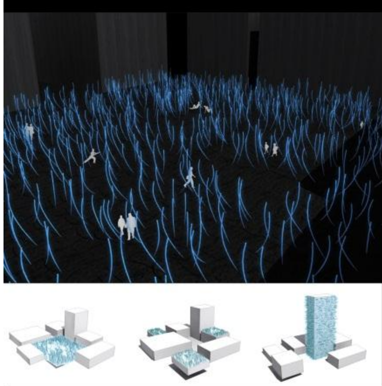
HA11_IBPCB

AMBIENT LIGHTING FOR NATURAL SPACES (VIBRIO FISCHERI)

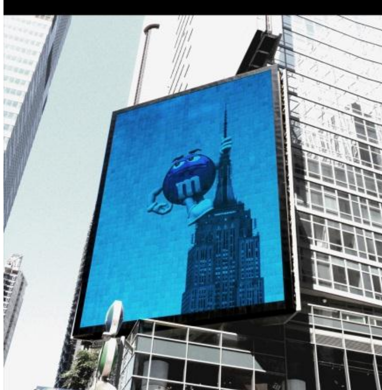
3D DISPOSABLE GREEN GLOWING STRUCTURES AND SIGNPOSTS (VIBRIO FISCHERI)

AMBIENT LIGHTING AND GLOWING BILBOARDS FOR URBAN SPACES (VIBRIO FISCHERI)

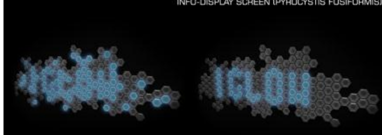
URBAN LIGHTING AND GREEN GLOWING HAB (VIBRIO FISCHERI)



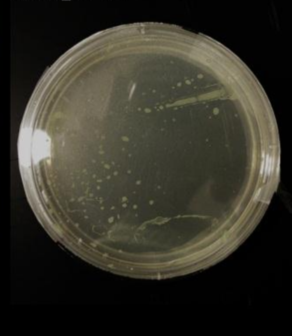
GLOWING BARFIELD (PYROCYSTIS FUSIFORMIS)



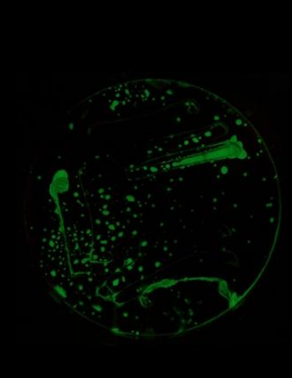
INFO-DISPLAY SCREEN (PYROCYSTIS FUSIFORMIS)



INFO-DISPLAY BILBOARD (PYROCYSTIS FUSIFORMIS)



PIXEL-BASED PROTOTYPE (VIBRIO FISCHERI)



PIXEL-BASED PROTOTYPE GLOWING (VIBRIO FISCHERI)

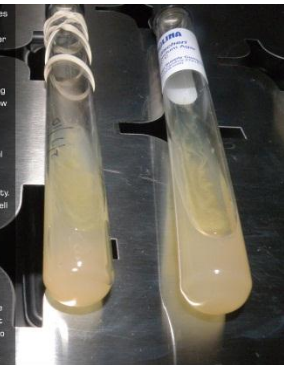
HYDROGEL PROTOTYPES (PYROCYSTIS FUSIFORMIS)

SCREEN PROTOTYPE (PYROCYSTIS FUSIFORMIS)

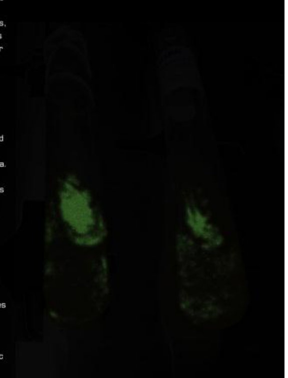
PIXEL-BASED PROTOTYPE (PYROCYSTIS FUSIFORMIS)

To start the experimentation stage of this researching, several tubes of Vibrio fischeri were ordered to check their glowing properties. Some of the tubes contained populations of bacteria and others agar nutrients. To grow them you have to rub carefully the tubes containing bacteria with a spatula and introduce it in the ones containing agar. Then you remove the spatula and cap loosely the tube. They grow as far as they have nutrients and they start glowing in about four days. They were put inside an incubator since they grow better if the temperature is within a range of 18°C to 27°C. In ten days they consumed the nutrients and their bioluminescent properties started decreasing until they died. After a week, some cultures were placed in the fridge at 4°C to keep them alive. Several subcultures were made during the process transferring a piece of culture from one tube to another one with nutrients. Vibrio fischeri does not glow much unless the population reaches a very high density. Besides they die if they run out of nutrients. Therefore they work well for faint illumination or in very high concentrations as long as they have nutrients. Vibrio fischeri does not need to receive light for glowing like photoluminiscent organisms because they chemically glow. These features should be considered for design when using these bacteria. Vibrio fischeri can be used for static commercial billboards. In that case, the bacteria would make the images more visible at night but the structure where the bacteria would be implemented should reproduce the image very clearly. Otherwise the image would not be visible. Eventually the image would disappear but that might be an advantage for a commercial strategy. It would also take a while for the image to be recognizable while the bacteria are growing. Since they are organic living beings, they could be used to illuminate natural environments without placing artificial lamps in the woods. Vibrio fischeri performs chemical bioluminescence and follows a circadian rhythm, which makes it glow naturally at night. Since there is no need to have a very powerful lighting source in the woods, Vibrio fischeri would perfectly work for highlighting remarkable spots or for signposting paths. A flexible structure made of natural rubber or other organic biodegradable material, could work to adapt its shape to organic natural shapes and be attached to them. If the geometry of this structure is pixel based and it is provided with a number of holes or cavities, it could host certain amount of agar. Agar is a glucose substance extracted from red algae and it works pretty well to feed Vibrio fischeri. It would have to be replaced to keep bacteria alive though. However the prototype could be designed in a way that releases agar or that includes either red algae or any sort of gelatin that might work as a nutrient source for the bacteria. Vibrio fischeri could also be used to create ambient lighting for interior or exterior spaces at night. It could be embedded in modules able to be aggregated to form 3D usable structures. These structures would then emit faint light generating different ambient conditions around them. The bacteria could be placed in removable small containers attached to the modules so that they can be replaced, or the modules could be filled with nutrients inside.

Besides bacteria there are unicellular algae that also glow naturally in the dark. This is the case of Pyrocystis fusiformis, a species of dinoflagellates that lives in sea water. Pyrocystis fusiformis produces bioluminescence in a circadian rhythm. It photosynthesizes during the day and produces bioluminescence when mechanically or chemically stimulated at night. It emits blue-green light from microsources found evenly distributed throughout the cytoplasmatic layer surrounding the large central vacuole. During the day the microsources migrate from the cell´s periphery to a spherical region distal to the nucleus. During their migration from the periphery they are replaced by chloroplasts. This results in a lack of bioluminescence. The microstructures return to the periphery at night, and produce bioluminescence. According to the "burglar alarm theory" Pyrocystis f usiformis emits light to attract attention to its predator. Whenever a predator approaches a population of dinoflagellates, it moves the water exciting them. Hence they glow and the predator is illuminated increasing the chances that it is itself preyed upon. To start cultivating Pyrocystis fusiformis, four 50ml bags containing dinoflagellates were ordered along with nutrients and vitamins for them to grow. Artificial salty water was created using distilled waterand adding marine salts to it (35gr of salts for every liter of distilled water). Then nutrients, minerals and the dinoflagellates were poured in the water in 1:3 proportion; 10ml of minerals and 10ml of vitamins for 1500ml of dinoflagellates in 500ml of salty water. They were put inside the incubator at 25°C with a timer that controlled a lamp to light them in cycles of 12h on and 12h off. The nutrients helped the dinoflagellates to grow and the fluorescent lamp provided them with light to make the photosynthesis to achieve their own circadian rhythm for glowing. The first culture did not glow at all so a sample was watched under the microscope to check it. It did not glow because the water was contaminated by an organism that was killing the cells. More dinoflagellates were ordered and the same protocol was repeated to fill two containers of one liter each. This time the lighting cycle was modified to 17h on and 7h off. The bacteria started glowing in three days. After a month the containers were split and more nutrients, vitamins and artificial salty water were added to the new containers. As a result six containers of one liter successfully grew and emitted light. Different kinds of geometries were tested to check dinoflagellates´ glowing behavior. The first one was a pixel-pocket structure that would allow each pixel to glow independently if excited by movement. It was made injecting 10ml of Pyrocystis fusiformis in each pixel. It worked pretty well and each pixel could be excited to glow. Based on this prototype there is the possibility to think of a screen or billboard that emits light and at the same time, displays information, images or text. It can be done controlling the movement of each pixel individually to be on or off. The pixels could be excited by a mechanical device or by sound waves. This sort of geometry could be used for façades or for commercial purposes. The advantage of this system regarding billboards made of static glowing bacteria like Vibrio fischeri is that the information displayed can change according to the movement of the pixels. However there is the need to think about a mechanism to move the pixels so that they glow. A second kind of geometry was filled in with Pyrocystis fusiformis to test its behavior. The volume injected in this geometry was also 10ml but in this case, the container was more superficial. The idea was to design a transparent surface to divide spaces able to glow when excited by movement. However out of three prototypes placed in the incubator only one was glowing and not very much. Apparently dinoflagellates glow better in 3D-like containers. The fourth prototype developed was a 200ml bag filled with Pyrocystis fusiformis. Its glowing properties did not differ much from the ones the one liter containers show. It achieved the same brightness as one of these original containers. It was also placed inside the incubator. This fourth prototype geometry can be used for highways signal lights. The dinoflagellates inside could be excited either by the movement of cars activating a device that is communicated with the lighting source, or just by the wind. Designing a prototype that emits light without consuming electricity taking advantage of Pyrocystis fusiformis glowing properties, means the recognition of a living form of wealth translated into an architectural outcome. Besides controlling the density of a population of dinoflagellates helps to regulate its quorum sensing mechanisms. That means manipulating the kind of swarm intelligence a population of dinoflagellates shows to improve its glowing properties; and therefore the architectural outcome. Furthermore there is a way to achieve a design that is not only consuming energy to glow but transforming the one that uses into something else besides light. This kind of prototype would be a bar field where each bar contains salty water with populations of Pyrocystis fusiformis. This bar field would be moved by the wind. This movement would excite the bacteria inside the bars and they would glow. At the base of each bar, a device could be placed to use the kinetic energy produced by the movement of the bars for different purposes depending on where the prototype is placed. It could be built in public plazas, rooftops or building façades. The kinetic energy could be used to warm the ground, for pavement lighting,to set up an electricity network with plugs that could be used by people, or it could be transformed into electricity to supply buildings with it.

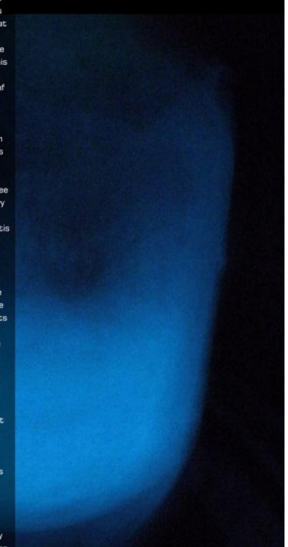


VIBRIO FISCHERI CULTURE WITH AGAR



VIBRIO FISCHERI CULTURE GLOWING

PYROCYSTIS FUSIFORMIS CULTURE



PYROCYSTIS FUSIFORMIS CULTURE GLOWING