Andrew Yeow, Anjali James, Tan Beng Kwee Clement, Kevin Kim, Pavithren V.S. Pakianathan, Leong Wei Qi, Tan Wei Lin

Digital Health Studio in the Outdoors

Digital Health Studio

The DHS is a **user-centric responsive room**, aimed to enrich the activities taking place in the room at the Global Innovation Hub in Singapore. The studio is designed to meet the user's needs for a **flexible, adaptable and 'fit to the purpose' space**. It can take on multiple functions, serving as a digital health **design studio** for employees, an **Executive Briefing Center (EBC)** for various MSD stakeholders, co-location of a team or **workshop** purposes, or as a **meeting space**.

Wellness of the outdoors

The DHS is conceptualised as an EBC in the outdoors; it harnesses the wellness of the outdoors and brings it indoors to **invigorate** the static office environment, as well as to provide a literal change of **scenery** for office workers. This stands complementary to the work of MSD in bringing wellness to people through its medicines and therapies.

In adherence to this concept, the team has envisioned a physical interior space and finishings of the DHS, furnitures, an immersive experience for its users, as well as integrated digital control and analytical systems upon which the room will operate.

Merck Sharp & Dohme

MSD is a global pharmaceutical company based in Kenilworth, NJ, USA. Established in 1891, it has a long history of leading developments in medical treatment, such as the development of the first mumps, rubella and measles vaccines. Their more recent innovations include Keytruda, a drug treatment recognised as a breakthrough technology for the treatment of cancer.

Physical, Control and Analytics layers

Analytics Layer

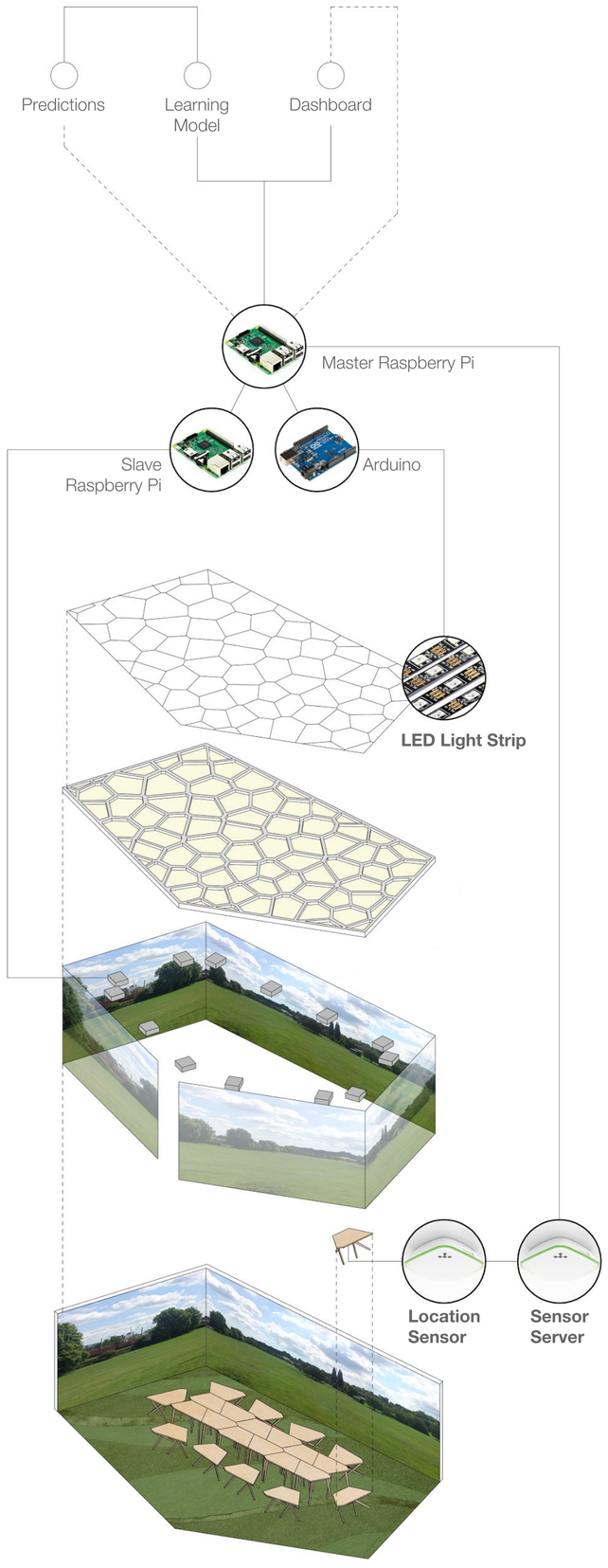
In this layer, room usage data collected by the Raspberry Pi is analysed through a learning model, which provides predictions in a feedback loop.

Control Layer

This layer is the connection between the physical and the analytics layer, comprising of the light, sound and projector sub-systems that are controlled by the Raspberry Pi.

Physical Layer

This layer comprises of components that visitor can see and interact with, including: modular multi-purpose furniture, location-tracking sensors, and a lighting installation and system.



Learning Model

The learning model is trained using historical data about the room usage - number of users, duration of use, purpose of use, light and sound settings and is used to predict the recommended settings for the room.

Dashboard

The data collected from the room is aggregated and presented through visualizations in a dashboard that shows the activity levels detected by sensors in different parts of the room.

Lighting Sub-system

Interior lighting is designed to simulate natural lighting from the sun, through control of the LED color temperature from cool white to warm yellow based on user preferences.

Tessellated Ceiling

The ceiling is tessellated with multiple panels of geometrical shapes, referencing the non-orthogonal shape of the roof, and providing visual dynamism for users.

Projector Sub-system

A projection system creates an immersive, all-around virtual environment of the natural outdoors, bringing users to a variety of locations and natural scenes. Digital content can also be displayed within the projections.

Sensor Sub-system

Sensor system localises objects in the room and collects information on which parts of the room and furniture arrangements are more frequently utilised.

Transformable Furniture

A custom-designed furniture transforms between a chair and table, enabling multiple configurations and uses of the room. A woody, randomised aesthetic references the outdoors.

User Flow and Operation

User enters room and activates the room controller

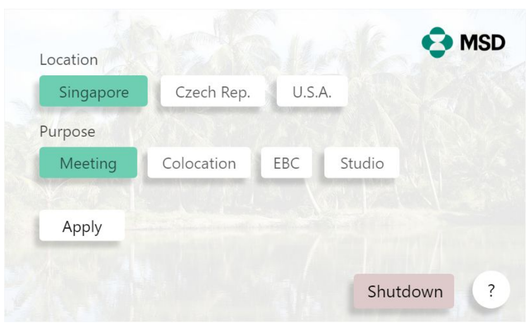
User inputs information such as number of people, use of the room, and selects the desired virtual environment

Lighting and ambient sounds are automatically adjusted based on previous preferences.

Lighting and sound levels can be readjusted to desired levels.

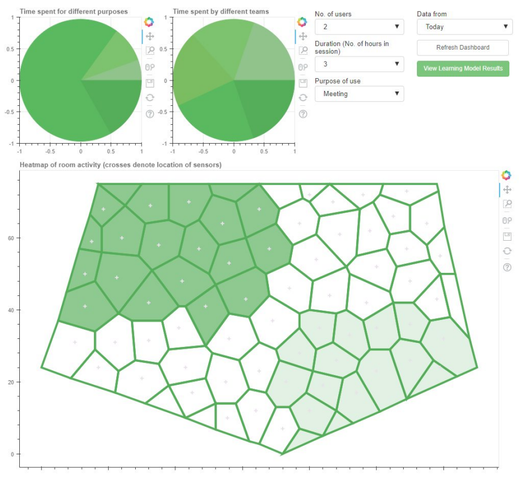
Interior furniture can be reconfigured and arranged for use.

Room Controller Interface



The controller provides options for users to input information about their use of the room, as well as manual controls for interior lighting and sound conditions.

Staff Dashboard



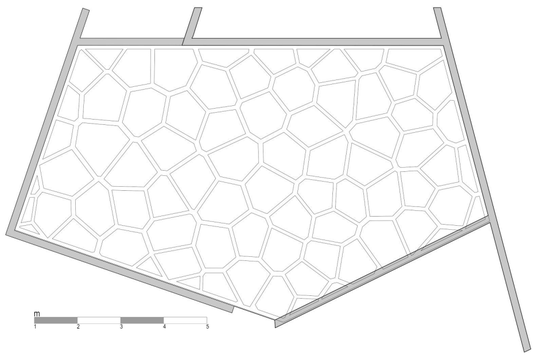
The staff dashboard provides an overview of the room usage, such as its use for different purposes and by different functional teams, averaged positions of the furniture and overall trends of their placement.

Digital Health Studio in the Outdoors

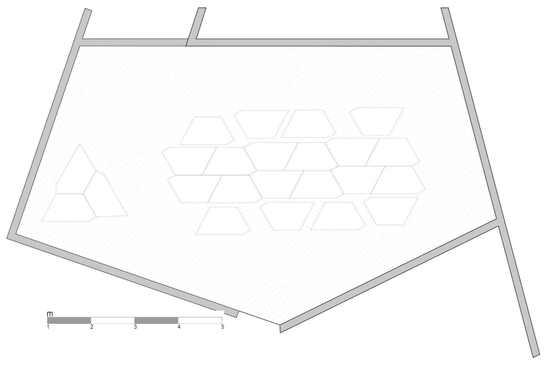
Physical layer

The Physical layer consists of everything the visitor can see and interact with, including the room itself. This layer can be broken down into 3 main components: the modular furniture design, the ceiling installation which also acts as a light diffuser, which results in softer ambient lighting in the room, and location tracking sensors. The technicalities behind the lights and sensors will be covered under the Control layer.

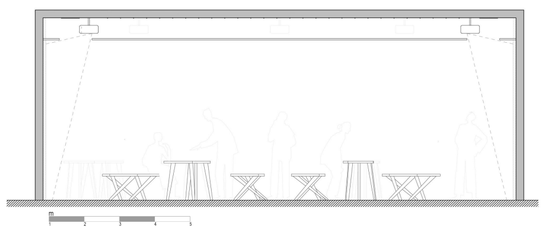
Reflected ceiling plan

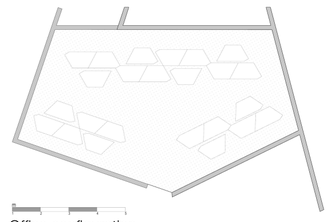


Floor plan

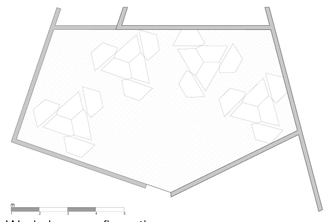


Section

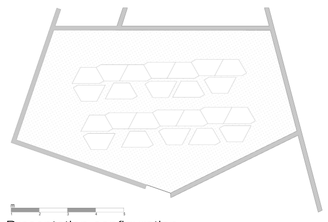




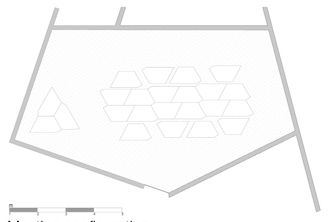
Office configuration



Workshop configuration



Presentation configuration

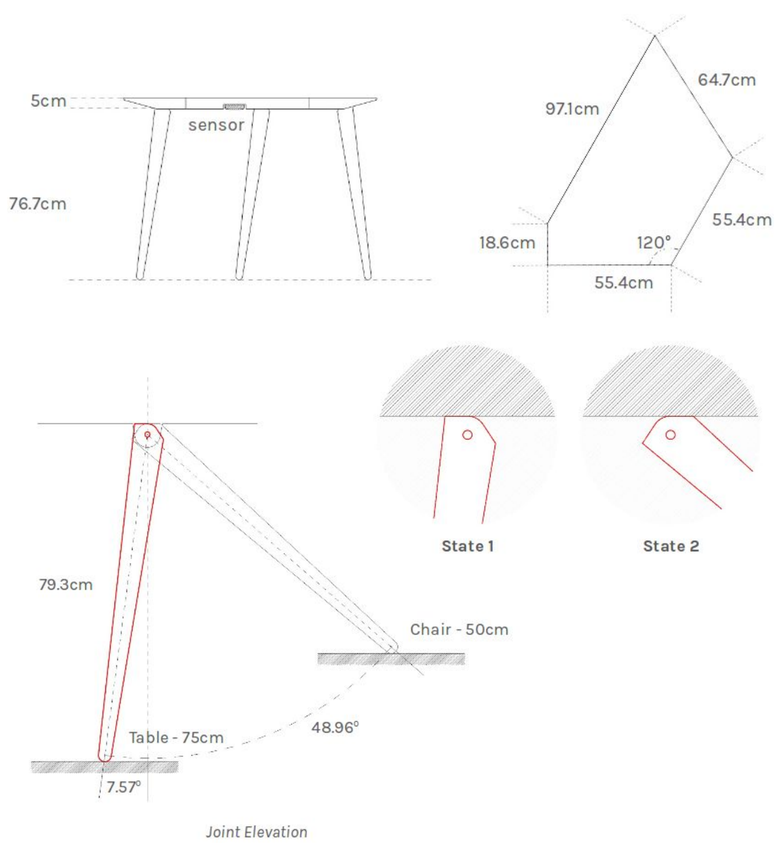


Meeting configuration

Possible room configurations

The room itself is designed to be flexible in nature, to meet MSD's requirements of having a low maintenance room to allow for an annual refresh of the room if needed, yet still ensuring that the room is able to adapt to meet the functional requirements of the different programmes the room is supposed to host.

The modular furniture of the room is meant to fulfil this intended design of the room, and is notably the only physical object within the room that the user can interact with, other than the Raspberry Pi (RPi) that would allow the user to change the room's settings as they desire.



Joint Elevation

Transformable Furniture

A unique pentagonal geometry was designed to allow the furniture to be combined together in different configurations, such as a long, linear table, or dispersed islands of workspaces, for different uses.

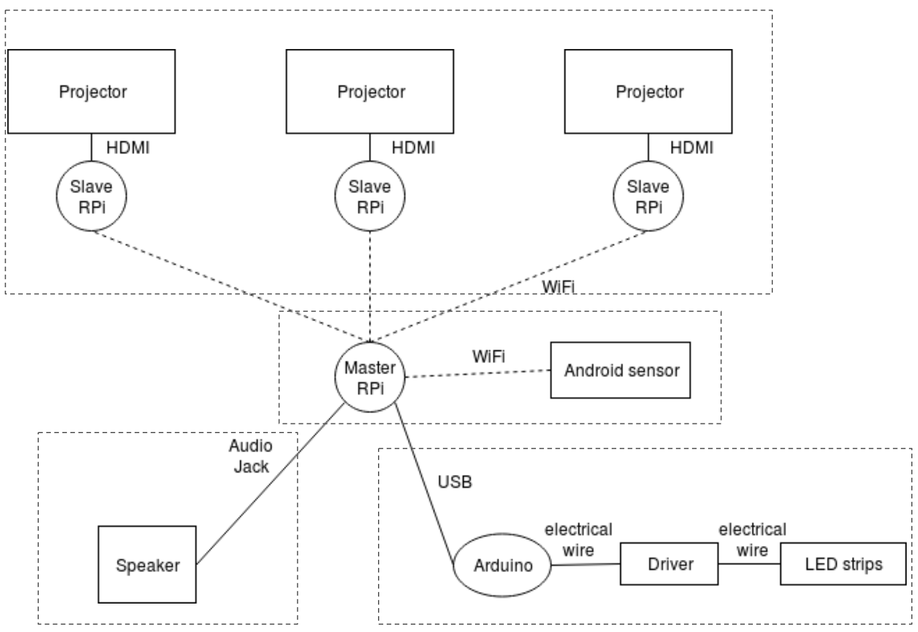
To enable a flexible use of the room, we designed a piece of furniture that could transform between a table- and chair-configuration. To do so, we created a swivel joint with a unique geometry that allow the legs to change between 2 positions, vertical or diagonal, that effectively change the height of the furniture. This swivel joint is then attached on the underside of the furniture surface.

To transform the furniture, a torsion spring is embedded within each swivel joint such that the legs will naturally swing outwards into the table-configuration, while a manual latch mechanism pulls the legs inwards through attached steel cables in a coordinated manner into the chair-configuration.

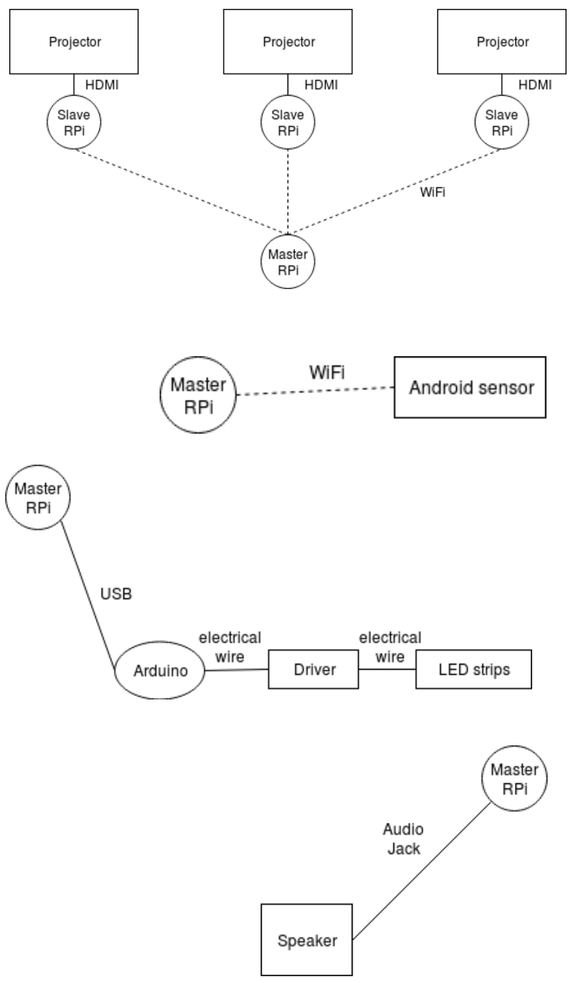
Control layer

The control layer of Digital Health Studio consists of four subsystems: projector, light, speaker and sensor data subsystem. There is a total of 13 projectors, each connected to a Raspberry Pi (RPi) via HDMI.

There is a total of 14 RPis: 1 master RPi and 13 slave RPis connected via WiFi. The master RPi is connected to three other modules: the speakers via audio jack, an Arduino to control the LED light strips and Android sensors that detect nearby furniture and users.



Due to the project budget limitations, the actual design has been scaled down from 13 to 3 projectors to capture the essence of the design while working within the resource constraint.



Projector Subsystem

The projector subsystem displays a panoramic view of videos across the room walls using the projectors. When a video file is played in the master RPi, the video file is split according to the number of slave RPis connected to the master and each split is streamed to the respective slaves, which is then projected onto the walls.

Sensor Subsystem

The sensor subsystem detects the location of the users and the furniture in the room. This is done through the use of Bluetooth Low Energy transmitters (Beacons) which are attached to people or pieces of furniture. These Beacons broadcast an identifier which is picked up by Gateways. The strength of the identifier picked up allows the Gateways to determine approximate distances from the Beacons.

Light Subsystem

The light subsystem controls the colour and intensity of the LED light strips to simulate the effect of natural lighting, enhancing the outdoors experience. When a user indicates the desired light setting on the UI screen of the master RPi, the input is sent to the Arduino, which controls the LED strips.

Sound Subsystem

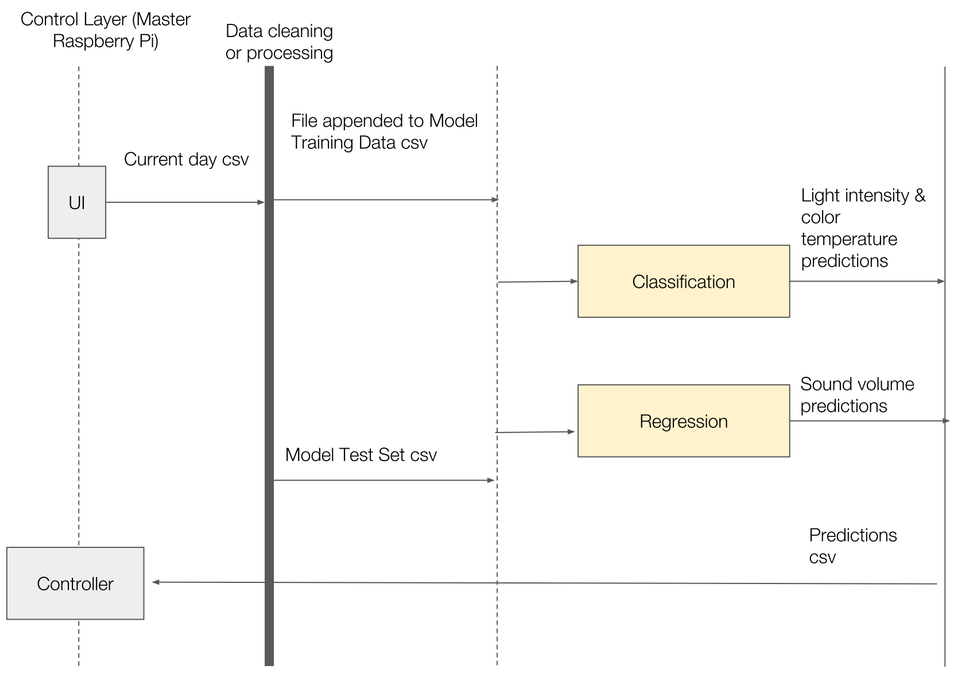
The sound subsystem controls the volume of background music. The user indicates the desired volume on the UI screen of the master RPi to control the speaker.

Analytics layer

The Analytics layer analyses the gathered data to create a learning model framework, which would help to record and eventually predict the preferred user settings in the future.

The Analytics layer also send the analysed data as a dashboard to MSD staff, making it easier for them to review the collected and analysed data.

Learning Model Framework



The data collected from the room will be aggregated and presented through visualizations in a dashboard that will show the levels of activity detected by sensors in different parts of the room.

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