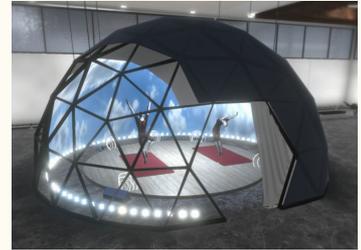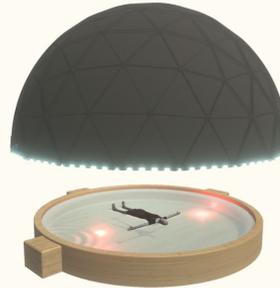# ELLIE

"Imagination will often carry us to worlds that never were, but without it we go nowhere"

-Carl Sagan

Introducing ELLIE:

The world's first modular dome that marries environment, multi-sensory content, and neuroscience to create groundbreaking immersive experiences.

Modular Design

The purpose of this document is to draw a modular design for a modular volumetric immersive platform. It's intent is to enable the reader to see the components that go into building such a platform and the considerations that go into their functionality.

A volumetric approach is used so that components could be considered modular and adapted to suit the needs of the installation environment.

No hardware component is reliant on another and no hardware parameters have a strict set of rules in which to operate. Designs are considered in terms of impact over implementation in order for the reader to adapt to such needs as installation and transportation require.

01 configurations

Workout
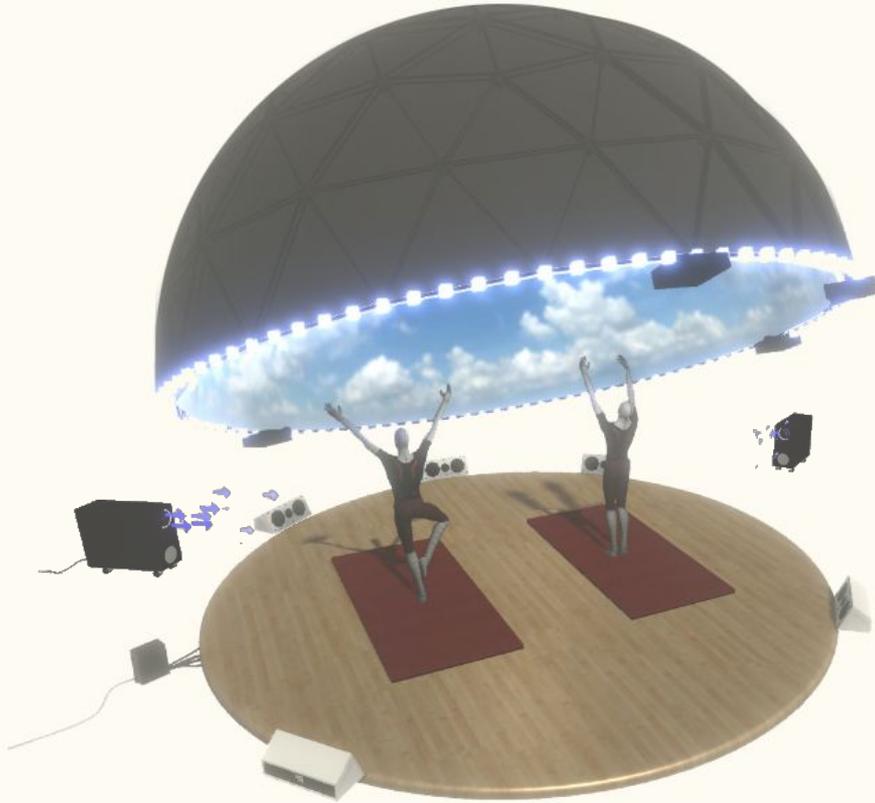
This configuration best suits the needs of a workout studio.

A 5m diameter tilted dome encloses the users in the visual experience.

With modular air blowers providing directional air flow inline with the visualization, users will be both immersed and kept cool during their workout.

The floor space illustrated here is 5m in diameter and has a capacity of up to 4 users (depending upon the session type).

Imagine working out while looking out across fields of swaying grass from a hill top vantage.
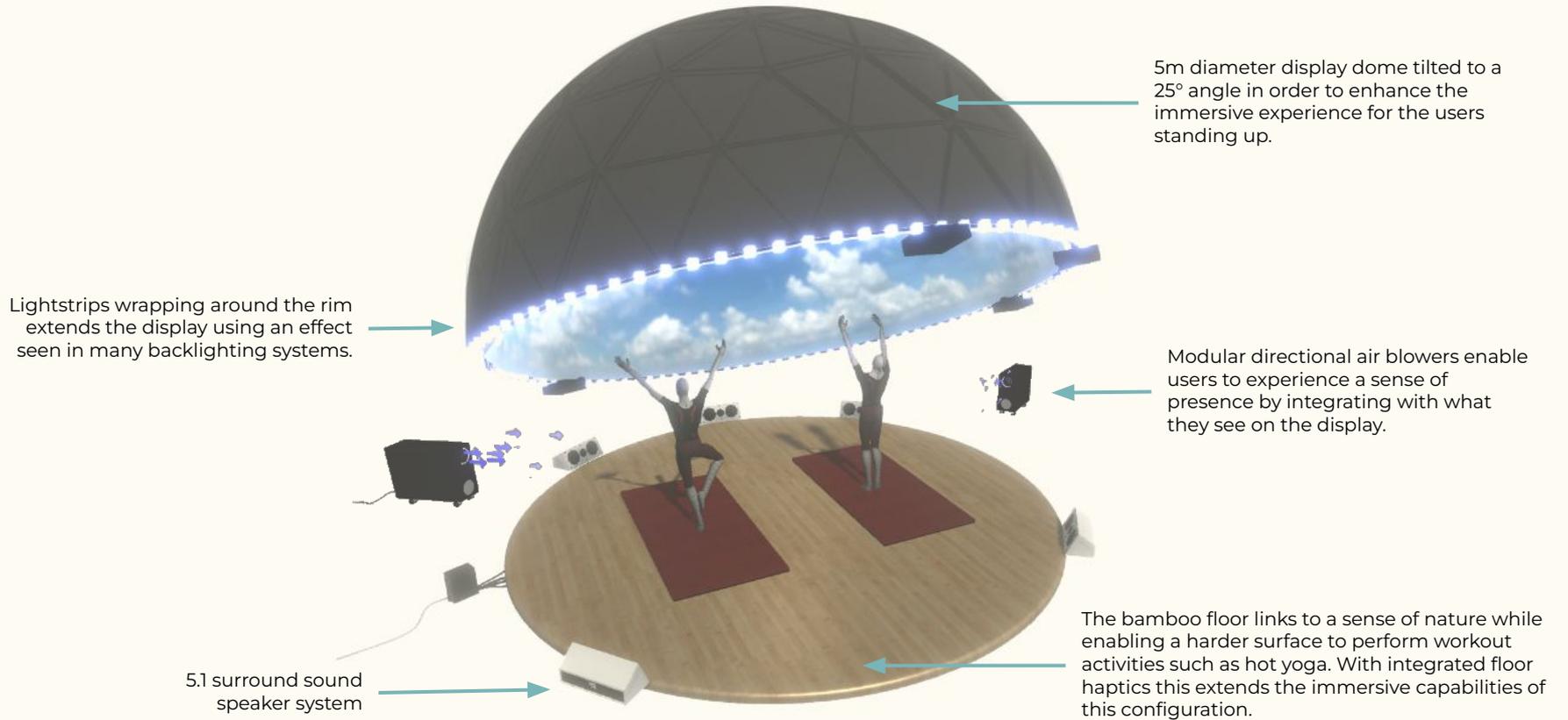
5m diameter display dome tilted to a 25° angle in order to enhance the immersive experience for the users standing up.
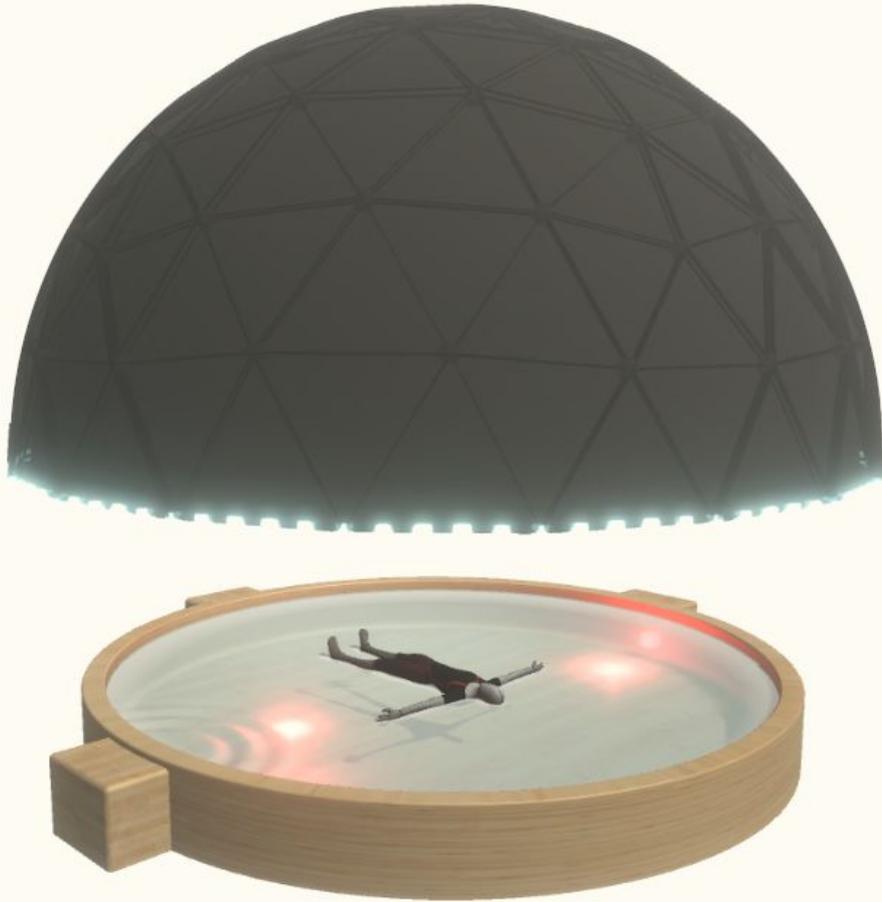
Lightstrips wrapping around the rim extends the display using an effect seen in many backlighting systems.

Modular directional air blowers enable users to experience a sense of presence by integrating with what they see on the display.

The bamboo floor links to a sense of nature while enabling a harder surface to perform workout activities such as hot yoga. With integrated floor haptics this extends the immersive capabilities of this configuration.

5.1 surround sound speaker system

Float

This configuration best suits the relaxation environment of a high end spa.

While the user is suspended in the pool they will be looking up into the dome providing an almost infinity deep visual experience.

The pool illustrated here is just under 5m in diameter and has a capacity of 2 users floating.

Imagine watching a starry night with comets flying over head while feeling suspended on top calm ocean waters.

Sound is reproduced above the water line and under the water, synchronised so as to not break the audio experience while the users ears bob above and below the water line.

Lightstrips wrapping around the rim extends the display using an effect seen in many backlighting systems.

Within the pool we include a haptic system that moves the water around the user giving them the impression of lying on a gently moving ocean surface or curling waves from the shallows of a beach.
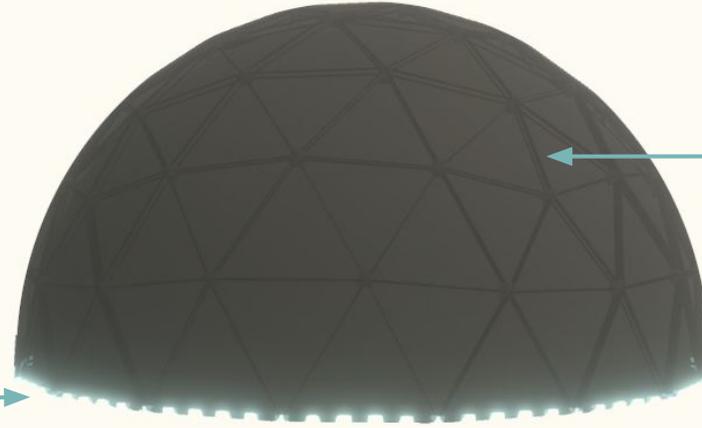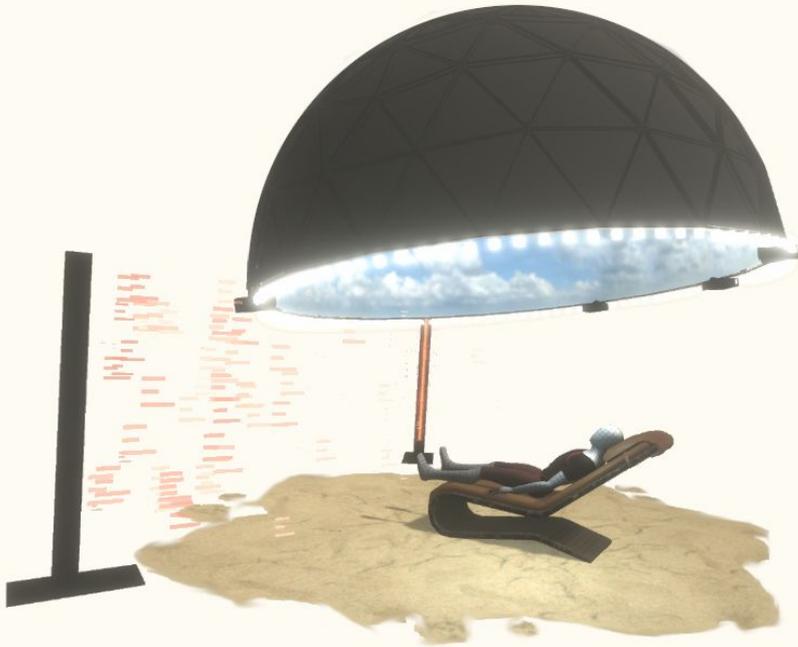
5m diameter display dome not tilted in this configuration as the user will be floating looking straight upwards while they lie on their back, therefore not having a tilt will give the most immersive display.
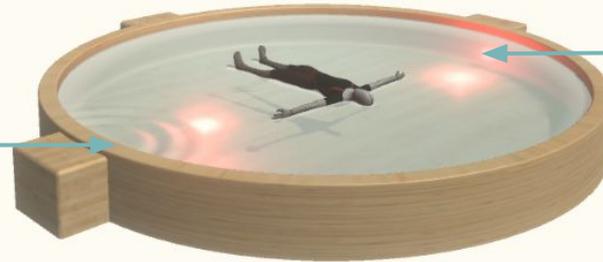
We also add lights within the pool to immerse the user further.

Meditate

This configuration best suits the relaxation environment of a high end spa.
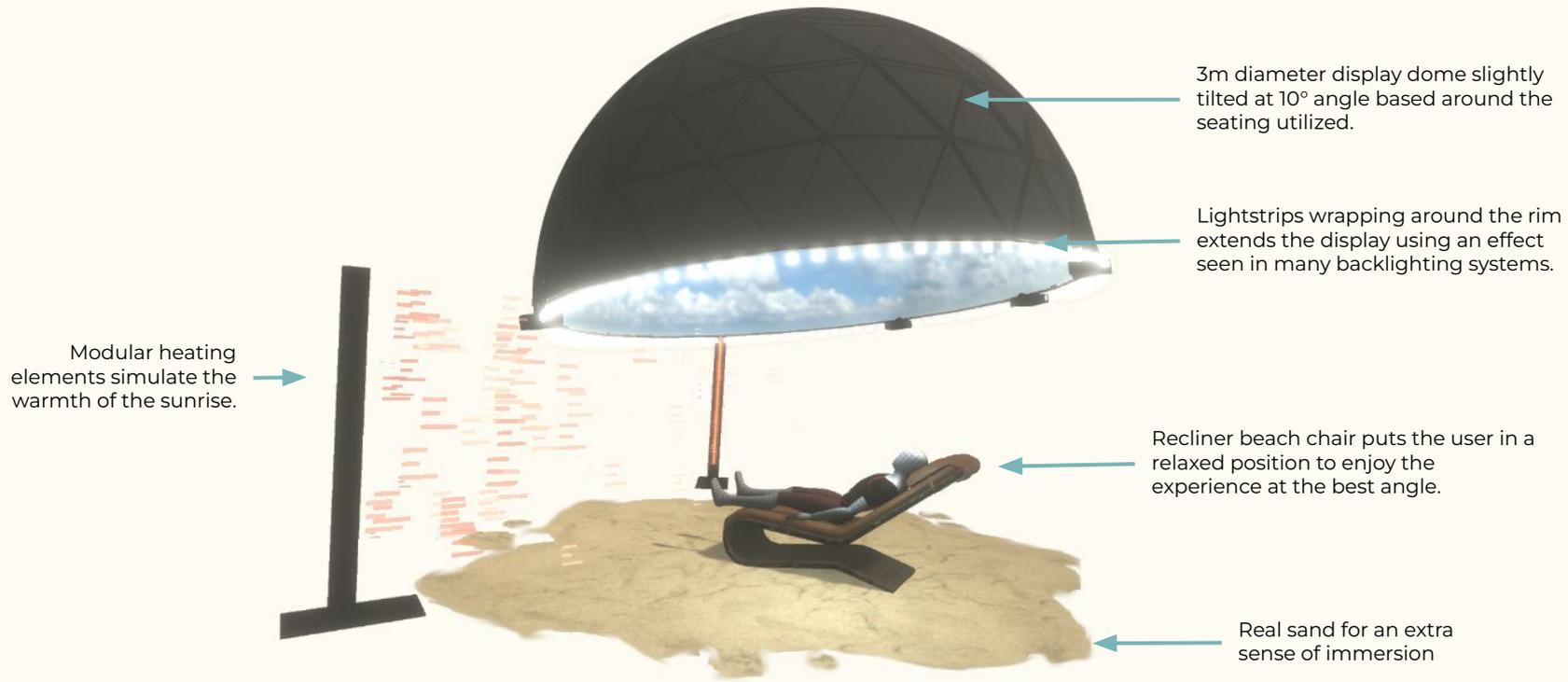
Example:
Real sand makes up the floor and as you look up into the dome you are immersed in the summer sky.

Heaters are utilized here to give you the ultimate beach like experience of the sun beaming down upon you.

This utilizes a smaller dome for a single user relaxation experience..

Imagine encapsulating yourself in a beach experience from the middle of the city in a high end spa.

3m diameter display dome slightly tilted at 10° angle based around the seating utilized.

Lightstrips wrapping around the rim extends the display using an effect seen in many backlighting systems.

Modular heating elements simulate the warmth of the sunrise.

Recliner beach chair puts the user in a relaxed position to enjoy the experience at the best angle.

Real sand for an extra sense of immersion

Bedroom

This configuration best suits the bedrooms of high end hotels giving guests the ultimate end of day relaxation experience.

This utilizes a smaller dome that encompasses the bed from a vertical direction for its user relaxation experience..

Imagine sleeping out among the stars with your partner as the soothing sounds of nature serenade you to sleep.

Smaller 3m diameter display dome not tilted as the users are looking directly upwards from the bed

Lightstrips wrapping around the rim extends the display using an effect seen in many backlighting systems.

5.1 surround sound speaker system

Solid framed bed to avoid reverberation from the speaker system
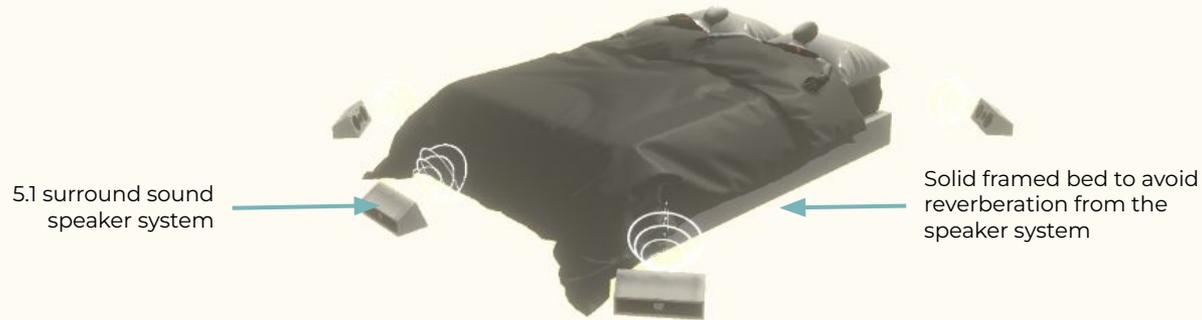
Theater

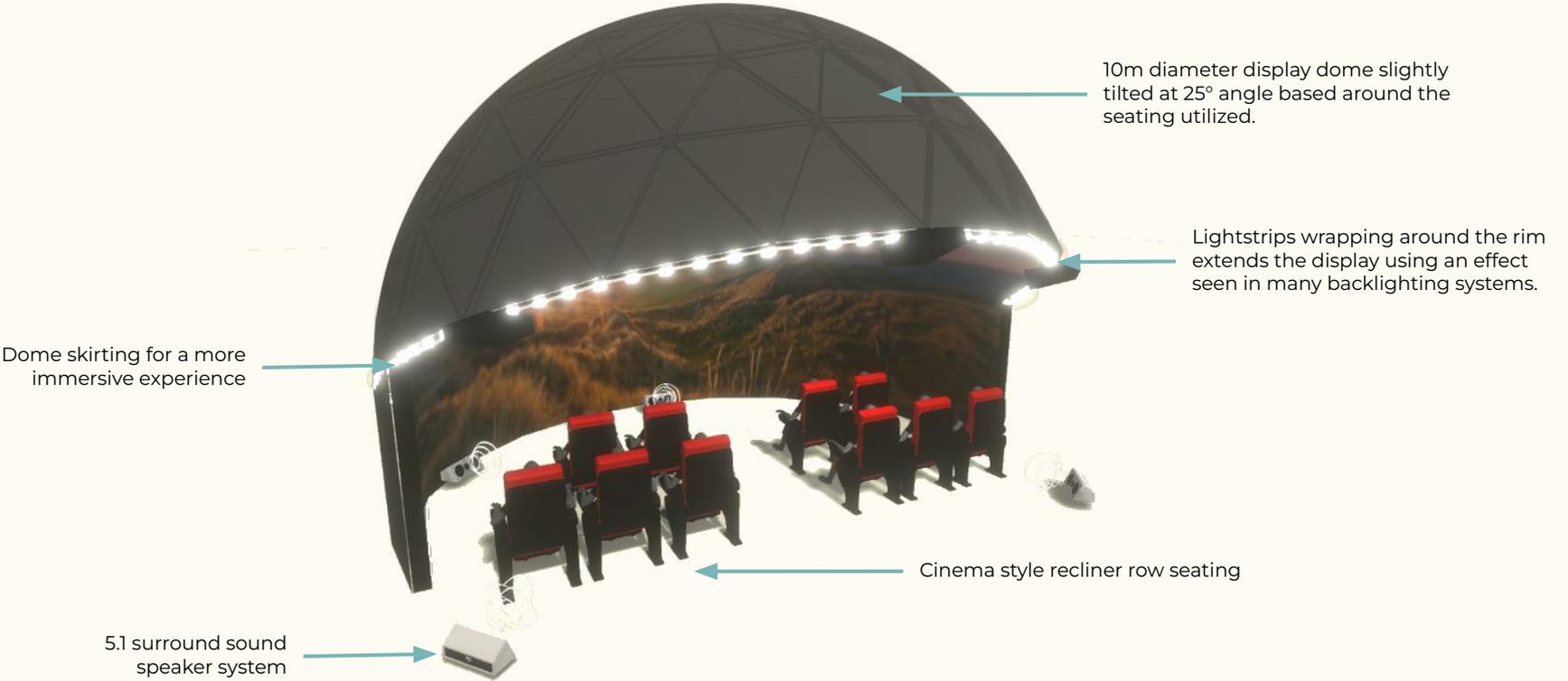This configuration best suits a larger scale experience much like a theatre environment.

This utilizes a larger dome than the others for a many user experience.

Bring the ultimate immersive experience to your users with the immersion of a tilted 10m diameter dome and encompassing dome skirt display.

10m diameter display dome slightly tilted at 25° angle based around the seating utilized.

Lightstrips wrapping around the rim extends the display using an effect seen in many backlighting systems.

Dome skirting for a more immersive experience

Cinema style recliner row seating

5.1 surround sound speaker system

Meditation

Meditation (guided and non-guided).

Location Experiences

Teleport to real world or virtual: static or moving scenes intended for meditation, basic relaxation, excitement (wingsuit), education (biology, nature, geography, etc)

Virtual Concerts

Room to stand and dance, 1 or more people, haptic vibration in the floor. Floor screens create 360 iexperience

Workout and yoga sessions

Yoga, virtual kickboxing, etc on top of a mountain or other scene.

360 Virtual Canvas

Virtually paint on the screens with hand or head movements. Save it, share it, possibly collaborate with other pod in real time

Physical Therapy

Room for clinician in the pod and proper set-up: massages, sports or injury recovery therapy, acupuncture, assisted stretching, etc.
Guided Mental therapy:

Gaming Display

Virtual multiplayer and local co-op gaming (I'm sure tons of possibilities.

Float Spa

Meditation, Physical therapy/massage, NSFW experiences, Music visualization, interactive art
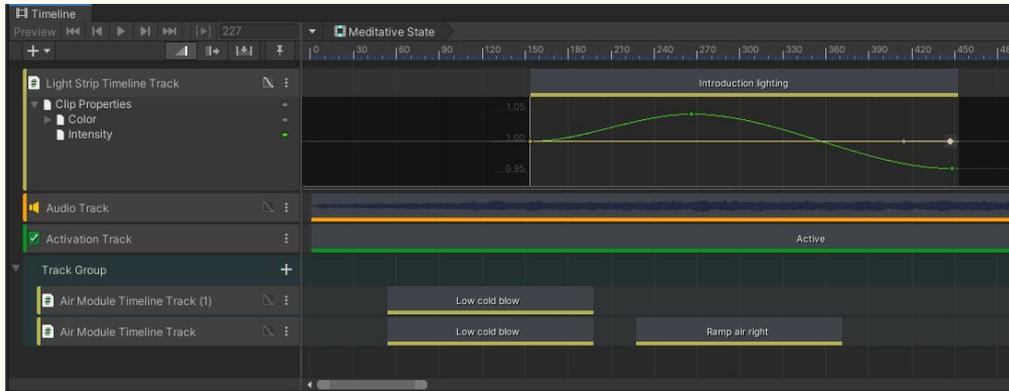
Music Visualizations

Programmed creations of a painting on the screens timed to the music as you watch it develop Simulate the music creating the art. Variations of light shows, music visualizations, etc.
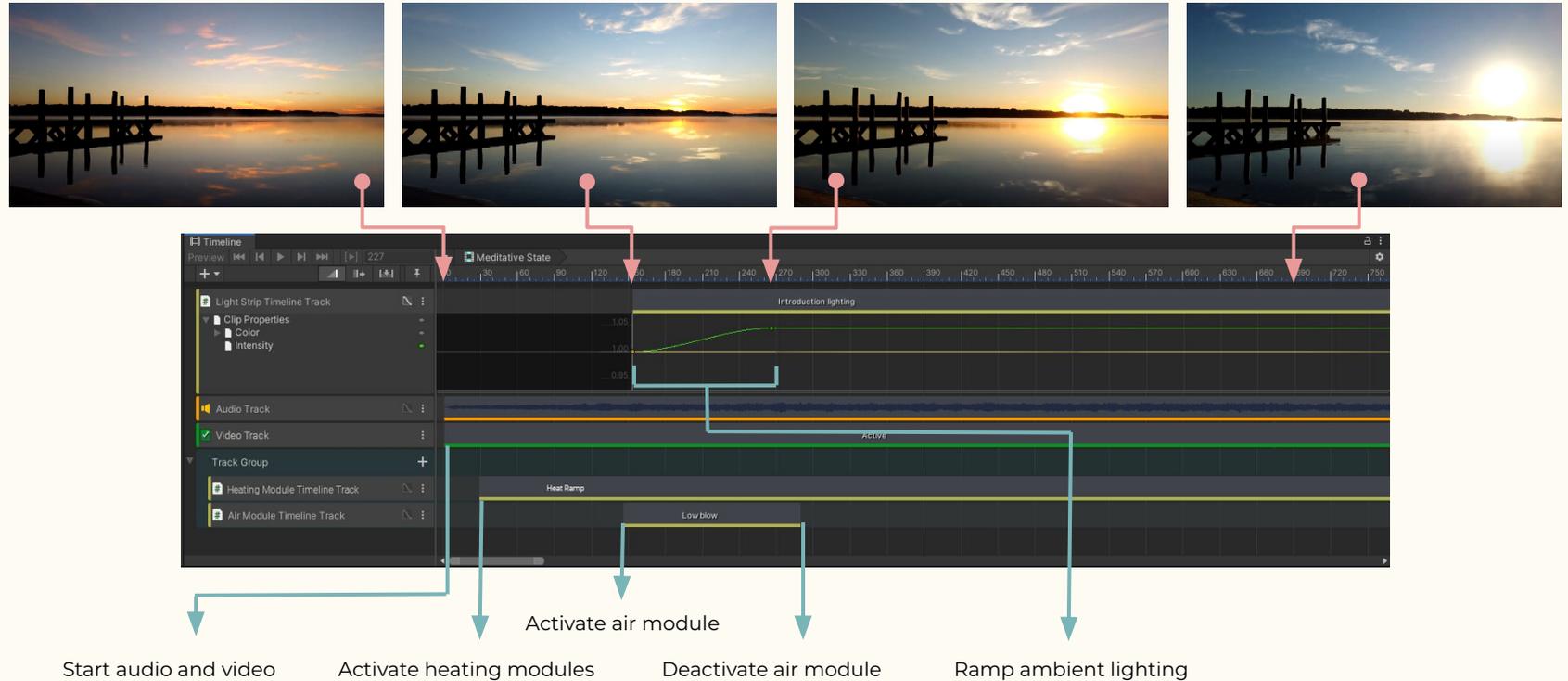
02 flow

timeline

details

Tying all the components of this platform together is a timeline software integration with intermediary hardware layers. Whenever a user runs a session (meditation, location experience etc) the software will control when each component will activate and the set of parameters for that component to run. To perform this level of timed component control we utilize a tool called a timeline editor.

Timeline editors can often be seen in video or music editing software to place video and audio clips in sequence and manage their transitions. Here we still use this sequencing for not only video and audio but also to control other sensory devices such as air blowers and haptics.

To create this application will require knowledge of software application development including video, audio and formats described in the later sections of this document.

Mockup of a timeline showing activations and parameters for components being set over time

In this example we show a timelapse from a video showing the sunrising, these moments are indicated on the timeline editor with the red arrows. You can then see the corresponding tracks for the ambient lighting, audio/video input and both the heating and air modules. The green arrows show instructions for the components interfaces.

Start audio and video

Activate heating modules

Activate air module

Deactivate air module

Ramp ambient lighting

03 display

Illustration of a dome display with user performing yoga moves

dome display

features

360° projection dome enables user to be enveloped into visual experience without the need for head mounted display (virtual or augmented reality).

4 DLP Projectors for full coverage placed with 3 at 45° and the last at 180° from center of the others.

3K display resolution.

Capacity for 10 people seated or 4 performing activities (such as yoga).

Lightweight frame enables both a floor mounting solution available or ceiling suspension (~150kg weight).

Variable tilt angle depending upon viewing requirement (lying down would be no tilt).
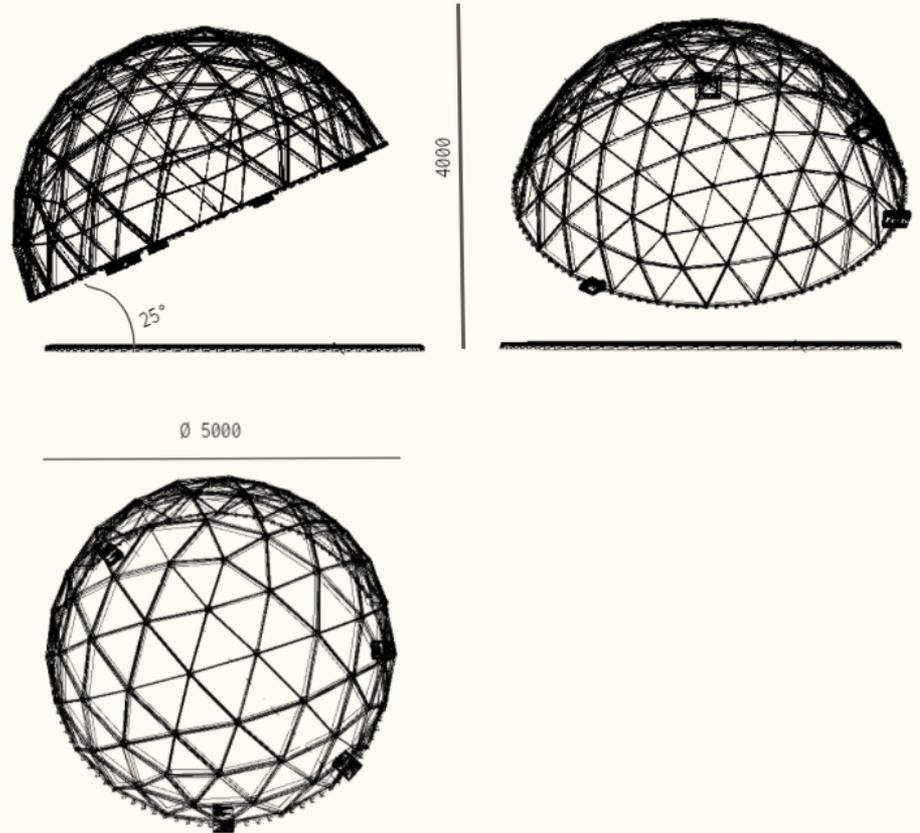
specification

Diameter 5m

Floor Area 15 sq. m

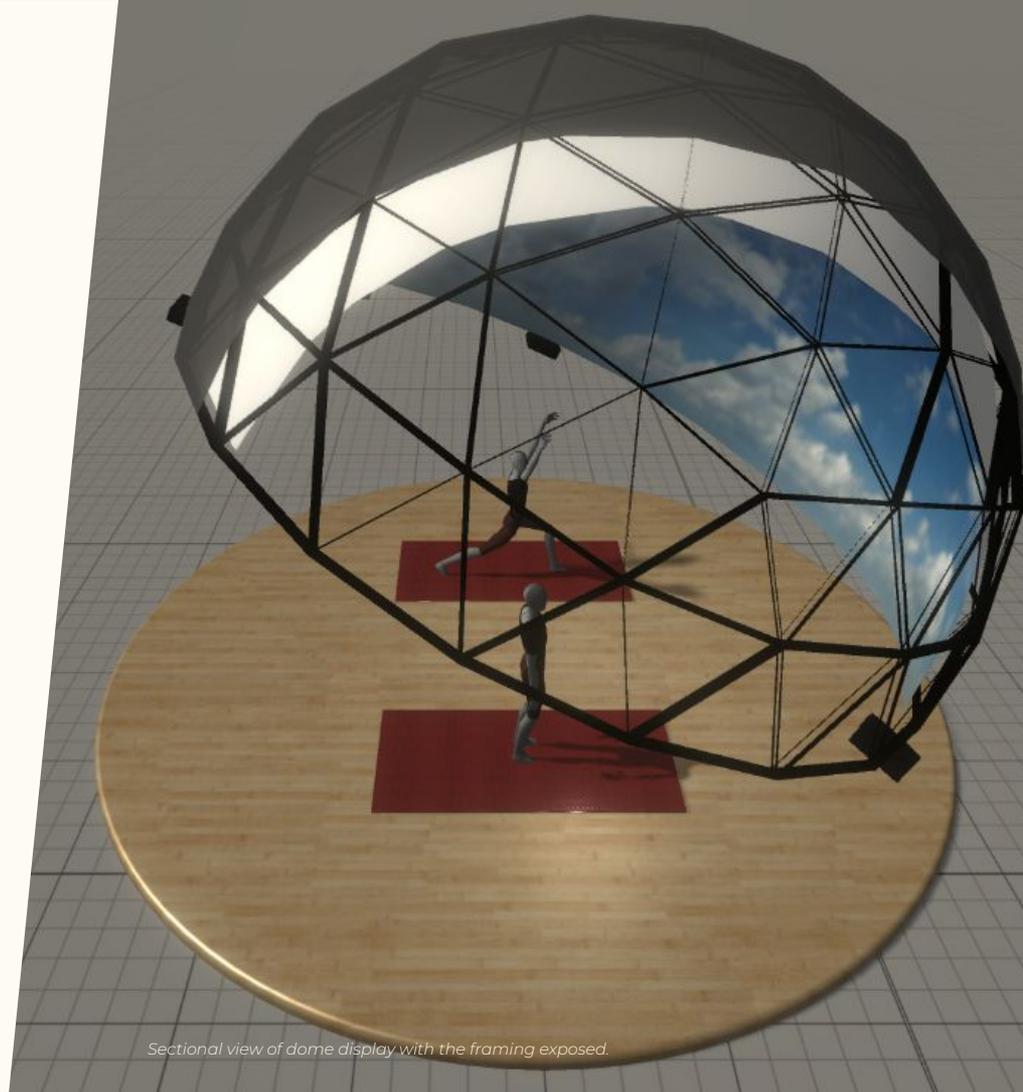Height 4m+ (variable with tilt angle)

Weight 150kg (dome + equipment)

pricing

5m diameter dome illustrated comes in around $60k.

This price includes projection system and projection mapping software for the dome shape.

Source Fulldome Pro https://fulldome.pro/

Sectional view of dome display with the framing exposed.

skirting display

features

Creates a more enclosed display utilizing a vertical display from the dome rim to floor.

Avoids casting shadows from the users onto this skirting display by using a rear projection system.

Multiple projectors used to map each part of the skirt display.

considerations

This is not a complete off the shelf product, but it utilizes available off the shelf products.

Projection medium would need to be cut to align with the tilt and height of the dome rim.

Rear projectors would need to be mapped to match the display location by an intermediate software setup.

Impedance by the skirting must be considered for other components (for example blocking air blowers or muffling speakers).
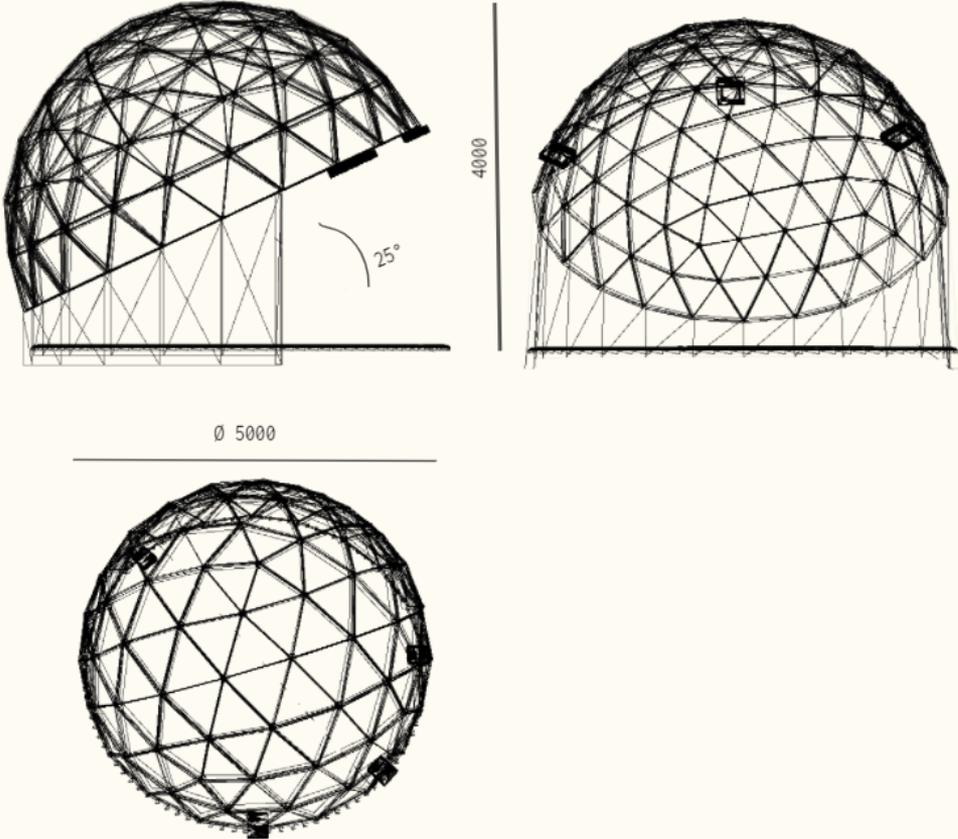
Illustration of a dome display with skirt display

specification

Diameter 5m

Floor Area 15 sq. m

Height 4m+ (for dome variable with tilt angle)

Weight 170kg (dome + equipment + skirting)

25°

4000

Ø 5000

pricing

Rear projection film costs upwards of a base price around $250 per 3m x 1.5m.

Projectors vary according to quality and resolution, it is recommended a starting point of no less than 2500 lumens.

Illustration of a dome display with skirt display

interface

Dome projection systems usually come with the mapping software required to run projection mapped visualizations across the dome seamlessly interlacing the images from each projector.

This integrated system will still need to be fed the visuals at the correct moment corresponding to the timeline platform mentioned at the start of this document. This will require an application developer with knowledge of distributed systems where the server will provide the projection system the visual to display.

The skirting would be a bespoke size depending upon the tilt and size of the dome above it. An application developer would be required to determine the part of the visual to display via each rear projector to its corresponding skirting. A developer with knowledge of projection medium and projection mapping would be preferable.

04 lighting

Illustration of up lighting shown here in red and down lighting in green

addressable lights

features

Situated around the rim of the dome we have addressable lights pointing up into the dome and pointing down away from it. Addressable lights mean that each individual light can have its color and intensity controlled by the timeline platform.

Option to be used in a synchronous manner to extend the display beyond the done with responsive peripheral lighting (each led is given a color and brightness corresponding to the display it sits alongside).

Option to be used as a visual replacement when sessions contain only an audio source (for example displaying red illuminating the done to promote healing).
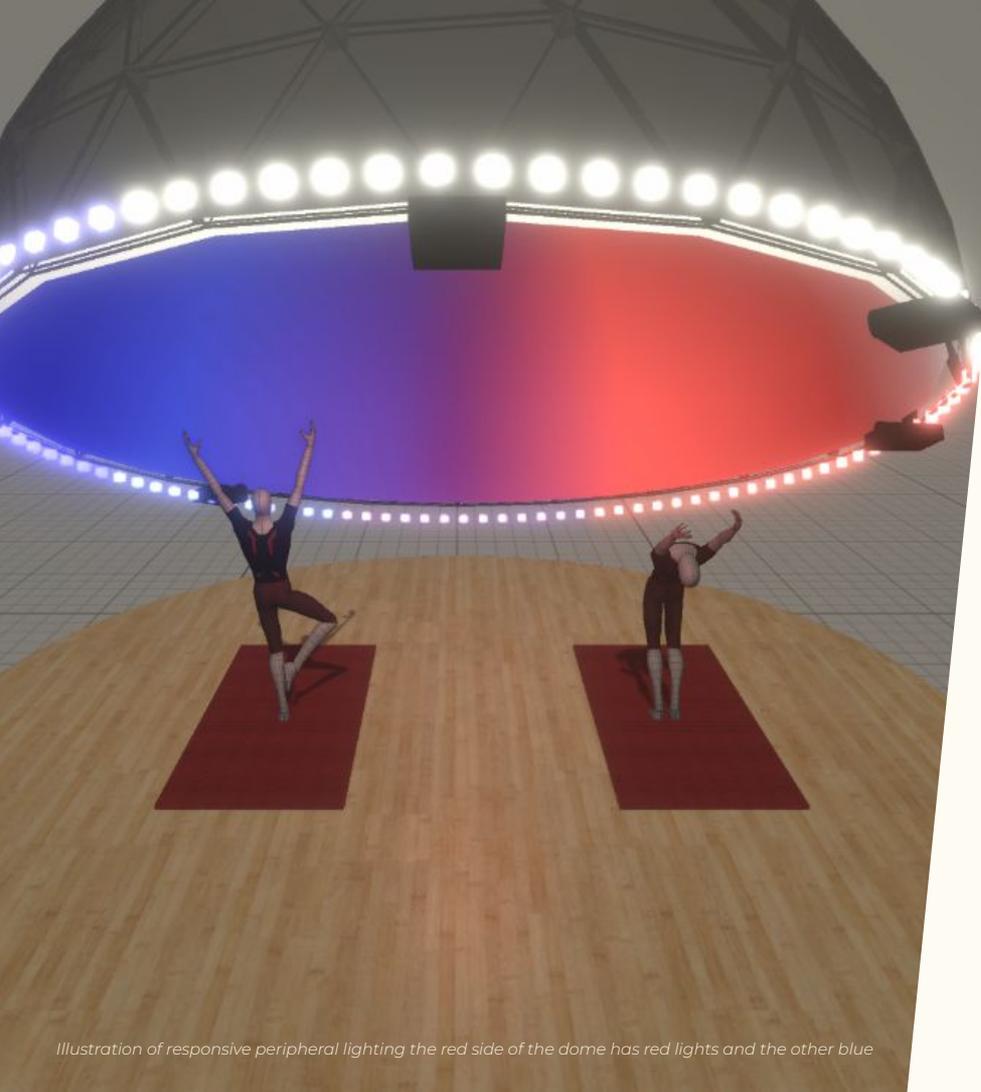
Option to be used as ambient lighting when users arrive and depart from their sessions.

specification

Single lighting strip length required ~15.7m

480 LEDs per strip section (5m) at 5mm pitch
giving ~1500 LEDs total per strip.
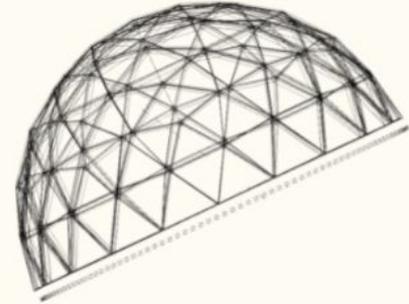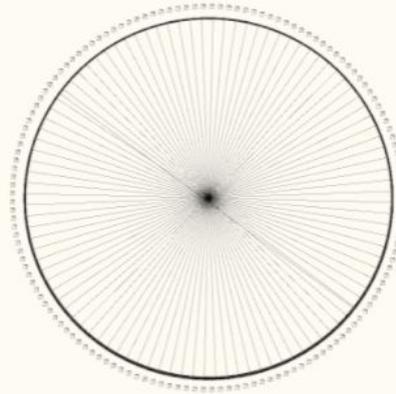
Illustration of responsive peripheral lighting the red side of the dome has red lights and the other blue

responsive lighting

features

Responsive peripheral lighting is an effective proven method for convincing the audience that the display expands further than the display medium itself (an example of this is the responsive backlight illumination available for home entertainment).

The visual is assessed at timed intervals, that visual is then run through a pixel matrix to determine which color is at which point. This information is then passed to be used for that lighting zone.

Can be used for non pre processed visual input using an input reader (takes the visual input through a source like HDMI and determines the incoming visual at realtime).

Illustration of ambient lighting affecting the inside of the dome and the flooring

ambient lighting

features

During some elements of a session the lights may act as ambient lighting, this may be used for instance when users are arriving and departing from the platform. Dim lighting can help the users navigate into position and or set the mood for the upcoming session.

Once the session begins the timeline platform can blend the current lighting condition to the session lighting specified on the timeline.

To extend the ambient lighting we could interface with (if installed at the location) Internet Of Things (IOT) enabled lighting which would be activated in time with the installed ambient lighting.

pricing

5050 RGBA addressable light strips ~$200 for 5m length (6000+ lumen, 480 LEDs)

Power supply ~$40 per 5m length

Control driver board for hardware interface ~$100

Illustration of single strip of addressable lights showing different colors and intensities

interface

Different size displays require different amounts of lights, to cope with this disparity we use a zonal system to describe the lights to the software platform and then use an intermediate step within the light strip hardware interface driver to dictate which lights refer to which zone.

This zonal system means the number of lights for various configurations will not matter to the software platform which only is concerned with processing the zone colors and intensities.

This hardware interface requires a hardware developer with knowledge of addressable light strip displays, LED intensities suited to installation type and location; and coding interfaces for the timeline platform communication.

As an example, say we have a system with 100 zones and we have 1500 addressable lights around the rim of the dome. Every 15 lights would reference a single zone.

The opposite case is that we have 2000 zones with only 1000 addressable lights, here we would skip every other zone with each light.

The illustration here has 100 addressable lights and 4 zones to exaggerate the system implementation.

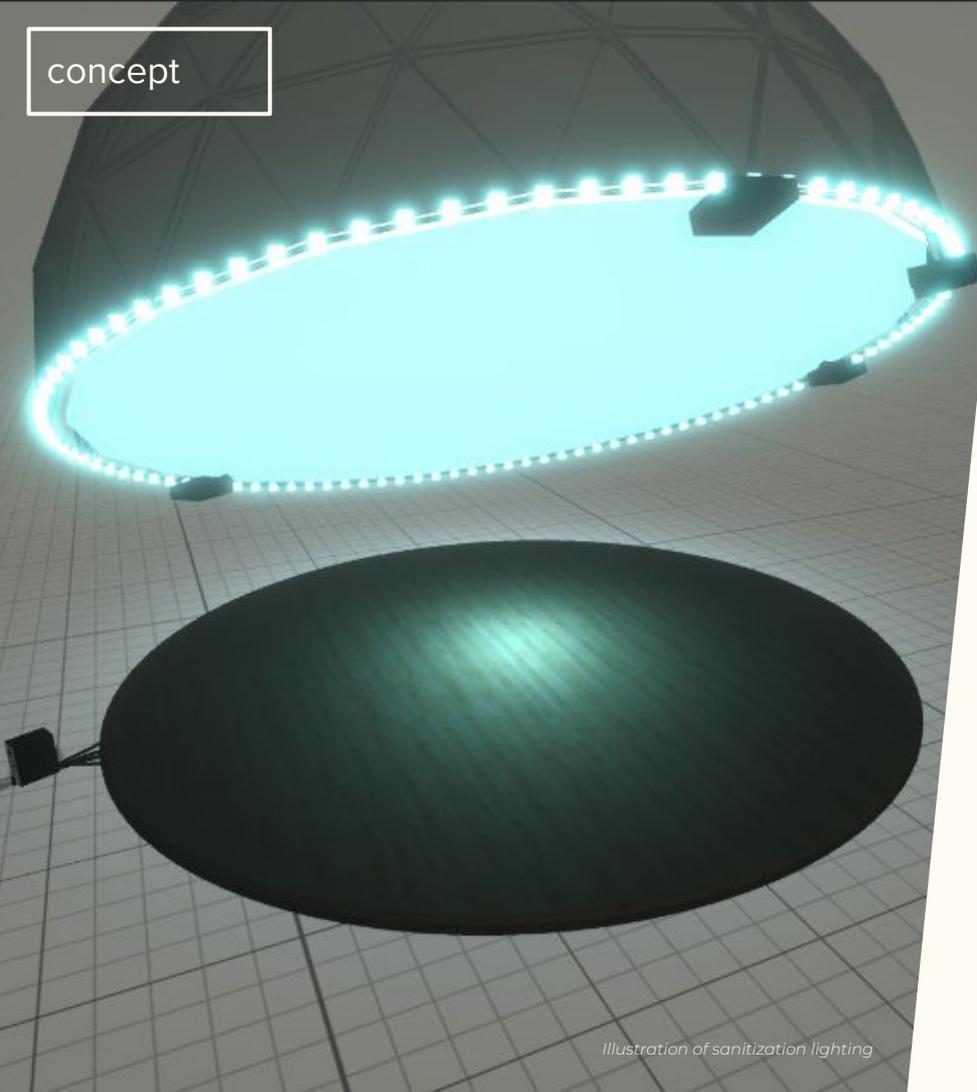*Illustration of 100 addressable lights utilizing 4 zones.*

0:08

timeline

These two paused images illustrate light zones (squares around the central image) at two points in time on a video.

0:23

sanitization lighting

features

Utilizes High-Energy Visible light (HEV) to help eliminate ever-multiplying bacteria like S. aureus and E. coli.

HEV light is a frequency of light that has a wavelength of 405nm – 450nm and appears blue to the eyes. Because of its destructive effect on bacteria, HEV light can function as a disinfectant (it's also safe for humans, pets, and plants)

considerations

No source as yet found for addressable LED strips with HEV.

Turned on during hours of non operation as an extra sanitizing step, after 8-12 hours of use the lights would kill around 50% to 70% of S.aureus and around 60% to 80% of E. coli.

Especially with the current climate post the year 2020 sanitization is both a nice to have for areas where multiple users from different households attend and a great marketing bullet point.

Illustration of sanitization lighting

pricing

There are consumer lighting companies such as LIFX that produce HEV IOT smart lights. If no addressable sources are found then an alternative would be to mount these HEV IOT smart lights as well as the addressable LED strips.

Source LIFX
https://www.lifx.com/pages/lifx-clean-germ-buster

Illustration of underwater lighting

underwater lighting

features

For installations that utilize water based therapy and activities such as floatation tanks underwater lighting could be installed and then controlled the same way as the IOT lighting specified above as additional lighting.

considerations

All bonding and grounding requirements for pool and spa lights need to be applied.

pricing

Pricing per underwater lights $300+.

Requires power supply and expert installation (at extra cost).

Control driver board for hardware interface ~$100

05 audio

Illustration of speaker setup around two users performing yoga moves

surround sound

features

Surround sound enriches the experience provided by the sessions.

With multiple channels users will more deeply comprehend directionality to the experience they are within.

considerations

A lot of meditative applications lean towards providing binaural audio, however this is best listened to on headphones, which is harder to provide in a large spaced multi-user environment where users may be performing exercises such as yoga. Headphone leads are a safety concern and wireless can be a problem when dealing with a larger number of users at once with synchronization, interference and the supported number of bluetooth devices. As such surround sound speakers are a freeing and proven system for providing spatial audio.

specification

Surround Sound installation comes in many varieties such as 5.1, 7.1, 7.2 etc.

The variety for the installation should be based partially on the session source audio available.

Considerations should also be made to installation type:

- Modular floor standing speakers for open concepts and transportable concepts.
- Mini speakers such as Bose could be added to the rim of the dome to clear floor space around the platform.

Center

Left

Right

Left Rear

Right Rear
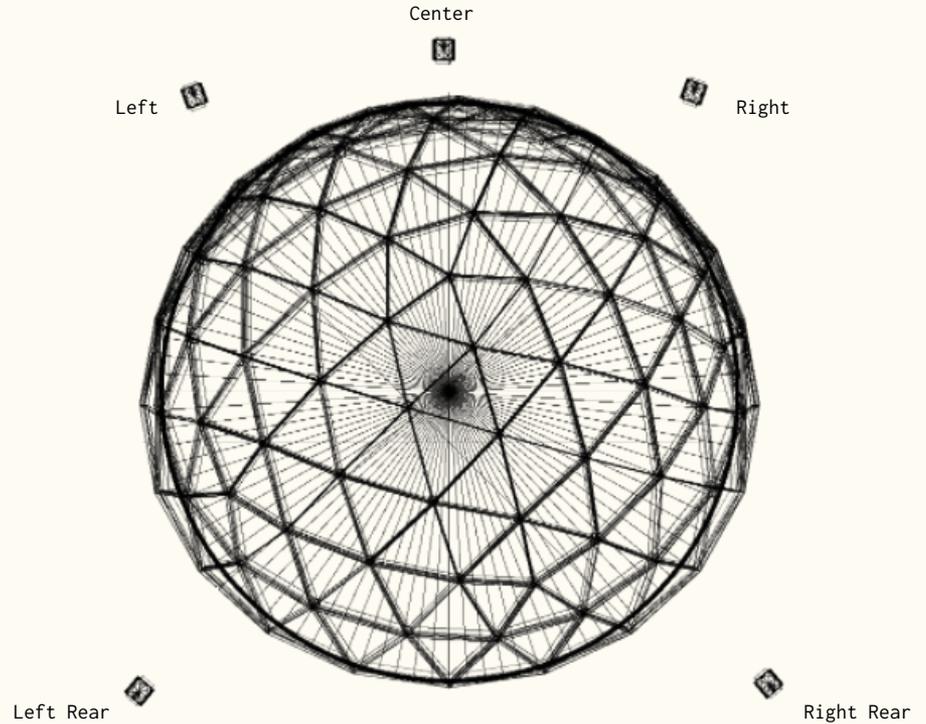
pricing

Pricing for surround sound systems vary wildly depending on quality and installation type, but they are easy enough to assess online.

Some dome display systems come with a built in surround sound systems, however quality can vary as some come built into the projectors which is less than ideal (small in size and usually reduce directional quality).

Bose Lifestyle 650 (home installation style 5.1 surround sound) $4000

https://www.bose.com/en_us/products/speakers/home_theater/lifestyle-650-home-theater-system.html#v=ls_650_black

Yamaha S112V (professional club loudspeaker) $564 per speaker

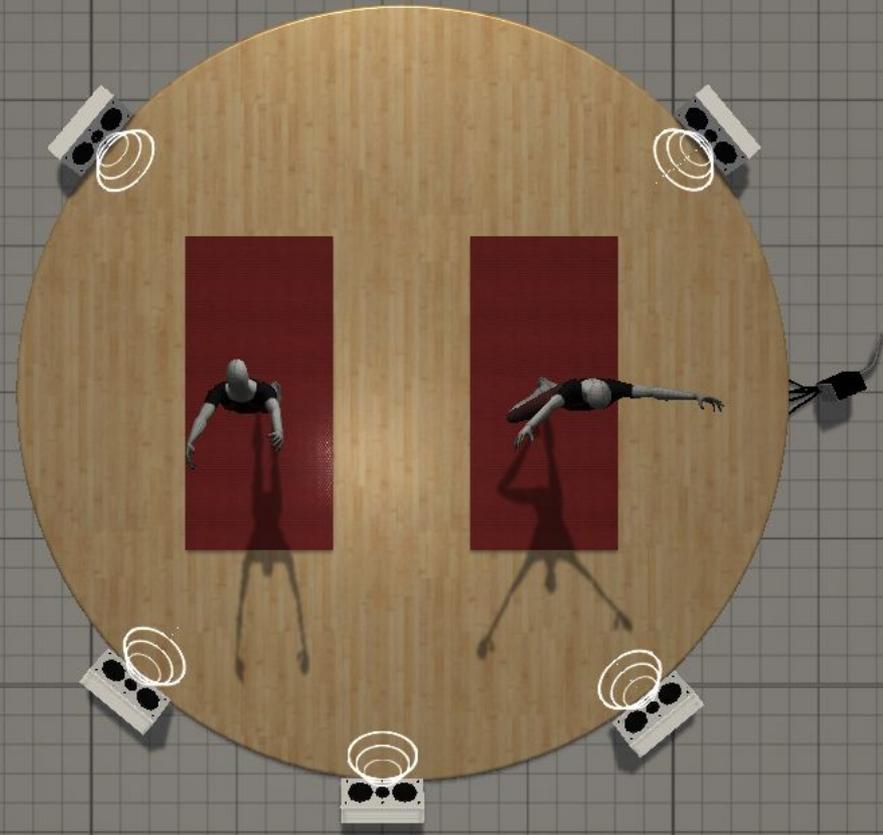https://usa.yamaha.com/products/proaudio/speakers/concert_club_v_series/index.html

Illustration of speaker setup around two users performing yoga moves from top down view

features

As mentioned above binaural audio is better listened to with headphones at present, in a group setting this could be done but is an added complication. One method is to have users sync with an app broadcasting the audio at a set time inline with the timeline.

Another is multiple bluetooth headphones connecting, but this requires a bluetooth transmitter device attached to the output.

For smaller single person or lower number installations multiple headphone jacks split from the main jack could be provided from the front of the installation. This reduces installation complexity however trailing wires must be considered as a trip and or tangle hazard.
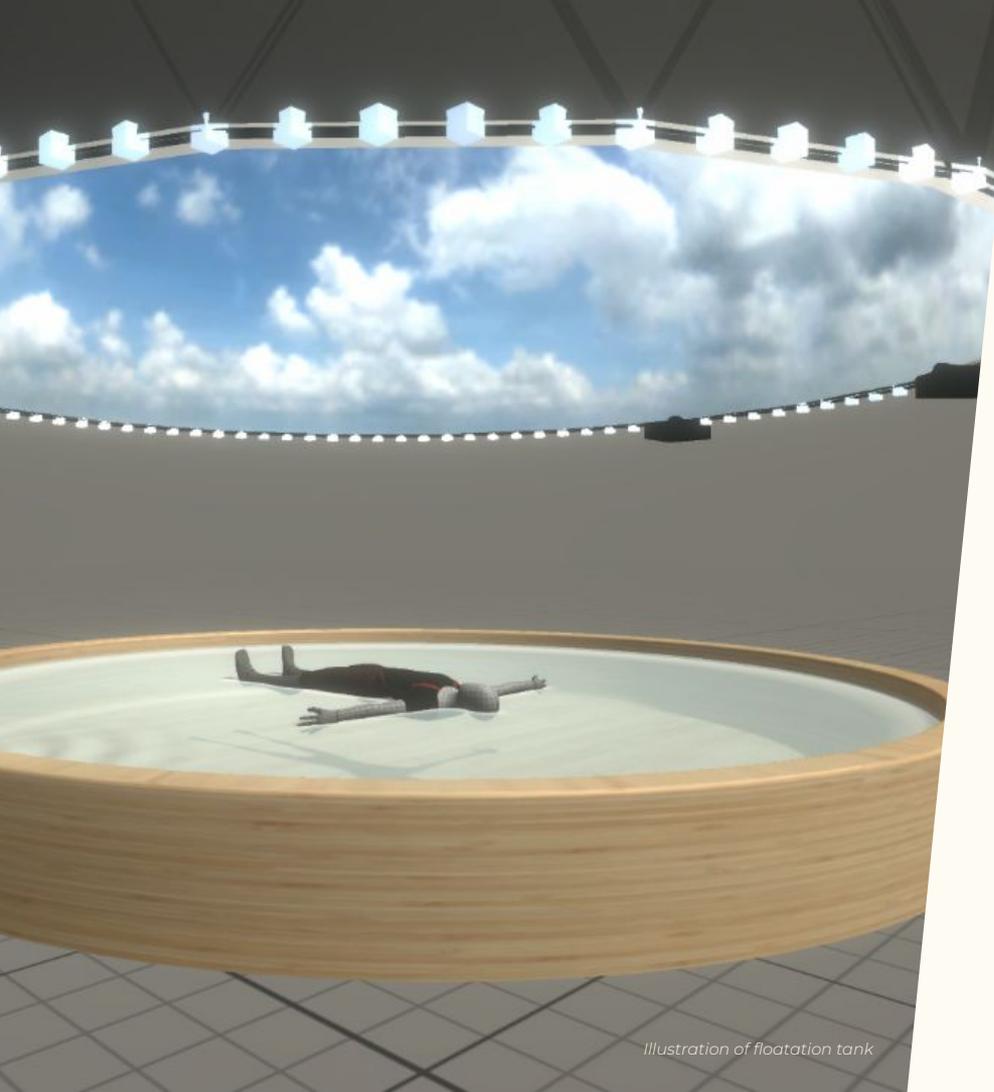
pricing

Premium wireless headphones (with wired option) Bose QuietComfort 45 headphones ~$330.

https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/quietcomfort-headphones-45.html#v=qc45_white_smoke

Bluetooth transmitter devices start around ~$50 for connecting two bluetooth devices (headphones) to one transmitter.

Illustration of floatation tank

underwater audio

features

For installations that utilize water based therapy and activities such as floatation tanks underwater speakers could be additionally installed.

The speakers can be installed in such a way that whether you are in or out of the water, users can hear almost exactly the same tone.

considerations

Quality of sound reproduction underwater has a few extra provisions because of using the water as a medium for the audio to travel in:

- Keep speakers away from water jets and other features.
- Do not install the speakers directly opposite of each other (this could cause the soundwaves to cancel out).
- Underwater, you will not find sound produced in stereo or surround (this is because the waves travel so fast in water that the human mind can't process if they're coming from a left or right channel. This makes swimming pools strictly a mono environment).

pricing

Pricing for underwater speakers comes in around ~$350 per speaker.

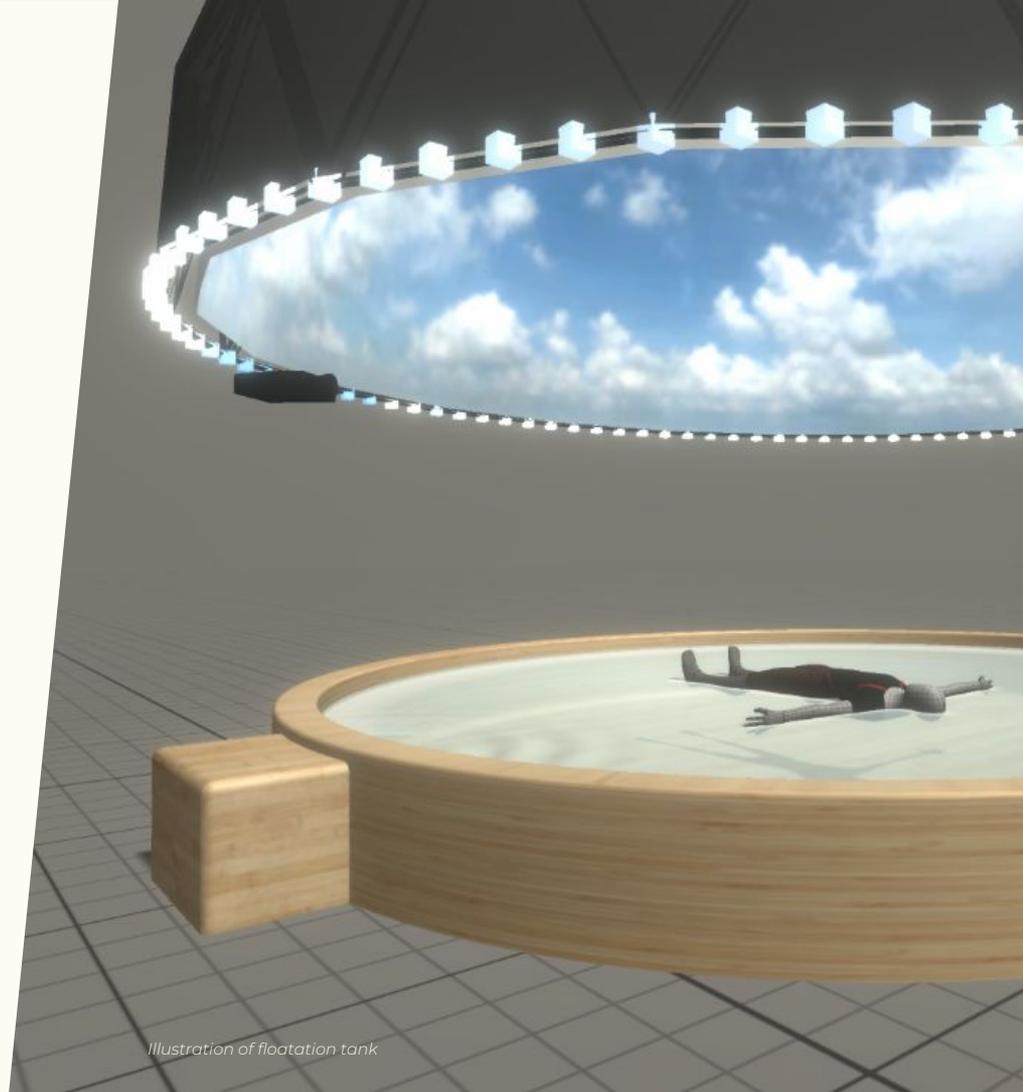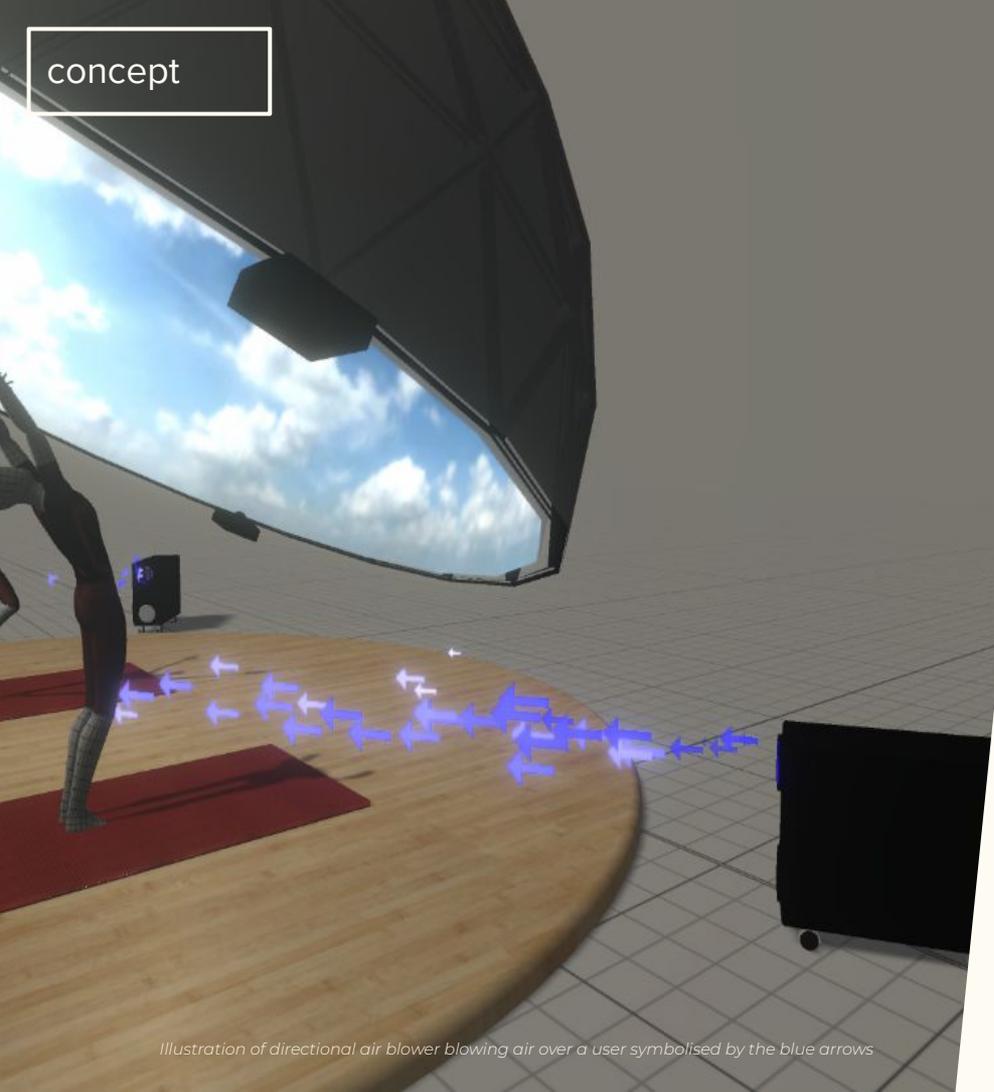Requires expert installation at additional cost.

Example underwater speaker
https://products.electrovoice.com/na/en/uw30

Illustration of floatation tank

airflow

directional air blowers

features

This system utilizes directional blowers to give the sense to the users of incoming air from multiple directions.

When not producing directional airflow for a session these air blowers can be utilized to increase the comfort level of users within the volume by providing a cooling breeze.

Directional air blowers illustrated here are modular in design so many can be used at varying angles around the volume.

considerations

At the time of writing this modular design there were no off the shelf modular air blowers found like the ones described here.

However many of the components that go into making such air blowers exist as off the shelf parts and should be easy to combine into an enclosure.
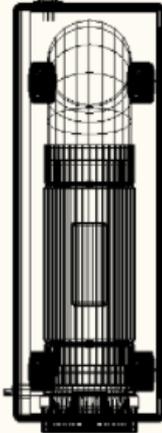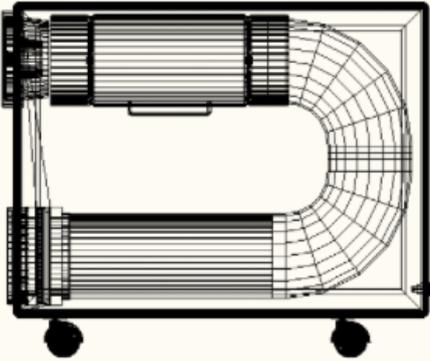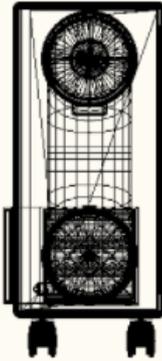
Illustration of directional air blower blowing air over a user symbolised by the blue arrows

specification

Size 1m(H) x 0.5m(w) x 1.3m(D)

Power requirement 110v

pricing

As stated there is no off the shelf product available, so it would have to be constructed from off the shelf parts.


Illustration of directional air blower

interface

The timeline editor specifies which directional vector the air is blowing in and an intermediate system determines where the blower is in relation to the forward vector of the display and extrapolates the amount of air to be blown using the timeline editor's directional vector for incoming air.
An example of this is that if two blowers are situated to the left and right of the forward vector from the dome (that is the direction from the low point of the dome to the high point in the illustrations) and the timeline parameters specifies an incoming air directly from the front, then both blowers will blow at the same percentage. However if the timeline specifies an incoming flow to the left then the blowers will bias towards the left blower being more intense.

A hardware engineer with experience in full product development is required to complete this modular air blower and one with a knowledge of coding interfaces is needed to create this intermediate hardware interface to the timeline editor. Knowledge of air flow dynamics is a plus when considering a hardware engineer as they would need to know volume and duct blower fan volume calculations in order to choose the right powered duct blower to pull air through the filters and to push that air across the volume.
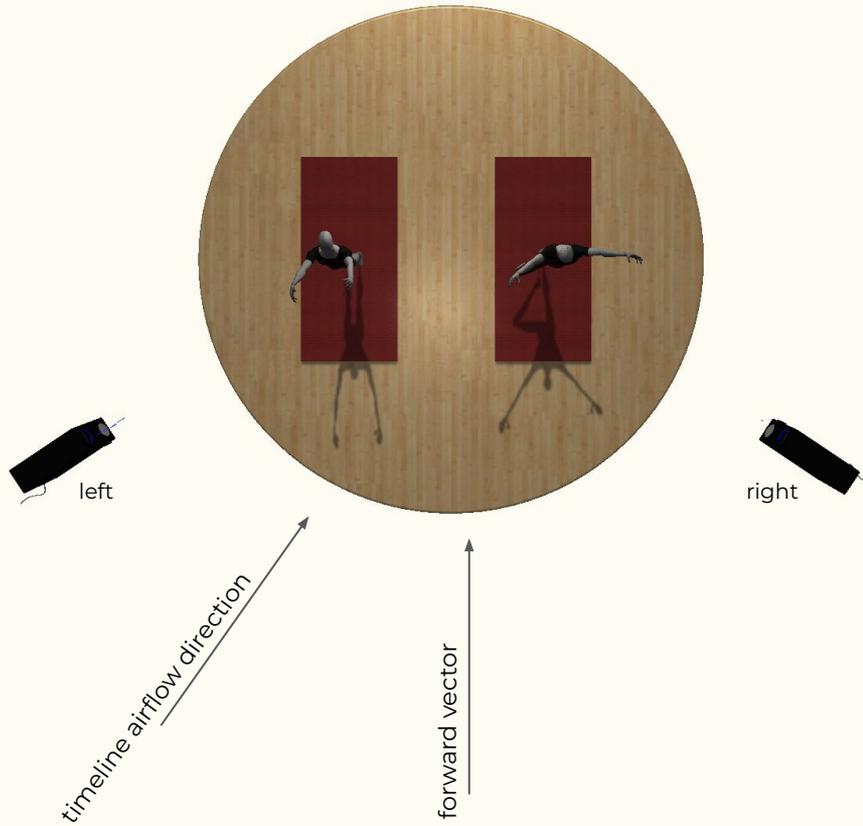
timeline

Here the illustration shows two air modules at ~70° on either side of the forward vector.

At a point on the timeline the airflow is at 50% of the potential maximum airflow and it is incoming in the illustration marked "timeline airflow direction".
That incoming airflow is at ~30° from the forward vector.

Using the above numbers we can calculate that the airflow from the left (illustration left) is ~40% and the airflow from the right is ~10% (based on angular difference between air modules and the bias towards left, multiplied by the percentage of airflow set on the timeline).

left

right

timeline airflow direction

forward vector

timeline

It's important to note that air unlike light and sound takes more time to cover a set distance so where the timeline editor specifies an incoming air flow the intermediate system based on the installation will look ahead in the timeline to make up the airflow time to travel.

An example of this would be a 1.5m diameter dome having air blowers look ahead a few seconds, whereas a larger 5m dome may need many more seconds of lead time.

Illustrated here is a time in the video (green arrow) when a breeze is blowing some grass, we want to have our blower simulate this by activating the right blower. We know it takes 15 seconds at the activated speed for the air to reach the middle of the volume where the users are. So we seek ahead in the timeline (red arrow) 15 seconds to see if the air blowers would be activated.
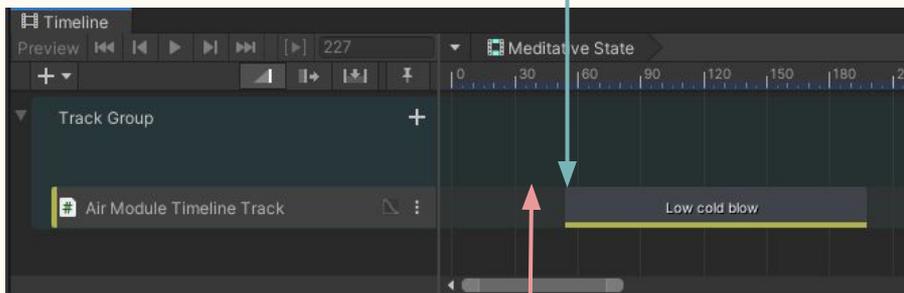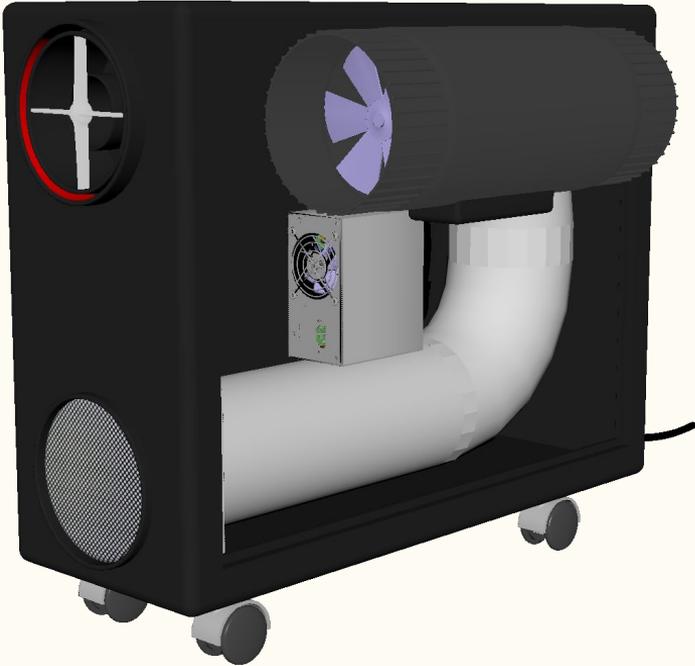
duct blower

features

The duct blower is the section that moves the air in, through and out of the air blower.
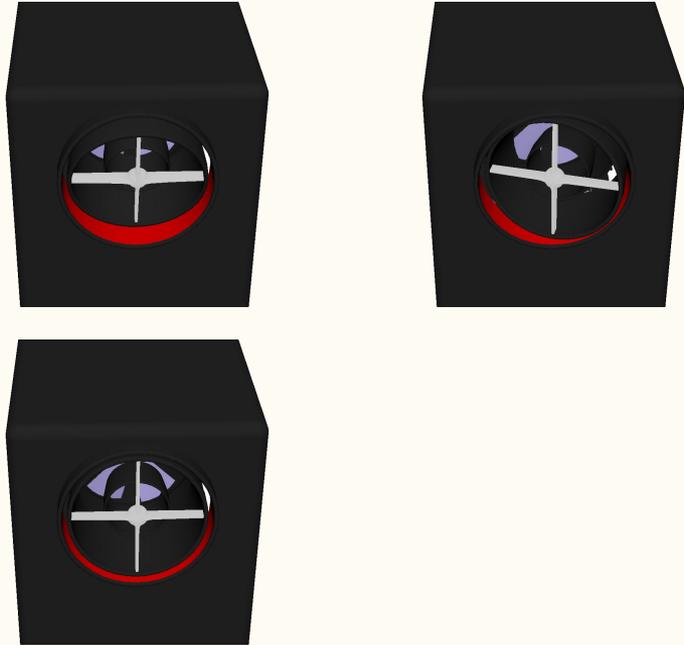
considerations

It's important to assess volume of air flow for the installation space; you want to make sure that the air blower can cover the distance from its installation point to where the user is standing, with enough force that the user can comprehend a noticeable difference in airflow from one direction over another.

In relation to the air flow requirement it should be noted that not all air blowers are created equally in terms of the noise that their motors produce during intense activity. Brushless motors and housing that has reduced vibration can all aid in noise reduction as well as attention paid to the build quality of the entire air blowers case with potential for further noise reduction by incorporating rubber seals.

Illustration of duct blower section.

finely tuned directionality

features

As an extra step in fine tuning the direction of the air flow this air blower design comes with a hemispherical adjustable air vent. This can provide an extra ~15° in movement from the air blower both horizontally and vertically. This can help with installations where floor space around the platform is limited or on raised/lowered surfaces.

Illustration of fine tuning of the vent with left, forward and down directions...

filtration

features

Removing dust particles from the incoming air is important for both maintenance of the air blower and the health and enjoyment of the user within the session. This air blower has been designed with a two stage process. The front being the prevention of large particulate matter entering the system using a grill.

The second utilizes a replaceable HEPA air filter, which can easily be exchanged by sliding out the insert from the side (so as not to require opening the case of the blower).

Illustration of filter grill at the front of the air blower towards the bottom of the unit

considerations

HEPA inserts are available as off the shelf options, so sizing of the air filter slide and the proceeding ducting should take into consideration the size of the HEPA insert purchased.

When selecting the air blower and filters consideration should be made to the power required to pull air through the filters (filters can reduce air flow significantly).

Illustration of replaceable HEPA air filter at the side of the air blower

sanitization

features

As an optional insert this air blower design we could install a UV light solution for sanitizing the air. As this is an enclosed solution the dose of UV light would be quite high in comparison to the sanitization mentioned earlier in the lighting section.

considerations

Especially with the current climate in 2020 sanitization is both a nice to have for areas where multiple users from different households attend and a great marketing bullet point.

Currently some commercial HVAC solutions are utilizing UV lights for sanitization.
Pricing on these UV air treatment system inserts start at around ~$250 per unit.

Example of UV air treatment
https://www.odorstop.com/os72-72-watt-uv-air-purifier-with-16-bulbs/

*Illustration of UV air treatment probe inserted into bottom pipe section*

scent

features

An optional insert for this air blower could be to utilize scent, as with the replaceable filter this would require an insert slot on the side of the air blower. Working similar to the plug in air fresheners this system would use a heating element controlled by the air blower controller to dictate at what time to heat the element and disperse the scent.

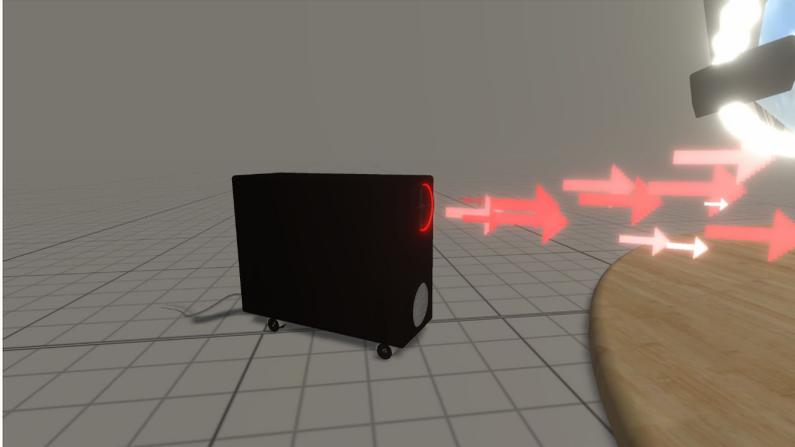## considerations

The scent system insert should deviate from the ducting in order to collect the scent from the dispersal method and this deviation should be value controlled. This would allow the scent to be almost muted instantly at the correct timing with the timeline point of deactivation.
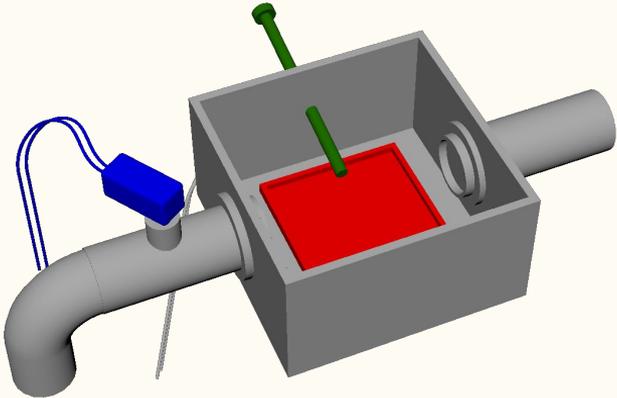
Illustration of scent components; red is a thermal pad, green oil release, and blue airway release value

temperature

features

An optional insert for the air blower would be to provide warm or cool air at points in the session.

Switching between heating elements and a cooling system similar to a swamp cooler concept.

considerations

It should be noted that strong warm air can still be cooling if blown quick enough, because of evaporative cooling where the skin's moisture with air flowing over it is evaporated carrying away heat.

Illustration of duct vent indicating heated air by showing a red ring

07 temperature

directional heat

features

Directional temperature during a session could be achieved by using a series of infrared heating elements around the platform. These heating elements would be turned on and off to certain levels during a session in order to heat zones within the platform.

considerations

It should be noted that the efficiency of this method lowers as the overall volume temperature is raised (an example of this is having one side heat for a prolonged period of time, the other side is then turned on, but the effect on the user is reduced as the starting temperature of the volume has increased).

Unlike other components like lighting, heating takes a longer time to take effect as a heated element has to raise to temperature and then cross the distance to the user, obviously smaller volumes would see effects quicker. Speeding up this heating process could be done using an induction heating method.

Another point to note is that this is a "generalized" directional heating method, as the user will feel heat from the equivalent of a quadrant (towards the front right or from the back left) as opposed to other hardware components in this document that have a tighter directionality.

Illustration of heating elements to the left and right

If the location that the platform is installed in has Internet Of Things (IOT) enabled temperature control with a supported API the software could communicate with the ambient heating of the location to match with points on the timeline.

This would not be directional and as it is not localized near the users it would be more of a general temperature. For example a meditation session with a hilltop visual could be cooler as opposed to a hot yoga session on with a beach visual with a warmer ambient temperature.
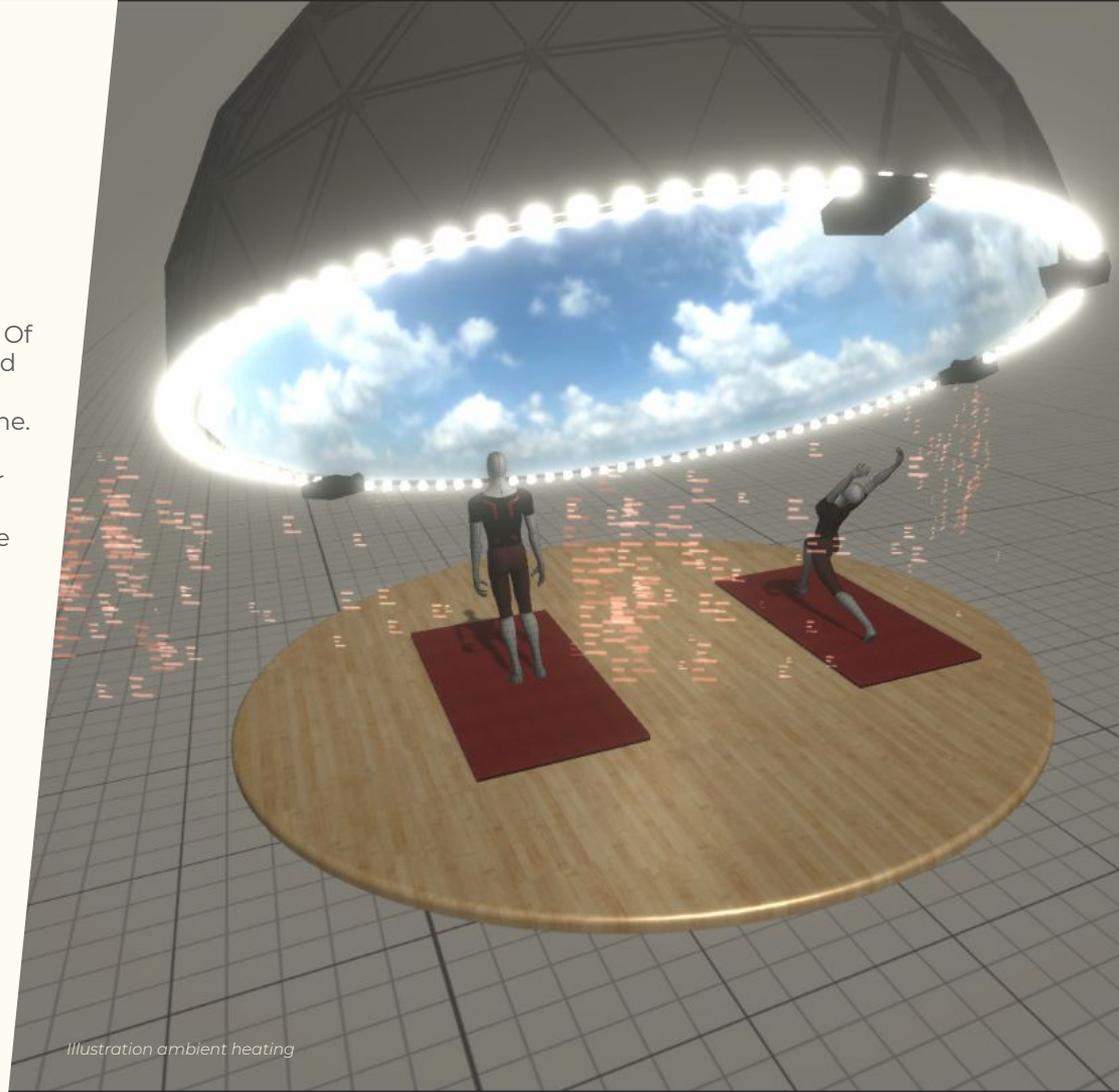
Illustration ambient heating
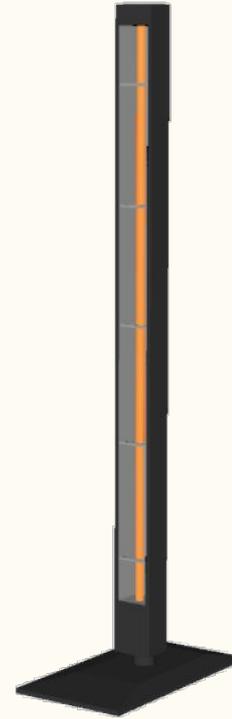
pricing

Some IOT based localized heaters can be found on the market from companies such as Honeywell.

For direct control instead of IOT a customized solution would need to be created. A hardware solution utilizing existing heating elements available online could be controlled with a bluetooth or wired interface via a relay board.

Illustration of concept localized heating element

interface

It's important to note that the intermediate layer would need to look ahead in the timeline to get up to the desired heat level.

A hardware engineer with experience in full product development is required to complete these heating components and one with a knowledge of coding interfaces is needed to create this intermediate hardware interface to the timeline editor. For IOT based options a programmer with knowledge of developing for IOT devices would be beneficial.

Illustration of a floor being influenced by haptic devices

floor haptics

features

Floor haptics enable the users to feel vibrations emanating from different directions with differing paths across the floor. This system can be used for example during a breathing exercise where a vibration can be sent past the user while they are breathing in, then sent away during the point at which they are asked to breathe out.

considerations

To achieve haptics across a floor space an array of bass shakers installed equidistant apart is utilized. As an effect is issued from the timeline each bass shaker is activated to a certain intensity for a period of time. The best way to think of this is utilizing a haptic wave (curve) through the floor with the high points indicating greater intensities.

specification

The number of bass shakers is a multiple of the size of the floor space, an individual with a stance of 0.5m across from foot to foot would feel a bass shaker within its set resonance sphere (which is affected by the material used in the flooring and its thickness).

For example we could have a spacing of 0.75m between bass shakers with a potential overlap, the reason for the overlap is to account for someone standing directly over one bass shaker, the overlap would mean they would still feel haptics from the bass shakers to the left and right of them.

A suspended floor would extenuate the haptic vibration and it's important to make sure that the resonance does not cause sound at connections and or at joins, this would disrupt the spatial sound being played through the speaker system. Dampeners should be installed where the floor meets the ground to avoid one such resonance point.
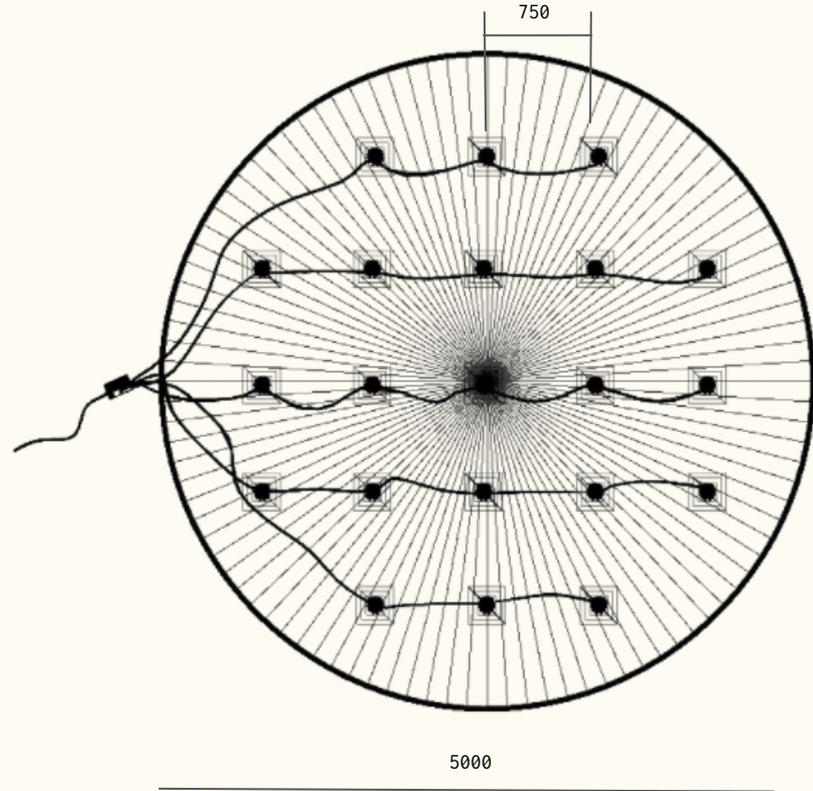
pricing

Bass shakers as shown in the illustration come in a variety of sizes and the coverage and floor material would need to be assessed to select the correct ones.

As an example pricing for a 50 watt bass shaker starts at ~$50.

Dayton Audio
https://www.daytonaudio.com/product/1245/bst-1-high-power-pro-tactile-bass-shaker-50-watts

Additional costs include amps to drive the bass shakers, wiring and a control unit working as an interface from the timeline editor.
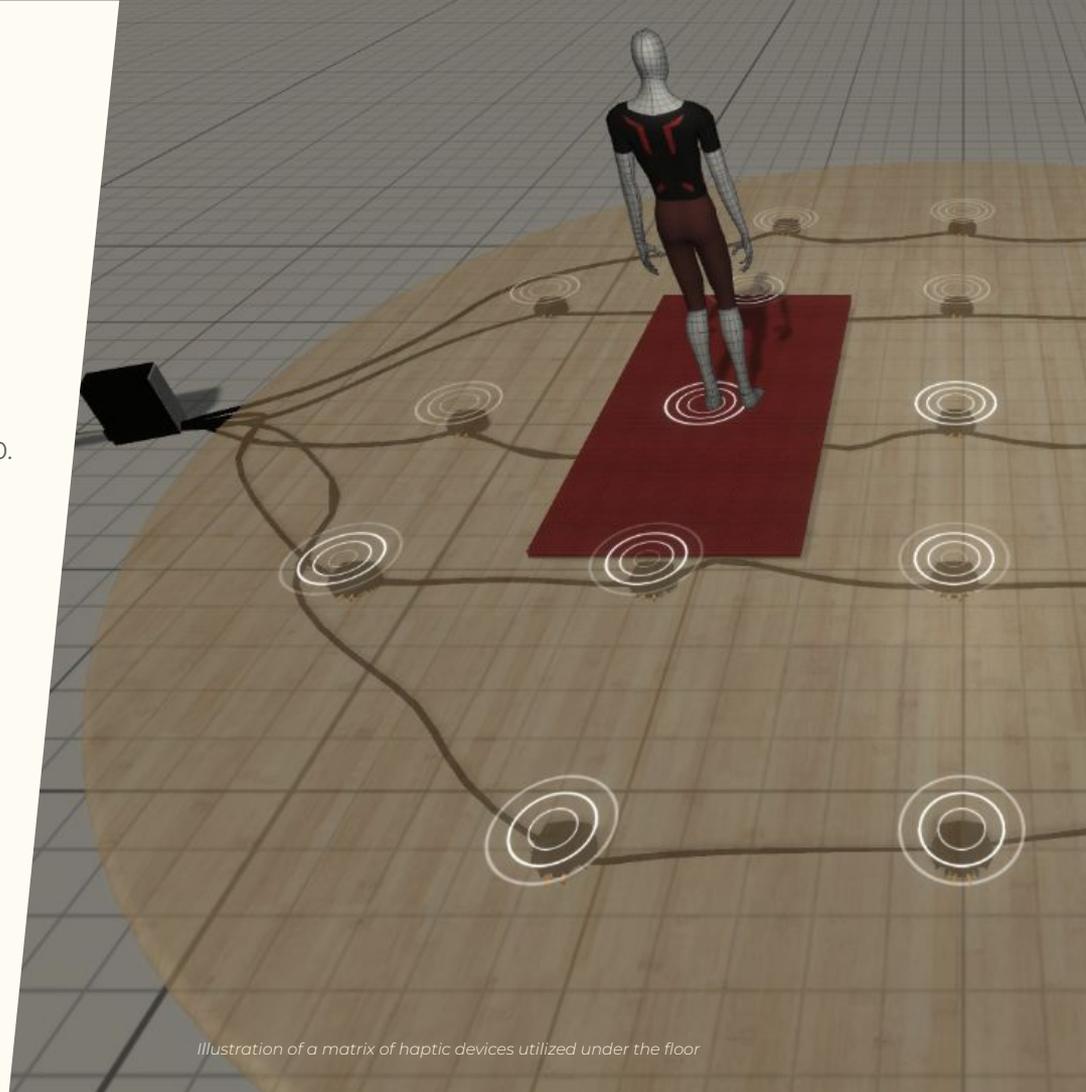
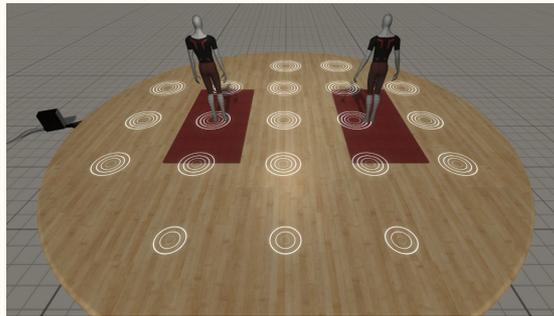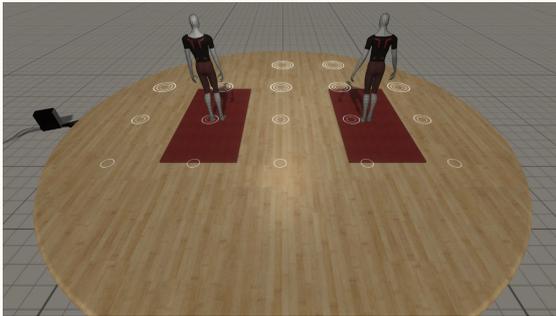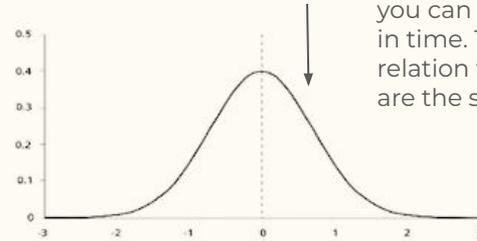*Illustration of a matrix of haptic devices utilized under the floor*

interface

The haptic wave would be such that it would be programmed to move in a direction, for this reason all bass shakers would need to be individually addressable and mapped into a matrix. The timeline would specify a direction in relation to the forward vector of the display and then an intermediate interaction layer would process that for the bass shaker matrix. This way the timeline does not need to know the bass shaker configuration, simply pass the direction of the wave.

A hardware developer with knowledge of wiring up speaker systems, insulation and resonance management would be beneficially. Additionally when considering the interface a developer would need to calculate the separation of the bass shakers and their power ratio in relation to the input wave curve to produce a reasonable and comfortable haptic response.

timeline

These two sequence images show a wave starting large at the front and then moving back past the users. Above them you can see the timeline instance and its curve at that point in time. This curve would include a directional vector in relation to the forward vector (for this illustration both vectors are the same).

water wave haptics

features

The sense of motion is induced here using wave haptics. We use a pneumatic system that utilizes pressurized air to move water within a chamber, producing waves.

considerations

A drop in the pool surface (trenches) can be utilized in front of this chamber to produce a more potent wave simulation.

Depending upon the speed the chamber is filled with air can determine wave strength. This wave strength would be set within the timeline editor at the point of its activation.

Illustration of start of wave from the pneumatic system

specification

A series of values are used in the pneumatic system which would be located at sections along the side of the tank. Using multiple displacement chambers at once will meet at different points in the pool producing convergence of waves, in turn making the effect directional.

For illustration purposes I have included an overview of how a pneumatic system works in displacing water and creating a wave effect.

In figure A the air compressor pushes air (green arrows) into the system lifting the plug (red) to where it blocks a release pipe. The air then enters the chamber with the water (blue) displacing said water from the chamber into the pool.

In figure B the air compressor stops and the plug is repositioned into its seat (plugs are repositioned here using a spring mechanism), the water then levels out with the volume in the pool making it rise within the chamber. The air then exits out of the release pipe.

This displacement of the water in quick succession causes the waves in the pool's volume of water.
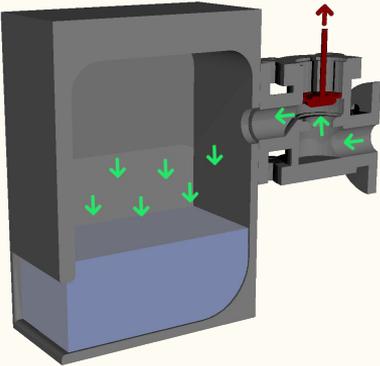

Figure A: Illustration of an air displacing water from the chamber.
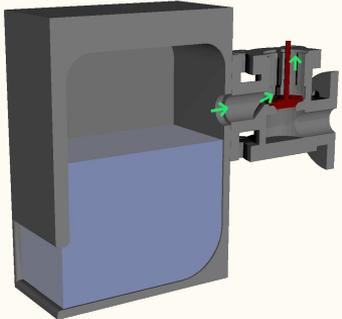
Figure B: Illustration of an air displacing water from the chamber.

pricing

There are commercial off the shelf systems that pool installers use labelled under "wave pool technology" however these are used to create beach simulations i.e. one direction. As such either a modification to position or a modification to the whole commercial offering would be needed.
A pneumatic system like the one mentioned here should be easy enough to reproduce with off the shelf parts and an enclosed chamber for the air to perform its displacement.
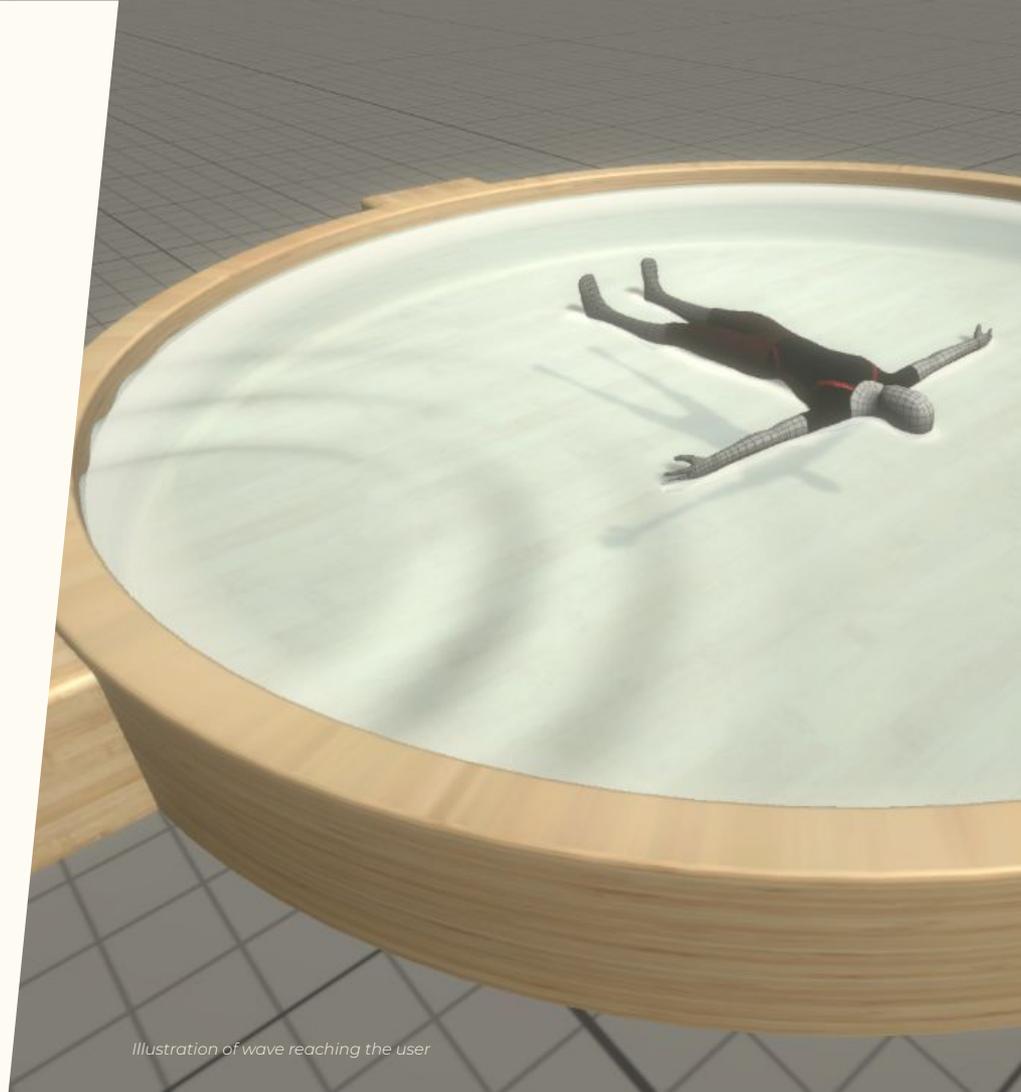
Illustration of wave reaching the user
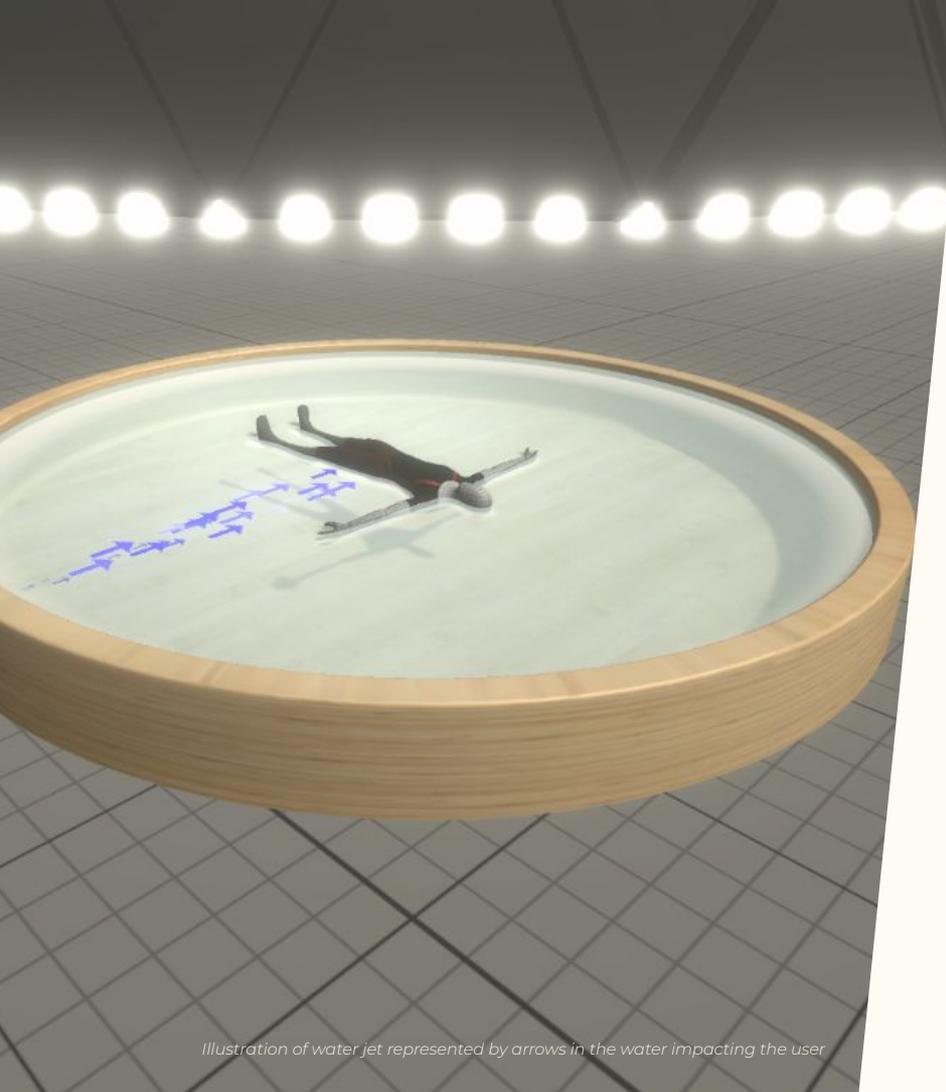
Illustration of water jet represented by arrows in the water impacting the user

water jet haptics

features

Using off the shelf water jets placed around the pool and the addition of values to select which water jet is activated we can create directional haptics in the water for the user.

considerations

With standard installation of pool water jets it's common practice to point them so as to improve the circulation of water in the pool. This is so as to avoid dead areas where the water is stagnant and therefore not circulated regularly through the pool filter.
Using pool jets to also create haptic interactions like this system requires either additional jets or ones which can be manually or automatically moved in order to still enable good water circulation in the pool.

Water jet installations usually are fed from a single source after a filter and post the pumping system that is removing water from the pool. In this water haptic solution we would use valves between the filter and the jets in order to select which jets are active and by how much at any one time.

specification

3 to 8 jets increasing granularity of directional haptics with increased number of water jets.

3 jet system would incorporate a front jet and two side jets at 90°. 8 jet system would establish a water jet at 45° intervals.

Consideration on the number of water jets should take into account the directionality of the sessions to be played. For example a beach scene may surface from the lower 3 jets with the feeling of water coming towards the user and around their sides. However a session where the water spirals around the user would benefit from a surrounding 4 to 8 jet system.
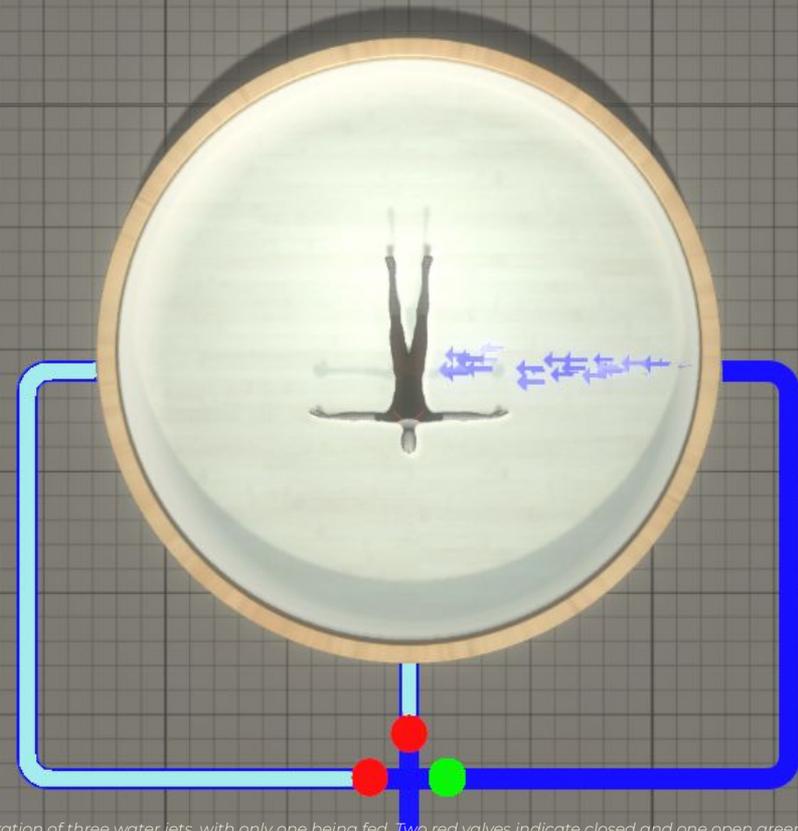
Illustration of three water jets, with only one being fed. Two red valves indicate closed and one open green

pricing

This system uses an off the shelf installation of water jets with a simple modification with the introduction of valves linked to a controller.

Pricing for valve actuators come in ~$150 and are attached to an inline tube value which prices ~$100. Pricing varies depending on the volume of water being used.

For finer angles of directionality more water jets may be required to be installed.

Requires expert installation at additional cost.
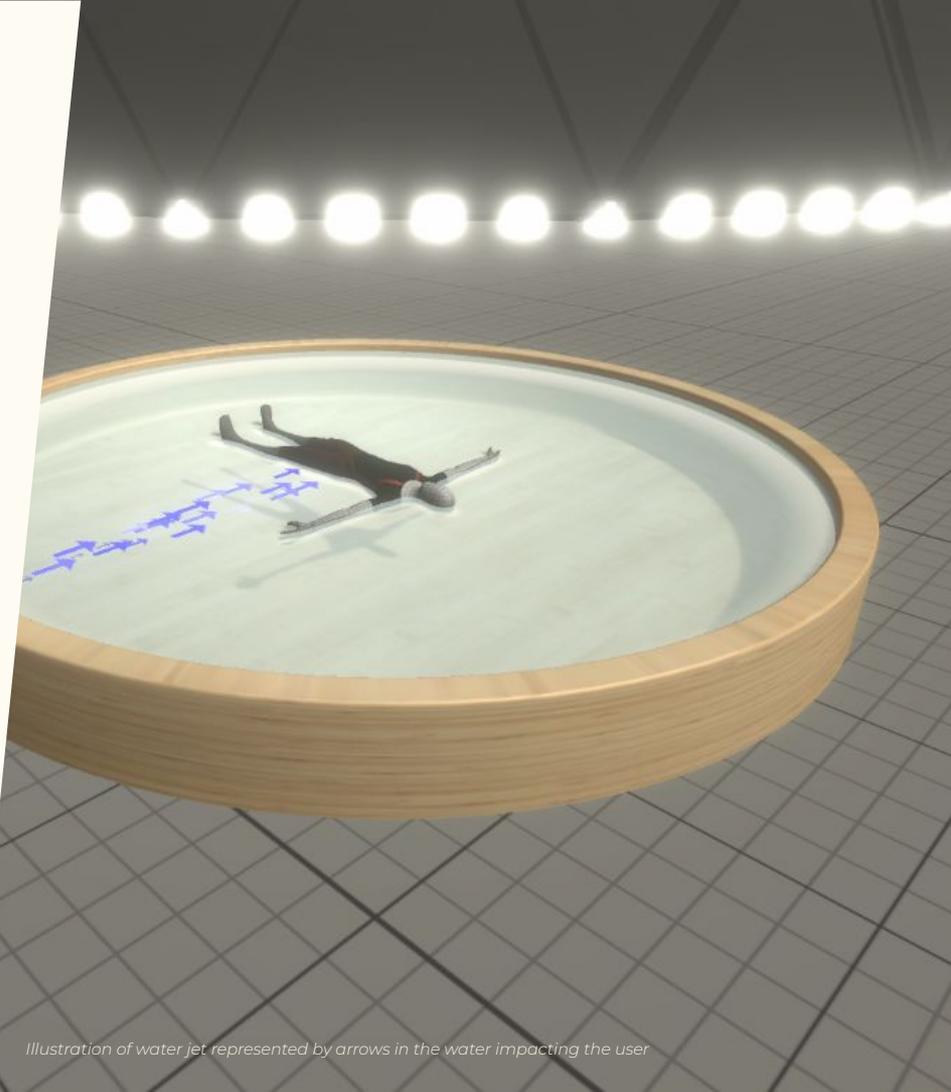
Illustration of water jet represented by arrows in the water impacting the user

10 telepresence

Illustration of a yoga instructor being projected onto a remote platform

stream

features

A camera positioned on the rim of the dome enables a streamer to stream themselves to others using the platform.

When projected onto the other dome (and skirt) they appear as an overlay on the visual the user is experiencing.

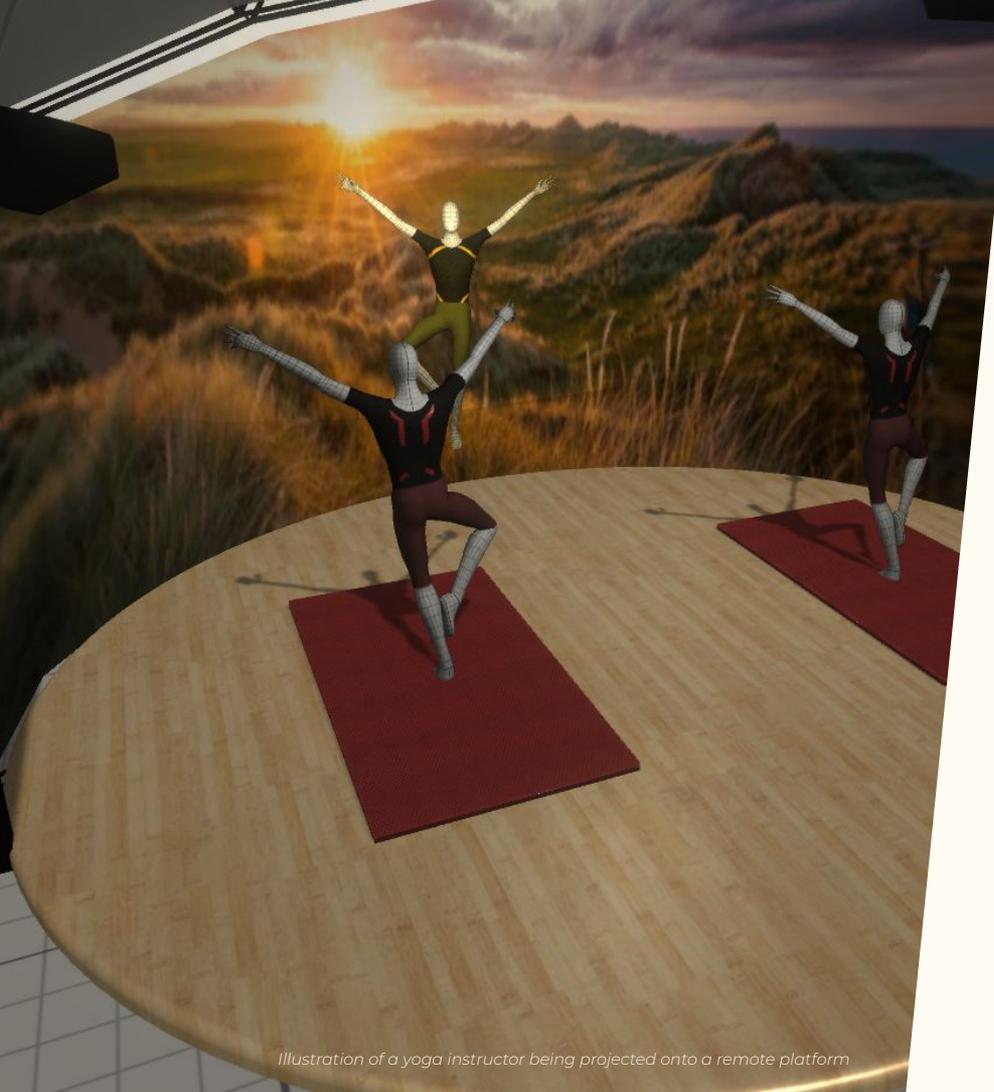As the streamer moves their projection is mapped onto the dome to avoid image warping on the projected medium.

The streamer can choose to have an overlay of their own visual showing them in a picture and picture view much like many of today's video conferencing applications. This way they can adjust their position, posture etc for better aesthetics for the viewers.

An example usage may be a yoga instructor teaching a class of students remotely or a presenter instructing an audience.

This stream could be broadcast onto a non-platform display (such as a laptop of tv) and the instructor is not required to be at a platform site for capture they can be remote with a camera to stream.

specification

High resolution streaming capable camera

Wide angle lens for adequate capture capability

Positioned on rim pointing out from the front of the dome to the back

If skirt is applied a slot is required to allow the lens to protrude and not be obscured

Operator can use capture software linked to camera to zoom and frame subject

Illustration of green surface used behind the users
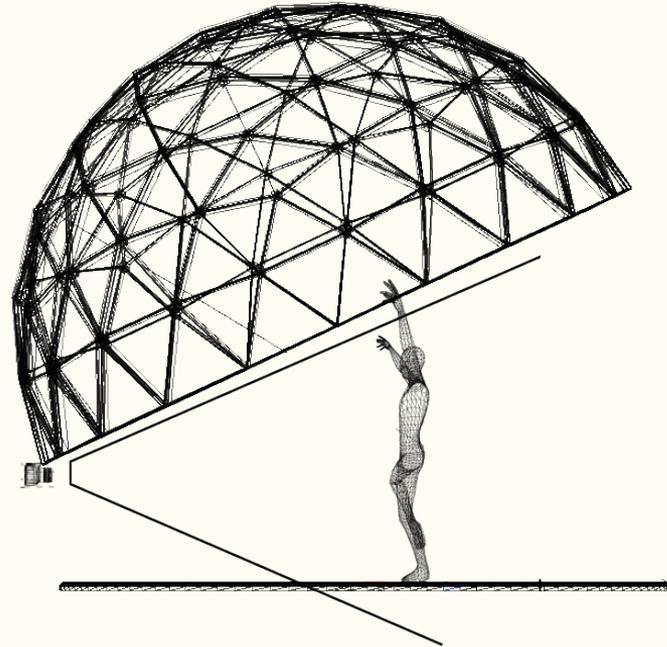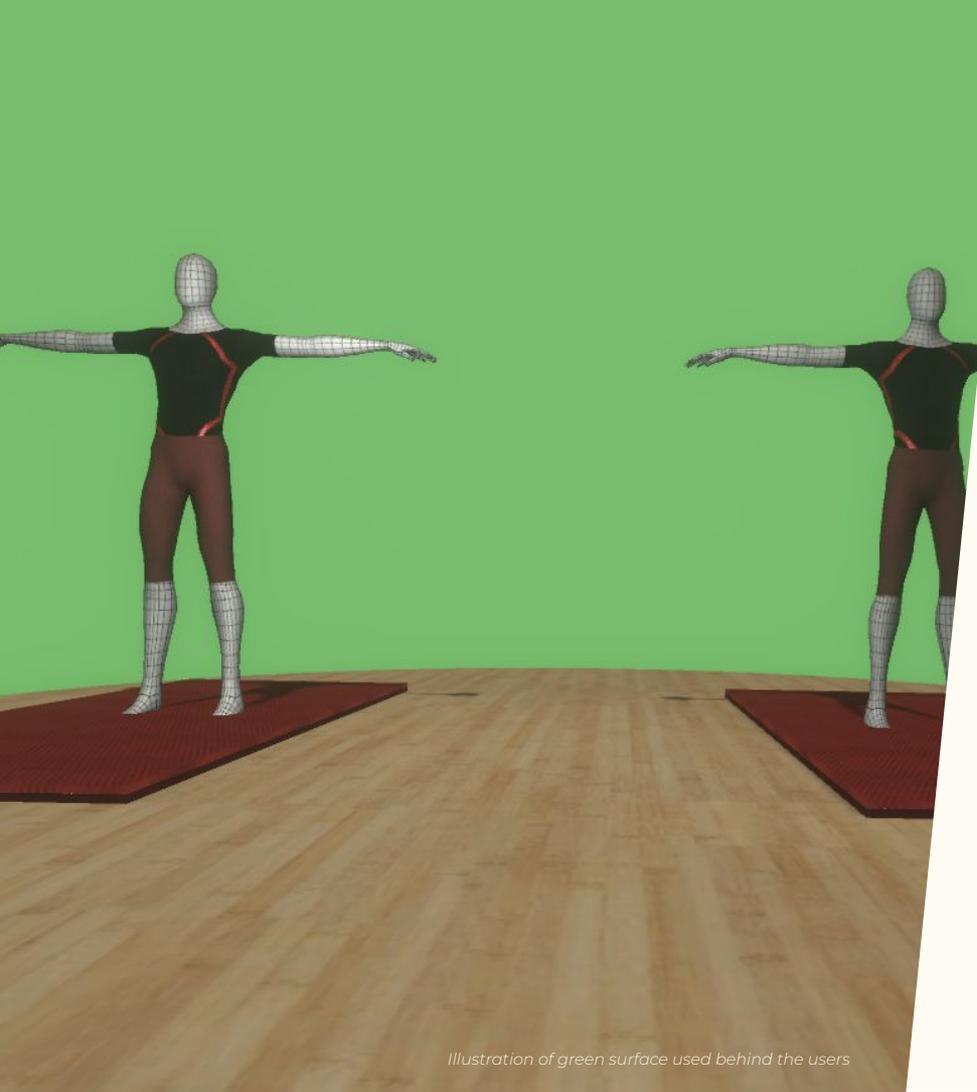
background

With the camera focused from the front to the back of the platform it will capture information behind the user.

With current visual capture software we can sometimes remove the background (higher likelihood if it's non-dynamic) without using green screen style chroma key usage. However a chroma key behind the users may be required in order to perform a subtraction effect. This chroma key could use the well lit background of the platforms location or be applied as with the skirt around the rim of the dome covering the field of view from the camera.

pricing

Starting with the Canon EOS SL3 (SLR camera for higher resolution and image quality) with streaming capabilities at ~$700

https://www.usa.canon.com/internet/portal/us/home/products/details/cameras/eos-dslr-and-mirrorless-cameras/dslr/eos-rebel-sl3-ef-s-18-55mm-is-stm-lens-kit

Requires a wide angle lens suitable for the field of view, for instance the Canon 24mm f/2.8 STM ~$130

https://www.usa.canon.com/internet/portal/us/home/products/details/lenses/ef/wide-angle/ef-s-24mm-f-2-8-stm/ef-s-24mm-f2-8-stm

Illustration of a yoga instructor being projected onto a remote platform

Illustration of a instructor transposed into a virtual environment

volumetric

features

Using volumetric captured subjects transposed into virtual worlds we can create more realistic displays of instructors or collaborators (captured subject) onto the platform.

Operators on the fly can change the angle and distance of the camera in the virtual world to frame the captured subject, for example emphasizing parts to the technique of a yoga pose.

Volumetric capture as opposed to the streamed capture overlay described previously gives us a more realistic experience with the capture subject as they can be placed and lit correctly in correlation to the virtual world they are being displayed within.

process

Volumetric capture uses devices such as a pair of cameras using a stereoscopic rig, an array of cameras around the rim and or a mixture of depth cameras and RGB cameras. These capture the subject and using software abstract the background.

The subjects 3D capture is then placed within the virtual world.

Lights within the virtual world can then light the subject correctly and cast shadows from them onto virtual surfaces.

The result can then be captured and displayed onto a medium such as the dome.

Subject capture

Virtual World

Subject displayed and lit accurately within the virtual world

Illustration of a collaborative yoga session across multiple platforms

collaborate

features

In addition to the stream ability we have collaborate functionality where many platforms see each other within the dome projection.

This should be thought of as a joint collaboration session across many platforms. As more platforms are added the software maps the overlay to a configured location upon the projection. The limiting factor is the scale of the overlaid projection on the dome to incorporate all the other overlays.

In the image shown on this slide we have many groups collaborating with several pairs on the display and two at the location.

interface

Platforms will need to have the ability to connect across a network in order to receive the streamed sessions from other locations. The interface would require a lobby based system where groups of platforms could connect in a online room at a set time in order to initiative a collaborative session.

For the visual aspect the projectors will need to be fed a combined visual solution of both the base visualization and any overlays from the other platforms connected across the network.

Instructors and or coordinators will need to be able to relay voice to other platforms for synchronicity and for any session material. They will also need to be able to start the visuals and any session audio so all locations are synchronized.

Both networking infrastructure and application developers adept in network solutions will be required.

brain stimulation & neurofeedback

features

Combine new brain stimulation and biofeedback programs within any of the configurations to enhance meditation
and induce desired mental states, address neuropsychiatric disorders and assist with motor skills rehabilitation.

With possible modalities:

Magnetic Stimulation
- Transcranial Magnetic Stimulation (TMS)
- Low Field Magnetic Stimulation (LFMS)
Electrical Stimulation
- Vagus Nerve Stimulation
- Deep Brain Stimulation
- Transcranial Direct Current Stimulation (tDCS)
- Transcranial Alternating Current Stimulation (tACS)
- Transcranial Random Noise Stimulation (tRCS)
Electromagnetic Radiation
- Optogenetics
- Near-Infrared Stimulation
Ultrasound
- Low Intensity Focused Ultrasound (LIFUP)
Neurofeedback
- Quantitative EEG (QEEG)
- Other: HPN, HEG, A/T, IUM, Beta Reset, Coherence

interface

The timeline editor specifies which directional vector the water direction (wave or jet) should be flowing and an intermediate system determines where the output is in relation to the forward vector of the display and extrapolates the force of water to be processed using the timeline editor's directional vector for water flow.
An example of this is that if two water jets (as with the illustration above) are situated to the left and right of the forward vector from the dome (that is the direction from the low point of the dome to the high point in the illustrations) and the timeline parameters specifies an incoming water flow directly from the front, then both water jets will active at the same percentage. However if the timeline specifies an incoming water flow to the left then the water flow will bias towards the left jet being more intense.

A hardware engineer with experience in water valves and flow is required to complete this setup and one with a knowledge of coding interfaces is needed to create this intermediate hardware interface to the timeline editor. Knowledge of fluid dynamics is a plus when considering a hardware engineer.

Water Jet Activation

timeline

It's important to note that water flow unlike light and sound takes more time to cover a set distance so where the timeline editor specifies an incoming water flow the intermediate system based on the installation will look ahead in the timeline to make up the water time to travel.

Illustrated here is a time in the video (green arrow) when a wave approaches the user, we want to have our water jet simulate this by activating ahead of time. We know it takes 30 seconds for the water to reach the user hence activating it 30 seconds ahead of time (red arrow).
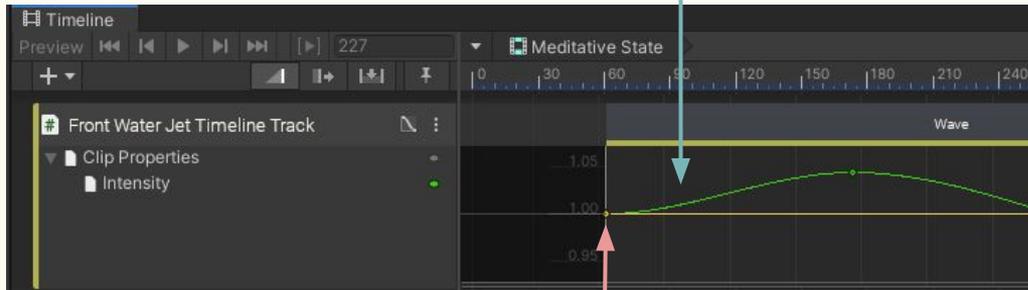
Dome display suppliers often provide some initial content; for instance included in the package from the supplier listed Fulldome.pro boosts "the biggest content starter package on the market" (per their marketing material).

The type of existing dome footage on the market can be found in the following examples:

https://360art.pro/product_samskara.html

https://360art.pro/product_dinoplanet.html

https://www.jameshood.com/mesmerica360

Dome display content comes in formats such as "Fisheye 360x180" or "Circular equidistant projection".

Considerations should be made to whether or not the dome installation is a "tilted installation" as depicted in illustrations in this documentation. Some video will appear oddly angled if shot for a non-tilted display and shown on a tilted display; and vice versa.

Flat video as seen on televisions can be converted from flat to fisheye. Although not the best use of the dome it extends the amount of scenarios available for replay.

This flat video is displayed on the dome as it would on a television with some skewing to deal with the curvature of the dome, ambient effects are then used to give the impression of the display spanning the domes surface.

Software such as 360art can be used as a pipeline to upscale, adjust and add the ambient effects mentioned to fill the screen
source https://360art.pro/

The easiest method for real life video creation would be to use a 360 camera (such as Ricoh Theta or Insta360 Pro) to capture required footage.

Insta360 https://www.insta360.com/
Ricoh Theta https://theta360.com/en/

Then use software such as Adobe After Effects and Adobe Premiere to convert from 360 video into the Dome format.

YouTube tutorial https://www.youtube.com/watch?v=xM_PDDpaD_Y&t=670s

During conversion considerations for the tilt of the display and the prominent front direction of the footage should be made.

Alternate content could be produced directly in software from composited captured footage in the above mentioned software packages; or using capture or direct feeds from a game engine such as Unity 3D, Unreal Engine, Blender, Maya etc.

Example site talking about the process https://veer.tv/blog/capture-360-photos-videos-from-modelling-tool-game-engine/