

# OUR SANDBOX

## INTERACTIVE PAVILION

“We have to start thinking of sand as a precious resource not only worthy of conversation but in dire need of our protection.”

*The Good Stuff*

SS 2020 // MediaArchitecture Biennale 2020 #Futures Implied  
Maximiliane Nirschl

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## / context

As the main ingredient of concrete, asphalt and cement, about 40 billion tons of sand are used every year to build the growing cities all over the world. With increasing urbanisation and the growing population on our planet, the demand for sand has almost doubled.

But sand is not a renewable resource. There is not enough sand to keep meeting the high demand.

Sand harvesting endangers natural habitats and destroys ecosystems. Dredging of rivers and seas affects the local farming and fishing industries and pollutes the water.

For the production of concrete enormous amounts of energy are needed.

*The Economist*

## / concept

**OUR SANDBOX** is an interactive pavilion that raises awareness about the highly precious (building) material sand.

It is a 4x4x4 meter standalone cube, built from raw concrete, with a floor covered in sand. The inside is illuminated by black light which immerses the visitors in a magical space. Four brooms are leaning on the walls, offering to be used by the visitor to sweep away the sand. Under the sand, an infographic about sand, what it is needed for, its shortage, and the environmental impact of its harvesting, is printed with UV colour. Visitors can thereby bring the discussion about sand to the light.

The scenery is accompanied by a four-channel spatial sound loop. The sound is created only by using sand as an instrument, played by hand, which creates a calm and harmonic feeling.

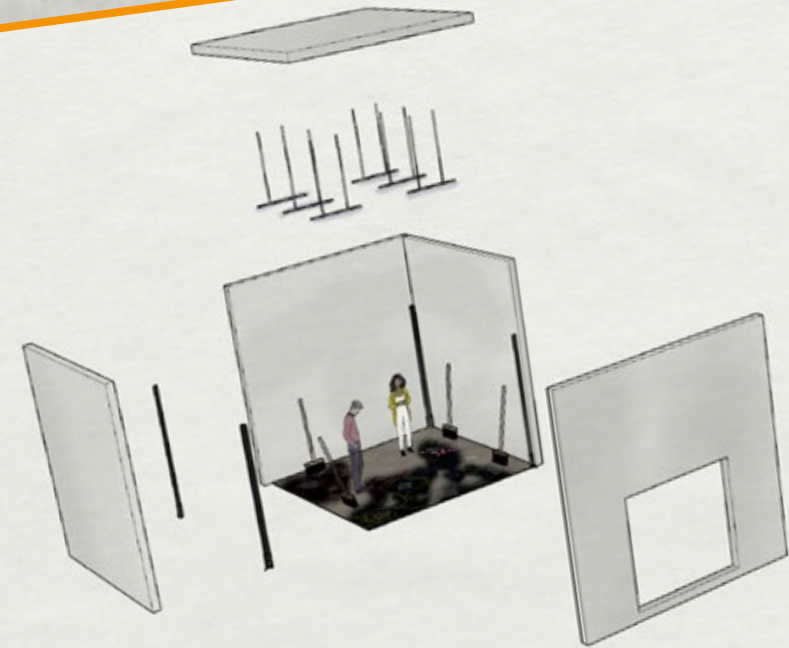
Whenever one of the brooms is used, a second soundtrack is faded in. That second track consists of the sharp sounds that are produced during sand harvesting, sand manufacturing, concrete manufacturing, and recordings of confrontations with the Indian sand Mafia. Each of the four brooms is connected to one of the four corners and therefore controls the sound of one speaker.

A video showing the prototype of **OUR SANDBOX** is available here:  
<https://vimeo.com/441147250>



## / site

The installation is situated on a public plot that is reserved for new building projects. Until the construction works start, the installation raises awareness about sand as a precious building material and criticises its inflationary use. It also gives information about alternative building materials that have to be considered for every new building project.



## / architectural design

The size of the concrete cube with 16m<sup>2</sup> represents the size of a standard room we live in, be it a bedroom or an office. This connects the experience to everybody's daily life. The shape of a box refers to the mass of aesthetically similar concrete modules that form most of our living space, which also criticises this uniformity while architecture has to act more regional to achieve sustainability goals. The high ceiling, though, creates the sense of sacral place, enforced by the atmospheric black light, because sand has to become recognized as a highly precious material. The black light allows to direct the focus only on the sensory experience with the haptic floor, the spatial sound and the information given by the infographic. The entrances is covered with a black curtain to block out the daylight.





# / information design

- An infographic covers the whole floor.  
Five different colours indicate different topics:
- / Shortage of sand (red)
  - / Environmental impact of sand harvesting (blue)
  - / Information about sand as a material (yellow)
  - / The Indian sand Mafia (purple)
  - / Alternative building materials (green)

The information in the squares is connected with lines that guide the visitor through the information and connect the single pieces of information about the complex topic. Little graphics, such as a representation of the Indian gorilla crocodile, enrich the visual storytelling.

„Industrial extraction and high temperatures in the production process lead to one tonne of CO2 emitted for every tonne of cement produced. This accounts for 5% of annual global anthropogenic CO2 produced.“

Archworld

„There's no sand left“

cambodian sand in singapore

Sand is one of the most critical resources there is.

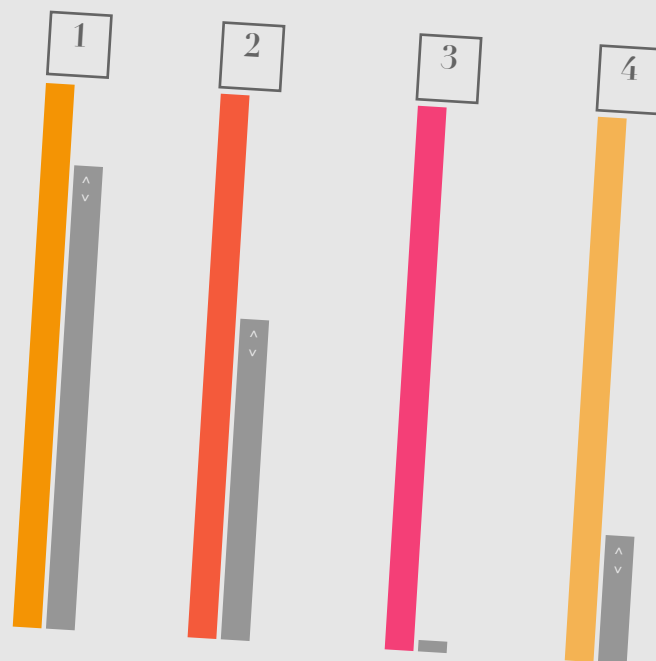
„Sand is one of the most critical resources there is.“



interactive broom // exploded view



## Four channel spatial sound



## / sound

The spatial (four-channel) soundscape that fills the space continuously is created only by sand and hands. It is a soothing sound piece. This sound piece is available (as stereo sound) here: <https://soundcloud.com/user-816436937/our-sandbox-sand-stereo>. For each of the four speakers (one speaker in every corner), there is a second sound track that will only play when triggered by the interactive brooms. This second channel is a collection of the harsh sounds from sand harvesting, artificial sand manufacturing, concrete manufacturing or recordings from encounters with the Indian sand Mafia. One of the topics belongs to one of the four speakers. Examples of these sounds can be listened to here:

<https://soundcloud.com/user-816436937/our-sandbox-harsh-collection>

The sound installation is controlled by a custom-built speaker interface made from an Arduino mega, an Adafruit sound shield and a Wi-fi-module.

- / sand harvesting
- / sand manufacturing
- / sand Mafia
- / concrete manufacturing

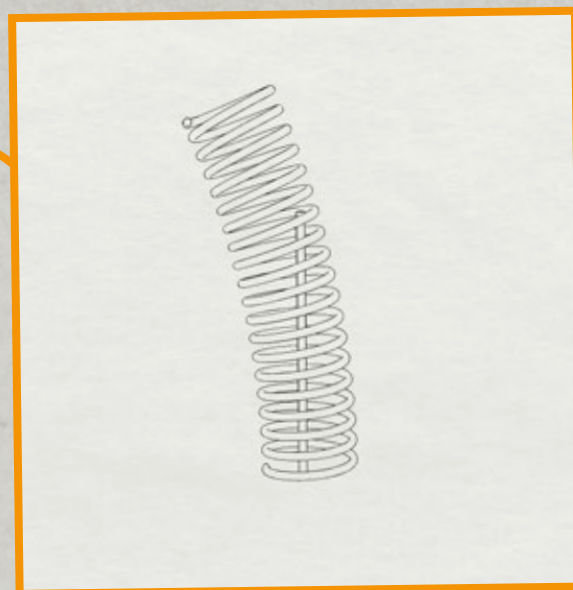
## / interactive brooms

Four interactive brooms are placed in the inside space. They allow the visitor to bring the information beneath the sand to the light. Each broom holds a custom-built whisker sensor which detects when a visitor uses the broom for sweeping. This interaction triggers the second sound channel which consists of harsh sounds that are created whenever humans interfere with machinery to mine or process sand.

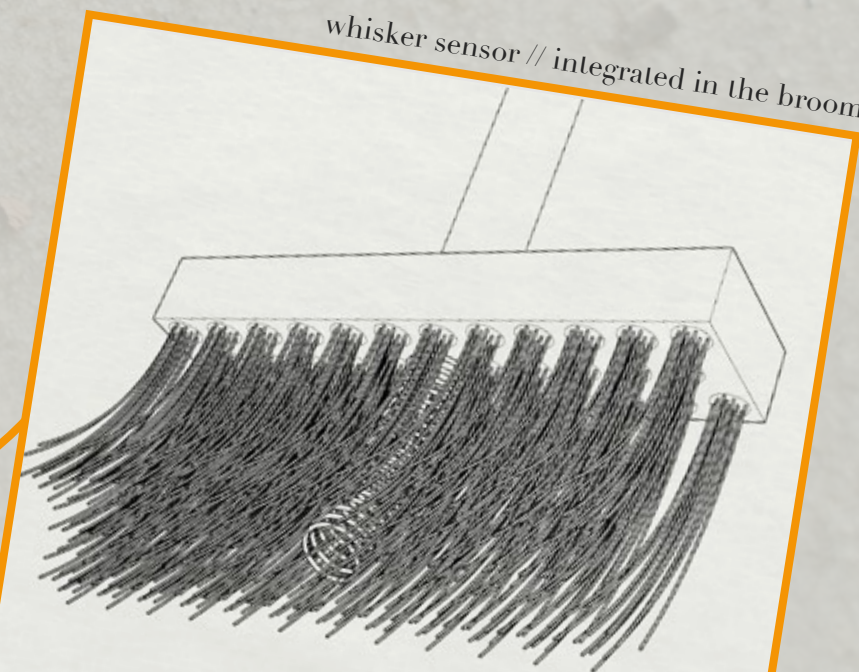
### WHISKER SENSOR

A connector (e.g. a nail) is fixed between the hairs of the broom, surrounded by a spring. Both spring and connector are connected to an electrical circuit, which connects to an esp 8622 board. If the spring gets bent because the broom is used for swiping, it touches the connector inside, and closes the circuit. This signal is then registered by the board and transmitted via Wi-fi to the arduino mega board on the corresponding speaker interface.

whisker sensor



whisker sensor // integrated in the broom





## /arduino setup () (prototype)

```
void setup() {
  Serial.begin(9600);
  pinMode(LEDPin, OUTPUT);
  pinMode(buttonPin, INPUT);
  Serial.println("Adafruit VSI053 Library Test");

  // initialise the music player
  if (!musicPlayer.begin()) {
    Serial.println(F("Couldn't find VSI053, right pins defined?"));
    while (1);
  }
  Serial.println(F("VSI053 found"));

  if (!SD.begin(CARD_CS)) {
    Serial.println(F("SD failed, or not present"));
    while (1); // don't do anything more
  }
  Serial.println("SD OK!");

  // list files
  printDirectory(SD.open("/"), 0);

  // Set volume for left, right channels. lower numbers == louder volume!
  musicPlayer.setVolume(150, 1);
  // set birth channels to silent before starting the loop.
}
```

## /media

### ARDUINO (speaker interface)

The Arduino technology is used to control the sound. An Arduino mega board, powered by 5V, is connected to a sound shield that holds a micro SD card (for storing the sound files). A Wi-fi module creates a wireless connection to an MCU ESP board that is installed inside of the broom. This ESP board, powered by a rechargeable battery, is connected to the whisker sensor and sends the trigger information to the main arduino board when the sensor detects the use of the broom. This setup continuously plays the sand sound-scape while waiting for the signal from the whisker sensor. When it detects interaction, the second track with the harsh sounds of e.g. sand harvesting is played for a couple of seconds (on top of the sand sound-scape).

### BLACK LIGHT

Six fluorescent black light tubes, installed on a height of 2,5 meters, are used to illuminate the pavilion. The information graphic on the floor is printed with fluorescent colour so it becomes visible, even gives the illusion of lighting itself, when exposed to the black light.

## /arduino loop () (prototype)

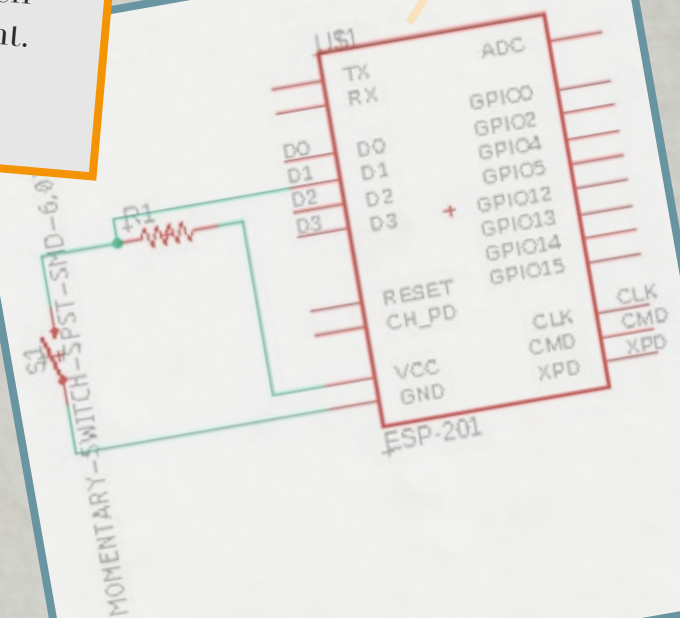
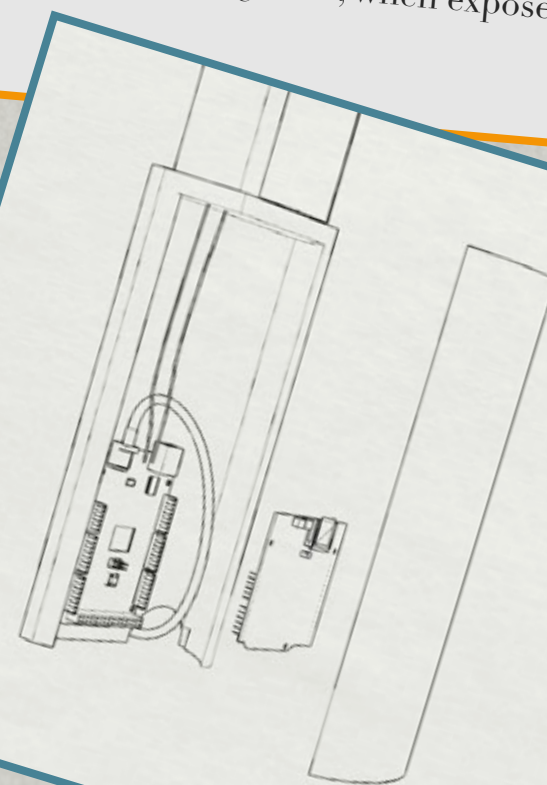
```
void loop() {
  // Start playing a file, then we can do stuff while waiting for it to finish
  if (!musicPlayer.startPlayingFile("/track001.mp3")) {
    Serial.println("Could not open file track001.mp3");
    while (1);
  }
  Serial.println(F("Started playing"));

  while (musicPlayer.isPlaying()) {
    // file is now playing in the 'background' so now's a good time to do sth. else
    // whisker sensor part:
    buttonRead = digitalRead(buttonPin);
    Serial.println(buttonRead);
    delay(dt);
    // buttonRead is either 1 (broom is not used) or 0 (broom is used)
    // stereo volume -> first value is corresponding with left channel (harsh sounds)
    musicPlayer.setVolume(buttonRead * 1000, 1);
    // Volume for "broom is used" = 0 -> loud; Volume for "broom is not used" = 1000 -> silent

    // millis -> sound plays at least 5 seconds (interval) to avoid harsh changes
    unsigned long currentMillis = millis();
    Serial.println(currentMillis);

    if (currentMillis - previousMillis >= interval) {
      previousMillis = currentMillis;
      musicPlayer.setVolume(buttonRead * 100, 1);
      delay(100);
    }
  }
}
```

arduino // speaker interface



esp 8622 board // circuit



# / material costs

22,99	4x esp8622 board
155,76	4x arduino mega
125,04	4x adafruit sound shield „music maker“
14,29	4x wifi-module
12,36	4x micro-sd card
20,00	resistors, extension cables, wires, nails
31,45	5x wooden broom
4,00	4x steel spring
20,99	4x battery for esp boards
15,40	ca. 100 kg quartz sand
12.064,00	concrete elements with mounting 64m2 wall, 16m2 ceiling, 16m2 base plate
149,10	6 x black light tubes
38,26	6 x light hanging
47,60	2L black color
150,00	sight tight curtain black
200,00	extra
€ 13.071,24	<b>SUM</b>

# / materials

## PREFABRICATED / REUSED CONCRETE

The architecture is constructed using prefabricated raw concrete elements. This allows a fast setup on site and cost reduction. If possible, elements should be used that are recycled and will be reused after the installation.

## VINYL BACKFLOOR (PhotoFabrics)

This new printing technology allows a high-resolution print on the backside of a transparent vinyl floor which is very durable.

## RIVER SAND

River sand is naturally fabricated sand. During thousands of years of rock erosion, water formed round and soft grains. This prevents the floor from being scratched too much, when constantly moving the sand on top. Grain sizes between 0,5mm and 2mm are dust-free but still fine enough to be moved easily with brooms.

# / MAB 20

OUR SANDBOX is a proposal for the MediaArchitecture Biennale 2020/21 #FuturesImplied and refers to the topic "More-than-Human-Cities".





## / sustainability

**OUR SANDBOX** is criticizing non-sustainability in building projects and, in general, in the context of sand. Therefore, it uses common technology and building standards to display and to connect to real-world problems. But of course, the installation will be built in the most sustainably way possible without compromising its message. The electrical parts will be connected in a way to be rebuild-able (e.g. no soldering). Where possible, renewable energy sources will be used. The use of wooden brooms with natural hairs supports the prevention of plastic waste.

The lamps, the speakers and the sand can be reused. Also, the brooms can be reused after the electrical parts are removed. The pavilion itself should be realized with concrete modules that can be dismantled, either to relocate the installation or to be used for another building.

## / alternative setup

As an alternative to the proposed pavilion, the installation can also be set up in an existing room that can be darkened. The infographic can be adjusted on any floor dimensions bigger than 14m<sup>2</sup>.

In this case, the floor has to be painted black or covered with a second floor that works as a background for the infographic. Black light has to be installed and power supply for the speakers and the charging stations of the brooms are required.



# / research

Alternative Construction Materials - Future Cities Laboratory (FCL)

*ETH Zürich*

fcl.ethz.ch/research/archipelago-cities/alternative-construction-materials.html  
14.07.2020

Sand mining: the global environmental crisis you've probably never heard of

*Vince Beiser, 27 Feb 2017 07.15 GMT Last modified on Mon 3 Feb 2020 12.50 GMT*

www.theguardian.com/cities/2017/feb/27/sand-mining-global-environmental-crisis-never-heard  
01.07.2020

11 Green Building materials way better than Concrete

*Archworld, 10.12.2017*

www.youtube.com/watch?v=VsahyCrZgsk  
14.07.2020

Why is sand in short supply? | The Economist

*The Economist*

www.youtube.com/watch?v=8J78ezpadFo  
01.07.2020

A microscopic look at why the world is running out of sand

*Verge Science*

www.youtube.com/watch?v=V234gcno-To  
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ENVIRONMENTAL IMPACT OF SAND HARVESTING A CASE STUDY OF MAGARINI-MALINDI

www.drsresearch.org/info-free-essays/socio-economic-environmental-impact-sand-harvesting-case-study-magarini-malindi/

01.07.2020

We Are Running Out of Sand. Yes. SAND.

*The Good Stuff*

www.youtube.com/watch?v=o\_Oik7CBueM  
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How Sand Mining Impacts Ecosystem

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The Hidden Environmental Toll of Mining the World's Sand

*By Fred Pearce, February 5, 2019*

e36o.yale.edu/features/the-hidden-environmental-toll-of-mining-the-worlds-sand  
01.07.2020

How Sand Mining Destroys One Home to Build Another | Short Film Showcase

*National Geographic*

www.youtube.com/watch?v=fpc3hhHicas  
11.07.2020

Why Sand Mining is a Global Environmental Crisis...

*MRSS Dev , 15.11.2018*

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Impact of sand mining | Sumaira Abdulali | TEDxXIE

*TEDx Talks , 05.07.2016*

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