Acoustics Modeling

Bridgewater Hall
Manchester, UK
Arup Acoustics

Early ray tracing to predict performance…

Graphic Modeling

How do you visualize sound?
Like Edward Munch or typographically?
Choose physical or computer model?

Physical Models...size matters...

Accurate modeling at 1:10 if frequency is at 10x
How much detail is needed?

The ‘real’ building vs.

1:40 corrugated board models ranging from detailed…

...to stripped down……….
…which are all accurate enough to determine its basic acoustic characteristics—dead or live—and length and smoothness of reverberation…

…so, is this model ok?

Schermerhorn Hall, Nashville

An alternative modeling theory…

…reflections of sound can be predicted by rays… therefore a narrow beam of light (a laser) can demonstrate the path of sound in space…
Quick and dirty acoustics models are similar to daylighting models...

Model reflective surfaces with foil, non-reflective with cardboard

'Scanning' with laser shows distribution of light and effectiveness of reflectors...
…long exposure captures information…

High power laser pointer
(20 euros in Paris)

Courtyard model at CAT

Computer-based ray tracing

Shoe Box Hall  Wide (Fan) Hall  Reverse Fan Hall

…can draw rays and display the effect…
…options can be compared
…multiple listener points can be analyzed
…complexity of analysis can be selected

…beauty and performance can be imagined, if not guaranteed

Meyerson Hall
Dallas, TX
I.M. Pei
Animation is possible!

…dynamic ray tracing

…or dynamic wave front generation

Sigh! Ecotect is gone!

Winspear Opera House, Dallas

—Foster + Partners w/Sound Space
Copenhagen Concert Hall used both computer and physical models:

— Atelier Jean Nouvel w/Nagata Acoustics

Model behavior
A not-to-scale miniature version of the real thing helps tune a design  BY JOANNE CONCHAR, AIA

FROM THE EARLIEST STAGES of the project, the client for Jean Nouvel’s Copenhagen Concert Hall, Basalt Aarhus, had decided that the building’s acoustics must be sound, not sound. “We wanted the music to be the star of the show,” explains Harald Bagger, the architect. “The focus for the hall is the music, not the acoustics.”

At the design stage, the team built a 1/3-scale model of the concert hall. Because of the hall’s size, it was necessary to use both computer and physical models. The computer model allowed for precise measurement and analysis of the acoustic environment. However, the physical model allowed for the acoustics to be tested in real-time, with the ability to make changes and adjustments as needed.

Nagata Acoustics
Nagata Acoustics was commissioned to help the design team understand the acoustic environment of the concert hall. The design team worked closely with Nagata Acoustics to ensure that the hall met the client’s requirements for acoustical performance.

How to get there?

Voxman Hall, University of Iowa, integrated design goals

Audio Speakers

Stage Lighting

House Lighting

Fire Protection

Acoustic Transparency

How to get there?
LMN Architects used parametric modeling, 1/3 scale mock-up for the concert hall’s theatroacoustic ceiling.

Grasshopper model ray tracing

Acoustic consultant Jaffe Holden

Auralization combines digital models with sound tracks

Auralization and specialized listening environments, like Sound Lab in Arup’s New York City office, allow for side-by-side comparisons of rooms that have sought-after acoustics with spaces that exist only as digital models. Here, an Arup acoustician compares Vienna’s Musikvereinssaal (1870) with an unbuilt concert hall (right).

Photos: Andreas Pessenlehner/EPA/Corbis (left); Arup (middle)
Acoustic consulting

One of the world's leading acoustic consultancies, Arup helps clients achieve their acoustical aspirations, from creating concert halls with beautiful sound to reducing the impact of airport noise.

http://www.arup.com/Services/Acoustic_Consulting

The sound of wind farms

http://video.arup.com/?v=1_pqe8e2or

Seeing is believing

https://www.youtube.com/watch?v=c6FzQ_liaNU