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## Chapter 1

**THE 'BOUN BANG FAI' ROCKETS OF THAILAND AND LAOS:  
POSSIBLE KEY TO DETERMINING THE SPREAD OF  
ROCKETRY IN THE ORIENT\***

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Previous IAF and International Congress of the History of Science papers by the author have investigated the early development of the rocket in China and India [1]. Prof. Fang-Toh Sun, Pan Jixing and others have also studied the earliest Chinese rockets, while Y. S. Chae has concentrated on 14th to 17th century rocketry in Korea [2]. Gradually, we are gaining a clearer understanding of the development of the first rockets in Asia and the sub-continent of India, though the spread of this technology throughout Asia is still not well established. The allegedly millennia-old *Boun Bang Fai* phenomenon represents an ideal opportunity to further this study. Moreover, while S. J. Tambiah and other cultural anthropologists have closely examined the intricate religious and cultural aspects of this important annual event, so far as known, no objective, factual history has been attempted. The outstanding question for the historian of rocketry is: assuming the *Bang Fai* is 1,000 years old, how did knowledge of the gunpowder rocket first reach these regions of Thailand and Laos? Did it come from China or India, or was it indigenously developed?

## BACKGROUND

Before examining details of *Bang Fai* festivals and rockets, it is essential to set down some fundamental historical points. First, the countries mentioned in this paper—Thailand, Laos, Burma and Cambodia (Kampuchea)—were all heavily Indianized early in their histories, despite their close geographical proximities to China. Vietnam is the most Chinese in character of all the countries of Southeast Asia and, in fact, was under Chinese rule for a millennia. On the other hand, the Chinese traded throughout Southeast Asia, thereby influencing the cultures of the other countries in the region as well. One example of an early Chinese-Siam contact was the visit of the Mandarin Haw Chow Chi to the Siamese court of Sukhothai in 1282 to sign a peace treaty, followed by visits of the Thai King Ramkhamhaeng

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to the Chinese Emperor in 1294 and 1300, from which he brought back a number of Chinese artisans.)

Nevertheless, the Indianization process took firm root by roughly the 11th to 13th Centuries. This Indianization is strongly evidenced today by the Sanskrit and other Indian-derived spoken and written languages of Thailand, Laos, Burma and Cambodia, as well the unmistakable Indianized styles of art, architecture, music, dance, native costume and customs of those countries, though with localized modifications. In the realm of religion and religiously-inspired literature, Buddhism started in northeastern India in the 6th century B.C., and spread to Sri Lanka (formerly Ceylon), then to Burma by the 5th century A.D. (However, Buddhism in India all but ceased to exist in India by 1200 A.D., where it had been supplanted by Hinduism and other faiths.) From Burma, the Theravada branch of Buddhism penetrated to the area of modern Thailand by the 6th century A.D., and was adopted as the state religion by the early Thai kings in the early 13th century.

The 1353, Fa Mgoun of Luang Prabang united small Lao principalities along the Mekong into the Kingdom of Laos and also established Theravada Buddhism. Meanwhile, from the 9th to 15th centuries flourished the Khmer or Angkor Empire, centered at Angkor (in modern Kampuchea), considered the greatest and most culturally advanced civilization on mainland southeast Asia. Thailand and Laos were heavily influenced by Khmer civilization which was, as Southeast Asia historian G. Coedès notes, "authentically Indian in type. . ." [3]. We must bear in mind, however, that particularly in Burma, Thailand and Laos, religion practiced in those countries has been a conglomeration of Buddhism, animism and Brahmanism with animistic beliefs in nature spirits still held today. By several accounts, as will be seen, the *Boun Bang Fai* practice appears to have been grafted onto, or borrowed by, Buddhistic tradition, along with animistic elements.

Finally, in regard to the development of gunpowder and the rocket itself, there seems to be a general agreement by the writers cited at the beginning of this paper, and by other authorities on the subject, that the earliest known mention of gunpowder is found in the Chinese Sung Dynasty work *Wu Ching Tsung Yao* (Essentials of Military Classics), edited by Tseng Kung-Liang on imperial order, and completed 1044 A.D. Dr. Joseph Needham, the eminent historian of Chinese science, maintains there was a "proto-gunpowder" used in China as early as the mid-9th century A.D. [4]. In his own researches into early Indian rocketry, the present writer has found that mythological, undatable allusions to alleged very ancient, pre-Christian era uses of gunpowder and rockets is inadmissible as proof of Indian claims to these inventions, though the Indians may well have been conduits for the spread of this technology elsewhere.

## **BOUN BANG FAI FESTIVALS IN PRACTICE**

With the above background in mind, we can now focus on the phenomenon of the *Boun Bang Fai*. First, the term itself, with slight variations in spelling and pronunciation, is applied to both Thai and Lao, which are very close linguistically. In northern Thai it is *Bokfai* (but also given as *Bang Fai* to Westerners), *Bongfai* in central Thai and *Bangfai* in Lao [5]. *Boun Bang Fai* poses a fascinating case study

for rocket historian and etymologist alike. *Boun Bang Fai* literally means "merit of rockets," but has come to mean "merit of (firing) rockets." Another generalized meaning is "fair (or festival) of rockets," or simply "rocket festival." Significantly, the word *bang* is from Northeastern Thailand, or more correctly Laos, and has crept into the Thai language. It means "bamboo cylinder," and probably comes from Sanskrit roots meaning "tube," perhaps also the root of the word "bamboo." Indeed, the old Indian word for rocket, such as the bamboo and metal war rockets of the 15th to 18th Centuries that were used primarily in the central of southern part of India was *bán*. *Fai* in Thai means "fire," so together *Bang Fai* is "fire tube," or simply "rocket," though this is really a specific kind of decorated rocket peculiar to Northeastern Thailand. *Fei* is also a Chinese (both Cantonese and Mandarin) word, but it means "flying," and therefore probably does not have any connection with the origin or literal meaning of *Boun Bang Fai*. (For millennia the word for "fire" in Chinese has been *huo*.) The word *Boun*, from the Pali *Puñña*, means "merit." This is merit in the Buddhistic sense of doing the good deed of promoting community harmony or well-being in sponsoring the *Boun Bang Fai* festivals, though the religious nature of the *Boun Bang Fai* is more animistic than Buddhist, since it is the rain gods that are propitiated.

Traditionally, the festival is held in the Buddhist sixth month (mid-May) to celebrate the birth, enlightenment and death of the Buddha. Conveniently, this time also precedes the rainy season upon which the growing of rice depends. The *Boun Bang Fai* is thus a fertility festival, the accompanying songs, dances, jokes and puppet shows conveying all that it implies. Through interviews with Thai Buddhist monks both in Thailand and the U.S., the author finds that the celebrations are held in perhaps 18 provinces in Thailand in the northeast region. Similar enquiries was made in a more limited way of Laotians participating in the Laotian (non-flying) *Boun Bang Fai* Rocket Festival in Washington, D.C. on June 28, 1987 as part of the Smithsonian Institution's annual Folklife Festival. (It was impossible for the author to visit Laos in 1977 at the same time he visited Thailand.) It would appear that the *Boun Bang Fai* is largely confined to the Vientiane area, which faces Thailand from the banks of the Mekong and Luang Prabang, the old capital. Basically, according to Thongtanh Souvannaphanh, who made a rocket for the Washington, D.C. festival just cited, the festivals of Thailand and Laos are very similar, except that in Laos, as he recalls from his youth, the Buddhist monks play a central role and are (or were) the holders of the secrets of making rockets with laymen assisting. Klausner affirms this, observing that in Vientiane the *Boun Bang Fai* ceremony is even more intimately associated and identified with Buddhism" [6]. In both Thailand and Laos, however, nothing is written of the making of the rockets, which is passed down orally and largely learned by empirical practice.

The festival is a competition between different villages or *wats* (temples) as to which rocket goes the highest. Judges with stopwatches time flights from lift-offs to landings. At the *Boun Bang Fai* witnessed by the author on May 22, 1977 at Nong Son Hon, about 12 km south of Nong Khai, northeast Thailand, the typical times of flight were noted on the judges scoresheets: 24.5 seconds, 22.5 seconds, 23, 19.5, 33.1, and 10.1 seconds. Nong Son Hon is a provincial town, however, and the rockets were small to medium-sized, averaging about 20 ft (6 m) long. About 20-30

were fired during the festival. (Though one rocket guidestick was measured on the ground by the author with tape measure and was found to be 45 ft or 13.7 m long.) Hoskin, who observed the largest of the Thai *Bang Fai* rocket festivals, held at Yasothon, capital of Yasothon Province (Figure 1), 578 km (360 miles) northeast of Bangkok, reports that expected burn times were around 40 seconds, and that the record claimed was 70 seconds. (The average number of rockets fired each year at Yasothon is between 70 and 80.) [7]. The largest rockets at Yasothon are carried on decorated vans and may measure 13 ft (4 m) for the casing, plus a 33 ft (10 m) stabilizing stick or tail of bamboo. The large Yasothon rockets, Hoskin continues, are packed with 150-200 kilos (330-440 lbs) of gunpowder, but this does not appear to be the norm. Tournier, the earliest reference this researcher has found on the *Bang Fai* phenomenon, published in 1900, notes that certain of the Lao rockets reach 12 to 15 m (40-50 ft) long and are charged with 10 to 12 kilos (22-26 lbs) of powder [8]. While Meeker, in 1959, says Lao *Bang Fai* rockets are 20-30 ft (6-9 m) long, with the largest ones "charged with as many pounds of saltpeter [gunpowder]."

In none of the published sources consulted are diameters of *Bang Fai* rockets mentioned, though the author found that the maximum outside diameter of the bamboo rocket cases in the Nong Khai area are 5 in (12.7 cm). The inside diameter is 4.25 in (10.7 cm). But the finished rocket cases actually consist of about seven bamboo shafts lashed in a bundle, with only one shaft serving as the propulsion tube. The extra, empty shafts are decorative only, and artificially expand the size of the rocket. True diameters of *Bang Fai* rockets might thus amount to more than a foot (30 cm), and they are made even more imposing by the attachment of traditional Naga, or snake head cutouts along the rockets. More about Naga decorations later. The length of each average bamboo section from joint to joint, as measured near Nong Khai, is 11 in (28 cm), while the maximum outside diameter of the guidestick is 3.25 in (8.2 cm), tapering down to 0.25 in (0.6 cm). *Bang Fai* rocket altitudes are difficult to gauge, but those at Nong Son Hon appeared to have soared to around 500 ft (150 m). Some *Bang Fai* rockets go up to 1,000 ft (304 m) or more, and a few have been known to fly across the Mekong River into Laos, perhaps half a mile (800 m) away, at a narrow point at Nong Son Hon and other locations.

Since the *Bang Fai* festivals are part religious, part carnival, bets are wagered on rocket performances, bets averaging from 100 to 1,000 Thai Bahts (\$5-\$50), with equivalent amounts bet in Laotian Kips. Both honor and money are bestowed upon the winners; loving cups have also been mentioned at Nong Son Hon, though these were not seen. The "losers," or those whose rockets utterly fail, as many do, are unceremoniously tossed into the Mekong River or handy mudholes with jokes made at their expense. The entire atmosphere of *Bang Fai* festivals is one of revelry yet reverence for the tradition and the holy Buddhist monks. To many, the underlying theme is not forgotten. They believe a misfired rocket offends the rain spirits, portending bad crops or other ill-fortune. But generally, the usually placid Thai and Lao in these regions are uncharacteristically uninhibited during the celebration, ribald humor abounding, but with the always solemn monks and local policemen on hand to make sure everything remains genuinely peaceful.



**Figure 1** Poster of the largest Bang Fai rocket festival which was held at Yasothon Province in Thailand, 1981 (courtesy, Tourist Authority of Thailand).

Most writers on the *Bang Fai* festival, notably Tambiah, Deydier, Faure, Zago and Archambault, dwell upon details of the rites themselves, and the very complex intertwining of their Buddhistic-animistic-Brahmanic elements [10]. But it is enough for our purposes here to state that the festival lasts three days, and is sometimes initiated by villagers paying homage and offerings to the village guardian spirit contained in a miniature *wat* on the outskirts of the village. Traditionally, the village elders meet to decide whether to hold the festival or not, and when. (Tambiah makes the significant point that it is more important for the right climatic conditions to be present than to necessarily have the festival held on Visakha Puja, celebrating the birth, enlightenment and death of the Buddha—indicating that the Buddhists probably adopted the festival as their own.) When all is approved for the festival, the *wat* becomes the center of activities. The monks bless the opening of the festivities, but all the monks interviewed by the author are adamant that there is neither a special *Bang Fai* prayer, nor do they mention the festival in Buddhistic writings. Rather, there is a generic blessing for the well-being of the people, their crops and animals. On the second day there is a parade of the rockets three times around the temple, signifying the Triple Gems of Buddhist theology. Offerings are also given to the monks, which may include saffron robes, sandals, begging bowls, blankets, rice, fruit, and so on. Graceful dances to the beating of tam-tams and other instruments are held, while on the third day the rockets are fired. At Yasothon, the Governor often fires the first or "prediction" rocket, which predicts whether the rains will come. The other rockets communicate with the rain spirits, sometimes identified as Phraya Thaen, or the Lord of the Rain. Communication can also be made with the Phi, or (animistic) spirits. Besides the rocket altitude or "religious rocketry contest," as it has sometimes been called, there are also sub-contests for the best-looking rockets. (At the Smithsonian's Laotian Rocket Festival mentioned above, the author was one of the judges for choosing the most attractive rocket and the best chanting and dancing, the grading done on a one-to-ten point system; local fire regulations prohibited the actual firing of rockets on this occasion, so they were all inert.)

The best *Bang Fai* rockets (Figure 2) are gorgeously decorated with colored foil paper, banners, garlands or tassels and the all-important Naga snake head and back. The Cobra snake heads and backs are painted wood cutouts that are easily detachable from the rockets prior to firing and are used over and over again like Christmas tree ornaments in the West. Not all *Bang Fai* rockets come with Naga heads, however. The bigger rockets may also include curious parasols, which are similarly removed before liftoff. The importance of the Naga is that he is the Hindu god of the soil, a fertility symbol and deity from India. Buddhist mythology also holds that the Naga protected the Buddha during a 7-day rain at Lake Muchalinda following his "awakening." The Naga protected the Buddha by spreading his hood like a parasol, which is probably the reason for this feature on the rocket.

The usual launcher for a *Bang Fai* rocket is a crudely-made ladder or scaffold of flat pieces of wood or thick branches, which is propped against a tree at an 80-90° angle. At Nong Son Hon, no "countdowns" were called. The rockets were simply laid against a ladder, while a man in the tree, at great risk to himself, lighted the fuse when the signal was given on the ground by another man waving a tree-



branch. (Evidently the man on the ground had to await a nod from the judges.) The man in the tree remained there, awaiting the next rocket.



**Figure 2** Rocket dance during a **Boun Bang Fai** at Yasothon, ca. 1976. There are also special **Bang Fai** songs for the occasion. The Naga snake head, umbrella and tasseled decorations are removed prior to a flight (postcard, author's collection).

## **ASCRIBED ORIGINS OF THE BANG FAI**

None of the *Bang Fai* participants interviewed, nor any of the sources consulted, were able to relate a factual account of the origin of the rocket festival, though numerous mythological legends are offered. Excerpts of a few are presented to give a flavor of them. Deydier, for example, tells of the sons of the King of the Nagas, who were "the rival of Thao Phadeng for obtaining the hand of Nang Ay. The father of Nang Ay did not know to whom to give his daughter. He counseled the two suitors upon the fabrication of rockets. The one who could send the rocket to the greatest distance would become the husband of Nang Ay. Thao Phadeng won, but the sons of the King of the Nagas did not accept defeat and decided to obtain Nang Ay dead or alive. . ." The story continues [11].

A more complicated version of this tale is given by Tambiah, in which the events are placed in the city of Eak Cha Chi Ta in Nong Han (now Sakhon, Nakhon Province of Thailand). Nang Ay's father is identified as Phya Khom, while the suitor is Chao Pa Dang (or Thao Phadeng). There is also a rocket festival to decide the winner of the hand of Nang Ay (also given as Aikom). There is a good deal of magic and subplots in the story which need not be related here. What is of interest for our purposes is that Tambiah identifies Phya Khom as a Cambodian or Khmer name, though we cannot automatically assume that the tale—and hence the festival—dates to the Khmer period (9th to 15h Centuries A.D.) [12].

Still other variations of the Nang Ay story are found. According to Meeker, the modern *Bang Fai* commemorates the wedding of a "southern Lao princess," during which rockets were fired for three days. The inhabitants of the heavens became fearful that the wedding guests were trying to set fire to them and asked help from the Hindu God Indra, who doused the pyrotechnics. Hence rain is encouraged by the firing of rockets [13].

Another fable, given by Deydier, says that on the day of Thao Kathanam's marriage with the daughter of the King of Champa there was a great fete:

Installed on the summit of Mount Gijakuta [the mythological Vulture's Peak], the Yaksa [a class of superhuman beings like gnomes], the Gandharva [servants of the god Indra] and the Phi [spirits] launched rockets for celebrating the event. During three days, all the rockets mounted towards the sky, where they reached the world of Catullokapala [the four guardians of the world]. The Then [genies] thought that the habitants of the Earth launched fire for burning the Muong Then [city of the Then]. They proceeded to place themselves under the protection of the God Indra. The latter provoked the storms, rain and a great cutting wind for destroying these balls of fire. The debris of the rockets fell on Earth, catching the trees and devouring parasite plants. After that day, when they were able to obtain rain, they launched the rockets towards the sky for frightening the Then [14].

Archaimbault collected more elaborate versions of this tale, one of which involves the daughter of the King of Champasak. It is also mentioned that the rockets were made of different sizes and weights, by genies who compressed the powder very well into bamboos, then closed them with mixtures of cooked and uncooked rice and perfumed leaves. The "divinities" then fixed on the rocket sticks, inserted the fuses and ornately decorated the rockets with gilded gold and silver sheets and stones of seven colors. The wind broke the rockets, which then scattered the stones and gilded sheets into flowers and fruits of all sorts over the forests, plains and mountains. Since that time, men have tried to imitate the work of the Phi spirits in making beautifully decorated rockets [15]. Champa was a real entity. It was a heavily Indianized and powerful kingdom on the east coast of present Vietnam, lasting from 192-1471 A.D., and comprising parts of Laos and Cambodia. Champasak is a city in southern Laos and was established as a kingdom itself in 1713.

Additionally, there is the brief explanation by the Thai writer Pramaj Thasanasuman, who says that the *Bang Fai* is a custom derived from Brahmanic fire worship, particularly of the Khom group, which used to dominate a part of the "golden peninsular" covering most of northeastern Thailand, "the Khoms still practising fire worship" [16]. Similarly, Archaimbault identifies the cult of Upagutta "engaged in the fete of rockets in southern and middle Laos." Manifestations of the Upagutta (also spelled as Uppakrut, or Phra Uppakrut) are mentioned in detail by Tambiah [17]. An even more bizarre "clue" along these lines is given by Deydier, who notes that on all the rockets fired in the Thai *Bang Fai* festivals is a curious motif, which is also seen (ca. 1952) on the bracelets and necklaces of the people in the Laotian province of Chieng Khouang (Xieng Khoang). He observes that "certain reliable authors have circulated the hypotheses that these motifs . . . are the survival of the old Sun cult. . ." Following the pillage of Vientiane by the Siamese in 1827, Deydier concludes, the majority (20,000) of the population was "deported to

the right side of the Mekong River [to Nong Khai]," and that the Thai practitioners of the *Bang Fai* custom may indeed be descendants of the former Laotian Sun cult. No particular "motif," however, was noted by the author in his observations of *Bang Fai* rockets near Nong Khai [18].

## RATIONAL EXPLANATIONS OF THE ORIGIN OF THE BANG FAI ROCKETS

As fantastic as the above myths and cult explanations can be, there is still something to be learned towards a rational interpretation of the probable origin of the *Bang Fai* rockets. Perhaps the most important point is that none of the legends and explanations exhibit Chinese roots. Rather, the emphasis is upon Indian mythology or heavily Indianized Southeast Asian folklore. The Indian Naga Cobra-God decoration is particularly compelling. On the other hand, it cannot be entirely dismissed that Sung or later Chinese dynasty traders, missions or missionaries may have implanted knowledge of gunpowder or fireworks, or of the basic construction of the gunpowder rocket, which was then adapted to the needs of the Indianized Asian cultures.

The question of origin is indeed a most puzzling if not impossible one to unravel. Apart from the difficulty in confronting a melange of myths and languages, the historian of early rocketry is also faced with the fact that for centuries the southern Laotian-northeastern Thailand (old Siam) regions have always been agricultural and remote, and thus rarely visited by outsiders, who may have noted the strange and colorful *Bang Fai* custom. Moreover, a visitor would have had to have arrived in the area precisely on time for the once-a-year festival. It was mentioned above that the earliest reference found on the *Bang Fai* is dated to 1900 (Tournier, ref. 8, which was actually written in 1899). The Jesuit father Giovanni Maria Leira and the Dutch merchant Gerrit Van Wusthoff were evidently the first Europeans to reach Vientiane, in 1641, the latter writing an interesting account of his travels, though Europeans (notably the Portuguese) had been to Siam earlier. Van Wusthoff arrived on a feast day, but it was during the 12th month, not the 6th. He did see fireworks, which had also been seen at Lakhon, but they were not connected with the *Bang Fai*, nor were they described in any detail [19]. A similar early account, by Monsieur de la Loubere, following his visit to Siam in 1687-1688, says interestingly: "I saw no Fire-works, in which nevertheless the *Chineses* [sic] of *Siam* do excel, and they made some very curious [ones] during our residence at *Siam* and *Louvo*" [20].

Several other early European descriptions or mentions of Siamese and Lao fireworks have been found, mainly dating to the 19th century, but one of the most interesting and relevant is a newspaper cutting appearing to date from September, 1784:

"On Fire Balloons—*Petits de la Croix's* Reception of the French Ambassador by the *King of Siam*. . . The fireworks that were played at night were perfectly fine. There were rockets as big as one of our hogsheads, and of proportionable length. They mounted about the middle region of the air, and cast so great a blaze, that they lighted the country six leagues [18 miles or 30 km] around. . . The inventor of this firework sitting himself down on the end of one of these rockets, ordered it to be fired, and was whisked up into the air higher than any four steeples in the world could reach were they set one upon another. The

rocket, having spent its strength, and being ready to fall down . . . the engineer opened a sort of umbrella he had carried with him, which when it was extended, was little less than thirty feet [9 m] in diameter. This umbrella was made of feathers [by which the engineer] . . . came to the ground" [21].

Could the "engineer" have been a northeastern Siamese who had come to the newly established (1783) capital of Bangkok to dramatically demonstrate a *Bang Fai* rocket with a larger *parasol cum parachute*? If nothing else, this account shows the Siamese were expert pyrotechnists by this period.

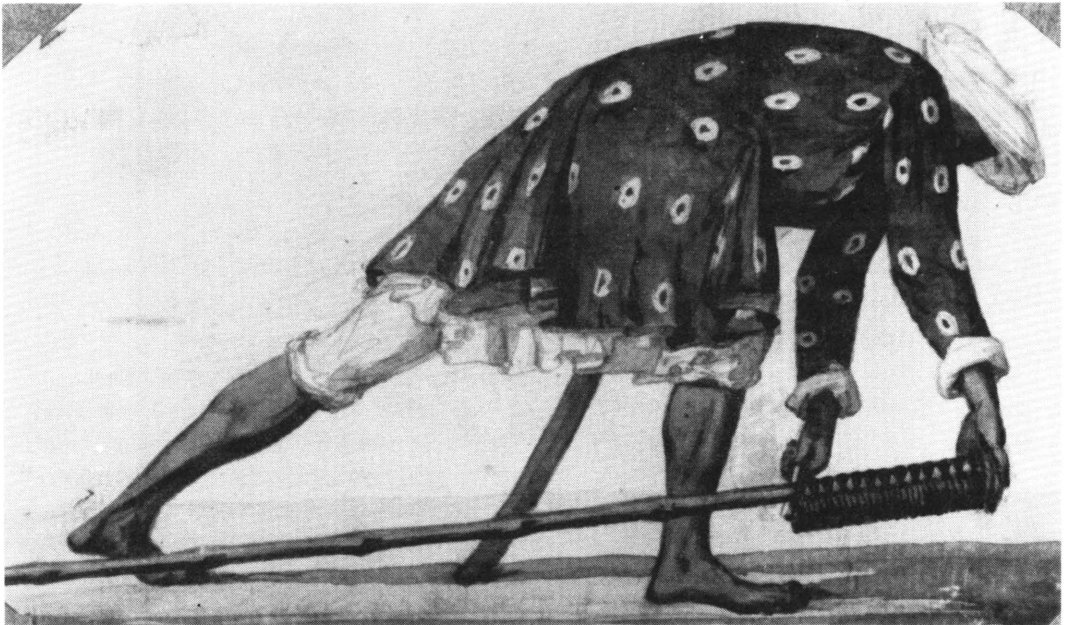
Another important firework description comes from the Chinese merchant Chou Ta-Kouan when he visited Angkor, the fabulous capital of the Khmers in Kambuja (Cambodia) during 1296-1297. If one can believe the translation, fireworks were then already well developed and set off during feast days. Masts as tall as 120 ft (35 m) were placed in front of the palace for launching rockets. The rockets, or simply "fireworks" or "firecrackers" as rendered by Sun, were allegedly fired from the tops and could be seen for 100 li (35 miles or 55 km). Chou Ta-Kouan also spoke of saltpeter imported from China to Kambuja, though obviously the Khmers were able to procure or prepare their own [22].



Figure 3 Chinese firework vendor selling skyrockets during Chinese New Year, 18th century. Note the diminutive size of the rockets (detail of a color handscroll of New Year scenes by Ting Kuan-P'eng, National Palace Museum, Taipei).

Though it is difficult to establish any historical connection between supposed 13th century Cambodian rockets and the Siamese (or Thai) and Laotian *Bang Fai* variety, there is indication enough that pyrotechny was generally known and practiced in the Indianized Southeast Asian states by the 17th century and possibly going back to the 13th century. There is also a suggestion that the Chinese, or Chinese residents of Siam and Laos, may have introduced pyrotechny or had prac-

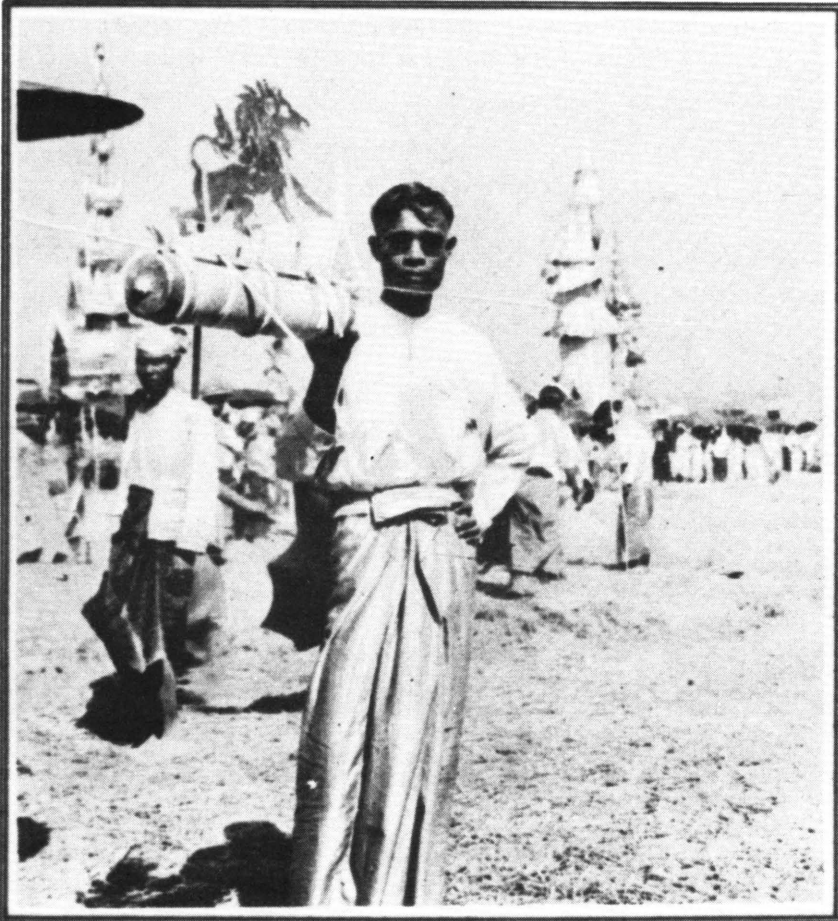
ticed it for some years in this region. However, as pointed out in the author's earlier researches into Chinese rocketry, the Chinese preferred to keep their firework and war rockets small, and do not appear to have developed rockets to any great extent, even up to the 19th century. Westerners during the Opium War period are known to have mocked Chinese war rockets for their diminutiveness and ineffectiveness, and it is noted that the basic design or construction of the standard 19th century Chinese war rocket differed little from those described and depicted in the famous *Wu Pei Chi* (Records of War Preparations) written by Mao Yuan-I in 1621 [23]. Nonetheless, there is considerable datable evidence, as seen in the investigations of Prof. Sun, Pan Jixing, and Prof. Needham cited above (Refs. 1 and 4), that the Chinese do indeed appear to have originated gunpowder and the rocket. But again, Chinese rockets evidently did not undergo much development, especially in size. They weighed but a few ounces during the Opium Wars of the 1840s-1860s, as contrasted with more advanced Indian war rockets of the 18th and earlier centuries, which weighed, on the average, 6 lbs (2.7 kg). The latter were effective enough to have inspired the British of the Napoleonic era to evolve their "Congreve rockets." In technology alone, Indian rocketry may therefore well have played a role in the development, if not the origin, of the *Bang Fai* rockets [24] (Figure 3).



**Figure 4** Indian rocketeer firing a war rocket, late 18th century. The rockets were either laid upon the ground and ignited, propped up against rocks or trees, or lit and thrown (from Robert Home, *Album of Sketches Including Classical and Renaissance*, Victoria and Albert Museum, London).

Finally, there is one more factor to consider in determining the possible origin of these rockets. There is (or was) another exotic Asian application of rocketry, the funeral rockets of Burma. These were extremely large and were fired at funerals, usually of elder Buddhist monks or "bonzes." European descriptions of this custom go back to at least the late 18th century. The rocket cases were made out of hol-

lowed tree trunks, some being 20 ft (6 m) long. To prevent them from splitting, the Burmese funeral rockets were secured with iron hoops and also wrapped with rattan, similar to the construction of the *Bang Fai* variety. Cox reported that in 1797 the King of Burma set out to make one with an astounding 10,500 lbs (4,760 kg) of powder [25] (Figure 4). Variations of this custom, which has been reported in our own century, consist of huge bamboo and paper-covered pagoda-like structures called *pyathats*, which are decorated with scenes from the life of the Buddha. On one level of the pythat lies the corpse of the deceased bonze. He is cremated with the aid of decorated rockets running up lines toward the top of the pythat. The rockets are made of hollowed-out bamboo stalks, four or five feet (1.2 to 1.5 m) long and bound securely with bamboo straps. Others are known to be eight to nine feet (2.4 to 2.7 m) long and four or five (1.2 to 1.5 m) in circumference, secured with iron hoops and rattan lashings. Cardboard or metal cutouts of religious or mythical figures or animals are mounted on them such as tigers or hares. Byron significantly noted that Nagas were (ca. 1930) among the "favourites." [26] (Figure 5).



**Figure 5** Burmese funeral rocket which moves along a rope and sets fire to a *pythat*, a pagoda-like structure holding the body of a deceased high Buddhist monk, thereby cremating him. Note the lion decoration on top of the rocket. Naga shapes are also used (From *The Illustrated London News*, Vol. 176, May 17, 1930, p.870).

Considering the sizes of the Burmese rockets, the Naga motif, the country's proximity to Thailand and Laos, and its Theravada Buddhism, it does not seem unreasonable to assume that there may be some connection between the funeral and *Bang Fai* rockets, or at least between the technologies. The allusion to the Buddha's funeral pyre mentioned by Klausner and others in explaining the origin of the *Bang Fai* tradition, is pertinent [27]. Unfortunately, when the author visited Rangoon in 1977, following his observations of the *Bang Fai* festival in Thailand, there was no opportunity to witness Burmese funeral rockets, nor could the librarian of the University of Rangoon shed any light on the matter, though it was believed that the custom of using the rockets was still practiced. In any event, it is conceivable that along with other aspects of Indianization, rocket technology, particularly the making of large rockets, may have been transferred from India to Burma, then to either Thailand or Laos, where it was adapted to local needs and customs. The Burmese had long engaged in trade, as well as conflict, with their Thai and Lao neighbors. (In the latter regard for example, Vientiane was seized by Burma in 1574, and remained in Burmese control until Soulingna-Vongsa ascended the throne in 1637.)

In the final analysis, the theories expressed above require considerably more research, especially in the histories of trade and cultural intercourse between Thailand, Laos, China and India.

## CONSTRUCTION OF BANG FAI ROCKETS

The making of *Bang Fai* rockets is rarely mentioned in descriptions of the festival. Perhaps this is because it is an oral tradition. Also, in Laos where the monks play a leading role in the manufacture, they wish to maintain their monopoly. Likewise, Western and other observers are (and have always been) so entranced by the festival's spectacle and complex religious fabric, that they ignore its technology.

Each *wat* (temple) has its own style, but generally, according to Thasanasuman, there are three types of rockets: the standard-sized *Bang Fai*, which holds no more than 12 kilograms (26 lbs) of powder; the medium size, known as *Bang Fai Mun*, holding more than 12 kilos; and the large size, called *Bang Fai Saen*, holding as much as 120 kilograms (264 lbs) and up. It takes a real expert to make the *Bang Fai Saen*, which may easily explode, and which are very expensive (In the smaller communities the expense of the *Bang Fai* rocket which, after all, represents the town or village in the *Bang Fai* contest, is borne by donations throughout the community.). The usual rockets made are the *Bang Fai Mun* [28].

The rockets are prepared weeks before the festival. The first step is to gather long stalks of *mai phai* or wood bamboo that are straight, hard, and of the proper dimensions. This is not so easy as it sounds. Traditionally, the rockets should be made of wood, not metal pipes, which is considered "cheating" as well as dangerous, according to Soulamany. However, since about 1985 polyvinyl-chloride, or PVC, plastic drain pipes are being substituted, because they are safe, easy to work (cut and drill), strong, lightweight which gives better fuel to weight ratios, come in convenient sizes and are cheap. PVC seems to be permissible [29]. (Following the

Smithsonian Lao Rocket Festival mentioned above, the author was able to procure one of the rockets for the collection of the National Air and Space Museum; this 17 ft 4 in., or 5.3 m long rocket is made of PVC but has a cardboard Naga head.) If bamboo is used, it must be stripped of leaves with a *phla* knife and Sun-dried or burned to make it dry. It is also reamed out with a rod called a *lequam*. A stalk of bamboo averages 3-4 m (10-13 ft) in length. PVC piping comes in 10 ft (3 m) lengths and different diameters, the most commonly used being in the 3 to 6 inch (7.7-15.2 cm) range for small to large sized-rockets. Zinc sheets are fitted into the PVC tubes, which are then bound tightly with coiled ropes to prevent splitting, and to limit fragmentation, should the rocket burst. Steel wire may also be used for the binding [30].

Next comes the critical preparation of the gunpowder. Formulae are sometimes "temple secrets," since they may prematurely disclose expected rocket performance. At least this is one belief, since the *Bang Fai* rocket powders do not vary that much. Picanon, writing in 1901 of Laotian *Bang Fai* rockets, mentions ten parts of saltpeter, three parts of charcoal and one part of sulfur [31]. At Nong Son Hon, the author was informed by rocket-maker Wan Polsak that a standard formula was ten parts saltpeter, three parts charcoal and four parts of sulfur. While Hoskin at Yasothon learned of the formula three parts charcoal to ten parts saltpeter, with no addition of sulfur [32].

The saltpeter, called *kikiya*, is not always of the best kind. Indeed, as far back as the 17th century, Loubere wrote:

They do make very bad Gunpowder [for guns]. The defect, they say, proceeds from the *Salt-Petre* which they gather from their Rocks, where it is made of the dung of Batts [sic], Animals which are exceeding[ly] large and very plentiful throughout India [i.e. Siam]. But whether this Salt-Petre be good or bad, the King of *Siam* sells a great deal of it to Strangers [33].

This of course was bat guano, from which sodium nitrate, or so-called "Chilean saltpeter," is extracted. The Kha Chong Pran cave in northeast Thailand is especially well known for bat guano mining, the nitrates and phosphates used mainly for fertilizers. Souvannaphanh recalls that bat guano was also used for rocket powder in Laos, whereas in Thailand the guano of the *ging ging* bird is sometimes used [34]. Seventeenth century European travel accounts other than Loubere's mention the old Siamese saltpeter trade, which was a monopoly of the King. Tournier, writing in 1900 (1899) lists, among Laos' natural resources, carbon beds at Se-kong and Luang Prabang; sulfur mines at Luang Prabang and Hua-Panh; and saltpeter mines at Vientiane and Luang Prabang. (Both the early history of firearms and saltpeter trade in Siam are still imperfectly known, though in 1922 Sewell wrote on the former) [35]. It is assumed that the saltpeter mines mentioned by Tournier were legitimately of potassium nitrate. In any case, Souvannaphanh says that commercially bought potassium nitrate, of the kind used for meat preservation, is also obtained for the rockets. The *kikiya*, of whatever grade, is boiled with water, the powdered charcoal added and heat reduced while constantly being stirred. (No mention is made in this account of the addition of the sulfur, which is often not included.) If mined indigenously, no doubt the sulfur is prepared, or used to be, in a manner



similar to the methods described by Yunming [36]. As with potassium nitrate, commercially refined sulfur is also purchased. The charcoal is always homemade. Bamboo is not used because it is too hard.

According to Soulamany: "Take *mai pheuai* or *maillao hang*, very dry wood, and cut it into splints the size of a finger and about 12 inches (30.4 cm) long. The wood is then burned to make charcoal (but the pit is not buried in earth). The charcoal is carefully cleaned to remove dirt." At Nong Son Hon, the charcoal was burned in a clay oven for 12 hours. When all the ingredients are thus made and brought together in the right proportions, they are spread out in the Sun to dry, and then the dried mixture is pounded in a wooden mortar until it is a fine powder [37].

The rocket body is further prepared by stopping one end with a piece of *ton samek* wood and mud. A hole may be made for ignition, but ignition from the top of the rocket is a personal preference and is generally not considered safe. If PCV pipes are used, the top and bottom are plugged with a thick paste of clay and sugar, the sugar acting as a binder. Hard wooden plugs are then added and bolted to the top of the plastic PCV body. The powder is then poured into the rocket (or PCV) tubes, and pounded until it is rock hard. The powder is tested from time to time during the mixing and pounding process simply by taking a pinch and burning it, according to Souvannaphanh. Often, the pounding and other rocket-making is conducted right in the temple pavilion, by having one or two wood planks removed from the floor, and placing the rocket case upright for filling. Heavy wooden pestles bound with cloth are used for pounding or tamping. This "pounder" is call a *sak*. If the rocket is loaded outside, it can be propped against a tree. Normally, half a kilo (1 lb) of powder is placed in every time. According to Soulamany, a 12 inch (30.4 cm) depth of powder is tamped down to two or three inches (5 to 7.6 cm) thickness. There are, however, different strengths of powder. The strongest powder is in the middle, with layers of less powerful powder on either side. Interestingly enough, *Bang Fai* rockets approximate the conical exhaust cavities common to Western gunpowder, or pyrotechnic, rockets. This is done with a series of stepped-down cylindrical holes or cavities. In either case, the effect is still the same, to provide an internal burning area. Some *Bang Fai* rockets, however, may be driven "solid," with the lengthy and narrow fuse hole serving as the cavity. It would be worthwhile to learn if Burmese or early Indian rockets were made this way too [38].

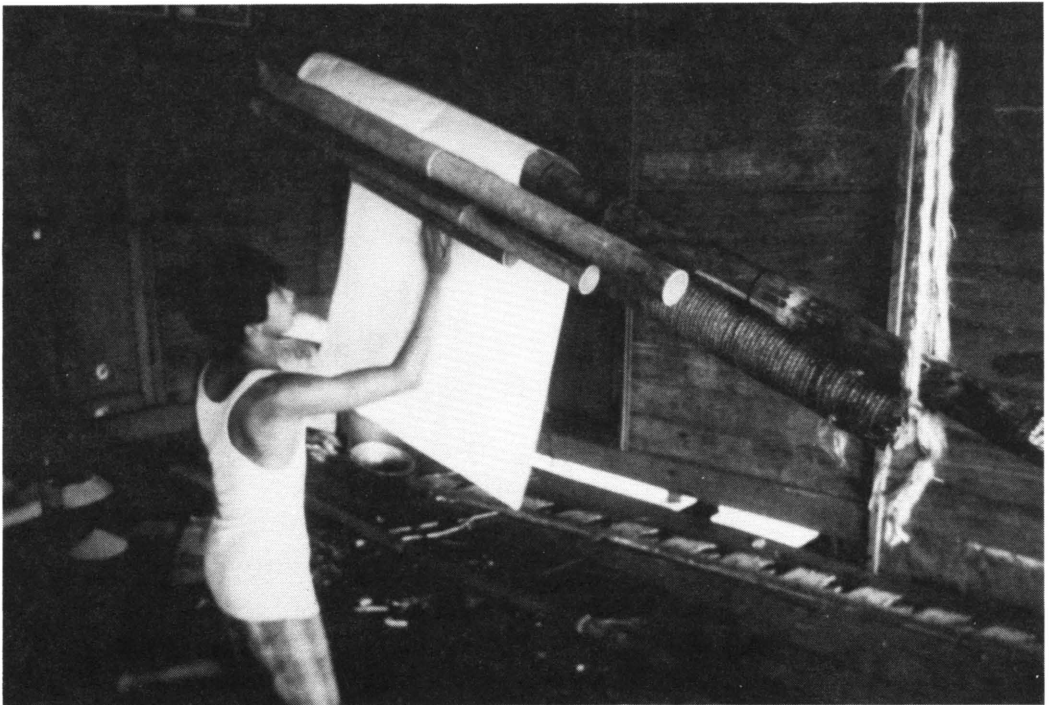
For larger rockets, a modern innovation is the automobile jack, which the author saw being used as a hydraulic rocket press. Following the powder charging, by whatever means, the bodies of the rockets are often wrapped with coils of rattan or rope wet with water, so that they constrict and become tighter as they dry [39].

A long, straight, wrought-iron rod is used to tamp in the fuse hole, which almost runs the length of the interior of the rocket. This must be carefully done by an experienced person so that the hole is straight and not off-center. The preferred way is for the fuse to protrude from the bottom, though as mentioned earlier, top-burning fuses have also been tried. The fuse powder is made of the same formula as the propellant, only wetted to make it burn slower. The final part of the rocket-making is attaching the guidestick with three or four strands of wire, each at about six places equi-distant from each other [40].

The rockets are then decorated. The author witnessed this process, which, for a standard-size rocket, may take three or four hours. Additional lengths of bamboo, usually about seven in number, are attached around the charged rocket body and cut to the same length, so that the rocket body becomes fatter. These additional tubes are hollow and only meant for decoration, though they do add considerable weight to the finished rocket and no doubt retard its performance. The young Thais (often pre-teens) engaged in decorating the rockets, carefully mark with pencils where each section should fit and where it should be cut (Figure 6). (Older, more experienced hands actually make the rockets.) The extra bamboo sections are secured with wire or rattan strips. "Sometimes these sections have soundmaking instruments attached or are made like whistles, so that as they fly, they make a sound," says Souvannaphanh. In the decorated rocket observed by the writer, the front ends of the additional bamboo tubes were simply shaved off at 45°, giving the finished rocket a somewhat pointed, though large head. Homemade paste, which may be made out of rice-water or tapioca, is rubbed along the smooth rocket body and tail. First, white sheets of paper are applied as a kind of undercoat, then store-bought gift-wrapping and other colored paper is pasted or stapled on this, until the entire rocket is covered in a most colorful and pleasing way (Figure 7). Red, green, and blue aluminum foil sheets are also used as decoration covering. If Naga head and back cutouts are available, these are added and apparently fitted into specially sawed out slots on the rocket body. The *Bang Fai* rocket is thus complete and ready to fire to meet the rain spirits [41].

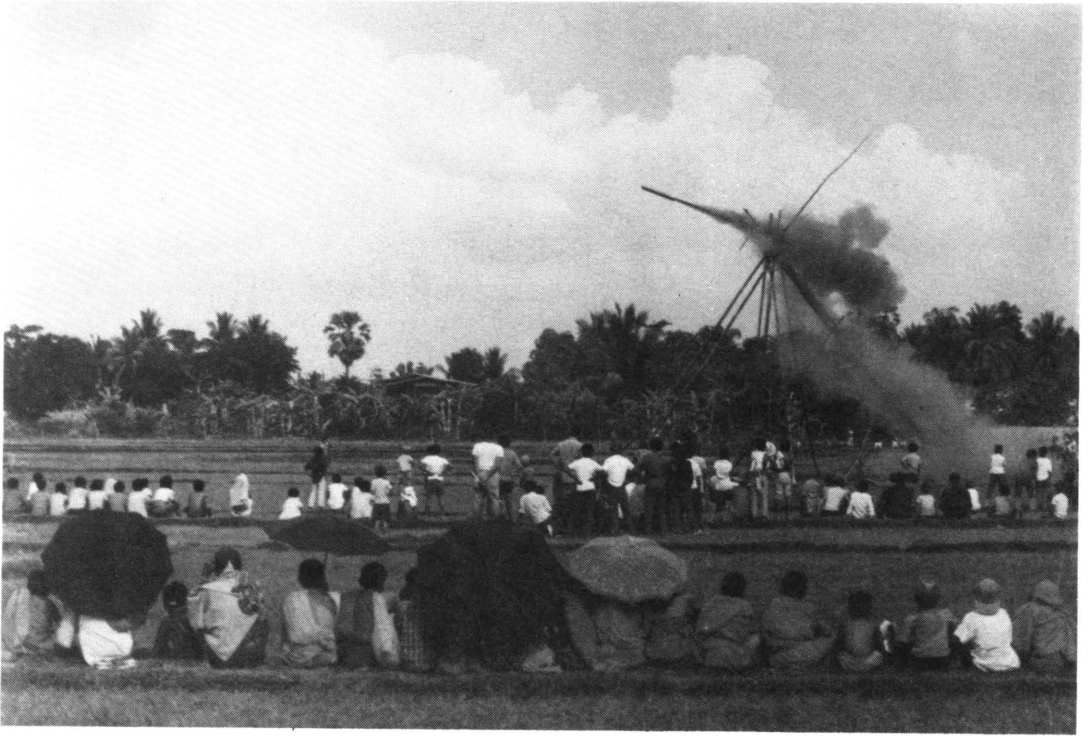


**Figure 6** Measuring a Boun Bang Fai rocket during its construction, Nong Khai, Thailand, May 20, 1977 (photo by Frank H. Winter).

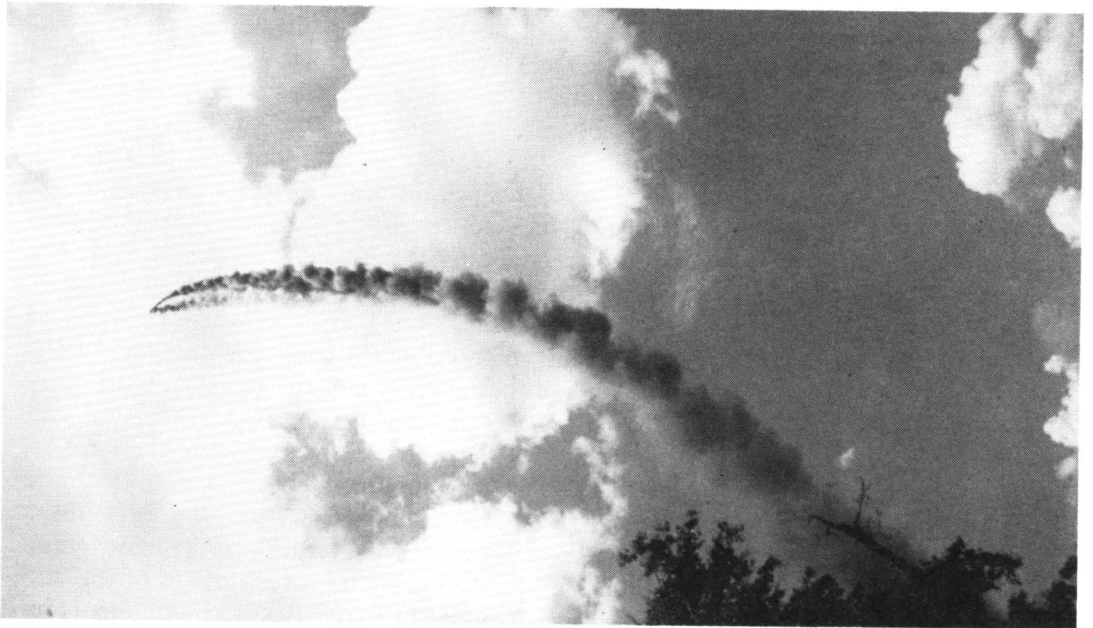


**Figure 7** Gluing the undersheet of white paper during the decoration of a *Bang Fai* rocket, Nong Khai, Thailand, May 20, 1977. Note the rope wrapping around the central, propulsive tube of the rocket. Note also, on the ground, the Naga snake back fixture, which fits into slots on the rocket body (photo by Frank H. Winter).

Just recently, however, sometime after this paper was written, the author learned two interesting new facts, which further add to the puzzle of the *Bang Fai* phenomena. In the first instance, the Tai (Thai) peoples of the Hsi-shuang-bana region of Yunan, China, similarly practice the *Bang Fai* custom. In the second instance, in Japan, there is a remarkably similar annual custom of launching large home-made bamboo rockets. Known as the Dragon Rocket Festival of Yoshida-cho, in Saitama Prefecture, west of Tokyo, this event takes place every October 5th, apparently as a Shinto (or animistic) harvest festival. New questions are thus opened. In the case of the *Bang Fai* practiced by the Tai, did the *Boun Bang Fai* originate in China after all? Or, if the custom (and/or technology) began in India, did it spread to Southern China first and then into the Laos-Siam region? Thus, we are essentially back at our starting point: Where did this phenomena start in the first place? Yet the manifestation of another annual rocket festival in far away Japan poses still more mysteries: Are the Dragon and *Boun Bang Fai* festivals related? Or did they evolve independently? Or was the Dragon Festival, and/or its technology, later "imported" into Japan by a traveler from Thailand or Laos? The present study, then, is incomplete and requires follow-up papers and certainly a separate one on the Yoshida Festival. It is hoped at least, that the paper presented here contributes toward the groundwork in the continuing investigation of the still largely unknown and important area of the spread of early rocket technology (Figures 8 and 9) [42].



**Figure 8** Boun Bang Fai launch in Laos, ca. 1983. From a calendar published by La Direction du Cinema Lao, 1984 (courtesy, Frank Proschan, Smithsonian Folklife Festival Office).



**Figure 9** Launch of a Boun Bang Fai rocket, Nong Song Hong, Thailand, May 22, 1977 (photo by Frank H. Winter).

## ADDITIONAL REFERENCE NOTES

4. Since writing this paper, Professor Needham has produced his long awaited *Science and Civilisation in China - Vol. 5 - Chemistry and Chemical Technology Part 7: Military Technology; The Gunpowder Epic* (Cambridge University Press: Cambridge, 1986), which must be considered the most definitive source of the history of early Chinese rocketry. I am grateful and honored by his mention in this work of my earlier allusion to *Bang Fai* rockets.
6. Virtually identical to the Laotian *Boun Bang Fai* phenomena is the That Luang festival of Laos which, before the Communist regime banned it about 1975, was held every October or November on the That Luang parade grounds of Vientiane as an Asian Spring festival to pray for rain to help the rice crop. The author learned of this festival after the preparation of this paper. See: Lorna B. Grobb, "Laotian Festival," *Asia and the Americas*, Vol. XLVI, November 1946, pp.498-499; and David A. Andelman, "Laos After the Takeover," *New York Times Magazine*, October 24, 1976, p.14. It is also interesting to note the existence of the Xe Bangfei River, which runs from the middle of Laos, across the Mekong and into the Nong Lahan Lake near Sakon Nakhon, Thailand.
11. The "Triple Gems," or Threefold Refuge of Buddhist theology, are: "I go to the Buddha for refuge, I go to the Doctrine for refuge, I go to the Order for refuge."
17. Tambiah identifies Uppakrut as a swamp spirit "which also symbolizes rain." He protects the village and ensures rain. Villagers thus identify him with the Naga. Tambiah adds that Uppakrut was the subject of a local Indian cult centered in Mathura or Muttra, just south of Delhi along the Jumna River. Uppakrut, rendered as Upagotha, likewise appears in Burmese legends and rituals.
20. Fireworks have, of course, been well known and practiced in both China and India alike for centuries. The Indian *Divali* Festival, or Festival of Lights, is of some interest, since it too has to do with agriculture and is essentially a harvest celebration. *Divali* is one of the most important festivals of the Hindu year and occurs during late October to early November. Lamps are lit and fireworks let off. However, unlike *Bang Fai*, it does not feature very large rockets.
26. Still another variation of the Burmese funeral rockets was for the rockets, called *doons*, to be fastened to the axles of low, four-wheeled carriages. "Surmounting these," wrote Christopher Winter in 1858, "are placed figures of men and animals of the most grotesque description. . ." The animals included elephants, rams, buffaloes and dragons (note that the Naga of India and Thailand is also a kind of dragon). These curious rocket cars were thus allowed to "run," but they created so much havoc that, about the same time (ca. 1858), the authorities tried to prohibit them. Indeed, Carey, writing in 1818, reported that a ten or twelve-year old boy was killed in a few minutes, when one of the standard, though large Burmese funeral rockets ran over him. Yet the custom, perhaps, persists until today. Shway Yoe, writing in 1963 (Ref. 26), mentions it but says police must be around for safety reasons. Though there is still another occasion to fire large Burman rockets, as noted by Hamilton, who observed that during the late 17th to early 18th centuries, every September, wealthy Burman gentlemen would fire these rockets as a sign that their house (*baw*) was in the favor of the gods; if the rocket misbehaved the gods were angry with them. If the rockets worked well, a man still felt it wise to build a new *baw* and dedicate it to his favorite god. Hamilton saw one of these rockets 120 ft (36.5 m) long.
32. Hoskin (Ref. 7) had his article published after the preparation of this paper, as "Rockets for Rain" in, *Air and Space Magazine*, Vol. 2, February/March 1988, pp.69-73, though the article did not incorporate his technical notes, which were used in this paper.

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40. Author's notes (Ref. 30).
41. Author's notes; Interview, Souvannaphanh (Ref. 6).
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