



ISSN 2583-9020

An Electronic Veda Journal

वेद वाणी

(vEda vaaNee)

Volume 2, Issue 2, July 2024



Printed and Published by

Veda Samskruti Samiti

Malkajgiri

Hyderabad TS

King Bhoja's Knowledge of Yantras (Mechanical Devices) in *Samarāṅgaṇa Sūtradhāra*

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Abstract

The *Samarāṅgaṇa Sūtradhāra* (SS) ascribed to King Bhoja (11th CE) is a rare technical treatise in Sanskrit. It contains details about the *yantras* or mechanical devices. Bhoja has contributed considerably towards this subject by giving details regarding the construction and the principles of many *yantras*. The 31st chapter of the *Samarāṅgaṇa Sūtradhāra*, called 'Yantravidhāna' gives a full description of various mechanical devices. It also describes simple mechanical tools for day-to-day use like pulley, etc. Moreover, *yantras* for amusement, domestic purposes, for defence, for conveyance and for water machines have also been discussed. This article will bring to light the various *yantras* described in this text and establish the fact that the knowledge of design, construction of mechanical devices were well-known and in active use in India many centuries ago.

Introduction

In ancient India, outstanding contributions have been made in the realms of literature, art, religion and philosophy. In addition, topics pertaining to major sciences like medicine, mathematics etc., have always formed the recognised subjects for research.

Tantra and *yantra* are familiar words in Sanskrit, where *tantra* is the scheme or principle and *yantra* is the means or practical form of it. The idea of a *yantra* has been popular from ancient times; it has been applied in the field of esoteric matters and scientific knowledge.

In certain forms of worship, the *yantra* is a chart in which it is believed that spiritual power is stored up. It is drawn on a flat ground or etched in metals. It has components or details which must be strictly conformed to. As an instrument for achieving spiritual

power, it eminently deserved the name "yantra" (i.e.) a mystical means.

In general parlance, the Sanskrit term 'yantra' is derived from the root 'yam' – 'to control'. We can see that the word *yantra* has been used freely to depict any contrivance. *Arthaśāstra*, (II. 19, 24) refers to contrivances starting from the very simple and common ones like: *ghaṭī-yantra* – the pulley used in the well to fetch water; *taila-yantra* – for extracting oil from the seeds; *ikṣu-yantra* – a sugarcane-juice maker, waterwheels and weighing balances. But this does not mean knowledge of complicated mechanisms is not found in ancient Sanskrit scriptures (Veda Samskriti).

Ancient India had produced mechanical applications and tools for scientific activities. The *pākayantras* (surgical instruments), the *rasāyana yantras* (laboratory equipment) and the *yantras* described in Jyotiṣa works, are some of them.

There are three principal classes of *Yantras* present. They are:

- (i) *Yāna yantras* (Machines for transportation) – *Vimāna* and *Rathas*.
- (ii) *Udaka yantras* – *Vāri, dhārā yantras* including water wheels, pipes and showers; and (iii) *Saṅgrāma yantras* – machines of warfare.

The earliest reference to a *yantra* is noted in the Vedas. The *ratha* or chariot, the best creation of the ancient Indian architects falls under the *yāna yantra* category. The *Vājasaneyī Samhitā*, the *Śathapatha Brāhmaṇa* and the *Atharvaveda* hail the *rathakāra* (chariot maker) as an important person. The *Ṛgveda* (V. 2. 11; 29. 15; 73. 10; X. 39. 14) mentions great architects like the *Ṛbhus*, *Viśvakarman*, *Tvaṣṭṛ* and *Takṣan*; it also praises *rathakāra* as *dhīra* (highly skilled) and *manīṣin* (equipoised).

Similarly, we can find such references regarding the *yantras* across several Sanskrit literary works. Among these, the *Samarāṅgaṇa Sūtradhāra* (SS), a rare treatise on architecture in general, is ascribed to King Bhoja of Dhāra (1018-1060 CE), an author of great merit. Bhoja is credited with works in every branch of knowledge, in every field of Sanskrit Literature. *Śṛṅgāraprakāśa* is considered as his *magnum opus* in the field of poetics.

The SS is a monumental treatise of Bhoja on architecture and iconography. In the 83 chapters, he deals with town-planning, house-architecture, palace architecture, temple architecture and dwells at length on iconography. While explaining palace architecture, he delves in detail on the *yantras* or mechanical contrivances. The value of contribution of Bhoja on this subject is greater

than any other author, because he provides information regarding the basic principles required in building the *yantras*.

The 31st chapter of SS titled ‘*Yantra-vidhāna*’ contains 224 verses. This chapter describes simple mechanical tools for day-to-day use like pulley etc. It also describes *yantras* for amusement, automation for household purposes, transportation and in the field of defence and warfare.

Definition of a *Yantra*

The SS defines a *yantra* as that which controls and directs the movements of objects according to prescribed objectives. *Yantra* uses the five elements or *pañca-bhūtas* to serve a specific objective or purpose. As Bhoja also derives the term *yantra*, from the root ‘*yam*’ (SS. 31. 3-4):

यदृच्छया प्रवृत्तानि भूतानि स्वेन वर्त्मना ।
नियम्यास्मिन् नयति यत् तद् यन्त्रमिति कीर्तितम् ॥
स्वरसेन प्रवृत्तानि भूतानि स्वमनीषया ।
कृतं यस्माद् यमयति तद्वा यन्त्रमिति स्मृतम् ॥

Pañcabhūtas as the Bīja of a Yantra

SS (31. 5) states that the five *bījas* (“constituent elements”) are the essential factors of a *yantra*. They are Earth, Water, Fire, Air and Space. As the first four depend upon Space or Ether for their movement or operation, Ether acts as the substratum, hence the five *bījas*:

तस्य बीजं चतुर्धा स्यात् क्षितिरापोऽनलोऽनिलः ।
आश्रयत्वेन चैतेषां विद्यदपि उपयुज्यते ॥

Among these, the *Kṣiti* (Earth) is more prominent quantitatively and qualitatively in any *yantra*.

Bhoja also discusses *sūta* or mercury, as an indispensable element in the *Vimāna yantra*. He considers mercury as an Earth element

(*Pārthiva*), even if one might find the qualities of Fire, Water and Air in it (SS. 31. 6):

भिन्नः सूतश्च कैरुक्तः ते च सम्यङ् न जानते ।
प्रकृत्या पार्थिवः सूतस्त्रायात् तत्र क्रिया भवेत् ॥

General Characteristics of Yantras

The text mentions four general characteristics of *yantras* (SS. 31. 10):

- (i) *Svayam-vāhaka* – working on its own
- (ii) *Sakṛtprerya* – propelled only once
- (iii) *Antaritavāhya* – machine with hidden mechanism.
- (iv) *Adūravāhya* – kept nearby.

Bhoja also declares that (SS. 31. 14-5), the machine whose mechanism is not readily perceivable (*alaksyatā*) and creates awe (*vicitratva*), in the beholder, is the best *yantra*.
Secondary *Bījas* of a *Yantra*:

Bhoja dictates that the *yantra* is known by the dominant Element in it. Also, he enumerates (SS. 31. 25-7) materials like, metals – tin, iron, copper and silver; wood, leather and textiles; the wheels, the suspenders, the hangings, rods, shafts, the caps and the tools as secondary materials to be used along with the primary *bījas* for the *Pārthiva yantra*.

After delineating the secondary *bījas*, SS (31. 42-3) appropriately states that these *bījas* are multiple. Sometimes one *bīja* takes dominance over the others. The text also says that any part or component has Earth as its secondary *bīja*, while Ether remains as the primary *bīja*. These two combining with the other Elements produce incalculable varieties of *yantras*; their forms also are innumerable (SS. 31. 44cd-45):

साध्यस्य रूपवशतः सन्निवेशो यतो भवेत् ॥
यन्त्राणामाकृतिस्तेन निर्णेतुं नैव शक्यते ।
यथावद्बीजसंयोगः सौश्लिष्ट्यं श्लक्ष्णतापि च ॥

Qualities of a Yantra

A good machine, according to Bhoja (SS. 31. 45-9ab), has the following good attributes or qualities (*yantra-guṇas*):

1. Utilization of the elements in reasonable proportion – *yathāvad-bījasamyoga*
2. Well-built – *sauśliṣṭya*
3. Clear-featured – *ślakṣṇatā*
4. Imperceivable – *alaksyatā*
5. Efficient functioning – *nirvahaṇa*
6. Weightless – *laghutva*
7. Quiet or Noiseless – *śabdahīnatā*
8. Noisy when necessary – *śabde sādhye tadādhiḥyam*
9. Not brittle – *āsaiṭhilya*
10. Not stiff – *agāḍhatā*
11. Lucid movement – *vahanīṣu samastāsu sauśliṣṭyam cāskhaladgati*
12. With desired result – *yathābhīṣṭārtha kāritvam*
13. Securing rhythmic movement – *layatāla-anugāmitā*
14. Going into action when required – *iṣṭakāle-arthadarśitvam*
15. Regaining static position – *punaḥ-samyaktva-samvṛtiḥ*
16. Smooth appearance – *anulbaṇatva*
17. Imitating (various species) – *tādrūpya*
18. Steadiness – *dārḍhya*
19. Smoothness – *masṛnatā* and
20. Longevity – *cirakālasahatva*.

As mentioned earlier, Bhoja considers *alaksyatā* (invisible nature) and *suśliṣṭatva* (perfection) as the best qualities of a machine. A *yantra* is a contrived object and an abnormal entity. When these special qualities could be visualized, the viewers lose interest. For example, in case of a doorkeeper-machine, the *alaksyatā* (imperceptibility of the *yantra* and its composition) lies in making it look realistic like a doorkeeper. In other words, *alaksyatā*

leads to comprehension of the idea in the minds of the viewers.

The *suśliṣṭatva* means perfection of construction. Only when the different parts of a machine are assembled in proper synchronisation, taking care of all minute details, the desired effect is accomplished.

Functions of a Yantra (SS. 31. 50cd-57ab):

The peculiar actions of a machine and the timeframe in which they work pave way for their special characteristics. Sound, height, form or touch, etc. mark the special features. The movement of the machine could be in all directions and can be either slow or fast. Sound could be either pleasing or scary. A very important variety of *yantra* of this category is *Vāditra* along with its sub-varieties – (i) *gīta* (vocal music, songs): *paṭaha*, *vamśa*, *rājamārga* and *deśī*; (ii) *vādya* (musical instruments): *vīṇā*, *kāmsyatāla*, *ṭṛmilā* and *karaṭā* and (iii) *nṛtya* (dance): *nātaka*, *tāṇḍava*, *lāsya*, *rājamārga* and *deśī*.

Bhoja also says (SS. 31. 60-4) that some other *yantras* are used to portray, *rūpa* (forms). There are varieties of such machinery used to bring to the audience, the whole theme of a story. For instance, depiction of the churning of the ocean or Nṛsimha killing Hiranyākṣa – the entire episode gets narrated scene by scene through the machines acting out the various characters of the story. Also, the machines can represent the fight between elephants, the *dolākelis* (the swing-play) and different varieties of *sabhās*, the automatic servant machine and so on.

Varieties of Yantra

Bhoja does not provide any specific classification of various *yantras*. However, the *yantras* can be broadly grouped under five categories – (i) *Vinoda yantras* (Machines for

Entertainment), (ii) *Gṛhya* and *Pālaka yantras* (Machines for Household and Defense), (iii) *Sangrāma yantra* (War Machines), (iv) *Vāri yantras* (Water Machines) and (v) *Yāna yantras* (Vehicles).

(i) Vinoda Yantras – Yantras for Amusements:

(a) *Bhūmika-Śayyā-Prasarpaṇa* (SS. 31. 65) – The bed placed on the ground floor of a five-storeyed structure is made to go upwards from one level to other sequentially.

(b) *Putrikā-Nāḍīprabodhana* (SS. 31. 66-7ab) – It is a kind of chronometer. In a wide circular vessel, thirty ivory figures lie flat all along the circumference. As it revolves, the figure of a lady placed at the centre, wakes up one of the ivory figures for every hour (*nāḍikā*).

(c) *Kṣīrābdhiśayyā* (SS. 31. 67cd-9ab) – This is another pleasure contrivance. A serpent-like bed moves up and down by the easy flow of air.

(d) *Gola-bhramaṇa yantra* (SS. 31. 69cd-70ab) under *vinoda yantras*. In this *yantra* needles are used to mark the movements of the planets. Mentioning such an astronomical model under *vinoda yantras* leads us to understand that the sciences and mathematics and astronomy were so prevalent and were involved even in day-to-day activities.



Fig. 1: Gola-bhramaṇa yantra – Mechanical device to stimulate planetary motions

- (e) Another chronometer (SS. 31. 70cd-71ab) has the figurine of a rider on a chariot or an elephant. As the rider, on his mount keeps moving around, the chronometer strikes, marking the hour.
- (f) A dancing doll circumambulates to the rhythm of a musical instrument, while adding oil to a lamp – SS. 31. 71cd-72ab.
- (g) Amusing *yantras* like are speaking/ singing/ dancing birds, dancing elephant/ horse/ monkey, are operated by the adjusting the flow of air – (SS. 31. 72cd-73)

Bhoja also gives some details on the fabrication or construction few of the amusement *yantras*:

- (a) A wooden bird of slender cylindrical shape has a hollow body in two well-joined halves. Inside the hollow body a copper mechanism one-inch-long and one-quarter inch high is placed leaving a hole at the centre. The air passing through the hole when the bird moves, creates a pleasing sound (SS. 31. 89-90):

अङ्गलेन मितमङ्गलपादेनोच्छ्रितं द्विपुटकं तनुवृत्तम् ।
संविधेयमृजु मध्यगरन्ध्रं श्लिष्टसन्धि दृढताम्रमयं तत् ॥
दारवेषु विहगेषु तदन्तः क्षिप्तमुद्रतसमीरवशेन ।
आतनोति विचलन्मृदुशब्दं शृण्वतां भवति चित्रकरं च ॥



Fig. 2: Vinoda yantra – Mechanical bird that makes pleasing sound through windpipes

- (b) This bird-like contrivance is similar to the above, except that, there is a drum-like piece placed inside the hollow body. As the figure of the bird oscillates, a highly pleasing sound emanates. Bhoja adds that this sound reduces the anger of the ladies who are cross (SS. 31. 91-2):

सुश्लिष्टखण्डद्वितयेन कृत्वा सरन्द्रमन्तर्मुर्जानुकारम् ।
ग्रस्तं तथा कुण्डलयोर्युगेन मध्ये पुटं तस्य मृदु प्रदेयम् ॥
पूर्वोक्तयन्त्रे विधिनोदरेऽस्य क्षिप्तेथ शय्यातलसंस्थमेतत् ।
ध्वनिं ततः सञ्चलनादनङ्गक्रीडारसोल्लासकरं करोति ॥



Fig. 3: Vinoda yantra – Mechanical bird that makes pleasing sound through a built-in drum

Bhoja concludes this section stating that he has described only the basic principles and the constituents of the machinery; actual construction has not been discussed by him (SS. 31. 80cd):

कथितान्यत्र बीजानि यन्त्राणां घटना न यत् ॥
He further adds that he remains silent on the actual mode of construction so that men of imagination could develop on those and construct similar *yantras* (SS. 31. 81ab, 82ab):
तस्माद् व्यक्तीकृतेष्वेषु न स्यात् स्वार्थो न कौतुकम् ।
अभ्यूह्यं स्वधिया प्राज्ञैर्यन्त्राणां कर्म यद् यथा ।

Interestingly, Bhoja declares that some of the *yantras* described are those actually seen by him (SS. 31. 82cd):

यन्त्राणि यानि दृष्टानि कीर्तितान्यत्र तान्यपि ॥

Bhoja reiterates, that he has maintained silence on the actual mode of construction. He had done so not out of ignorance but for keeping it a secret (SS. 31. 79cd):

यन्त्राणां घटना नोक्ता गुप्त्यर्थं न अज्ञतावशात् ॥

(ii) Gṛhya and Pālaka Yantras – Yantras for Domestic and Defensive use:

(a) This variety of *Gṛhya yantras* (SS. 31. 101-03) comprises human figures suited for carrying out different functions. The various parts of the human body, made from wood are fixed together to form such figures. A leather covering is given to make it look like a human. The movements are managed by the strings attached to rods controlling each limb.

(b) These automatons perform actions like – playing instruments, giving *tāmbūla*, sprinkling water and so on (SS. 31. 104):

करग्रहण-ताम्बूल-प्रदान-जलसेचन-प्रणामादि ।
आदर्श-प्रतिलोकन-वीणावाद्यादि च करोति ॥



Fig. 4: Gṛhya yantra – Mechanical doll for household services

(c) Similar automatons are used in the palace as doorkeepers (*Pālakas*) wielding weapons. These can also quietly and quickly attack the intruders (SS. 31. 106-07):

खड्गहस्तमथ मुद्गर-हस्तं कुन्तहस्तमथवा यदि तत् स्यात् ।
तन् निहन्ति विशतो निशि चौरान् द्वारि संवृत-मुखं प्रसभेन ॥



Fig. 5: Pālaka yantra – Mechanized Doorkeeper

(iii) Saṅgrāma Yantra – Yantras for warfare:

The science of *yantras* is applicable to the science of *Dhanur-vidyā* (Warcraft). There are four classes of weapons viz., *Mukta*, *amukta*, *muktāmukta* and *yantra mukta*. Of these varieties the last one classifies the weapons used in warfare.

Bhoja closes this section with the mention of weapons such as *Cāpas*, *Śataghnīs*, etc. *Uṣṭragrīvas* (camel's neck like machine resembling probably the modern cranes), is a new machine mentioned by Bhoja. He also indicates two types of classification namely, *guptyārtha* and *kriḍārtha* being military and pleasure or entertainment *yantras* (SS. 31. 108):

ये चापाद्या ये शतघ्न्यादयोऽस्मिन्नुष्ट्रग्रीवाद्याश्च दुर्गस्य गुप्त्यै ।

ये क्रीडाद्याः क्रीडनार्थं च राज्ञां सर्वेऽपि स्युर्योगतस्तेगुणानाम् ॥

(iv) Vāri Yantras – Water Machines (SS. 31. 109-14):

The *Vāri yantra* or water machines are fourfold, grouped in two broad classifications viz., *Kāryasiddhyārtha* (Purposeful) and *Kriḍārtha* (Pleasure giving). They are: (a) *Pāta yantra* (Waterfall machine), (b) *Samanādikā* – for release of water from tanks placed at higher level,

(c) *Pāta-sama-ucchrāya* and (d) *Ucchrāya* – these mechanisms help in letting water down from a height and directing it to go up again through columns. These are more like our electric motors used to pump water to higher elevations and over long distances such as for irrigation. Of the above four the first *yantra* comes under the *Kāryasiddhyartha* category while the other three fall under the *Krīḍārtha* category.

Then Bhoja explains two more major classifications of *yantras*, viz., (a) *Dhārāgrha* (shower bower) (SS. 31. 117-72) and (b) *Dolāgrha* (swing-machines) (SS. 31. 173-218). The popularity of *Dhārāgrha* can be known from its varieties as follows: (i) *Pravarṣaṇa* – the shower; (ii) *Praṇāla* – the pipe; (iii) *Jalamagna* – chamber under water, and (iv) *Nandyāvarta* – a special design in mid-water to play hide and seek.

The *Dolāgrha* is also called *Rathadolā*. It is a swing or merry-go-round in which people ride in seats and enjoy the pleasure of wheeling round. It has five main varieties – (a) *Vasanta*, (b) *Madanotsava*, (c) *Vasantatilaka*, (d) *Vibhramaka* and (e) *Tripura*. All these are levels built upon one another and have a mechanism to rotate them in a complex or circular motion. The last by name *Tripura* has three tiers each on a higher plane than the earlier one.

(v) *Yāna Yantras* – Conveyance machines:

The *Vimāna yantra*, which rises from the ground and travels in the air, is the only *yantra*, that Bhoja (SS. 31, 95-8) has described under the category of *yāna yantras*. There are numerous references in Sanskrit Literature to *Vimāna*. But the description of actual construction is rarely found anywhere. However, Bhoja gives detailed description of

the *Vimāna* made of wood flying in the air and the wooden bird machine travelling in the sky.



Fig. 6: *Yāna yantra* – Flying machine

These are described in chapter 31 of *SS* giving the mechanical details of the formation and the operation of the machine only at the peripheral level. Still, it gives information about the use of mercury to generate power (31. 98):

अयः कपालाहित-मन्दवह्नि-प्रतप्त-तत्कुम्भ-भुवा गुणेन ।
व्योम्नो झगित्याभरण-त्वमेति सन्तप्तगर्जत् रसरज-शक्त्या ॥

Conclusion

No other *Śilpa* text, so far discovered, other than the *Samarāṅgaṇa Sūtradhāra*, would appear to contain any chapter on *yantras*. It is only Bhoja, who had recorded some details about these machines and their uses. This knowledge seems to have been handed down through generations, only through oral transmission. Another limitation for the lack of widespread use of these concepts and ideas may be due to a lack of documentation of the actual process of making these *yantras*. Bhoja says that it was done so to promote the imagination of men at large. The silence about the actual process was also to preserve the actual knowledge.

From Bhoja's narrations we come to know that even by his time the science of mechanical devices has been closely guarded. Because of this, the continuity of knowledge sharing got severed somewhere down the line. Inventions of new machines, since late 17th or 18th century have ushered in an era of Industrial Revolution with substantial growth and economic prosperity. The younger generation could delve deep into our ancient texts and cull out information regarding the machinery (*yantra*) and the related knowledge for their possible exploitation, leading to new pathways for innovation.

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Veda Samskruti is an inherent intellectual property of Bhaarata dEsham. It is the basic duty and right of every citizen in Bhaarata dEsham to protect this Intellectual property. Indian Constitution and Law provides provision for protection and preservation of its culture, its monuments, architecture etc.

The Chaturvedas said to have 1131 shaakhaas right up to the time of Aadi Shankaraachaarya and thereafter during last more than ten centuries, many shaakhaas are out of practice due to various reasons and presently only seven shaakaas are in the practice of Guru shiShya parampara.

There is a need to continuously preserve these available shaakhaas which may likely to disappear in future due to various external forces acting in the country vigorously with the power of money and global politics. It is time for the intellectuals of Bharata dEsham to wake-up and work collectively to protect and preserve Veda Samskruti of Bharata dEsham, by empowering the Youth of Bharat dEsham, the future care takers of this great Indian Heritage , with suitable education of our correct history and culture.

The above background lead to formation of this Veda Samskruti Samiti which is registered under Societies acts of Government of Telangana, with Regd. No. 961/2016 by Sri A.H. Prabhakara Rao, who is the Founder and President of the Samiti.

The vEda vaaNee e-journal, [ISSN 2583-9020](https://doi.org/10.26434/chemrxiv-2024-12345), is now publishing its **Volume 2, Issue 2, July 2024.**