8th International Conference on Science, Technology and Management
India International Centre, New Delhi
(ICSTM-17)
2nd July 2017, www.conferenceworld.in
ISBN: 978-93-86171-52-8

STUDYING TRADITIONAL DANCE FORMS - Mathematical Study of Odissi Dance Postures

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ABSTRACT

Studying traditional dance forms using an interdisciplinary approach expands what it means to study dance and also helps understanding dance forms with greater clarity. It highlights the fact that being a traditional dancer is more than just being a performer; dance embodiment becomes a space of learning through an amalgamation of humanities and sciences.

This project is built around the mathematical study of Odissi dance. Since there is almost no study in this field this project first confirms the possibility of study in this field then provides a base for further research.

I. INTRODUCTION

This is a study that examines different postures of Odissi Dance using a mathematical approach. Using the data acquired, the project aims at expanding traditional methods of teaching dance technique and creating a method of understanding the Odissi form mathematically. Using a mathematical approach to teach adds to the traditional imitative mode of learning.

In traditional India dance students dedicated almost all their time to the art form, Gurus (teachers) would teach the dance using verbal instruction and perform the movements for the students to copy and learn(rote and imitative learning). The modern Guru- Shishya relationship is a blend of the traditional gurukul system and modern teacher- student relationship. Even though students are expected to surrender themselves to the art form, the atmosphere in which the Guru imparts knowledge in a questioning atmosphere. Students are given opportunities to question the teachings and explore the form. This gives students a choice, to either continue to follow the set structure and rules, or explore the many different components of the dance form and expand what it means.

Exploring traditional dance forms through other disciplinary approaches creates a platform to engage in critical questioning and examination of the dance form. This can be done through learning the dance form or by studying its various aspects; that is, allowing usage of multiple lenses to look at the dance forms. Dance becomes more than just a sacred system; it now can be viewed as a knowledge system. This means rather than viewing traditional dance as mythological or religious sentiment; dance can be viewed as an object of interdisciplinary study. The link between humanities and dance has been explored; but the link between the sciences and dance hasn't been examined to its full extent in India. This study is an attempt to bridge this gap.

I chose this project because being an Odissi dancer and a math major I have studied these subjects separately and saw potential in an interdisciplinary study. My training in Odissi dance equipped me with the much required knowledge base to conduct this study. I recognised the need to explore the many teaching methods one could offer for the dance form as I have found greater understanding and meaning studying it through various

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ISBN: 978-93-86171-52-8

perspectives. It is my interest that drives me to work on this project and having access to faculty that can help me with this project is a huge motivating factor. Considering the scope of the project, it has been limited only to a few postures, but the results obtained can be used as raw material for other projects or can help draw attention to the lack of information about Odissi dance. This could also be a way to inspire more research in the field.

II. METHODOLOGY

Odissi dance has evolved around temples carvings in Odisha. Architecture in Hindu temples have precise measurements and proportions, hence all carvings have a lot of symmetry or are very geometrical. In fact there are documents of the study of the exact science of human proportion from ancient India. For example the Silpasutra is an ancient Indian text that reduces the human body to vertical and horizontal lines. The Vedas describe the human body with arms outstretched as "'he is as broad as he is high'".[1] It was believed that disproportion in the temples would cause disruption in peace and make the prayers ineffective. So when the Gurus borrowed postures from the temples, the dance form mirrored the precise proportions and measurements observed in the carvings. This is why the dance form is very geometrical. Hence though the movements are very fluid and graceful a mathematical approach to understanding and exploring the various postures of Odissi dance is feasible.

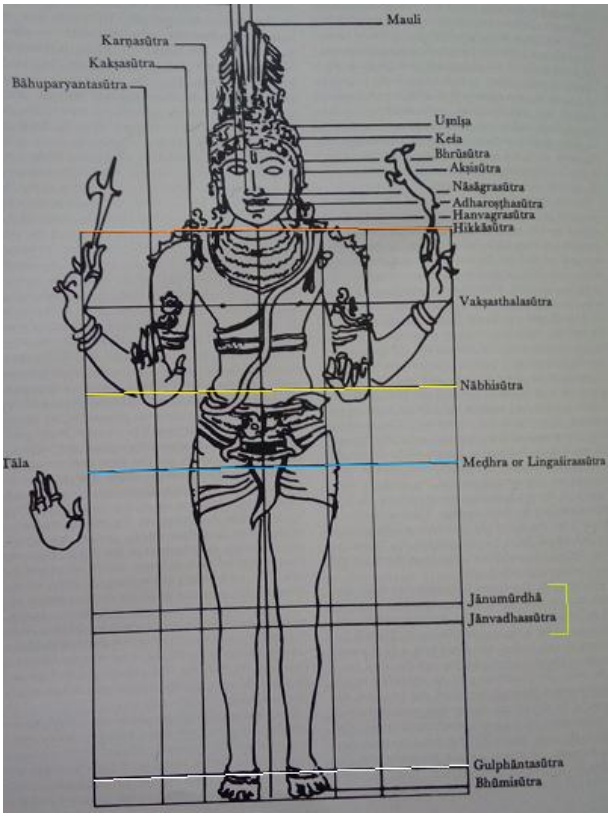

Fig 1. This image shows the various axis used to map the human body, the image has been taken from kapila vatsyayans book the square and the circle of indian arts, [fig 41] (107)

The body while in dance posture broadly speaking forms many geometrical shapes but all postures can be mapped within squares and circles. "The centre of the wheel (*cakra*) of the Vedic and Upanisadic image corresponds to the navel of the human body. Thus we have a pictorial image of Man set in a frame-work of a

circle with the navel at its centre and a vertical median corresponding to one diameter of the circle."[2] Kapila Vatsyayan further goes on to explain each movement and its deviation from the vertical median. The consequence of exploring the furthest symmetrical extensions from the vertical median is formation of a square within the circle. All postures can thus be mapped using the square and circle and base lines.

Fig 2. This image shows how dance postures can be mapped within squares and circles it has been taken from Kapila Vastyayans book the square and the circle of indian arts, [fig 50] (116)

While choosing the postures to be studied the Abhinaya Chandrika was referred. Due to the variety of postures but short time frame three postures were chosen, namely Chauka (horizontal plane and vertical), Tribhang and Abhang. Since these are the most commonly used postures and most other postures can be derived from them they were the best suited for the project.

III. RESEARCH METHODS

To gather required data two methods have been chosen. The comparison between the data collected by the two different approaches and temple sculpture in these postures should in theory provide answers to whether mathematics can or should be involved in teaching Odissi dance.

The first part of the research was to mathematically construct the human body while in the chosen postures using the strictly codified geometric approach given in Kapila Vatsyayans book The Square and The Circle of The Indian Arts.

According to Vatsyayans structure of the human form there is a central vertical line that passes through our body through our navel. The deviation from the line on either side must be balanced to be in correct posture. Horizontally there are three major divisions in the body determined by the central point or navel and the joints of the skeletal system. The hikkasutra(marked red in Fig 1) is the horizontal axis passing through the shoulders and through the pivot joint of the neck; the bhadrasutra or nabhisutra(marked yellow in Fig 1) passes through the navel; the katisutra(marked blue in Fig 1) passes through the pelvis; lastly two axis through knees the janusutra(marked green in Fig 1) and gulphasutra passing through ankles(marked white in Fig 1). [3]

Using these axes as guidelines, balanced geometrical figures were mapped within squares and circles. Then using rules of congruence, parallel lines and other theorems of geometry angles created in the joints were approximately calculated. (Due to lack of appropriate technology accurate readings or mappings cannot be made.)

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ISBN: 978-93-86171-52-8

The second part of the method implemented uses the human body as a subject. Pictures of the human body were taken while in the chosen postures. After which using the grid created by Kapila Vatsyayan, parallels were drawn and angels compared to the mathematically constructed Odissi dance postures.

IV. DATA

4.1. Chauka

"Chauka literally means square, which represents the first completely stable structure. [...] Chuaka is a basic odissi stance where the weight of the body is distributed equally on both the sides. In Chauka the heels face the centre; the toe point outwards and there is a distance of about one foot between the two heels. The knees are out-turned and the thighs are bent."[4]

Fig 3. the black lines on the image show the original chauka posture, this is an example of how movements are created through deviations from the chauka posture

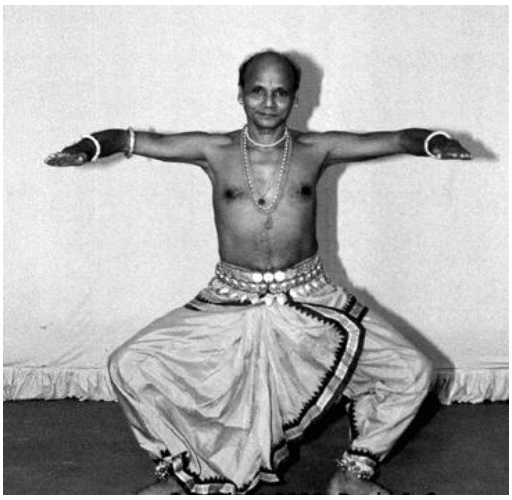

Fig 4 Chauka by Guru Kelucharan Mohapatra

[These images have been downloaded from Fig 3:Odissi,Wikipedia, http://www.wikiwand.com/en/Odissi and Fig 4: https://ars6394.wordpress.com/tag/chauka/#jp-carousel-324]

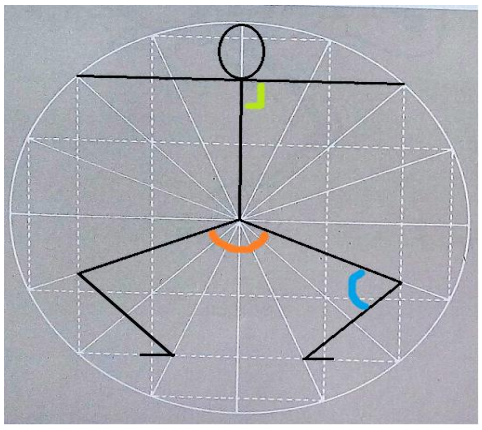

Fig 5.

Green Angle: 90 degrees

Orange Angle: 135 degrees

Blue Angle: 67.5 degrees`

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There is no deviation from the central axis in the upper half of the body. The symmetry of the body around the central axis in the lower half of the body (below the katisutra marked blue in Fig 1) is what differentiates Chauka from other postures. This is now mathematically confirmed and can be visually appreciated.

4.2. Tribhang

"The word tri-bhanga means three breaks. [...] The tribhanga is evolved by one half of lower body remaining static along the central plumb line while the other leg usually crosses the first. Half of the body from the torso upwards deflects in the opposite direction. The head or neck provides the third deflection. The tribhanga is achieved by a sharp deflection of the hip from the horizontal Kati sutra, and the head deflecting to the same side as the hip. The bends are made at the knees, the torso and the neck."[5]

Fig 6.

Fig 7.

[These images show the posture Tribhang in sculpture and human form, the images have been taken from Fig 6: Tribhanga, Wikipedia, https://en.wikipedia.org/wiki/Tribhanga and Fig 7: Tribhanga, http://www.indianetzone.com/58/tribhanga.htm]

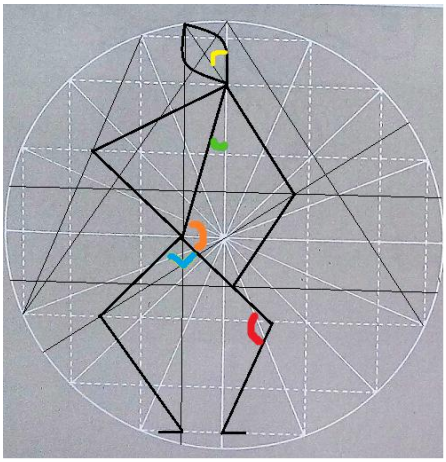

Fig 8. Yellow Angle (head deflection): 33.75 degrees,Blue Angle (between the legs): 90 degrees

Red Angle (at the knees): 112.5 degrees ,Orange Angle (at the waist): 118.125 degrees

The Mathematical study makes it clear that this is a complex posture and proper and accurate analysis of this needs better technology. A very interesting observation is that though the second bend in the body is at the waist

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its deviation from the central vertical line is to be measured at the joint of the chest and neck (angle marked green in the image). (Unfortunately the measurement of this angle was beyond the scope of the project).

Another observation is that on extending the lines drawn to represent the calves downward into the ground a 90 degree angle must be obtained. (This observation came from studying the human form while in posture)

4.3. Abhang

Odissi posture in which, all the weight of the body is shifted to one leg.

Fig 9.

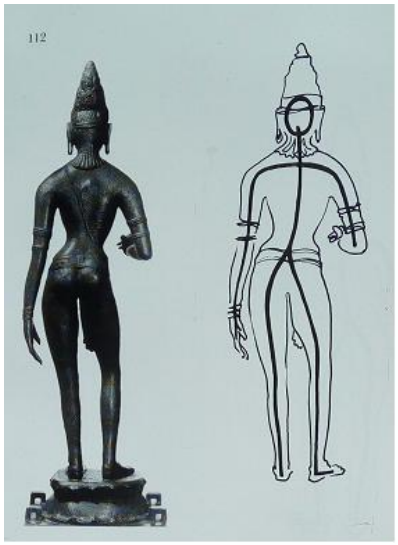

Fig 10.

[Fig 9 shows the similarities in sculpture and dance posture of the posture Abhang. Fig 10 shows how the posture abhang can be visualised using lines; these images have been downloaded from Fig 9: https://www.google.co.in/search?q=abhang+odissi+dance and Fig 10 from Kapila Vatsyayan's book the squareand circle of Indian arts (112)]

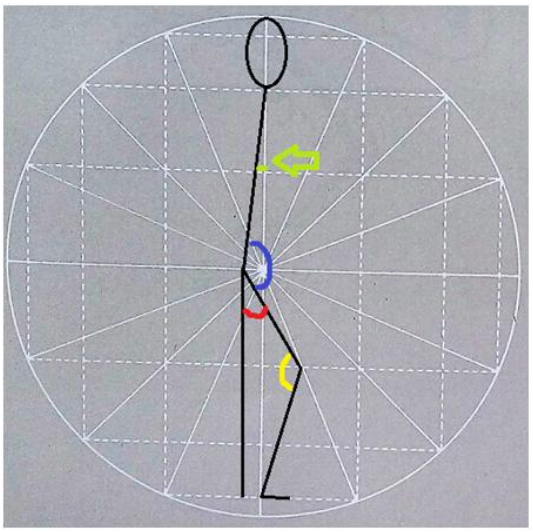

Fig 11. Blue Angle (at the waist): 157.5 degrees

Red Angle (between the legs): 22.5 degrees

Yellow Angle (at the knee): 67.5 degrees

Similar to Tribhang the green angle here represents the deviation of the waist from the central line. Comparing the deviation one can see how Tribhang and Abhang manifest differently in the upperbody.

V. RESULT

Studying sculpture, human body and the mathematical grid it's clear that there exists very visible parallels between the three.

The mathematical grid only allows certain body types to fit within it hence it cannot be applied universally for all dancers. Also for different body types that do fit into the structure different angles will be obtained.

Though this means there is no accurate measurement applicable to the postures bends, and also keeping in mind that while dancing a dancer cannot constantly be in a particular angle (a dancer has to re create the posture to fit the transitions between postures), the angles can be thought of as guidelines. Since a square and circle are symmetrical shapes all the angles obtained will be nearly the same; that is we should get a small range. Due to limited resources this project doesn't provide this range.

But what it does is provide the means to create mathematically constructed structures for all Odissi postures. Since this shows there is a logical and structured way of representing Odissi posture, it confirms the possibility of study in Odissi using mathematics.

Comparing sculpture and human form one can clearly see the influence and the way sculpture has been translated to dance posture by creators of Odissi dance. It also makes it clear that though sculpture is clearly geometrical, depending on the body type each posture looks different and has to be performed differently. This is where traditional teaching methods are especially effective. Since every individual body is different, learning how the posture uniquely fits one's body can only come with repetitive practise. The mathematical structure can of course be used as guidelines and added information. This can finally aid the learning process.

Viewing the clean stick diagrams of the postures and then comparing the angles formed in the body while dancing can helpful in correcting posture. The stick diagrams help create and imagery of the correct posture and can aid students who connect to pictorial data.

Considering all this, the mathematical approach isn't limited but will be appreciated more by certain students. Howard Gardner has identified nine different types of intelligences. This sort of teaching practise will resonate with students with high Bodily-Kinesthetic Intelligence ("Body Smart") along with Spatial Intelligence ("Picture Smart").

During the creation of the mathematically created postures, I referred many images and diagrams. But I also had to perform the postures to understand where and how the body was placed. This shows that in order to study dance using an interdisciplinary approach or applying dance knowledge to another subject one needs to have a good grasp on the dance technique.

VI. CONCLUSION

A mathematical understanding of dance postures does create a new approach to teaching dance posture. It makes the implicit understanding of dance posture more explicit. This means when a dancer's body falls into posture they unconsciously set their joints at certain angles; this study makes the unconscious choice a conscious one.

Since studying the angles doesn't aid the body, but is knowledge for the mind; one could say that study of dance is restricted to the mind while dancing is restricted to the body. This study shows that this mind body duality is a fallacy. As when dancers are made aware of the angels there bodies are falling into unconsciously, though its knowledge for the mind a dancer with high Bodily-Kinesthetic Intelligence ("Body Smart") along with Spatial Intelligence ("Picture Smart") can relate to the posture with higher understanding. Hence this can be considered a good interdisciplinary teaching practice.

Lastly using different perspectives to study traditional dance forms does create the possibility for deeper understanding of the form. It makes dance more than just an art that is performed. This also means that interdisciplinary learning of dance can revolutionise teaching methods of dance.

Due to very little existing research in this field, this research work is ground breaking. This project doesn't provide concrete results applicable to all dancers; but it creates a base on which further research can be conducted in this field and also opens up interdisciplinary education in classical dance. It opens up the many other possibilities of study in Odissi dance using mathematics. The method created to study an individual's body in Odissi posture, can be further used to study various angles while the body moves in Odissi dance. Studying the angles formed in motion, there is a possibility of denoting movements in mathematical equations. Considering that Odissi posture can be mathematically expressed and fit into squares and circles; it confirms the fact that notation to write Odissi dance is possible.

VII. ACKNOWLEDGEMENTS

I would like to thank my faculty advisor Aadya Kaktikar for all her support and input at every stage of this project. I'm also grateful for the funding I have received from Shiv Nadar University under the OUR project. I am thankful for the support I received from my family, especially my grandfather (Achu) who motivated me to start my research work.

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