THE 17th CENTURY

TIANGONG KAIWU-MINES AND WEAPONS

The transport section opens with the humble wheelbarrow, an ingenious piece of craftmanship that is still in use today. Its centrally mounted wheel distributes weight so evenly that it is capable of transporting up to six human passengers at once.

Boats are also meticulously described, specially the flat-bottom river boats used to transport the grain tribute along the Grand Canal.
Due attention is given to essential elements of navigation, like compass and anchors.
A scaffold is erected from which a number of workers lift the trunk of the anchor to allow it to be hammered by those working below. The four claws of the anchor are forged first and then attached to the trunk one by one applying to the joints a soldering material with the help of long sticks.

A brief mention of Western technology appears in this section when the author mentions that the countries of the West have a remarkable chemical solder.
Coal mining is also described together with the many kinds of coals.
Coal was widely used as a fuel during the Ming dynasty, but they never attempted to convert the energy released from its heat into the power of motion: that was always provided by human beings and domestic animals.
China's population was so large, that they never had to worry about having insufficient manpower and thus never tried to develop labour-saving mechanical devices. Special attention is given to the timber erected to prevent collapse of the galleries, and to the thick hollow bamboo pipe to channel the poisonous gas.

The frequent accidents due to gas inhalation in the mining process are also described, together with the remedies that have to be applied. Refining and smelting metals are described at length, providing different methods for the different metals.
Smelting an ore containing both copper and lead requires a furnace that lets the two metals flow from different holes, placed at different heights. That allows lead that melts first to flow from the upper hole, while copper that melts later flows from the lower one.

Iron deserves a special section, and describes the ways to produce pig iron and wrought iron: the blast furnace at right produces pig iron that afterwards runs into the square ditch.
This is surrounded by a low wall to protect the workers that manipulate it with willow sticks and add to it a certain amount of finely screened earth. The weapons section highlights the need of the scholar class to be knowledgeable about warfare.
Its focus goes first to bows and arrows: it analyzes the sound of the flying arrows and explains how to determine the pull of the bow.

It also gives an important place to firearms.
This is the only section in which some influence of the western world is visible.
Some devices are typically Chinese, like the landmine that could be operated with the pressure of a person's foot, or the submarine mine that could be exploded at a distance.
Others, like muskets had been introduced by the Portuguese. The author praises the high quality of western cannons, that he calls red barbarian cannons, but he falls short in his description.
When a few years after the publication of this book China entered a decade of frantic fighting, all sides will turn to the Portuguese and the Jesuits to obtain Western cannons, incomparably better than the Chinese ones.
The Chinese, who had invented gunpowder and firearms, lagged by then behind the others.
Paper making is described in full detail.
First comes the cooking of the inner mass of bamboo in a pot, then the ways to place exactly a screen on top of the bamboo pulp in order to obtain the different types of paper.
The last steps entail the pressing of the paper sheets and finally the drying of the sheets. The last section of the book deals with gems.
The digging of pearls is described in detail: the diver is tied at the waist with a long rope and jumps into the water with his head protected.
A curved pipe attached to his mouth enables him to draw breath.
When the diver feels short of breath he pulls the waist rope and is quickly hoisted out of the water.
The author prudently adds that some, whose luck happens to be adverse, are drowned.

Song Yingxing described a world with a meticulous specialized labour: by the end of the Ming there were 360 categories of artisans.
It has been argued that this large quantity pointed to an excessively fragmented division of labour.
But it also disclosed the sparkling vitality of Chinese society.

The Tiangong kaiwu unveils the technological background of the extraordinary Chinese productivity.

The book takes for granted the module system and the mass production that are at the core of the Chinese productive system.

This was a world that could not be easily destroyed and the long and consistent Chinese technological tradition will resurface once the Ming-Qing transition turmoil will be over.