The Role of Couples Spaces in Propagation of Vedic Chants, Bells, Conch-Shells and Gongs in Worship at Hindu Temples

M.G. Prasad
Noise and Vibration Control Laboratory
Department of Mechanical Engineering
Stevens Institute of Technology, Hoboken, New Jersey
mprasad@stevens.edu

presented at Workshop on
Sound Perception of Places of Worship (of different Religions) via a multidisciplinary anthropological and acoustic approach
Lord Krishna with “CONCH-SHELL”

Lord Shiva with “DRUM”

“ROSARY” as Speech Alphabet Sounds

Goddess Saraswathi with “VEENA”

Lord Krishna with “FLUTE”
The Vedas, which are the foundational literature of Hinduism, are the collection of mantras chanted with precise acoustical characteristics.

Oral tradition has been very efficient in transmitting the Vedic chanting from master to disciple over generations.

Vedic chants in Hindu worship are well known. In addition to Vedic chants, Instruments such as Conch-Shells, Bells and Gongs are commonly used to enhance the spiritual experience of the devotees during the worship.

This study presents acoustical studies of chants and of these instruments sounding individually as well as collectively.
“It would form a fascinating chapter of history to try and trace the gradual development of musical instruments and musical knowledge, from the rhythmic chanting of Rig-Veda in the ancient home of the Aryan race to the Indian music of the present day”

-- Sir C. V. Raman (1922)
“Expressed in the Vedic language, which is derived from classical Sanskrit, the verses of the Vedas were traditionally chanted during sacred rituals and recited daily in Vedic communities.

The value of this tradition lies not only in the rich content of its oral literature but also in the ingenious techniques employed by the Brahmin priests in preserving the texts intact over thousands of years.

To ensure that the sound of each word remains unaltered, practitioners are taught from childhood complex recitation techniques that are based on tonal accents, a unique manner of pronouncing each letter and specific speech combinations.”

(World Intangible Cultural Heritage – ICH)

UNESCO Proclamation 2003
Conch-Shell, Bell and Gong used for the study
Floor plan of The Narayanaswami Temple at Melkote, Karnataka, India

- Garbha-Griha
- Ardha-Mantapa
- Maha-Mantapa
Hindu Temple and Cultural Society in the Bridgewater, New Jersey, USA

Main Deity: Sri Venkateswara

Floor Sketch View

Temple

(a)

(b)
The Hindu Temple Society of Capital District, Albany, NY, USA

Main Deity: Sri Lakshmi - Sri Narayana

Floor Sketch View

Height of Garbhagriha = 2.44 m
Height of Ardhaksetra = 2.44 m

(a) Temple

(b) Floor Sketch View

Rectangles represent various other deities

S = Source
R = Receiver

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.35 m</td>
<td>1.83 m</td>
<td>2.13 m</td>
<td>0.91 m</td>
<td>0.61 m</td>
<td>2.44 m</td>
</tr>
</tbody>
</table>
Reverberant Sound Field in **Garbha-Griha** and **Ardha-Mantapa**

(a) Source in Garbha-Griha

(b) Source in Ardha-Mantapa
Reverberant Sound Field in Garbha-Griha and Ardha-Mantapa

Source in Garbha-Griha
Reverberant Sound Field in Garbha-Griha and Ardha-Mantapa

Source in Ardha-Mantapa
Modeling of Garbha-Griha and Ardha-Mantapa

If we model the entire Garbha-Griha and Ardha-Mantapa spaces as highly reflective and diffuse field then the sound pressure level (SPL) at any given point is,

\[ L_{P1} = L_w + 10 \log \left( \frac{4}{R} \right) \]  - - - - - - (1)

If we assume the space as entirely free field then the sound pressure level at the corresponding point \( r \), close to Ardha-Mantapa for a given source of sound power level can be written as \( L_w \)

\[ L_{P2} = L_w + 10 \log \left( \frac{1}{4\pi r^2} \right) \]  - - - - - - (2)

Subtracting Eqn. (2) from (1), we can obtain the increase in SPL of the room space as,

\[ \Delta L = L_{P1} - L_{P2} = 10 \log \left( \frac{16\pi r^2}{R} \right) \]  - - - - - - (3)

\[ R = \frac{S\alpha}{1 - \alpha} \] is the Room constant, \( m^2 \)

Surface area \( (S) \) in \( m^2 \), \( \bar{\alpha} \) s average absorption coefficient.
## Estimated Reverberation Time and increase in Sound Pressure Levels at various Hindu Temples

<table>
<thead>
<tr>
<th></th>
<th>Temple (Bridgewater, NJ)</th>
<th>Temple (Albany, NY)</th>
<th>Temple (Melkote, India)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume</td>
<td>$T_{60}$</td>
<td>$\Delta L$</td>
</tr>
<tr>
<td>Ardha-Mantapa</td>
<td>36.18</td>
<td>1.09</td>
<td>22.93</td>
</tr>
<tr>
<td>Garbha-Griha</td>
<td>43.86</td>
<td>1.14</td>
<td>22.32</td>
</tr>
<tr>
<td>Combined</td>
<td>80.02</td>
<td>1.12</td>
<td>19.62</td>
</tr>
</tbody>
</table>

\[
T_{60} = \frac{0.161V}{S\bar{\alpha}}
\]

Volume (V) in m$^3$, $T_{60}$ in sec, $\Delta L$ in dB

Surface area (S) in m$^2$, $\bar{\alpha}$ is average absorption coefficient, 0.015 for granite walls, 0.4 for person.
Spectra of Vedic-Chanting (alone)

$V = 147 \text{ Hz, 303 Hz, 400 Hz, ...}$

$\Delta L$ (measured) = 18 dB, $\Delta L$ (theoretical) = 19.6 dB
Conch-Shell Internal Structure

X-Ray tomography

Straightened conch-shell cavity profile (major and minor axis)
Spectra of a Conch-Shell (sounded alone)

C = 327.5 Hz, 655 Hz, 980 Hz

$\Delta L$ (measured) = 18.1 dB, $\Delta L$ (theoretical) = 19.6 dB
Spectra of a **Hand-Bell** (Sounded Alone)

B = 1262 Hz, 303 Hz, 2875 Hz

ΔL (measured) = 17.8 dB, ΔL (theoretical) = 19.6 dB
Impulse Response of Hand-Bell

(a) Anechoic chamber

(b) Temple (Bridgewater, NJ, USA)
Spectra of a Gong (Sounded Alone)

$G = 392 \text{ Hz}, 762 \text{ Hz}, 1437 \text{ Hz}$

$\Delta \mathcal{L} \text{ (measured)} = 17.2 \text{ dB}, \quad \Delta \mathcal{L} \text{ (theoretical)} = 19.6 \text{ dB}$
Spectra of Chant, Conch-Shell, Bell and Gong (Simultaneously Sounded)

327.5 Hz, 392 Hz, 440 Hz, 655 Hz…

$\Delta L$ (measured) = 16.7 dB, $\Delta L$ (theoretical) = 19.6 dB
## Summary of Observed Sounding Frequencies

<table>
<thead>
<tr>
<th>Type of Instrument</th>
<th>Observed Frequency (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vedic chant (alone)</td>
<td>147.5, 302, 440</td>
</tr>
<tr>
<td>Conch-Shell (sounding alone)</td>
<td>327.5, 655, 980, 1302.5, 1637, 1965, 2292.5</td>
</tr>
<tr>
<td>Bell (sounding alone)</td>
<td>1262.5, 2877.5</td>
</tr>
<tr>
<td>Gong (sounding alone)</td>
<td>392, 762, 1437, 1792, 2070, 2350, 2675, 3002</td>
</tr>
<tr>
<td>Simultaneous sounding of Vedic chant, Conch-Shell, Bell and Gong</td>
<td>327.5, 392, 440, 655, 762, 980, 1262.5, 1437, 1792, 2070, 2350, 2675, 2877.5, 3002</td>
</tr>
</tbody>
</table>
Worship through procession and inside the Ganesha Temple, Flushing, New York
Conclusions

- **Sound** plays a very important role in *Hinduism* and *Hindu worship spaces*.

- In addition to *Vedic chants*, musical instruments such as **Conch-Shells, Bells** and **Gongs** are also very commonly used to **enhance the spiritual** experience of the devotees during the worship.

- The measured spectra of chants and instruments show that the frequencies are spread across the active hearing range, which **helps focusing of mind** and further contribute to the spiritual experience of the devotees.

- The study shows that the highly reverberant characteristics of both **Garbha-Griha** and **Ardha-Mantapa** significantly enhance the acoustical environment and also enrich the spiritual experience of the devotees in Hindu Temples.
The author gratefully acknowledges the inspiration of his guru Yogi Sriranga Sadguru.

The author thanks Dr. B. Rajavel and Mr. Chenhui Zhao doctoral student at Stevens Institute of Technology for his help in the preparation of this presentation.

The authors thank Sri Vivek Vasanth, Sri Sunil Iyengar and Prof. Robert Harari (at Stevens Institute of Technology, Hoboken, NJ) for their help and discussions.

The authors also thanks Sri Siva Lakshmanarao Kakarala, Sri Naidu Bonthu and the priests Vidwan Pramod Acharya and Vidwan Sriram Acharaya of the Hindu Temple and Cultural Society in Bridgewater, New Jersey and Sri Mattur Balakrishna of the Hindu Temple Society of Capital District in Albany, New York for their help in making acoustic measurements.
Thank You!
Additional Slides
Worship is the pinnacle of communication between human beings and God in many religions. Worship can be individualistic (or) congregational.

Congregational worship usually requires dedicated spaces such as temples, gurdwaras, churches, synagogues and mosques.

Acoustics plays an very important role in worship spaces in all cultures and religions of the world. In Hinduism, acoustics is of major importance in various aspects of life namely spirituality, religion, culture, science, arts etc.

It is well known that sound plays a very important role in Hindu worship spaces namely homes, community halls and temples.
Shiva Panchaakshari mantra
Role of Acoustics
in
Vedic Hindu Tradition and Philosophy

M.G. Prasad and B. Rajavel
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“It would form a fascinating chapter of history to try and trace the gradual development of musical instruments and musical knowledge, from the rhythmic chanting of rig-veda in the ancient home of the Aryan race to the Indian music of the present day”

-Sir C. V. Raman (1922)
दिवपञ्चाक्षरीमन्त्रः

संहितापाठः
नर्मः शिवाय च।

पदपाठः
नर्मः शिवाय च।

क्रमपाठः
नर्मः शिवाय शिवाय च।

जरापाठः
नर्मः शिवाय शिवाय नमो नर्मः शिवाय शिवाय च च शिवाय शिवाय च।

घनपाठः
नर्मः शिवाय शिवाय नमो नर्मः शिवाय च च शिवाय नमो नर्मः शिवाय च। शिवाय च च शिवाय शिवाय च।
There are four stages of speech. The first three stages are hidden and are only perceptible to Yogis. The last stage is used by all the human beings.

<table>
<thead>
<tr>
<th>परा</th>
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<tr>
<td>पश्यन्ति</td>
<td>Pashyanthi (seen)</td>
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<tr>
<td>मध्यमा</td>
<td>Madhyama (Through Medium)</td>
</tr>
<tr>
<td>वैखरी</td>
<td>Vaikhari (Manifested)</td>
</tr>
</tbody>
</table>
Representation of the four fields of sound at **Vaikhari level**

- **Speech (Vaak)**
- **Language (Bhasha)**
- **Perception (Artha)**
- **Drama (Naatak)**

**Vaikhari**

- **Music (Sangeet)**
- **Vocal Instrument**
- **Dance (Nrtya)**

**Vaikhari**

- **Literature (Sahitya)**
- **Figures of Speech**
- **Metre**

**Vaikhari**

- **Naada Yoga, Naada Brahma, Shabda Brahma**
- **Yoga (Spirituality)**
- **Japa**
- **Chanting**

**Para**

**Pashyanthi**

**Madhyama**
The Order of Correspondence According to the Vedic Tradition

<p>| | |</p>
<table>
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<tr>
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<tbody>
<tr>
<td>Space</td>
<td>Sound</td>
</tr>
<tr>
<td>Air</td>
<td>Touch, Sound</td>
</tr>
<tr>
<td>Fire</td>
<td>Form, Touch, Sound</td>
</tr>
<tr>
<td>Water</td>
<td>Taste, Form, Touch and Sound</td>
</tr>
<tr>
<td>Earth</td>
<td>Smell, Taste, Form, Touch and Sound</td>
</tr>
</tbody>
</table>
**Acoustical Aspects of Hindu Worship Spaces**

- **Temples** (devaalayas or mandirs) as worship spaces have been an integral part of Hindu religion from ancient times.

- **Hindus** also use spaces such as community halls and specified space in their homes as spaces of worship.

- In addition to the mantras and bhajans, instruments such as **Conch-Shells**, **Bells** and **Gongs** are also used in the worship.

- The most important space in a Hindu temple is the space where the deity is installed called “**Garbha-Griha**” (or) “**Sanctum-Sanctorum**”.

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*Acoustics 2013 New Delhi*
Acoustical Aspects of Hindu Worship Spaces

- **Agama Shastras** on temple design prescribe that the whole temple is designed based on the size of the deity installed in the Garbha-Griha.

- **Garbha-Griha** is generally connected to another space (through its door opening) called **Ardha-Mantapa**.

- Both the **Garbha-Griha** and the **Ardha-Mantapa** are made of stones and are highly reflective with high reverberation time.

- The acoustical importance of Ardha-Mantapa is that a number of priests in addition to the main priest in the Garbha-Griha chant in unison and also the instruments such as conch-shells, bells and gongs are sounded in Ardha-Mantapa.

- The **Ardha-Mantapa** leads to a “main hall” referred as “**Maha-Mantapa**”. It is in this Maha-Mantapa where a large number of devotees assemble and participate in the worship.
‘Finger-In’ Effect on Conch-Shell Spectra

Recorded in Anechoic Chamber

Mic @ 2ft

Sound Pressure Level (dB)

Frequency (Hz)

C1, C2, C3, C4, C5, C6, C7, C8, C9

No Finger-in
With Maximum Finger-in
Spectra of Hand and Hanging-Bells
Spectra of a Gong when Stroked at Different Places

- Striking at the Center
- Striking at the Middle
- Striking at the Edge

Frequency (Hz)

Sound Pressure Level (dB)
There are two manifestations of GOD (Bramhan) to be realized: Shabda (Sound) and Param Bramhan (Light). One who has realized and is well versed in Shabda Bramhan will realize Param Bramhan ...

(Amrita Bindu Upanishat)
Consciousness (Chaitanya) in all beings is Shabda Bramhan according to me ...

Lakshmana Deshika in Sharada Tilaka

We worship the “Nada Bramhan” second to none which is blissful and is in all beings as consciousness and has expressed (manifested) itself as universe ...

Sangita Ratnakara (Saranga Deva)
There are four stages of speech. The first three stages are hidden and are only perceptible to Yogis. The last stage is used by all the human beings.

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Speech, Music, Literature and Yoga

- Speech (Vaak)
- Language (Bhasha)
- Perception (Artha)
- Drama (Naatak)

- Music (Sangeet)
  - Vocal Instrument
  - Dance (Nrtya)

- Poetry (Saahitya)
  - Figures of Speech
  - Metre

- Yoga (Spirituality)
  - Japa
  - Chanting

- Naada Yoga, Naada Brahma, Shabda Brahma

- Sanskrit Pronunciation Levels:
  - Vaikhari
  - Pashyanthi
  - Madhyama
  - Para
How Sound of Speech Manifests

An individual (soul) with a desire to speak encourages the mind. The mind strikes the heat (fire) center at the navel, which then pushes the air (wind). the sound (NADA) energy then gradually moves up through stomach, heart, throat, mouth as audible sound...

Ganarahasya Prakashini
Manifestation of Sound

Vaikhari is word manifestation. Madhyama is at memory level. Pashyanti is intentive level. Pure causal is Para.

The manifested air driven letters and assemblies first are caused at Mulaadhaar, then at heart as Pashyanti, then at intelligence as Madhyama (before it manifests) then as Vaikhari. All this happens in Sushumna of beings.

The Para stage of speech is at base of the spine. Pasyanthi stage is at the navel. Madhyama stage at the heart and Vikhari is at the throat.
Shabda

शब्दो ध्वनिश्च वर्णश्च मृदन्गादिभावो ध्वनि:
कणठ संयोग जन्मनो वर्णस्ते कादयो मतः

भाषा परिच्छेद

SHABDA

DHVANI
(VOICE)

VARNA
(LETTER SOUNDS)

ACOUSTICAL
SIGNAL
(AUDIBLE)

WORDS
SPEECH
## Hierarchy of Elements, Senses and Perception

<table>
<thead>
<tr>
<th>ATMAN</th>
<th>SPACE</th>
<th>EARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>AIR</td>
<td>SOUND</td>
<td>SKIN</td>
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<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>FIRE</td>
<td>TOUCH</td>
<td>EYES</td>
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<tr>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>WATER</td>
<td>SIGHT</td>
<td>TONGUE</td>
</tr>
<tr>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>EARTH</td>
<td>TASTE</td>
<td>NOSE</td>
</tr>
<tr>
<td></td>
<td>SMELL</td>
<td></td>
</tr>
</tbody>
</table>

- **Atman** (Self)
- **Space**
- **Air**
- **Fire**
- **Water**
- **Earth**
- **Senses**
  - **Sound**
  - **Touch**
  - **Sight**
  - **Taste**
  - **Smell**
- **Perception**
  - **Ears**
  - **Skin**
  - **Eyes**
  - **Tongue**
  - **Nose**
'SOME CONCEPTS'

* Sound is a property of space

* Air is carrier of sound

* Sound (with form) is letter

* Sound (physical) is generated through heat-air unison

* Speech is the fourth stage in sound production

* Sound propagates spatially

* Sound (name/word) and meaning are inseparable
Human Body as a Musical Instrument VEENA

Ref: Sriranga sadguru in "Amaravani"
Cognition and Listening

FIVE ORGANS OF COGNITION
EMANATING FROM THEIR SOURCE, THE MIND, LIKE FIVE RIVERS SPEED ONWARD TO SPEECH. THE FLOWING SPEECH, IN ITS DWELLING PLACE, THE MOUTH BECOMES FIVE FOLD.

YAJURVEDA XXXIV-II

पञ्चनदयः सरस्वतीमपि यन्ति सस्त्रोतसः सरस्वती तु पञ्चधा सो देशोभवत्सरित

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>COGNITION</th>
<th>SPEAKER</th>
<th>LISTENER</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEARING</td>
<td>(MIND)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOUCH</td>
<td>(MIND)</td>
<td></td>
<td></td>
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<tr>
<td>VISION</td>
<td>(MIND)</td>
<td>SPEECH</td>
<td></td>
</tr>
<tr>
<td>TASTE</td>
<td>(MIND)</td>
<td></td>
<td></td>
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<tr>
<td>SMELL</td>
<td>(MIND)</td>
<td></td>
<td></td>
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<tr>
<td>UNIVERSE</td>
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</tbody>
</table>
There are innumerable approaches to attain spiritual development and bliss. However its our view that the approach through sound is most effective.

The one who wishes to achieve excellence in yoga should concentrate attentively on “sound” by overcoming distractions.

(Ref : Shankaracharya in “yoga taravali”)

योग तारावली शंकराचार्य
The four fold description of sound production in Vedic Hindu literature can be used to describe the Consciousness.

Sound plays a major role in spiritual development of human beings in addition to its important role in arts and culture.

Further work is needed to investigate the relationship of acoustics to Consciousness.
Thank You!
Veda Mantras

- Mantras (chants) are orally transmitted from teacher to disciples.
- Precision in intonations and phonetics.
- Intrinsic pitch difference can be overridden.
- Provides experience and meaning.
- Oral transfer of knowledge through ages through memory.
Notes or Intonation or Vowels in Music language and Mantras

भाषा
Language

स्वर
Svara

संगीत
Music

वेदा
Vedas

स्वर्यते इति स्वर
It Sounds, So it is Svara

Matra Laxanam
मात्रा लक्षणम
ॐ
नित्यानंद वपूर्णिसन्तर्गतात पत्र्याष्टरं: क्रमात्
व्याप्तं येन वराचरात्मकं विदं शबद्यते: रूपं जगत
शब्दं भ्रमं यद्चिं सुकृतिनं: चैतन्यमण्तर्गतं
तद्वो नादनिषं शशाङ्कं सदनं नायाधीषं महं:
शारदा तिलकं तंत्रं
लक्ष्मण देसिकंद्र

May the great one, which has perennial corten bliss as its body, which has pervaded all the animate and inanimate universe through word and meaning from alphabets continously flowing from it, which is inner consciousness (Chiaithnaya) in the physical bodies refered as “Shabda Bramha” by the blessed ones, that (great one) controller (Lord) of speech, residing in moon protect all of

Sharda Tilaka Tantraman

Lakshmanama Lessikama