The Art of Networking

Sarah Grant

Sarah Grant, visiting lecturer at Die Angewandte in Vienna and previously guest professor for New Media at the Kunsthochschule Kassel, has a background as a professional web developer and an artist. She studied art, in particular sculpture and printmaking, completing a masters from NYU at the Interactive Telecommunications Program in media arts.

Even though I have a technical background as a programmer, my relationship to antennas, radio waves, and the electromagnetic spectrum is experimental rather than practical. When I say experimental, I mean working somewhere at the intersection of bio art and networking engineering. When I work with electromagnetic waves, specifically within the Wi-Fi bands, or with the design and construction of antennas, it is from an exploratory point of view. I started exploring antennas as sculpture in a project with my partner Danja Vasiliev, called *LANscapes*. It is a research project in merging the practices of environmental art and network engineering. We started this work at a residency at Ljudmila in Ljubljana, Slovenia.[1] We chose a landscape and studied it in order to design experimental antennas and other potential components of network infrastructure, for example signal paths. Our goal was to create an envi-

1 Documentation of the residence is available on the website of Ljudmila: https://wiki.ljudmila.org/Rezidenca:%20Grant%20&%20Vasiliev (accessed 22.03.2022).

ronmental network as an art installation, with bio-electrical hybrid versions of infrastructure.

Following this experimental approach to reimagining communication networks, I visited the Critical Media Lab to collaborate with Selena Savić and Yann Martins to model cooperative housing with the assistance of an organism called *Physarum polycephalum*, or slime mould. Slime moulds are single cell amoeba creatures, that creep around forest floors looking for food. Once they find food, they surround it with their cellular body and create networks of protoplasmic tubes between all of the food sources. I was interested in slime mould because it is known for creating efficient resource distribution networks. I wanted to see if I could model different kinds of networking topologies with how I placed food on a surface. As you can see in this picture, the oat flakes have been dyed red and so as the slime mould consumes or breaks down the oat flake, it distributes the nutrients and food pigment throughout its body. I used food dye as a visual marker for tracing how information flows within a slime mould's protoplasmic tubes. At the conclusion of this project, Selena and I wrote an article summarizing the results of our experiments using slime mould as a computational resource distribution network.[2]

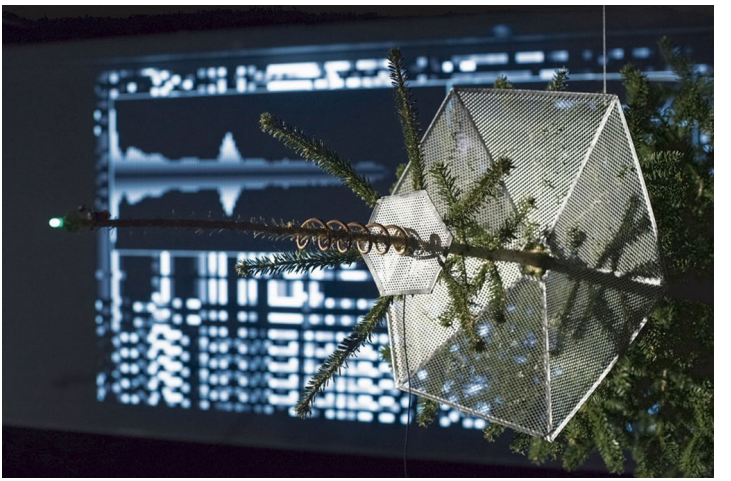
From a broad perspective, I am interested in thinking about how connections are made, specifically about data transfer using an organism like slime mould or a physical phenomenon like electromagnetic waves. However, since EM waves are intangible and given my background in sculpture, I am left longing for some kind of texture or tangible interface for understanding and interacting with this medium. This is part of the reason for why I am drawn to looking for models of networks within nature.

When we went to Ljubljana to for the *LANscapes* residency, we had this very abstract idea inspired by the fact that network infrastructure,

2 Selena Savić and Sarah Grant, "Slime Mold and Network Imaginaries: An Experimental Approach to Communication," *Leonardo*, July 21, 2022, 462–67, https://doi.org/10.1162/leon_a_02248.

data centres, antennas and wires, are usually just dropped into a landscape without much regard for the environment. We wished to identify processes or features found within the environment that mirror network infrastructure. We looked for a way to work together in collaboration with a given environment in order to make designs inspired by and in partnership with nature, such as new kinds of antennas or other parts of network infrastructure. In Ljubljana, we first tried to make the tree itself an antenna. We came across some very old papers from the time of World War I when people had already been trying to do this with some degree of success. We planned to follow what we were reading in these papers in order to replicate the experiments. However, we were blocked from pursuing this by city regulations; we were forbidden from doing things like inserting metal stakes into the tree trunks, which unfortunately was going to be part of the process of turning the tree into an antenna.

Figure 1: LANscapes installation at Ljudmila, Ljubljana, December 2019.



Courtesy of Sarah Grant

We decided to make our own reflective dishes that the tree could 'wear'. Additionally, since we were not able to get the permit in time from the city to do any work in a public space, and because this was as well happening in December with Christmas trees for sale everywhere, we ended up using a Christmas tree as our test tree for which we designed experimental kinds of antennas. This was not the direction I had originally envisioned, as in doing this we are still placing manmade infrastructure on top of nature – literally dressing a tree up in a spiral coil and collar – but it was all we could work with.

In the end we set up a stage performance with a few different trees wearing various antennas that were designed for them. This one in particular is a Wi-Fi antenna. It is really the very beginning of these experiments because after all, we only were able to scratch the surface of this line of thinking and prototyping.

Discussion

Selena Savić: Speaking of antennas, what I understand as a very general working principle is that electrons in the metal are getting excited and moving through the material in a sort of a pattern that creates the electromagnetic field and transmits this pattern to another antenna. This is actually the information. What is it that you can do in this engineering space? What is it in the antenna that lets you do different things, working at different frequencies? Or what do you need to know about antennas that lets you play with them?

Sarah Grant: My relationship to antennas is more about the forms that they take. It is a sculptural point of view, although I also take seriously the fact that they have to transmit properly at their assigned frequencies. Antennas are typically designed to transmit information as efficiently as possible. They are designed for a very specific use. My work here is not art for art's sake: what I wanted to intervene with, as an artist who also appreciates the technical qualities of an antenna, is to think of experimental forms an antenna can take while still performing its intended func-

tion. It is more about reimagining how the antenna looks, than about its electromagnetic properties, while still keeping those in mind because I want to make antennas that actually work.

Selena Savić: This reminds me of DIY projects that teach you how you can extend your Wi-Fi network range by making antennas and other kinds of things. I have tried to make such antennas a while back, and I remember that there were very precise instructions about dimensioning their square wave shape, how to bend the wire at precise distances relative to the wavelength of that signal. And then there were other materials that had to be introduced on top. I remember from that design that I would not be able to intuitively figure out how to make such an antenna, or why the antenna I made is not doing what I am expecting it to do. In other words, the form of an antenna matters for its operation. You were obviously able to make antennas that work, so I was wondering, how do you know what you can change, where you can intervene?

Sarah Grant: I appreciate the fact that there is a lot of skill and training that goes into designing an antenna. I am typically on the software side of things, and I have lots of experience dealing with different kinds of software issues. When it comes to doing things like building antennas, I take a completely experimental approach, and I think it is good to be kind of naive. When I do not know what I am doing, it does not hold me back from trying unexpected things, and figuring out how to make it work.

On the other hand, of course, I kind of know what I am doing. I understand the basic idea about how certain antennas for certain frequencies should look like. One thing that is important for my practice and also for all other members of our art studio Weise7, is that we do not want to just play around with something. We actually do want things to work. This is because we all have these deeply technical backgrounds. It would bother me to make something that spoke to an idea, but did not really see it through all the way to the end of actually working.

Roberto Bottazzi: What is the link between slime mould and antennas? Is it something that you want to or have been pressing further?

Sarah Grant: My work with slime mould is not an antenna experimentation. The work with slime mould is in the domain of network topologies and attempts to model what happens in software in terms of creating efficient networks. I rely on what seems to be innate to the slime mould nature, to know how to do that.

Roberto Bottazzi: Do you think that because slime moulds were used to model cities, such as for example in the Tokyo rail network experiment? Would you say that is the nature of radio signals that makes the slime moulds incapable of modelling a network like a network of antennas?

Sarah Grant: I think slime mould is capable of modelling any network. But the thing that is interesting about it, is that the slime mould obviously does not know what I am trying to model with it, a computer network or a city. The way it behaves could be applied to all kinds of networks and at the end of the day, it does not actually matter what kinds of networks we are talking about – if it is about railway stations or the design of a freeway or a computer network or a network of antennas. A network is a network and it has its particular computational function. Slime moulds are an interesting creature to work with when exploring how to model networks under different environmental conditions.

Importantly though, we cannot just cut and paste slime mould's behaviour into a human experience or a human reality. It is not a one-to-one relationship. What I do is to take a phenomenon which is in this typically technical realm, for instance a network, and step to the side to see how a network manifests in a slime mould when it is trying to eat food. I observe any insights that I can gain from that. I intentionally put myself in these situations where the outcome is uncertain. It is possible that something really amazing would come out of this or that absolutely nothing would come out of it. I am looking for bridges: modelling a distributed network with slime mould, seeking to observe something of interest, which I can then take back into computer networking, but which maybe just would not fit.

Roberto Bottazzi: It is totally right what you said about that slime mould, it does not really care if you are using it to simulate a city or anything else. That is also the case for a Turing machine. A Turing machine is not built to model or simulate anything in particular. I wondered whether, in case of radio signals, an attempt to model them with slime mould would be problematic because they are essentially not the same kind of thing. In fact, the opposite could have posed an interesting condition: to model radio signals with something that was not thinking that way. Because slime mould still thinks, but it does not think in radio waves, it does not think of space in that kind of format.

Sarah Grant: Maybe there is some other creature that would be suitable to model radio waves. It seems to me like a lot of engineering problems that we face have been solved by different creatures and organisms in biological processes that have existed for millions of years. It sometimes feels like we are reverse-engineering the world so that we can use these behaviours or phenomena to control things for our own ends.

Selena Savić: It is a very interesting problem to think about, looking at the way you present your interests in engineering: engineering practice being a code that you apply to the question of networking. Networking taken as an abstract term, which happens in the body of the slime mould, or which happens also in our engineered network infrastructures for communication. I think this material practice of making an antenna somehow encodes it in a certain way and also distances itself from pure efficiency. Technical problems of communicating across a distance have been solved in many ways, and while it can always be made more efficient, the question is what do we actually know about it? How do we organize this knowledge of telecommunication? To what extent do you know what is going to happen and how do you make something happen? It is a process of distancing from simply solving the problem.

Sarah Grant: I think about this quite a lot. If you remove the requirement that something is perfectly efficient, it opens up a lot of possibilities for other forms that something like at an antenna could take. The other rea-

son I am drawn to doing experiments like this, even if it results in a less efficient antenna, is an attraction to knowing how these particular technologies work. I would say this is my aesthetic. Not everyone cares to think about all those things, even though communication networks and antennas are so present in our environment. It is not even that they are embedded in our environment, we are embedded in their environment really. I do like to make work that brings some of these things to attention in a way that is more visually appealing, in a different visual language, in a way which might cause people to think about these networks as part of themselves, something we are born into, and participate in.