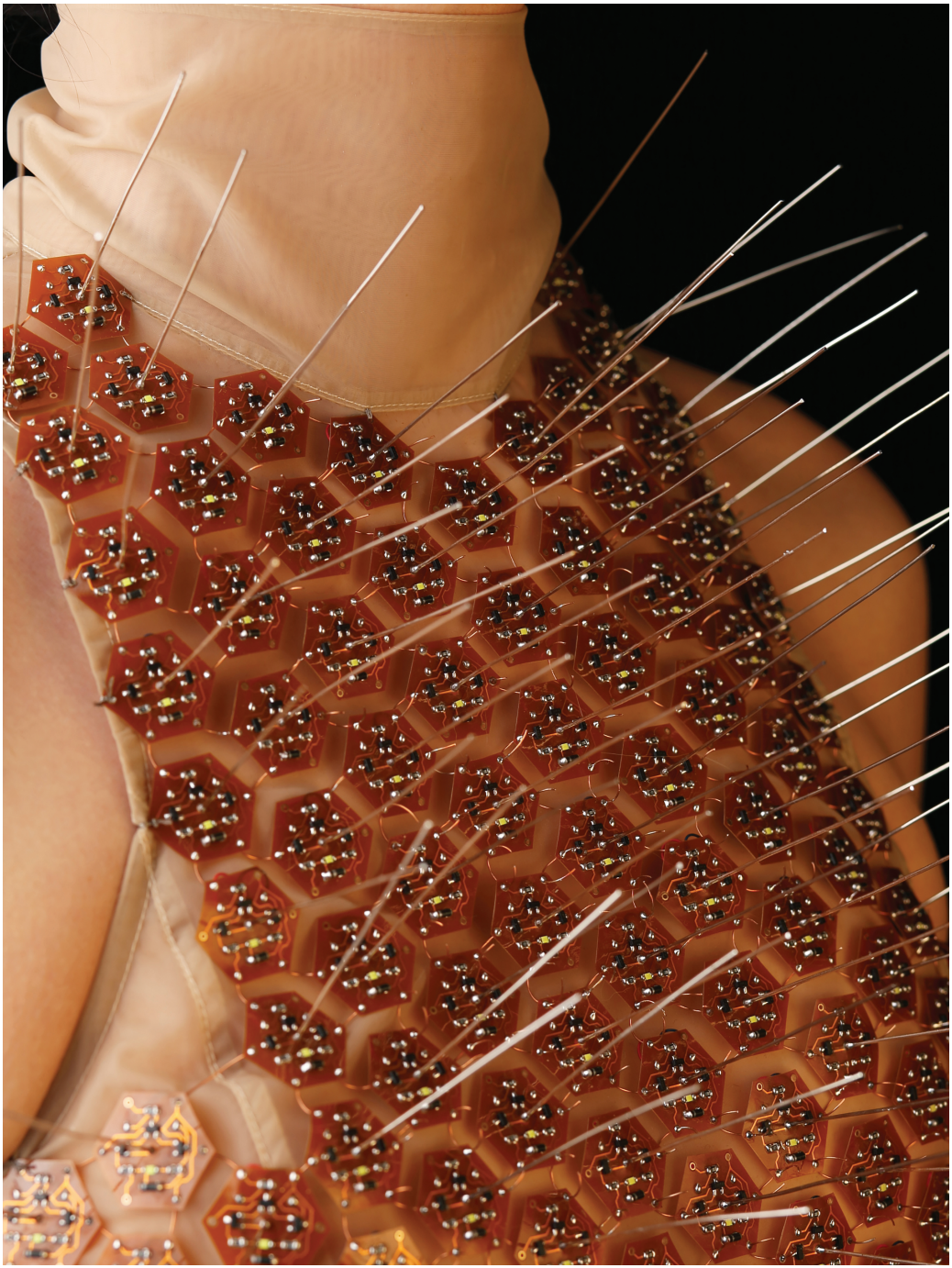

**Vivian Xu**, The Sonic Skin (2018).

# Radically Rethinking Sericulture

Vivian Xu

*The individual is always in interaction with her environment, a coupling that enables different identities to stabilise over time – the silkworm and the mulberry tree. Non-life also features in these couplings, but its status in the relationship is far from clear. Where does non-life end and life begin? In this interview, Vivian Xu asks what it means for technological systems to be understood as a natural part of this mix.*

**We are more comfortable thinking of living systems and mechanical systems as separate – life versus non-life. In the realm of interactions between them, where might a different understanding of that relationship be possible?**

A large part of my practice is based on the study of the machine –animal continuum. Humans have long explored conceptions of life through technology (for example, through mechanical automata imitating living systems), but what intrigues and inspires me in a contemporary sense is a relationship between mechanical and behavioural systems (chemical and biological) that interface the unpredictability of the living with the controlled (predictable) behaviour of the machine. It is one that complicates our understanding of both – of the machine, and of life. In my eyes, it is electricity that unites them in action and interaction: Digital machines operate through electronic circuits, electricity serves as a medium for digital communication, and, in the case of the biological body (whether it is the nervous system or DNA), electricity acts as a medium for biological communication. It is electricity – as medium and communication – that breathes life into both.

So, I find myself adhering to a more bionic view (electromechanical, if you will) of the relationship between life and non-life. I am especially inspired by Manuel DeLanda's vision of 'Nonorganic Life' (1) that tries to re-examine that relationship. What I draw from DeLanda's work is that the boundaries of life, or categori sation of life, is subject to fluctuation and open to challenge: This is especially true in today's world. In this understanding, our concept of life changes in reference to the perspective of the subject, i.e., what counts as life is intimately bound to the eye of the beholder. What we perceive as life often exists (and transforms) in a similar timescale to us, and so, because of this, appears life-like. This is the reason why we perceive plant life to be 'more alien' than mammalian life. If, however, we could set up a camera to capture the formation of geological landscapes over time and play that captured footage back at high speed, we would discover that they too exhibit behaviours that are life-like. They appear to self-organise, can be highly active and generative, and are open to change from interactions with other entities. Matter is constantly changing and rearranging in time ; so it is just a matter of whether we are able to perceive it or not. Eastern thought emphasises concepts that are similar to this – ideas which are becoming more and more prevalent in contemporary western philosophy.

## How do these ideas around the machine – animal continuum find expression in your work?

My work 'Living Devices' is the first of several explorations dealing with hybrid systems, where the system relies on both parts as a whole to function and generate meaning. Here, the device uses the electricity generated by embedded circuits to control a petri dish environment, generating a changing electromagnetic field that modifies the growth of bacteria into different patterns. The circuits are simple, running electricity between two node clusters to form a closed circuit through the agar (using the agar essentially like a wire). But because the agar is a conductive medium, the

path of the electrical current is more unpredictable than a wire, creating an electromagnetic field around the nodes. Affected by the field, bacteria may grow or not grow in different sections of the petri dish. Paired with various seeding designs and patterns, different end results can be generated. Originally, I worked with *E. coli* for practical reasons, but it would be interesting to continue this project with more exotic bacteria that have a greater sensitivity to electricity.

'The Silkworm Project' develops these ideas surrounding machine design and life further by working with animals that, themselves, have a more productive and interactive relationship with their environment. As part of a larger body of work called 'Insect Trilogy', I have been looking at three insect architects (silkworms, ants, and bees) with the aim of designing machine environments and a machine logic that create an intelligence system different from our (and their) own – a new bio-electronic ecosystem. 'The Silkworm Project' poses questions around production and autonomy in the designing of machine systems, creating a machine environment in which the spatial perception of the silkworm is hacked, causing it to spin self-driven, organic, three-dimensional silk structures.

**Activity in these `new ecologies' emerges in time, meaning that its different components – the silkworm and the machine – must interlock purposefully at each step. How does time play a role in this work?**

As a former film student, I am particularly interested in the nature of time-based media. For me, a biological medium is a time-based medium; but whereas film unfolds temporally within a VR, organic life unfolds over time in the physical world. A recreation of organic life is a recreation of an 'all together' time –space reality within an organism. Much like the internal film time inherent in the virtual world of the screen-based narrative, bio medium also has its inherent time – the circadian clock or biological clock.

Inherent time in the organism provides the scale on which the experiential reality of the organism is generated. When growing silkworms, time plays a crucial role in the determination of the worm's life cycle. Worms hatched in the beginning of April grow larger and have longer cycles than worms hatched in the beginning of May. This method is, perhaps, a rather simple and crude way of manipulating time in life-forms, but, if we consider the rapid developmental speed of current biotechnologies, there may very well be technologies in the near future that can change the 'frame rate' of living beings. Though it is near impossible to understand the internal reality of a worm (or any animal), one can speculate on how such technologies might change the experience of time for an organism and introduce an alternative sense of reality.

What, then, is an artist language based on the manipulation of biological media? What, then, is meaning in bio media? My goal in 'The Silkworm Project' is to try and negotiate between the biological time of the organism and the technological time of machines in order to find an equilibrium between the two. New realities revealed through new tools bring about new challenges of perception. Accordingly, we need to adjust our understanding of the world to better reflect the tools (both physical and conceptual) we use to generate new understanding. The purpose of redefining our definition of life is, therefore, to reflect the new realities that have been exposed. To hold on to historic models of perception is like trying to solve modern-day crises with Renaissance toolkits. Or, worse yet, blinkered by old models of perception, we may fail to foresee new challenges that loom immediately ahead. With 'The Silkworm Project', yes, I am interested in how technological and biological systems can generate a new coherent 'whole', but I am also interested in how we might play with the historical logic behind the development of computational and digital technologies. While the start of the information technology age was strongly influenced by the culture of weaving and textile production, I want to use digital processing in my work to influence the organisation of silk production straight from the

silkworm's own mouth. This is a different way of modelling the relationship between technology and life through new types of machine life that lock them intimately and coherently into each other.

**In `The Silkworm Project', an individual silkworm is faced with a new environment – one shaped by new technological parameters. You have suggested that a unique internal logic emerges in this new ecology. Is that logic one of an experimental `disorientation' or `adaptation' for the silkworm?**

This is not so easy to answer. Originally, I worked on creating an electro-stimulation grid that could ideally both stimulate specific animal behaviours and support a successful spinning environment. Here, the silkworm would be acting as both the input and output of the system. The end result, however, was a machine that was not able to properly function. For one, although silkworms are able to respond to electro-stimulation (because it can tap into their nervous system), I was unable to identify an ideal current range where a desirable behavioural reaction could be triggered in the worms without harming them. This forced me to look at spinning behaviours in a new way. I adjusted my approach from designing with the silkworm (i.e., using the silkworm as a tool influenced from outside within its environment) to thinking about how to design *for* the silkworm.

I started conducting my own spatial spinning experiments with silkworms, looking at how the insects navigate through space individually and collectively. For the collective experiments, I cultivated silkworms that produced multi coloured silk using both the Singaporean method, based on feeding coloured feed to the worms, and the Japanese approach of genetically engineering silkworms. Through colour tracking methods, I was able to observe the negotiations of two worms spinning in a common space and building upon each other. It was surprising to find that there were very few errors or overlap in their collaborative silk spinning, with the spatial

territory of each worm clearly marked through colour differentiation. Using basic properties of their own bodies (morphology, size, and shape) almost like a measuring stick to help predict and understand their environment, paired with a building process honed over thousands of years of evolution, the silkworms bypass a top-down spatial blueprint methodology in favour of a bottom-up responsiveness to local conditions – one that can generate an ever-changing array of spatially expressed silk-spun forms.

The goal I then set myself was to disrupt this equilibrium of insect perception, i.e., to introduce a new environment that generates spatial blind spots – a property that can be harnessed to create new types of spun-silk structures. This new environment includes a glass chamber where the curvature surface of the glass prevents the fully developed healthy pupa from identifying the corners and angles it would normally use to build a three-dimensional framework for its silk construction. The size of the jar is determined by the size of a healthy pupa, where too-wide a circumference would result in flat silk weaves, and too-steep a curvature would result in a fully formed cocoon. A vertical spinning motion of the chamber affects the silkworm's sense of gravitational pull, where the slow spinning provides a constant change of gravitational direction, thus confusing the insect's spatial orientation. It is essentially a machine that reflects the space beyond the silkworm's own perception. Though my experiments may, at times, yield interesting results, they are often hard to replicate.

**To understand sericulture, we need to look beyond the immediate ecology of the individual silkworm. Can you tell us a little more about the wider sericulture ecosystem and how it brings together living bodies, technology, and human culture?**

The relationship between Chinese people and the silkworm is very complicated. In our history, the advent of sericulture came before the invention of the written language. Its beginning is often attributed to the first Empress of

China: The story goes that she was sitting under a tree drinking steaming tea one day and a silk cocoon fell into her cup and unravelled into a continuous strand of silk. Though a romanticised myth of the beginning of silk reeling, rather than historical fact, it does go to show just how ancient this industry truly is. Up until the European medieval period, when sericulture started to spread across Europe, silk production was still largely centred within China (with the exception of Japan and India). As a luxury product, it was the basis for economic exchange between East and West via the Silk Road. Early weaving technologies (like the Jacquard loom) went on to inspire the invention of the computer.

Those new to sericulture may fail to realise the immense human labour needed to care for hundreds or thousands of silkworms. In the summer of 2019, I raised a total of 600 worms in Berlin divided into three batches of different age groups. I raised these worms from eggs (the size of a sesame seed) until they were fully grown worms (roughly 7 −8 cm when healthy and well-fed). I spent roughly 4 −5 hours daily feeding, cleaning, and documenting the worms. I needed to plan my daily routine − meetings, outings, etc . − based on the silkworms' feeding and cleaning needs. In this instance, the silkworms are more in control of my daily activities and timeframe than I am of theirs. In my first-hand experience, I would say this is first an industry of human and technological labour, one built to serve the needs and capabilities of an insect species, where the timeline of the insect dictates how that labour is organised: It is more of a socio-ecological system than many would imagine.

My focal point for 'The Silkworm Project' begins with the historical intersection between the organisation of material culture and the organisation of information and data. I see myself as following the traditions of both. Rather than working to change or replace an age-old tradition, I want to understand what the drivers are behind this extraordinary relationship we have created between living organisms, technology, and human culture. What interventions are possible as a stimulus to re-thinking those relationships in new

ways? In both China and the West, agricultural treatises played an important role in introducing sericulture to a wider audience. I am currently working on an artist book that models itself after these manuscripts in exploring the complex social, biological, ethical, and political issues that have come up in my research of this project.

### Sericulture is able both to resist change and adapt to new ideas. As the silk industry continues to innovate, how is the ethics of sericulture changing, and what does that mean for this ecosystem perspective?

Sericulture is built on the killing of silkworms, but, because the practice is also almost synonymous with Chinese culture (and as old as Chinese culture), there is an important layer of heritage and emotional attachment to the silkworm that is deeply rooted in Chinese society, even today. The ethical debate of sericulture stems mainly from a Western point of view of humanitarian practices. There is humane silk farming, which uses the Indian silkworm, but the silk produced is more like cotton and, therefore, is not as fine as silk produced by the Chinese silkworm (Bombyx mori), which still accounts for all the luxury silk products we consume. Although it is easy to say that old production techniques should cease and new ones that adhere to a Western sense of ethics should be embraced, critics of the method fail to understand the meaning of silk making in China as social and material culture. The whole-sale adoption of new methods risks being both reductive of that culture and impractical to implement. It would be a change that would affect the industry across China without taking into account the perspective of generations of Chinese family businesses that have thrived using older techniques.

In a way, this reveals a critical difference between how Eastern and Western thoughts relate to concepts of death. While the focal point of Western ethical debates on sericulture circle around the binary of life versus death,

I think traditional sericulture industries in East Asia have the quality and purpose of life as its main concern. Ancient sericulture treatises in China and Japan lay rules for taking care of silkworms as well as rules for the behavioural conduct of silkworm farmers. The worms are boiled in their cocoons towards the end of their life cycle; in China, the pupas are not wasted but rather cooked as high protein food, even today. When these practices are seen only in fragments from an outsider's point of view, it is easy to label them as superstitious, cruel, or abnormal, but it makes more sense when you view the ecosystem as a whole. Compared to other agricultural models used today, I find this more of a sustainable approach. As described earlier, 'The Silkworm Project' tries to embrace a different logic within this debate by exploring how new, meaningful relationships are possible that take into account the biological, cultural, and social elements of the wider sericulture ecosystem.

**A recent extension of your project addresses how new `live' printing technologies might revolutionise the production of garments and the field of wearable technologies in general. What insights are you beginning to uncover, and can you speculate on new forms of cultural- and self-expression that may emerge in the future as a consequence?**

'The Silkworm Project' got me thinking about wearables and how they might help us redefine the realm of our bodily relationship to clothing, even perhaps to reframe our bodies entirely. Since last year, I have been working on a wearable technology series that looks at skin as an interface, speculating on how we might use it to explore new sensory ecologies. Skin is particularly fascinating as the boundary between our internal and external environments – between ourselves and others. The idea is that by expanding, even blurring, your senses at your 'natural' boundary, you can momentarily increase your perception of the world around you. In a similar

vein, my collaborator at Dogma Lab – artist and musician Benjamin Bacon – has been working on body implants and instrumentation to exploit our capacity for enhanced sensory abilities. He has, for example, embedded magnets into his fingers that allow him to sense electromagnetic fields around him, such as that around electrical wiring in a wall or around an electrical socket. My interests are more in non-invasive modification and how we might learn from – and mimic – the sensory systems of other animals that are alien to the human experience at present.

'Electric Skin' is the first of two wearable pieces I am developing and draws inspiration from many animals' ability to sense electro-magnetic fields in their environment. The approach I am taking is to map this sensory function onto a circuit armour hosting antennas, which would allow human wearers to use their skin to experience their technical space, i.e., the layer of reality they cannot normally perceive around them made up of electrical signals. Our immediate environment has changed dramatically over the past 100 years with the development and proliferation of radio and information technologies; I think there is no reason why we should not try to 'evolve' and keep up with those changes. Recently, I was able to test a small patch of the circuit 'fabric' that I had created with users. It translates minute electromagnetic signals from the environment to your skin via gentle vibrations from vibration motors. The second project – 'Sonic Skin' – takes the idea of elevating human sensibilities with the assistance of wearable technology in a different direction. Inspired by a bat's or whale's sonar system (where the journey and reception of sound bouncing off surrounding surfaces is used to illustrate the spatial relationship between animal and environment), this project will develop a wearable armour of audible and directional sound that projects into (and back from) the environment around the contours of the wearer's body.

**You are the cofounder of Dogma Lab, along with Benjamin Bacon. The lab is set up to enable the different creative and research activities your work depends on. What does this space mean to you, and what does it say about the need to work in new ways around complex topics such as human sensory futures?**

Dogma Lab is really a personal playground for Benjamin and me. It has two components – a commercial side and the non-profit experimental side. Both Benjamin and I have worked in different realms such as experimental art, music, community, academia, tech, and commercial design, and we find it extremely important to be able to bring different perspectives into new projects. It gives us the opportunity to learn-through-doing and, in turn, to offer that experience of enrichment to others. In this sense, being elastic and multifaceted in the way we work is what we really love about design as a field of practice. Looking to the future of Dogma Lab, we are trying to build up a network of trusted professionals and collaborators that draws on previous project partnerships. With this, we are trying to create a healthy creative ecology that allows the resources obtained from commissioned projects to fund further experimental and research-based work. It also means we can use experimental work to inspire new ideas in the public realm through the creation of more interesting products, experiences, and communities. Right now, we are just beginning our journey in that direction. Hopefully, we will be successful.

I am a strong believer in education. In today's world, learning is shifting away from universities towards a more decentralised system, where one can gain experience and professionalise via multiple platforms, institutions, and organisations that exist independent of traditional schooling systems. I think that my experience at Genspace was extremely important in this sense, in that it opened my eyes to new possibilities for educational and collaborative practice. At the same time, having spoken with innovators and community organi sers in parts of Europe and East and Southeast Asia, one finds that each space is run in very different ways. Depending on

the local social and cultural atmosphere, each strives for its own – often very different – goals. There is little value in making general statements across these spaces, as each is tuned to the needs and interests of their own communities.

For these reasons, we are supporters of the DIY community; it is a means of democratising access to knowledge, tools, and skills (in a way that has not been possible in the past), whilst also responding to local conditions. The pool of creative talent encouraged to engage with any number of subjects through these communities is amazing. But this is not enough. DIY practitioners will need to gravitate towards more critical and systematic methodologies of creation if they are to gain a deeper understanding of a subject, so progress from enthusiast to expert. We are very fortunate that design methodology in the 21st century allows for both of these – a means of treating complex issues through critical design approaches while embracing an openness that allows for experimental collaboration (and the absorption of other perspectives). Design provides a basis for us to approach the world, but, following the same argument, it does not offer 'the solution' to everything. It must respect and engage with other disciplines to truly create impactful results. Therefore, we advocate for a trans disciplinary approach to collaborative creation over an interdisciplinary approach, i.e., one where new knowledge systems and processes are generated over long-term partnerships rather than just drawing on different bodies of knowledge to create something new.

## Reference

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## Author Biography

Vivian Xu is a Beijing-born media artist, designer, researcher, and educator. Her work explores the boundaries between bio and electronic media in creating new forms of machine logic, speculative life, and sensory systems. Her work often takes the form of objects, installations and/or wearables. She has shown, lectured, and performed at various institutions in China, the US, Europe, and Australia; these have included the National Art Museum of China in Beijing, the China Academy of Art in Hangzhou, the Chronus Art Center in Shanghai, the New York Science Museum, Art Laboratory Berlin, SymbioticA at the University of Western Australia, and the Kapelica Gallery in Ljubljana. Vivian co-founded Dogma Lab, a trans disciplinary design lab in Shanghai that is dedicated to creating experimental research at the intersection of design, technology, art, and science. Her work has been featured in media and press, including VICE China, Elle US, and the China Global TV English Channel. Vivian received her MFA in Design and Technology from Parsons the New School for Design in 2013, and she is currently an Assistant Professor of Media Arts at Duke Kunshan University in China.