or a large migration of birds or the birth of a two-headed snake.

The difficulty was to interpret these natural events correctly. Depending on the direction that thunder came from or birds flew to, an event could have different meanings. This is where we get to the compass. Diviners had to be precise in order to interpret the omens accurately. The compass gave them the accuracy they needed to advise others, including the rulers.

When Chinese inventions reached the West at different times over the centuries, Europeans sometimes found new uses for them. With the compass, European sailors were able to sail out of the sight of shore with some confidence that they would eventually find their way home again. When Christopher Columbus set out from Spain in 1492, he had compasses and other navigational instruments with him. He thought that he would eventually reach Asia, including China, with their aid.

AN EXPLOSIVE INVENTION

The Chinese invented gunpowder by the tenth century CE. The Chinese used gunpowder to make fireworks, but the invention of the gun by an Arab in 1304 quickly caught the attention of the Europeans. By the 14th century, the Europeans were making firearms powered by gunpowder.