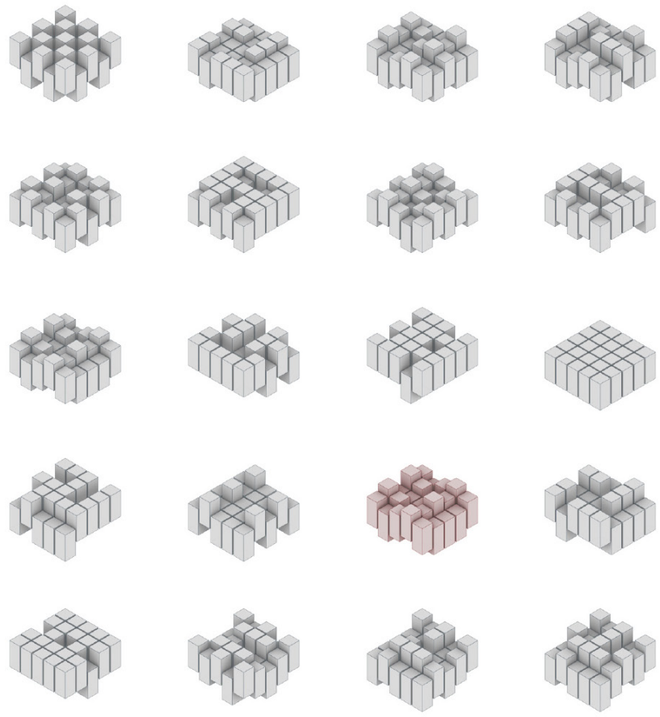


THE SOUND BENDING PROJECT

THE SOUND BENDING PROJECT

Student | Tarang Gupta 4917146

Mentor | Serdar Asut Design Informatics

Christien Janssen Building Physics | Acoustics

Delegate | Rodrigo O V Cardosso Board of Examiner

TU Delft
BK Bouwkunde

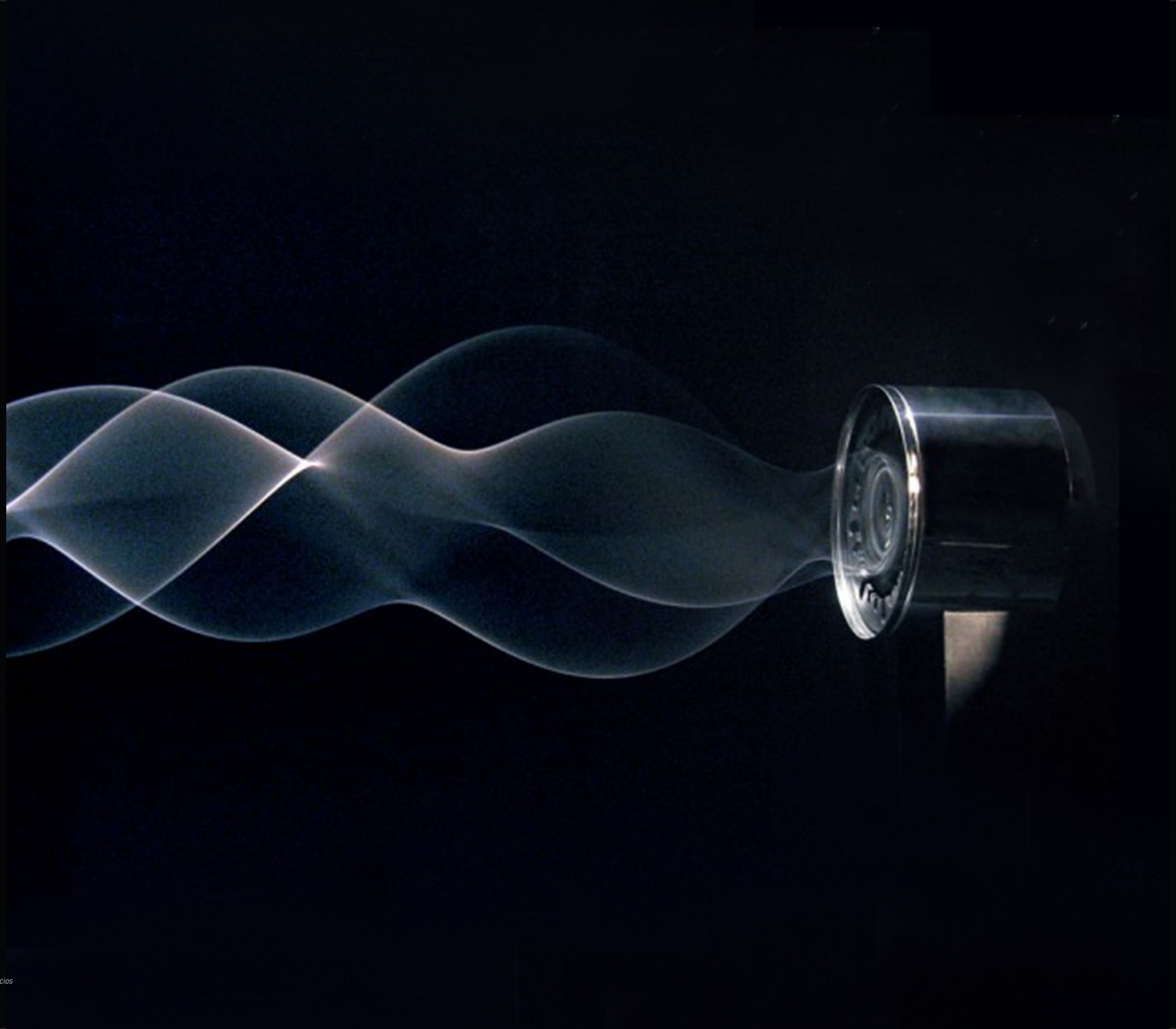
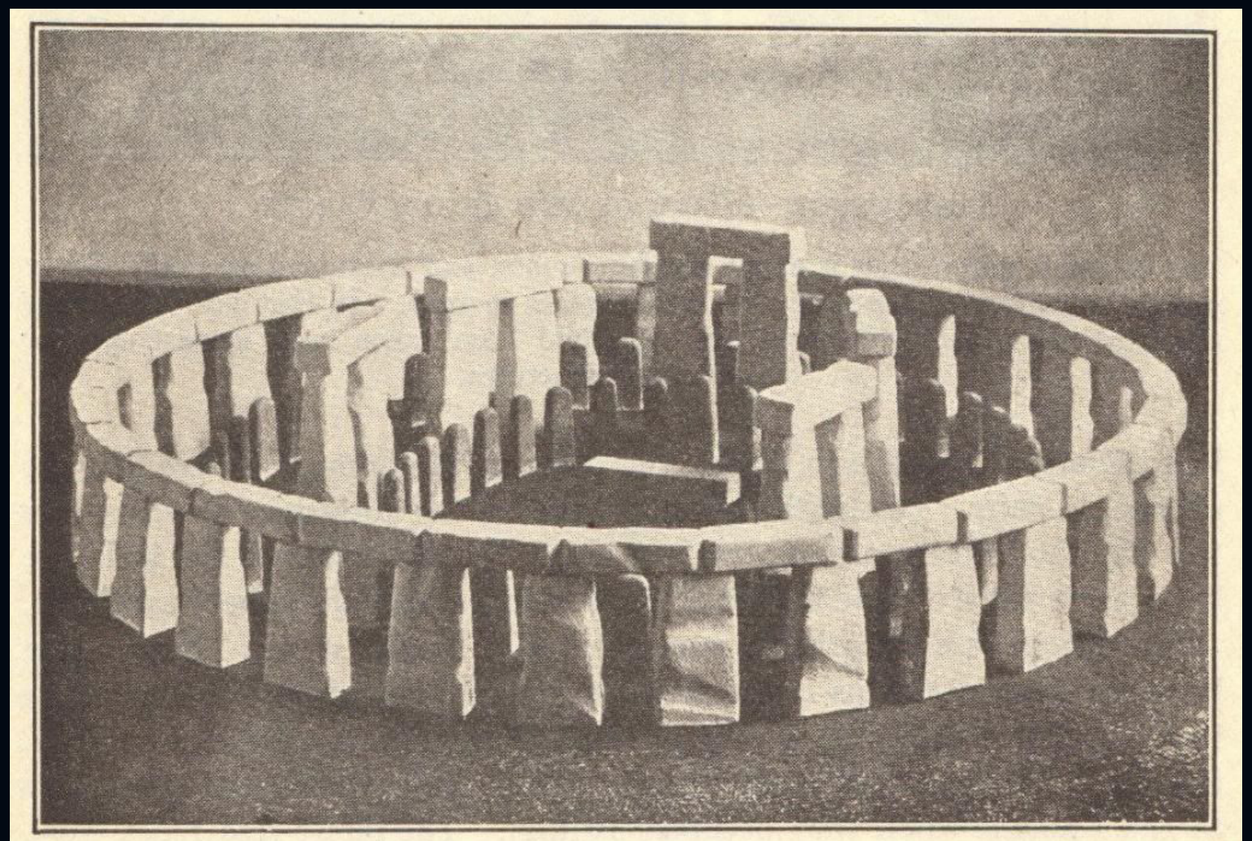


Image Source : Daniel Palacios

Image source : Stonehenge (Dr. Miles Russel - AKG Images)



STONEHENGE — RESTORATION

Image source : Stonehenge (Dr. Miles Russel - AKG Images)

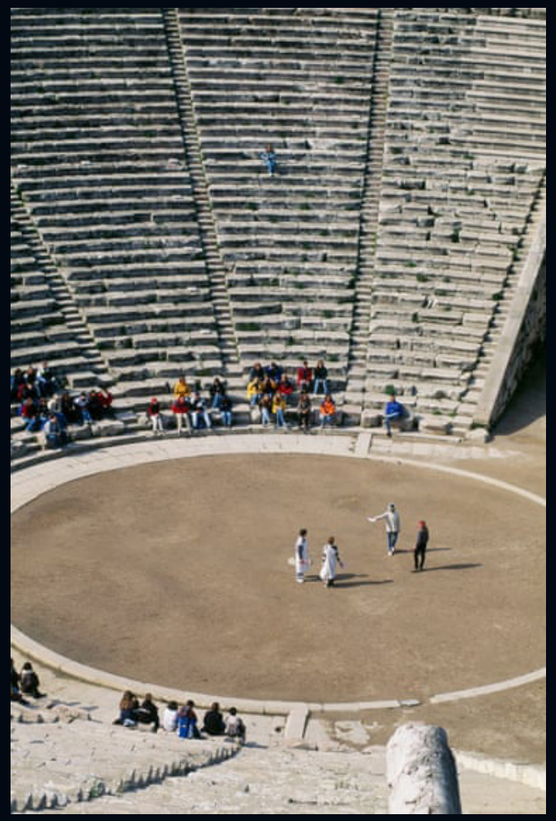


Image source : Epiradius theatre, Greece (DEA / S.Vannini/Getty Images), Colosseum, Rome (Author)

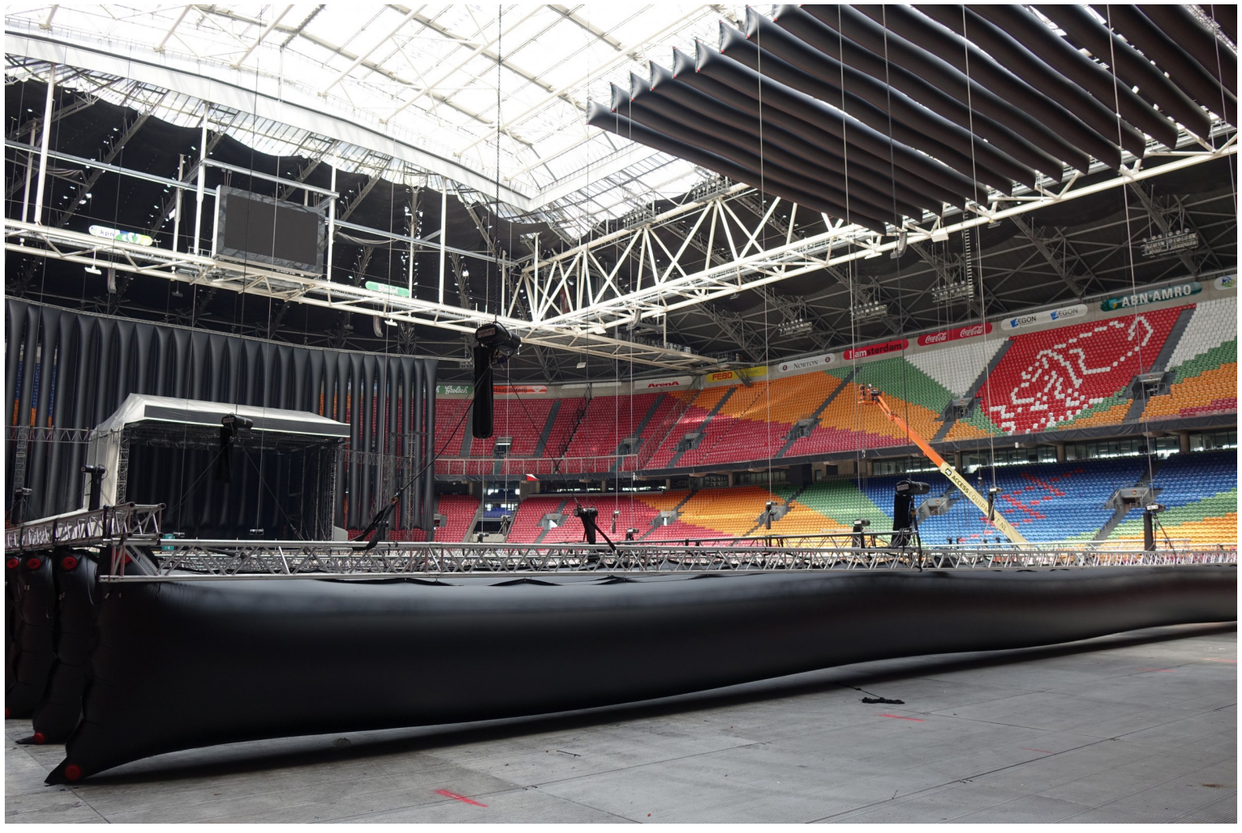
WHAT CHANGED ?

GRANDER & LOUDER V

Image source : Tottenham Hotspur stadium (Edward Hill)

MULTI-PURPOSE USE | DIFFERENT ACOUSTICAL NEEDS

Image source : Michael Marotta (Bohemian Rhapsody, vanyaland.com)



RESULT | RETRO-FIT DESIGN SOLUTIONS

Image source : top (Flex acoustics, flexac.com)

INDOOR PRACTICE | FACADE TO COVER COMPLEXITIES

"LISTEN! INTERIORS ARE LIKE LARGE INSTRUMENTS, COLLECTING SOUND, AMPLIFYING IT, TRANSMITTING IT ELSEWHERE."

- Peter Zumthor

"AN ALTERED STATE OF CONSCIOUSNESS...INVOLVES THE DESTABILIZATION OF ORDINARY CONSCIOUSNESS AND THE ESTABLISHMENT OF ANOTHER MODE OF AWARENESS."

-Barbara Crowe

"...[THE] INTERCONNECTION BETWEEN HUMANS AND SPACE IS A DIALOGUE THAT ENABLES US TO EXPERIENCE OURSELVES IN THE SOUND OF THE ROOM."

-Elizabeth Martin

"BUILDINGS PROVIDE SPACES FOR LIVING BUT ARE ALSO DE FACTO INSTRUMENTS, GIVING SHAPE TO THE SOUND OF THE WORLD. MUSIC AND ARCHITECTURE ARE RELATED NOT ONLY BY METAPHOR, BUT ALSO THROUGH CONCRETE SPACE. EVERY BUILDING I HAVE ADMIRED IS, IN EFFECT, A MUSICAL INSTRUMENT WHOSE PERFORMANCE GIVES SPACE A QUALITY THAT OFTEN SEEMS TO BE TRANSCENDENT AND IMMATERIAL."

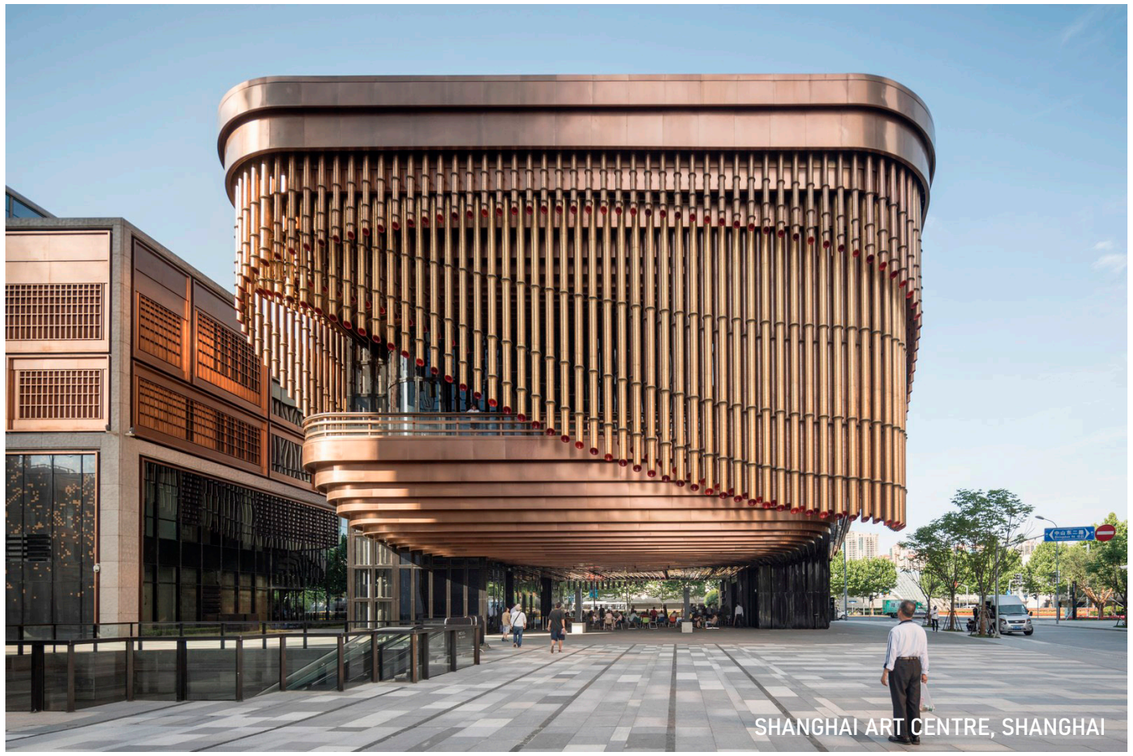
- Daniel Libeskind

"...WHEN WE REFLECT ON OUR AURAL EXPERIENCE, OUR RESPONSE - BOTH CEREBRAL AND EMOTIONAL - IS OFTEN HIGHLY CHARGED, TANGIBLE, IMMEDIATE AND VISCERAL."

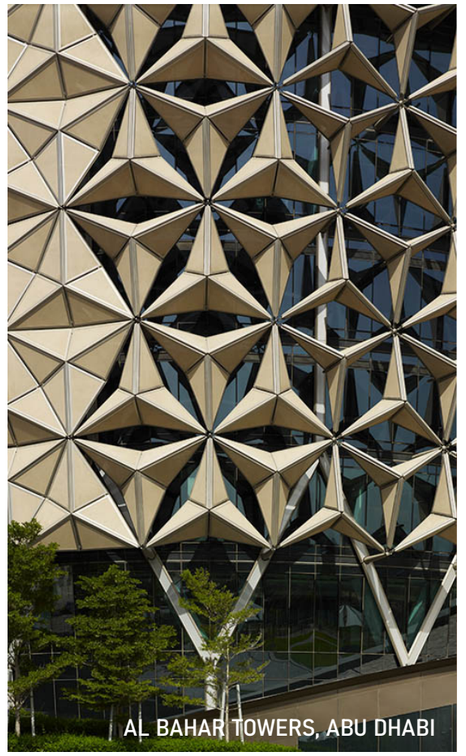
- Geoffrey Thun

"...REVERBERANT ACOUSTICS PLAYS A FUNDAMENTAL ROLE IN CONVEYING THE 'SACREDNESS' OF PLACE..."

- E. Cirillo



SHANGHAI ART CENTRE, SHANGHAI



AL BAHAR TOWERS, ABU DHABI

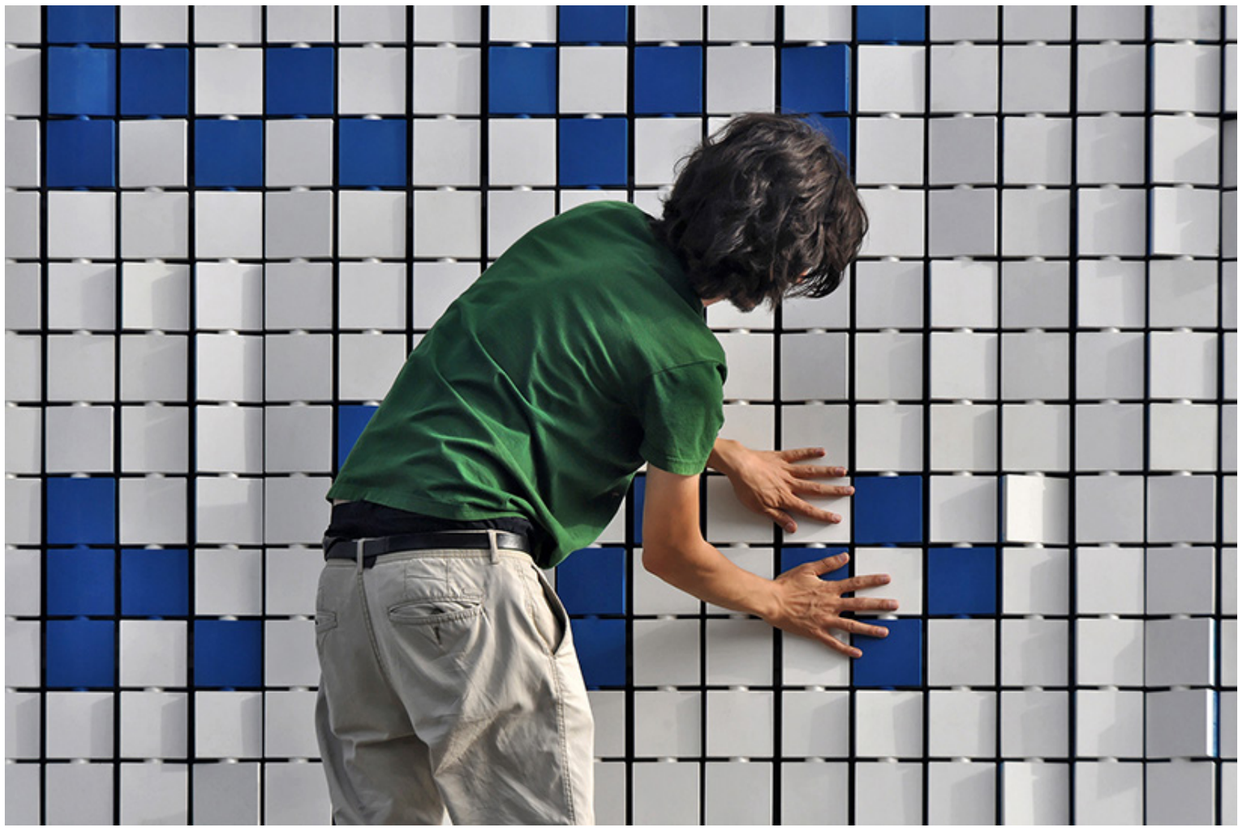
ADAPTIVE ARCHITECTURE | RESPONSE TO THE CHANGING ENVIRONMENTAL CONDITIONS.

Image source : left (surfacedesignshow.com), right (livinspaces.net)

WHAT ABOUT ADAPTIVE ACOUSTICS ?

It is still an idea in a nascent stage that needs answers and need to be explored.

AND WHAT ABOUT USER INDULGENCE ?



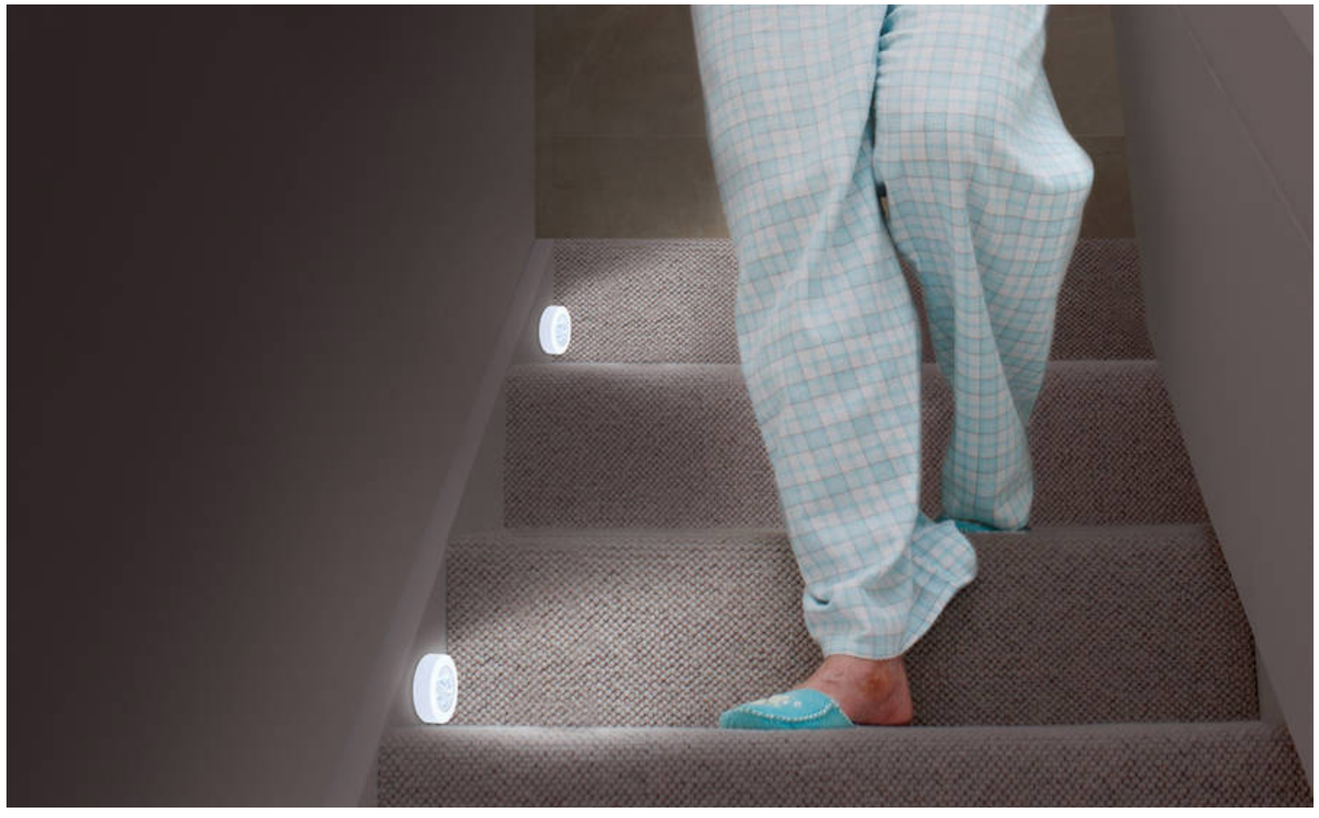
THE IDEA.

THE FOCUS NEEDS TO SHIFT TOWARDS IAD

INTERACTION ADAPTIVE DESIGN

WHICH ON THE OUTSIDE RESPONDS TO THE ENVIRONMENT AND ON THE INSIDE RESPONDS TO THE USER

A VERY SIMPLE EXAMPLE OF THIS IS A MOTION SENSED LIGHT.

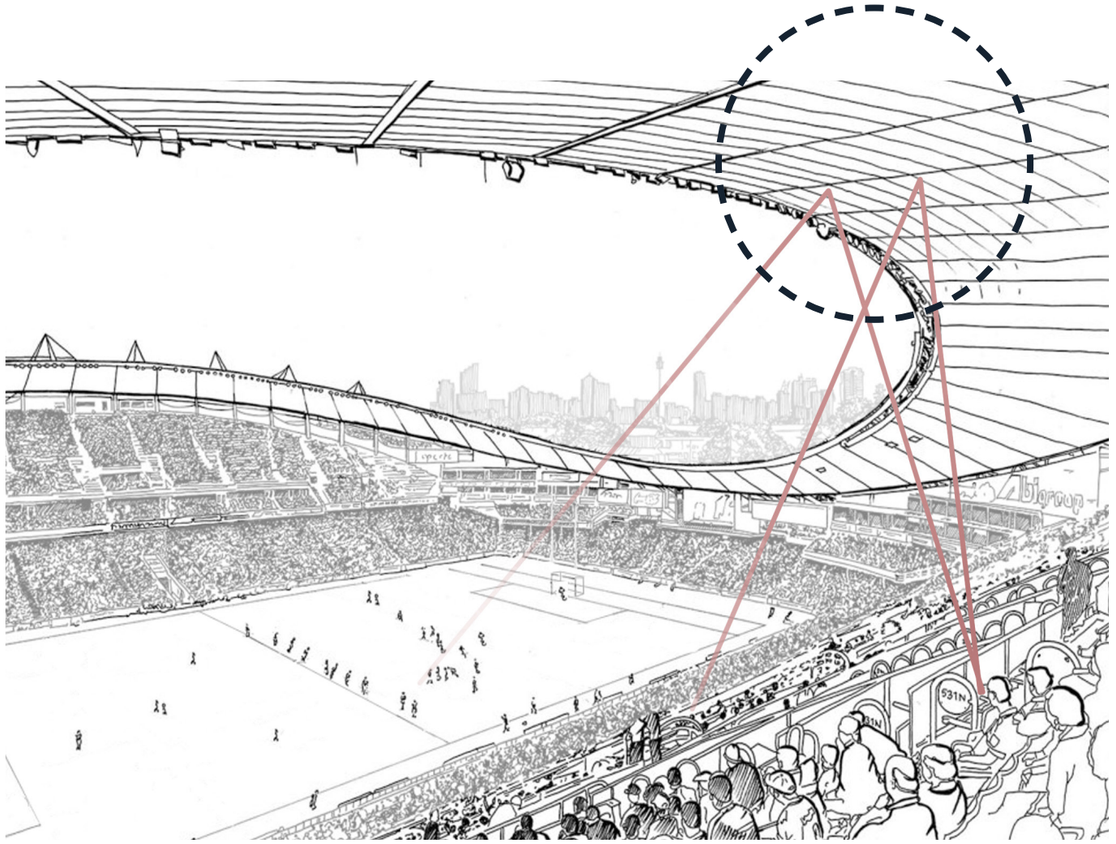


SO, HOW DO WE INTEGRATE SOUND AS AN ADVANTAGE

THE FIRST TASK WAS TO IDENTIFY SPACES WHERE THE USER BEHAVIOUR CAN HAVE A MAJOR IMPACT

AND WHAT BETTER SPACE THAN A JAM PACKED STADIUM

PROBLEM



STADIUM | SOUND FROM CROWD SCATTERED IN THE STADIUM

CONCERT HALL | A PARTICULAR FREQUNCY RANGE CAN BE CORRECTED TO ESCALATE THE QUALITY OF THE PERFORMER

LECTURE ROOM | IT IS DIFFICULT TO UNDERSTAND THE PROFESSOR IN THE BACK SEATS BY CORRECTING THE SPEECH TRANSMISSION INDEX AND IMPROVE THE LECTURE UNDERSTANDING

DIFFUSE

/ dɪ’fju:z /

verb

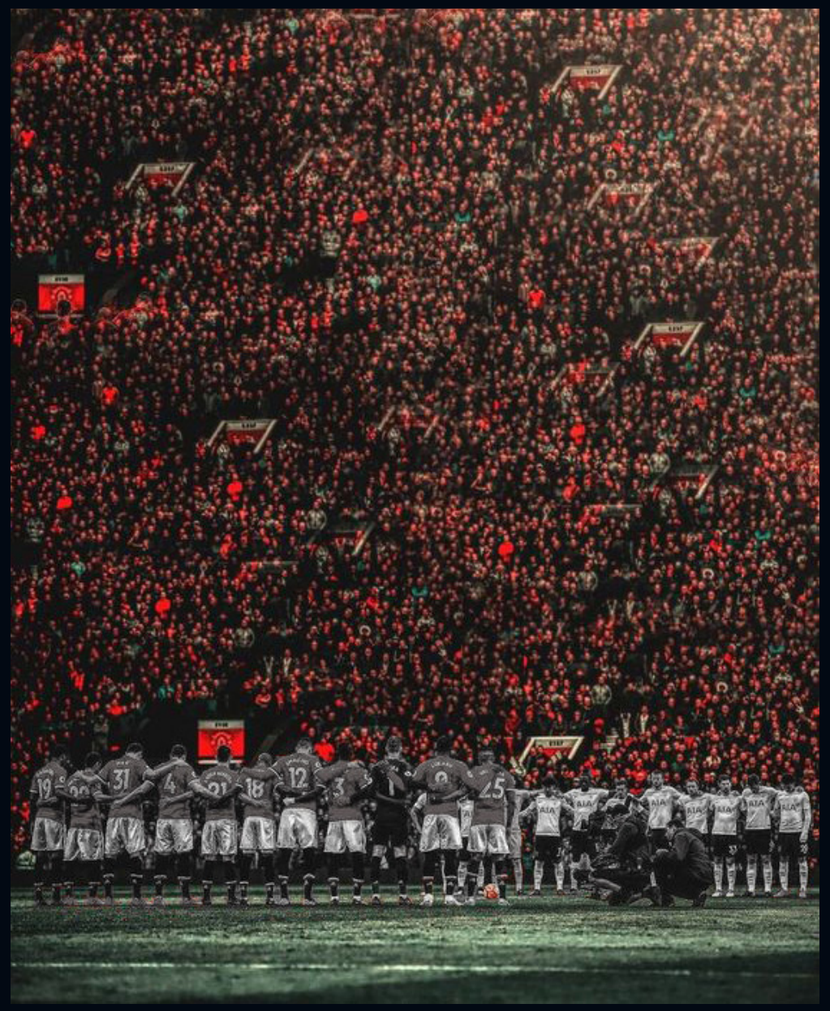
spread over a wide areaor between a large number of people.

“In the morning, sunlight diffused into the room“

WITH MANIPULATING THE WAY SOUND PROPAGATES IN A SPACE.

BALL DIFFUSE | IN CRICKET CATCH PRACTISE USING ROLLER

BALL DIFFUSE | IMPACTING THE DIRECTION



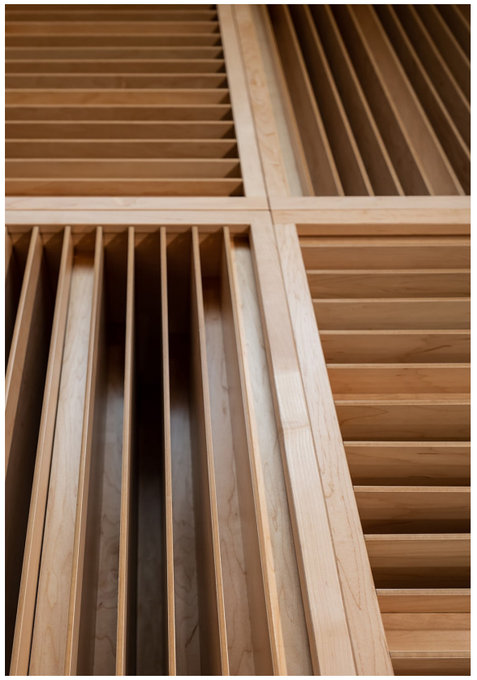
To enhance the experience of the 12th man by developing a sound responsive skin triggered with real time sound.

THE 12TH MAN

THE DESIGN.

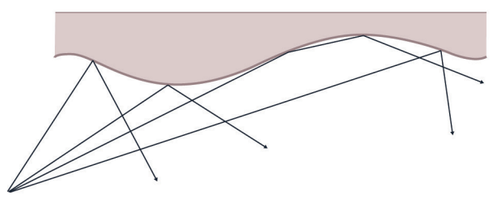
CONCEPT

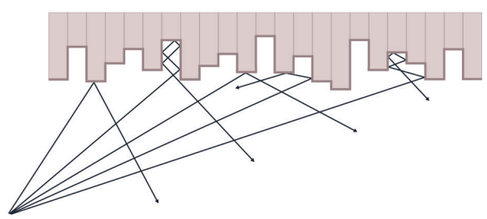
CONCEPT



LINEAR DIFFUSOR | UNI DIRECTION

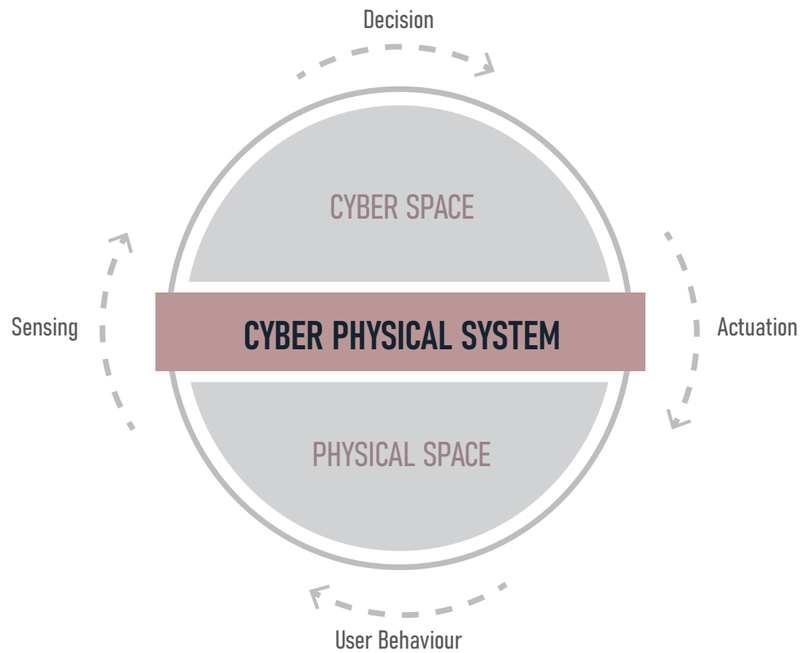
SKYLINE DIFFUSOR | OMNI DIRECTION





MOVING GEOMETRY | 3RD DIMENSION

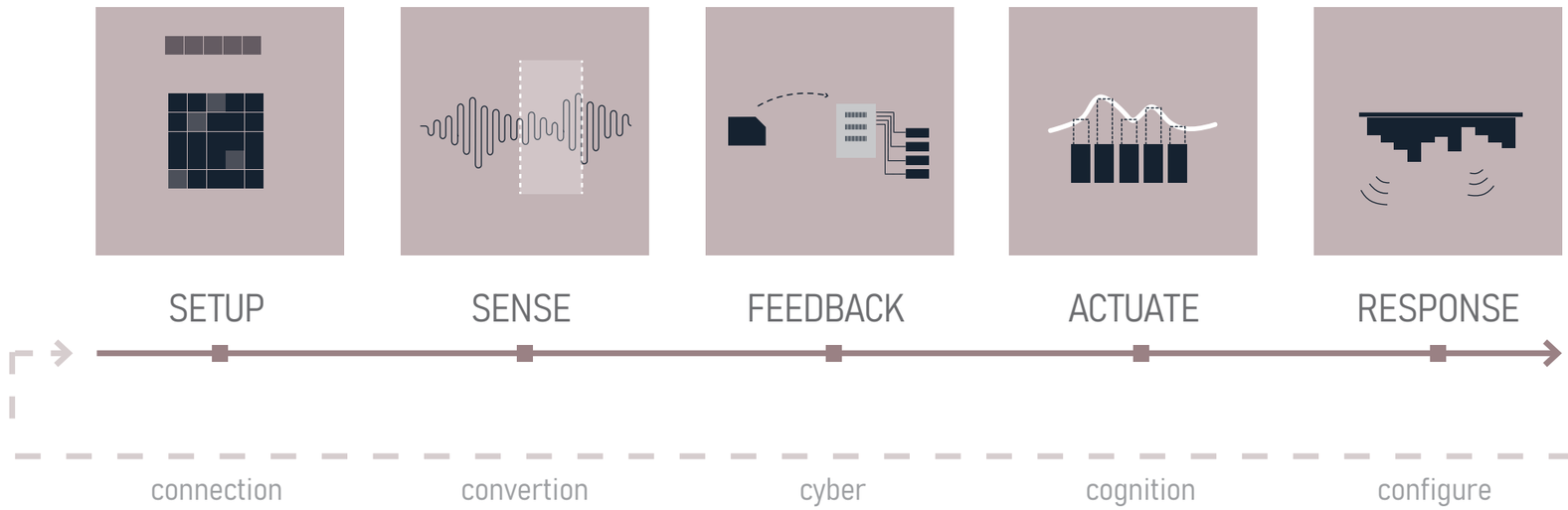
VISUAL TREAT | CHANGING GEOMETRIES



CYBER PHYSICAL SYSTEM | ACTUATION TRIGGERED BY THE USER BEHAVIOUR

AND THE TRIGGER IS TUNED TO THE LIVE SOUND IN THE SPACE

THE WORKING.



FIVE PRINCIPLES OF CPS

SETUP

PATTERN DESIGN

MOVEMENT STRATEGY | ALTERNATE GRID

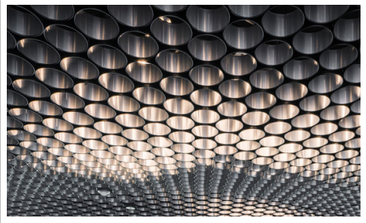
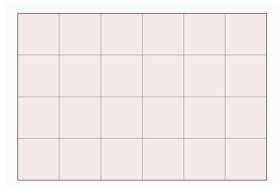
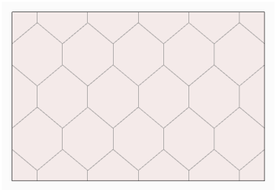
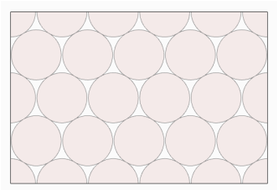
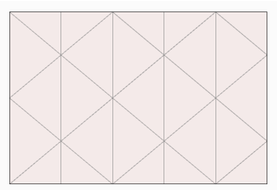
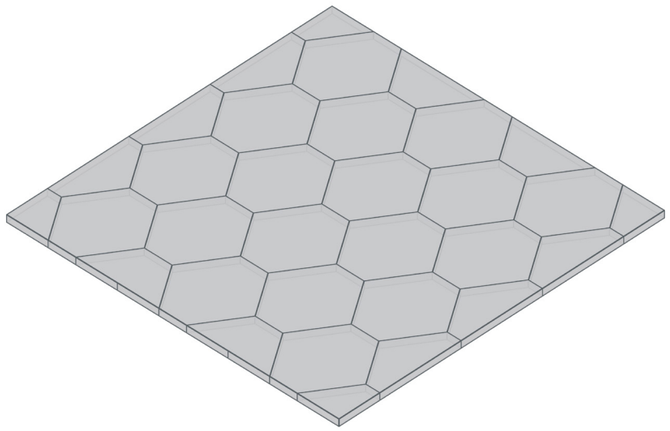
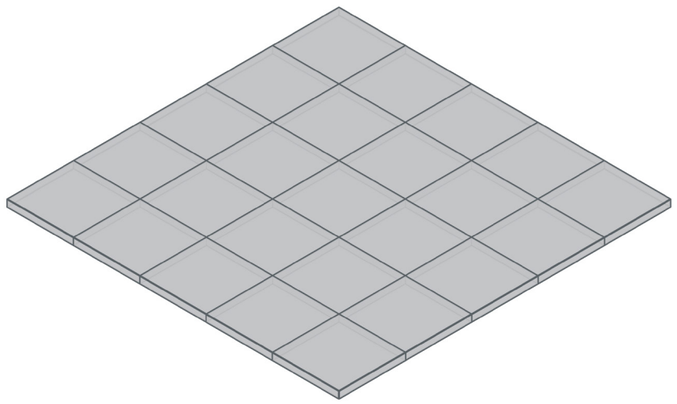
	FOOTBALL STADIUM	OFFICE WORKSPACE	LECTURE ROOM	AUDITORIUM
SPACE TYPE	Outdoor large open stand	Indoor small-size closed room	Indoor medium-size closed room	Indoor large-closed closed hall
CEILING IMAGE				
GRID TYPOLOGY				
SUPPORT FRAMEWORK	Structural grid roof support	Suspended false ceiling	Suspended false ceiling	Structural Coffered slab

Image source : Author



HEXA | GRID
KLEIN



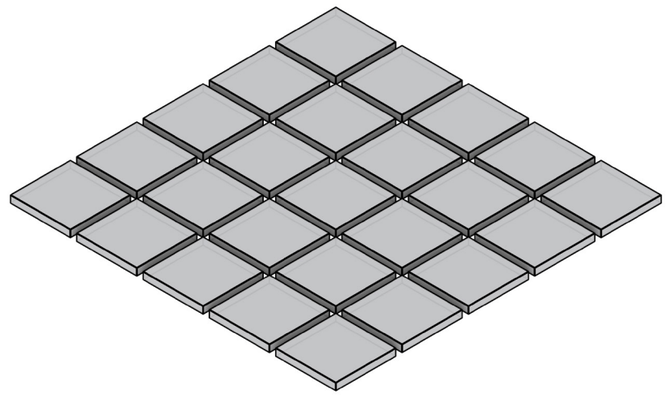
QUAD | GRID
GROOT
KLEIN

TILE | SIZE

SAME AS A CONVENTIONAL ACOUSTIC TILE

0.6 X 0.6 M

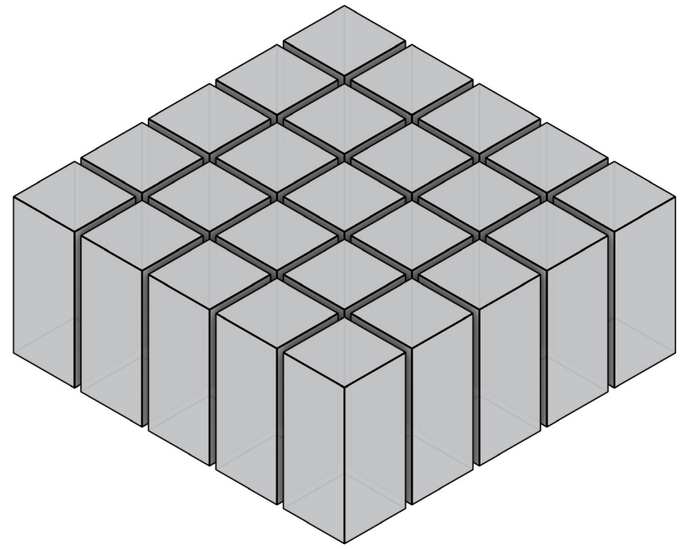
0.3 X 0.3 M



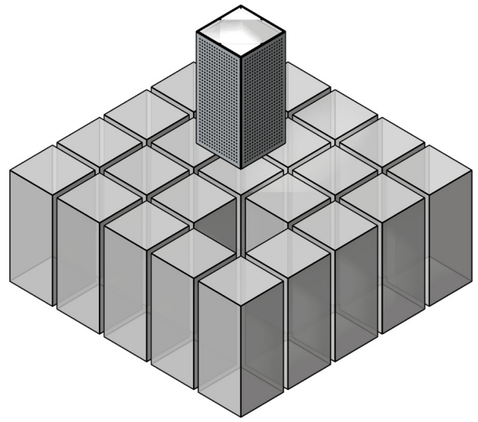
BLOCK | HEIGHT

AS PER THE RESEARCH FINDINGS

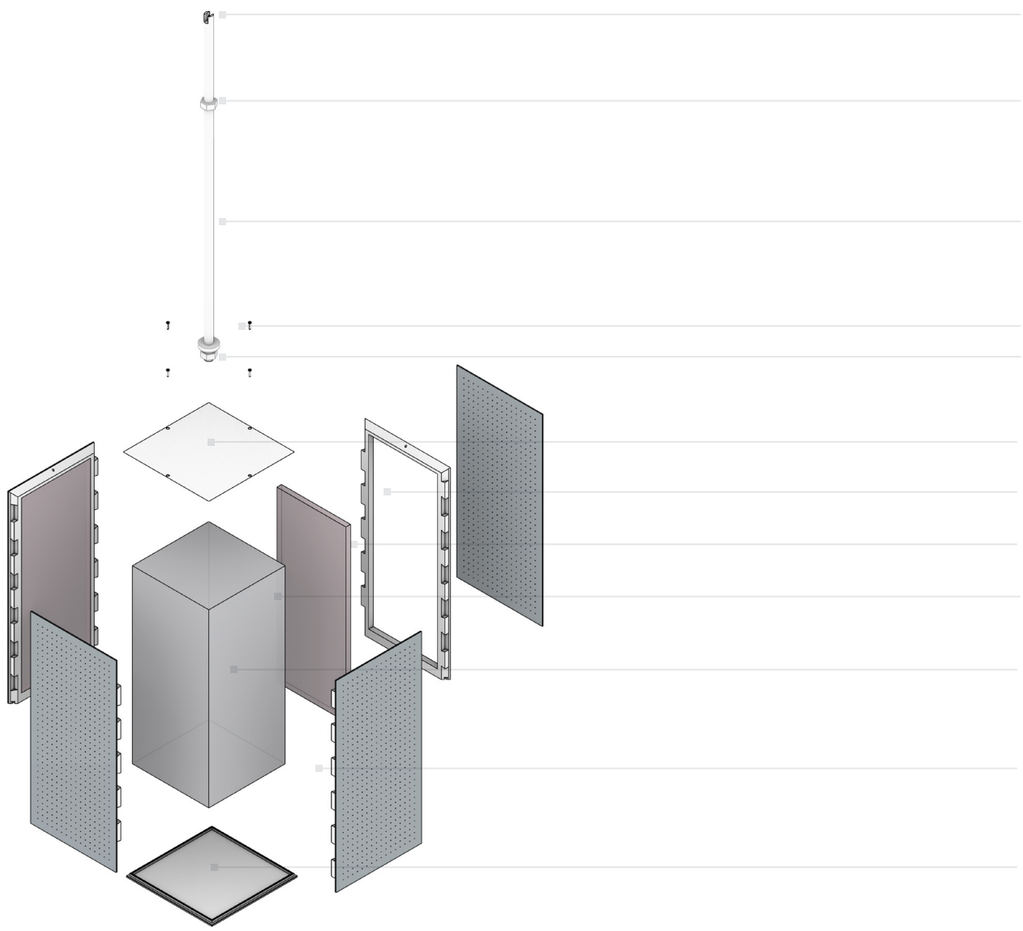
HEIGHT (H) = 2 X WIDTH (W)



ACUTE BLOCK



BLOCK COMPOSITION



Perforated sheet

Nut to adjust the vertical displacement height

20 mm hollow aluminium rod with custom cut at the top

Rubber wahser to
Nut to secure the rod into the block

8mm fibre sheet top flap

3mm perforated fibre sheet

12mm galvanised steel frame with dove tail joinery

12mm mineral fibre block

Glasswool filling

Custom acoustic tile

3mm fibre sheet bottom flap with snap joinery and painted finish under surface

FOUR TILES MAKE A BLOCK

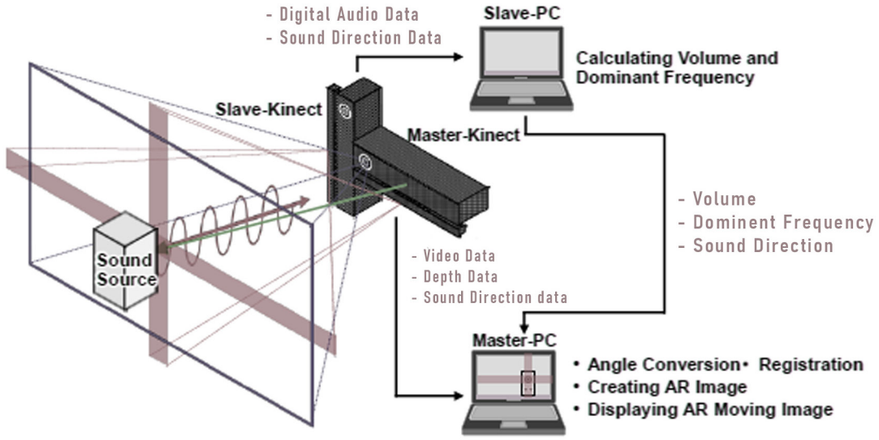
SENSE

SOUND SOURCE | LOCATION POINT

SOUND PRESSURE LEVEL (DB)

SOUND SOURCE FOR PROTOTYPE

DUAL-KINECT SYSTEM



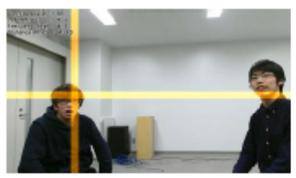


Fig. 3 Sample of output system

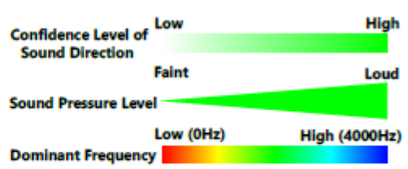
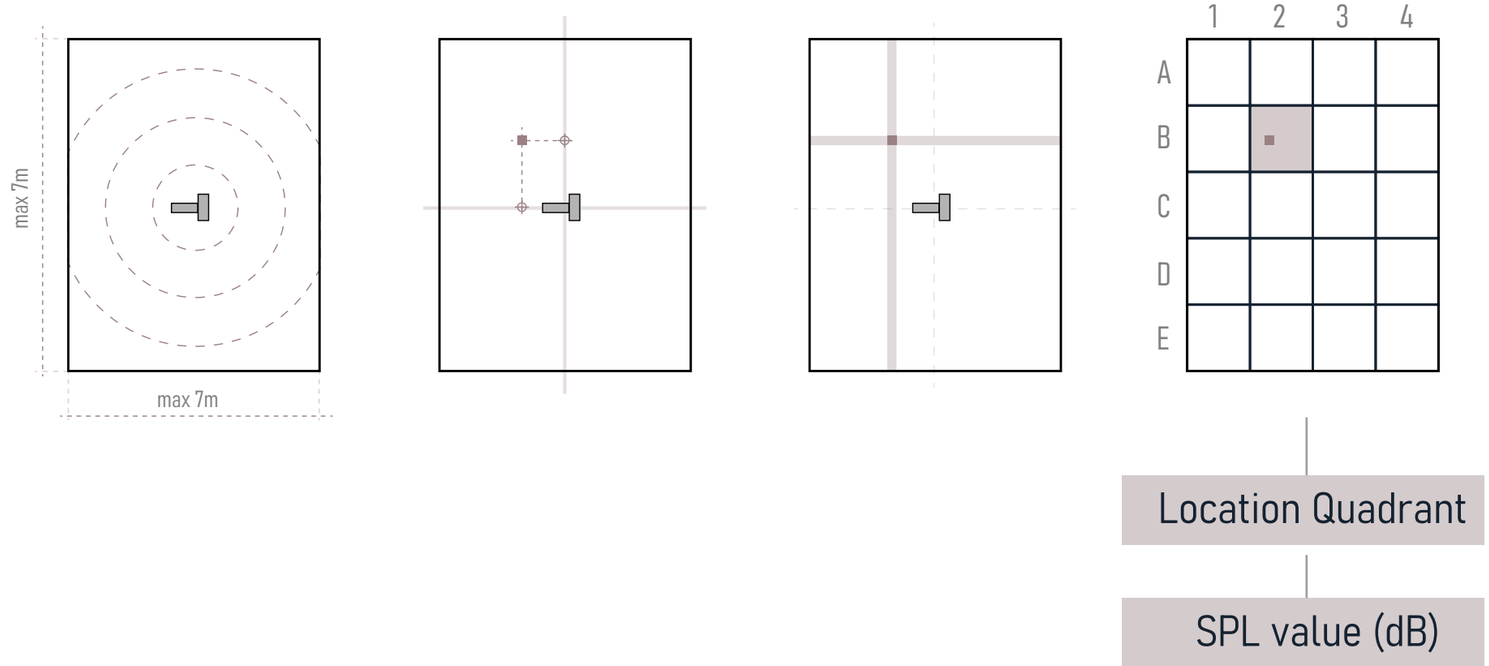


Fig. 4 Legend for AR lines

Image source : Yamasaki, 2016

SOURCE LOCALIZATION



FEEDBACK

DATA TYPE

FEEDBACK INPUT

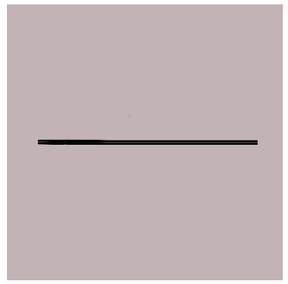
DATA SELECTION

DATA TYPE

STATIC

SPACE/ROOM BASED

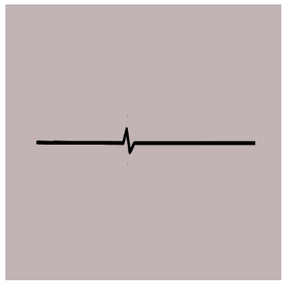
FIXED FOR A SPACE



SPORADIC

ACTIVITY/FUNCTION BASED

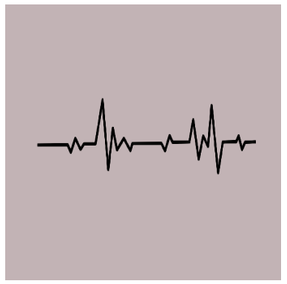
FIXED FOR SHORT DURATION



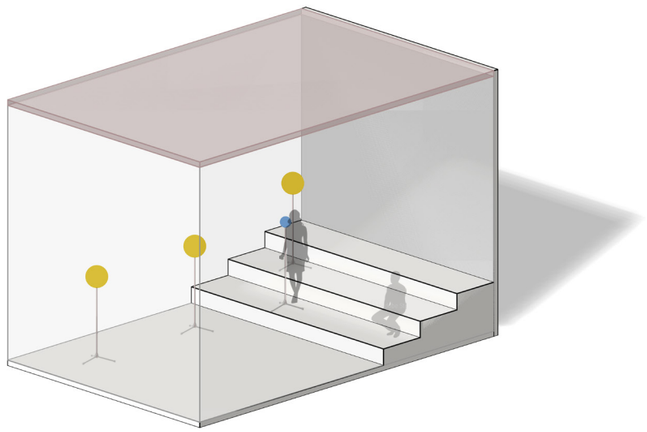
DYNAMIC

USER BEHAVIOUR BASED

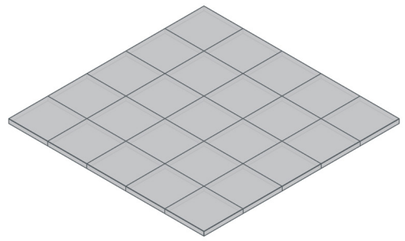
ALWAYS CHANGING



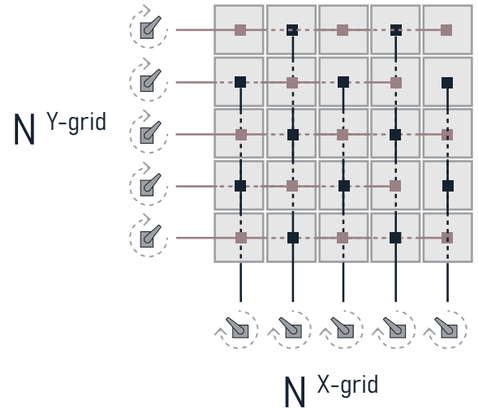
STATIC DATA



Room Type

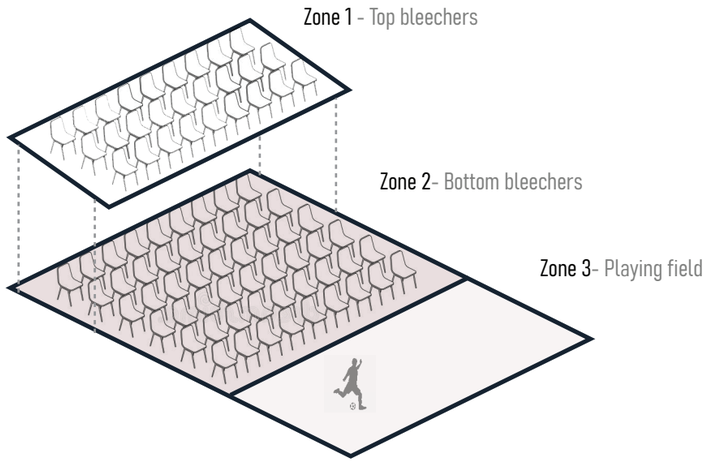


Block Design

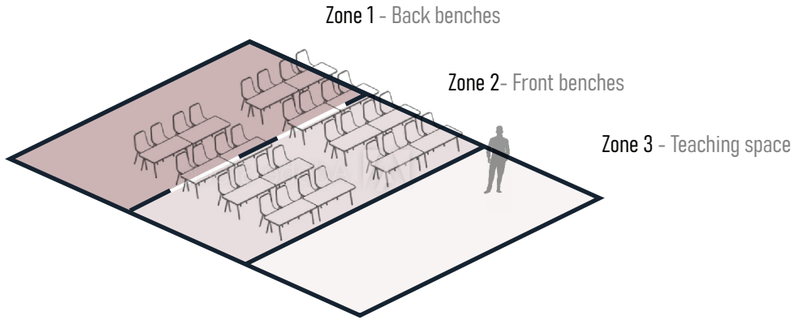


Actutor System

SPORADIC DATA



Stadium



Classroom

Zone Division

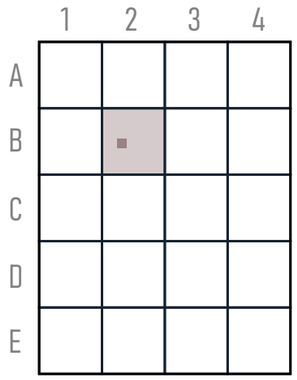
SPL

Ray incidence count

High | Low

Acoustic preference

DYNAMIC DATA



Location Quadrant

< 60 dB | 60 -90 dB | > 90 dB

SPL value (dB)

FEEDBACK INPUT

FEEDBACK LOOP INPUT					
STATIC		**SPORADIC**		**DYNAMIC**	
Room Type	Choice (A, B)	Number of Zones	Integer	Source Quadrant	Text + Integer
Block Design & Size	Choice (Quad G, Quad K, Hexa K)	Acoustic property preference	Choice (Number of Rays, SPL value)	SPL value range (dB)	Integer
Acoustic Properties	Room & block surfaces	Task	Choice (Maximize, Minimize)		
Number of Actuators	Integer (x-axis) + Integer(y-axis)				
Rotation steps	Integer				

ACTUATE

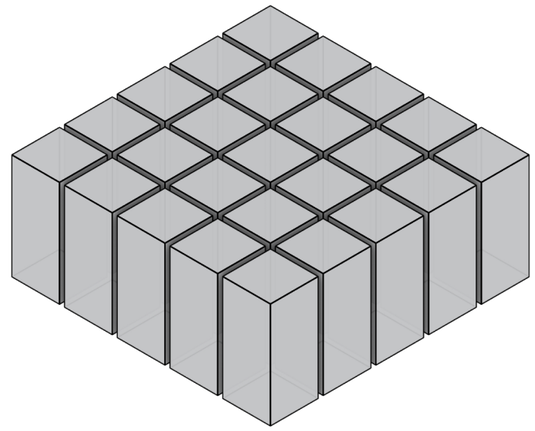
DIVISION GRIDS

DATA SIMPLIFICATION

FEEDBACK OUTPUT

BLOCK MOVEMENT

INSTEAD OF MOVING THEM INDIVIDUALLY, CREATE A SERIES WITH
WHICH WE CAN REDUCE THE MOTORS TO MOVE THE BLOCKS



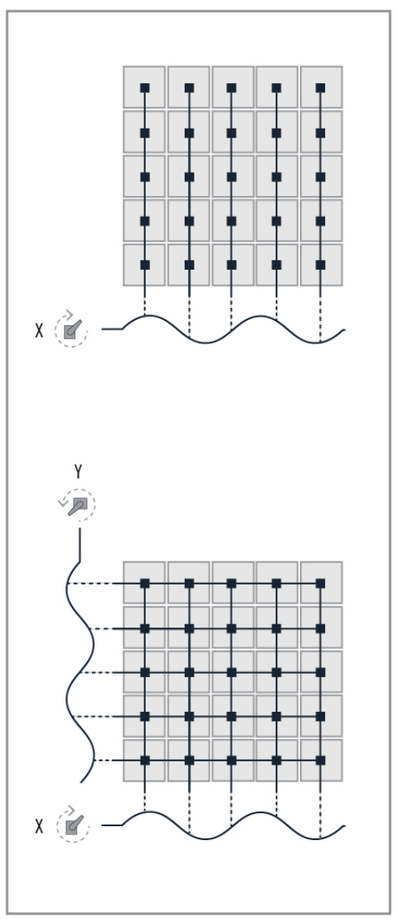
DIVISION GRIDS

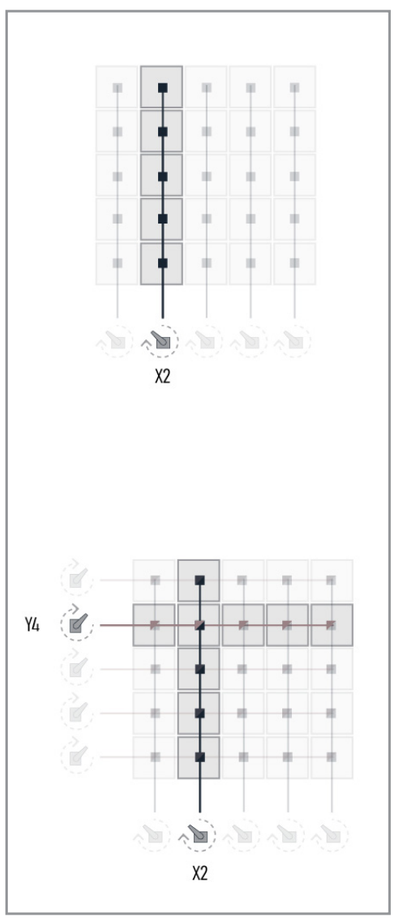
COGS & GEAR twin control

COGS & GEAR twin control

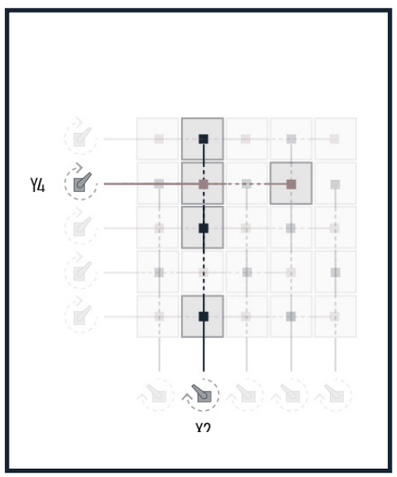
COGS & GEAR alternate grid

One-way

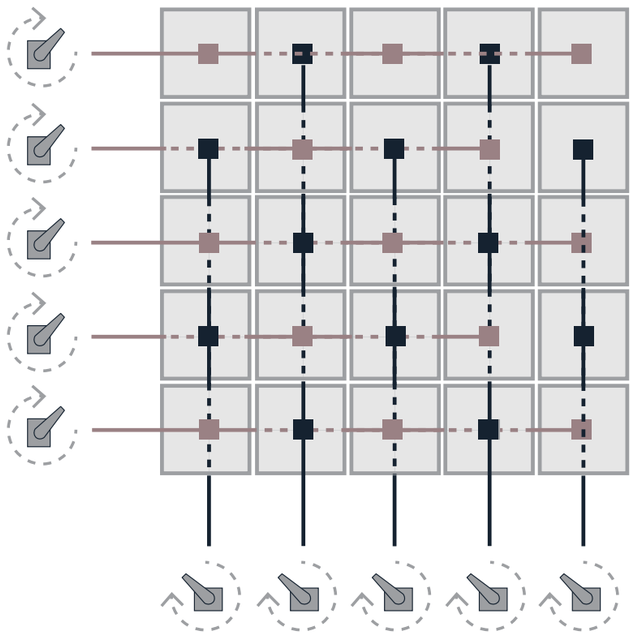




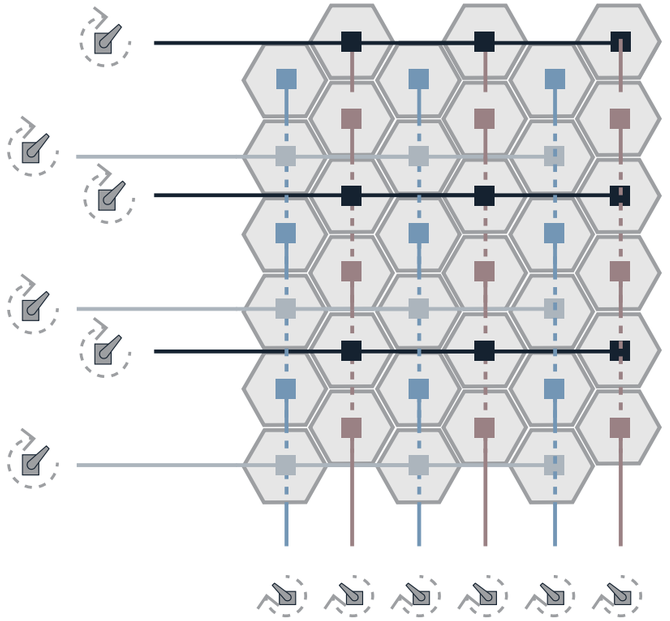
Two-way



ALTERNATE GRID



QUAD grid



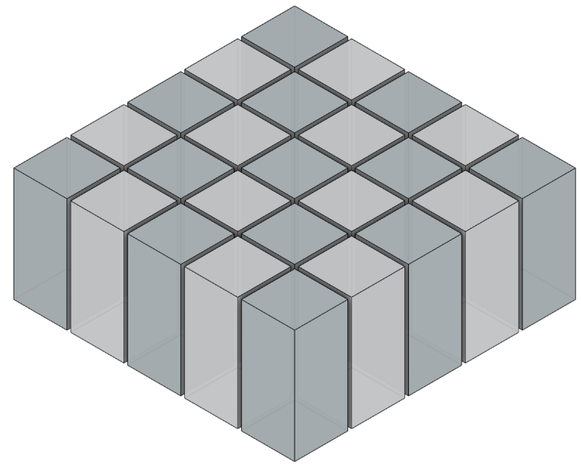
HEXA grid

SURFACE | PROPERTIES

MATERIAL'S ACOUSTIC CONSIDERATIONS

REFLECTIVE

ABSORPTIVE

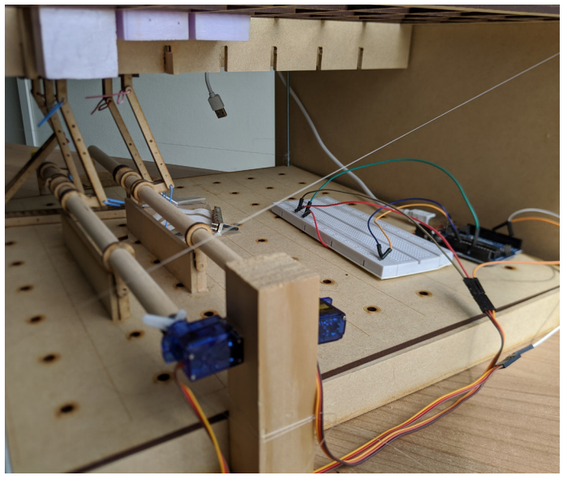


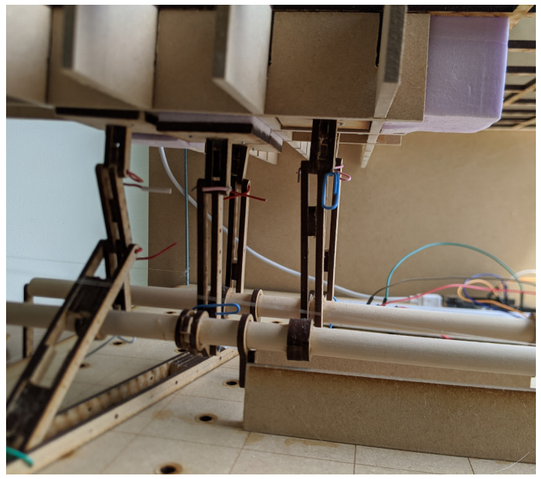
SURFACE | REFLECTIVE

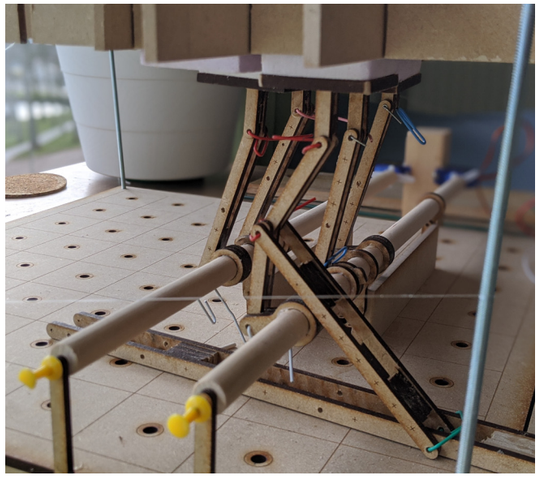
SURFACE | ABSORPTIVE

HOW DOES IT MOVE ?

PHYSICAL & DIGITAL PROTOTYPING

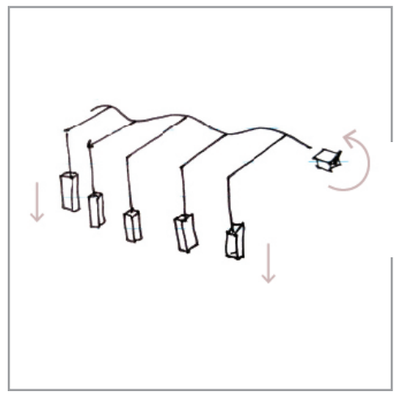




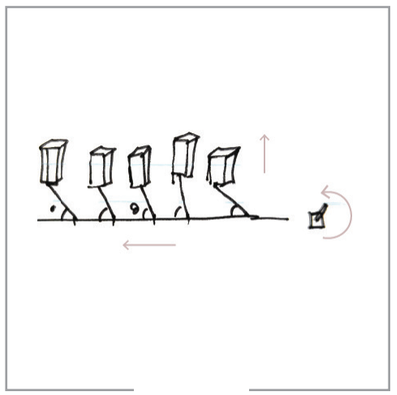


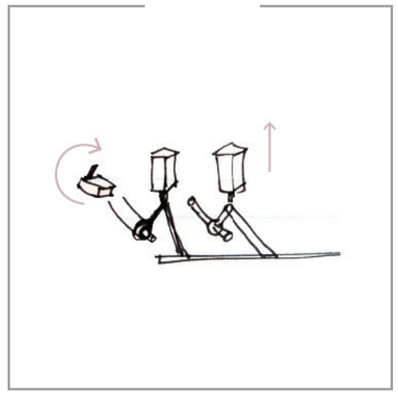
MOVEMENT MECHANICS

PULLEY & CABLE sine-wave

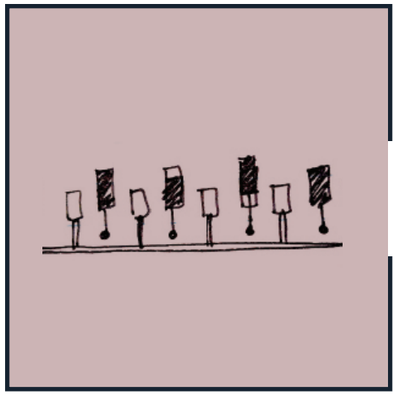


SLIDER CRANK single control





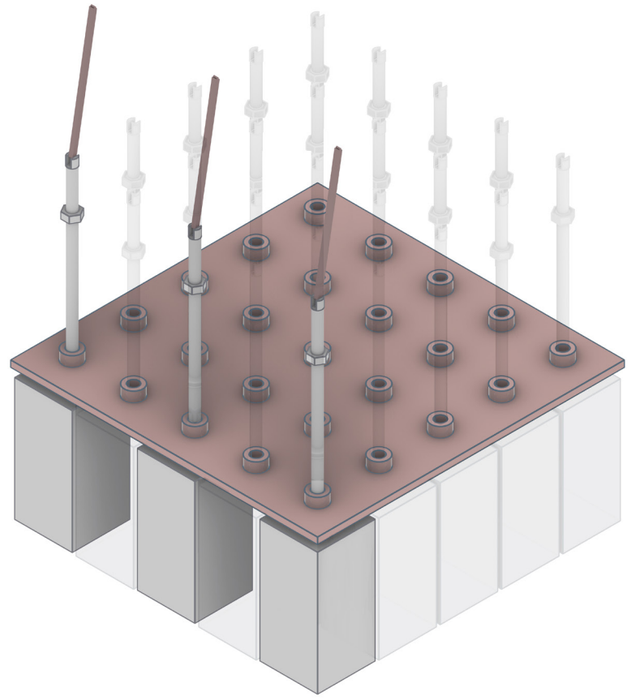
COGS & GEAR twin control



PSITON CRANK alternate grid

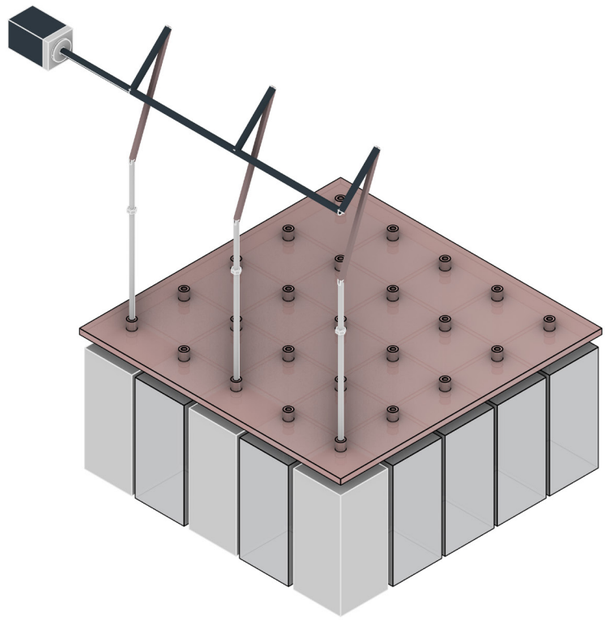
LEVER | CONTROL

FREE MOVEMENT LEVER TO CONVERT
ROTATION TO RETRACTION

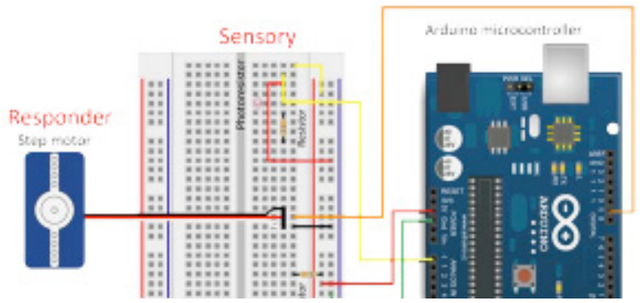


SPINDLE | MAIN AXIS

ROTATION FROM SERVO MOTOR
PISTON MOTION



LIMITING NUMBER OF STEPS



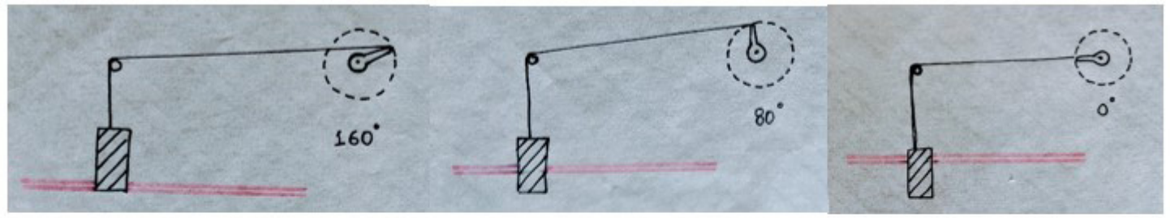
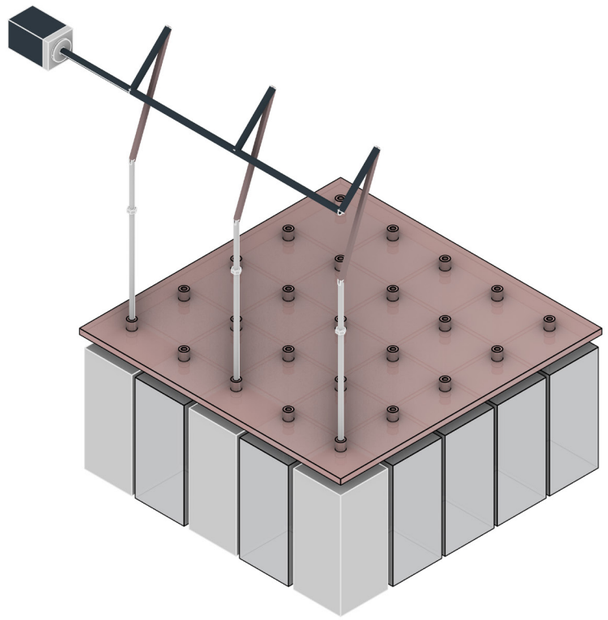


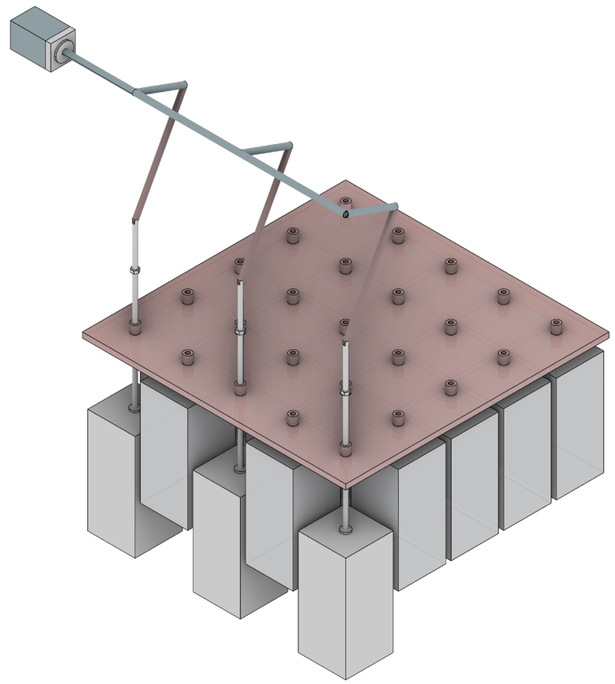
Figure 5.16 : Motor rotation steps

Input Value		0	0.5	1	1.5	2
Servo Rotation		160 °	40°	80 °	120°	0 °
Block Movement	Prototype	0 m	0.01 m	0.02 m	0.03 m	0.04 m
	Simulation	0 m	-	0.3 m	-	0.6 m

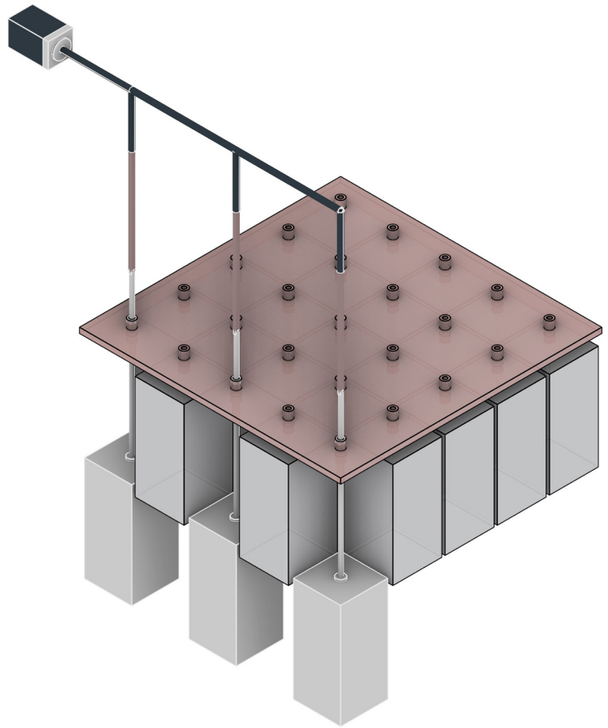
STANDBY | 0 DEGREE



MID-LEVEL | 80 DEGREE



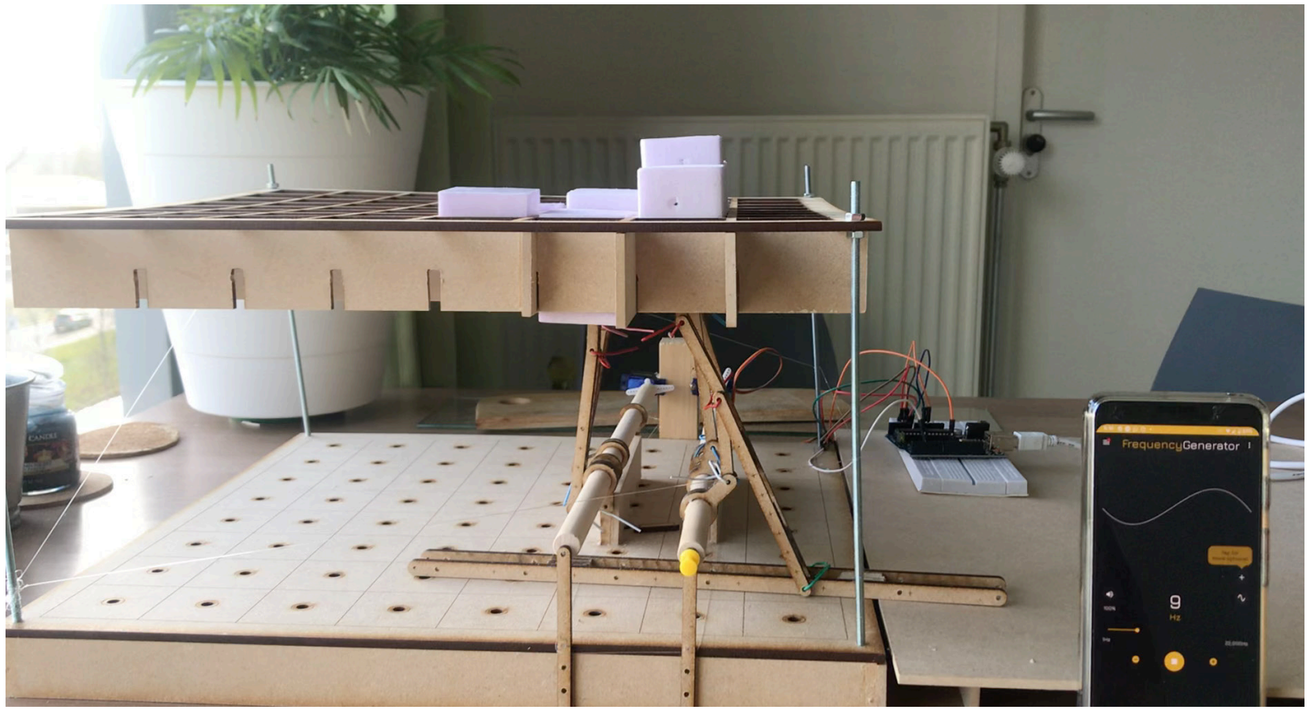
FULL DOWN | 160 DEGREE



REALTIME REACTION

RESPONSE | SOUND PRESSURE LEVEL AND FREQUENCY

PHYSICAL EVIDENCE



SPL DIFFERENCE

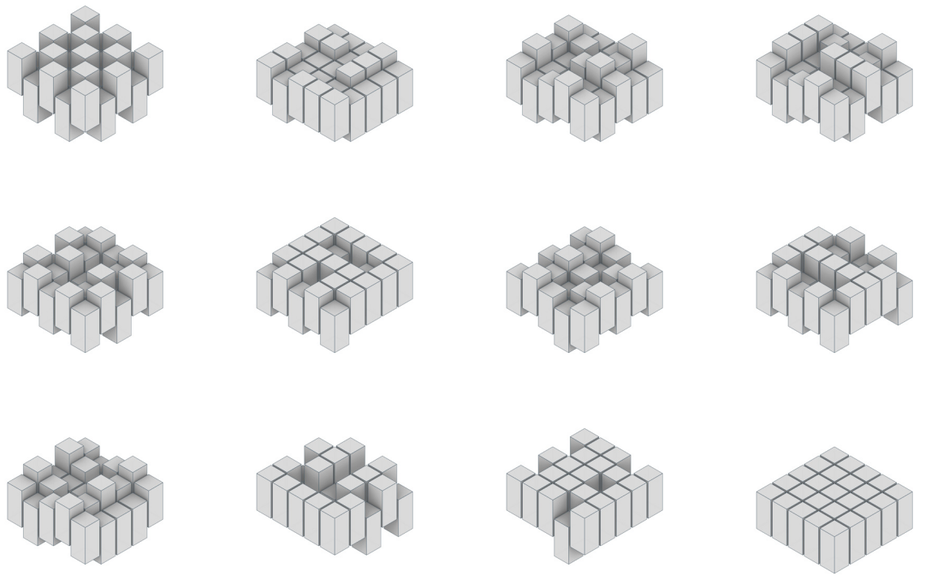
VISIBLE

REFRESH RATE

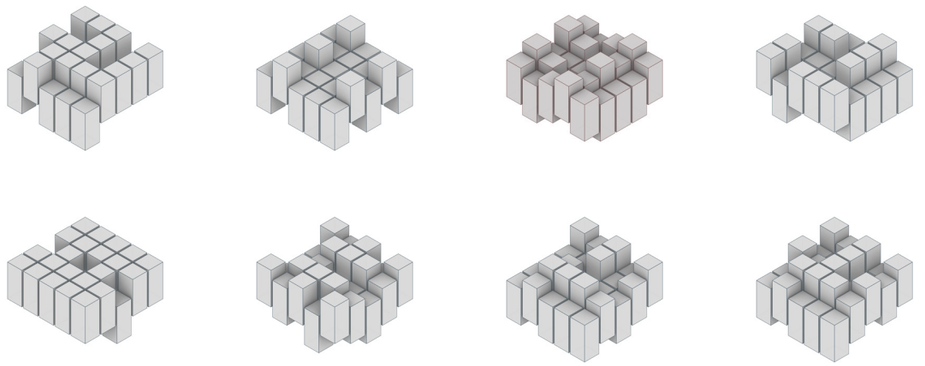
5 SECONDS

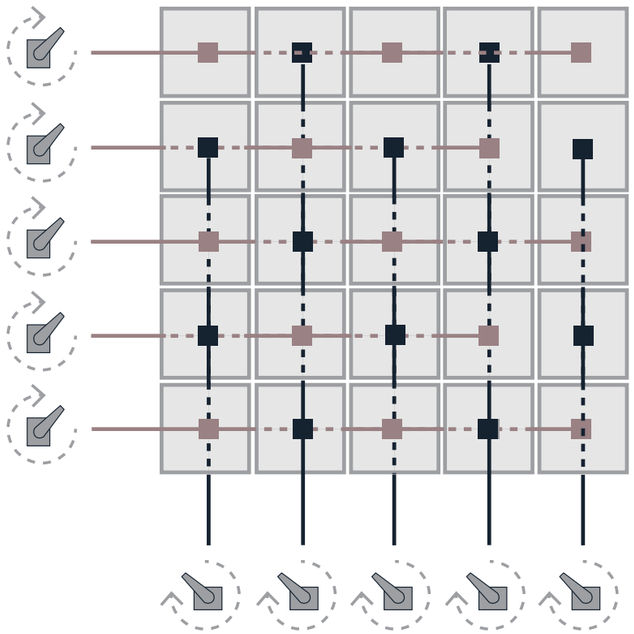
ACTUATION TIME

1-2 SECONDS

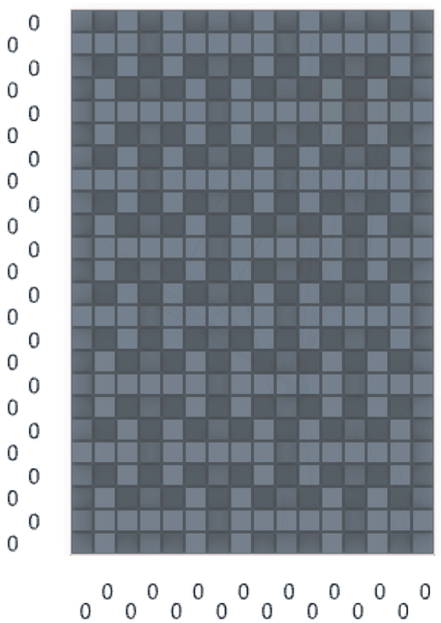


59,049 ITERATIONS

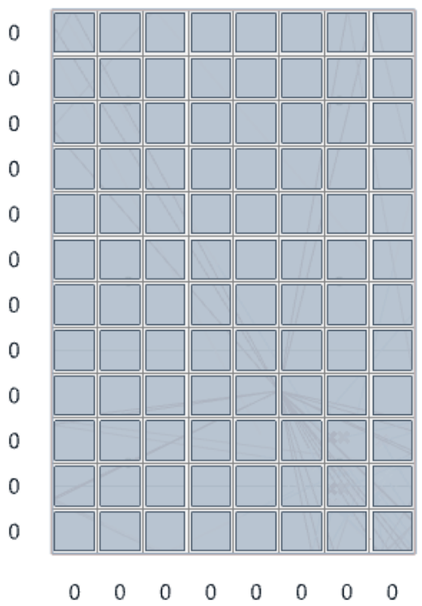




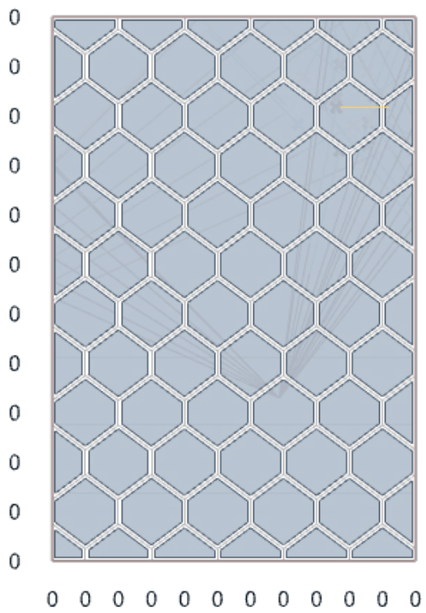
DATA SIMPLIFICATION



QUAD grid (Klein)

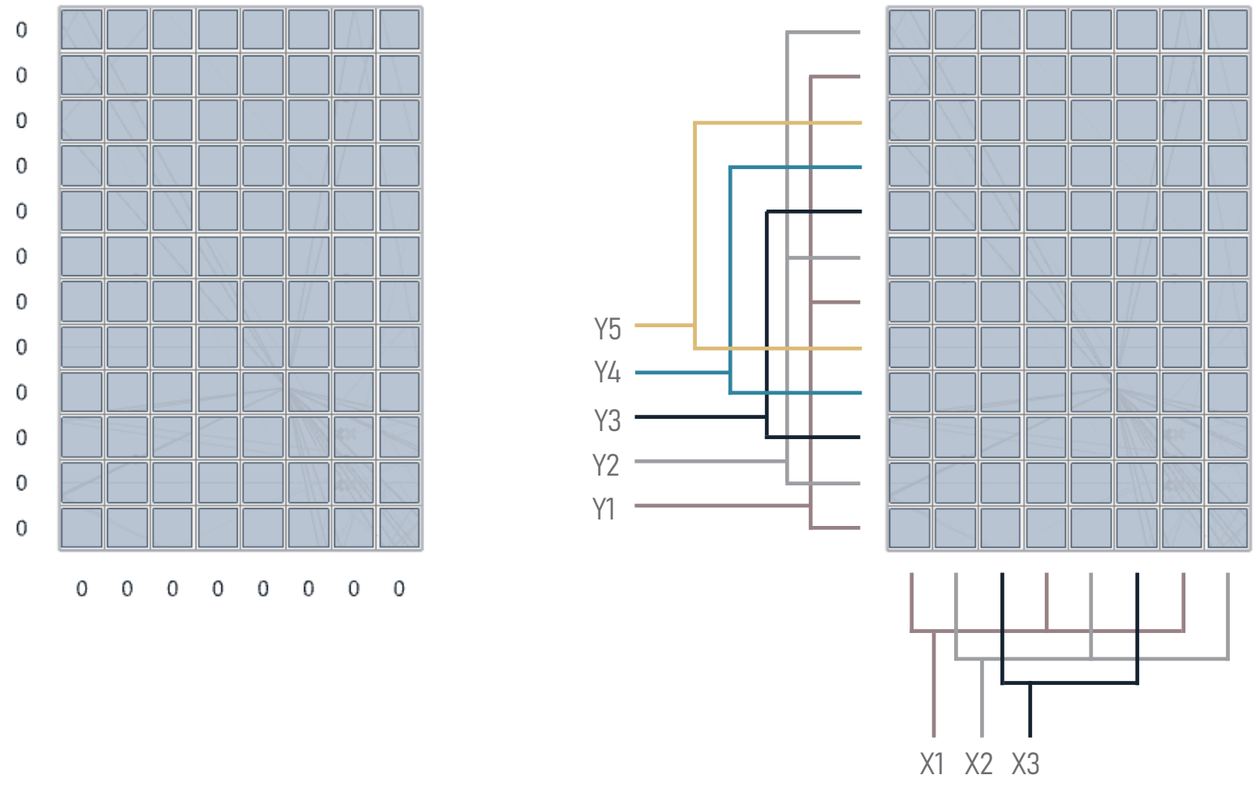


QUAD grid (Groot)



HEXA grid (Klein)

DATA SIMPLIFICATION



CONCEPT IS TO CREATE APERIODIC PATTERNS AND BRING DOWN CERTAIN BLOCKS

FEEDBACK OUTPUT

X AXIS	X1	X2	X3

Y AXIS	Y1	Y2	Y3	Y4	Y5

OUTPUT | EIGHT VARIABLES

RESPONSE

DATA GENERATION & ALLOCATION

CONFIGURATION GENERATION

VISUAL FEEDBACK

DATA GENERATION

- Limited result requirement
- Zone specific results

DATA ALLOCATION

- Optimum Selection
- Pre-calculated data

SUPERVISED LEARNING

CLASSIFICATION

ACOUSTIC RESULTS = FEATURE

ACTUATOR POSITION = LABEL

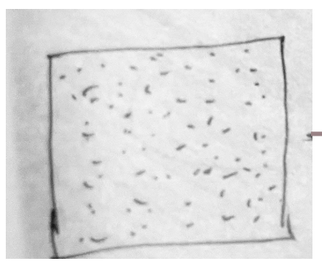
SELECTION

WHEN A FEATURE IS REQUIRED, THE SYSTEM GIVES THE RESULTING LABEL

DATA SELECTION

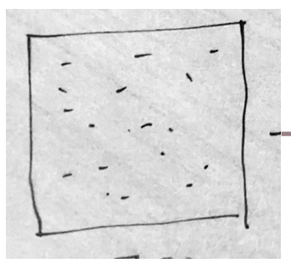
FEEDBACK LOOP INPUT					
STATIC		SPORADIC		DYNAMIC	
Room Type	Choice (A, B)	Number of Zones	Integer	Source Quadrant	Text + Integer
Block Design & Size	Choice (Quad G, Quad K, Hexa K)	Acoustic property preference	Choice (Number of Rays, SPL value)	SPL value range (dB)	Integer
Acoustic Properties	Room & block surfaces	Task	Choice (Maximize, Minimize)		
Number of Actuators	Integer (x-axis) + Integer(y-axis)				
Rotation steps	Integer				

TOTAL GENE POOL



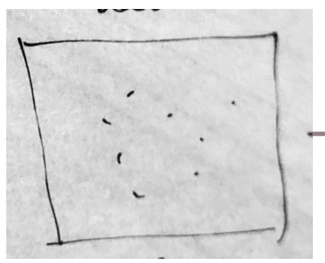
59,049

AFTER STATIC DATA



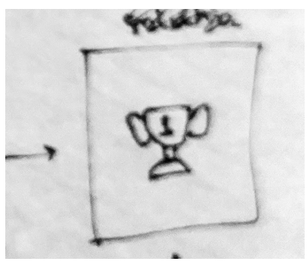
720

AFTER SPORADIC DATA



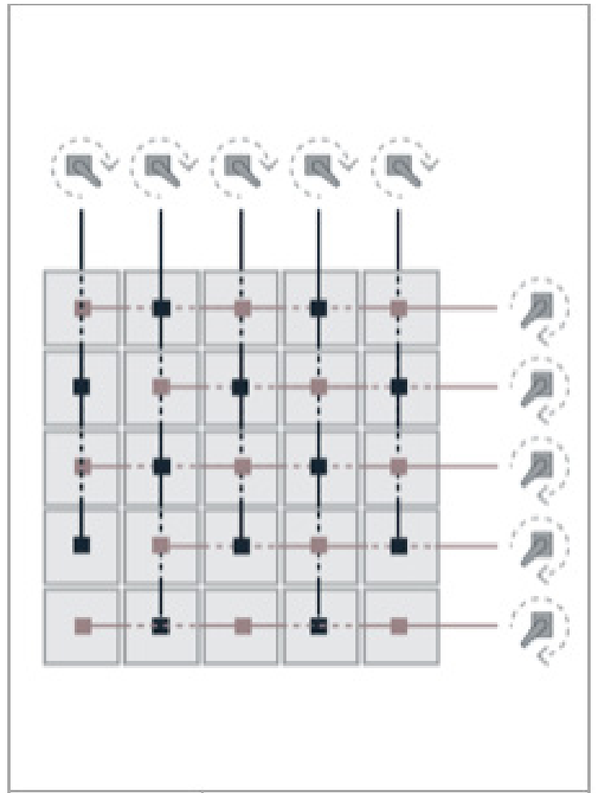
60

AFTER DYNAMIC DATA



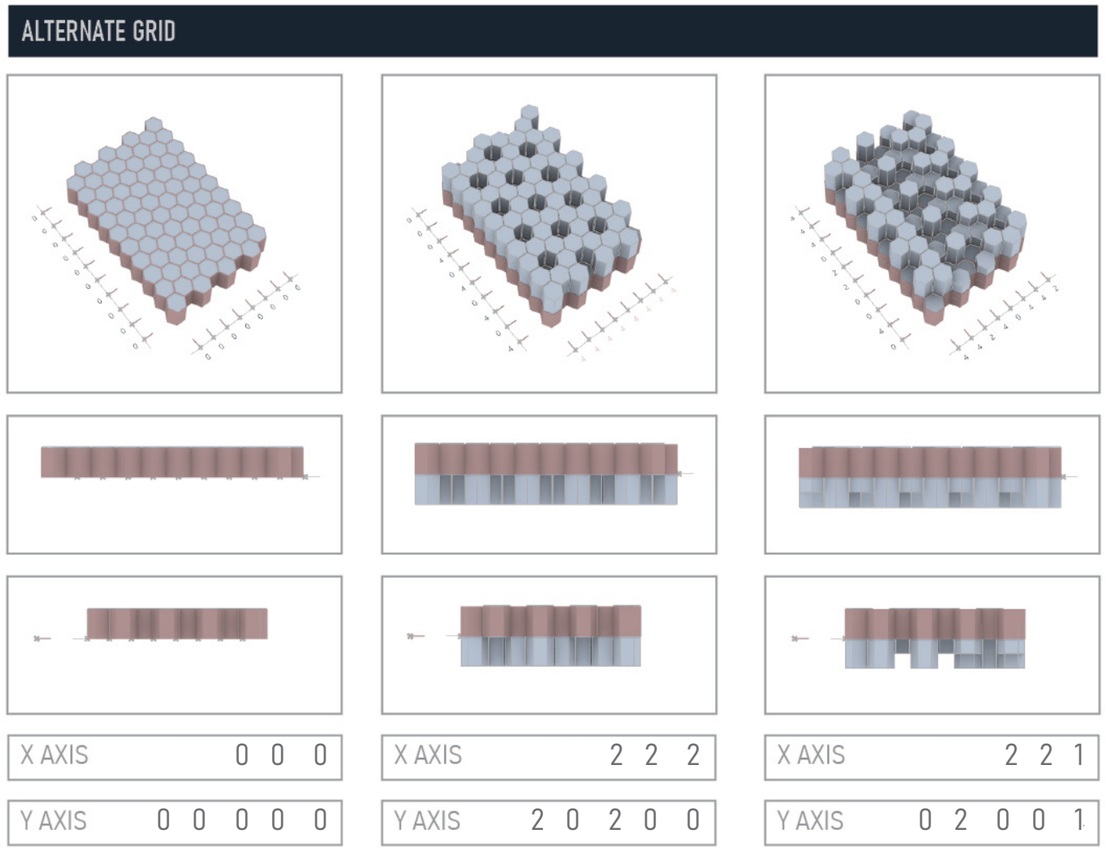
1

OUTPUT FOR ACTUATORS



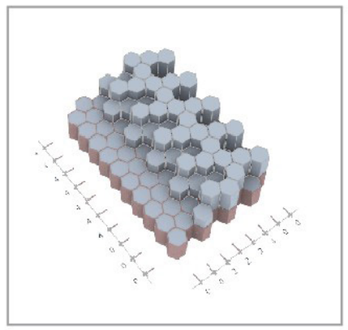
X axis	| 0 | 2 | 1 |
Y axis	| 0 | 1 | 0 | 2 | 1 |

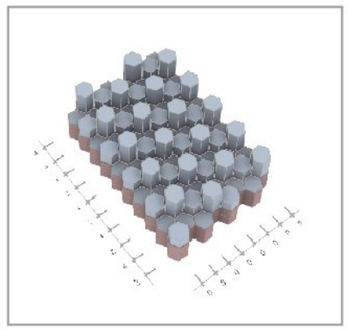
CONFIGURATION GENERATIONS

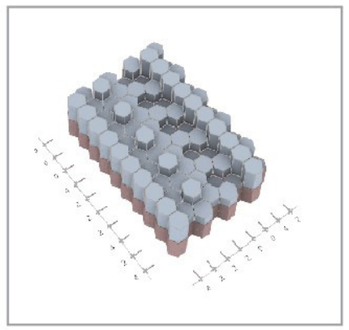


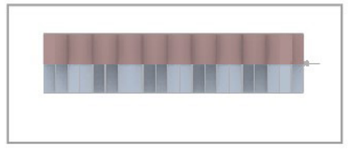
CONFIGURATION GENERATIONS

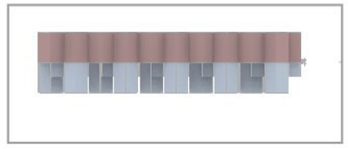
ALTERNATE GRID

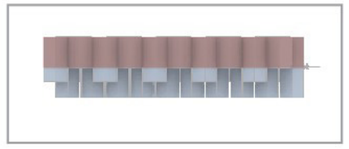


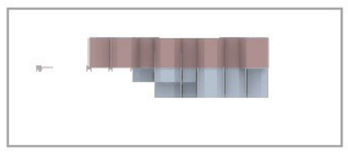


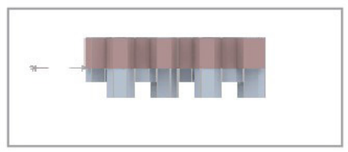


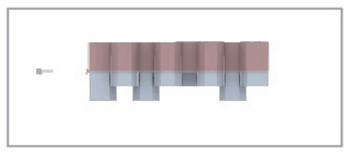










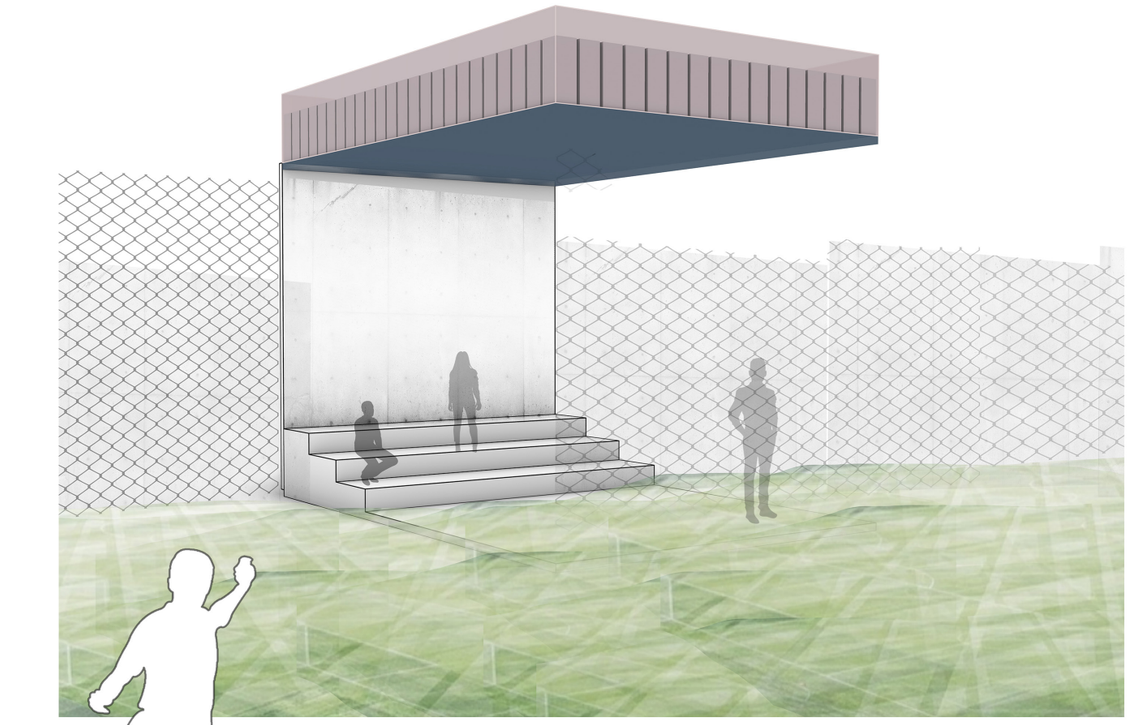


X AXIS	0	0	1
Y AXIS	0	0	2	2	1

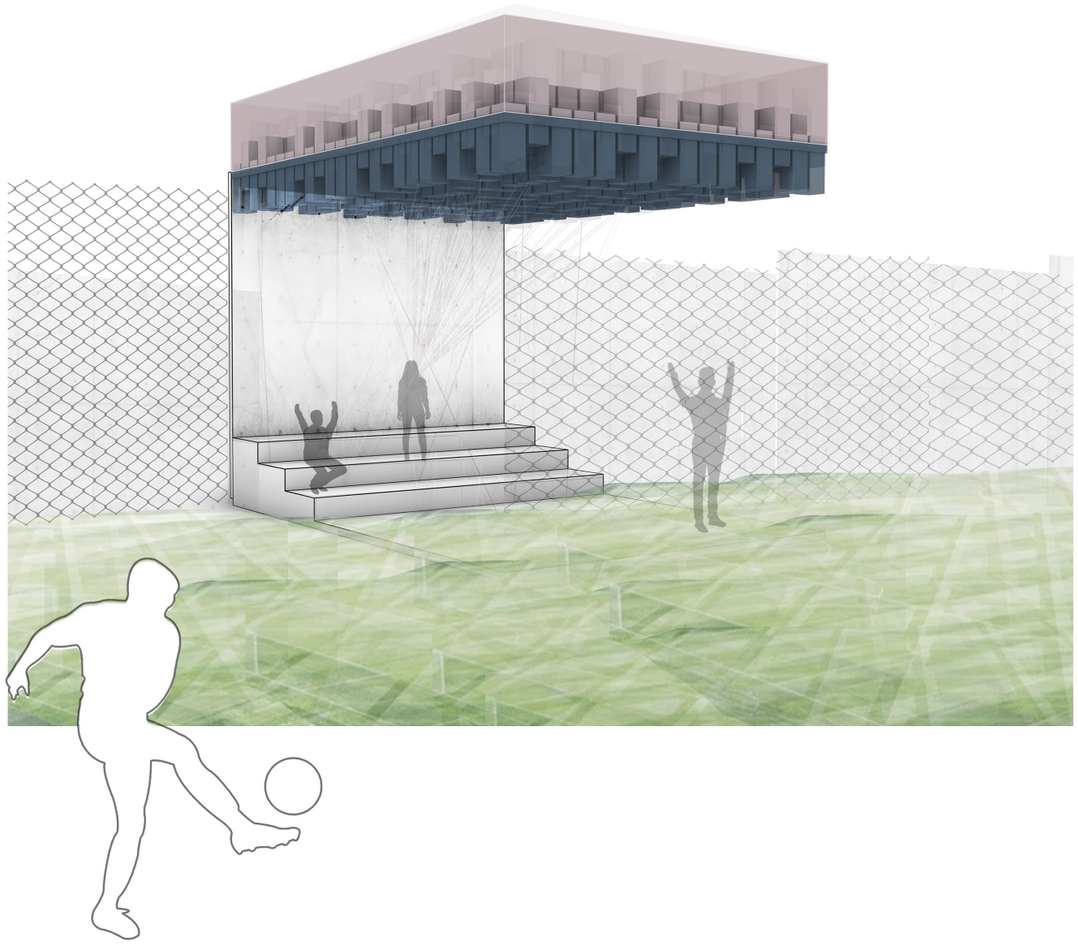
X AXIS	0	0	0
Y AXIS	1	2	1	2	1

X AXIS	2	1	1
Y AXIS	2	1	2	1	1

REAL-TIME VISUAL FEEDBACK



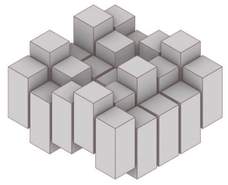
REAL-TIME VISUAL FEEDBACK



THE BRAIN.

CALCULATING ACOUSTICS FOR SO MANY ITERATIONS

ACOUSTIC CALCULATION



59,049 ITERATIONS

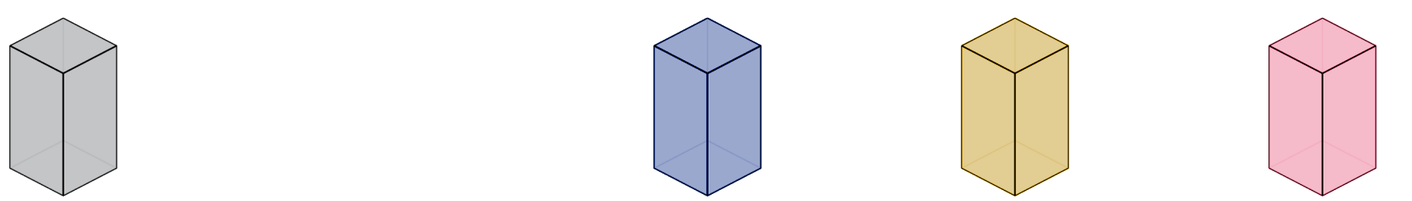
DIFFERENT BIM ENVIRONMENT

SIMULATION TIME

?

ITERATIVE TOOL

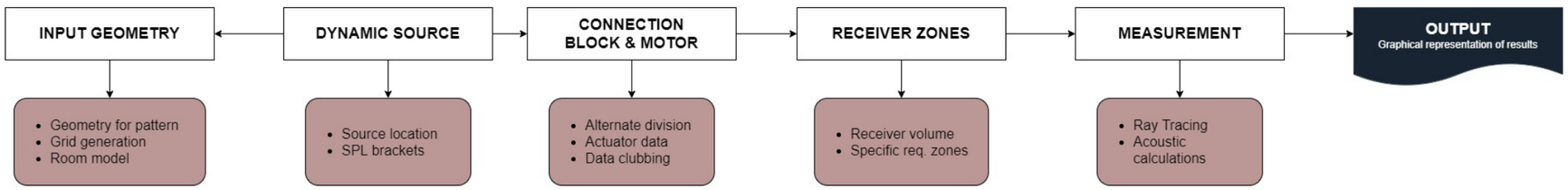
DESIGN INTEGRATION



BUILDING DESIGN | STRUCTURE | ENERGY | ACOUSTICS

GRASSHOPPER AND RHINO FORUM | GO TO SOFTWARE FOR ENGINEERS AND ARCHITECTS FOR GENERATING THE INITIAL DESIGN ITERATIONS.

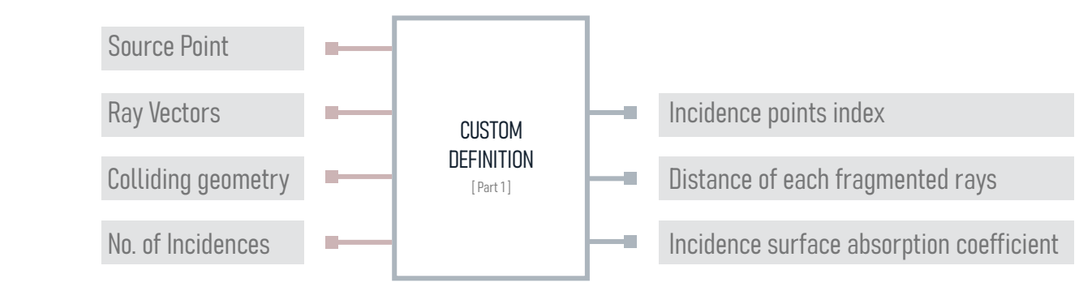
CUSTOM DEFINITION

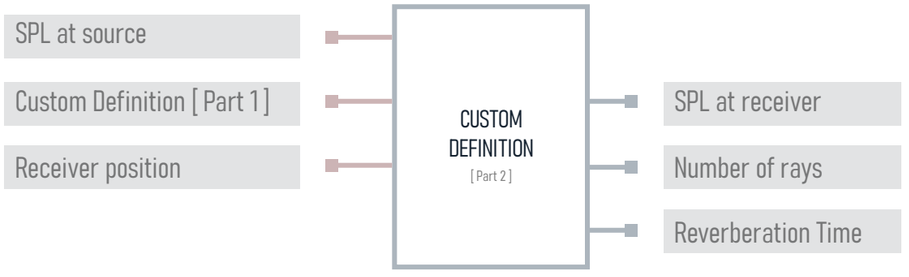


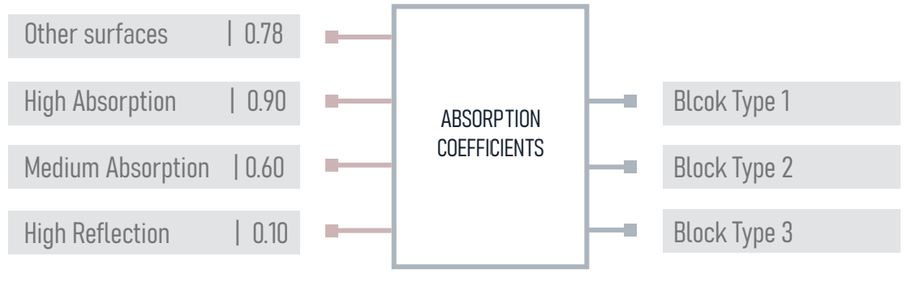
DYNAMIC GEOMTERY | DYNAMIC SOUND SOURCE | OPTIMIZATION CAPABILITIES

REDUCED COMPUTATION TIME | BASIC ACOUSTIC PROPERTIES

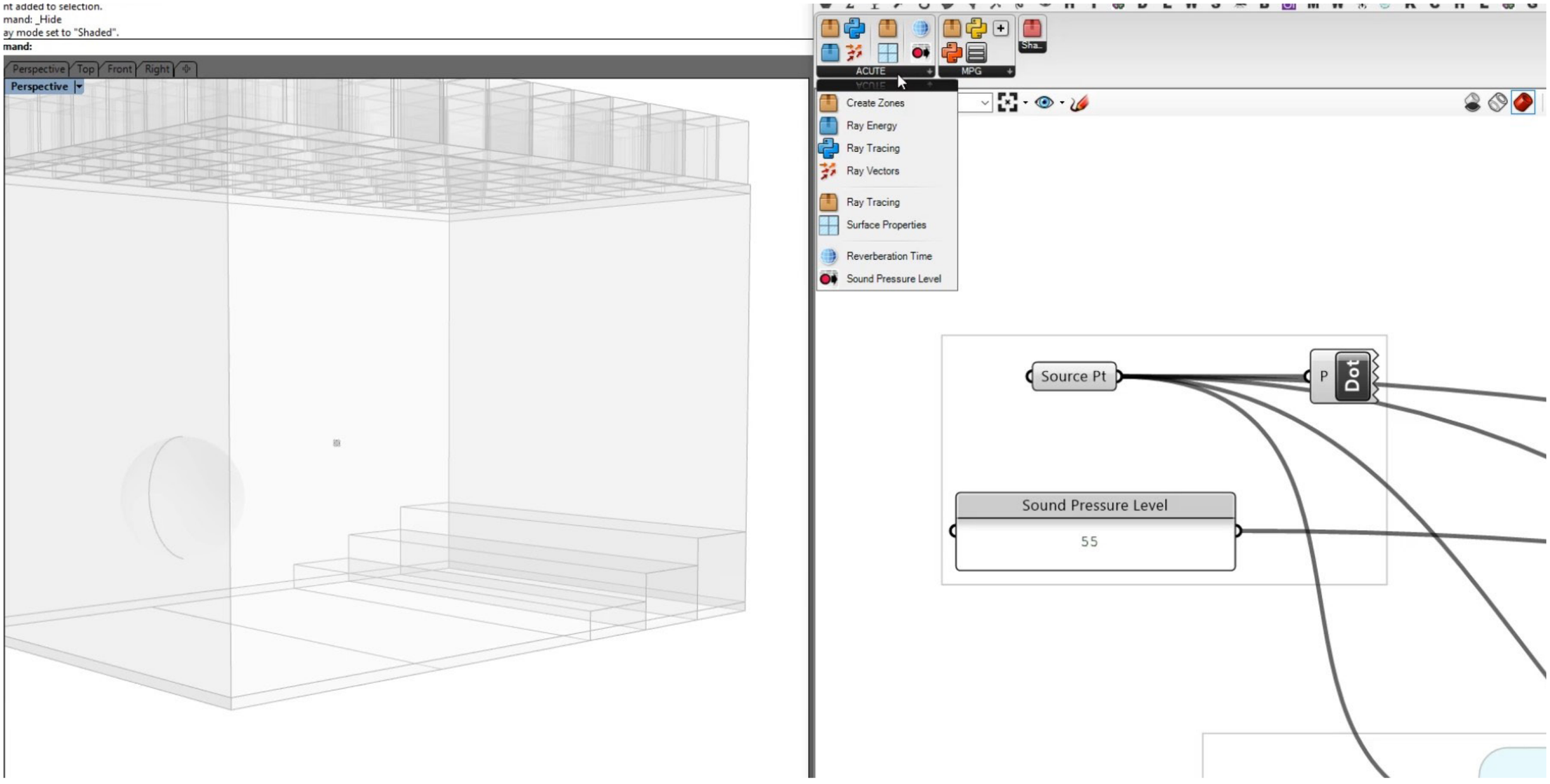
CUSTOM DEFINITION



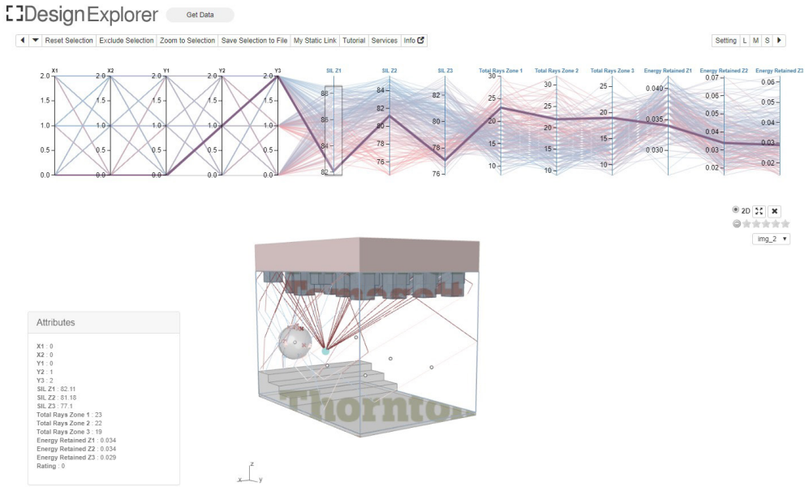




ACOUSTIC CALCULATIONS PLUGIN



OPTIMUM SOLUTION



MANUAL SELECTION WITH DESIGN EXPLORER

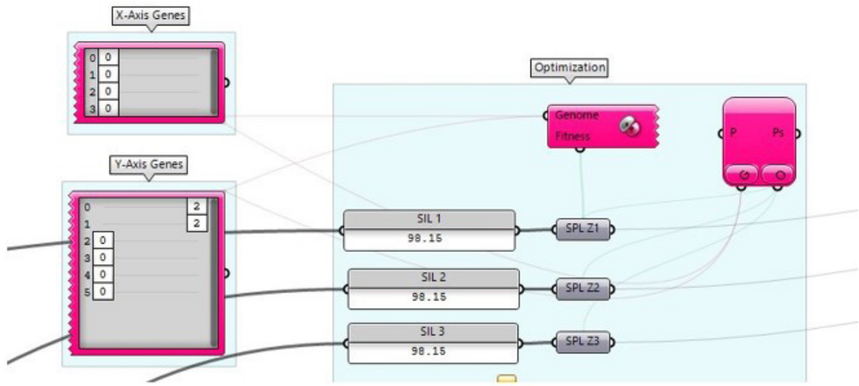
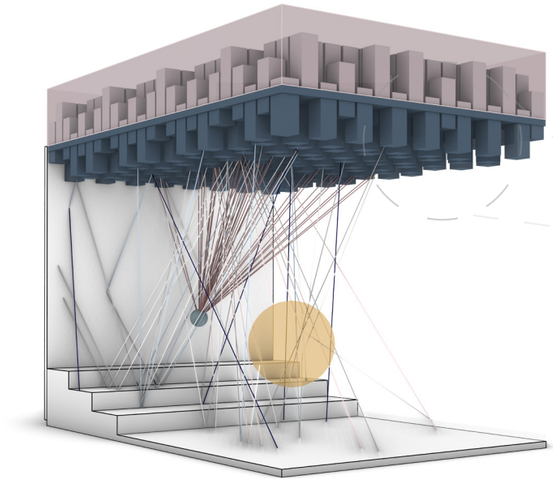
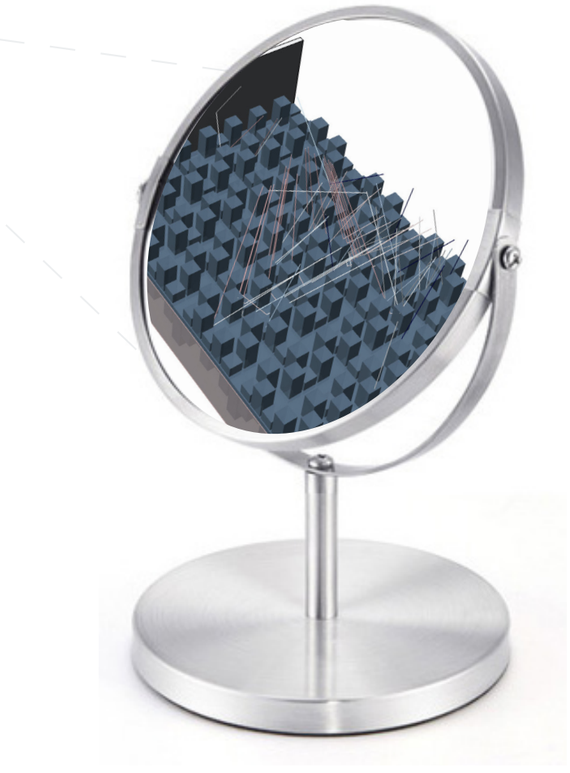


Figure 7.15 : Optimum solution search

SELECTION WITH MULTI-OBJECTIVE GENETIC OPTIMIZATION TOOLS

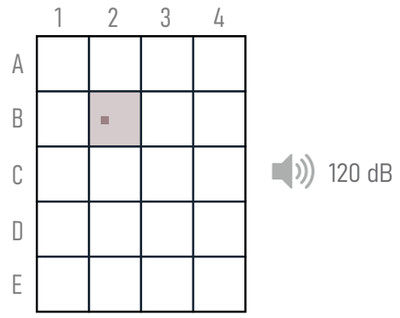
SCENARIO I RESULT

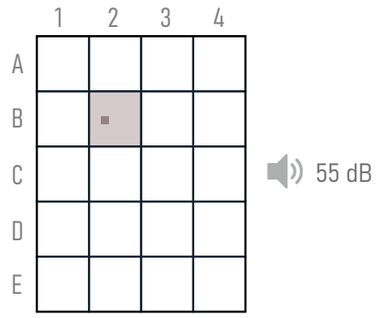


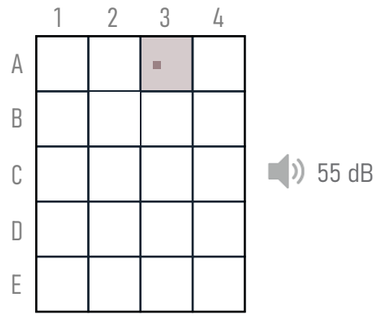


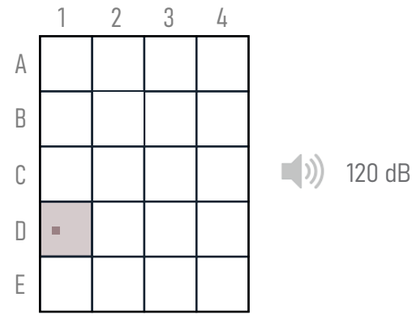
TEST AND VALIDATE THE CALCULATIONS

SAMPLE SCENARIOS









	OPEN ROOM		
Test Case	SCENARIO I		
Design Type	ACUTE block | Quad Klein		
Block Size - l x w x h (m)	0.3 x 0.3 x 0.6		
Source Position	B2		
Source Height	1. 8 m		
Source Sound Pressure level	120 dB		
Task	Zone 1	Zone 2	Zone 3
	Minimize	Minimize	Minimize

	CLOSED ROOM		
Test Case	SCENARIO II		
Design Type	ACUTE block | Quad Klein		
Block Size - l x w x h (m)	0.6 x 0.6 x 0.6		
Source Position	B2		
Source Height	1. 8 m		
Source Sound Pressure level	55 dB		
Task	Zone 1	Zone 2	Zone 3
	Minimize	Minimize	Minimize

Test Case	SCENARIO III
Design Type	ACUTE block | Quad Groote
Block Size - l x w x h (m)	0.6 x 0.6 x 0.8
Source Position	A3
Source Height	1.8 M
Source Sound Pressure level	55 dB
Task	Zone 1 / Zone 2 / Zone 3
	Minimize / Minimize / Minimize

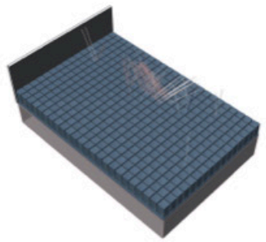
Test Case	SCENARIO IV
Design Type	ACUTE block | Quad Groote
Block Size - l x w x h (m)	0.6 x 0.6 x 0.8
Source Position	D1
Source Height	1. 5m
Source Sound Pressure level	120 dB
Task	Zone 1 / Zone 2 / Zone 3
	Minimize / Minimize / Minimize

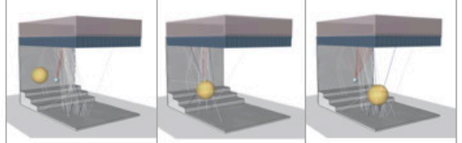
RESULT SHEET — OPEN ROOM

Test Case	SCENARIO I
Design Type	**ACUTE** block	Quad Klein
Block Size - **l** x **w** x **h** (m)	0.3 x 0.3 x 0.6
Source Position	B2
Source Height	1. 8 m
Source Sound Pressure level	120 dB

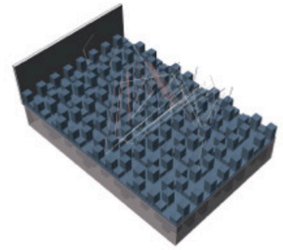
Task	Zone 1	Zone 2	Zone 3
	Minimize	Minimize	Minimize

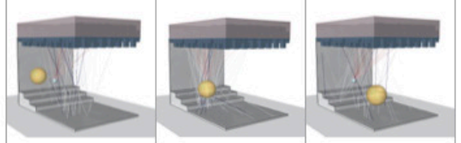
INITIAL POSITION



Zone Number	Receiver - Zone 1	Receiver - Zone 2	Receiver - Zone 3
Ray Tracing Diagram			
Order of Incidence 1	0	0	0
2	15	11	15
3	4	6	9
4	2	2	4
5	1	4	1
6	4	4	4
Total number of rays	35	27	33
Sound Pressure Level (dB)	105.82	107.57	108.85

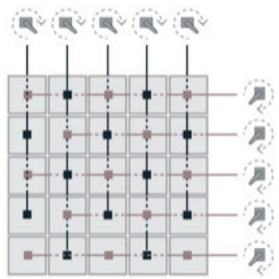
OPTIMIZED POSITION



Zone Number	Receiver - Zone 1	Receiver - Zone 2	Receiver - Zone 3
Ray Tracing Diagram			
Order of Incidence 1	0	0	0
2	14	8	11
3	10	9	15
4	4	11	8
5	1	5	3
6	4	9	4
Total number of rays	33	42	44
Sound Pressure Level (dB)	89.93	83.19	92.62

ACTUATOR DATA

The numbers represent the angle that the respective actuator has to move to configure the blocks in the optimized position.
The data is based on the preset algorithms created based on the acoustic simulations. The algorithms can be tweaked in order to achieve customized results.

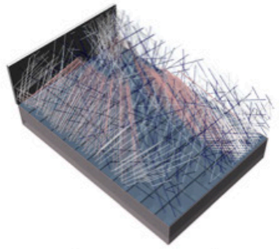
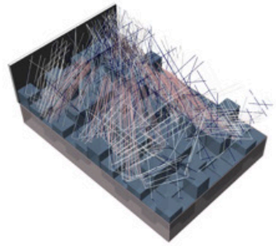
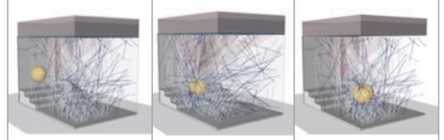
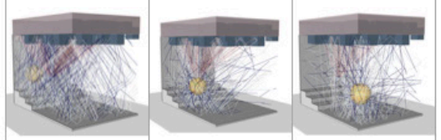
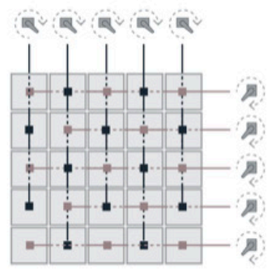


X axis	| 2 | 1 | 1 |
Y axis	| 1 | 1 | 2 | 1 | 0 |

RESULT SHEET — CLOSED ROOM

Test Case	SCENARIO II
Design Type	ACUTE block | Quad Grout
Block Size - l x w x h (m)	0.6 x 0.6 x 0.6
Source Position	B2
Source Height	1.8 m
Source Sound Pressure level	55 dB

Task	Zone 1	Zone 2	Zone 3
	Minimize	Minimize	Minimize

		INITIAL POSITION				OPTIMIZED POSITION			ACTUATOR DATA
Block Configuration									The numbers represent the angle that the respective actuator has to move to configure the blocks in the optimized position. The data is based on the preset algorithms created based on the acoustic simulations. The algorithms can be tweaked in order to achieve customized results.
Zone Number		Receiver - Zone 1	Receiver - Zone 2	Receiver - Zone 3		Receiver - Zone 1	Receiver - Zone 2	Receiver - Zone 3	
Ray Tracing Diagram									
Order of Incidence	1	0	0	0	1	0	0	0	
	2	14	14	14	2	18	12	18	
	3	35	51	49	3	41	38	59	
	4	38	87	73	4	20	63	61	
	5	29	102	67	5	32	71	52	
	6	27	101	56	6	25	75	56	
Total number of rays		143	355	259		136	259	246	X axis | 1 | 0 | 2 |
Sound Pressure Level (dB)		49.18	48.4	47.13		41.45	37.10	37.04	Y axis | 2 | 0 | 0 | 1 | 1 |

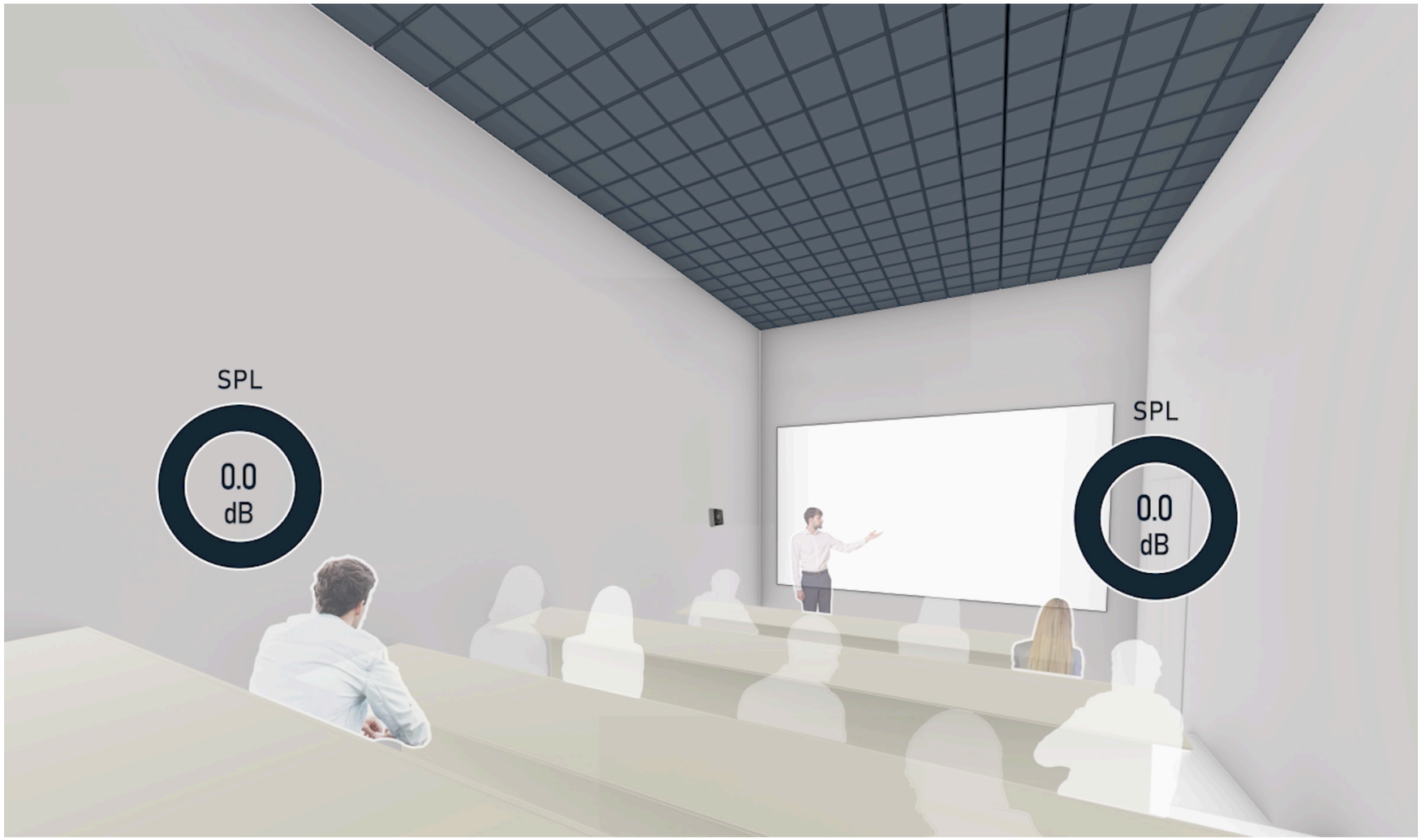
CONCLUSIVE RESULTS

SCENARIO I					OPEN ROOM | 120 dB	
	SPL (dB)				Number of Rays	
	INITIAL	OPTIMIZED	CHANGE	INITIAL	OPTIMIZE	CHANGE
Zone 1	105.82	89.93	▼ 15.89	35	33	▼ 2
Zone 2	107.57	83.19	▼ 24.38	27	42	▲ -15
Zone 3	108.85	92.62	▼ 16.23	33	44	▲ -11

SCENARIO II					CLOSED ROOM | 55 dB	
	SPL (dB)				Number of Rays	
	INITIAL	OPTIMIZED	CHANGE	INITIAL	OPTIMIZE	CHANGE
Zone 1	49.18	41.45	▼ 7.73	143	136	▼ 7
Zone 2	48.4	37.10	▼ 11.3	355	259	▼ 96
Zone 3	47.13	37.04	▼ 10.09	259	246	▼ 13

THE FUTURE.

WALL MOUNTED DEVICE



WALL MOUNTED DEVICE

EFFICIENT MODES

AUTO MODE

Maximum SPL or any other property

LOW TOLERANCE

SCENE MODE

Preset settings
Lecture
Discussion
Presentation

HIGH TOLERANCE

MANUAL MODE

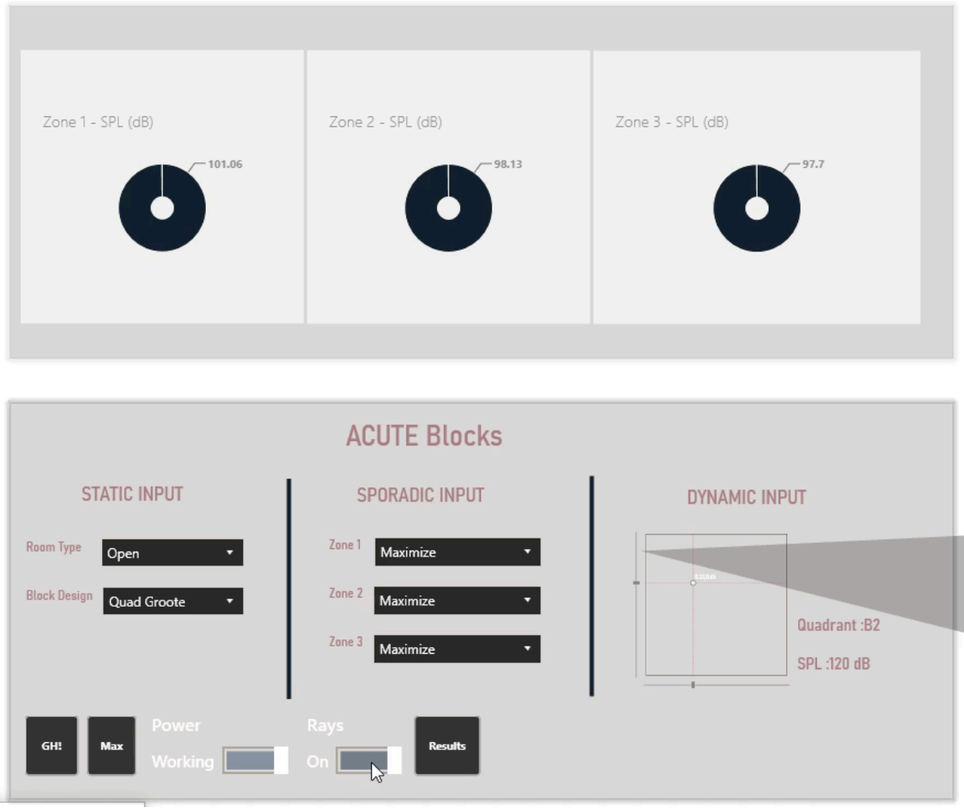
Custom settings
Zone control
Volume control

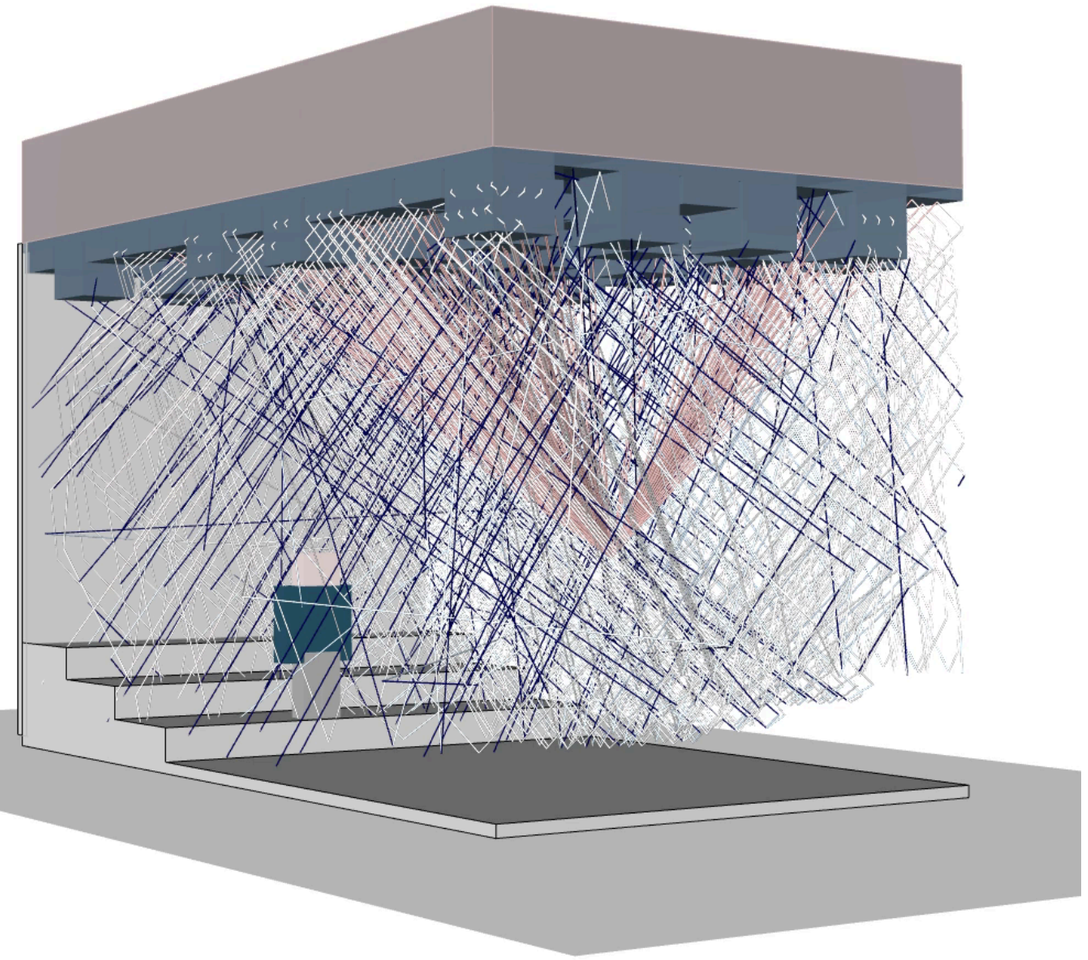
CUSTOM

STATIC DESIGN

STATIC | PRE-CONFIGURED

DIGITAL TOOL

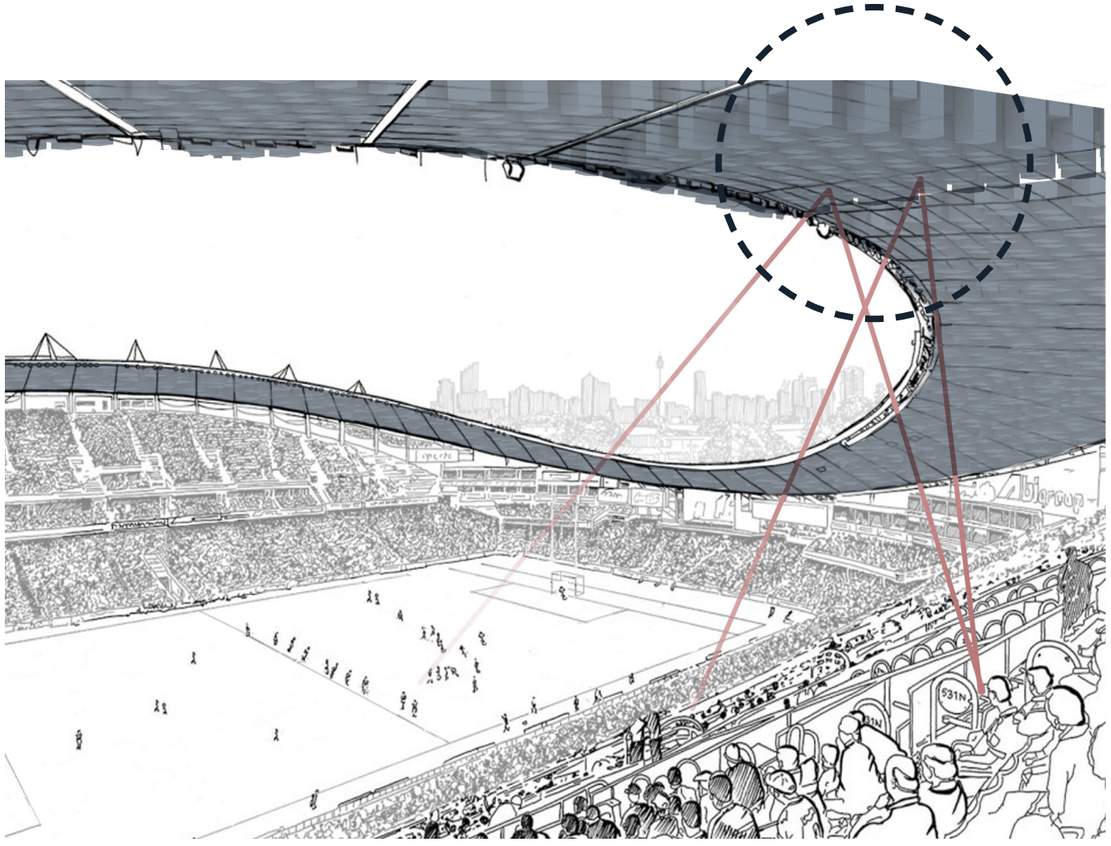




CLOSING STATEMENT

Sound is a tricky genre unlike light and temperature. It is highly complex to predict and control the user behavior in terms of sound. ***Thus, the intention is to correct the acoustics as a post-activity in a real-time response. Or use preset modes to alter for specific activities.***

RESEARCH OUTCOME



The sound waves coming from the crowd can be deflected or absorbed depending on the sound levels thus improving the **sound distribution** and controlling the **volume level**.

Image source : Author (modified from original source - Simon fieldhouse)

THE 12TH MAN

It is possible to enhance the user experience with a sound responsive skin triggered with real time sound and improve the acoustics as well as the game performance.

Image source : Author (modified from original source)

THOUGHT FOR CURIOSITY

Is it time to start integrating acoustic parameters with the plugin in place into the design process from the very initial stages of concept design?

And would you prefer a space with better acoustics that can enhance your productivity and experience in that space?

“Lets change the way we perceive sound in a space.”

Questions. Suggestions. Remarks.