

**Deepak Bhattacharya**

Radha Krishna

Kedar Gouri Road

Bhubaneswar.-751002

**P. C. Naik**

Chayapath Rural Research Centre

Nuagaon

Kusiapal

Kendrapada, 754250, Orissa

India

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## AN ANCIENT MARINER'S COMPASS: SELECTED DISCUSSION

*Indian civilization has been without a break for the last few millennia. This means there has been external connections and indigenous maritime assets. Among the remains, the maritime assets archaeology are much prized and cited, a dock being the most prized. It also precludes the requirement of knowledge of the seas i.e. a compass. In this exploratory, multi-disciplinary, original study, we report an ancient nature inspired compass, an archaeological model and a brief review. We also report a man made, large, fresh water, inland dock termed as Vela in tune with constellation Vela as in the Oriental and Occidental star charts.*

**Key words:** *Bhumi anla, Naksatra, Yantra, Nataraja, Archaeometry, Vela, Compass.*

## INTRODUCTION

The *kalingiyas* were master mariners [1] and their society till now organizes a month long somber penance termed as *khudurkuni osa* in remembrance of way lost sailor-cum-trader brothers, in the month of *Bhadrava* (Aug-Sep. i.e. peak monsoon period) which is followed by a week long jubilant festival of *Bali Yatra* (sojourn to the Island of Bali) preceded by *Boita Bandana* (ode to the sea gong vessel) on the *kartika poornima* i.e. full moon of Nov.[2]. R.C. Majumdar [3], cites noted historians Prof. S. K. Aiyangar, Radha Kumud Mukharjee and others who have held 'mastery over the ports of *Kalinga*, gave Rajendra Chola well equipped ships and sailors accustomed to voyage in the very regions which

he wanted to conquer. Yet no compass has been found, neither any dock. The *kalingiya* (c.7<sup>th</sup>A.D.) and later even the Chola (c.11<sup>th</sup>A.D.) mariners charted the seas extensively. We question what then was the methodology which enabled various societies to sail the high seas ranging over centuries? The *Yajur veda* [4] mentions 27 *skashatras*. The *linga* of *Sri Kala Hasti* (Dist. Chittoor, AP, India) has 27 stars etched on it in 9 layers, each layer having 3 stars. These are inspiration. This apart there are numerous other examples in India.

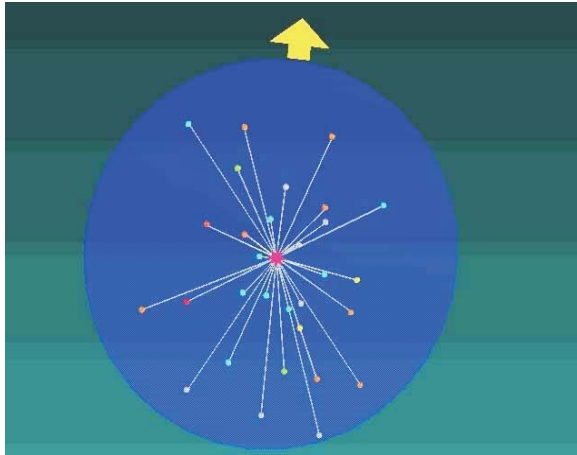


Figure 1. *Taraka*

Deepak Bhattacharya and Prahallad Chandra Naik [5] have presented that 27 bright stars can be connected in a radial pattern, which has been termed as *Taraka*. Fig. 1. shows 26 stars laid out around the central red star  $\alpha$  *Orionis* (*Rudra*) of the Orion Constellation (*Kalapurusha mandala*). The arrow marks the true north. The colours are as per star chart. Among all constellations it is the most spectacular and has a near central location in relation to the east/west or north/south hemispheres. Mariners world wide know it as Orion constellation. It acts as a crude overhead guide. This is the first research paper that correlated stars with man made Hindu archaeology on the ground.

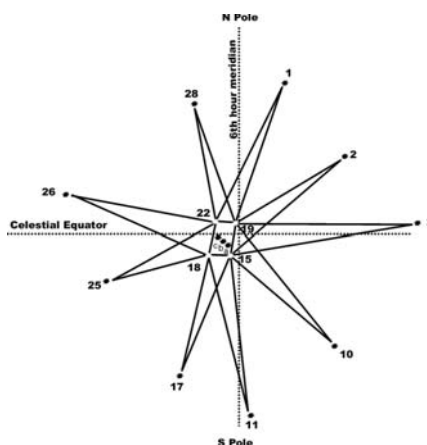


Figure 2. Nakshatra

Table 1. Members of the Nakshtra

Star No.	Occidental/Technical Name	Siddhantic/Hindu Name
1	Dhube ( $\alpha$ U Maj)	Kratu
2	Regulus ( $\alpha$ Leo)	Magha
3	----- ( $\beta$ Leo)	Falguni
10	P. Square ( $\alpha$ peg)	Falguni
11	S. Crux ( $\alpha$ Curcis)	Trisanku
17	Fomalhaut ( $\alpha$ Eri)	Matsyamukha
25	Cetus ( $\beta$ Cetu)	-----
26	Alpheratz ( $\alpha$ Andromeda)	U. Bhadrpada
28	Cassiopeia ( $\alpha$ Cass)	Kasyapa

Fig. 2 is that of a nine pointed star like pattern. The author duo selected 9 stars with the Orion constellation in the centre that were on the outmost rim in Fig. 1. Then they used the sophisticated 3D software [6], star charts [7] and a Japanese star globe to maintain conformity with the natural. They then connected the 9 outer stars to the constellation of Orion and formed a giant 9 pointed celestial star. It is called nakshatra (nine regions/nine pointed star). Table –I gives the names of the stars of the naksatra. Hindu names of the stars are indicated under head ‘Siddhantic’. The term Siddhanta denotes a naked eye Hindu school of Positional Astronomy. We have provided the set of terms for the benefit of scholars from the occidental / modern and siddhanta schools. Such a nakshatra is noticeable by mariners from  $60^0$  of latitude or meridian from any hemisphere in relation to location of  $\epsilon$  Orion.  $1^0$  being equal to 100 kms, on the ground,  $60^0$  work out to 6000kms from the centre of the Orion. Theoretically

this means if Orion's centre be aligned with Bhubaneswar (any of the ancient period ports of India included), and if a mariner has one of the stars on his head (apparent zenith) in any of the 9 sectors (khetras) he per say has to traverse 6000 kms (nautical/terrestrial) to reach destination. To do this, he has to grossly align his vessel along the lines of the nakshatra as shown in our Fig. 2. It may be borne in mind that the delta valley regions to the east and south east of Bhubaneswar were drained by a river of yore called Prachi. The term 'Prachi', means Orient. From Prachi valley (86°E/20°N.), north and south of 60°, latitudes are frigid zones sans any civilization. East and west by 60°s are the Pacific and the Atlantic oceans – the limiting factors. Visually  $\alpha$  Ori, the celestial guide and India's geographic location form a compatible couple.



Figure 3a. Bhumi Anla

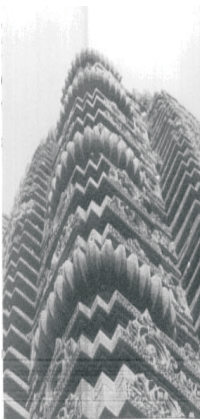


Figure 3b. Bhumi Anla

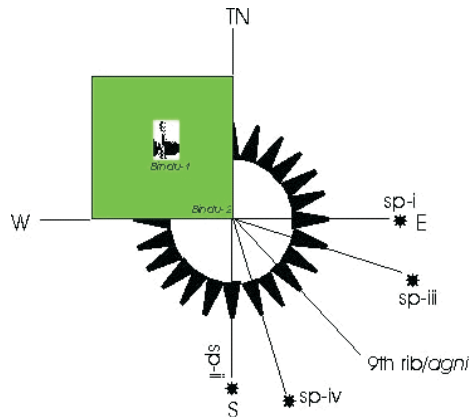


Figure 3c. Bhumi Anla

The *Kalingiya bakrakar rekha deulas* (kalingan curvilinear linear spires) have *Bhumi anlas* along the four corners. As per *siddhanta*, *agni* (SE), *nairtya* (SW), *vayu* (NW), and *aisanya* (NE), are the four corners. The *Bhumi anlas* mark the same on a spire. The *Bhumi anla* is a stone member of abstract architecture having no relation with religion, socio-culture, sovereignty or dynasty. Ribs on the body of this element is much alike the fruit *Phyllanthus emblica* (*anla*), whereas it marks a elevation/structural strata. It is therefore called *Bhumi anla* (*Ba*). Each *bhumi* is delineated by a set of four *Bas* set along the temple spire's corner. They are noted on structures from c. 650 A.D. In Fig. 3a we can see the curvilinear outline surmounted with a circular ribbed coping stone, and the *Ba* series along the corner. Fig. 3b is that of the series from Mukteswar spire c.9<sup>th</sup> A.D. (200yrs, refinement). It shows a series of 4 *Ba* (5<sup>th</sup> not visible from camera location), which are cordant and oriented towards the space. Fig. 3c is a schematic representation of a *Ba* in the *aisanya* (south-east) corner. The grey area is the structure. Of a circular cross section the *Ba*'s inner 90<sup>o</sup> (¼ th) is embedded into the *koni-paga* (corner buttress arrangement), the remaining 270<sup>o</sup> (¾ th) is exposed. Each quadrant of 90<sup>o</sup> span has 5 ribs including the embedded quadrant. 4 ribs mark the four cardinal directions (5x4+4=24). Of the 24 ribs, 17 ribs project out i.e. a *Ba* covers 270<sup>o</sup> at a span of 15<sup>o</sup> per rib Fig 1 & 2. The 3<sup>rd</sup> rib is the mid of every quadrant. In reference to Fig. 3c sp-ii is a star located in the north eastern direction that at diurnal transit becomes visually aligned with the 3<sup>rd</sup> rib. This marks the *aisanya* position. It is the most convenient point of alignment. All stars in line with it and around are in the quadrant *aisanya*. Directions sp-iii and sp-iv mark the theoretical alignment points with the other ribs of the *Ba* and their transit through the arc zone of *aisanya*. Thus the star position can be announced with ease at an arc interval of 15<sup>o</sup>.

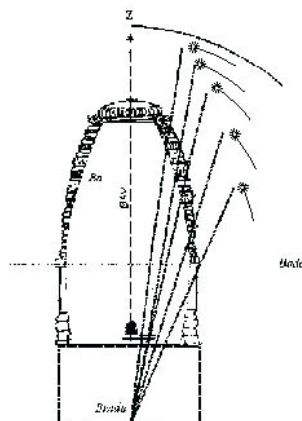


Figure 4. Altitude Determination

The standard astronomical specification for the location of the celestial bodies uses the local vertical hemisphere of the sky as frame of reference for coordinates [8], the coordinates being (i) altitude and (ii) azimuth. The *Ba* can be used to bring out these two coordinates to trace and track the astral body. In place of the local hemisphere the *Ba* uses the corner hemisphere as frame of reference.

In altitude determination, longitudes come into play in respect to the zenith. Zenithal observation requires a vertical reference. The structure acts as the vertical. The 5 *Ba* have fixed strata of the known angular elevation at  $60^\circ$ ,  $70^\circ$ ,  $75^\circ$ ,  $80^\circ$ ,  $85^\circ$ .

to the base respectively. Morphology and placement of the *Ba* on the curvilinear outline allow the extension of lines of sight along each of the *Ba* into the infinite space around. 5 fixed celestial strata (domains) can then be drawn as 5 (structure centric) parabolic zones covering the visible span of the sky. Each represents an altitude zone. This is of much practical use in naked eye positional astronomy. It allows naked eye alignment and instantly yields the altitude of the aligned astral member. Astrals that are aligned with the local latitude attain the zenith position of the spire ( $90^\circ$ ), which is the highest. Fig 4 schematically presents the concept of altitude determination, at any location.

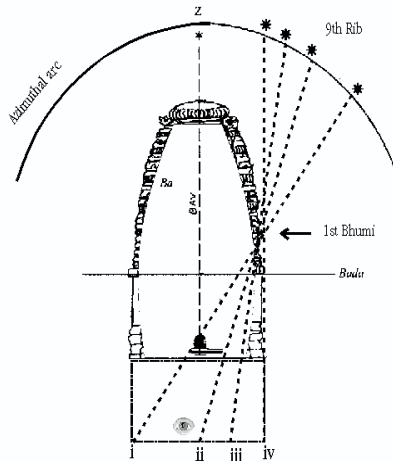


Figure 5. Azimuth Determination

Since the *Bhumi anal* are set at a reducing geometric progression and the ribs deviate at the  $15^\circ$  angle (Fig. 3c), it allows projection of (another set) of lines of view to form an imaginary celestial grid at  $15^\circ$  spacing, enmeshing the structure. It is zenithal in projection. Ribs of all the *Bhumi anla* are repetitive arcs, are cordant, their cross sections reduce with gain in elevation. It is helpful

in generating the longitudes. The 1<sup>st</sup> *bhumi* is the lowest and is of practical use in naked eye observations for azimuth readings. Fig-5 describes the azimuth tracking aspects, at any location. Fig. 4 and 5 may be studied conjointly for topical appreciation. On acquisition of skill this methodology enables quick determination of altitude and azimuth. It does not require the knowledge about geographical and astronomical domains (i.e. latitudes & longitudes). In contrast to modern system (magnetic pole based direction computation) this scheme envisages corner oriented direction computing, which is why, the abstract *Bhumi anlas* are located at the corners. The simultaneous alignment from 4 corners yields good global positioning, and a grid lock methodology which is in tune with poly positioned astral transit time unit(s). This can be used anywhere. The methodology as in Fig. 4 and Fig. 5 is that of an ancient sextant.

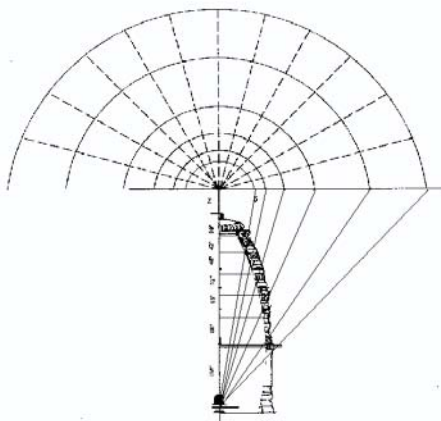


Figure 6. *Astralabe & Zenithal Projection Aspects*

Deepak Bhattacharya and Prahallad Chandra Naik [9] in their next research paper then presented that a grid alike an geography map of zenithal projection can be constructed in the sky or on the ground by using the *Bhumi anlas*, see Fig. 6. Modern astronomers and mariners also note similar grids on medieval planispheric astrolabes. In Fig-6 one half is shown for projection method elucidation. Either halves when joined make a zenithal projection that yields true direction, which is of paramount importance for a mariner, and specially those who used natural resources like surface winds and ocean currents to sail. We may note that such imaginary astrolabe is in relation to the location of the Hindu structure. However, a model can also be used at any location.

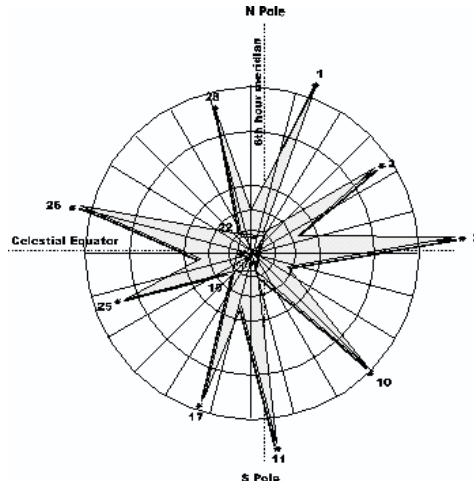


Figure 7. Comparison with a Modern Compass

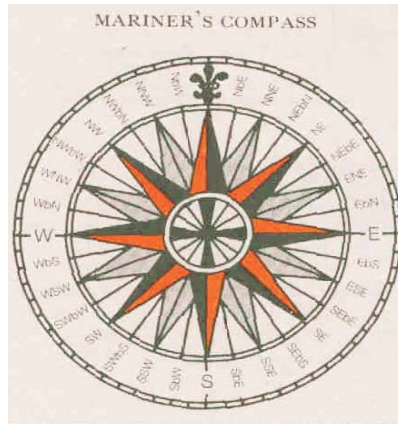


Figure 8. Comparison with a Modern Compass

Deepak Bhattacharya and Prahallad Chandra Naik [10] in their next research paper have further presented that Fig. 2 can be superposed on a fully constructed astrolabe as in Fig. 6. We then arrive at Fig. 7, which is a 9 pointed device (*nakshatra yantra*). An uneducated yet trained mind can use this 9 pointed celestial compass/device to even chart the distance sailing time, correct path if change had to be done due to inclement weather and home in onto target destination. Our Fig. 8 is that of the modern 8 pointed compass. We provide it for contrast and compare. It offers suggestive homology with F-7.



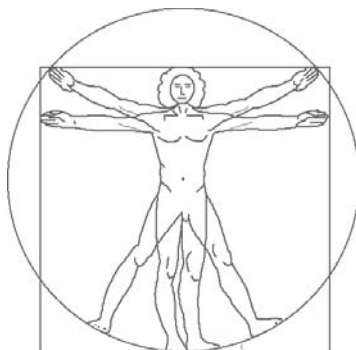


Figure 9. *Nakshatra & Nataraja – Universal Proportions and Directions*

Figures 1 to 7 are conjectural projection based on abstract (secular) archaeological members. India is also a treasure trove of icons. Icons may have been influenced by positional astronomy or may have been used to reflect astronomical aspects. We note that in literary tradition of various covenance, various societies of ancient and mediaeval India in relation to *Nataraja* (dance-lord) have variously preserved astro concepts. Among the modern scholars dateable to between 1912 and 1924, A. K. Coomarswami [11] was the first to highlight it, followed by T.A.G. Rao [12]. However, no correspondence with iconic art or dated archaeology was done until Deepak Bhattacharya [13] did so in various forums as run up to *IJHS* series. Taking cue, N. Raghavan [14] followed Bhattacharya & Naik with a spacio-temporal contrast and comparison model to aver correspondence between Hindu icons and constellations. Deepak Bhattacharya and Prahallad Chandra Naik [15] then made a super-positional study involving 27, 16, 10 & 4 stars that are around *alpha Orionis* in relation to the orientation of the hand and feet of the poly armed *Nataraja* icons and then again comparing it with the Vitruvian Man of Leonardo-da-Vinci. Fig 9 is that of the Vitruvian Man [16]. Fig. 10 is that of a *Nataraja* icon having 10 arms that is on the spire of Fig. 3a. It is dated to c.650A.D. We have marked the *Nataraja* icon with imaginary lines to generate various geometrical forms (proportions) and slopes (angles) in relation to 2 points on the torso (centre chest and the navel), inscribed within a circle as is done in the Vitruvian scheme. We noted a more developed scheme in Fig. 10 as compared to the scheme in Fig. 9. In Fig. 11 we have marked out the positions of the 10 palms, the 2 feet and have joined them with lines radiating from the navel of the *Nataraja*. In Fig. 12 we have superposed our Fig. 1. In Fig. 13 we have superposed our Fig. 2. We note that the art format of *Nataraja* offers good homology with positional astronomy in current epoch i.e. the proportions and directions are in tune with the Universe. They offer more details than the Vitruvian scheme. All this in turn offers authentic material and good scope for our caption.

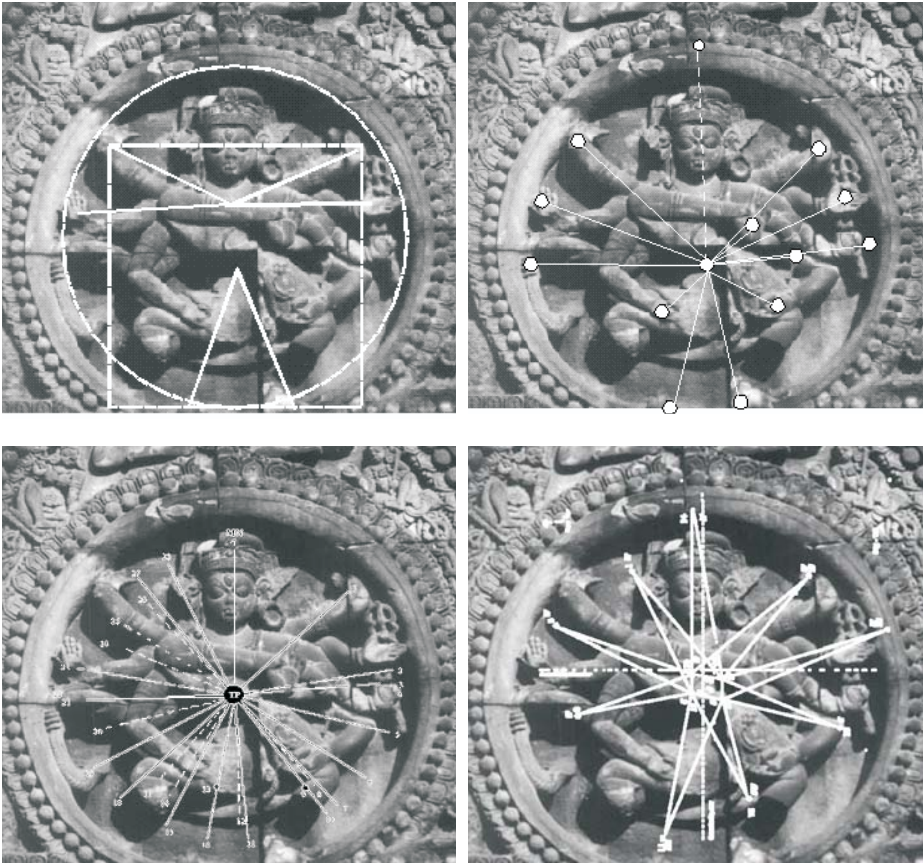


Figure 10-13. Nakshatra & Nataraja – Universal Proportions and Directions

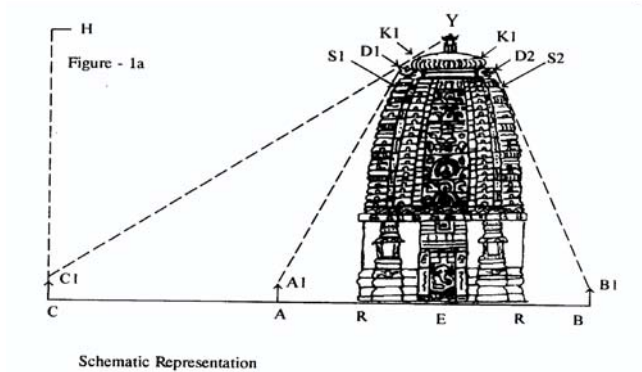


Figure 14. Distance Determination

Deepak Bhattacharya and Prahallad Chandra Naik [17] in their next research paper titled “Archaeometry: A Glimps into History of Ancient Indian Engineering Science”, published by the Institute of Engineers India, 2008 (Bhattacharya awarded Gold Medal by Engineering Congress), have shown how the ancient *kalingiyas* could use the model as in Fig. 3 & 4 and with ease convert altitude into distances (offset) on the ground and calculate gross traversing time, by applying the formula  $CH = AB = CR$ . For this the zenithal projection as in Fig. 6 has to be drawn around the spire. Position of the home/destination star has to be aligned (from current sailing location) using the *Bhumi anlas* as in Fig. 4. The arc separation calculated from zenith (spire/vertical) has then to be converted into nautical distance. The method is schematically shown in Fig. 14. Here ‘E’ is the vertical at  $0^{\circ}$ . It is the home/destination. Location ‘A’ at  $15^{\circ}$  marks a gross distance of 1500 units of nautical distance, and location ‘C’ at  $45^{\circ}$  marks a gross distance of 4500 units of nautical distance.



Figure 15. Ancient Riparian Land & Ancient Inland Dock

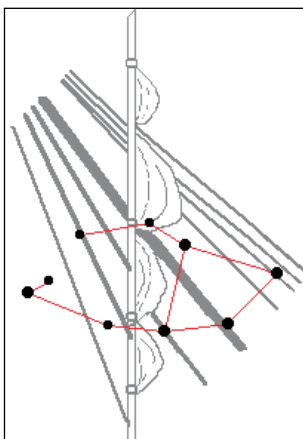
If a ancient society had attained and had persevered to preserve its navigational heritage, it is logical to attempt an search for a inland dock (maritime heritage). Our Fig. 15 is a satellite picture [18] of the Prachi delta wherein are located our candidate structure and which is the native historical-cum-cultural land of the above type of architecture and archaeology. The societies that live



thereupon have variously been credited with a glorious past of maritime history [19]. The visible range satellite picture is reminiscent of a very unique and ancient riparian delta-valley region colloquially known as *upataka*. We have compared it with the deltas of the Amazon, the Congo and the Mekong. Non have such unique riparian topography. Everything supports maritime activity, yet no archaeology has been reported that can be construed as an ancient dock. Author duo then reverted once again to the star maps of the Occidental and Oriental (Hindu, naked eye positional astronomy) schools. They used the model *Taraka* (Positional Astronomy). In relation to *alpha Orionis*, in the south-eastern sky is the constellation *Vela*, which is drawn as a masted boat and is also so known in either schools. Lexicons of *Sanskrit* and numerous Indian vernaculars describe the term *vela* as floatilla/floatsam, and as armada. A ground survey was conducted in the said direction from 1998-2000, on the basis of the *Taraka* model (see Ref. No.5). A site was located adjacent to the c. 1<sup>st</sup> millennia B.C., mud embankment fort namely, *Sisupala gada* [20], along the right bank of river Gandhabati (*Gangua*). In Latin it denotes sail. Similarly phonetic and representative art of various constituent stars of the constellation *Vela* offer correlation with corresponding Hindu and Helino-Persian phones. Fig. 16a gives the loric picture as in Occidental star maps. Fig. 16b gives the constellation *Vela* superposed on the mythic sails (we have downloaded F-16a & F-16b from the www, with thanks).



Figure 16a. Ancient Riparian Land & Ancient Inland Dock



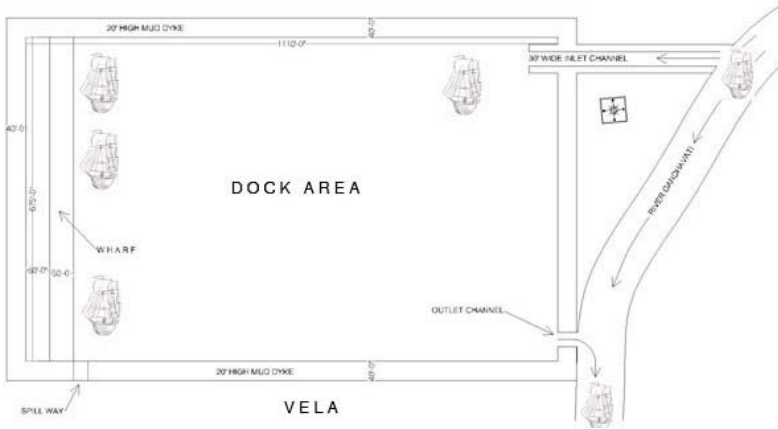
*Figure 16b. Ancient Riparian Land & Ancient Inland Dock*



*Figure 17. Ancient Riparian Land & Ancient Inland Dock*

Our Fig. 17 is the satellite view cum location of dock Vela. It is a depression. It has been downloaded from Google maps (with thanks). This apart, Govt. irrigation maps, drainage maps, Survey of India maps and Top sheets were studied and field verified. A multi-disciplinary teams consisting of hydrologists [21], engineers, geographers, [22] and port officials were invited and data was presented. Thereafter, Deepak Bhattacharya and Prahallad Chandra Naik [23] presented the historical and cultural aspects of this fresh water, inland river

dock among historians. Dock *Vela* is many times larger than the Harrapan dock at Lothal [24,25].



*Figure 18. Ancient Riparian Land & Ancient Inland Dock*

Fig. 18 gives the mechanical dimensions of dock *Vela*. The reader's right is due east. Satellite image [F-17] gives the tell-tell view of erstwhile drainages that are around. Dock *Vela* [Fig. 12a] has all the four sides bounded with two openings only in the east. Its length is 1100 feet and breadth is 675 feet. The height of the four side mud embankments is 20 feet, width at top is 40 feet. The two connections are with the ancient river Gandhabati (Gangua). There was one connection to the north east corner and the other was at the south-east corner. Between 1998 & 2005 there were attempts by the land and builder syndicates and mafia to encroach which continues. The south east corner inlet was encroached some time ago. The north-east passage is yet in-situ, in-tact. Its connection is a channel type, i.e. it has sidereal guides as are noted in present day Suez and Panama canals. The width of the north-east connection channel is 30feet and depth is of 12-15 feet. It can allow pass of one vessel at a time in a convoy. At the south-west corner was a spill way. Its lower base was 2 feet above the upper wharf. Both the connecting passages were closed with mud (10-12ft.high) in the year 1992 [26]. This was done allegedly to avert annual flooding of the *Vela* base, because, at present its bottom is lower than that of river *Gangua*. We may note that the constellation *Vela* has two variable tentacle (type) protrusions towards the east. Similarly, dock *Vela* has two sides of variable length extending towards the due east. Author No.1 while surveying for INTACH [27] had listed this site as of heritage value. The two connecting passages signify the 'inlet' and 'out let' for water and traffic flow as is noted in inland river traffic (right hand rule). At in-let (north-east corner) river *Gangua*

makes an angular turn. We know, fluid thrust is highest on the outer side of the curve. In relation to Vela [Fig. 12] the point of highest stream flow thrust is incident on to in-let channel. This could have facilitated draught inside Vela, easy and controlled turn towards port side and finally in marshalling of *Boitas* (large curved vessels) through the guided channel (post turning). Sailing upstream from Vela would have required hoisting of the sail by the boita to reach the various *Katakas* (cantonments) upto *Suvarnapura Kataka* (in dist. Sonepore) via the Kulkhai-Mahanadi riparian route. The down stream opening (closed by encroachers & govt.) can be interpreted as vessel and water outlet. It would take the *Boita* to the sea via, the Chilika at ebb. The society of Bhubaneswar celebrate every fortnight a ritual of hoisting a lamp atop Lord Lingaraj's spire called "*Chaturdasi Mahadeepa*". This is a flaming torch. It could have also acted as an ancient Light House. *Chaturdasi* marks the day of up-regulation in tidal amplitude and in its inland ingression. Orissan coastal rivers have tidal ingression of the order ranging between 50-100 Kms.[28]. Vela is located within this range. Its base elevation varies from 3-6 mts. above MSL between south-east and north-east monsoon episodes. The flaming torch is hoisted by a member of the *samartha niyoga* (able bodied clan). Mariner's profession is also a profession of the able bodied. We have marked our Fig. 18 with symbolic *Boitas*, berth and stream flow suggesting in-let and out-let mechanism. The berths are marked by large blocks of laterite stones. The Kalingiya mariners and vessels among other merchandise also used to ferry full grown bull tuskers. Fig. 19 dated to between c.8-10<sup>th</sup> A.D, depicts such historical event (artifact ~ Orissa State Museum). This required firm perching of the floatsam to enable shifting and positioning of heavy merchandise. It also alludes to the size of the vessels. Possibly, for such reason the wharfs are wide. It also allowed close mooring.



Figure 19.

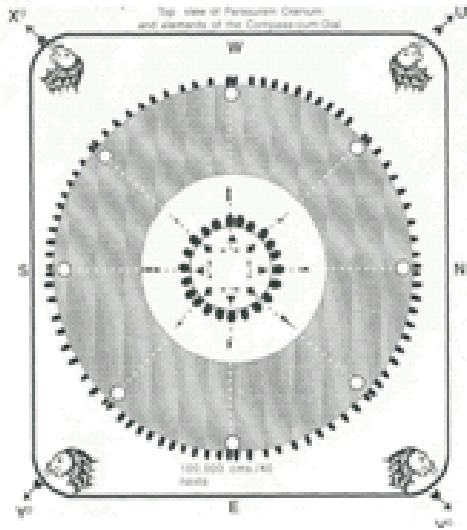


Figure 20. The Compass

In this segment, the author duo report a Compass in dated archaeology. This is a first time original report. Fig. 20 is an schematic representation of the cranium top of the temple of Sri Parasuramesvar, c.650 A.D., which is the candidate structure in our Figs. 3a, 6, 7, 10 & 14 (cranium). On this date, the local community and historical dynasty are known to have had international trade and political connections. The structure, is a royal edifice (*Raj dutta kirti*). Hence, this piece of archaeology is a valid representative member. This is in spite of the fact that, around 1910 the temple top was re-set as part of conservation under the superintendence of a British Executive Engineer, Public Works Department, Mr. M.H. Arnott. The structure faces due west, marked by 'W'. This is top view. The top is surmounted with a massive circular coping stone having a domed architecture at an curvature of  $10^0$ . The edges have prominent 64 ribs in high bold form. Fig. 21 is a sample from Meghesvara, dated to c.12-14<sup>th</sup> A.D. Here we can see human figures at the 4 corners, crouching as if they are on the lookout. They are looking down towards earth. These figures are known as *Charinees* (1/4<sup>th</sup>). The cardinal directions are marked by divine icons associated with the sky. Period based structures have similar cranium architecture with finer variations. Such design continued exclusively in the *Kalinga* till c.16<sup>th</sup> A.D. The user of this type of device seems to have much valued it and has celebrated it as his most prized possession, which is why they have placed it atop cranium. The credit of discovery cum-invention-cum-innovations rightfully belongs to them.

In our Fig. 20, the 4 cardinals are marked by jointed ribs with facility for insertion of staff (direction marking). They are marked as 'E', 'W', 'N' & 'S'.



The 4 corners are also similarly marked ( $4+4=8$ ). The 8 number flag staff points have an additional rib each. This makes the total ( $64+8$ ) as 72 ribs. It maps the azimuth at  $5^{\circ}$ . Thus it marks 8 directions and subdivides the azimuth into 8 equal zones. Each zones works out to a span of  $45^{\circ}$ . The mid centre also has another smaller ribbed stone, along with a raised abacus (24") that is square at base, octagonal at mid and circular cum ribbed at top, with pointers (not shown). It is known as *akasa-linga*. The vertices of its octagon and the pointers on the domed-circular top are cordant with the 8 direction of the larger ring that is below. It is as alike a small dial above a large dial. The 22 mini ribs maps each of the zone of the larger dial into 3 sub-divisions of equal parts of  $15^{\circ}$  each. In our Fig. 8 there is also an inner mini dial.



Figure 21. The Compass

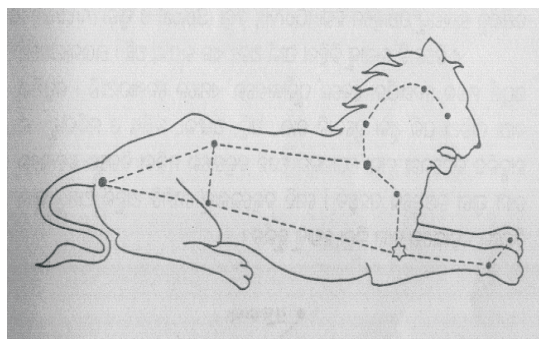


Figure 22. The Compass



Figure 23. The Compass

Each of the four corner have a set of jointed lions (*jodi-singha*). Two full torsos are jointed at an angle of  $90^0$ , having a common neck, nape and head. The nose tip is cordant with a corner flag mast. As per Hindu system of naked eye positional astronomy (*Siddhanta*) they mark the four corners viz. *vayu* (north-west) *nairitya* (south-west) *agni* (south-east) *aisanya* (north-east). Fig. 22, gives a schematic representation constellation Leo and Fig. 23 is the close up photograph of the *jodi-singha*. The art parameter of the 4 lions have much homology with the Sphinx of the Nile valley. The sphinx has both its fore arms kept parallel to each other (as in F-22), in our case they are crossed (one paw above the other). Of the 4 lions only 2 are extant at position 'X' and 'Y' (F-20). The other two have fallen off. We may note that the face of the Lion is raised. On closer examination it is found that each of the *jodi singha* look upwards out in variable angles of the inclined plane i.e. they do not look into the horizon. This means each member is looking out to a different object in the sky. On a star map if we identify *alpha Orionis* (star Betelgeuse) as the point coincident with the *akasa-linga* i.e. the cranium's centre (see Ref. No.3) then its four corners mark four very prominent stars namely 'Y' = Southern Cross (*Trisanku*) in the south-east Hemisphere, 'X' = Archernar (*Nadimukha*) in the south-west Hemisphere, 'U' = Cassiopeia (*Kasyapa*) in the north-west Hemisphere and 'V' = Dubhe (*Kratu*) in the north-east Hemisphere (Ursa-Major). These four stars have varied elevations. Therefore, we may say that the 4 jointed lions are looking at these four permanent positions in the sky. Similarly flag pole 'W' marks *alpha Taurus* (*Vrsabha*), 'E' = Pocyon (*Prsva*), 'N' = Auriga (*Brahmagani*), 'S' = Canopus (*Agasti*). Colloquially a *jodi singha* is also known as *Dikapala* (maintainer of direction). From c.10<sup>th</sup> A.D., onwards the cardinals are additionally marked by a divine figure (associated with the sky), known as *Khetrapala* (maintainer of zone/region). Pre c.10<sup>th</sup> A.D., *khetrapala* is not noted, the *jodi singha* \ *dikapala* also look into the horizon at similar angles. The combination of 4 *Dikapala* and 4 *Khetrapala* is known as *astadikapala* i.e. octagonal-direction-maintaining scheme. It appears from c.10<sup>th</sup> A.D., and is noted

to have been discontinued between c.12<sup>th</sup> -14<sup>th</sup> A.D. *Charinees* (seem to) appear in lesser monuments. Our reported device (Fig. 20) is from the extant earliest cognate structure. It is a case of *astadikapala*. It is astronomer's cum mariner's device in material. The reported scheme allude to poly layered GPS. It offers scope for relationing with all our figures. Commerce and Trade historians [29] have referred to a (non traceable) navigation device called 'yantra'. We may tentatively call our find as *Nashatra Yantra*.

It is often said that a mariner's profession calls for high degree of intelligence. The term Kalinga denotes a historical state, its natives have not migrated, they continue to occupy the same geographical domain and with passion associate with their heritage. The term *Kalinga* denotes histo-geog-cum-cultural entity. Hence we have to use it. Lexicons [30] indicate that the literary meaning of the term '*Kalinga*' means 'cleaver an intelligent'. Among the natives (*kalingiyas*), sailing was an profession and members of the traditional sailing families even to this date are known as *sadhavas* (the accomplished). The sailors were highly regarded members in the past societies. The erstwhile inhabitants of Mohenjodaro and Harappa were known as *Dasus*. In the districts around dock Vela an sizable, non aboriginal, authentic native sub-population bear the title *Das* (and its variants). Lexicons [31] indicate that the term '*Das*' is a synonym of *Dhivara* (sailor). The compass was the apex attainment of such a society, which is why they have 'cleverly and intelligently' enshrined it as the apex signature using state sponsored art, architecture and engineering. Fig. 24 is that of (north-south oriented) Lothal dock, which was excavated in western India (Gujarat) and is dated to Harrapa civilization period dated to c. 3<sup>rd</sup> millennium B.C. It measures 660 feet in length x 42 feet in width (see Ref. No.24 & 25). We may note, that both the docks are rectangular hydraulic devices. We have provided the scanned copy of Lothal from published literature (Ref.No.25). Fig. 25 is a satellite image of Lothal dock. This is done for topical compare.

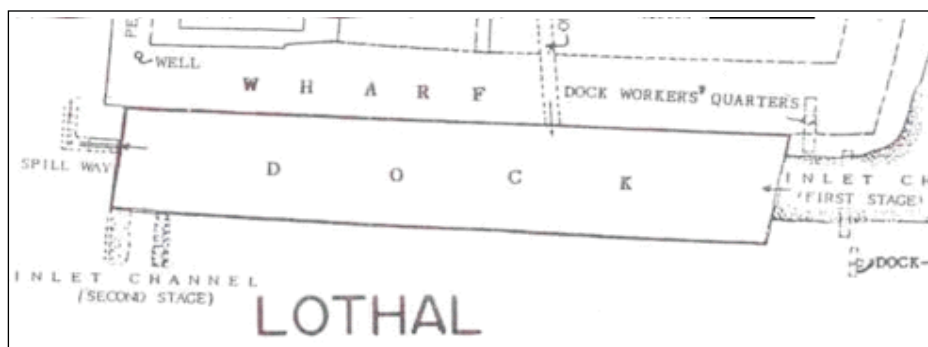


Figure 24. Discussion



Figure 25. Discussion

The date of the candidate structure as in our Figs.3a, to 6 and 10 to 14 which are all in relation to Fig - 20 is dt. to c.650A.D. (the structure of Sri Parasuramesvara) at location-Bhubaneswar  $\sim 20.15^{\circ}\text{N}/85.52^{\circ}\text{E}$ , Orissa, India. On pan India basis, every structure is privy to various chapters of various sciences. Each have adopted unique information embedding mechanism. We may not ere if we say, that the ancient scientists have adopted 'very large system integration (VLSI)' techniques. Again, each regional technique seems to be original and unique. This was possibly done to attract only the involved minds and/or to veil it from the evil eye and also to permatise such achievements, for posterity. The methodology of instruction is *chitra katha* (hieroglyphics). It transcends all barriers of speech i.e. it is universal language as alike the profession of maritime activity.

## CONCLUSION

The *Naksatra yantra* positions itself as a strong candidate forerunner of the mediaeval planispheric astralabes and also of the modern navigation compass. Temple structures are permatised almanacs on durable plastic which embed art and science of past times. It embeds nature's and society's contribution to science. Dock *Vela* is also a first time find cum report. This discussion is original. Multi-lateral, multi-disciplinary research is warranted.

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## *Sažetak*

### **DREVNI POMORSKI KOMPAS: IZBOR IZ RASPRAVE**

*Indijska civilizacija posljednjih tisućljeća nije stala u svom razvoju. To znači da su oduvijek postojale veze s vanjskim svijetom, a postoje i ostaci indijske pomorske tradicije. Među tim ostacima najcjenjeniji i najčešće spominjani su upravo oni koji se odnose na pomorsku tradiciju, što uključuje i potrebu za posjedovanjem znanja o morima, odnosno za poznavanjem pomorskog kompasa. U ovom se istraživačkom, multidisciplinarnom i izvornom radu opisuje drevni pomorski kompas, te se ukratko donosi prikaz jednog potpuno zastarjelog modela. Osim toga daje se prikaz ručno izrađenog, velikog, Vela modela, koji je dobio naziv prema sazviježđu Vela, koje kao takvo postoji u zvjezdanim kartama Istoka i Zapada.*

***Ključne riječi:*** *Bhumi anla, Naksatra, Yantra, Nataraja, Archaeometry, Vela kompas*

**Deepak Bhattacharya**

*Radha Krishna*

*Kedar Gouri Road*

*Bhubaneswar.-751002*

**P. C. Naik**

*Chayapath Rural Research Centre*

*Nuagaon*

*Kusiapal*

*Kendrapada, 754250, Orissa*

*Indija*