TIBETAN TECHNOLOGY AND THE WEST

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It is now recognised among historians of science and technology that China was pre-eminent in influencing the course of medieval European technology and the Scientific Revolution of the seventeenth and eighteenth centuries. The Jesuit eulogy for Chinese science and technology (which formed the main vehicle for the transmission of Chinese scientific ideas) was blind, however to technological originality in Asian countries outside the scope of their missionary activities. It may be for this reason that till quite recently the history of technology in estimating Asia had emphasised the role played by China to the exclusion of nearly all other countries in the Far East. While one cannot overestimate the importance and magnitude of the Chinese influence, it may be of interest to readers of this *Bulletin* to learn that instances of possible Tibetan influence on the course of European technology have come to the notice of modern scholarship.

According to Lynn White (1), Tibet with its "technology of prayers" (by which he means the various devices employed in the clockwise rotation of *mantra*) was an important source for European technology. The method by which the simple yet fundamental mechanical techniques associated with the use of the Tibetan prayer wheel (མ་ཉི་ཆོས་འཁོར་) were transmitted to Europe, it is claimed, can be found in the slave trade which built up a population of thousands of so-called 'Tartar' slaves in every major Italian city and which reached its climax in the middle of the fifteenth century. The fact that there existed effective canonical prohibitions against dealing in Christian slaves and that Muslim slaves were both surly and prone to escape meant that slaves from the Shamanist and Buddhist areas of Central Asia were the chief supply for the Italian market.. These the Genoese merchants secured in great numbers from slave traders wholesaling in the Black Sea ports. The majority of these slaves, we can be sure, came "... from the regions bordering Tibet and China on the north."(2) Thus while they were not Tibetans themselves, they did come from an area within the sphere of Tibetan cultural influence and for that reason White holds that we need not be surprised to find basic Tibetan devices appearing in Italy at this time and being transformed to practical use in their new context. On the basis of his researches and those of Joseph Needhan we can now list five of these devices as follows:

I THE VERTICAL AXLE WIND PRAYER WHEEL

Lynn White suggests that the invention of the vertical axle windmill in Europe was discovered as a result of one of the direct transmissions of the slaves and that its origin can be found in the Tibetan prayer cylinders rotating on a vertical axle and powered by an anemometer —like wind turbine. The earliest appearance of this in Tibet is unlikely to have preceded the introduction of the *mani* formula itself as a formal 'support' for religious devotion and meditation by Jowo Atisha (Pandit Dipankara Srijnana) who arrived in Tibet in 1042 A.D. It is not inconceivable, however, that the Central Asian peoples were using wind-driven gadgets of religious significance in pre-Buddhist times. In Europe the first appearance of the vertical axle windmill can be found in a sketch by the Italian engineer Mariano Jacopo Taccola, datable 1438-1450. White suggests that Taccola's device was of direct Tibetan inspection because of the slaves mentioned earlier; also because he claims that various Tibetan art motifs are detectable in European gothic art; (3) and finally also because of the two following technological borrowings from Tibet (II and III below). All these, he says, point towards some particular connection between Tibet and Italy at that time and which would make possible the Tibetan origin of Taccola's device.

Needham inclines to put forward a different thesis of diffusion. He sees the proper origin of the European vertical axle windmill in the Arabic writings of the ninth and tenth ecnturies but he suggests that the Tibetan wind turbines could have influenced Persian windmills because, as he puts it "...by then the greeting to the jewel in the lotus might have had time to work its benevolent technological effects for suffering humanity." He therefore recognises that" a Mongol Tibetan Shamanist and Buddhist ancestry must be regarded as at least as probable as the more conventional Graeco-Arabic one."(4)

II THE BALL-AND-CHAIN GOVENOR

The essential mechanical innovation in the ordinary Tibetan hand prayer-wheel is the small ball-and-chain govenor attached to its periphery to maintain rotation. White says that the development in Europe of the compound crank and connecting rod in the 1420's made Western technicians much concerned with helping mechanical crank motion over the "dead spot". (5) This led to the exploration of possible forms of govenor and by 1482-1501 the ball-and-chain govenor on exactly the Tibetan model is found in the sketch book of an Italian engineer.

III HOT-AIR TURBINES

Hot-air turbines were found in Tibet used for turning prayer cylinders in the draught over the fire in the tents of nomads. They are still found today in the Tibetan Buddhist areas of the Himayalan countries where they are used in temples and shrine rooms to turn paper cylinders

inscribed with *mantra* by the action of heated air rising from a butter lamp. By the late fifteenth century Italian technicians were putting such small turbines into chimney flues and gearing them to turn spits and, as White indicates, it was"...an elegant automation, since the hotter the fire thefaster the roast spins." (6) In 1629, Branca shows us a small roling mill powered by the heat rising from a forge. Such experiments failed to produce a major source of power, but they had a significant by-product in accidental technology; the screw propellor of ships and thus eventually the aeroplance propellor were apparently inspired by the metal hot-air turbines in chimneys rather than by the wooden, and often spoon-bladed water turbines.

The appearance in Italy almost simultaneously of three items so closely related to the methods of rotating the Tibetan prayer cylinder (the vertical axle windmill, the ball-and-chain govenor and the hot-air turbine) does seem to make the case for independent Italian invention more improbable.

IV THE STEAM-JET FIRE-BLOWER

Related to the idea of the use of heat rising is that of using a jet of steam. It has long been recognised that the pre-natal form of the steam engine's boiler is the *sufflator* of the Middle Ages, a simple device consisting of a vessel containing water that when heated emits a jet of steam.(7) Branca's early experiments in the utilisation of steam force were consciously derived from *sufflators* of this kind. Yet it is most remarkable that the Tibetan steam-jet fire-blower could well provide the derivation of the classical and medieval *sufflator*. The Tibetan model still takes the form of a bottle-shaped conical copper kettle surmounted by a bird's head, the beak of which, sometimes quite elongated, points downwards and has a pinhole at the end. The steam emitted is thus directed onto the flame and the hot air carried with it blows the fire up, as I have observed in experiments with my own model. At a high altitude this is particularly useful. Needham suggests (8) that Alexander the Great's soldiers may have brought it back to Greece in time to influence the aeolopile of Heron which in turn developed into the medieval *sufflator*. Apart from this possible channel, there were the 'Tartar' slaves in Italy whose steam jets may at least have modified the *sufflator*. This could be likely because the first European *sufflators* (9) to be made in the shape of birds are datable at 1579 which would have allowed sufficient time for the bird-shape of the Tibetan steam-jet fire-blower to have been copied.

V THE GIMBAL SUSPENSION OF THE TIBETAN GLOBE LAMP

The last device which might have come from Tibet to Europe is the system of gimbals inside the Tibetan globe lamp. This is a seemingly simple combination of rings whereby an oil lamp may be kept in hori-

zontal equilibrium no matter in what direction the globe is swung. Of the two models which I have seen, both have a suspension of four rings and five pirot-axes with an oil containes in the centre. They were intended for hanging in a relatively exposed temple hall or porch. In Euorpe this technique is associated with one of its most widespread Renaissance applications, the mounting of the mariner's compass so that it is independent of the motion of the ship, and is known as the Cardan suspension. The gimbal suspension was in fact known in Europe by the ninth century applied to such things as portable hand-stores. Needham is in favour of the diffusion of the Sino-Tibetan system of gimbals through the Arabs to medieval Europe, but is unwilling to commit himself too strongly on the subject. (10)

If the credibility for the transmission of these Tibetan devices is not doubted, then its signifiance in the history of technology cannot be overestimated. As has been seen they carried with them important stimuli to the development of European technology. However, it is clear that for the moment, due to the lack of further documentation and evidence, the researches of Needham and White cannot be considered as above the level of brilliant speculation, however we may be tempted otherwise. If nothing else they go to show that technologically medieval Tibet compares favourably with medieval Europe. In this connection we should remember that iron-chain suspension bridges were widely used throughout Tibet at an early date, long before Europe constructed hers, to give but a single example. The life of Thariston Gyalpo, the great Tibetan *mahasiddha* and iron bridge builder is itself a demonstration of how in Tibet, as in ancient Greece and Egyprt, technology (བཟོ་རིག་པ་) was inseparable from religion. (11)

Finally, it is worth mentioning that the study of certain aspects of Tibetan Budddism (such as the texts and commentaries on the (དུས་ཀྱི་འཁོར་ལོ་)could reveal a lot concerning actual scientific theorizing inTibet, notably in the fields of medicine (12) and astronomy. Needham, who is possibly the greatest living exponent of oriental science, has said that "...Tantrism represents one of the fields of research in which interesting discoveries concerning the early history of science in Asia are most likely to be made."

NOTES

1. *Tibet, India and Malaya as Sources of Western Medieval Technology*, American Historical Review, Vol LXV (1960), p.515 et seq., by Lynn White, Jr.

2. *Del traffico e delle condizione degli shiavi in Vcnezia nei tempi di mezzo*, Miscellanea di storia Italiana, Vol I (1862), p. 470 by Lazari.

3. On this see *Le Moyen Age Fantastique: Antiquites et exotisnes dans l'art gothique*, (Paris, 1955) pp. 247-48 by Jurgis Baltousaitis.

4. *Science and Civilisation in China*, Vol. IV, pt. 2, p. 567, by Joseph Needham.

5. Lynn White, *op.cit*, p.520.

6. *op.cit*, p. 519.

7. *Medieval Technology and Social Change*, (O.U.P 1962) pp.91 and 92, by Lynn White, Jr.

8. Needham, *op.cit.*, p. 228.

9. See *Inventioni* (Parma, 1579) by G.B. Isaachi.

10. Needham, *op.cit.*, pp.231 and 236.

11. For a reference to the literature on the iron bridge builder (ལྕགས་ཟམ་པ་) གྲུབ་ཐོབ་ཐང་སྟོང་རྒྱལ་པོ་ (1385-1464) see *The Life of Bu ston Rin po che*, Serie Orientale. Roma, Vol. XXXLV, (Rome, 1966), pp.48 and 49, note 2, edited and translated by D.S. Ruegg.

12. Apart from the following work and a few other German studies on Tibetan medicinal herbs practically no work has been done in this field; *Die Tibetishe Medizinphilosophic; der mensch als mikrokosmos*, (Zurich, 1953) by P.Cyril von Korvin—Krasinsky, O.S.B.