BREKKE STRAND

GEFFEN HALL

ACOUSTICAL IMPROVEMENTS FROM INCREMENTAL MODIFICATIONS

A simulation study
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Geffen Hall

Acoustics

Outline

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- 3D-model of Geffen Hall
- Simulations
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    - Why does it sound better with orchestra on Thrust Stage ?
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Background

NY Times, October 3, 2017 https://www.nytimes.com/2017/10/03/arts/music/lincoln-center-geffen-hall.html

- “Lincoln Center Scraps a $500 Million Geffen Hall Renovation
- the new approach will be less monumental and more incremental
- work to improve the hall’s acoustics
- explore the idea of bringing the stage further into the auditorium, as the Mostly Mozart festival
- weigh losing some seats to make the cavernous hall feel more intimate

Vulture, October 6, 2017 https://www.vulture.com/2017/10/the-overdone-plan-for-redoing-geffen-hall-is-history-good.html

- By knocking out the upper balcony, cutting down the number of seats, moving the stage out into the room (as already happens for Mostly Mozart) and fitting out the interior with sound-diffusing finishes, Lincoln Center should be able to buy itself what matters most—deluxe acoustics

Assumed success criteria for Geffen Hall

- Excellent acoustics for audience and musicians
    - EDT value ranges in Boston, Vienna and Amsterdam are adequate target values
- Shorter distance between performer and listener
- Maintain as many seats as possible –> maintain ticket revenue
- Minimize downtime – when the hall needs to be closed due to construction work
- Avoid non-reversible demolition if possible
- Cost-effective improvements
- Optimization task, see below:

maximize

ACOUSTICAL
IMPROVEMENT

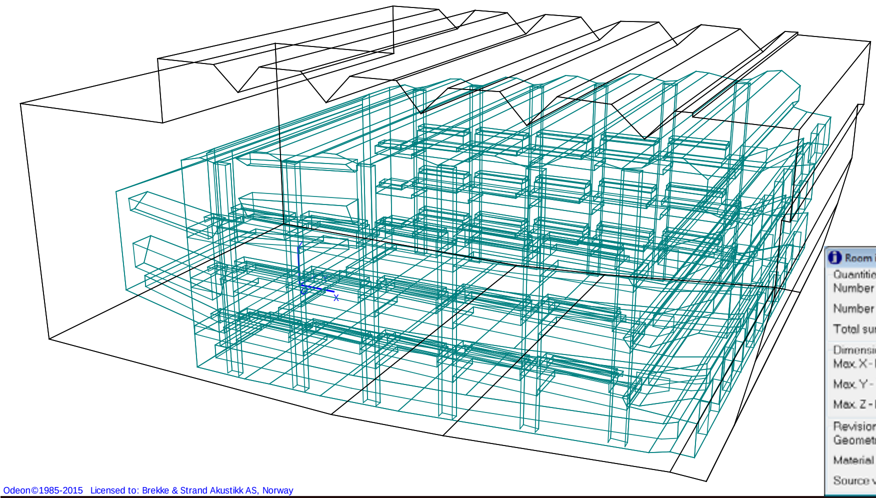
Minimize or avoid

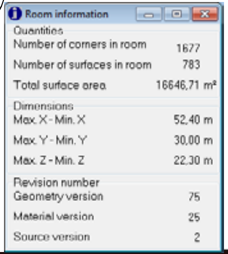
LOSS OF TICKET REVENUE
CONSTRUCTION COSTS
DOWNTIME
NON-REVERSIBLE DEMOLITION

3D-model

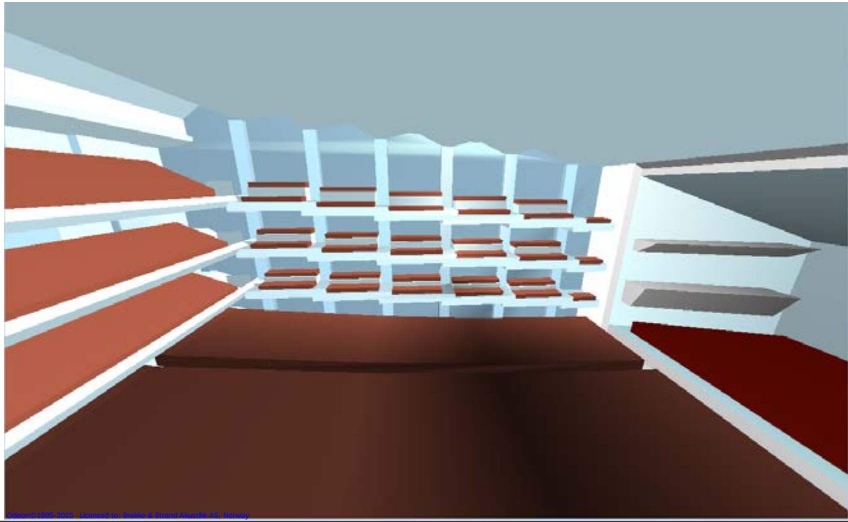
A 3D-model was built and tuned according to published data, with ODEON 14 software

Wireframe model





Interior view



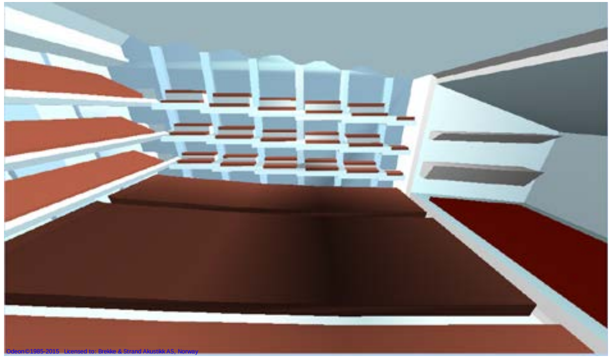
Simulations 1 => EDT is the critical parameter

Thrust Stage vs Regular Configuration

Why does it sound better with orchestra on Thrust Stage, like in Mostly Mozart ?

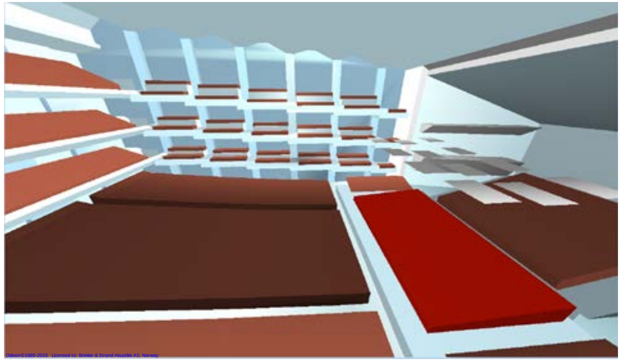
Which acoustical parameter better describes the reported differences ?

Answer: Early Decay Time (EDT) turned out to be the parameter that best describes the perceived difference between regular and Thrust Stage configurations.



Regular configuration 2742 seats

According to ISO 3382, EDT corresponds to the aspect known as Reverberance



Thrust Stage 2542 seats

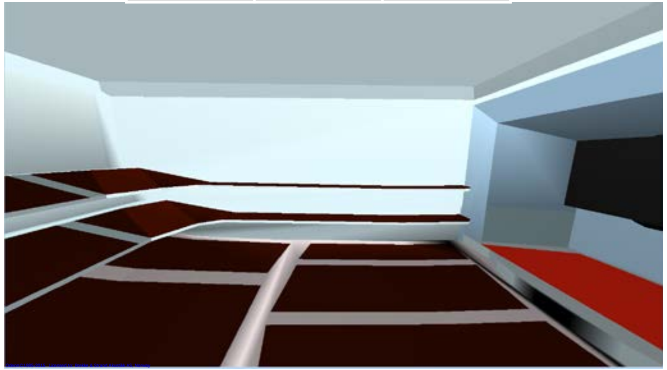
Simulations 2 => EDT target value ranges

EDT values simulated in 3 excellent halls, in stalls and in orchestra, source at Concert Master position. Resulting value ranges to the right:

	Stalls	Orchestra
Mid-frequencies MF	1.7-2.1 s	1.2-1.9 s
Low frequencies LF	1.9-2.2 s	1.3-2.0 s

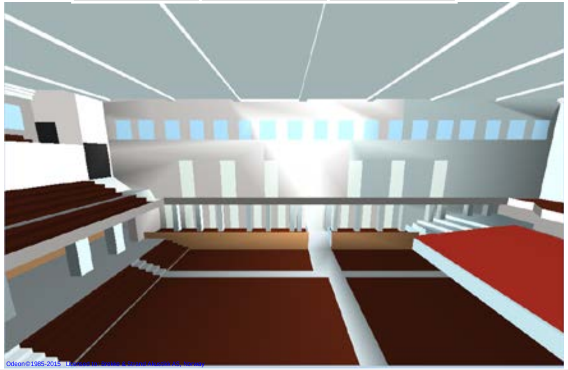
Boston Symphony Hall

BSH	Stalls	Orchestra
MF	1,8	1,3
LF	1,9	1,3



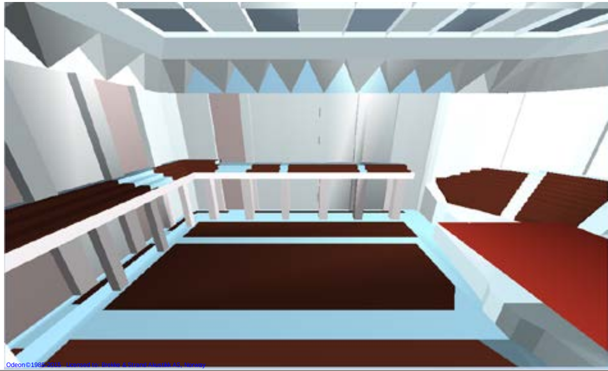
Vienna Musikverein

VM	Stalls	Orchestra
MF	1,7	1,2
LF	1,9	1,5



Amsterdam Concertgebouw

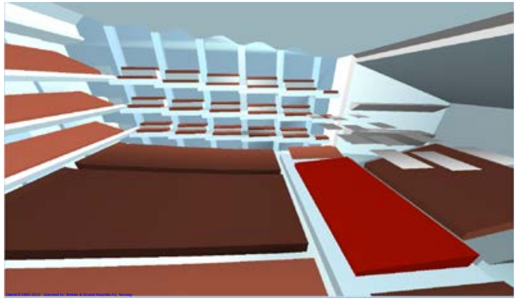
AC	Stalls	Orchestra
MF	2,1	1,9
LF	2,2	2,0



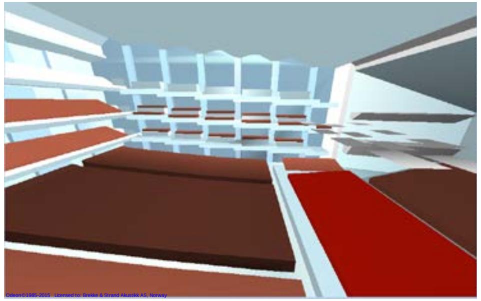
Suggested modifications

id	What ?	Why ?	Cost
A	Move orchestra to Thrust Stage	Successful in Mostly Mozart	Net loss 200 seats
B	Remove all seats from 3rd tier	Reduce sound absorption in upper volume (Hard Cap), without demolition or construction	Net loss 384 seats, work hours, storage, no/short downtime
C	Reinforce plywood wall cladding	Reduce bass absorption	Materials and work hours, moderate downtime
D	Remove entire 3rd tier	Establish plane hard cap walls like in classical halls, eliminate kick-down to sound absorbing surfaces (audience)	Non-reversible demolition, extencive downtime and work hours

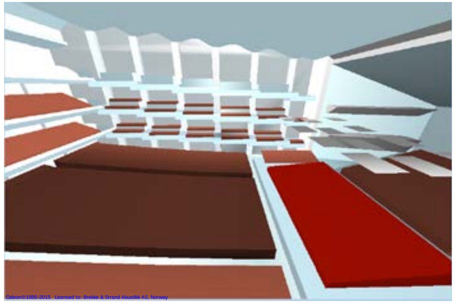
Models of suggested modifications



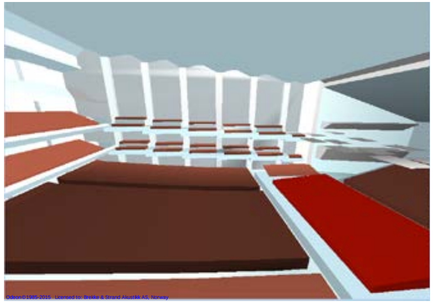
A
Thrust Stage



B+A
3rd tier seats out
Thrust Stage



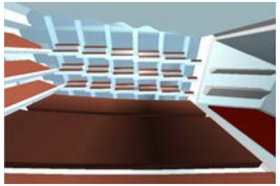
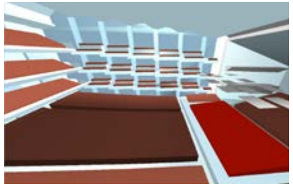
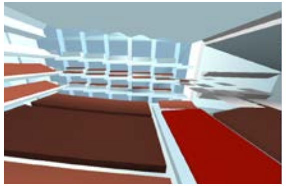
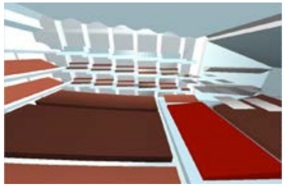
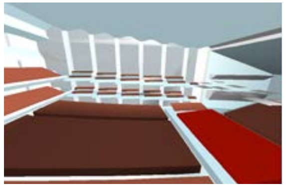
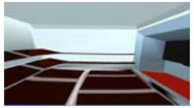
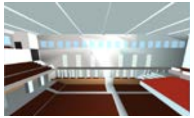
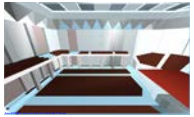
C+B+A
Heavier walls
3rd tier seats out
Thrust Stage



D+C+B+A
3rd tier removed
Heavier walls
Thrust Stage

Simulations 3: EDT with suggested modifications

		Initial condition	A Thrust Stage	B + 3rd tier chairs removed	C + heavier walls	D + 3rd tier demolished	Boston, Vienna, Amsterdam
stalls	MF	1,5	1,6	1,9	1,9	1,9	1.7-2.1
	LF	1,5	1,7	1,8	1,9	2,1	1.9-2.2
orch	MF	0,8	1,3	1,5	1,5	1,5	1.3-1.9
	LF	0,8	1,4	1,6	1,6	1,7	1.3-2.0
	points	0	2	3	4	4	4
	seats	2742	2542	2156	2156	2156	Average 2100

= value qualified, i.e. within value range in reference halls; 1 point for each green box

Comments to simulated results of modifications

A. Moving from regular stage to thrust stage provides a more than noticeable increase in reverberance in the stalls, yet not comparable with conditions in the 3 reference halls.
For musicians in the orchestra, it provides a dramatic improvement, bringing reverberance within the range of the 3 reference halls. Total 2 points. Loss of 200 seats justified.

B. Removing all 386 seats from 3rd tier improves reverberance further in stalls and orchestra. However lacking som warmth and bass response as perceived in stalls. Total 3 points. Loss of 386 seats justified.

C. Making walls of plywood heavier improves warmth and bass response in stalls as well as in orchestra, with reverberance similar to average in the 3 reference halls. Total 4 out of 4 points. Cost is justified.

D. Completely demolishing the 3rd tiers improves warmth and bass response further, with EDT values closer to those in Amsterdam. Total 4 out of 4 points. Justification of cost and permanent loss is not obvious, and should be carefully considered.

Other

Other listening aspects (ISO 3382) than Reverberance have been considered, but they do not alter conclusions.

Loudness, Clarity, Source Broadening and Envelopment in the Geffen Hall model do not differ significantly from the models of the 3 reference halls, and are not very sensitive to the modifications.

The improvement change in low-frequency Loudness follows the change in reverberance.

Increased low-frequency response after modifications may be less beneficial for events with reinforced music, a well known fact from classical concert halls.

Conclusions

Improvement of acoustics for symphonic music in Geffen Hall is highly wanted

Incremental modifications have been explored by simulations in 3D models of the hall

Reverberance turned out to be the most critical feature, measured by the parameter EDT

EDT values resulting from modifications were compared with those in 3 famous reference halls

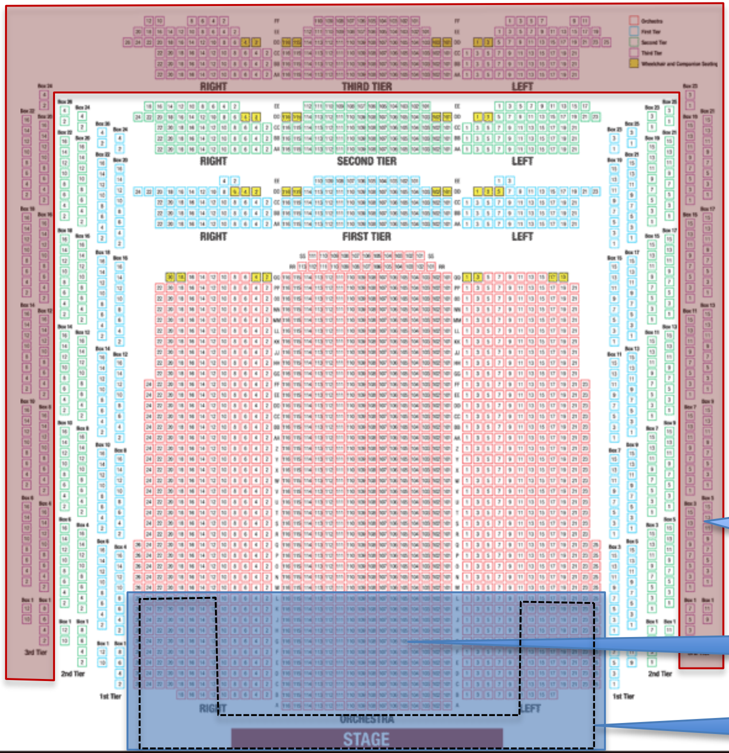
Improved acoustics can be made very cost-effective, but only if loss of seats is accepted

The following modifications are judged to justify loss of seats and other costs, with minimal downtime

- Moving from regular stage to Thrust Stage, justifies loss of 200 seats
- Remove and store all seats on all 3rd tiers, justifies loss of another 386 seats
- Increase weight of plywood all walls, justifies construction cost

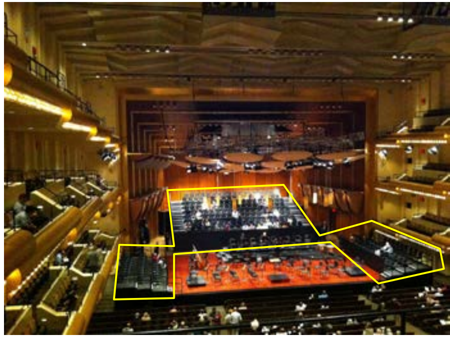
«Knocking out the upper balcony» (Vulture 2017): Demolition of entire 3rd tier can bring even more warmth and bass response, but the following should be carefully considered: Downtime; Cost; It is a non-reversible modification.

Details: Seat count – loosing seats



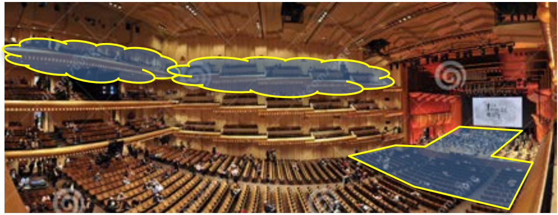
Count 0 (initial)	2742
- 11 rows	400
+ new surround	200
= Count 1	2542

Count 1	2542
- 3rd Tier	386
= Count 2	2156



Count 1 = 2542
(net loss 200)

Count 2 = 2156
(net loss 586)



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Thank you

More info?

The www center for search, research and open sources in acoustics

www.akutek.info

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