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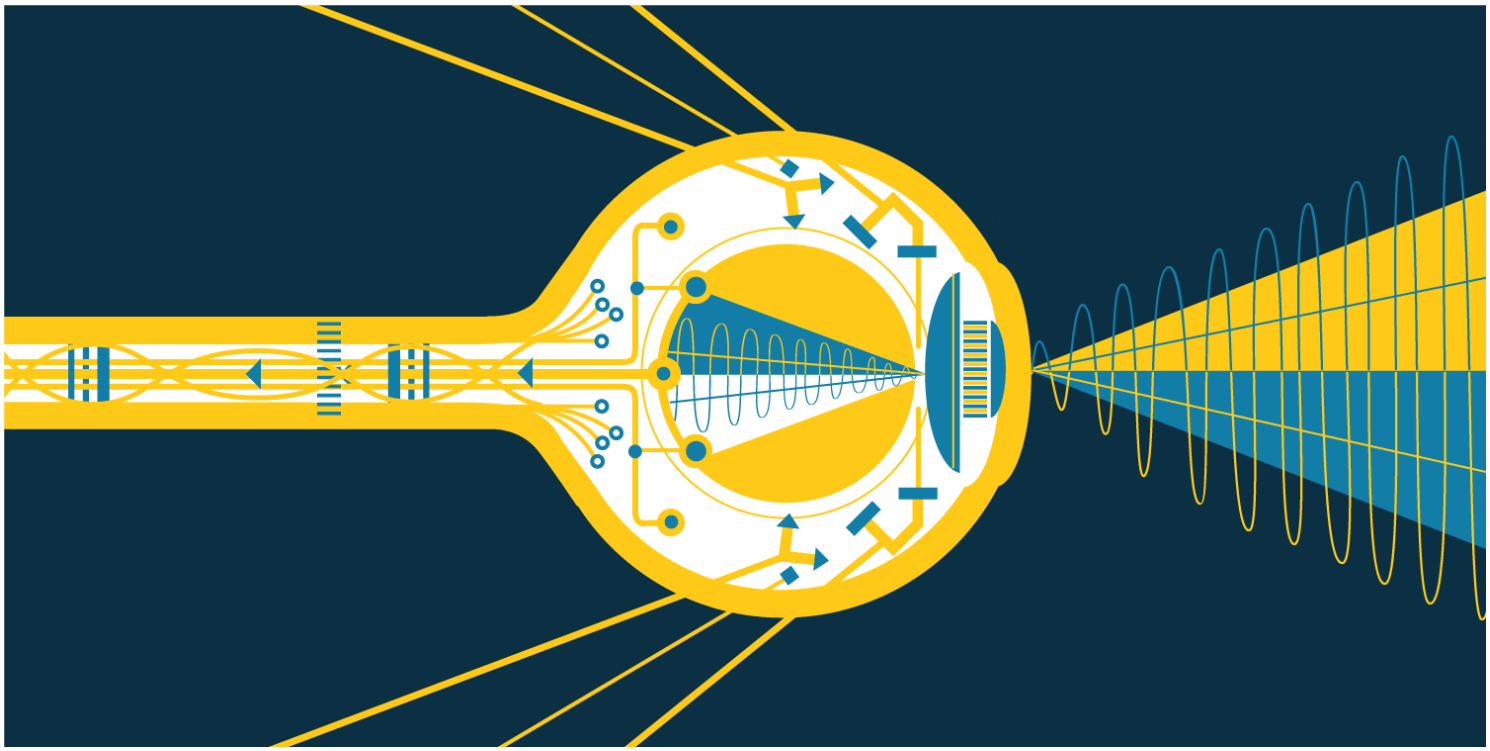
The Human Machine: Episode 2

Sense Hacking: The Real-Life Cyborgs of the DIY Augmentation Scene

Meet the people determined to shape their experience of the external world in new ways



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"Once the batteries are in, it's just on," says David Troetschel, handing me a small, coffin-shaped box. He points to a circle on what I think is the front of the device. "That's the sensor," he explains. "I wouldn't recommend letting it touch anything, unless you want to make yourself deaf." He hands me a pair of earbuds plugged into the box. "Have fun!"

I pop in the earbuds, and, for the next half hour, I'm technically a cyborg—and what I'm listening to are the sounds of "ambient radiation."

The term radiation may bring to mind the idea of toxicity—we hear about our skin being damaged by the sun's radiation, for example, or of mutations and diseases caused by radiation from nuclear weapons and accidents—but not all radiation is dangerous to humans. Electromagnetic radiation includes radio waves, microwaves, infrared light, and even visible light. Sound waves are a kind of radiation, too, as are gravitational waves. Any energized particle or wave moving through space counts as radiation.

"We're exposed to radiation everyday; it's not necessarily a dangerous thing," explains Troetschel, whose background is in industrial design. With the exception of visible and some infrared light, we don't see any of it.

But what if we could?

That question drives Troetschel and Team Radiation, a group of artists, designers, and researchers collaborating to build a prototype device for a new human sense, one that can detect electromagnetic waves typically imperceptible to us. They're one of three teams participating in Cyborg Futures, a course held at Parsons School of Design in New York City. The box I'm holding is a homemade electromagnetic field translator. Its sensor picks up ambient electromagnetic waves, and a motherboard, jerry-rigged from an old cassette player, converts those waves into audio that I can hear pumped through the headphones. It has DIY charm, with a rubber band holding a plastic top over the whole contraption.

"It's not meant to be a fear-mongering thing," Troetschel says. Rather, this new source of input is meant to inspire, to give people a chance to tap into a part of the world they haven't been able to reach before. "Through extra data, extra experience, you get abstract feelings that allow you to be more creative."

I've never been curious about sounds I can't usually hear, but as soon as the option becomes available, I want to hear everything. The first thing

I investigate with the so-called EMF translator is my cell phone. I carry it around all day, so I'm interested to hear the usually-imperceptible sounds it makes. I hold the box up to it: the headphones emit a frantic vibrating noise at a medium pitch. I try navigating between apps, and it makes an unsettling scurrying noise; when I send a text, I get a blast of a high-pitched tone. It's horrible, I say to two members of another group, Team Haptic, who are watching me cringe. "I guess you don't like your phone's aura," observes one.

As the rest of the class heads off to grab drinks, I hang back so I can listen to the various electronics I encounter between the classroom and the bar. My computer makes a fast, high-pitched noise, which reminds me of the whirr of an air-conditioning unit working overtime in the summer; an extension cord emits a persistent, flowing hum, like a digitized rushing river.

After leaving Parsons, I duck into a Staples store down the block to listen to a row of computers. I'm surprised to find that each computer has its own sound: an HP laptop is silent; a Lenovo is loud; one Dell clicks while another Dell creaks. Amazon's speaker system Alexa croaks compared to the other electronics, kind of like the way a smoker's voice sounds. The iPad has the same tone as my iPhone, but a lower pitch.

Finally, I walk down East 13th Street to the bar, cringing at the loud, noxious buzzing of streetlamps and stoplights, which gives me a headache almost immediately. New York is loud enough without hearing all its electronics, but this new stream of sensory input makes it even more overwhelming.

The world is full of input, and the way we sense the world around us *is* our experience. But humans sense a limited range. Even within our species, there's huge variability in what we sense. Some of us are sighted, some are not, and many people fall somewhere in between; the same is true of other senses like hearing.

Among other species, there's similarly huge variability: while we can experience a sliver of the electromagnetic spectrum through sight (visible light) or the feeling of heat (infrared), other animals sense different slivers of it, and in different ways. Snakes see in infrared, and spiders in ultraviolet; *Tradescantia* flowers turn colors when exposed to gamma rays, and rats can smell X-rays. Animals evolve to detect the world in whatever way that allows them to move, eat, and survive. Dolphins, bats, and people with limited vision can use degrees of echolocation to navigate, while polar bears can use their extremely sensitive olfactory sense to sniff out seals 3 kilometers away. Narwhals can intuit exactly how salty water is using their tusks, a skill that might mean they're less likely to get trapped in icy waters. And many lizards have a third primitive (or parietal) eye on the top of the head which helps them use the sun's light to navigate.

As a species, we've been inspired by other animals' ways of being in the world—we've built technologies to emulate birds' flight, or nocturnal animals' night vision. But it wasn't until the 1960s that we had a term to describe the merging of man and technology. *Cyborg* was coined by scientists Manfred Clynes and Nathan Kline for a 1960 article in the journal *Astronautics*. Cyborgs are a common trope in sci-fi since the

word was coined, and the years after saw an explosion of media that engaged with the idea, each reflecting the anxieties and fantasies of their respective years—from the murderous, assimilated Cybermen of 1960s *Doctor Who* through to the law-and-order authoritarianism of 1980s *RoboCop*.

Arguably, cyborgs have been with us long before the 1960s. Liviu Babitz, co-founder of commercial biohacking company Cyborg Nest, defines cyborgism as the moment "when the technology and body marry, and create a system that works together." In that case, he says, his grandfather, who had a pacemaker in his heart, was "an early cyborg, a pioneer." Prostheses, too, merge the body with technology, and they've been around since at least 950 B.C. The World Health Organization estimates that about 15 percent of the world's population uses some kind of mobility device, and it's estimated that about 30 million people have pacemakers. Does that mean the cyborg revolution is already here?

Not quite. A movement requires a sense of shared identity, and few people with prosthetics or pacemakers embrace the title *cyborg*. Even Justin Worst, COO at biohacking startup Grindhouse Wetware (tagline: "What would you like to be today?"), is reluctant to use it. By most peoples' standards, Worst's implants would qualify him as a cyborg: he has a magnet in the ring finger of his left hand, an NFC chip in his left hand, a BioThermo chip (a version of the chips used in pets for identification, but for reading body temperature) in his right bicep, a Northstar (a device which lights up in response to a magnet) implanted in the back of his hand, as well as three magnets in his forearm which he's "testing" for safety over the next year and will then get removed. But when I ask him if he's a cyborg, he gives me a lukewarm: "Kinda?"

"It's a fun thing to say—I have magnets and other chips in me, so it's like, oh yeah, I'm a cyborg," he says. But he doesn't feel like it's a strong identifier at the moment; being a cyborg isn't really advantageous or detrimental to anything, he says, and until elective, augmentative implants become more commonplace, he doesn't see a reason to identify strongly with the label.

To artist and cyborg Neil Harbisson, that feeling of identity is key. "If you feel like you are a cyborg, then you're a cyborg," he says. "It's more

a sense of identity than anything else." Harbisson has an antenna called the Eyeborg implanted in his skull which detects colors and translates them into sound. He's often referred to as the world's "first cyborg"—a photo of him appears on the Wikipedia page for the word—but he cringes at the title. He points out that there have long been people with technology in their bodies who don't particularly identify with the term. Others may strongly identify as cyborgs even if they have no implants or other bodily modification. They're drawn in by the idea of expanding the range of sensory experience.

After successfully lobbying for the right to wear the Eyeborg in his passport photo, Harbisson became known as the "first" cyborg in a legal sense. He developed the ability to hear color to overcome a type of colorblindness, achromatopsia, that means he sees in grayscale. In this sense, his Eyeborg is similar to a hearing aid, or a pacemaker—but Harbisson says that it wasn't any sense of loss that drove him to develop it. "I never wanted to change my sight, but some articles like to say that I had a problem and technology solved my problem," he says. "But no, it was an art project—my aim was to extend my perception of reality. I had no *problem*."

When we were children, the world promised us personal robots, handheld computers, virtual reality, and superhuman powers; we got the first three, so why not embrace the last? People like Harbisson and his lifelong friend Moon Ribas are among the artists who want to push the envelope on what humans can feel and experience. The two founded the Cyborg Foundation, a non-profit that, according to its website, aims to carve out a space for people who identify as "trans-species," to help them come out of "the cyborg closet." The Cyborg Foundation's website provides basic, gentle questions to guide people towards their goals:

"What kind of ability do you want to enhance? Or what kind of new sense do you want to develop? Is the tech you need already available? Do you need an implant?"

Troetschel, the designer who built the EMF translator, is driven by the possibility of "making the invisible visible." He says he's drawn to the idea of creating a new avenue for sensation—to translate imperceptible waves into something we can experience using our existing senses.

Experience is the key term here; Troetschel, and other people in the cyborg world, want to directly feel, see, or hear things they haven't before. In the case of Troetschel's EMF translator, there are already mundane devices that can detect and give us a readout of electromagnetic waves, but it's different to *sensing* those waves. By translating them into something audible, we experience something new, just as people who lose their sight find that they can start to interpret other sensory information in new ways to "see". Babitz explains this distinction between knowing and sensing by contrasting finding true north from reading a compass versus feeling the vibration from the North Sense magnet attached to him, which buzzes whenever he's facing magnetic north. Consulting a compass takes conscious effort; getting a buzz when you're facing north does not.

The other thrill is what our minds do with this new information. These artificial sensors provide data, but your brain must learn to interpret and make sense of it. "The brain has an amazing quality of being able to synthesize that data, even if it's highly abstract," says Troetschel. It can take an adjustment period to learn to interpret what the data *means;* for instance, Harbisson has spoken about how it took him months to pick out colors like blue and red from the stream of data from his Eyeborg.

His newest project is to learn to sense the colors in space, where a wider range of background electromagnetic waves are present than on Earth (our atmosphere filters the bulk of microwaves and gamma rays). He expects it will take at least a couple years. He's currently experimenting at simulating the real-life experience of being in space with his antenna by "listening" to video feeds broadcast by space agencies. "I can only do it for a few hours a day, or else I get headaches," he says. "There's many more colors than here [on Earth]; when we look at space, it's black, but it's not. It's full of invisible colors, and sensing them is a bit overwhelming." The plan is to eventually be

connected to a constant stream of data from those feeds, alongside the data gathered from his everyday life down at ground level.

Over time, the theory goes, that sense becomes part of you, and you see the world in a different way. This is the key to what's intriguing about the whole thing—that you're connected to the world in a way you've never connected before. "Walking around the city, you might start to develop more associations like, this corner sounds like *this*," says Troetschel of his experience wearing the EMF translator. "A couple blocks north of where Parsons is, there's a building that's under construction. The wifi router is really strong, and I can hear it half a mile away. I go the same general direction whenever I walk to class, and based on the sound, I know I'm going the right direction. I don't need to look at a street sign."

The experience allows you to connect not only to your surroundings, but also people all across the globe. The EMF translator, for example, is the product of a global effort; Troetschel got the design for the device from some Ukrainian hackers on YouTube, and like many of the other Cyborg Futures makers at Parsons, Troetschel saw the Cyborg Foundation's posts on social media and was excited by the idea of building new senses. The course has connected makers and cyborgs from all over the world: the syllabus featured Skype talks with Harbisson and Ribas, both based in Spain, as well as London-based Babitz, and cyborg model Viktoria Modesta, who often travels between the U.S. and Europe.

New senses also inspire new art. Troetschel says his classmates in Philadelphia have requested to borrow his EMF translator to create samples for their electronic music. Harbisson and Ribas also initially set out to develop new senses for the sake of art. While nature and technology are often presented as polar opposites—the "natural" world vs the created or manufactured—Harbisson says he feels a newfound kinship with nature, especially with species that can sense light via antennae.

Ribas, too, finds a new connection with nature through her device, which aggregates data from seismic monitoring services around the world and buzzes in her arm with increasing strength any time there's a earthquake that registers above 1.0 on the Richter scale. "I realize how alive our planet is," she says. "But most of the time we're not aware of that. It's made me realize how unadapted we are to our planet; if we'd always been perceiving earthquakes and were more aware that our bodies are constantly moving, we wouldn't build cities on the edges of tectonic plates. They're very dangerous places."

Beyond connecting with nature, the cyborg community presents a way to connect with others who share the same brand of curiosity. “Just as we’re interested in going to other planets, there’s more out there in terms of our senses,” says Babitz. “People know that technology and the human body have a future together.” The North Sense has broad appeal, claims Babitz, and in his experience the device has appealed to both people in the “alternative” piercing, tattoo, and body modification community as well as clean-cut urban professionals. “Now they have a shared interest.”

For many in that former category—who call themselves body hackers or grinders—people trying out a new sense are modifying or hacking their bodies simply because they can, and they find community among others who share that interest. To them, asking why you’d want to implant magnets or chips in the body is akin to asking someone with a tattoo or piercing why they did it: sometimes there’s a deeply meaningful story behind it, but aesthetics and curiosity are valid answers, too.

“I was always indecisive about what tattoos or piercings I’d want,” one grinder from Southern California (who wishes to remain anonymous) tells me. They have two magnets implanted in their left ring and middle fingers, and an NFC chip in the skin between their thumb and forefinger (the standard location for such an implant, they says). “I was initially drawn to getting magnets because I heard you could feel an electric current.” (You can.) Some members take pride in the DIY spirit of the grinder community; they tried to perform the implantation procedure on themself (with the supervision of an experienced body modification artist) but passed out halfway through.

“I could have just gotten the magnets and been like, ‘OK, I have the magnets, but I’m not interested in becoming a cyborg,’ but the community is what drew me in,” she says. “The emphasis on DIY—I just think it’s really cool, and listening to these incredibly intelligent people problem solve together and support each other in their different projects.”

So what's it actually like, I ask Babitz, to always know where north is? It's hard to explain, he says. "How would you explain smell to someone who has never smelled before?"

When you're experiencing the world, you're rarely thinking about individual sensations. A pleasant walk in the park just is; you might take a moment to focus on each sensory input—the sound of birds, the feel of warm sun on your face, the sight of blooming flowers, or a *really* good tree—but in general, we don't spend a lot of time processing which modality our experience is coming from. Babitz, who has been wearing his North Sense for four months, says that the most important part of his experience has been consistent wear. That's allowed him, over time, to trust the relationship between his new device and his brain. "Initially you might think, 'Hey, that isn't north,' but then you realize that [the North Sense] is technology and you're not. You learn to listen to it," he says.

Eventually, you may forget this is a new sense at all. Take a moment and think about what you're doing right now, as you're reading this—are you paying attention to the sensation of your clothes on your skin, or the sounds or smells drifting around you? A sense—vision, hearing, Harbisson's Eyeborg, Ribas's seismic sense—will constantly feed you data, but you're not always paying attention to it. "We sense so much more than we can remember or process," says Babitz. Once you feel something all the time, you get used to it, and you learn to tune it out. "Sometimes I don't feel it, and I wonder if it's even working," he says.

Then, says Babitz, this new sense becomes integrated into your overall sensory experience. The North Sense has given him an additional feeling of connection to a place: helping you orient geographically, or adding another layer to your memory to a familiar one—it might even become part of your dreams, says Babitz. "Just as you remember the smell or color of a place, I now remember the magnetic orientation of a room."

Currently, we're still in what Babitz calls an "on-boarding process." It's one that humanity must undergo before widespread acceptance of augmentative, curiosity-driven cyborg-esque modifications.

"Imagine if you had the iPhone 7 instead of an iPhone 1," says Babitz. "That would've been too overwhelming to even understand the capacity, the options." A touchscreen interface was unfamiliar enough to most people in 2007; getting people to learn to navigate without desktop-style indicators, to use the device's touchscreen and zillions of app options, and choose to pay for additional expensive investments like AirPods, would be an overload. People would be turned off.

Even this early stage of cyborg tech—magnets, chips—has found opposition. Some are uncomfortable with bodily modification, seeing it as a gateway to a major loss of privacy, or even the singularity. Worst says that after he and several other Grindhouse Wetware members were featured in an episode of MTV's *True Life* for their Northstar implants, they received a rash of harsh comments on social media. And strangers at parties can be weird about his implants, too. Once, he remembers, "I had one girl tell me, 'Oh I know you're a nice person but uh, I think this is the work of the devil and I kind of want the device to die, and that you have to get it taken out of you.'" Worst shrugged it off good-naturedly, saying, "Uhh…OK!"

I ask Worst why he thinks people are against it. He says some of the pushback comes from people's religious beliefs—"mostly the mark of the beast, Revelation sort of things"—or their conspiracy theories. Some are concerned about privacy, fearing that chips will allow Big Brother to track them. But it's absurd to think that the government could track you with such a chip, says the Southern California grinder. "Literally, you have to be touching it in order to get it to read; you can't do GPS or anything with these things." Like those in pets, the chips they have implanted can only be read from a close distance.

"Your phone can track you *so much* better," they also point out. "If you have Facebook or a cell phone, that's so much more useful to the government than an NFC chip."

Worst says he's also run into people who are concerned about involuntary implants or tracking. "I've had people ask if we're going to market [Grindhouse products] to the government," he says. "We're against that; we don't want to forcibly put any of our technology into people."

The key, says Babitz, is to start slow, and to ease people into the idea that we can enhance our bodies with technology. For some, the opportunity to experience new senses can inspire awe and art. And this kind of technology lays the groundwork for enhancing existing senses or body parts—the DIY makerspace can work on designs too niche for the traditional medical or engineering community to create commercial products for.

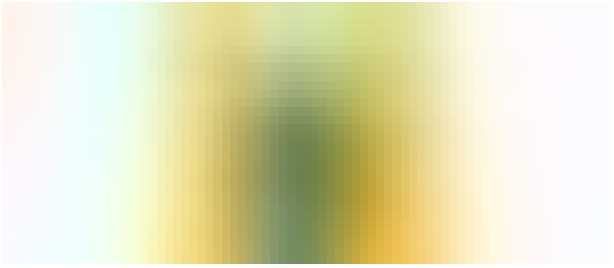
But it's going to require a delicate touch for the movement to gain more momentum; already, people with implants (particularly magnets like the North Sense) are wondering whether biohacking's heyday has passed. For one, the movement will need to address those privacy concerns, no matter how farfetched people's worries are. While current technologies are still too primitive to warrant concern, some makers are keen on the idea of all-around body monitoring—something that would be optional, of course, but a more obvious target for hacking of personal data.

Current body monitoring, in the form of activity trackers, are already raising reasonable questions about privacy: should people submit their activity information to healthcare companies for discounts? What does this mean for the future of monitoring and healthcare? Insurance companies are already trying to make use of such data by offering lower premiums to people who hand it over, for example. Any implanted tracker should raise similar questions around privacy and surveillance, and body hacking proponents should be prepared to openly discuss long-term solutions.

Until the expertise and materials required to take on these projects become more accessible, the DIY bodyhacking and sense augmentation space will be a playground for the well-off and connected. The hacker/makerspaces that support this type of work are notoriously white and male, and raw materials for such projects can range from hundreds to thousands of dollars. Even if you wish to buy a commercial product, a device like the North Sense will run you $425. Like with any other form of innovation, the fewer people who are able to contribute, the slower the progress.

If sense augmentation does come into the mainstream, there will still be people who are uninterested, and that's OK; for those within the cyborg and grinder movements, choice is paramount. People seek the freedom to modify their bodies while recognizing that what they want may not be what others want—but they work together nonetheless to create new ways of experiencing. "It's not that we'll all become the same, but that the choice will be much wider," says Harbisson. "We'll decide what senses or organs we'll want during our lifetime, and that's the biggest change: the options we will suddenly have."

Editor's note: This piece was corrected after publication to anonymize an interviewee.



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