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SENSING MACHINES

AN INTERVIEW WITH CHRIS SALTER.

BY CHRIS SALTER AND FELIX HÜTTEMANN

FELIX HÜTTEMANN: Mr. Salter, how would you describe your work and research in a few sentences?

CHRIS SALTER: My artistic and scholarly work focuses on how our sensing bodies and the technical environments we inhabit co-produce each other. In this way, the immersive installations and performances that I create are partially informed by my scientific work, which operates at the intersection of STS, media and performance studies.

FELIX HÜTTEMANN: What originally inspired you to focus on immersive media and sensory perception?

CHRIS SALTER: This comes from both my doctoral training in theater and music/computer sound at Stanford (my PhD advisor was Carl Weber, a German-born theater director who assisted Bertolt Brecht in the 1950s) and my interests in how the roles of spectating and performing are re-formulated by technical systems. Things that can be called »performative« are very much anchored in the temporal emergence of new forms of subjectivity (whether human or non), and not subject to the long problematics of fixed representation. In this way, performance is something which also operates in and through the senses and the body. Theater, live performance and (for lack of a better word) »immersive experiences« are those that you are inside of and yet, are completely artificial—in the sense of how Antonin Artaud described theater itself as a »la réalité virtuelle«—as something that does not carry its reality within itself but is a doubling of reality.

FELIX HÜTTEMANN: Your work moves between art, science, and technology. How do you define the role of the artist in this field of tension?

CHRIS SALTER: Well, the production of artistic experiences is already rooted in the word *techne* (*ars* in Latin)—which indicates practice, skill, creation. While artists have long used technology in their work, it's only since the dawn of electronic and computational systems that artists are now grappling with systems that employ concepts that were earlier on strictly reserved for biological entities: autonomy, cognition, self-organization, sentience and so forth. This is leading to what Simon Penny called a »quasi-biological« sense of art, since now we are making things which can dynamically learn, adapt, recognize patterns and react to those patterns in real time. Thus, artists now have to grapple with these strange »alien agencies« (as the

title of one of my books goes) which, in essence, dethrone older notions of control, predictability and knowing that have long been the bread and butter of art making. I think this is one of the greatest tensions in the contemporary arts that attempt to harness new technoscientific explorations.

> FELIX HÜTTEMANN: You often work with multisensory experiences in your projects. Why is it important to go beyond the sense of sight?

CHRIS SALTER: We historically are seen to have five senses (actually, anthropologists and other sensory historians argue that we have far more than these five Aristotelian-established senses that correspond to the five sense organs), which we use to sense and make sense of the world. But in fact, historically, this ocularcentric view is a relatively new phenomena—dating really back to the late 18th and 19th centuries in Europe. If you encounter artistic experiences in Asia, Africa or indigenous cultures, they already are multisensorial—it's already understood that art, which was meant to celebrate gods or spirits, does this across all of the senses. This also becomes evident at the start of the 20th century in Europe when artists sought somehow new forms of spiritual awakening inspired by their interest in and investigation of indigenous societies, especially as a counter to the dawn of industrial societies. Look at the titles of works from a composer like the early 20th century Russian Alekansdr Scriabin—*Poem of Ecstasy* or his unrealized work *The Mysterium*, which sought to use scent, fire, light, sound, vibration, and architecture. These historical examples demonstrate that multimodal approaches are nothing new, and the fact that we think that the world is predominantly visual has long been challenged by the arts.

> FELIX HÜTTEMANN: In your opinion, is there an ocularcentrism in media science and/or media art?

CHRIS SALTER: In the sense that media sciences and media arts are still stuck in questions of image representation, well, yes. It seems that we are constantly trying to represent or grasp the unrepresentable. Here's an interesting example: Everyone currently is rushing to understand how deep neural networks (essentially, big groups of multiplied numbers that demonstrate statistical relationships in data—other groups of numbers) that make up what people like to call »artificial intelligence« produce the kinds of images they do—images that seem to have no solidity, that continually change and thus, have little sense of historical rootedness even though they are comprised of existing images. The models of neural networks we use to detect and classify images (for example, so-called »Convolutional Neural Networks« which were originally used to read/identify the signatures on American bank checks) are based on how we think the visual system of the brain works: breaking down images into smaller and smaller components called »features«. But when you think about it, such representations are simply numerical operations. We choose to render them as images, but there is no inherent reason to do this. My

friend Takashi Ikegami, a renowned artificial life researcher, calls this the »human bottleneck«; we have to represent these numerical processes ultimately in 2 or 3 dimensions, so our perception can grasp them. But these processes are mathematically beyond our comprehension. In other words, we quickly resort to what and how we have been culturally trained to know about the world, mainly through language and images. But according to sensory anthropologists, this strong reliance on word and image is *cultural*—it is not given in our biology (even though more than 50% of the brain's processing power is devoted to visual processing). If you look at some research in non-ocularcentric neural networks, for example, how olfaction could be modeled, you will see very different structures and models that are far away from the vision-centric models that we now use. But artists are not using these models, and many cultural studies scholars don't even know they exist. So, this lack of uptake leads to the concept that the real breakthroughs with »AI« are in generating sentences and making images of the Pope wearing a Balenciaga puffer jacket.

> FELIX HÜTTEMANN: Which new technologies currently fascinate you most in terms of their artistic or scientific application?

CHRIS SALTER: Well, I don't think we have begun to grasp what these statistically based neural networks are capable of, especially when you start to look at models that are more influenced by chemical models or dynamical systems—for example, neural networks like those modeling spiking neurons or what is called »liquid state networks« that simulate complex temporal behaviors like in the brain. Clearly, we are moving, as I said earlier, to grappling with technologies that are »quasi-biological«, which will link electronic computation with chemical computation. No one knows where this is going to go, but it is clear that we have to somehow look at earlier ideas from cybernetics that are now reappearing in a different context and with different technical possibilities. The next step is to connect these models to the real physical world and create feedback between the world and these abstract models.

> FELIX HÜTTEMANN: How does artificial intelligence influence your work in interactive art and the media laboratory, especially with regard to sensory perception of smell and taste?

CHRIS SALTER: That's an interesting question. As I said previously, right now, I'm interested in how we can embody these abstract, brain-in-a-vat models (for example, like Large Language Models) back into the physical world. I'm of the mindset of that school of AI researchers who call for an »embodied« approach to AI, because without a body, you simply (at least in my sense) cannot have intelligence—by which I take the understanding of intelligence from the late philosopher Hubert Dreyfus—as common sense about the world; that is, something that is learned in and through our bodies and our histories. The models that everyone is now

fascinated by are very much rooted in the genealogies of AI research going back to the 1950s, with their focus on Natural Language Processing and getting machines to understand images. But these systems still lack experiential common sense, because they have very limited notions of memory, especially experienced memory. The kind of neural nets that could model other senses, like taste or smell or even something distributed, like proprioception, are still in the research phase and are not really accessible, especially because they require displays that are not audiovisual, like screens.

> FELIX HÜTTEMANN: You have worked together with scientists, engineers, and artists. How do you manage to bridge the gap between these disciplines?

CHRIS SALTER: It's complex, and it depends on what the goal is. If the project is trying to generate new knowledge—i.e., a research project—then the project has to be defined around a set of goals that will be different for the different participants. There is no such thing as a common language, but there might be something called a »consensual domain«, where people from different practices and fields attempt to work together, a shared form of interaction. In this sense, an artistic object can act as a kind of »boundary object«, a term used by sociologists of science to denote a conception or physical thing that rides the boundaries of disciplines and thus, allows different people to get work done together because the object can be »flexibly interpreted« from different positions but is still strong enough to maintain its commonality among the group. Since all of my artistic projects somehow originate in these research contexts (at least at first), we are looking to see what scientific questions can emerge for different stakeholders out of the need to produce an aesthetic object or experience. Because I have training in the social sciences, humanities, arts and technology, I have to do a lot of translation between different epistemic cultures. But ultimately, there is a difference between inscription and representation (which normally is understood as how knowledge is disseminated) and experience, which is what art is. In this sense, art is not a representation of science at all—that is not its purpose—to create durable knowledge. It operates outside the realm of measurement and instead, in the realm of the aesthetic, which, as we have been discussing, is sense perception.

> FELIX HÜTTEMANN: Is there a particular interdisciplinary project that was particularly groundbreaking for you?

CHRIS SALTER: I have learned a great deal working with non-artists—anthropologists, sociologists, philosophers, physicists—because they look at the world in a different way than artists. The projects I've done with these people are the most interesting for me.

FELIX HÜTTEMANN: How do you see the future of immersive media – will we move into a sensor-driven world?

CHRIS SALTER: We're already there. Sometimes I look at scientific advances and wonder how the arts can ever catch up—things are moving very fast. So, what the arts that are involved with these new systems should do is to defamiliarize them, make them strange, and frame them in a different way from our very limited understanding of what we think of as technological or scientific »progress«. This is a political position, but it's necessary to counterbalance the overwhelming tendency to pick up and uncritically reify what capitalism keeps dishing out to us in terms of technoscientific advances.

FELIX HÜTTEMANN: Your book *Sensing Machines* examines how machines are increasingly acquiring sensory capabilities. What prompted you to delve deeper into this topic?

CHRIS SALTER: That book started out due to my interest in a kind of cultural history of psychophysics, the discipline invented by the German philosopher and physicist Gustav Fechner in the mid-19th century. I was reading all of this work in critical data studies about the quantified self (and we were conducting artistic projects on this at the same time) and was increasingly frustrated by the lack of historical understanding of these tendencies, which began emerging in the experimental psychology of the 19th century, and was about quantifying sense perception. When you examine the lab of someone like Wundt in Leipzig (who also influenced what the historian Kurt Danziger calls »constructing the subject«), all of this physiological knowledge about how we perceive the world and how we can measure, i.e., quantify, this perception comes from machines—the chronograph which measured reaction times, the kymograph, which calculated pulse or the plethysmograph, which measured blood pressure and eventually ended up in the Apple Watch (in an optical version). When one partially takes on this historical perspective, one sees that our senses have long been in a feedback loop with instruments and machines.

FELIX HÜTTEMANN: How are sensing machines changing our understanding of perception and reality?

CHRIS SALTER: The loop between human and machine sensing was established as experimental psychology emerged. But, as I write in *Sensing Machines*, our new sensing machines like distributed wireless sensor networks or worn devices like Smartwatches or the Google absorbed *Fitbit*, are different from those of physiologists or psychologists like Wundt, Titchener or Etienne Jules-Marey because they have another kind of autonomy designed into them—the data of those human subjects that are sensed is removed from the individual subject. In other words, there was still a connection between the person who produced the data, the instrument and the resulting numbers. The way we understand the temporal role of sensing

now is radically different. What we see is not necessarily what we get, but instead, a different kind of algorithmically processed time based on different statistical processes. Through sophisticated changes in electronics and computation, these sensing machines eventually become attached to and interdependent on the bodies they measure and, ironically, at the same time, completely divorced from them.

> FELIX HÜTTEMANN: Is there a historical or technological turning point that was particularly decisive for the development of such machines?

CHRIS SALTER: The mid-19th century in Europe is critical for these developments, because it is when scientists attempted to quantify the human senses using machines and thus, to make sense perception an object of technical knowledge.

> FELIX HÜTTEMANN: In your book, you talk about electronic noses and tongues. To what extent are these technologies more than mere imitations of human senses?

CHRIS SALTER: The so-called lower senses, which are both mechanical (touch) and chemical (taste and smell), have long been difficult to computationally model because they need more complex »displays« to render their results. These technologies, like biological systems, require both sensors and techniques of analysis—in humans, this involves a complex mix of neural-chemical physiology (or, in the case of touch, sensorimotor capacities)—the brain in consort with distributed neurons or receptors across the body. But in the case of these electronic systems, they depend on electrical devices and then computational systems with mathematical-statistical characteristics, neural networks that classify or predict or distinguish one molecular makeup from another. There is a difference, however, between classifying something (does this taste salty or sweet) and making meaning out of that. So, these machine sensors can detect and classify, but they can't really make meaning out of what they detect. In this sense, they are pale imitations of (at least) human senses.

> FELIX HÜTTEMANN: Can machines really adapt taste and smell, or is it just a sophisticated form of data processing?

CHRIS SALTER: If you take an engineering approach to sensing, then tasting and smelling in biological systems (like humans) can simply be articulated as stimuli-sensation-perception, insofar as perception means interpreting the difference between different molecular combinations. In this limited sense, it can be argued that biological sensing systems are simply processing chemical data. But when it comes to the production of meaning in relationship to those smells or tastes, machines have a long way to go!

FELIX HÜTTEMANN: How could electronic noses and tongues change cuisine, gastronomy or food production in the future?

CHRIS SALTER: They already are. Our food, and in particular, processed food, is being optimized by these technologies, particularly in the area of biosensors. For example, one area that these sensors are being applied to is wine tasting, which is gradually shifting from human oenophiles to machines, as electronic noses get better at classifying things like spoilage and/or the level of acidity. As more reports come out about how alcohol is really not good for your health, such systems will slowly replace human tasters. Food production has long been an area of application for chemical sensing technologies as well as mechanical sensing. E-noses were developed in the food industry in the early 1990s to cost-effectively monitor taste in test situations. At the same time, one of the interesting phenomena that came out of the COVID-19 pandemic was that scientists rushed to repurpose all of these biochemical sensors, which aim to sniff out chemical components that could be used in biological attacks, to detect airborne particles that would signify the presence of the COVID-19 virus.

FELIX HÜTTEMANN: Do you see a danger in machines being able to analyze taste and smell better than humans, for example, in relation to industrial food standards or personalized diets?

CHRIS SALTER: This is a general question in terms of whether machines that sense will replace our own abilities. But from eyeglasses and cochlear implants to sensory substitution technologies, this has long taken place. Yet, there needs to be a strong distinction made between the detection of chemicals that make up what we smell or taste, and the ability to contextualize those things into things which make meaning for human beings. So, for example, I may have an e-tongue that, through its biochemical-electronic makeup, detects a particular taste, but that machine is (still) unable to position that taste in a catalogue of memories or experiences that we can associate with those tastes.

FELIX HÜTTEMANN: Are there already artistic or experimental projects that deal with machine tasting or smelling that were particularly in the focus of your perspective?

CHRIS SALTER: There is a smattering of such projects, particularly coming from Japan, but these technologies are still relatively expensive and either confined to research labs or available only to industry. Many artistic projects play with the idea of these technologies—usually in a metaphoric manner—but rarely with the technologies themselves.

FELIX HÜTTEMANN: The combination of culinary art and technology is fascinating, but also controversial. Do you see ethical questions arise when machines replace or surpass human senses?

CHRIS SALTER: Insofar as ethical questions around artificial neural networks are predominantly focused on the lack of diversity in data sets, one could, I suppose, see ethical issues if these artificial sense organs can only recognize tastes or smells that are predominantly Euro-American-based. This is an exaggeration, of course, but the ethical questions that will emerge are mainly about whether machines can replace human senses and what that entails. As I've pointed out earlier in this interview, currently these systems are good at detecting tastes and smells but have no ability to place them into context—or to find multimodal relations (i.e., the fact that when you lose your sense of smell, it affects how you taste things) between the different senses.

> FELIX HÜTTEMANN: How could electronic noses affect the perfume industry or wine tasting? Would they make human experts superfluous? Digital sommeliers, for example, have been a dream of the wine industry for some time and are increasingly being worked on.

CHRIS SALTER: The beverage industry is one of the early adopters of these electronic noses and tongues. I've already mentioned wine tasting, but another interesting example of this is the Japanese whiskey industry. The research of one of the inventors of the e-tongue, a scientist named Kiyoshi Toko, actually led to the development of a new variation on a Japanese highball cocktail combining whiskey and soda, which was subsequently served on the Japanese ANA airline!

> FELIX HÜTTEMANN: Is machine tasting and smelling a form of creativity, or is it pure analysis?

CHRIS SALTER: If these technologies were in the hands of artists or creative people, perhaps we would see them as creative. But currently they are simply detectors that basically analyze combinations of molecules. What is impressive is that they are able to simulate what is labelled *selectivity*, the ability to decompose hundreds or thousands of molecules into individually recognizable substances. For example, each taste bud has around 50-150 receptor cells that food molecules bind to and that represent the five tastes. In other words, even though the amount of chemicals that enter the mouth when we eat is astoundingly large, our mouth and brain cooperate with each other to deduce somehow five basic tastes out of a molecular chaos. But to do this, the researchers created hardware and software that would exhibit behaviors similar to human physiology—that ability to break down chemical substances into the five tastes—by way of statistical processes.

> FELIX HÜTTEMANN: If you imagine a future where sensory machines are ubiquitous, what would it look like?

CHRIS SALTER: I like to quote McLuhan when asked questions about the future: »We look at the present through a rearview mirror. We march backwards into the future«.

FELIX HÜTTEMANN: Do you think our own perception will change as we make more and more sensory decisions dependent on machines?

CHRIS SALTER: Currently, our attention and concentration is changing based on the extensive hours we spend glued to both the screens of social networks and generating words and images with neural networks. At the moment, these neural networks are still primitive because they have few senses—mainly vision by way of cameras, sound by way of microphones and text by way of typing. But as they start gaining more sensors and sense modalities (and also gain the ability to fuse or »integrate« these different senses) and ways of interpreting the physical and material world, they will also start to become another kind of »sentient« entity in the world, together with animals and plants.

FELIX HÜTTEMANN: Is there a specific technological or artistic project that you would like to realize?

CHRIS SALTER: Right now, I'm working on theater texts from the early 20th century that had certain utopian ideas about the future, the environment, and technology. One is the Russian Cubo-Futurist poet Velimir Khlebnikov's 1922 somewhat science fiction play *Zangezi: A Supersaga in 20 Planes*, which is about the inability to communicate in standard language. The text is partially written in what the Russian Futurists called »Zaum« (literally, »beyond sense« or »trans-sense«). This is interesting in the context of a world in which we now live, where we are surrounded by machines that produce something that appears to be human language but, in effect, are just gigantic probability systems. The other text, which we are just beginning to explore in the context of another famous theater work about the future – Karel Čapek's R.U.R. (Rossum's Universal Robots), in which the Czech word *Robota* suddenly reached widespread exposure. R.U.R. celebrated its 100th anniversary in 2020, and in 2023, the MIT Press released a book which featured a new translation of the play together with commentaries not from artists or literary critics but instead, from scientists, predominantly artificial life researchers, about the impact of the play on their thinking. In the context of a new interdisciplinary research project on the performativity of AI systems in situated action (i.e., how they are actually used) which involves social, human and natural scientists together with my lab, the Immersive Arts Space at the Zurich University of the Arts, we will explore how R.U.R. might be perceived in this historic moment of sensing machines.