The New Sonic Boom: Designing Dynamic Acoustic Environments

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THE NEW SONIC BOOM
Designing Dynamic Acoustic Environments

How cutting-edge architects and artists are collaborating to break the architectural sound barrier

Jim Lutz
Architecture Program
University of Memphis

Steve Roden
Sound Artist
Los Angeles

The American Institute of Architects
2006 National Convention – Los Angeles
LEARNING OBJECTIVES
This session is not about architectural acoustics in the usual sense, rather it is about the use of sound as an architectural medium employed to create, define and embody space.
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1. To present and analyze historical and contemporary works of architecture demonstrating the relationship between sound and space.

2. To expose participants to emerging audio technology and present its potential for architectural applications.

3. To make the concept of sound as an architectural medium real and accessible through a first-person presentation of a case study.
PRESENTATION OUTLINE

I. FROM CAVES TO MICROCHIPS:
A Brief History of Architecture, Sound and Music
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   A Brief History of Architecture, Sound and Music

II. SEE HEAR NOW: Emerging Audio Technology
PRESENTATION OUTLINE

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A Brief History of Architecture, Sound and Music

II. SEE HEAR NOW:  Emerging Audio Technology

III. SPACE + SOUND + TECHNOLOGY:
New Sonic Environments
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I. FROM CAVES TO MICROCHIPS:
   A Brief History of Architecture, Sound and Music

II. SEE HEAR NOW: Emerging Audio Technology

III. SPACE + SOUND + TECHNOLOGY:
   New Sonic Environments

IV. SUMMARY AND CONCLUSION
PRESENTATION OUTLINE

I. FROM CAVES TO MICROCHIPS: A Brief History of Architecture, Sound and Music

II. SEE HEAR NOW: Emerging Audio Technology

III. SPACE + SOUND + TECHNOLOGY: New Sonic Environments

IV. SUMMARY AND CONCLUSION

V. CASE STUDY: Serpentine Pavilion
   Steve Roden, Sound Artist
I. FROM CAVES TO MICROCHIPS:
A Brief History of Architecture, Sound and Music
ARCHITECTURE
Permanent

SOUND
ARCHITECTURE
Permanent

SOUND
Ephemeral
ARCHITECTURE
Permanent
Substantive

SOUND
Ephemeral
Immaterial
ARCHITECTURE
Permanent
Substantive
Fixed

SOUND
Ephemeral
Immaterial
ARCHITECTURE
Permanent
Substantive
Fixed

SOUND
Ephemeral
Immaterial
Dynamic
ARCHITECTURE
Permanent
Substantive
Fixed
1D, 2D, 3D
(Width, Length, Height)

SOUND
Ephemeral
Immaterial
Dynamic
ARCHITECTURE
Permanent
Substantive
Fixed
1D, 2D, 3D
(Width, Length, Height)

SOUND
Ephemeral
Immaterial
Dynamic
4D
(Time)
ARCHITECTURE
Permanent
Substantive
Fixed
1D, 2D, 3D
(Width, Length, Height)

SOUND
Ephemeral
Immaterial
Dynamic
4D
(Time)

MUSIC
ARCHITECTURE
- Permanent
- Substantive
- Fixed
- 1D, 2D, 3D
  (Width, Length, Height)

SOUND
- Ephemeral
- Immaterial
- Dynamic
- 4D
  (Time)

MUSIC
- Functional/
  Representational
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<th>ARCHITECTURE</th>
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ARCHITECTURE
Permanent
Substantive
Fixed
1D, 2D, 3D
(Width, Length, Height)

FUNCTIONALITY
Representational
Calculated

SOUND
Ephemeral
Immaterial
Dynamic
4D
(Time)

MUSIC
Abstract
ARCHITECTURE
Permanent
Substantive
Fixed
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(Width, Length, Height)

SOUND
Ephemeral
Immaterial
Dynamic
4D
(Time)

MUSIC
Abstract
Improvisational

Functional/
Representational
Calculated
ARCHITECTURE
- Permanent
- Substantive
- Fixed
- 1D, 2D, 3D (Width, Length, Height)
- Functional/
  Representative
- Calculated
- Laborious

SOUND
- Ephemeral
- Immaterial
- Dynamic
- 4D (Time)

MUSIC
- Abstract
- Improvisational
**ARCHITECTURE**
Permanent
Substantive
Fixed
1D, 2D, 3D
(Width, Length, Height)

**SOUND**
Ephemeral
Immaterial
Dynamic
4D
(Time)

**MUSIC**
Abstract
Improvisational
Extemporaneous

Functional/
Representational
Calculated
Laborious
“The paintings are positioned to correspond with those spots capable of producing prolonged echoes of a particular intensity.”

-Iégor Reznikoff, Anthropologist

The Music of Caves
Paleolithic Wall Paintings
Grotte de Niaux, Ariège, France
Pythagoras of Samos
Circa 500 B.C.E.
Pythagoras of Samos
Circa 500 B.C.E.

\[ a^2 + b^2 = c^2 \]
Pythagoras of Samos
Circa 500 B.C.E.
Tonic
Octave
THE NEW SONIC BOOM

\[ \begin{align*}
1 & = \\
1 & = \\
2 & = \end{align*} \]
Fifth
Fourth
\[ \begin{align*}
2 & = 3 \\
3 & = 4
\end{align*} \]
Harmonic Proportions

Tonic

Octave

Fifth

Fourth

1:1

1:2

2:3

3:4
Pythagoras 500 BCE
Greek Mathematician & Philosopher

“All Is Number”
Vitruvius
1st Century BCE/CE

“The architect ought also to know music in order to understand canonical and mathematical theory...”

The Ten Books of Architecture
Book 1, Chapter 1
St. Bernard of Clairvaux
Founder of Cistercian order
12th Century

“What is God? He is width, height, and depth. There must be no decoration, only proportion.”

Santa Maria in Cosmedin
Rome, 12th Century
Leon Battista Alberti
15th Century

“These numbers which we have reviewed were not employed by architects randomly or indiscriminately but according to a harmonic relationship.”

On the Art of Building in Ten Books
Book 9, Chapter 6
Andrea Palladio
16th Century

“There are seven types of rooms that are the most beautiful and well proportioned... circular, square (1:1), length equal to the diagonal of the square (1:1.141), square and a third (3:4), square and a half (2:3), square and two thirds (3:5), and two squares (1:2).”

The Four Books on Architecture
Book 1, Chapter 21
Architectural Theory in 17th Century France

The idea of harmonic proportion was debated and challenged by the French Academy of Architecture in the 17th century.

François Blondel (1617-86) argued for a “Marriage of music and architecture.”

Claude Perrault (1613-88) argued “The taste of our age—or at least of our nation—differs from that of the Ancients.”
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At this point in history the theoretical relationship between music and architecture fell out of favor for the next two centuries, only to be picked up again with particular vigor at the dawn of the 20th century.
Thinking Outside the (Music) Box
Collaborations between Composers & Architects

“The poet is one who starts from the seat of the unmeasurable and travels towards the measurable, but who keeps the force of the unmeasurable with him at all times.” – Louis Kahn
Successful collaborations between composers and architects are possible because:

Isomorphic correspondences exist between the two allied arts – concepts such as structure, rhythm, harmony/dissonance, metrics, etc. provide a common language for discourse.

Music and Architecture find commonality in Mathematics.
Philips Pavilion
Brussels World’s Fair –1958
Le Corbusier / Iannis Xenakis / Edgard Varesè
**Philips Pavilion**  
Brussels World’s Fair –1958  
Le Corbusier / Iannis Xenakis / Edgard Varesè

**Performance Space**  
*for Prometeo*  
Venice and Milan – 1983 / 84  
Renzo Piano / Luigi Nono
Philips Pavilion
Brussels World’s Fair – 1958
Le Corbusier / Iannis Xenakis / Edgard Varesè

Performance Space for Prometeo
Venice and Milan – 1983 / 84
Renzo Piano / Luigi Nono

Pavilion of the Swiss Confederation
Hanover – Expo 2000
Peter Zumthor / Daniel Ott
Philips Pavilion
Brussels World’s Fair –1958
Le Corbusier / Iannis Xenakis / Edgard Varesè
“My idea is that music should have a part in this...It is a scenario to be created wholly from relationships: light, plasticity, design and music...It will be the first truly electric work and with symphonic power.” - Le Corbusier
“...I want to let you know immediately that I find your project superb and that I accept with great pleasure your offer of collaboration.” -Edgar Varesè
“Metastasis was the source of...The Philips Pavilion...which I designed and made out of ruled surfaces much like my fields of string glissandi.” - Iannis Xenakis

Musical score of glissandi from *Metastasis* 1953 – 1954

Conceptual sketches by Xenakis showing pavilion’s geometry
“Metastasis was the source of...The Philips Pavilion...which I designed and made out of ruled surfaces much like my fields of string glissandi.” -Iannis Xenakis
Performance Space for Prometeo
Venice and Milan – 1983 / 84
Renzo Piano / Luigi Nono
Renzo Piano - Architect

Luigi Nono - Composer
“We must learn to live with the plurality of times and spaces, with multiplicities and with differences.” - Luigi Nono
“The music in *Prometeo* is not projected into perspective, over the heads of the audience as in traditional opera house, but instead inundates the audience, which becomes fully immersed in the performance.”  - Renzo Piano
“The most beautiful adventure for an architect is to build a space for music. Perhaps it is more beautiful for a luthier to design a violin, but both are about building instruments.” -Renzo Piano
Pavilion of the Swiss Confederation
Hanover – Expo 2000
Peter Zumthor / Daniel Ott
“The spatial and structural engineering is designed to amplify and direct the tone and timbre of the commissioned musical compositions. The image of a large sound-box was used as a basis for the design.” - Excerpt from: Swiss Sound Box - A handbook for the Pavilion of the Swiss Confederation

“I had this idea of ‘spatial music’ with mobile musicians inside a continually changing sound space...One of the aims is to complement / cross the musical flow, to intervene and disrupt constructively.”

– Daniel Ott

Peter Zumthor

Daniel Ott
“I have to produce images in my mind and in the minds of my collaborators. Any time we work on it, we have an image of how it looks. Then it’s easy to react on it...” - Peter Zumthor on “form”
The composer has attempted to convert the number that he gathered from the Swiss Sound Box enterprise into a composition and in turn to convert the rows of numbers and proportions produced by the composition into sounds and time-based structures. For example, architectural numbers: twelve stacks, three courts, the number of beam layers within a stack, etc.
“The resulting Sound Box music consists of heterogeneous building blocks that can be reconfigured daily during the 153-day performance.” - Excerpt from: Swiss Sound Box Handbook on “Composition Method.”
CONCLUSION

The three buildings cited as examples were constructed as temporary, purpose-built structures, in essence as ephemeral as the music performed within them.

Music and Architecture informed one another through a common language shared by Architect and Composer, allowing for and facilitating collaboration.
II.

SEE HEAR NOW:
Emerging Audio Technology
Digital Audio Control Systems

Aegis Hyposurface
Mark Goulthorpe/
dECOi Architects
1999-2001
Digital Audio Control Systems

Aegis Hyposurface
Mark Goulthorpe/dECOi Architects
1999-2001
Digital Audio Control Systems
Bone Mass Transducers

Boundary Interference
Installation at Harvard GSD
Ean White, Designer
2001
Hypersonic Sound
Active Noise Cancellation

Use them as a concert hall – or a sanctuary.
Active/Adaptive Noise Cancellation

Schematic Diagram
Active Noise Cancellation
Tunable Pink Noise

Masking Software
Acoustically Responsive Materials

FLEXGRID
Hariri + Hariri with James Clar

URBAN CAMELEON
University of Dublin
Software

Sentri System
(Smart Sensor Enabled Neutral Threat Recognition and Identification)
Chicago

Genware
Algorithmic/Genetic Software
Alisa Andrasek - Columbia University
III.
SPACE + SOUND + TECHNOLOGY:
New Sonic Environments
BLUR BUILDING
Diller + Scifidio with Christian Marclay
Yverdon-Les-Bains, Switzerland, 2002
Braincoats
Mind Zone
Zaha Hadid with Ryoji Ikeda
Son-O-House
NOX/Lars Spuybroek with Edwin van der Heide
Son en Breugel, Netherlands, 2002-2004
Son-O-House
NOX/Lars Spuybroek with Edwin van der Heide
Son en Breugel, Netherlands, 2002-2004
IV.
SUMMARY AND CONCLUSION
CONCLUSIONS AND SUMMARY
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II. The relationship between architecture and music was renewed with particular vigor during the 20th century.
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III. New sonic technologies are emerging that will allow architects to use sound as never before.
CONCLUSIONS AND SUMMARY

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II. The relationship between architecture and music was renewed with particular vigor during the 20th century.

III. New sonic technologies are emerging that will allow architects to use sound as never before.

IV. Architects are using sound in the 21st century to shape form and space.
V.

CASE STUDY:
Serpentine Pavilion
Steve Roden, Sound Artist
**Serpentine Pavilion**
Álvaro Siza and Eduardo Souto de Moura
Sound performance by Steve Roden
London, 2005
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Seminar Evaluation

Please take a moment to complete the evaluation form. Thank you.

Moderator: Jim Lutz, University of Memphis
Memphis, Tennessee

Speaker 1: Steve Roden
in between noise
Pasadena, California