

# The Image with Temporality by Luminous Bacteria and Digital Screen Printing

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This paper discusses temporality in Research through Design (RtD) through the author's research. The author has been conducting research based on the creation of artworks using bioluminescent bacteria and digital screen printing. This research is divided into two phases: creation as practice and theorizing as research, which progress in a way that they feed back each other. In the practice, the author creates printed images that are transformed over time by bacterial ink. In the research, the significance of the work is considered after the fact by comparing it with theories from multiple fields. In this paper, I would like to organize the temporality in practice, and then consider the significance of a research approach that provides feedback between research and practice. **CCS CONCEPTS** • HCI • Interaction devices • Displays and imagers

**Additional Keywords and Phrases:** art practice, bioluminescent bacteria, digital screen printing, RtD

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## 1 INTRODUCTION

Research based on practice, including in the field of design and art, has been discussed as an approach that differs from the scientific method, which aims to solve problems based on objective facts.

One of the triggers for this is Christopher Frayling's article *Research in Art and Design*[1]. Frayling classified research in art and design into three categories: Research into art and design, Research through art and design, and Research for art and design, and critically discussed the role of each. Among them, Research through art and design (RtD) is positioned as research through the practice of creating artifacts. Koskinen et al. pointed out the ambiguity of the concept of “practice” in Frayling's RtD, and critically inherit its methodology as Constructive Design Research [2]. This is a classification of “practice” into three levels: 1) Lab (research in a closed space such as a laboratory), 2) Field (research in the field where problems occur), and 3) Showroom (research in a place for sharing and discussing such as an exhibition). It could be noted that the perspective presented by Koskinen et al. of dividing practice into phases focuses on the temporal development in the research. In order to discuss this temporal relationship between research and practice in research, I would like to introduce the author's research on a medium with a peculiar temporality.

The author's approach to research is based on the production of artworks and considers the significance of his artworks by comparing them with related theories. Here, “practice” refers to the creation and exhibition of artworks, while “research” refers to the investigation of the background and discussion of the work in light of related theories.

## 2 BIOLUMINESCENT BACTERIA

Luminescent bacteria live mainly in the sea and on the surface and inside the bodies of fish and squid, and are so familiar to us that they can be found on fish in supermarkets. These bacteria emit a very faint light that can be seen by the naked eye. To emit light, the bacteria need to grow at a certain density. This is because a mechanism called quorum sensing, in which the bacteria detect their own growth density, controls luminescence [4]. Individual bacteria emit autoinducers while sensing the density of their proliferation as a group. In other words, luminescent bacteria do not emit light individually, but only when they form a group with a certain density. Some species live in symbiosis with anglerfish and

squid, and function as luminous organs for predation and courtship. Despite these ecological characteristics and biochemical aspects of luminescence, it remains unclear why these bacteria actually emit light.

Furthermore, this bacterium has a unique historical background. In Japan during World War II, luminescent bacteria were considered as lighting devices for blackout operations. Yata Haneda, a luminescent biologist at the time, developed lighting for nighttime activities using luminescent bacteria at the request of the army stationed in Singapore[5]. In Japan, microbiologist Hiroshi Nakamura proposed signs and markers using luminescent bacteria for the evacuation of civilians during a blackout[6].

Referring to their military use of bioluminescent bacteria as visual media, one of the aims of this research is to critically develop them as bio-media art.

### 3 PRACTICE PHASE

An ink for screen-printing live bacteria was developed, referring to examples of the use of luminescent bacteria in wartime. The bacteria were cultured in a liquid medium for marine organisms (Marine Broth 2216) in an incubator at 17 degrees Celsius for 24 hours. Then, 5% gelatin was added to the culture medium and allowed to absorb for 24 hours to form a paste while the bacteria were still alive. The screens were made using a digital screen plate maker (Mi Screen a4). This machine uses heat to make holes in a filled screen from a digital binary image. The screen was placed in close contact with the agar medium, and ink was applied on top of the screen.

In the exhibition, the printed images were shown to the viewer as the bacteria transformed them. Immediately after printing, the image does not emit light because it has not grown sufficiently, but after a few days, the image appears to grow and emit light in the shape of the screen. After that, the printed image collapses and gradually transforms into one large surface due to the growth of the bacteria. Since the bacteria spread to the surrounding area while consuming nutrients from the medium, it is thought that only the outlines of the image continue to emit light after the central part of the image loses light due to the depletion of nutrients. Because of the low light intensity of the bacteria, these works are displayed in a dark room. The viewer sees the images created by the luminous bacteria while experiencing the process of acclimation of the eyes to darkness. This is a physiological response of human vision called dark adaptation[7]. There are photoreceptors on the retina that are active in light and dark conditions separately. Dark adaptation is the time required for these to switch. During this process, the two types of photoreceptors are in an antagonistic state, which accentuates individual differences in brightness and color perception.

The author has produced four works using this technique. One of them, *Inter-control* (2023), is related to temporality(Fig. 1). In this work, the date and time of printing were printed. Printing was done approximately once every five hours, and a total of 25 sheets were displayed during the five-day exhibition. As mentioned above, during the production process, incubation must be started two days prior to the printing to ensure that the printing is completed by the time the exhibition begins. In other words, the production process is determined by the bacteria. In addition, to maintain the bacteria's survival, they need to be passed on and supplied with nutrients once a month. In this work, the use of luminescent bacteria as the material emphasizes the bodily adaptation of the artist to the luminescent bacteria, requiring him to adjust his creation procedures to the luminescent bacteria.



Figure 1: *Inter-control* (2023)

#### 4 RESEARCH PHASE

These works have been discussed within the theoretical frameworks of 1) image processing, 2) communication and media theory, and 3) animal theory.

1) Regarding image processing, I have discussed the critical significance of digital images in relation to the author's work and the approach of video artists in the early 1960s [8]. Video artists of the time transformed television “deliberately maladjusted” through external approaches such as feedback using magnets and cameras [9]. On the other hand, modern computer image processing is well-adjusted to computerization and display. The author considers the critical significance of these and other luminous bacterial works for digital images by positioning the practices of microorganisms and images, such as Alexander Fleming's germ paintings [10], in which he painted pictures with microorganisms of various colors, as image processing by microorganisms.

2) From the perspective of communication and media theory, I discussed the theory of John Durham Peters [11], who pointed out that digital technology is returning “media” to its original meaning of *milieu*, and emphasized the importance of nonverbal communication. Peters emphasized the importance of nonverbal communication [12]. I introduced the author's work to critically discuss this idea in concrete form, and compared and examined the classical media theory of William Ivins Jr.'s theory of print culture and Marshall McLuhan's theory of television [13][14].

3) From the viewpoint of animal theory, the significance of luminous bacterial works was discussed based on the concept of Attunement proposed by the philosopher of science Vinciane Despret [15]. Citing examples such as Hans the Wise, the horse and the rider, and the rat and the scientist, Despret referred to Attunement as a mutual relationship in which humans inspire animals and animals in turn inspire humans at the physical level [16]. This concept has been developed into a discussion of emotions and feelings with relatively higher animals. By applying this concept to the author's work, I examined what kind of Attunement is possible for microorganisms that differ from animals.

#### 5 DISCUSSION

The bacterial growth and human dark adaptation we have seen so far can be said to be the temporality of the artifact, and the points emphasized in the inter-control can be said to have a specific temporality in the production process.

Finally, we would like to consider the relationship between research and practice. In this study, we have examined the characteristics of these works and productions by connecting them to media theory and animal theory. This approach may allow us to seek a way of describing the physical specificity of the work that does not prescribe it to a unified context.

The method of this work is to refer to wartime Japanese use of the work, and then to translate it into the work, adding a new context from a contemporary perspective. Such a connection of history and theory to practice allows us to see the possibility of artifacts different from those originally intended. More to the point, to take into account that it was once used for military purposes, one can become aware of its negative aspects by looking at one's own practice in a self-critical manner. By taking this into account and feeding it back into our own practice, we can maximize its potential while at the same time confronting the dangers it entails.

I have discussed the temporal structure of this study. Even though this is a unique case, we have divided the temporality that may be included in design research through practice into phases of practice. Furthermore, by connecting it to theories in other fields and examining definitions after the fact, we can find the possibility of more multidimensional artifacts. We believe that this will lead to a more multifaceted product.

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