

Mechanical Contrivances and Dharu Vimanas described in “Samarangana Sutradhara” of Bhojadeva

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Abstract: Our ancestors have given a lot of prominence to science and technology. This is more and more evident as we refer many of our ancient Sanskrit works related to science and technology. Samarangana Sutradhara of Bhojadeva is one of the best examples of such works. This article which is based on the chapter ‘Yantravidhanam’ of Samarangana Sutradhara mainly concentrates on definition and classification of yantras, various constituent elements, meritorious features, description of various yantras, details regarding the construction of a few of the yantras, description of Dharu vimanas, use of mercury vortex engines, details regarding its construction, practical application of Dharu vimanas and finally our analysis and conclusion on this topic based on our study and the articles referred.

Keywords: Samarangana Sutradhara, Yantras, Mechanical Contrivances, Constituent Elements, Dharu Vimanas, Mercury Vortex Engine.

I. Introduction

Samarangana Sutradhara of Bhojadeva (Paramara ruler of Dhara) is a great work on ancient Architecture. Bhojadeva was first and foremost man of great learning who has been credited for his works in almost every branch of knowledge. Samarangana Sutradhara which is in eighty three chapters deals with town planning, house architecture, temple architecture, various sculptural subjects, canons of paintings and devotes a big chapter on art of mechanical contrivances, the yantras. Chapter thirty one of this book specializes in mechanical contrivances and yantras, specifically having verses 95-100 dealing with construction of vimanas or aerial cars. This article mainly summarizes the contents of chapter thirty one and specifically explains Named Yantravidhanam and description of Dharu vimanas in detail.

II. Definition of Yantra

The word yantra is derived from ‘yam’ dhatu which means to control. Yantra is a commonly used term in ancient India for any contrivance or machine. Bhojadeva defines yantra as follows.

“Yadruchhaya pravruttni bhutani svena vartmana |
Niyamyasmin nayati yat tad yantramiti keertitam ||
Svarasena pravruttni bhutani svamanishaya |
Krutam yasmaad yamayati tad va yantramiti smrutam ||”

Dr. Sudarshan Kumar Sharma in his English translation of Samarangana Sutradhara translates the above verses as follows.

“That which carries out having controlled the beings moved off wantonly by personal moving path, that verily is (defined) as yantra or Mechanical contrivance.

Or Yantra or mechanical contrivance is remembered as that which controls the (activity) put into action as also the beings activating by their personal tastes or sentiment as per inspiration of mind.” (Sharma 2012:363)

Dr. V.R. Raghavan in his article “Yantras or Mechanical Contrivances in Ancient India” describes that yantra is so called because it controls and directs according to a plan, the motions of things that act each according to its own nature.

III. Constituent elements of Yantra

According to Bhojadeva, ‘Bija’ or ‘Constituent elements’ of yantra are four. They are ‘Kshitiraha’ – earth, ‘Aap’- water, ‘Analaha’- fire and ‘Anilaha’- air with ‘Vijayat’ – ether being the medium of action. ‘Suta’ or mercury has been declared as distinct element which by nature is ‘Parthiva’ along with earth, water and fire. By the way its liquid state and combustibility is postulated, suta hardly bears any distinction from other constituent elements. Suta’s insusceptibility to fire, its nature of being brought under earth becomes unavoidably justifiable. The constituent element of everything is the soul individually as well as distinctly. Due to intermingling of these mutually, many varieties of mechanical contrivances stand justifiable. Bhojadeva classifies yantra mainly into three categories. They are:

- a. **‘Svayamvahakam’** and **‘Sakrt Preryam’** – These are the two classes of yantra, ‘that which is automatic’ and ‘requires occasional propelling’.
- b. Other type of classification is **‘Antaritam’**- Having the principal of action or motor mechanism hidden or concealed from public view with **‘Vahyam’** or the machine to be carried by another.
- c. Finally **‘Durataha vahyam’**- The one which is really obscure which might be distant or proximate but carriagable from the place from which the machine acts.

‘Svayamvahakam’ is considered as the best and other classifications as inferior to it. Even among ‘Svayamvahakams’, ‘Antaritam’ or concealed are considered being the best irrespective of whether they are distant or proximate.

According to Bhojadeva in a machine of marvelous excitement, movement is automatic and in the one carriagable by another it depends on the carrier being. He has compared the later with insect having the support of water wheeled machine. He describes that movement of Svayam vahakam and Sakrt preryam machines excites us, and the weirdness of machines which belong to ‘antarita’ category marvels us. These machines might be the one which require propulsion from inside or the one which require propulsion from the center or from the combination of two or triad or four as well. By the terrestrial constituent element ‘Parthivam’ the terrestrial element becomes acquirable and by the water generatives or thermal resources the terrestrial norm or element assumes form. The same is achieved by those generated by power and that same by the wind mills. That generated by water is achieved as fit for water or thermal or turbine instruments, by power contrivances or wheels and wind mills. In case of the one generated by fire or power, the constituent element may be mercury (Suta) and the same as such in course of that generated from seeds of terrestrial elements, the constituent element may be the one pertaining to waters as also of those thermal or turbined ones. Bhojadeva further illustrates the constituent elements of everything in complete form. He describes:

- Formulas dealing with the erection of walls or parapets.
- Crushing or pounding or pulverization or grinding of cloddy weights or grinding of heavy clods.
- Measurement of interval between the lines between earth’s center and surface in case of plumber’s activity.
- The wheels of various kinds steel, copper and silver, the tin, their grinding and moulding.
- The wood or timber, the leather or hide, the cloth, which is employed in those endowed with constituent elements.
- The rods- ‘Yasti’, shafts – ‘Kartara’, and caps – ‘Urdaka’, a wheel and rotator – ‘Cakra and Bhramaraka’.
- The array of syringes, the sharp arrow normed instruments or clippers and choppers are the constituent elements they know in ‘Aurvara’ i.e a fertile track of ‘Sringavali’ and ‘Naracha’ or fertilizing elements heating and boiling water, mixing and dissolving, pouring of and filling with water providing of a belt of water .

The fire’s constituent element of earth machines are: ‘Dhara’ – pouring, ‘Jalabharaha’- the water filling and circulation, and ‘Payasa Bhramanam’- rotation of waters. The motion towards a higher plane being the spatial features of parthiva yantras are the personal constituent elements of iron. The air as born by its own instinct is stipulated as viable by thickest ligatures, by bellows – ‘drtis’, by fanning- ‘bijanadyaha’ and by flaps ‘gajakarna’. If it is encracked and made to be left along it becomes a constituent element of earth in the world. The wood, the hide and Iron, the two sprung out of water may be the earth machines. The other one the water may even be that as hydraulic slanting, elevated and low lying one. In turbine machines constituent element exists individually. The application of fire-bijas on earth-machines comprises heating and boiling; of water, mixing and dissolving, pouring of and filling with water, and providing a belt of water. Height, size, closeness and motion towards a higher plane are spatial featured in Parthiva-yantras. Similarly in machines which are mainly jala-yantras the use of timber, hide and metal forms the Parthiva element and so on. (Raghavan 1952:18)

IV. Merits of good Yantra

According to Bhojadeva we just can’t decide the capability of the yantra just by looking at its shape. He describes the merits of good machine as follows.

- i. **‘Yathavat bheeja samyogaha’**- Proper and proportionate utilization of constituent elements.
- ii. **‘Soushlishtyam’**- Well-knit construction
- iii. **‘Shlakshnata’**- Firmness of appearance
- iv. **‘Alakshatha’**- Inscrutability
- v. **‘Nirvahanam’**- Functional efficiency
- vi. **‘Laghutvam’**- Lightness
- vii. **‘Shabdaheenatha’**- Freedom from noise
- viii. **‘Shabdhe sadhye tadadikyam’** – A loud noise when noise is intended
- ix. **‘Ashaitilyam’**- Freedom from looseness
- x. **‘Aghadhata’**- Freedom from stiffness
- xi. **‘Vahaneeshu samastaasu soughlistya’**- Smooth and unhampered motion

- xii. **‘Chaskalaadgathihi’** - Production of intended effects in cases where the ware is of curious category.
- xiii. **‘Yathabeestharthakaritvam layata lanumanita’** - The securing of the rhythmic quality in motion – particularly in entertainment wares.
- xiv. **‘Ishtakale arthadarshitvam’**-Going into action when required.
- xv. **‘Punaha samyavatva samvrutthihi’**- Resumption of the still state when not required, chiefly in cases of pieces for pastime.
- xvi. **‘Anulbhanatvam’**- Verisimilitude in the case of bodies intended to represent birds, animals.
- xvii. **‘Taadrupyam’**- Firmness
- xviii. **‘Dardyam’**- Durability
- xix. **‘Asrunata’**- Softness
- xx. **‘Chirakaalasahtvam’**-Enduring capacity for a sufficient period of time.

Bhojadeva further describes varieties of things which can be accomplished through yantras such as ‘Kshirabdhisayana’ which is a serpent like bed, yantra which produces fire in the midst of water and vice versa, a few kinds of chronometers, an astronomical model called ‘Gola’, a mechanical contrivance which pores oil into lamp, some entertaining yantras like singing and dancing birds and animals, an wooden bird which creates a pleasing sound, ‘Ratha dola’- Merry Go Round, bedroom accessories, aerial vehicles, robots, vari-yantras or fountains, ‘Darigriha’ shower-bower in garden, two storeyed ‘pranala’ built like Pushpakavimana, ‘Jalamagna’-chamber under water surrounded by mechanical lotuses, fishes, birds etc., some military equipments, ‘Ustragriva’ similar to modern cranes, protective military yantras, etc. According to him movements which are impossible in actual life are also possible through yantras. He suggests that many such yantras can be invented by men who have good imagination using the same constituent elements and basic principles described by him. He even describes that he has personally seen most of the yantras which he has described. He also mentions that he has not explained more details related to construction of these yantras just with the intention of preserving the important knowledge. (Raghavan 1952)

V. Description of Dharu Vimanas

Bhojadeva describes two types of Dharu vimanas.

• **Laghu Dharu Vimana**

Verses 95-96 of chapter 31 of Samarangana Sutradhara describes Laghu Dharu vimana. It is the most fascinating yantra described by Bhojadeva in his works. Even though he gives the barest details, this book is one of the few sanskrit texts which speaks about the actual construction of vimanas. (Sharma 2012:380-81)

“Laghu dharumayam mahavihangam dhruda suslishta tanum vidhaaya tasya|
Udare rasayantram aadadeetha jvalanaadhaaramadho asya chaati poornam||
Taroodaha purushastasya pakshadwandwochaallaproyjitena anilena|
Sputasvantaha Paaradasyasya shaktya chitram kurvannambare yaati dooram||”

According to Bhojadeva main material of the body of vimana is lightwood-‘Laghu Dharu’, shape of the vimana is that of a huge bird-‘maha vihanga’ with a wing on both the sides. He explains that the internal structure has a fire chamber with mercury placed over flame which acts as a motive force. The power generated by the heated mercury, helped by the concurrent action of the wings which are flapped by a rider inside, makes the yantra go up and travel far. (Raghavan 1952:23-24)

• **Alaghu Dharu Vimana**

Verses 97-98 of chapter 31 of Samarangana Sutradhara describes Alaghu Dharu vimana which is a heavier Dharu vimana. (Sharma 2012:381-82)

“Tiyameva suramandiratulyam sanchalatyam alaghu dharuvimanam|
Aadadheetha vidhinaa chatur antastasya paradabruthan drudhakumbhaam||
Ataha kapaala ahita manda vahni pratapta tat kumbha bhuvaa gunena|
Vyomno jhagityabharanatvameti santapta garjad rasarajashaktya||”

While laghu Dharu vimana is in the shape of bird, alaghu Dharu vimana is in the shape of temple. It flies along a heavy aerial car made of wood. It is a heavier Dharu vimana which contains four pitchers of mercury over iron ovens. When mercury i.e. ‘rasaraja’ is heated, it explodes quickly and becomes an object of decoration in the sky mainly because of pots heated by the slow ignition burnt within the steel or Iron potsherd.

Indologist ‘William Clendenon’ has described Mercury Vortex Engine in his translation of Smarangana Sutradhara as follows.

“Inside the circular air frame, place the mercury engine with its electric/ultrasonic mercury boiler at the bottom center. By means of the power latent in the mercury which sets the driving whirlwind in motion a man sitting inside may travel a great distance in the sky in a most marvelous manner. Four strong mercury containers must be built into the interior structure. When these have been heated by controlled fire from iron containers, the vimana develops thunder-power through the mercury. And at once it becomes like a pearl in the sky.” (Childress 1991:256)

According to Bhojadeva the boiling mercury ovens produce a terrific noise which can scare away the elephants. Hence it is used in battles for the same purpose. The roar could be increased by strengthening the mercury chambers, so that elephants are thrown completely out of control. This specific military use of aircraft against elephants tempts one to suggest that the Hasti-yantra advocated by Kautilya against elephants was something like the heavier Dharu-vimana described by Bhoja. (Raghavan 1952:24)

VI. Analysis and Conclusion

Bhojadeva is considered as one of the greatest kings who ruled Paramara dynasty between 1010 and 1055 AD. Samarangana Sutradhara is written by him during this period. Bhojadeva mentions that he has seen many of the mechanical contrivances which he has described. This shows that mechanical contrivances described in Samarangana Sutradhara existed even before this period. This means our ancestors during and even before this era were tech savvies. They were using yantras not only to assist them in their work but also for pleasure and enjoying the luxurious life. There are many mechanical contrivances which were designed to assist construction activities, protective military activities and even day to day activities. A few of the mechanical contrivances described in Samarangana Sutradhara are not those which were available for common man's use but mainly designed as luxury commodities for royal class of people.

Here as researchers our main focus is not on who used those mechanical contrivances or yantras but the fact that it was being used, i.e. such a technology prevailed. Great king and scholar Bhojadeva has analysed the constituent elements of yantras and described them in detail with many illustrations. An interesting fact here is that 'Suta' i.e. mercury being considered as one of the constituent elements and 'Vijayat' or ether being considered as medium of action. Classification of yantras such as Automatic, those which require propelling, those which have concealed motor, those which are to be carried by another and those which are distant or proximate stands prevalent even today. Even today people prefer automatic machines than other classes of machines. The merits of good machines which Bhojadeva has described around thousand years ago are relevant even to today's machines. He also mentions that he has not given the complete details regarding the construction of such yantras mainly to protect such data reaching the wrong hands.

Another interesting aspect of Samarangana Sutradhara is the description of Dharu vimanas which we made of lightwood. He describes bird shaped laghu Dharu vimana similar to our modern aeroplane and temple shaped Alaghu Dharu vimana which flies in air along with a heavier aerial car. Concept of Alaghu Dharu vimana is something which makes us think of a missile or a rocket which flies high in air with the help of a launcher. Most interesting fact related to Dharu vimana is the usage of Mercury vortex engine, the forerunner of the ion engines being made by NASA in mid 1950s to 1970s.

As per the article titled "Innovative Engines" written by Glenn Research center (NASA Facts), Dr. Harold Kaufman designed and built the first broad-beam electron bombardment ion engine in 1959 which used mercury as fuel. Later on these ion engines were modified and launched on the Space Electric Rocket Test I (SERT I) in 1964 and SERT II in 1970 which were successful. The main drawback of mercury ion engine was after exiting the ion engine, some mercury or cesium atoms would condense onto the ground test hardware, causing numerous cleanup difficulties. In the 1970's, NASA managers decided that if ion propulsion research was to continue, it would have to be environmentally clean and less hazardous. Glenn researchers soon turned to xenon as a cleaner, simpler fuel for ion engines, with many of the same characteristics as mercury.

Ion engines are also described in Maharshi Bharadwaja's Vymanika Shastra. It is also said that India's first unmanned aircraft Marutsakha which was designed and demonstrated by Professor Thalpade in year 1895 also used Mercury Ion Engine. This shows that thousands of years before NASA developed mercury ion engines, such engines were already being used by our ancestors. The astonishing fact is that no one knows how such great works of our ancestors got lost as eras cruised by.

References

Books

- [1] Sharma 2012: Sharma, Sudarshan Kumar. "Named Yantravidhanam I.e. The Chapter Dealing with the Preparation of Mechanical Contrivances." *Samarangana Sutradhara of Bhojadeva An Ancient Treatise on Architecture*. 2nd ed. Vol. I. Delhi: Parimal Publications, 2012. 363-406. Print.
- [2] Childress 1991:256 Childress, David Hatcher, and Ivan Terence Sanderson. *Vimana Aircraft of Ancient India and Atlantis*. Adventures Unlimited Press, 1991.
- [3] Raghavan 1952: Raghavan, Venkatarama. *Yantras or mechanical contrivances in ancient India*. Indian Institute of Culture, 1956.

Journal Articles

- [4] Roy 1984: Roy, Mira *The Concept of Yantra in the Samarangana Sutradhara of Bhoja*, Indian Journal of History of Science, 19(2):118-124, 1984.

Website Articles

- [5] NASA Facts: Accessed on 13th December 2015 *Innovative Engines: Glenn Ion Propulsion Research Tames the Challenges of 21st Century Space Travel*, Glenn Research Center, Cleveland, Ohio 44135–3191 <http://www.nasa.gov/centers/glenn/about/fs08grc.html>

Reports

- [6] Mukunda 1974: Mukunda, H. S., et al. *"A critical study of the work "Vymanika Shastra"."* Scientific Option: Indian Institute of Science, Bangalore (1974): 5-12. Print.