

The Bio-Actuation Interactive Interface

The 'Undefined' Installation

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Abstract – In cities, masses of individuals cooperate to travel within pre-established ranges of motion; the vessel, or city, is unresponsive to each existence. Individuals muted by the city's bustle inevitably seek a sense of presence, an amplification to rejoice in their uniqueness. Permanently fixed frameworks and outlined trajectories construct urban environments, through apparent, unambiguous forms and stationary walls. All physical barriers are obstacles that create predefined, stationary routes that humans are forced to adapt to, muffling the ability for humans to be present and perceive the world through the full scope of their senses.

Curated to break down barriers among everyday objects and biology, the *Bio-Actuation Interactive Interface* allows humans to 'communicate' with bacteria and watch the space around them morph. The bacteria showcased are genetically engineered to secrete color, the output of a chemical reaction. The interface enhances the user's state of mind as the color that the bacteria secretes is programmed for specific times of the day, evoking certain feelings, responses, and emotions, formulating a positive image for biotechnology.

How can humans delineate the space around them? How does this affect the mental health of large populations?

Key Words – Bio-actuation, biomimicry, agitation, urban reimagination/revamp

INTRODUCTION

The *Bio-Actuation Interactive Interface* is a tangible re-imagination of urbanism for all to engage with, reshape, and burgeon the capacity at which their senses can be engaged by diminishing the overwhelming effects of urban environments. Actuated by human presence, the installation responds to motion and physical interaction, unveiling how the body can construct the environment surrounding them, in contrast to the physical boundaries of the vessel, or city restricting a person's movement and ability to engage with their surroundings.

Organic landscapes are created by the entities inhabiting them and are reformed and reconstructed by mutual interactions based around the needs of living organisms in their ecosystem. Natural landscapes also embody subjective decisions as microcosms in each natural ecosystem or macrocosm. In natural environments, the presence of each

individual is amplified as each step leaves a unique impression, the space recognizing individual existence.

DESIGN INTENTIONS

I. *Educate the public about technology in design*

Biotechnology – How can biology power the future (combat climate change)? Why is bio-design important today?
'Communicate' with bacteria – How can people engage with bacteria, something that is often stigmatized? Will an interactive (bio-powered) installation create a positive image for biotechnology and bacteria seen everywhere?

II. *Enliven public spaces*

Engage multiple senses – How can the senses be stimulated? How can bio-interactivity be optimized to its capacity? How can urban spaces/environments be reimagined and improved?

Improve the user's state of mind - How can installations improve peoples' moods on the global scale? How can installations evoke positive feelings and emotions that can be translated into the workplace? Could an installation help individuals to improve their quality of work, productivity, and overall success?

THE FUTURE OF BIOTECHNOLOGY

Typically, installations do not embrace biology and the miraculous ways it can intersect with technology. Stigma leads children to believe that bacteria are disgusting and are insignificant, although the planet will undoubtedly rely on them in the immediate future. [1]



FIGURE 1: *E. Chromi*. – Bacterial sensors (bio-bricks) are inserted into *E. Coli* to produce pigment. [2]

E. Chromi., a precedent for the *Bio-Actuation Interactive Interface*, utilizes standardized sequences of DNA in a format called bio-bricks. Genetically engineered bacteria design their own bio-bricks using genes copied from existing organisms, which are then inserted into *E. Coli* that can secrete colors visible to the naked eye. Bacterial biosensors (bio-bricks) can tell a person the concentration of the pollutant with a detection bio-brick. The detector is linked to two other bio-bricks, the sensitivity tuner and the color generator. The sensitivity tuner determines how drastic the environmental change is and communicates a color and a level of transparency or intensity to the color generator. In the future, *E. Chromi* will be used for personal in-home disease monitoring in the form of a yogurt. The bacteria in the yogurt react to the culture in your gut and secrete colors in one's stool to tell the user if their gut culture is healthy.

THE IMPORTANCE OF SENSORIAL ENGAGEMENT

The Impact of Sensory-Based Movement Activities on Students in General Education (2016) is a study that delves into the movement of students throughout the school day and the effects it has on academics and "time on task." The investigation examined impacts of sensory-based movement activities on academic learning and analyzed the teacher's and student's perceptions of the activities. [3] Similarly, other studies examining sensorial engagement and its correlation with boring cityscapes suggests that dull environments increase sadness, addiction, and disease-related stress. Streetscapes and buildings ignore the need for sensory engagement, not allowing for comfort, happiness, or optimal functionality for future human populations. [4] Many studies show that breaks (for periods of sensory engagement) are essential in helping employees de-stress and re-charge for the rest of the workday. Regular breaks can also help improve overall job satisfaction and productivity levels. [5] Walking past an interactive installation in the city while taking a break for lunch is a great way to get some fresh air and engage the senses, even for a quick moment.

The physical and social environments of urban life can contribute both positively and negatively to mental health and wellbeing. Cities are associated with higher rates of mental health problems compared to rural areas: an almost 40% higher risk of depression, over 20% more anxiety, and double the risk of schizophrenia. Additionally, cities correlate to more loneliness, isolation, and stress. Good mental health can improve people's enjoyment, coping skills, relationships, educational achievement, employment and physical health problems.

People who live in the city experience increased levels of stimuli: population density, noise, smells, sights, disarray, pollution, and intensity of other inputs. Every aspect of urban environments is deliberately designed to assert meanings and messages, such as advertisements that evoke behavioral responses and attitudes. These stimuli trigger action and thought and become more potent as an inability to

'cope' sets in, often overloading the mind and resulting in burnout. Overload increases the body's baseline levels of arousal, stress, and preparedness, but also drives people to seek relief in quiet, private spaces. Over time this urge may evolve into social isolation associated with depression and anxiety, and also forms the basis of the ecological hypothesis of schizophrenia. [6]

COLORS AND PSYCHOLOGICAL CORRELATION

The colors in a person's surroundings can affect a person's health – physically or mentally. Various colors propagate varying impacts. Blues and greens form a calming ambiance, whereas oranges and yellows heighten productivity and the ability to focus. In color theory, every hue on the spectrum from white to black has an influence on how a person thinks, acts, and responds to the world around them.

Color	Psychological Effect(s)
Yellow	<ul style="list-style-type: none"> Brightens mood, increases energy levels, uplifting, lively, joyful
Orange	<ul style="list-style-type: none"> Exciting, burst of energy
Pink	<ul style="list-style-type: none"> Calms nerves, relieves feelings of anger, aggression, and neglect, love, playfulness, kindness
Green	<ul style="list-style-type: none"> Reduces anxiety, feelings of prosperity, restorative, mind-clearing, encourages composure
Light purple	<ul style="list-style-type: none"> Sparks creativity, calming feeling, light and airy
Blue	<ul style="list-style-type: none"> Calming feeling, centered, relaxed, serene, lowers blood pressure, clears the mind, steadies breathing

Research shows that the colors generally found in hospitals and healthcare sites are white and green as these tones promote healing, facility competence, and motivation for both staff and patients. At the same time, spaces for children are usually colorful, bright, and full of patterns to boost morale.

Mental health units developed by the London-based charity Hospital Rooms bring color to wards and healthcare facilities to provide welcoming and inclusive atmospheres for patients in rehabilitation experiencing personality disorders, self-harm, depression, and other mental health issues. The rooms, founded by Tim Shaw and Niamh White, introduce colorful interiors and exteriors, resulting in an overwhelmingly positive response. [8]

REVAMPING URBAN ENVIRONMENTS

Design Intentions

Engage more senses: public space

- Change in color [visual]
 - Light up [visual]
 - Fluid movement as art [auditory] [touch] [visual]
 - Change the pattern [visual] [touch]
 - Expand, contract [visual] [touch] [sound]
 - Appear/disappear [visual]
 - Spread [visual] [sound]
 - Texture [touch]
 - Triggering smell [smell]
 - Drinking algae [taste]
 - Smell good - trigger appetite [taste]
 - Liquid sounds (dripping, flowing, mixing) [sound] [visual]
 - Frame | env. produces sound [sound]
 - Bacteria/E. Coli responds [visual] [sound]
- TOUCH → AUDITORY → VISUAL
→ TASTE → SMELL

FIGURE 2: Chiara Blissett – conceptual ideation and sensorial design intentions. [9]

Drawing upon sensorial engagement research and color psychology, I generated lists of captivating, abstract reimaginings of urban expanses and the forms they could take. All of these reimaginings engaged multiple types of physical perception. From these lists, my sketches emanated, each expressing a wall that one could interact with and manipulate. Urban spaces should have the embedded capacity to involve the five senses and improve city-dwellers' psychological states, as they could significantly improve human mental health. This could translate to their educational or work-related engagement and success, and reduce the likelihood of burnout.

The final design includes a modular partition system composed of aggregated tiles, each of which is cast from translucent silicone. Each silicone piece appears to resemble a flower embedded with hollow channels and paths. These span to the tips of the 'petals,' which stem from the center. A biopsy punch was used to create a hole in the center of the hollow channel, connecting a syringe. The syringe houses genetically engineered bacteria that secrete color in response to a chemical reaction or a change in their environment. Programmed sensors on the tips of the 'petals' detect the motion of a person passing by, causing the syringes to pump the bacteria into the actuators.

When the movement of the algae occurs, the bioluminescent algae are agitated, evoking a reaction of oxygen within the complex molecule luciferin. This reaction releases the extra energy in the form of cold light. What makes the installation more interesting is that the algae will subsequently dispense a specific color, depending on the time of the day.

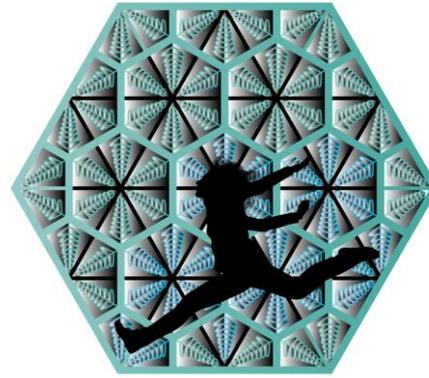


FIGURE 3: Chiara Blissett – A digital rendition of the final wall installation. [10]

The chart below illustrates the range of environments that bacteria are in that cause them to secrete particular pigments at particular times. The intensity and transparency of the hue are reliant on how drastic the changes are in the environment from its previous state identified by the detection bio-brick. The detector passes this information to the sensitivity tuner, which determines how deep the pigment will be. The tuner then translates the pigment hue to the color generator, which then secretes a color visible to the naked eye, hopefully evoking positive user responses.

TABLE 2 : Genetic Program Inputs, Outputs, and Correlative Time [11,12]

Input	Output	Time of Day
↓ Light	Yellow	Early morning
↑ Heat	Orange	Late morning
↑ Light	Pink	Early afternoon/ lunchtime
↓ Heat	Green	Late afternoon
↓ Acidity	Light Purple	Early evening
↑ Acidity	Blue	Late evening

DISCUSSION

How can we reimagine urban environments in a way that doesn't physically restrict us?

Chiara: "Attempting to reimagine the urban spaces we live in today is challenging – the world we inhabit is composed of an inconceivable number of factors, many of which are not submissive. Revamping cities is not necessarily a matter of coming up with solutions to specific problems. Often times, the best designs arise from the miraculous, out-of-this-world ideas that are not produced for any particular reason except to expand the boundaries of what is tangibly possible. But

that doesn't mean the product can't serve a purpose. The purpose should be discovered throughout the process – the abstraction should be the mainstay of each creation. Try to reimagine urban spaces as you know them; the results may be enthralling!"

How can society engage with biology and the static objects around them?

Chiara: "Today you can find numerous ways that scientists and designers are intersecting biology and everyday objects. Attempting to redesign objects to be powered by biology is difficult, but don't be discouraged! Find everyday objects that you want to revamp and find ways that biology could be embedded within, no matter how insane. For example, imagine devices and electronics you use every day being powered by the energy that bacteria produce, instead of requiring electricity – the possibilities are endless!"

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