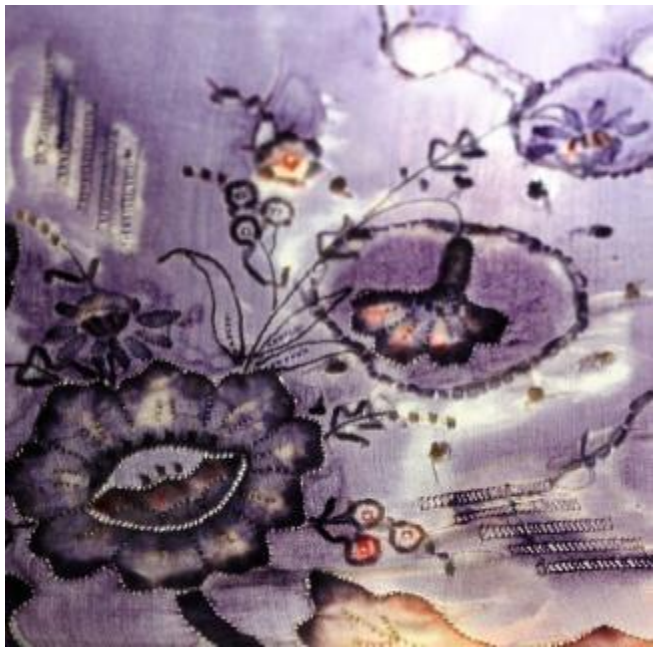
COMMUNICATING BACTERIA

Anna Dumitriu

The *Communicating Bacteria* Project combines bioart, historical textile techniques and 3D mapped video projections to explore new research currently being undertaken in the field of bacterial communication, to engage a wide audience in the field and increase debate and understanding of this potentially new form of infection control. The project is funded by The Wellcome Trust.



"Communicating Bacteria" by Anna Dumitriu, medium: antique embroidery, contemporary embroidery and bacterial pigments. Photograph copyright Anna Dumitriu.

Bacteria have intricate communication capabilities, for example: quorum sensing (voting on issues affecting the colony and signaling their presence to other bacteria); chemotactic signaling (detecting harmful or favorable substances in the environment); and plasmid exchange (e.g. for transfer of antibiotic resistance genes). This is now being investigated as a form of social intelligence as it is realized that these so called 'simplest' of life forms can work collectively, obtain information about their environment (and other cells) and use that information in a 'meaningful' way. Using signaling chemicals such as *Homoserine Lactone*, the bacteria pass on messages to nearby cells, which can be either part of their colony or other living cells (including eukaryotic and plant cells).

The project is led by artist Anna Dumitriu; in collaboration with microbiologists Dr Simon Park and Dr John Paul, and video artist Alex May. Dumitriu's long-term artistic practice is focused around microbiology and collaborative practice. *Communicating Bacteria* [1] builds strongly on her earlier work – including *Cybernetic Bacteria 2.0*, a digital media installation presented at ISEA 2010 – and current role as artist in residence on the on the UK Clinical Research Consortium *Modernising Medical Microbiol-*

ogy Project at The University of Oxford, Nuffield Centre for Clinical Medicine, which looks at the changing face of medical microbiology in light of the possibilities of (near) real-time genome mapping of bacteria and developments in bioinformatics.

The importance of the public understanding of microbiology cannot be understated. Many businesses play on public fears in order to add value to their products, while newspapers and TV shows fill our minds with images of bacteria as armies of tiny monsters ready to attack unless we buy some new hand wash or detergent.

The infection control potential of interfering with bacterial communication and quorum sensing mechanisms is at an early stage, however it is known that:

This 'census-taking' enables the group to express specific genes only at particular population densities. Quorum sensing is widespread; it occurs in numerous Gram-negative and Gram-positive bacteria. In general, processes controlled by quorum sensing are ones that are unproductive when undertaken by an individual bacterium but become effective when undertaken by the group. For example, quorum sensing controls bioluminescence, secretion of virulence factors, sporulation, and conjugation. Thus, quorum sensing is a mechanism that allows bacteria to function as multi-cellular organisms. [2]

Therefore, the ability to block the receptors that receive quorum sensing signals would lead to bacteria that are no longer able to turn on those processes. To be able to block the expression of virulence factors (such as bacterial toxins) would render highly pathogenic organisms far less dangerous. Further down the line an understanding of the exact signaling mechanisms might even lead to the possibility of directing the behavior of bacteria.

The *Communicating Bacteria* Project involves the development of a body of new work, including: textile designs stained with dyes made from bacteria that change colour depending on the behaviour and communication of bacteria, crochet patterns based on bacterial responses, interactive interventions that are modeled according to behavior and communication between bacteria, and a series of hacked antique whitework embroidered pieces created using genetically modified bacteria.

Textile art has a long history of communicating difficult and complex stories and ideas, from the Bayeux Tapestry to the AIDS Memorial Quilt. The soft qualities of the fabric and the skills of the makers help to reach out to a wide audience of all ages. Dr Simon Park had previously created a number of previous works involving the staining of cloth with bacterial pigments (and slime moulds) and his expertise and inspiration was integral in the development of this project.

The antique whitework (white on white) embroideries are worked in to by hand with delicately stitched images of bacteria and communications networks. Dumitriu's modern stitches are far heavier handed than those of the original makers, creating an interesting juxtaposition. Additional patterns are created using a genetically modified strain of*Chromobacterium violaceum* called CV026. *Chromobacterium violaceum* is white in its natural state but turns purple when it receives a communication; but, since bacteria grow in colonies and individual bacteria are continually sending and receiving signals it always appears purple. However, the CV026 strain is effectively mute. It can receive a chemical communication signal but cannot send one, so it only turns purple in the presence of a communication from another bacterium. When exposed to unmodified *Chromobacterium violaceum* it slowly turns purple as the chemical signal spreads.

Around the time of the enlightenment, the perversely difficult practice of whitework embroidery was considered to be one of the highest levels of achievement for a woman. They would sew in the evenings by candlelight, straining their eyes to see the tiny stitches, hunched over their embroidery hoops, their bodies twisted and constricted by tight corsetry, one pinprick of blood meaning the whole piece would be ruined. This coincided with the period in which many of their male counterparts started to become 'gentleman scientists' and to rigorously study the world around them 'scientifically.' This was the time when the scientific method was developed and disciplinary boundaries were drawn between art and science. By juxtaposing whitework with her scientific practice, Dumitriu considers these paradigmatic changes in the process of research and current moves towards transdisciplinarity, alongside a consideration of what 'feminine' approaches to science might mean.

Central to the installation is a stunning antique Edwardian whitework dress, with Dumitriu's additional stitching and a purple pattern created by the process of bacterial communication. The dress was laid out on a one meter square agar plate (a makeshift Petri dish from a DIY centre normally used for mixing concrete and sterilized with ethanol), inoculated with CV026 and left to grow, be absorbed into the fibers and travel along the fine stitches. After a day or so of incubation the white CV026 was exposed to the *Chromobacterium violaceum* and the communication signal traveled across the fabric as the white bacteria turned purple. This process was filmed using time-lapse photography and the resulting film was projected, using 3D video mapping technology (developed by Alex May) across the dress and related objects within the final installation. The dress having been dried, sterilized and made safe.

The project continues to be developed and work is now being undertaken to develop methods to exhibit the process taking place live and run participatory sessions working with the team. This entails the development of a modular Category Two bio-containment facility that can be constructed within art gallery settings, whilst fully conforming to health and safety requirements and enabling a much deeper level of engagement and understanding of these complex microbiological processes through a powerful and experiential artistic approach.

References and Notes:

1. *Communicating Bacteria Project Official Website, http://www.normalflora.co.uk (accessed June 28, 2011).*
2. *Bonnie Bassler's official website at Princeton University, http://www.molbio.princeton.edu/index.php?option=content&task=view&id=27 (accessed June 28, 2011).*