Agents of Spatial Influence: DIARA Methodology Diagnostic

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SITUATION

In a world connected by omnipresent technology, we are increasingly isolated from each other. Instead we turn to machines for comfort, like the computer from "Her" or robotic Aibo dogs for the elderly. We don't realize that machines are algorithms coded to influence us, nudge us to a predetermined agenda, and change the way we behave with each other ethically. To truly connect with each other, we have to know how we relate to our digital tech and machines, to know how we desire, fear, and interact with our devices. We have to know ourselves.

One of the emerging technologies that threaten to influence and change our future is bioprinting. The ability to make organs on-demand, produce living cell matrices for experimental research, and generate skin and tissue replacement, threatens to redefine our biological identities. With such power of creation comes the responsibility to understand what we can do to ourselves and how technology changes our humanity. We need machines that relate to us in human terms, providing human-like gestures that show connection with us with personality and engagement, such as shy lamps, arrogant surveillance cameras, and flaky chatbots. Instead bioprinters like the RegenHUD Discovery600 and Advance Solutions BioAssemblyBot are impersonal, expensive devices manufactured to satisfy growing pharmaceutical and medical devices markets, giving their clients powerful tools that they themselves hardly know how to use.

In order to put humanity into bioprinting and resurrect our relationship with our machines for a sustainable, humane future, we develop a bioprinter named DIARA that communicates with humans by reading gestures, expressions, and emotions, and locomoting in 3D space and extruding hydrogel material in response. Born on 2020-02-22 from salvaged parts of the remains of a Monoprice mini 3D printer, DIARA has been documenting her growth on Twitter via a photo and text feed that updates her latest interactions with people. Slowly gaining the ability to extrude biomaterials from her creators, DIARA is learning to interpret human gestures using a Kinect camera, and human expressions and emotions using the Unity Affdex package (as in https://youtu.be/ZTeKU1SBXUk). With each new dimension of human interaction, DIARA gains new ways to locomote its printhead for extrusion, interpreting arm gestures like sliding as movement of the head, facial expressions like eyebrow raises as moving to the back, etc. This project investigates nonverbal languages that bridge human and mechanical locomotion, like the way our gestures are interpreted by robots, and robot gestures are interpreted by humans spatially. DIARA extrudes biomaterials based on alginate, calcium chloride, and agarose for edible consumption by humans. We are also investigating mycelium, potato starch, and cellulose nanofiber as extrusion material.
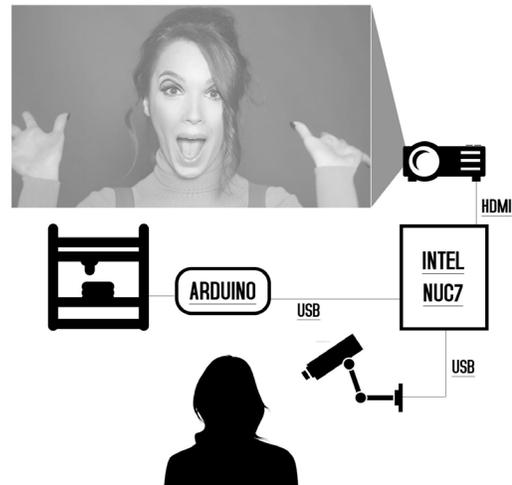

Figure 1: Exhibit plan using a webcam to capture human face, detect emotions and expressions in Unity on the NUC7 computer, and use that to control motors in the bioprinter. Expressions can also be viewed for feedback on projection.

NARRATIVE

The exhibition plan consists of a camera connected to a computer that forwards detected facial expressions and hand gestures into communicative cues for the bioprinter (Figure 1), making it move in different directions as it extrudes material. The viewer can also see her own gestures and emotions being recognized by the system in the projection.

It is expected that Audiences will view the bioprinter as the most novel and interactive part of the installation. As the audience journey shows (Figure 2, and also as a prototype online here: https://www.figma.com/proto/J2KCKkWqWeSB5w85Ac7qs9/DIARABioprintDemo01GIF), human gestures and expressions will be coordinated with specific locomotion of the printer head. For example, when the audience raises the eyebrows, the machine will move backward; when audiences act sad, the machine will extrude a curve that looks like the lips of a sad face.

The audience may be surprised by the interaction of the machine when it doesn't do exactly what the rules dictate. One challenge I foresee is having to structure the interaction so that the audience is doing a sequence of actions that lead to a specific outcome. We may have to give them directions on what to do, but this also violates the spontaneity of the interaction. Part of the fun may be seeing their own gestures and emotions recognized by the computer on the projection and reacting to see what the bioprinter is doing at that time. However, when they look in that direction, the tracking of the face may be lost, so that only the arm gestures would still be recognized.
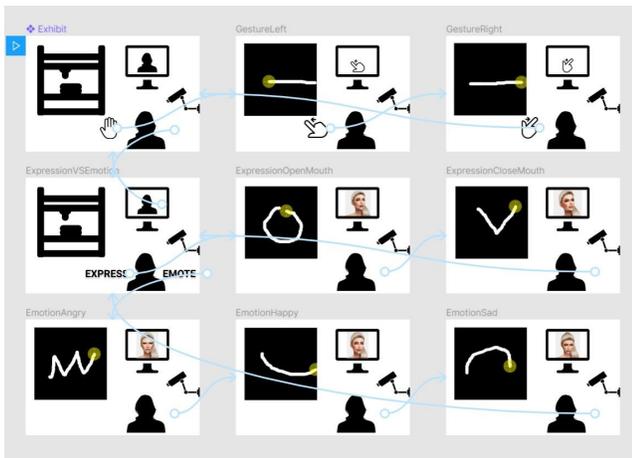
Figure 2: Storyboard of interaction. Audiences will see the interactions on the screen as well as on the printer-extruder. One way to interact is with arm gestures swiping left and right (upper row), while another is using facial expressions like mouse opened and mouse closed (middle row). The facial emotion of audiences can also translate to stereotypic actions of the bioprinter, like angry or happy faces (bottom row).

QUESTIONS

These challenges bring up the question of how to design an interaction that is engaging in that audiences can use their own gestures and emotions, but is still constrained enough that machines can interpret the gestures correctly and make some locomotive movement that reflects that. In particular how predictable do the movements have to be? Perhaps we also want to let the machine take liberties to keep the audience guessing.

Another pressing matter is whether we can make the interaction into a game. Currently there's no real direction in terms of what the audience need to do to communicate with the machine. My current proposal consists of the machine working on the print (biomaterial) throughout the course of the exhibition, as a way to reflect the many influences of the audiences that came before it, making different gestures that all contribute to the print. The pattern is not determined and the interaction has no "optimal" direction. At the end of the show, DIARA will make a tweet to her Twitter account showing the final edible product. However, another way to do this is to make a specific piece like a wedding cake or layered cake or a honeycomb pattern. In this case the audience has to use their gestures to move the machine in the appropriate way to allow this to happen. In this case there's a right and wrong, but the output is necessarily going to be different from the conception, making it a gamified process whether the audience gets close to the ideal specified by the computer.

As we envision it, the most critical need currently is to make the bioprinter work, make the interactions work in some way, and then determine whether a guided interaction or free-formed interaction would serve our purpose better. Meanwhile we'll continue with development of the persona of the bioprinter

DIARA as an artifact of a refurbished parts machine, with growing understanding of the world of human nonverbal communication, so that it gains a character that can be used to drive people to empathize and discover her more, online and off. These two points combined would continue bringing people to the exhibition based only on the idea of bioprinting and a unique machine that replies to human interaction. The details of the interaction needs to be tested, be it a proscriptive approach or a free-form approach.