

# SCIENCE AND CIVILISATION IN CHINA

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VOLUME 4

PHYSICS AND PHYSICAL TECHNOLOGY

PART II: MECHANICAL ENGINEERING

 CAMBRIDGE  
UNIVERSITY PRESS

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## (7) THE BALLOON IN EAST AND WEST

The balloon may be said to be related topologically to the parachute, for a sufficient constriction of the latter's orifice turns it into the former. But physically they are quite different, for in one case the descent of a curved fabric surface is delayed by the drag of the aerial medium, while in the other, its ascent is facilitated by the presence of a medium lighter than air confined beneath it. As we have already indicated, the

<sup>a</sup> If any reader should doubt the possibility of his feat, similar accounts collected by Kerlus (1) may prove convincing. The facts could easily be tested.

<sup>b</sup> (1), p. 47.

<sup>c</sup> (1), pp. 237, 248, 263, (2), pp. 232 ff.; cf. Huard (2), p. 29.

<sup>d</sup> It is certain that Lenormand did not know of the suggestions of Leonardo, and that he was stimulated by the Siamese relation; it is almost certain that he was ignorant of Veranzio's proposal.

<sup>1</sup> 雨蓋

balloon or aerostat, the 'cloud captured in a bag', was a product of the pneumatic chemistry of the European 18th century.<sup>a</sup> Remarkably enough, the first two aerial voyages ever made by man were accomplished in a single year, +1783, by Pilâtre de Rozier and the Marquis d'Arlandes in a Montgolfier hot-air balloon, and then in the following month by J. A. C. Charles and his mechanic Robert in a hydrogen balloon. The simpler of these forms, using nothing but hot air, could have originated very much earlier than this, and in fact in model form it did.

Easter merry-makers in +17th-century Europe had an entertaining trick of making empty eggshells rise in the air literally 'under their own steam'. This is reported in many books, for example Jacques de Fonteny's poem *L'Oeuf de Pasques* of +1616, which describes it as a traditional custom.<sup>b</sup> The procedure was simple enough, requiring only a little deftness; the contents of an egg being emptied through a small hole and the shell very carefully dried, the right amount of dew (pure water) was introduced and the hole closed with wax. Then in the hot sun the egg would move uneasily, grow light, and rise up into the air, floating a moment before falling.<sup>c</sup> How ancient this trick was in Europe we do not know, but we were quite astonished to read of it in the book of Duhem because we had already come across a similar model of the lighter-than-air flying-machine in a Chinese text, not of the +17th but of the -2nd. This is the *Huai-Nan Wan Pi Shu*<sup>1</sup> (The Ten Thousand Infallible Arts of the Prince of Huai-Nan), that compendium of ancient Taoist techniques which we have occasion to refer to so often in this work.<sup>d</sup> Liu An's book of secrets, if not exactly now as he himself knew it, must certainly be a Han compilation. The text says, in its usual concise way: 'Eggs can be made to fly in the air by the aid of burning tinder.' And an ancient commentary incorporated in the text explains: 'Take an egg and remove the contents from the shell, then ignite a little mugwort tinder (inside the hole)<sup>e</sup> so as to cause a strong air-current. The egg will of itself rise in the air and fly away.'<sup>f</sup> Thus the method of Liu An was more akin to that of the Montgolfier brothers than to that of the eggs raised by steam, since nothing but hot air was employed. The discovery of this text puts a rather different complexion on the relations of China and Europe in the prehistory of aerostatic flight.

When the present Section was first drafted we doubted whether China had had any part in this, but we are now inclined to think that the Han tradition was never lost. China was likely to be the home of hot-air balloons for several different reasons. Paper was available, as nowhere else in the world, from the Han period onwards, and

<sup>a</sup> Cf. Duhem (1), pp. 332, 369, 370 ff., 418 ff., 437, 442 ff.; Gibbs-Smith (4), pp. 53 ff., 64 ff., 74 ff.

<sup>b</sup> The literary references are given in Duhem (1), p. 401. Illustration in Fludd (2), p. 186.

<sup>c</sup> The water-vapour formed by the evaporation of the dew expels the air through the pores in the shell, and ultimately when the wax melts, through the hole. The hot steam inside the egg is just sufficiently buoyant to raise the shell for a short time into the air before being dissipated itself by the same channels.

<sup>d</sup> Cf. Sections 26 (Vol. 4, pt. 1, pp. 69, 91, 279, 316 above), 30, 33, 34, 40 and 44. On the book's bibliography, see Kaltenmark (2), p. 32, and on its comparative position in the literature of China and Europe, Ho Ping-Yü & Needham (2).

<sup>e</sup> Normally used for making incense sticks and moxibustion cones (cf. Vol. 1, Fig. 29).

<sup>f</sup> *TPYL*, ch. 736, p. 86 and ch. 928, p. 66, tr. auct.

<sup>1</sup> 淮南萬畢術

the development of the classical globular paper lanterns would have encouraged experimentation. When their upper openings were too small and the source of light and heat unusually strong, they must sometimes have shown a tendency to rise and float free of support. And indeed it is not difficult to find instances of the popular survival of hot-air balloons as an ancient sport in the Chinese culture-area. Goullart, for instance, gives a graphic description of seasonal customs involving this in the Lichiang region of Yunnan province.<sup>a</sup> He tells us that in July, the critical month before the rainy season, the rice was already planted and the people did not have much to do, so in the evenings, besides dancing, the young men and the Nakhi girls flew hot-air balloons made of rough oiled paper pasted over a bamboo framework. With bunches of burning pine splinters underneath, these would sail up into the night air, some floating in the distance like red stars for several minutes before bursting into flame and falling far away. Duhem, again, reports similar pastimes in Cambodia.<sup>b</sup> Medieval descriptions are still needed to fill the gap in continuity, but it is probable that further search will reveal them. The Han evidence and the ethnological evidence together make a *prima facie* case for a perennial Chinese tradition, and indeed it is very unlikely that the tribal people and peasants of north-western Yunnan derive their proceedings from the France of Montgolfier.<sup>c</sup>

It might even be urged that a practice originally Chinese was brought to the knowledge of Europeans at the time of the Mongol invasions. Much evidence has been collected from eastern European chronicles<sup>d</sup> that hot-air balloons shaped like dragons were used for signalling or as standards by the Mongol army at the Battle of Liegnitz in +1241, and this is accepted as assured by many writers.<sup>e</sup> Certainly many of the early +15th-century German works on military technology, such as the MSS. of Konrad Kyaser's *Bellifortis*, show drawings of horsemen holding what appear to be flying dragons in the air on the end of cords.<sup>f</sup> He states that they contained oil-lamps as well as combustibles to give an effect of vomiting forth fire. It is rather difficult to evaluate these descriptions and pictures, which in some respect recall kites rather than hot-air balloons, and the subject needs further study, but we are inclined to believe that a considerable aerostatic element was involved.<sup>g</sup> Whatever the arrangements actually were, they seem to have continued into the +16th century, for an account of the entry of Charles V into München in +1530, with an accompanying contemporary woodcut, attests the appearance of a similar flying or floating and fire-breathing dragon.<sup>h</sup>

<sup>a</sup> (1), p. 178. Mr Wei Tê-Hsin remembers like ploys in Fukien.

<sup>b</sup> (1), p. 409.

<sup>c</sup> This presents a case somewhat parallel to that of the Cardan suspension seen above, p. 233. Gimbal lamps in their nests of pivoted rings made during the last two centuries on the frontiers of Tibet derive much more probably from the Chinese tradition beginning with Ting Huan in the +2nd century than from the Italy of Jerome Cardan.

<sup>d</sup> See Hennig (1); Feldhaus (8, 15, 20).

<sup>e</sup> See Feldhaus (1), cols. 653 ff.; Forbes (4a); Plischke (2). Large paper lanterns for signalling are often referred to in Chinese accounts of military operations, as at the siege of Khaifêng by the Mongols in +1232 (*TCKM*, pt. 3, ch. 19, p. 50a; cf. p. 577 above), but we have not met with any statement that they floated in the air.

<sup>f</sup> See Berthelot (5); Feldhaus (1), *loc. cit.*, and others.

<sup>g</sup> Duhem (1), for example, pp. 404, 411, 412, is sceptical, but reproduces the illustrations, (2), pp. 36 ff., figs. 17, 18. Cf. the dragon standards of Romans and Parthians (Feldhaus (1), col. 198).

<sup>h</sup> Bassermann-Jordan (1), pp. 64 ff.

If some of these creatures had an orifice behind as well as at the front, they were perhaps precursors of the wind-sock. And here again there is an East Asian background, for Tissandier (6), describing some of the kites of Japan, mentions and depicts a huge hollow paper fish with a large open mouth and a smaller opening at the rear, which was used for decoration and as a sensitive wind-vane or weathercock. As he was writing in 1886, no reverse influence from occidental aviation technology could have been in play, and if the wind-sock was found in Japan it had almost certainly been in China earlier.

Perhaps these phenomena may have some relation to the ideas of Albert of Saxony (+ 1316 to + 1390),<sup>a</sup> who imagined that things might float at the surface between the sphere of air and that of fire, just as they floated at the surface between water and air. Could he have known of the Mongol hot-air dragon-standards? In any event, his suggestion stimulated the Jesuit Caspar Schott in + 1658, who was the first to speak of the possibility of aerostatic flight.<sup>b</sup> Schott also discussed the flying eggs of de Fonteny and others. Then in + 1709 came the activities of the Brazilian priest Fr Gusmão, who succeeded in burning the curtains of the King of Portugal's audience hall with a model Montgolfière.<sup>c</sup> Barely eight decades had then to pass before men were truly in the air. Thus by tracing a tenuous thread, illuminated only very fitfully, we come back to a view often formerly held on less secure evidence, namely that China did play a considerable part in the prehistory of the balloon and the airship.

So far as we know, traditional China carried out no aerostatic experiments of Montgolfian scale and daring.<sup>d</sup> But the great interest taken by Chinese scholars, however, in the news which came from France in the penultimate decade of the + 18th century, might bear witness to the existence of certain traditions. In one of his most curious letters, written from Peking on 15 November + 1784 (just a year after the first Paris ascents), the Jesuit J. J. Amiot (4) described the interest which the literati were showing, and said that they were disposed to reconsider in a Montgolfian light ancient stories long dismissed as fables. Amiot himself, no disparager of ancient China's sages, wondered whether perhaps Huang Ti or Shen Nung might not have known of some fluid lighter than air long since forgotten. 'This suggestion', he added, 'I send for what it may be worth.' But there was excitement not only in the capital. The southerner Wang Ta-Hai travelled abroad in the East Indies between + 1783 and + 1790, making notes which he collected in his *Hai Tao I Chih Chai Lüeh* prefaced in

<sup>a</sup> Cf. Sarton (1), vol. 3, pp. 1428 ff.

<sup>b</sup> Duhem (1), pp. 334 ff., 339.

<sup>c</sup> The epic, or tragi-comedy, of Fr Gusmão is a very involved story, and may be read in Duhem (1), pp. 417 ff. or Gibbs-Smith (4), pp. 53 ff., (5).

<sup>d</sup> There is a peculiar story, generally dismissed out of hand, which may yet prove to have some basis at present unknown. Giles (9) tells us that a certain Fr Besson is said to have written in + 1694 that a balloon ascended from Peking at the accession of the emperor 'Fo Kien' in + 1306. But no new reign began in that year, and no emperor bore that name. Pfister (1), in his encyclopaedia of the Jesuit mission in China, knows no such Father as Besson, but there was a Joseph Besson (+ 1607 to + 1691) who was a missionary in Syria, so the rumour may have been started by him. Curious 18th-century prints in Chinoiserie style of this aerostat, pictured as an elongated dirigible with nine gondolas, continue to appear in popular articles. Cf. Duhem (1), pp. 85, 376, 403, 409, but even he brings no solution for this puzzle; nor Feldhaus (2), p. 54.

the following year. In this he gave an account, necessarily at second hand, of the new balloon or 'sky-ship' (*thien chhuan*<sup>1</sup>):<sup>a</sup>

This boat is short and small, resembling a dome-shaped pavilion and capable of containing ten men. Attached to it there is a pair of bellows, or air-pump, of exquisite workmanship, in shape like a globe; several people work this with all their might, whereupon the ship flies up high into the heavens. There it is borne about by the winds, but if they wish to navigate it they spread sails and make use of quadrants to measure distances. When they reach their destination they take in their sails and let the ship descend. It has been reported that these ships have been burnt and injured by the sun's rays, while persons venturing in them have been scorched to death, so people hardly dare to go on using them.

This sounds like an echo of a hydrogen balloon, with a second conversation about Daedalus and Icarus occupying the same line. But it testifies to the living interest shown by Chinese scholars and travellers, conscious of their own past, in the opening phase of man's conquest of air and space.

#### (n) CONCLUSION

About the year 1911 an old gentleman taking a stroll in Peking had his attention drawn to an aeroplane flying overhead, but with perfect sang-froid remarked 'Ah, a man in a kite!'<sup>b</sup> Chinese reactions to modern technology did not stop there, however, and quite a number of authors, though lacking that balanced judgment which an exhaustive acquaintance with sources both eastern and western alone could give, did not fail to maintain the emergence of occidental technology from oriental origins. Wang Chih-Chhun,<sup>2</sup> for instance, wrote:<sup>c</sup>

The useful arts and techniques originated from the earliest generations; thus geometry was invented by Jan Tzu (Jan Chhiu,<sup>3</sup> one of the disciples of Confucius), but later on the Chinese lost his books and Western people studied them, so that they became skilled in mathematics. So also the automatically striking clock was invented by a (Chinese) monk, but the method was lost in China. Western people studied it and developed refined (time-keeping) machines. As for the steam-engine, it really originates from (the monk) I-Hsing of the Thang, who had a way of making bronze wheels turn automatically by the aid of rushing water—all that was added was the use of steam and the change of name. As for fire-arms, they originated in the fighting at Tshai-shih<sup>4</sup> in the time of Yü Yün-Wên<sup>5</sup> (of the

<sup>a</sup> Ch. 5, tr. Anon. (37), p. 55. We say necessarily at second hand, for it is quite unlikely that any Montgolfian balloons had been seen in Asia before 1800. Possibly the first were those used by the French in their invasion of Viet-Nam (Tonkin) in 1884 (cf. Lê Thánh-Khôi (1), p. 378). Several interesting contemporary Chinese prints showing these observation-balloons have been published by Tissandier (1). The French balloon corps had been started in 1877, and the same writer gives details of the corresponding Chinese unit trained by French instructors at the request of Li Hung-Chang in 1888. This was the embryo of the Chinese Air Force of today. French balloon observers were used again during the troubles of 1900, and an album of their photographs of Peking exists (Anon. 43).

<sup>b</sup> For this story I am indebted to Mrs Ingle, formerly of Chhilu University.

<sup>c</sup> In his *Kuo Chhao You Yuan Chi*<sup>6</sup> (Record of the Pacification of a Far Country); an account of his ambassadorship to Russia, ch. 19; quoted *KCKW*, ch. 5, p. 28a, tr. auct. Cf. p. 525.

<sup>1</sup> 天船

<sup>2</sup> 王之春

<sup>3</sup> 冉求

<sup>4</sup> 采石

<sup>5</sup> 虞允文

<sup>6</sup> 國朝柔遠記