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TECHNOLOGY HORIZONS | 2015

the new body language

How wearables, implantables, and wireless networks will connect our communities and alter our anatomies

SCENARIOS OF A GENERATIONAL SHIFT

TECHNOLOGY ENABLERS OF BODY AREA NETWORKS

PLUS:
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NEW BODY LANGUAGE 2015

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Artifact from the Future, not a real product. First appeared in Health Horizons 2013.

WELCOME

A few months ago we were running a foresight workshop in a quirky Midwestern office, surrounded by executives, marketers, and bench scientists of a large food manufacturer. When we asked for "signals of things to come," wearable fitness trackers came up immediately. *"I have one. You have one. That's not that surprising. But now my great aunt has one! She's competing with me on FitBit!"* We stopped and did a quick temperature check of adoption in the wider social circles of this group. *"My daughter." "My mother." "My neighbor." "All my kid's friends…until they take them off at school."* Every one of the two-dozen people in the room had recently encountered wrist-wrapping wearables in the wild.

This is not a unique report. Wearables have reached the point of ubiquity in at least some circles. Those circles are extending beyond the Silicon Valley techies, and at least some of those wearables are evolving beyond the buzzing, vibrating wrist adornments that can now be had for $30 a piece, in a 3-pack, at Costco.

In this inaugural issue of *Future Now*, we're going beyond this present moment, pulsing on our wrists, to look at whole bodies: social bodies, bodies already adept at communicating, automating, and connecting in various ways. We're discovering how technologies are knitting together in a new kind of connective tissue—inside and outside our semi-permeable skin—united by ubiquitous wireless signals. These technologies are altering our anatomy, but they're doing more than that. They're expanding what our bodies are able to communicate—building on the many existing gestures our various cultures have already evolved. You could call it a New Body Language. And this new language is giving us new ways to relate to ourselves, to one another, and to the increasingly Automated World around us.

Most pieces in this issue focus on the human side of the Human+Machine Symbiosis that IFTF's Technology Horizons team has been tracking this year—how body area networks will augment the intentions and expressions that play out in our everyday lives. Some pieces illuminate the subtle, even invisible technologies that broker our outrageous level of connection—the machines that feed off our passively generated data and varying motivations. In fashion and fandom, striking a pose or igniting struggle, we express the new body language.

Welcome to 2025.

Miriam Lueck Avery **Rod Falcon**

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A GUIDE TO

the New Body Language

How wearables, wireless and implants will connect our communities and alter our anatomy

In the next decade, as computational power and connectivity are built into virtually everything, reconfiguring our personal technologies will be as simple as putting on a jacket or removing a pair of shoes.

At a technical level, this is the story of an emerging world of body area networks, where devices in, on and around the body can be reconfigured throughout the day to enhance our experience of any situation.

At the personal level, the transformation brought on by these technologies will be more intimate and profound. We will see the rise of an entirely new kind of body language, mediated by a constantly evolving suite of personal technologies. Ranging from passive and secretive to wildly aggressive, this new body language will shape how we use wearable and implantable technologies to express our deepest social, cultural, and individual aspirations.

And like our existing body language, the expressions of our technology-infused bodies will shift constantly and vary for different people and contexts. Body area networks will amplify both our natural commonalities and create countless variations of Human+Machine Symbiosis. As the New Body Language emerges, it will require new frameworks to define technologies and strategies that empower people.

One such framework begins with intentions and expressions. In the emerging landscape, five critical pairs of intentions will generate a world of expressions as we make choices about how to configure and reconfigure our body area networks.

MIRIAM LUECK AVERY
has led research on well-being, food futures, and cultural agility, and teaches in IFTF's Foresight Studio.

HIDING/CONNECTING via technologies will build our social identities and self-awareness

ISOLATING/INTEGRATING our devices, data, and identities will shape the ways we relate to larger systems

IGNORING/ENGAGING new flows of sensation and information will help us manage our attention and awareness

DISPOSING/INVESTING in pieces of our body area networks will allow us to change the expressions of our tech-infused bodies minute-to-minute

REINFORCING/TRANSFORMING society and ourselves through everyday actions

Each time we express ourselves with technology, we will strike a particular balance in each pair of intentions. Over time, these expressions, in turn, will create archetypes that help us make sense of the diverse ways we will relate to technologies—and the opportunities for innovation. The story of the New Body Language, then, is the story of the myriad ways people, companies, governments, and humanity will strike these balances as they express their intentions.

BALANCING OUR INTENTIONS

The intentions that will form the New Body Language come in polar pairs that we will balance in different ways to create a wide variety expressions—personal and cultural, consistent and contradictory. To understand the expressions that will emerge, we must first understand the tensions across these polar pairs.

HIDING/CONNECTING | By revealing intimate details about our own bodies and selves and connecting us with others in new ways, the New Body Language will permeate our social and personal lives. We will use body area network technologies to connect with our heroes flying through the air, as Bradley Kreit explores in his article "The Amplified Fan," and with our most intimate partners, as Jamais Cascio reveals in the generational scenario "Memory." Sometimes, however, our bodies are a feedback device for us alone, as Keiichi Matsuda reflects in his interview with Mike Leibhold.

ISOLATING/INTEGRATING | By buying into branded ecosystems or keeping body area networks fragmented, we can control privacy and adopt varying levels of integration into diverse systems. In the short term, science fiction author Ramez Naam anticipates more narrow and task-specific uses of body area network technology, isolated from day-to-day life and the perils of hackable networks. Further out, he sees these technologies "intuitively, seamlessly, effortlessly integrate external sources of information" into human cognition, bringing people around the world closer together. In the generational scenario "Papers, Please," the New Body Language becomes an asset for governments around the world.

IGNORING/ENGAGING | Whether we ignore it entirely or allow it to engage our attention with fantastical interfaces, the New Body Language creates new ways to manage our attention. In "Altered Anatomies," body hacker Amal Graafstra posits that "a good implant becomes so fully integrated into daily life that it disappears." Indeed, the end state of much of the New Body Language is to become as invisible and subconscious as our postures and micro-expressions. David Pescovitz gives us a glimpse of the rapidly approaching ability to "Mind Meld"—where networks of human brains will allow humanity to engage with our problems on a whole new level.

DISPOSING/INVESTING | We won't adopt all technologies in our body area networks in 18- to 24-month upgrade cycles. The permanence of body area networks and their configurations will vary widely. In "High Fashion Meets Maker Manufacturing," Lyn Jeffery argues that the fast-paced worlds of fashion and technology will look more alike than different. But as we invest in prostheses in our brains, our sense of durability may shift radically.

REINFORCING/TRANSFORMING | Each choice we make, however insignificant it seems, holds the power to reinforce our existing society or change it. Body area networks will help us choose what a good life means. Improvement is not always about radical change, however. An interview from the future with Jan English-Lueck reflects on how technologies can reinforce cultural structures of obligation. But the New Body Language can also be profoundly transformative. Jamais Cascio's generational scenario "X-Ray" vividly depicts how a moment of radical empathy can transform the course of history. ■

Left: Artwork by Keichi Matsuda
Right: Courtesy of Amal Graafstra

Mind Meld

Towards Brain-To-Brain Networking

Telepathy. ESP. Mentalism. Whatever you call it, the ability to communicate thoughts, feelings, or experiences without using our known sensory channels is a timeless superpower that's served countless science fiction tales, sparked endless debates between paranormal researchers and skeptics, and injected wonder into centuries of magic. But as Arthur C. Clarke famously said, "Any sufficiently advanced technology is indistinguishable from magic." In the not-so-distant future, advances in neuroscience, molecular biology, and computer science will make it possible to link our brains together in synthetic telepathy. Along the way, we'll be faced with profoundly difficult ethical questions and hopefully develop new empathic tendencies. And ultimately, we'll learn through experience that the most powerful computers on the network are the ones inside our heads. The following are some of the most mind-blowing recent breakthroughs in the realm of brain-to-brain interfaces.

DAVID PESCOVITZ is co-editor at *Boing Boing*, a Research Director at IFTF, and has written for *Wired*, *Scientific American*, and the *New York Times*.

2012 Hearing the Voices in Someone Else's Head

UC Berkeley researchers were able to identify the words that volunteers heard just by monitoring and decoding the activity in the volunteers' temporal lobe, the region of the brain that processes auditory information. (The individuals had been implanted with electrodes as part of a multi-step surgical procedure to treat epilepsy and had volunteered to be part of this unrelated study.) According to neuroscientist Brian N. Pasley, when people imagine that they are speaking a word, the same parts of the brain are activated as when they actually say the word out loud. "If you can understand the relationship well enough between the brain recordings and sound, you could either synthesize the actual sound a person is thinking, or just write out the words with a type of interface device," he says.

2013 Interspecies ESP

In a pioneering demonstration of an interspecies brain-to-brain interface, Harvard radiology professor Seung-Schik Yoo and his colleagues enabled a human to transmit a mental signal directly to a sleeping rat's motor cortex, triggering the rodent to move its tail. Their major breakthrough was devising an interface that was entirely noninvasive—no holes in the human or rat's head necessary. The person wore a hat outfitted with EEG electrodes that detect neural activity through the scalp, while the rat was positioned under a focused ultrasound machine that delivers a beam of acoustic energy to a specific region of the brain. Whenever the human looked at a flickering light on a computer display, it generated a specific brainwave pattern that triggered the ultrasound beam, spurring the rodent to unconsciously move its tail. Someday, the researchers wrote in their scientific paper, a bidirectional system based on their technique could make it possible for "neural information [to] be transmitted between individuals separated by a great distance using the Internet protocol."

2013 Head Games

In 2013, University of Washington researchers demonstrated the first noninvasive human-to-human brain interface and also the likely future of videogaming. Computational neuroscientist Rajesh Rao wore an EEG cap while watching a Space Invaders game play out on a computer screen. Across campus, Rao's colleague Andrea Stocco had his finger near a button that would fire the laser cannon in the game, although he couldn't actually see the game itself. Stocco was under a transcranial magnetic stimulation (TMS) coil, a machine that delivers pulses to stimulate specific regions of the brain. When the moment came for Rao to fire his laser cannon, he imagined the act but didn't actually move a muscle. That brain activity stimulated the TMS coil near Stocco's head, triggering him to involuntarily click the button to fire the cannon. "We plugged a brain into the most complex computer anyone has ever studied, and that is another brain," said Chantel Prat, a psychology professor on the research team.

2014 Mental Morse Code

Hola. Ciao. Those were the two words sent directly from a person's brain in India to three people's minds in France via a system devised by Starlab Barcelona. The sender of the message, wearing an EEG helmet, imagined moving his hands or feet, a visualization translated into a zero or one. The series of zeros and ones was transmitted to the remote locations where the recipients were positioned under TMS coils, which delivered pulses to specific regions of the brain. In this case, the pulses from the TMS devices triggered the receiver to see flashes of lights, representing the signals sent from India. In Starlab Barcelona's scientific paper the researchers described this kind of computer-mediated brain-to-brain communication as "hyperinteraction." "We envision that hyperinteraction technologies will eventually have a profound impact on the social structure of our civilization and raise important ethical issues," they wrote.

2015 A Computer of Interconnected Brains

After decades of pioneering work on mind-controlled prosthetic limbs, Duke University neuroengineer Miguel Nicolelis and his team are now developing "networks formed by multiple animal brains, cooperating and exchanging information in real time through direct brain-to-brain interfaces." They call them "brainets." In one experiment, Nicolelis's lab implanted electrodes in multiple rats and wired them together. The rats learned to coordinate their brains and share simple information between them. Next, the researchers moved on to monkeys, again linking pairs and even trios of the animals' brains together via computer. The monkeys learned to collaboratively control a computer representation of a robot arm with only their thoughts. "Essentially, we created a super-brain," Nicolelis said. ■

Devices 'Disappear'

A Vision For Tomorrow's User Interfaces

Advances in computing power are largely the work of scientists and engineers, whose ingenuity pushes our devices to do more, faster, and with fewer constraints. But it's often artists that provide us visions of how we might use these new capabilities, what the interfaces of the future will be, and what people will and won't want from advanced technology. In his works, London-based designer and filmmaker Keiichi Matsuda has put forth one of the most influential visions of how body area network technology might be used to create a world of augmented reality (AR), in which the world we move through is overlaid with digital information of all kinds.

IFTF asked Keiichi to share his visions of the future, walking us through the evolution, body area networks from his perspective in words and images. The human experience of this future may be, he suggests, radically transformative.

MIKE LIEBHOLD is a tech futurist, ranch hacker, and IFTF Distinguished Fellow.

KEIICHI MATSUDA is a London-based designer and filmmaker.

“Body area networks are part of a group of technologies that are leading to a future where computers, systems, and devices ‘disappear.’ … They will no longer be things we look at, but things we experience the world through. … Your body becomes a feedback device, allowing wearable devices to feed you information through your senses. It can be simple: personal headphones, or a vibration when a new message appears. The display technology in some AR devices follow this same logic, scanning images directly to your retina. You’re no longer looking at a screen, your retinas themselves are the screen. ... Systems will cease to be tools employed consciously, and start to become fluid, invisible. Technology will change, from a series of smart objects, to something more like a filter through which we understand reality. This could be a utopian dream: transcendence. But while our data is controlled by governments and private corporations, you can’t help but fear for how vulnerable this shift is making us.”

“Everybody will see the world in a different way ... In this world, your experiences will be intensely personal. You will be able to shape some of your own experiences based on your tastes and interests, and will have others shaped for you. You will live in a subjective space, where everything is tuned for your identity, and the line between virtual and physical has long been forgotten. You might look back and laugh about the very concept of objectivity.”

All artwork in this feature by Keiichi Matsuda

“Maybe at some point there is a service that allows you to swap and share world-views with friends. Then the reality tourism industry takes off, offering a chance to take a break from yourself. First, you are offered celebrity curators. Eventually, ‘purpose-built identities’ emerge, made with a particular outlook on life that is fun, challenging, sexy, or relaxing to inhabit. With all that on offer, you might be tempted to become a perpetual tourist, role-playing life as a character, or as many characters. People may no longer see the point in the individual sense of identity, and prefer to move between roles and realities. What started as a heavily individualistic movement may, ironically, culminate in the destruction of the ego.”

BEFORE

Body Area Networks

Thomas Zimmerman's Vision of the Connected Self

Twenty years ago in a lab at MIT, an engineer and inventor with an interest in rock guitar was exploring ways to bring computers, people, and musical instruments closer together. Joining a research team that had developed a way for computers to map the movements of a musician's hands across an instrument, he came up with a new breakthrough: he created the foundation for what we now call "body area networks."

Thomas Zimmerman's 1995 work with his MIT Media Labs colleagues Neil Gershenfeld and Joe Paradiso (also with the cooperation of cellist Yo Yo Ma, who allowed his bow to be fitted with a sensor) led them to see how the human body itself could be used like an antenna to wirelessly send and receive data. Although the initial inspiration was musical, they realized that this had implications for all sorts of non-musical things. In a demonstration, Zimmerman built a system that could send a digital business card between two people with just a handshake. Naming this invention the "Personal Area Network" (PAN), Zimmerman imagined a cloud of data around each person carrying a PAN device in their pocket. If body area networks can be said to have a founding father, Zimmerman is it.

Photo courtesy of Thomas Zimmerman

When he invented the first PAN in the mid 1990s Zimmerman was already a veteran of Atari and a founding member with computer scientist Jaron Lanier of one of the first virtual reality product makers—VPL Research. Zimmerman was probably best known, however, as inventor of the DataGlove, a real glove fitted with electronic sensors that made its movements recognizable by a computer. The DataGlove was the first device that enabled the human hand to move around in cyberspace. For Zimmerman, the coolest application was its utility in strumming an air guitar. The invention of the DataGlove defined the direction of his later research—finding practical ways to make communications between people easier by simplifying how we interact with computers.

The Personal Area Network opened up the potential for what Zimmerman calls a world of "contagious information" that effortlessly travels in an electric cloud and no longer needs to be manually tapped out on screens and keyboards. The data in that cloud could be read by nearby devices to automatically unlock doors, swap personal or business information, turn on lights, even provide health status updates. Zimmerman imagined computers that log you on as soon as you come within a meter of them, log themselves off when you walk away, and cars that start when they recognize your electronic field. A key to the PAN is that it requires only minimal hardware and generates a low energy electronic field, making it inexpensive and lightweight. Zimmerman foresees a day when everyone will have a Personal Area Network embedded in their smartphones.

It's not difficult to imagine how "contagious information" generated by body area networks could change not just our relationship with machines, but our view of our bodies themselves. We'll view our bodies as as parts of computer networks, altering the way we interact in social environments such as dating, play, business, and school.

Now a research staff member at IBM Research-Almaden in Silicon Valley, Zimmerman continues his research on body area networks. And he says he's still fascinated by the musical side of his work. He's currently working on improving a set of electronic drums that can be played without touching them. ■

DAVID THIGPEN
is a Research Affiliate at IFTF, teaches journalism at UC Berkeley, and was a music reporter for *Time Magazine.*

Artifact from the Future, not a real product. First appeared in Technology Horizons 2015.

The Electrospit

Wearables for Digital Music-Makers

Music has always been a huge part of wearable technology—but most of the innovation has been devices for listening, not creating. Musician Bosco Kante, brand manager Maya Kante, music producer Pete Ho, and rapper/digital strategist Lance Coleman want to change that. They've created a smartphone-connected wearable instrument, the Electrospit, that functions like a portable talkbox—a device that lets you "vocalize" an instrument by changing its sound with your mouth. And they might be the ideal people to introduce such a device to the world.

Bosco Kante composed the theme song to "In Living Color" while in college. He has produced hits for Bay Area mainstays such as E-40, and won a Grammy for a collaboration with Kanye West. But while Kante is best know for his music, he is also an inventor and technologist. Known to many as the "talkbox king," the devices he uses to make music have largely been his own creations.

"Making talkboxes was an oral tradition at the time," Maya Kante explained to *Future Now*. "You couldn't go to Guitar Center and pick one up or go on the Internet to find instructions. Someone had to teach you, and then you'd pass that knowledge down to someone else."

Bosco Kante was part of a maker culture that existed long before there was a capital 'M' maker movement. All over the U.S., particularly in communities of color, innovators have been pioneering DIY projects from modifying bicycles with sound systems to creating completely new shells for gaming devices. He modified early cell phones, disassembling them and spray-painting the cases for friends and he created his own custom turntables and mixers with affordable components. "It was innovation based on necessity, not leisure time." He hacked his first talkbox together with a digital keyboard, an ASR-10 sampler, and a home stereo amp. He learned the technique to use it from renowned G-funk producer Battlecat. And Kante has never stopped iterating since.

"I'm always taking technology that was designed for something and adapting it," Bosco Kante said.

But the inspiration to make a wearable talkbox came from the frequent problems he had with his instruments' size.

Travelling was always a difficultly; getting through security at airports often proved troublesome. And it also affected his ability to perform live.

"There's been a number of times where I didn't perform because the stage layout couldn't accommodate my equipment," the "talkbox king" recalled.

For instance, when he performed with Kanye West for the American Music Awards, he wasn't able to play live and instead had to lip-sync, a totally different kind of performance.

"I wanted to make it convenient to have it in a backpack where I can just pull it out and jump on stage and do my thing," Bosco Kante said.

But their vision for the device evolved, from an instrument for Kante's personal use to a consumer device.

The group aims to bring music back to the body—digital music creation is now the norm, but it mostly happens at a desktop—and give digital musicians the freedom to perform live. But they also wanted to bring attention to under-recognized innovators.

Photo courtesy of Bosco Kante

Electrospit—(From left to right) Pete Ho, Maya Kante, Bosco Kante, and Lance Coleman created a wearable instrument, called the Electrospit. They perform and record as a group under the name Electrospit, as well.

> "The group aims to bring music back to the body—and give digital musicians the freedom to perform live.

"Part of the motivation is wanting to be an example of, and put a spotlight on, people of color who are innovators who are creating and making technology," Maya Kante explains. "Because it's been happening for a long time."

They decided a way to make the device more light-weight and accessible was to leverage a device most people already have: a mobile phone.

"You can take advantage of the synthesizer that's already in the phone. Instead of an external keyboard, you can use a different sound generation technology," Bosco Kante asserts.

He started off creating prototypes by hand. "With PVC pipes, it was a little bit too crude because it gets hard to get good tolerances and make components airtight," so he turned to 3D printing for more recent prototypes.

They created a solid Electrospit prototype as part of their residency at Zoo Labs, a West Oakland-based music accelerator founded by Vinitha Watson. It took a lot of experimentation (at one point he tried putting the speaker in his mouth, which actually worked fairly well) but now the prototype of the device has already been used in recordings with artists like Big Boi of Outkast, Phantogram, and Skrillex.

But as you might expect, the Kantes and their team don't have any plans to stop experimenting with this technology any time soon. They have an abundance of ideas for how their tech might develop in the coming years.

"The technology could advance to allow you to sound like a specific charactor or icon, say Beyonce," Maya Kante speculates. "Another one of our founders explained it could be used as a controller for other devices in the house, so it could bring singing and music back into people's daily lives. There are a lot of possibilities to think through—we're just getting started." ■

BEN HAMAMOTO brings his background in community journalism to IFTF, where he researches and writes about identity, art, health, food, technology, and culture.

Wearable Experiments created this jersey that links fans with the Dutch Ladies 7's Rugby team.

Photo courtesy of Billie Whitehouse/Wearable Experiments

FEELING THE RUSH

THE AMPLIFIED FAN

In 2012, extreme athlete Felix Baumgartner made history in two ways: he broke the world record for the highest skydive and set the world record for the largest number of video streams, with 8 million live viewers.

To get Baumgartner up and down safely, a team of scientists measured the full body intensity of the experience. His stress levels, breathing and heart rate, and numerous other details were captured and shared with his scientific team. Viewers saw nothing more than the visuals. Watching him jump, they could only imagine the knot in his stomach, the force of the wind on his body. But that's about to change. In a few short years, viewers will be able to feel it.

BRADLEY KREIT
has led research on the future of automation, health information, and consumer engagement and teaches in IFTF's Foresight Studio.

Photo courtesy of Catapult Sports

As we rapidly adopt body area networks, entertaining and engaging viewers will move from the two-dimensional images we see on screens to become immersive, social, full-body experiences that better connect fans to their favorite atheletes—and to one another.

The tools to create these kinds of experiences are being built from biosensing devices that capture the physical and emotional intensity of games and athletic experiences—and actuators to communicate them.

BEYOND THE SCREEN: wearing the game on your sleeves

When it comes to developing sports wearables, the goal is largely better data and statistical measures for sports teams and fans alike—but the result will be better spectator experiences. At least that's the vision of companies like Wearable Experiments—and early products like their Alert Shirt. Designed to enhance the experiences of rugby fans, and working with a companion app called FoxTel that collects and transmits data feeds, the shirt transforms that data into physical sensations that flow through haptic feedback motors. An anxious moment produces a tightening sensation; a tackle creates a physical rumble in the chest. Adrenaline, exhaustion, and excitement all get communicated. As Billie Whitehouse, Wearable Experiments' founder and chief designer, describes the shirt, "The emotions [of a game] played out in the chest of a fan's jersey."

Companies like SportRadar are at the vanguard of the perpetual effort to better measure athletic performance. In 2015 they signed a four-year partnership with the NFL to outfit players with accelerometers, RFID chips, and other sensors to precisely track each individual player's speed, acceleration, and mobility for each individual play.

The major difference between athletic programming and other entertainment is simple: sports is an event. A shared experience. And we're about to get a lot better at sharing experiences. Fanmode is looking to reinvent the fan experience by giving distant viewers the ability to cheer their teams as if they were there. A simple app with swipe controls to cheer and boo, Fanmode aims to turn isolated fans into a co-present community. Their goal is to take the sentiment data of the fans using their app—the excitement, the anger—and display it in signs in stadiums to let a lone fan cheering at a television from home send applause into the stadium.

Taken together, Fanmode and Wearable Experiments suggest an intriguing future for spectator sports: You probably won't be able to attend the Super Bowl in person in 2025, but you'll feel the excitement and send your applause just like you were there.

FROM TV TO STREAMING: fandom in the age of peer-to-peer media

As major sports leagues have flourished, we've also witnessed the sudden rise in recent years of entirely new kinds of athletes. Perhaps none more startling than the rise of video games as a spectator competition, as witnessed through companies like Twitch. Twitch, which didn't exist until 2011, is home to more than 1.5 million live videogame streamers, who are watched by more than 100 million fans every month. The average viewer spends 90 minutes on Twitch—every single day.

Phrases like "streams" and "viewer" don't quite capture the experience of fandom. Twitch streams are interactive; fans chat with each other over text while gamers wear headsets and talk as they play. Twitch, and services like it, have taken off in part because they bring community to the once solitary activity of playing video games. Adding technologies like the Alert Shirt to enhance the experience is an intuitive next step.

It makes perfect sense that sports are driving these changes. The last decade was marked by a shift away from shared media and experiences. Newspapers gave way to blogs; blockbuster movies gave way to YouTube; television gets consumed on-demand. But even as this shift has taken place and the value of shared, static reality has declined, the value of one type of live programming—of shared reality—has skyrocketed. Sports, the ability to share the highs, lows, and emotions of watching a game with others, is worth more than ever. Indeed, ESPN's subscription fees are more than four times the cost of the second most valuable cable channel.

In the next decade, entertainment and fandom will move beyond the constraints of the screen and become an embodied, multisensory experience that we share in real-time with fans all over the world. ■

Kirby Lee/USA Today Sports

THE NEUROSCIENCE OF FANDOM

While spectator sports stretch back centuries—and can be found in virtually every human culture—we are just beginning to understand the science behind why fandom can spark such fanaticism. Although the research is still in early stages, researchers are finding that spectators empathize physiologically with athletes. Studies have shown that players and fans feel similar hormonal spikes and drops based on the outcomes of games. Neuroscientists have begun demonstrating that mirror neurons, which enable us to simulate the experiences of those we're watching, activate when watching sports and are now beginning to identify how different variables affect engagement. For instance, announcers may inform fans but appear to reduce how much we empathize with the athletes we watch. As our understanding improves over the next decade, these insights will be built into the shirts, headsets, and apps we use to supercharge the experiences of fandom.

Photo courtesy of Billie Whitehouse/Wearable Experiments

Wearable Experiments' Alert Shirt communicates impact, heart beat, exhaustion and excitement

Photo courtesy of Ramez Naam

AT THE NEXUS OF

Science Fiction and Future Fact with Ramez Naam

The single most important law of futures studies is that there are no facts about the future. Only fictions. Ramez Naam lives by that law, having written the award-winning Nexus series of science fiction novels that provoke readers with thrilling tales of digital telepathy, brain-hacking, biotechnology, and civil liberties in the networked age. Ramez's visionary fiction is rooted in science fact. For 13 years, he was a computer scientist and technologist at Microsoft, where he helped lead the development of tools like Outlook, Internet Explorer, and Bing. Ramez is also the author of two future-focused works of non-fiction, *More Than Human: Embracing the Promise of Biological Enhancement* and *The Infinite Resource: The Power of Ideas on a Finite Planet*. We spoke with Ramez about the promise and peril of wearable computing.

In the last few years, the first wearables have become mainstream in forms like the Fitbit and Apple Watch. As someone who has been involved in building digital technology for decades, and also imagining its future as a science fiction writer, what is surprising you most about the way this is playing out?

I'm surprised how much value people are getting out of a very limited amount of data. In science fiction, wearables or implants tend towards the more sophisticated—tracking your metabolism, your levels of nutrients, your blood chemistry, etc… or are able to manipulate those. But we're seeing millions of people wearing devices that measure little more than their number of steps taken.

To me that speaks of the incredible power of feedback on our behavior. Even a limited, very indirect variable like how many steps you're taking is enough to motivate people to do more. So why wouldn't people adopt something simple that gives them this one piece of data?

What scares you the most about wearables?

The scariest thing in wearables is security. Everything on the planet can be hacked. We have to accept that in this day and age. Humans have yet to build a truly secure system. We can make things more secure, in the sense that it takes more effort or time or money to attack them, or that there's less valuable data for them to give up. But we'll never hit 100% security on anything. So now we have this explosion of devices—between the Internet of Things and the explosion of wearables (which we might think of as part of the IoT). And that means that we're increasing the attack surface, increasing the number of potential ways to hack into someone's data.

> "In tech, particularly software, one motto is 'move fast and break things.' But when it comes to a human being, you can't do that.

When wearables were only Fitbits and fairly limited in their functionality, that might have not been such a big deal. But now, with the Apple Watch and that class of devices, you have another device on your person that has access to your email, your texts, possibly your files, a GPS that tracks your location, and so on. That's one more way to potentially get that information of yours. And as we start talking about the rest of the Internet of Things—when cars, homes, thermostats, appliances, power outlets, light bulbs, and everything else are online—that attack surface just keeps growing. Will all of those vendors do rigorous security testing? Will they all update their software frequently enough when bugs are found? Because there are always security bugs found.

Does that mean we should give up on wearables or connected devices? No. They still offer huge value. But I think we need to find ways to push for higher levels of security, higher levels of ongoing vigilance, and better defense and policing against crimes.

What is the technology's potential that makes these risks worthwhile?

I'm excited by the prospect of more intimate data input and output for these devices. Looking down at a smart watch is a little more convenient than looking at a phone. But the user interface is limited on such a tiny screen. I'm looking forward to devices that can display information right into my visual field, and to devices that can accept gestures and glances as input. Google Glass was a flop of a product. It just wasn't there yet in terms of utility or convenience. But I think we'll see more happening in this direction each year. HoloLens looks truly impressive. It's still too big and bulky. But Moore's Law being what it is, we'll see the electronics get smaller and cheaper, the power requirements drop, and the devices get more sophisticated.

I also think we'll see more narrow and task-specific use of this technology. I'm excited by things like the Daqri Smart Helmet, which is an augmented reality helmet for industrial uses. You'd never wear this thing in your day-to-day life (unless, maybe, you're Daft Punk), but for some jobs, you can see that there's a lot of value. And similar things may happen for motorcycle riders—there are at least half a dozen smart motorcycle helmets in development that can add things like mapping or proximity sensors and collision avoidance to the riding experience. Basically, it's still incredibly early days. We're at the Apple II level of wearables now.

Ten years ago, you wrote "More Than Human," about the future of technologies to enhance the body and mind. Has research in this space moved faster or slower than you expected?

Mostly research on human enhancement has moved more slowly than I expected. There are two reasons for that. First, while biology really is code, it's spaghetti code. The genome is a lot like software. But it's crazily messy, interwoven software, where you can't change one variable without affecting a dozen others. So there are fairly few things we can tweak inside the human body or brain without risk of substantial side effects elsewhere.

Second, we're incredibly risk-averse in medicine or any intervention with a person's life or wellbeing. In tech, particularly software, one motto is "move fast and break things." Speed of innovation is key. If you deploy bad code to your servers and introduce

continues p. 24

DAVID PESCOVITZ
Research Director

a bug, you can always fix it and deploy the new version, often within hours. But when it comes to a human being—you can't do that. If you break something, someone possibly dies. There are liability issues. And there's our ethical framework for medicine: "do no harm."

> "The reality is that when you put technology in someone's hands, mostly they want to use it to make a better life for themselves and their family.

I didn't appreciate a decade ago just how much that slows down research in medicine and related fields.

That said, there is very real progress happening. In genetics, with CRISPR (a system for gene editing), we have better and cheaper genetic tools than ever before. And it'll get better yet. We had the first approval of a gene therapy technique—where we tweak the genes in living humans—in Europe recently, and the first in the US may be quite soon. And in brain-computer interfaces and implants, the field is going gangbusters lately, with both NIH and, increasingly, DARPA helping to push things along.

So we're getting there.

What do you see as the biggest possible benefits to closing the gap between humans and machines?

One, our machines are already cognitive prosthesis. Your cell phone stores the phone numbers of your friends and family. You've probably forgotten most of them, but it has them. It's a machine extension of your memory. Wikipedia has vast troves of knowledge—it's an extension of your knowledge base. But they're still "out there." The more intuitively, seamlessly, and effortlessly we integrate those external sources of information into our lives the smarter we all get. It's a boost to our cognitive abilities—and that pays off in richer lives, in better decisions, and in an increase to the pace at which we can innovate and invent new ways to improve our lives.

Two, closing the gap between humans and machines helps us bring other humans closer. There's this meme out there that we're all anti-social now, staring into our screens. But the reality is that we're becoming hyper-social. We can connect with family, friends, and loved ones more easily and more immediately than ever before. I know what's going on with my friends' kids better than ever before. I know what's going on with my extended family on the other side of the planet better than ever before. When something like the Iran nuclear deal is happening, I can see what people actually in Iran think. That's increased human connection, mediated by technology. And technology can take that even further. I see progress in real-time speech translation, for instance, as an amazing step towards connecting the globe, and boosting empathy between people of different cultures. I think the possibilities here—and their impact on the world—are enormous.

In your science fiction novels, technological telepathy is real. Are we headed in that direction?

We are. The science of brain-computer interfaces is progressing. We've sent video and audio and touch into people's brains. We can use neurotechnology to see what you're looking at or to read your intentions.

But really, even today, without any of that technology being widely deployed, we have something much more like telepathy than ever before. When people are texting each other from around the globe, or tweeting about a protest that they're in, or taking video with their phone and posting it online, or sharing it realtime with things like Periscope, we're transcending distance. Distance is still real for the physical. But for the spread of ideas and emotions, it's dying, rapidly.

Your fiction presents technology as a double-edged sword. Are you personally optimistic or pessimistic about the future?

I'm an optimist. Look around the world. Poverty is down, crime is down, disease is down, hunger is down. Literacy and education are up. A lot of that has to do with technology. The reality is that when you put technology in someone's hands, mostly they want to use it to make a better life for themselves and their family. So that's what sells. That's as true in Nairobi as it is in Nebraska. Over the next few decades I think we'll see all of those trends continue—more freedom, more people able to live lives that fulfill their potential, and less of the poverty that's been the default state of humanity for millennia.

Does that mean everything will be absolutely rosy? No, definitely not. The world isn't perfect. There are still tragedies and atrocities. There are still huge, looming problems we have to deal with. And every technology ever invented can be and will be used to harm others, or will have some unexpected negative side effect.

But in the long term, it's clear. The trajectory of the world is upwards. ■

THE NEW BODY LANGUAGE

Scenarios of a generational shift

The future appears as a strange, distant vision but meets us as a familiar, comfortable present,

each step along the way offering us fluency in the new languages our technologies enable. Three scenarios take us into futures where body area networks teeter on the brink of familiarity, a generation from now. Heads of state and protesters on the street alike adopt this new technology. It's there for the most intimate moments of our lives and the most shocking turning points in history. The scenarios depict strikingly different uses of this new body language—drawing our attention to how intentions may be highly individual, but interact in dizzingly complex ways.

JAMAIS CASCIO
is an IFTF Distinguished Fellow, writer, speaker, futurist, and investigator of the plausibly surreal.

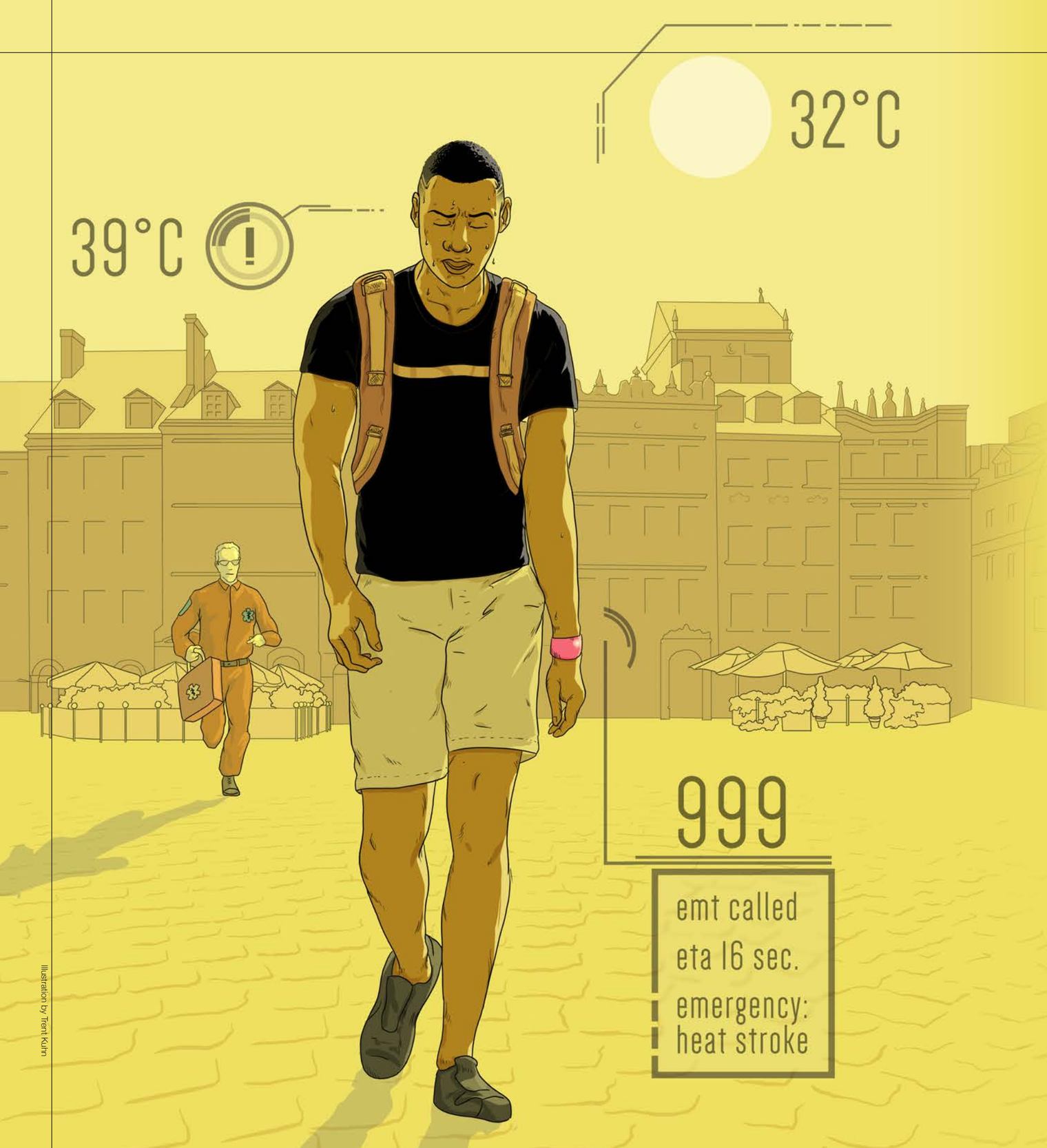


Illustration by Trent Kuhn

PAPERS, PLEASE

In this scenario, body area network technologies are commonplace and diverse, but with different rules and affordances in different parts of the world. As they start to encompass a role combining personal information system and personal identification system, some nations may begin to require their use by all citizens... and even all visitors.

When I finally got a chance to visit Scotland, everyone joked about the weather and the food. Nobody mentioned the passports.

That's not what the newly independent Republic of Scotland government calls them for citizens, of course—that's a bit too reminiscent of a 20th century dictatorship's "internal passports." But everyone in the RS, citizen or visitor, needs to carry one of these little widgets on their person. I'm told that locals prefer an earpiece or ring, but a tourist like me gets a simple wristband.

Like lots of things these days, it immediately wanted to partner with my mobile, only there was no "would you like to…" involved—it just did it. I guess it used some kind of government-only backdoor. My malware monitor app immediately traced where it connected, but it appeared only to be piggybacking on the GPS and crypto-identity functions, at least at first.

I will say that the passport made it much simpler to be a tourist in Scotland than I've ever experienced anywhere else. Doors opened automatically for me, both literally and figuratively. The passport pulsed on my wrist to give me directions, so I never got lost, and I could pay for things just by waving or nodding my acknowledgement of the purchase, so currency exchange wasn't a problem. It also gave me a haptic signal when I was putting myself at risk, and while that took me awhile to get used to, I did manage to avoid one of the anti-war marches that way.

Far and away the most useful—and worrisome—bit was when I was overcome by heatstroke. Edinburgh is still not fully adapted to regular 35°C summers, and the lack of aircon (and my own failure to drink enough water) left me on the verge of passing out. Because I hadn't recognized that the passport had been buzzing warnings at me, it took action on my behalf. By the time I realized that I was feeling dizzy, medical responders had found me, my doctor back home had been updated, and my emergency contacts had been messaged, twice. I knew that the wristband included some basic biomonitor functions, but I was a bit startled to find that the RS tourist passport did that forced-connection thing to my healthware implants, too.

I've never really liked the "all in one" body network systems that assume you want everything to talk to everything else. I like being able to mix up the kinds of technology I have on me (and in me), and more importantly to be able to decide on my own what can connect to what. I intentionally keep my healthware isolated from my mobile, my clothing, and my homeware—there have been too many cases of hackers and viruses attacking implanted systems. I may be paranoid, but I grew up in the Age of Anonymous—I know that everything can be hacked.

After I got home, I checked the malware monitor's forensic records. Apparently, the passport only began to search for standard healthware devices when my body temperature and heart rate started to increase. I suppose I should be glad that it waited until there was some sort of need for that information before taking it without asking. But it does make me wonder what else the system might have decided on its own that it needed, and whether I'd ever be allowed to say no. ■

MEMORY

In this scenario, personal area network devices and accessories—PANDAs—are most widely used as health and biology monitors, keeping close watch over numerous physiological functions. Now, a new generation of device has made it possible to "write" as well as "read" biological responses.

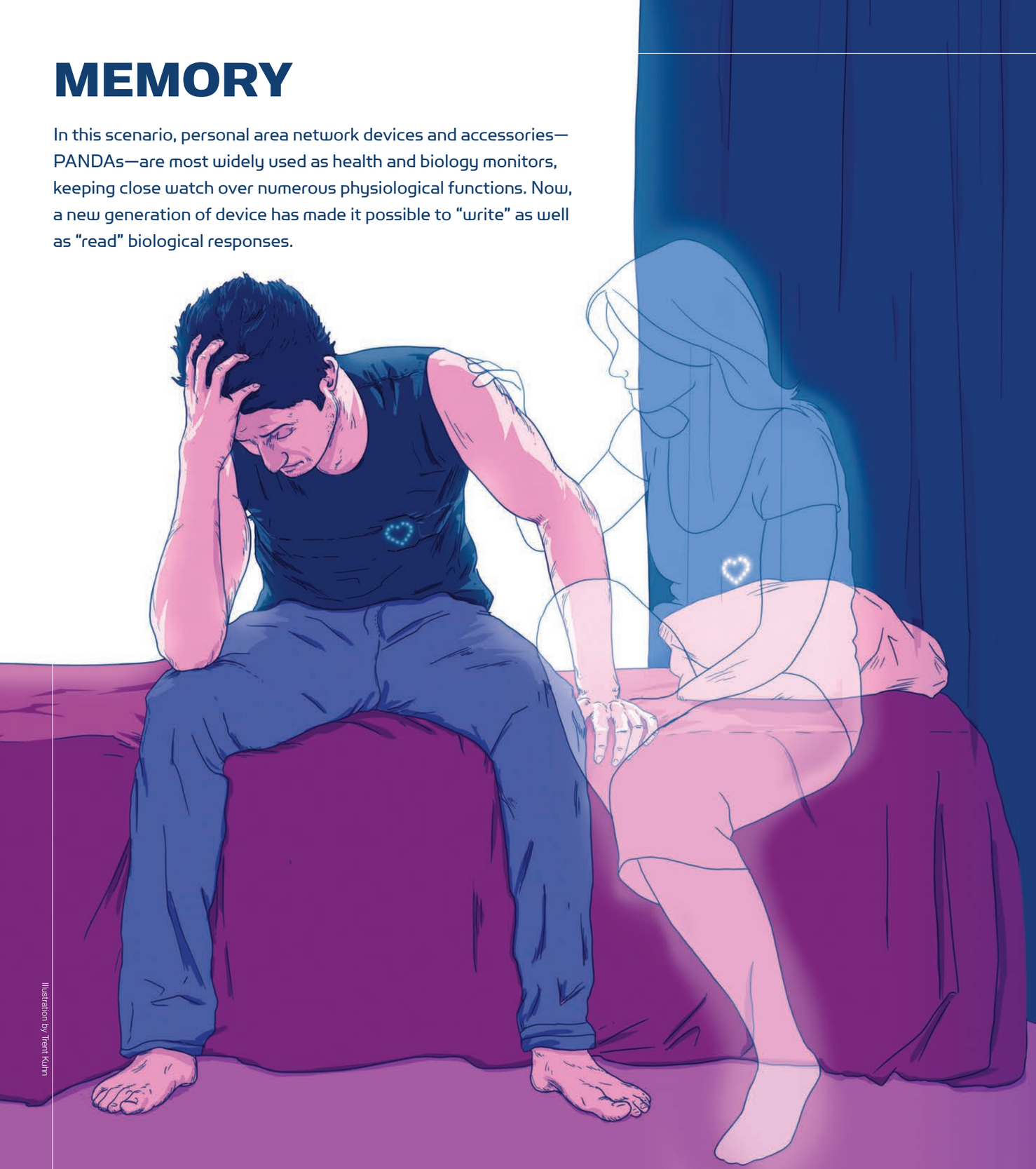


Illustration by Trent Kuhn

My doctor wants me to get rid of it. My meditation group wants me to release it into the wild. And I swear to God that I've been repeatedly asked to sell it. But it's the last I have of her, and I'm going to keep it for as long as I can.

Isabella—Izzy—loved toys, romantic gestures, and travel. I suppose that's not altogether unusual, but it did mean that she was a very early adopter of the Heartwave mod for our PANDAs. She said it was so that she could feel my love for her when she was out of the country, but at the time I suspected it was also (more?) because it was a piece of tech that nobody else around here had. No matter now, but after the first time we tried it when she took a trip we knew we'd never want to get rid of it.

I'm still not even entirely sure how it works. It ties into the bioreaders everybody wears, and tracks the various body signals of emotion (heart rate, adrenalin, dopamine, and the like). It also can induce those same signals, at least in a limited way (using some kind of direct neuromagnetic stimulation, I think). It's kind of an odd sensation at first, familiar yet foreign, deeply intimate but clearly externally-generated. But the instant when you know with certainty that this sudden emotional wave you're feeling is coming from someone you love is mind-blowing.

Izzy described it as half-waking up in the middle of the night and feeling your partner's toes touching yours in bed. Gentle contact, but unmistakable and present. We even played with the recording function, layering playback over the real-time emotions.

If you've ever tried a Heartwave, you know that it doesn't just send warm fuzzy feelings.

I've read that the number one reason people get rid of a Heartwave setup is that they can't stand feeling someone else's anxiety or passing moments of anger. With me and Izzy, it was different; rather her feeling my anxiety, sending anxiety in response, and each of us making the other feel worse, we seemed to read each other's complementary disquiet as a reminder that we'll always be here for each other. We'd calm each other down. It's not an unusual response with a Heartwave, but unfortunately it's not universal.

When the… thing… happened, Izzy was halfway around the world, riding back to her hotel, and I had just gotten up for the day. We could feel each other, that gentle contact, rewarding and calming. I could tell she was tired, somehow, and just beginning to doze off in her seat.

The fear spike was so strong it knocked me down. My own anxiety shot up both in response to and in alignment with hers. Then, just as fast as it rose, it came down, leaving us feeling a dizzying warmth and love. For five long minutes I could feel that love, holding on as tightly as she could, then finally fading. Well before the authorities contacted me, I knew what had happened.

I replay those last five minutes every morning, always starting with the fear spike. It's as much hers as the love. It's not because I can't let go. It's because I don't want to. ■

X-RAY VISION

In this scenario, body area networks (here known as "selfies") are universally Internet-connected, uploading realtime information (health, location, environmental data) to the cloud. Although the information is private, it may still be accessible to governments or to the device manufacturers.

Hayward '26 wasn't the first time health monitor data could be used to analyze a big event, but it was the one that everyone noticed. Hayward Alpha hit at 4:40 in the afternoon, when most people were heading home from work or chores. Heart rates jumped when the 6.3 quake hit, staying high throughout the 90 seconds of shaking. Unsurprisingly, the pattern of racing hearts matched the propagation of seismic waves from the quake's center, racing north up the fault line, moving more slowly through the Oakland hills.

Interesting enough on its own, but it was the readings from Hayward Omega an hour later that really got people's attention. The 7.8 was terrifying in and of itself, but coming just as the initial panic from Alpha was settling down pushed residents to new levels of panic, triggering hundreds, possibly thousands, of fatal heart attacks. Omega knocked down pretty much every sizable building in the region that hadn't been brought up to the latest earthquake codes, trapping over forty-two thousand people when they collapsed. Looking at the heart rate data from immediately afterwards is gut-wrenching: spikes of panic, followed by ongoing waves of heartbeats dropping to zero.

Selfies were fairly primitive in the 2020s (I think they were still called "wearables" back then), but while today's richer sensors and stronger analytic systems offer us much more information, we still (fortunately) haven't duplicated the visceral shock of watching the heart rates after Hayward '26.

The crackdown on the Climate Marches in Sao Paolo comes close, however. Although most of the post-industrial world has moved to new models of civic authority, Brazil is one of the countries that still holds onto its police-based law enforcement system, with all of its faults and legacies. The demonstrations in April of 2038 brought out the worst in people, both civilian and police. Nearly three dozen citizens died in custody, but (as intended) flying eye microdrones documented everything. Video archives of the events of that evening matched the police reports exactly (in retrospect, that alone should have raised suspicion). Family members claimed that the arrestees had been killed by the police, but there was literally no evidence to support those assertions.

Until somebody started looking at the selfie biodata, that is. While the Sao Paolo police hackers had done an outstanding job of altering the video, they couldn't (or didn't think to) alter the data collected by the selfie implants and digital ink tattoos. Although the video recordings from multiple perspectives seemed complete, victim health data captured and stored by the sensors told a very different story.

Within three weeks, the Sao Paolo Police claims had completely fallen apart, as every impact, every electric shock, every choke-hold had been meticulously documented by the victims' bodies themselves. Some of the victims had newer systems, able to track body posture, limb position, and motion, allowing investigators to construct painfully life-like simulations of the events of the night of April 13, 2038. Evidence of the deliberate alteration of the video material soon followed.

While the Sao Paolo violence didn't approach the sheer scale of Hayward '26, the complexity, the completeness, and ultimately the intimacy of the selfie data gave it nearly equivalent emotional weight. By the end of 2038, people around the world knew what had been done, the names of the accused, and the faces of the victims. Because their bodies could remember what happened, the world could remember, too. ■

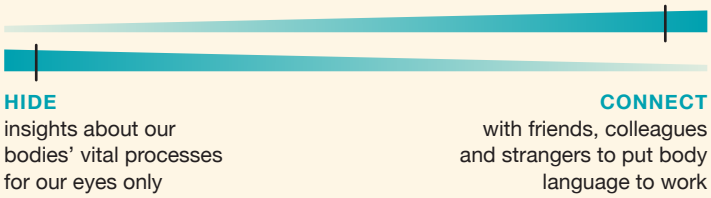
Illustration by Trent Kuhn

EXPRESSIONS OF
the New Body Language

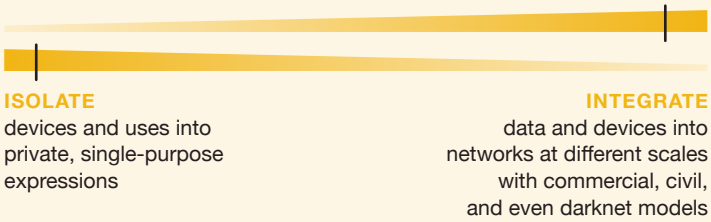
The intentions that will drive the New Body Language come in polar pairs that we will balance in different ways to create a wide variety of expressions—personal and cultural, consistent and contradictory. To understand the expressions that will emerge, we must first understand the tensions across these polar pairs. Together they provide a tool for making sense of the diverse ways we'll relate to personal technologies—and a framework for identifying innovation opportunities that meet users in relevant, personal, and contextually appropriate ways.

BALANCING OUR INTENTIONS

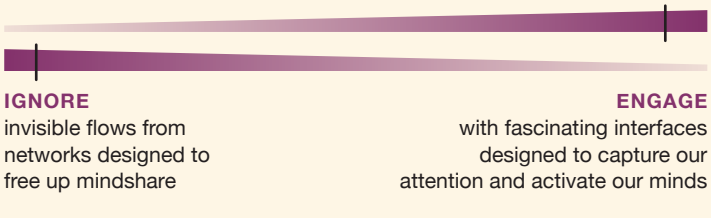
By hiding intimate details about our own bodies and selves or connecting with others in new ways, we will **build our social identities while learning about ourselves**.



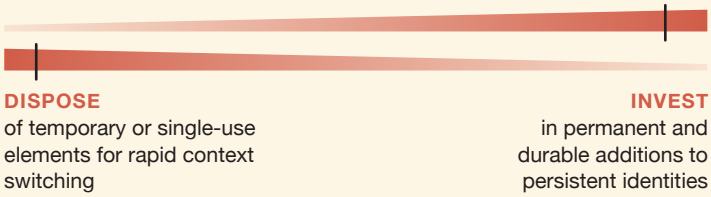
By buying into branded ecosystems or keeping body area networks fragmented, we will control privacy and **adopt varying levels of integration into larger ecosystems.**



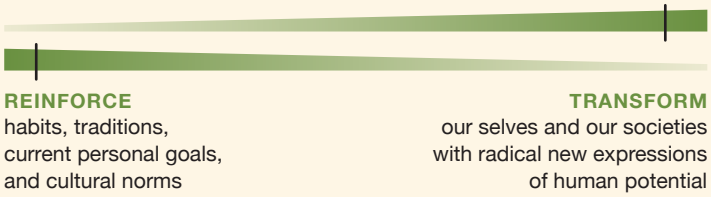
By allowing the mediated flows to disappear under our skin or engage our attention with fantastical interfaces, we will explore new ways to **manage our attention and awareness.**



By varying the upgrade cycles of our body area networks, we will be able to **change the expressions of our technology-infused bodies** from minute to minute.



By reinforcing or transforming our everyday actions, body area networks will help us **make and remake society,** altering what it means to live a good life.



SIX ARCHETYPES

Meet the expressions of the New Body Language: six archetypal people who have each configured technologies in, on, and around their bodies to strike a blance of different intentions. Here's what you'll learn about each expression:

What they're equipped with:

Devices and systems this person has configured. They range in complexity and effort required by the user. Some will be off-the-shelf services, while others require a bit more creativity. All of them help that person express their new body language.

What underlying technologies make it possible:

Technologies that enable the New Body Language. We've highlighted these as some of the most important to track over the next decade. See page 33 for more affordances of these technologies.

How they strike a balance of intentions:

As people implement body area networks, they will strike different balances of intention. These will vary greatly based on motivation, aspiration, and context.

THE ATHLETE

A multi-million dollar piece of machinery **optimized for performance** and **fan engagement**, being an athlete is now more competitive than ever, and is monitored down to each muscle-powering mitochondria. The Athlete is on a strict, **data-driven, predictive maintenance** schedule to **reduce injuries** and improve his mental clarity during the game. Across the league, performance is up (and he keeps breaking his own personal records every month). Annual drafts are hugely suspenseful spectacles. He's getting nervous about next month's salary negotiations; he's heard rumors that the league's systems can predict future declines in performance.

ENABLED BY:

- Sensors
- Human-machine interfaces
- Distributed computing
- Machine learning
- Inference engines

To strike this balance:

REINFORCE — TRANSFORM

Reinforcing iconic stardom by optimizing and keeping focus on performance

HIDE — CONNECT

Hiding potentially damaging movements from analysts before they manifest as injuries to deliver predictive maintenance

ISOLATE — INTEGRATE

Integrating real-time muscle-level biometrics to augment fan interactions in immersive media

THE FAN

It's almost 1 a.m. in London, but that doesn't mean The Fan can't **join live** for tonight's Sunday Night Football game in Pittsburgh for a **distributed shared experience**. She gets up to grab a snack when, OOOF… she staggers and catches herself on the doorframe. Someone just got tackled on the field, and her haptic feedback jersey surged a quick signal that made her diaphragm spasm. The sensation disappears, and she grins—it's pretty fun having the wind knocked out of you from 3,000 miles away. **It's like you're actually there.** She lets out a loud "WOOHOO!" that registers on her AwayGame app for **co-present engagement**. If the collective roar of either team's remote fans gets loud enough, their cheers will be pumped over loudspeaker into the stadium.

ENABLED BY:

- Auditory recognition technologies
- Natural language processing
- Human-machine interfaces
- Sensors
- Distributed energy and batteries

To strike this balance:

REINFORCE — TRANSFORM

Reinforcing beloved sports rituals in new contexts and with new sensations

HIDE — CONNECT

Connecting with co-present fans around the world and making their presence felt in the stadium

DISPOSE — INVEST

Investing in all the game-day embellishments, which take the place of expensive season tickets

THE EATER

The Eater was the kid with "weird" lunches in the cafeteria: miso soup or pickled *umeboshi* plums. Then for the 5th grade science fair, her class sampled their gut microbes, and suddenly she was the leader of the fermentation fad, **revealing connections between body and food**. She got her whole family in on the experiment, and now she uploads weekly microbial diversity results to a display in their kitchen. The Eater sees everything through the lens of food—**pioneering new forms of computer-food interaction**. She learned Arduino programming in engineering class and built an "umami meter," so she can **measure the deliciousness** of the afterschool snacks she concocts for her friends. Look, she's out in the backyard now with a handheld spectrometer, analyzing her peaches for peak-ripeness! If she has too many, she'll put them up on a public database for community food coordination—she's on a mission to **reduce food waste**.

ENABLED BY:

- Inference engine
- Computer vision
- Sensors
- Graph theory
- Distributed computing

To strike this balance:

REINFORCE — TRANSFORM

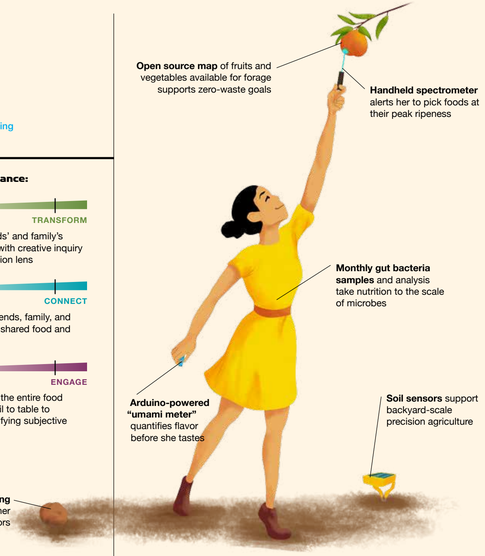
Transforming friends' and family's experience of food with creative inquiry and a higher-resolution lens

HIDE — CONNECT

Connecting with friends, family, and community through shared food and shared information

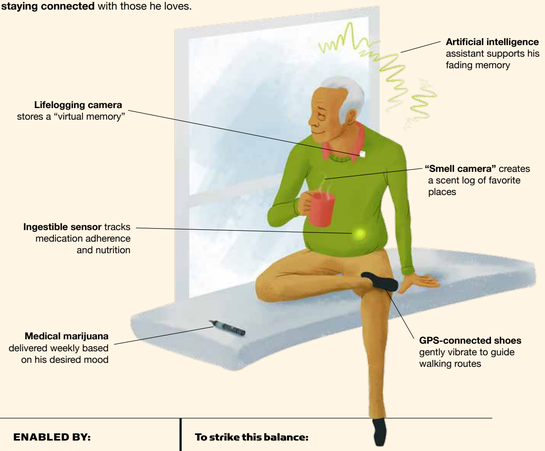
IGNORE — ENGAGE

Engaging fully with the entire food experience, from soil to table to intestines, by quantifying subjective experiences



THE UNWELL

First it was the coffee pot. He just couldn't remember how it worked. Then even as his quick wit and eloquent vocabulary slipped away, the Unwell assured his kids, "I'm 53, too young for Alzheimer's." But everyone knew something was different. The Unwell would never call himself that. He has rigged together an elaborate system to **keep things feeling normal**. He can ask his artificial intelligence assistant to jog his memory without feeling embarrassed. It makes **sure he takes his meds**, eats enough, goes out for walks without getting lost, and **automates daily therapy.** He just read about a procedure to implant a prosthetic hippocampus. Still, he might just accept that things are different now and focus on **staying connected** with those he loves.



ENABLED BY:

- Computer vision
- Sensors
- Natural language processing
- Machine learning
- Robotics

To strike this balance:

REINFORCE — TRANSFORM

Reinforcing the Unwell's baseline sense of identity and well-being by preserving relationships and favorite activities

HIDE — CONNECT

Hiding subtle changes from his family while keeping himself informed and sending the important data to his doctor

IGNORE — ENGAGE

Engaging with his devices and even automated systems to keep his mind sharp in the present

THE PARTIER

We all have that friend, the one who is a little too loud and posts way too often on Instagram but always has the coolest parties. Deep down, you want to be tagged in his pictures that get thousands of likes. The Partier is a living, breathing, media channel, **tracking social influence:** a carefully crafted vision of a lifestyle tricked out with high fashion tech right off the runway. His body area network takes **self-expression** to the next level and it instantly broadcasts for **brand promotion,** his own and his sponsors, to **connect with his friends and fellow partiers**. Best of all, drinks are always on him—companies are clamoring for him to promote their brands.

ENABLED BY:

- Sensors
- Human-machine interfaces
- Distributed energy and batteries
- Graph theory
- Blockchain technologies

To strike this balance:

HIDE — CONNECT

Connecting openly with everyone with radically transparent self-expression as his brand

IGNORE — ENGAGE

Ignoring the constant noise while still **engaging** his many friends and fans—a delicate balance that's necessary to prevent burnout

DISPOSE — INVEST

Prominently displaying buzz and mood with **disposable** branded accessories—always willing to try a new one if the price is right

THE LABORER

Everyday, the Laborer's body performs heroic **feats of strength**. But after 15 years on the job, even a small imbalance in her tool belt leaves her lower back screaming. She's trying her company's new integrated **safety system**: a lightweight exoskeleton that redistributes weight to protect her joints, while biometric sensors **prevent exhaustion**. It also integrates coordination and **project management.** Now she's in the zone, 500 feet up on scaffolding, following the augmented reality instructions streaming to her safety goggles. She's thankful for the new helmet that drowns out the noise pollution from jackhammering a few stories down. After her son's friend unlocked the proprietary AR device, she can now stream her favorite comedian's stand up—**integrating entertainment** while she takes a break.

ENABLED BY:

- Robotics
- Computer vision
- Distributed energy and batteries
- Human-machine interfaces
- Graph theory

To strike this balance:

HIDE — CONNECT

Connecting with project manager's dashboard for real-time stats on worker's performance or fatigue

ISOLATE — INTEGRATE

Integrating personal media streams into professional systems to improve user's experience, when it's safe to do so

DISPOSE — INVEST

Investing in a robotic extension of self for greather strength and safety—plus customized 3D-printed parts that can be melted down and remade for a new user

OVERVIEW

Each Expression of the New Body Language strikes a different balance of intentions. These intentions are complex and dynamic, and will change drastically based on time and place. A set of technology affordances and enablers, explained on the next page, make expressing all of these intentions possible.

THE ATHLETE

Reinforcing athlete's iconic stardom by optimizing and keeping focus on performance. **Hiding** potentially damaging movements from analysts before they manifest as injuries to deliver predictive maintenance. **Integrating** real-time muscle-level biometrics to augment fan interactions in immersive media.

THE FAN

Reinforcing beloved sports rituals in new contexts and with new sensations. **Connecting** with co-present fans around the world to make their presence felt in the stadium. **Investing** in all the game-day embellishments, which take the place of expensive season tickets.

THE EATER

Transforming our understanding of our bodies and environments with creative inquiry and higher-resolution lenses. **Connecting** with friends, family, and community through shared food and shared information. **Engaging** fully with the entire food experience—from soil to table to intestines—by quantifying subjective experiences.

THE UNWELL

Reinforcing his baseline sense of identity and well-being by preserving relationships and favorite activities. **Hiding** subtle changes from his family while keeping himself informed and sending important data to his doctor. **Engaging** with his devices and automated systems keeps his mind sharp in the present.

THE PARTIER

Connecting openly with everyone, radically transparent self-expression is his brand. **Ignoring** the constant noise while still engaging his many friends and fellow partiers is a delicate balance that's necessary to prevent burnout. **Disposing** of the accessories that track his buzz and mood. They always prominently display a brand—and he's always willing to try a new one if the price is right.

THE LABORER

Connecting with project manager's dashboard shows real-time stats on worker's performance or fatigue. **Integrating** personal media streams into professional systems improves the wearer's experience. **Investing** in a robotic extension of self makes the Laborer stronger and safer, while customized 3D printed parts can be melted down and remade for a new user.

AFFORDANCES AND ENABLING TECHNOLOGIES

Body area networks offer new capacities to both individuals and organizations. Across use cases are bigger picture technology affordances, each one connecting enabling technologies to specific opportunities and applications. In the spring, IFTF launched the research map *The Automated World*, which developed a series of five technology building blocks underpinning the future of automation. These building blocks lend amazing affordances to the New Body Language. They enable human expressions and form the connective tissue of body area network technologies.

CONTINUOUS CAPTURE AND SENSE-MAKING

Advances in sensors, transmission, data storage, and analysis capabilities will enable body area networks to provide a wealth of real-time data. As connected devices in and on us multiply, privacy becomes more challenging. We'll increasingly have to choose between the insights we want and the exposure we'll tolerate.

SIMULATING COMPLEX DECISIONS

Body area networks will bring new clarity to complex questions of personal health and well-being. From microbiotic sensors in our gut to clothing that senses every muscle, decisions of personal health will be simulated based on broader and more accurate inputs than today. How our behavior interacts with environmental health influencers will take decision support to another level.

ON-DEMAND INTELLIGENCE

Body area networks make vast amounts of data instantly available to us anywhere throughout our connected world. Artificial intelligence and supercomputing will be available not just in the palm of our hand, but inside our bodies, too.

EVOLVABLE HARDWARE

The fusion of software into hardware is transforming the way we think of performance upgrades of our devices, our machinery, and, in the future, our bodies. This means that body area network technologies will not be static, but constantly adapting to our demands for self-expression, functional needs, and regulatory guidelines.

ENCODED JUDGMENT

As intelligent machines make their way into the fabric of our lives, humans will start to encode boundaries into the behavior of automated devices. These boundaries will ensure human safety and also guide us towards our best intentions—or those of marketers.

ENABLING TECHNOLOGIES

Auditory recognition systems and computer vision will greatly expand the comfort and convenience of biometric data capture

Blockchain technologies will make transactions triggered automatically by our bodies more secure and private

Distributed computing will bring big data processing and analysis to even the smallest objects

Distributed energy and batteries will free our devices from inconvenient recharging

Graph theory will marshal human input and machine intelligence to offer creative solutions

Human-machine interfaces will make touch and gestures the primary interface of body area networks, making devices "disappear"

Inference engines will take complex biometric data to turn large, messy data into insight and prediction

Machine learning will ensure that as adoption increases, decision support will get more personal

Natural language processing will make the boundaries and suggestions of machine intelligence more accessible

Robotics will be an extension of our bodies through exoskeletons and prosthetics, while nano- and micro-scale robots may heal us on the molecular level

Sensors will use light, magnetism, and other non-invasive methods and tiny labs-on-a-chip to generate biological data in everyday life

SARAH SMITH
is a researcher and designer at IFTF, visualizing complex systems and provoking people to think about well-being futures in new ways.

With Miriam Lueck Avery, Andrew Trabulsi, and the Technology Horizons Team.

DESIGNING TECHNOLOGIES FOR

Our Radical, Adaptive Human Bodies

an interview with Sara Hendren

When talking about the future of wearable computing, many people assert that it presents huge opportunities for assistive technology. But what is "assistive technology"? The standard definition is a tool, such as a hearing aid, designed to restore or bring to the level of ability of a "normal" person. But designer and artist Sara Hendren argues that normal is subjective and questions the idea that we should strive for normal. *Future Now* sat down with Hendren to learn more about her perspective that all technologies are assistive—they allow us to do things we couldn't do on our own—and the design insights this way of thinking generates.

> "Say I want to design for people over 70 with age-related vision loss. Having people be the experts on their own capacities is the way to do it.

What do we gain by calling some things assistive technologies and other things just technologies?

Language matters. Historically, assistive technology has been part of fixing bodies that are broken. People who use them are seen as medical subjects needing a kind of proxy, a tool to get closer to a version of normal that the culture has held up as the life worth living. I think it's important that [not only] in the language, but also conceptually, we take another look at what alternate views of the world might we gain if we think of all technology as assisting various bodies to do various things.

No matter how limited the mobility, no matter how few senses are being deployed, the body is radical and adaptive. Design technologies let those bodies do the things they want to do, especially as self-defined by people in those bodies, instead of a top-down approach, presuming a kind of cultural normalcy.

Could you give an example of a project or design that comes out of this perspective?

I'm a huge fan of SpokenLayer, which makes written, visual text on the web into audio text with broadcast-quality sound. The guy who started this is dyslexic, and he grew up using talking books. That gave him this idea—even a sighted person would want content on the web that's now strictly visual to become audio.

Looking closely at the assistance required by what you'd think of as an extreme user is a really rich and generative research source—looking deeply will provide more help for more people more of the time. You're using people with atypical bodies and minds and seeing them as a rich resource of knowledge that can help open up a lot of avenues for technologies we should rethink.

Photos courtesy of Sara Hendren

The Americans with Disabilities Act in the US mandated many now-ubiquitous features of urban life, like curb cuts on ramps. These features now make life easier for people pushing strollers, pulling suitcases, and so on.

What do you think are the primary questions we should ask about this technological advancement and how we design for people with this kind of tech?

I'm excited to see, for instance, what the Institute for Human-Centered Design is creating in the User Expert Lab. They're trying to have this large database of people with all kinds of bodies, and cognitive and sensory organization, on hand so they can contract with industries. Having people be the experts on their own capacities is the way to do it.

I think primary on our minds should be, "What makes people's lives possible in the most daily way? Who can do their job more easily as a result of this technology?" In India, they've been building recycled rubber—kind of one-size-fits-all—lower limb prostheses. How are you going to compete with a million recycled rubber low-tech limbs given away for free? Dig deep into these conditions and make them benefit everyone. Make a lot of money doing it. Do it in a high-tech way, and do three or four loss-leader projects.

Also spend some time doing these other kinds of projects that help people think in generative, interesting ways about bodies.

I think sometimes the biggest promise can be these assistive and adoptive applications. If you were in more conversation with more people, you'd learn about these as market opportunities and ask, "How do we do the right thing to make the world that we want to live in?"

To what degree do you design in an open-ended way and to what degree do you think through how technology will or won't fit into people's lives?

I think it's possible to do both if you dig deep in a user-centered way and try to give it levity and abstraction. What can we learn that would keep this thing as open as possible? When the iPad came out, a lot of tech-savvy people went, "Nobody who does something productive on the web will use this." Remember when all of this suddenly became a game-changer around autism?

So I think we dig deep, certainly into atypicality, but also reconsidering ways we've decided that interaction with disability could be a rich resource. Abstracting from a particular user or situation can often be a game changer. Weird, specific, and deeply embedded in culture—the lessons are there for us. ■

BEN HAMAMOTO
Research Manager

High fashion meets maker manufacturing

The wearables dream team of 2025: Chinese and Western fashion designers and engineers who are great at software and hardware, where the "hardware" includes plastics, electronics, fabrics, natural materials, and screens.

Rafal Wegiel

Personal Tech Becomes Fashion

Fashion has always been a form of communication and self-expression, a quick visual signal of one's tastes, allegiances, and socioeconomic position. Over the next decade, personal fashion and personal computing will begin to blur, offering us a new way to think about what today we call "devices." Whereas today's personal devices help us communicate primarily through their connection to networks and software, the next generation of devices will allow us to communicate through their form factors as well. The colors, textures, and capacities of clothing, jewelry, and shoes, enhanced with digital powers, will be new modes of communication in and of themselves.

LYN JEFFREY
is a cultural anthropologist at IFTF who investigates people's creative responses to a rapidly changing world, on individual, house-hold, community, and national scales.

Today's wearables are mostly focused inward, on our relationship with ourselves, notes Rachel Hinman, a leading thinker on the intersection of tech and fashion. Health trackers help us understand our bodies in new ways and improve performance; smart clothing lights us up and keeps us safer at night as we ride our bikes, or heats our torso, hands, and feet on a cold day; smart shoes deliver buzzes to point out the right path through a city. But the real promise of smart wearables is precisely what has made mobile phones so powerful: their ability to connect us to others and to share our inner worlds. We'll need to rethink our technology user interface paradigms, devices, and brands, redesigning them to enable self-expression. There will be a lot to learn from the world of the atelier, with its exquisite attention to the rapid cycles of give-and-take between branded designs and the street.

Seeed Studio

The 'Tech Tie' on display at MAKE FASHION 2014.

HOW FASHION AND TECH WILL LOOK MORE ALIKE THAN DIFFERENT

Fashion and technology production cycles have traditionally been at polar ends of the manufacturing and consumption spectrum. Fashion is about originality and change, with studios producing two distinct collections every year. New designs seen on a runway become "fast fashion." They can be copied, manufactured, and distributed around the world in a matter of weeks. Their low cost and frequent updates drive rapid consumption cycles of "disposable" stylish products. Our personal devices, on the other hand, take years to develop; their "new looks" come out no more than once a year and often contain only the tiniest variations. And they remain among the most expensive personal items we own. With changes in the way that electronics are being developed, however, the world of 2025 is likely to include smart fashion that evolves just as quickly as today's ordinary clothes and accessories.

It starts with the rise of what IFTF calls "social manufacturing": the ability of small groups of people to quickly bring an idea to the shelf by using crowdfunding, local maker spaces, online learning resources, and services that link entrepreneurs to design and manufacturing in China. Nowhere has this been more evident than in electronics. Apple and Samsung currently dominate the phone market, but new entrants are popping up daily to create the kinds of edgy, connected accessories that will define the wearable category going forward—products like the Oculus Rift virtual reality headset didn't come out of corporate R&D labs. While the big companies release smart watches that look more or less like mini computers on your wrist, it will be smaller start-ups, sometimes in partnership with fashion brands, who will build the new world of fashion wearables.

HOW CHINA WILL BECOME A PLATFORM FOR GLOBAL SMART FASHION EXPERIMENTATION

Part of the story of the growing hardware renaissance is that more Western entrepreneurs are going directly to China. For the first time they are able to tap into superfast Chinese design and new small-batch manufacturing capacities. Perhaps even more importantly, into what inventor/hacker Bunnie Huang calls China's "network view" of IP and ownership. In the world of hardware start-ups, he writes, "Chinese entrepreneurs [have] had relatively unfettered access to cutting-edge technology, enabling start-ups to innovate while bootstrapping. Meanwhile, Western entrepreneurs often find themselves trapped in a spiderweb of IP frameworks, spending more money on lawyers than on tooling." Chinese engineers' access to technology is what allowed them to mix and match, driving the growth of low-end Chinese mobile phones that competed with Apple on the high end, and ultimately destroyed Nokia and Motorola in the space of a few years. Now imagine this applied to the world of smart objects.

Of course China is not just the world's largest electronics manufacturer, it is also the world's largest apparel maker, making over 40% of US apparel imports in 2014. Thus we may see many more experiments that bring together advanced garment manufacturing and personal electronics manufacturing. The wild card in this story is the future of China's *shanzhai,* or knock-off manufacturing. These shadow networks copy the latest runway fashions, manufacture them, and quickly distribute them to every major city in the world, to meet the demands of those who want to sync with global fashion trends but can't afford the steep prices the authentic versions command.

Now imagine this applied to the world of smart fashion.

All of this activity will be fueled by China's own need to innovate, driven by rising wages and slower economic growth. In city halls and corporate boardrooms around the world, economic growth is becoming linked with new strategies to support creativity and imagination. China is making bold moves in this regard, though it is too early to know exactly how they will play out. Earlier this year the Chinese State Council announced its "mass innovation" policy and Chinese Premier Li Keqiang personally visited a "maker space" in Shenzhen. The government rolled out new supports for entrepreneurs and small businesses, from community workshops, to educational curriculum, to Maker Faire festivals for DIY creators like the one in Shenzhen that drew nearly 300,000 visitors in June 2015.

The city of Shenzhen is leading the way among Chinese cities, with an ambitious International Makers Week and a web of new services and spaces meant to connect entrepreneurs to the vast design and manufacturing resources of the city. Not surprisingly, most of these have focused electronics, and smart manufacturing. But if the city can expand its small-batch manufacturing model to garment manufacturing as well, it may be able to compete with Shanghai and Beijing, China's fashion leaders, to build a bridge between apparel, electronics and smart clothing. To that end, a new Fashion Technology Industry Accelerator (FTIA) initiative was launched in Shenzhen in June 2015. A partnership between Shenzhen's Industrial Design Profession Association (SIDA) and the Council of Fashion Designers of Shenzhen, it aims to become the leading "fashion IoT platform in China," says FTIA co-founder David Chu.

We can already see the outlines of an unprecedented cross-border network of Chinese and Western know-how, capital, and creativity that could fuel innovative smart fashion, IoT, and personal computing products. Local manufacturing efforts such as New York-based Maker's Row, an online marketplace that connects American manufacturers and entrepreneurs so that they don't have to go abroad, could begin to play a bigger role in smart fashion experiments. But for the next decade at least, China will remain the go-to source for wearable electronics due to its position as the world's largest manufacturer of both electronics and garments, and to its dynamic design, materials, and entrepreneurial communities. ■

Today's successful experiments in smart jewelry and clothing

MAKE FASHION, a Calgary, Canada-based fashion collective, pairs fashion designers and artists with engineers and tech enthusiasts. At the 2015 Shenzhen Maker Faire, designer Kelly Hofer created a pair of pants that monitor muscle activity via EMG sensors and fading lights. Using Shenzhen resources, it took him less than a month.

VISIJAX, a UK company making motorcycle jackets to keep you safe via motion-activated LEDs and LEDs for nighttime visibility, has its factory in Shanghai.

FINNISH COMPANY CLOTHING+ makes over 3 million sensor products a year at its Chinese factory for its "textile-integrated electronics." The company works with brands like Adidas and Garmin for sports, and Philips for medical.

RINGLY, a $200 smart ring made of 18 karat gold and precious stones, notifies you when you're getting calls and emails. It's based in NYC and manufactured in Shenzhen.

Visijax

Visijax commuter coat—safety functionality is an early driver of tech-enabled clothing development.

NEW PARTNERSHIPS
Big brands will also continue their move into smart garments and accessories. Ralph Lauren's $295 smart shirt, Intel and Opening Ceremony's $500 MICA bracelet, and Tory Burch's $175 Fitbit bracelet are all examples of the new partnerships we'll see between fashion brands and tech companies (all made in China, of course).

Bodies That Buy:

Could bio-based purchasing bring us closer to our better selves?

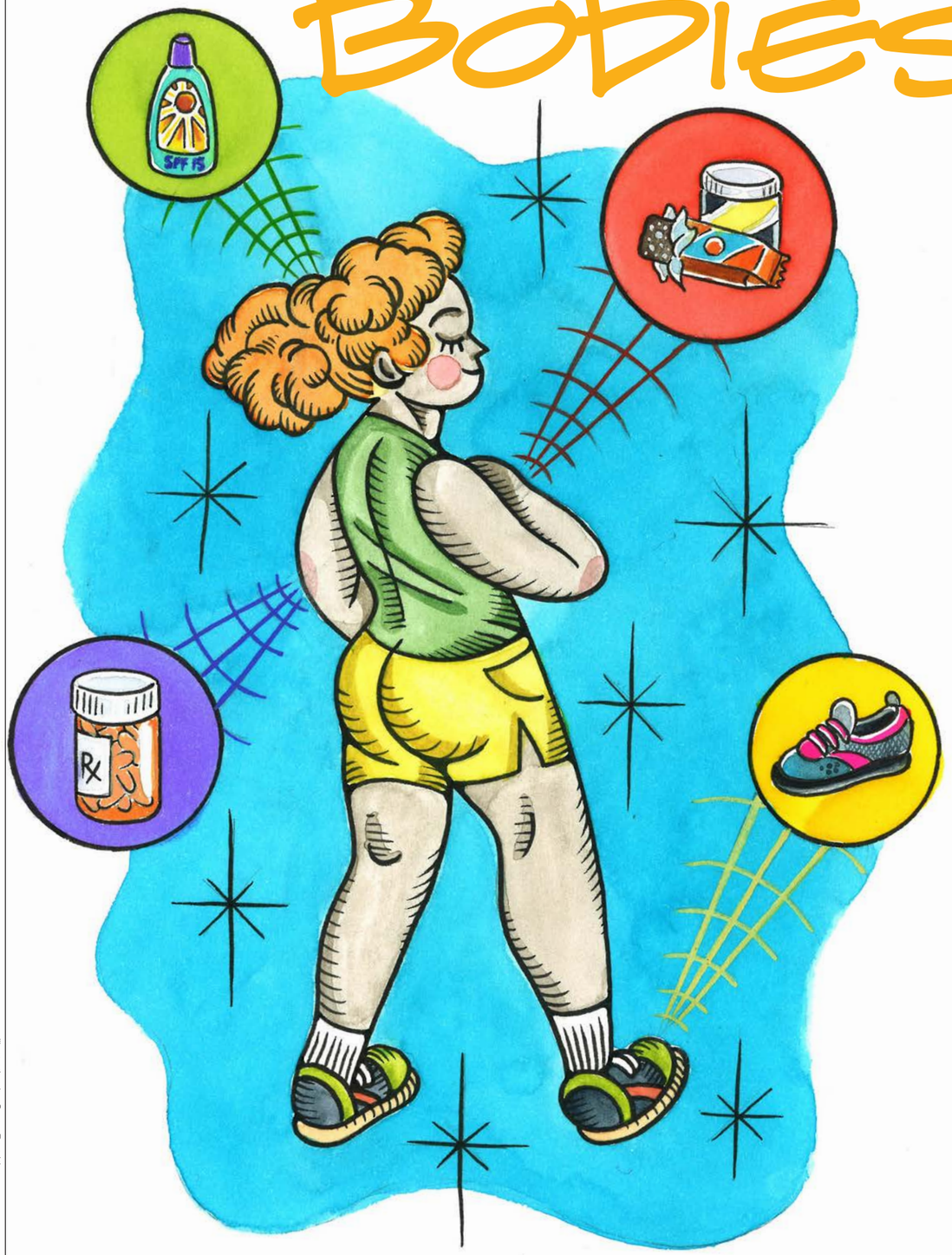
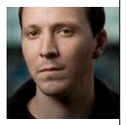


Illustration by Owen Partridge

Efforts to automate our personal lives are nothing new.

We use alarm clocks to automate waking up on time; calendar alerts to remind us of meetings; streaming services like Pandora to automatically deliver music tailored just to our preferences. But personal automation isn't just a matter of convenience; increasingly, we're learning that automating both big and small decisions can enable us to make decisions that we're happier with, leaving us feeling more relaxed and able to focus on more important things.

BRADLEY KREIT
Reasearch Director



THE BIOLOGY OF DECISION-MAKING

In 2007, David Bach published perhaps the best known of a genre of financial planning books based on a very simple strategy: if you set up a direct deposit into your retirement account, you can save without thinking much about it. If you do this year over year for enough time, you can still spend all the money in your bank account—the natural impulse—and set yourself up to become, as the title of the book suggested, an Automatic Millionaire.

Bach's argument—and the argument of a series of similar books by other authors—is rooted in a growing body of behavioral science research demonstrating that the act of making too many choices exhausts us and leads to worse decisions.

There are physiological markers of reduced decision-making ability: low blood glucose levels lower our abilities to exercise self-control, causing all sorts of unexpected problems.

In one recent study, Ohio State University psychology professor Brad Bushman found that married couples act more aggressively toward each other—by sticking pins into voodoo dolls representing their spouse and blasting them with loud, annoying noises—when they had measurably lower blood glucose levels. In an interview on the study, Bushman advises that, "Something like a protein bar would be a really good thing to have before discussing an important issue with your spouse."

YOUR BODY IS THE CONTEXT

But what if your body could remind you to eat a protein bar before a tense discussion with a spouse—or a boss?

As the next decade unfolds, our body area networks will take advantage of this new science of decision-making—the biomarkers and personal histories that affect the ways we decide—and remind us to do things like eat protein bars before tense conversations. Our bodies are becoming one of the new frontiers in contextual computing. In much the same way our phones can guide us toward different routes based on traffic patterns, our body area networks will guide us toward different decisions based on the patterns of our biomarkers—altering us when our decision-making ability is impaired or even taking action to get us in a better decision-making mindset.

And as the sensors we use to measure our biomarkers improve, the process for transforming our bodies into a platform for contextual computing will enter a virtuous, accelerating cycle. Most physiological measurements take specialized equipment and are painstakingly slow; for instance, measuring blood glucose involves pricking your finger for blood. The easier it becomes to measure our biomarkers, the better we'll understand the physiological analogs that shape our behaviors and decisions; the more useful these measures become, the more people will want them.

Food and dieting may be the most obvious domains to use these biomarkers to drive decisions, but they are hardly the only applications. From identifying shoes that fit best and furniture that helps improve posture to streaming media that improves our moods, the potential applications will expand faster and faster as our measurements get better and better.

MARKETING TO BIOMARKERS

But once we have this internal contextual understanding, what will we want our bodies to communicate? Simply pinging us with more information—in effect a notification presenting yet another decision—would be self-defeating. If our bodies are going to help us make better decisions, we'll need them to augment the decision-making abilities of our brains. They'll need to bypass the brain and make decisions on our behalf in much the same way a direct deposit into your retirement account bypasses your consciousness.

> IF OUR BODIES ARE GOING TO HELP US MAKE BETTER DECISIONS, WE'LL NEED THEM TO AUGMENT THE DECISION-MAKING ABILITIES OF OUR BRAINS.

As radical as it may sound, the idea of adapting the world to our bodies without our knowledge is already gaining traction. Adaptive interface design can now vary how information gets displayed based on a user's biometrics.

Could the same principle be used to sell us stuff? You bet, but perhaps in ways that remove one more layer of conscious decision-making. The world's most successful retailers deeply understand the value proposition of convenience. Amazon's Dash Replenishment Service API is already being built into water filters, ink jet printers, and coffee makers to allow these appliances to directly reorder supplies from Amazon. IBM and Samsung have developed a proof of concept network architecture that enables appliances to pick and choose from trusted vendors to negotiate autonomously for the best deal on the products that you like.

The Amazon Dash Button is a small device that can be placed anywhere in the home and programmed to automatically order a specified product when the button on its face is pushed.

These kinds of systems can be built into our smart watches just as easily as they can be built into our washing machines. In other words, it's becoming technically feasible to develop systems that allow changes in your body to automatically make purchases on your behalf.

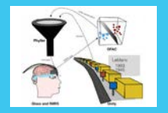
ASPIRATIONS OVER IMPULSES

Whether or not there's a practical difference in connecting your appliances to a retailer and connecting your body, there's a dramatic psychological difference. For the vast majority of us, a more convenient way to order coffee won't be a good enough reason to create a direct connection between our bodies and online retailers.

But what if your body area network could make shopping decisions that support your higher goals? What if it could save you money and help you become an automatic millionaire? What if it could buy foods you want to eat that also make you automatically healthy? Or only make purchases that align with your personal ethics?

Such a system would make this possible, allowing us to make decisions that are dictated more by our aspirations than our impulses. For many people, this, combined with the time and energy saved by outsourcing decisions, could be a sufficiently compelling reason to let our bodies speak for us and buy on our behalf. ■

We've begun to see the rise of adaptive interfaces that tailor user experience to current physiological and psychological states. These early signals of adaptive interfaces hint at a future in which our bodies don't simply tell machines to deliver information in different ways, but tell machines to deliver different kinds of products.



Monitor bloodflow to screen out messages

Developed by researchers at Tufts University, Phylter includes a headband that monitors signs of bloodflow to the brain's prefrontal cortex, which indicates high levels of focus. When Phylter sees high levels of focus, it automatically screens out low-priority emails and notifications on the wearer's phone to encourage focus on the task at hand.

Proverbial Wallets stop shopping

Developed by MIT researcher John Kestner, and in early stages of commercialization, his Proverbial Wallets take in contextual information to automatically adjust our perceptions of money and spending. For instance, the Mother Bear prototype wallet becomes harder to open when its owner is close to exceeding monthly budgeting goals.

Sleep sensor adjusts your television

Samsung's SleepSense is designed to seamlessly network with a user's smart home devices to optimize the environment for sleep. Based on sleep habits, SleepSense can adjust everything from lighting to the air conditioner to attempt to improve the user's sleep. And in the morning, when it senses its user is waking up, it can trigger a coffee maker to brew coffee.

What are the health and happiness tradeoffs for my indulgences?

Personalized results for
ALDOUS LEARY
Based on
GENOMICS
PREFERENCES
BIOMETRICS

Connect to Erowid

You can sign up for an Amazon S3 account online.

Access key ID AKIAJGDN5E

Secret access key

Show secret access key

Remember secret access key

An error occurred while loading or saving configuration information for evolution-alarm-notify. Some of your configuration settings may not work properly.

THINK AHEAD!

Upgrade to Premium

Hide browsing data from doctor ✓

Avoid insurance hassles ✓

No ads! ✓

Ensure your privacy ✓

PROCESSED FOODS

+1

BLISS	+ 1
ENERGY	+ 1
HEALTH	− 1

DEPRESSANT

+1

BLISS	+ 3
ENERGY	− 1
HEALTH	− 2

PESONAL WARNING:
POTENTIAL FOR CARDIAC ARREST

AMPHETAMINE

+8

BLISS	+ 3
ENERGY	+ 6
HEALTH	− 1

★ GROUP FAVORITE

CANNIBINOID

+2

BLISS	+ 5
ENERGY	− 3
HEALTH	− 0

SPONSORED AD

DISPENSARY 2 .7 MILES FROM HERE!

Artifact from the Future, not a real product. First appeared in Health Horizons 2013.

Altered Anatomies

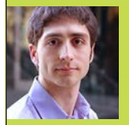
Voices from the Vanguard of Implantable Tech

Courtesy of Amal Graafstra

Implanting a computer chip in your body today is no easy task.

Unless it's part of a prescribed medical procedure, it often involves breaking the law and always involves breaking the skin. Still, a small but significant number of people are hacking their bodies with DIY implants—and their experiences offer valuable clues and insights about how to navigate a world in which implantable computing is commonplace.

ERI GENTRY
is a biofuturist at IFTF and founding president of BioCurious, the world's first hackerspace for biology.



ALESSANDRO VOTO
explores the future of value, security, and identity at IFTF, focusing on crypto-currencies.

To get a preview of this future, IFTF's Eri Gentry and Alessandro Voto sought out two pioneers in this space, Amal Graafstra and Seth Wahle, who are exploring the future of implantables by testing them on their own bodies.

Amal Graafstra

Amal, an avid DIY body hacker, discovered the means and inspiration for his RFID implant at his workplace. In 2005, managing IT systems for medical centers, as he carried boxes of hardware, he felt frustrated by key-based door access.

"Why am I using this 13th-century technology, a hunk of metal cut in a certain shape, to get in this door?" he thought. 'I could get RFID on my door. How do I get rid of the card? Oh, pets have this chip inside them.' I ordered a bunch of the tags. And within a few days was in my doctor's office saying, 'Put this thing right in my hand.' He was like, 'Well, what is it?' I said, 'It's like the chips pets get in the neck, but I want it here so I can get in my door.' He's like, 'That sounds cool,' and he does it.

"We all understood that the body is this machine, and you can upgrade it. Its purpose is to move your mind, your consciousness through this universe and experience it and influence it. And if you get an upgrade and improve your quality of life, that's great."

Why Not a Wearable? Staying Connected, Staying Free

"A good implant," Amal explains, "becomes so integrated with your daily life that it disappears. It's unmanaged. You think about it about as much as you think about your kidneys doing their job. Every time I come home, I go to my door, I swipe, I grab the doorknob. I don't think about it at all."

Amal contrasts the simplicity of his implant with the complexity of today's device ecosystem. "We have to manage a lot of things. Is my FitBit on? Is it charged? Everything you have to apply to your person when you get out of bed in the morning is management, and it's annoying.

"Picture leaving the house with no keys, no wallet, and no phone, you'd be like, 'What if I get locked out? What if I need money for the train?' It's this anxiety that your tools aren't with you, and you can't survive in the world. [For] people who can overcome that for even a short time…it feels like freedom."

Connectivity, Stealth, and Competitive Advantage

Seth Wahle came to implants with different experiences and a different mindset. A former Navy technician and avid hacker, he has a deep appreciation of the hidden security risks of implantables—and an appetite for self-experimentation. Without access to a willing doctor, he contacted a tattoo artist on Craigslist who placed NFC chip in his hand.

Seth Wahle

Seth soon realized that he could perform a "parlor trick" by picking up people's phones and bringing up a webpage by sending an address from his hand.

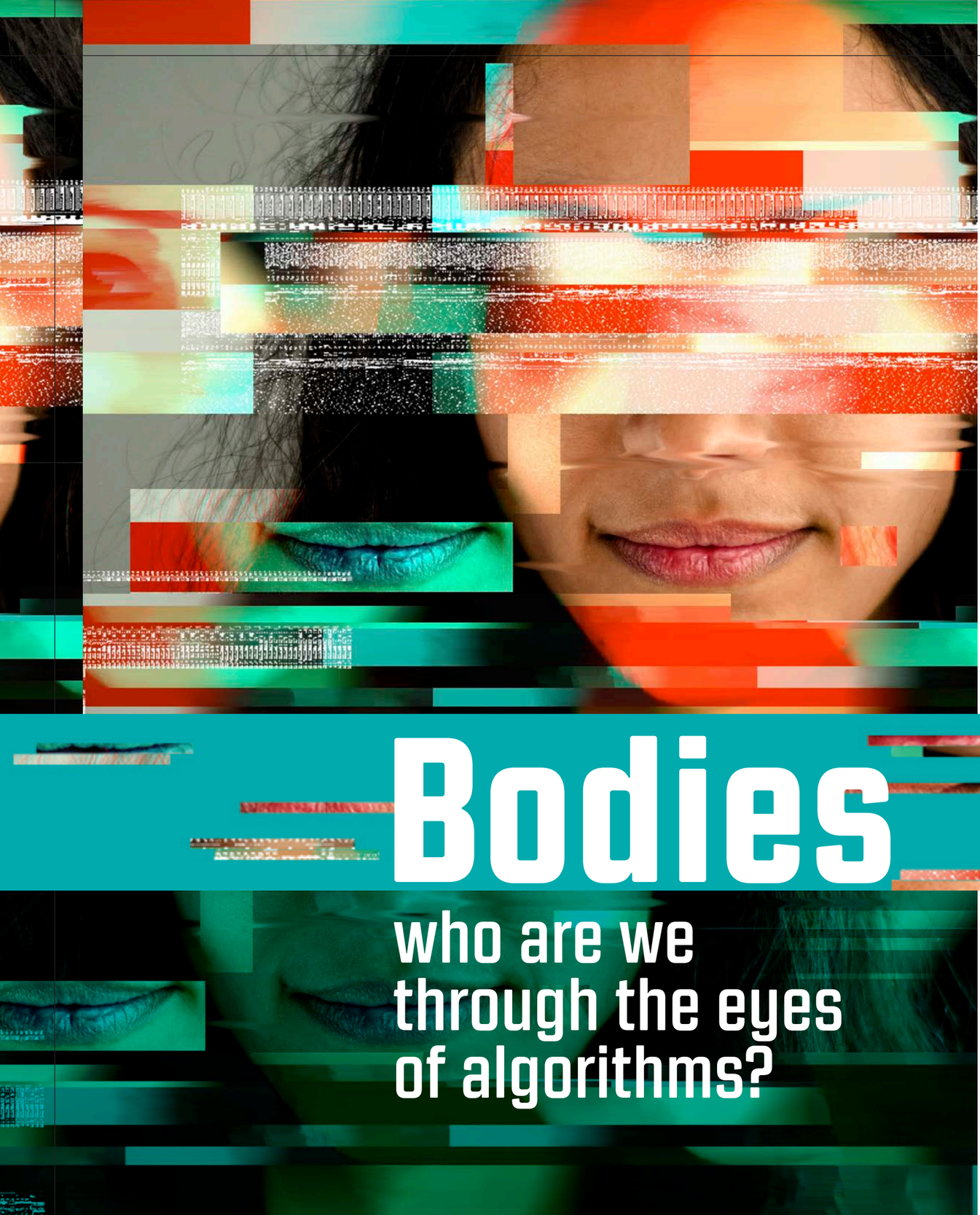
A local hacker group inspired him to use this trick in a dramatically new way. Hack Miami had just proved to national media that a Wi-Fi router could be installed to secretly hack over 380 people's phones. Seth told the group's organizer, "I can trigger a download with a chip in my hand." He proved his point by asking for people's numbers and infecting their phones with malware.

What do his implants mean to him now? Seth says, "It's about stealth. I can execute code silently. It kind of tied into my whole theory of bio-hack, why I would want to implant devices. I have something which allows me to interact with machines like no one else can." While implantables are, of course, internal devices, they have the potential to transform our relationships to our environments. Seth expressly wanted his implant to have the function of a compass.

"It could be a survival plus one," he said, citing it as an example of a use for the technology that would be subtle and unobtrusive, but hugely important in an emergency situation.

Whether for crisis response or exploration, body area networks are set to dramatically impact our lives and the way we experience them. Amal observed that a magnet implanted in his hand allowed him to literally feel when he was close to different kinds of metals.

"I came home with my magnet in my finger and [used a heat sealer device]. It buzzed really strongly. In only a matter of days, my brain was already starting to interpret, 'This means something about the environment around me.'… [It opens me up to a whole] universe I've never known before." ■



Bodies of Data

who are we through the eyes of algorithms?

Modified from a photo by Rodney Troy

Our identities have always been dynamic. We have to reconcile who we think we are with who we are in the eyes of our families and communities—and in the future, in the eyes of machines.

Going forward, we'll have to reconcile our identities with the massive amounts of data our body area networks produce, and what powerful algorithms can infer from that data. Computing devices within and around our bodies will contribute to stunningly detailed portraits of us, offering new views into who we are. These bodies of data will challenge, reinforce, and transform our existing identities, and create entirely new kinds of identity we never imagined.

More than a decade ago, an episode of the TV show "The King of Queens" featured a subplot where a character's TiVo "thought he was gay"—the device's algorithm kept offering him programs with LGBTQ themes. This plot-point was based on the real-life experience of a show's producer's friend. While some aspects of that episode may or may not have aged well, the idea that our electronics have an opinion about who we are is more relevant today than ever. As we move through the Web and about our lives at home, in cars, and on city streets, we generate massive amounts of data.

And marketers use these data to build profiles that capture preferences and needs, define markets, and provide insight for new products and services.

At the center of all this are algorithms that use various data points to infer aspects of our identities, such as gender, race, religion, religion or sexual orientation. For instance, going to Google's ad settings page allows you to see at least a partial view of the profile that the software giant has assembled on you. You can see the assumptions it's made about your age, gender, and interests. These profiles are often accurate—but they're far from perfect.

Today it might be reassuring when there's a discrepancy between who you think you are and who Google thinks you are. We assume that any discrepancy is the fault of an imperfect algorithm. Maybe your kid sister's searching spree was mistakenly attributed to you, skewing the algorithm's view of who you are.

But the technology is getting better all the time. With only our Web activity (and in some cases purchasing and demographic data), algorithms can already perform stunning acts of inference. As our body area networks get more sophisticated, we'll be adding things like biometric and body movement data to the mix—and the kinds of algorithmic inferences that will be possible might seem downright telepathic. In the next decade, if there's a discrepancy between who you think you are and who you are in the eyes of the algorithm, you might second-guess yourself, and not the data. Say an algorithm profiles you as older than you actually are; you may think, "I must look old for my age," and internalize that image of yourself.

And the possibilities for what our body language might reveal are nearly endless. What if you always assumed you came off as insecure, but an algorithm analyzing your gait identified you as fearless? What if you believe yourself to be utterly calm, but your typing patterns indicate you're a ball of nerves? More troublingly, what if your

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data revealed that your heart-rate spikes and your muscles tense when you interact with people who are of a different race?

On an individual level, these discoveries could be earth-shattering or utterly inconsequential, devastating or delightful, depending on who you are and what you learn. But for society as a whole, the impact is almost certain to be dramatic.

It will likely cause us to reexamine how we, as a society, understand and address issues such as racism and sexism. It will alter how we understand creativity and build professional networks.

These algorithmic identities could have more subtle impacts, as well. For instance, observing the way a marketing algorithm defines gender could reveal shifts in how people whose biological sex is male or female, on average, behave. Because an algorithm's understanding of what constitutes male or female behavior is more fluid, it may update its definitions before society does.

Robin James, associate professor of philosophy at the University of North Carolina at Charlotte, puts it this way: "Demanding conformity to one and only one feminine ideal is less profitable for Facebook than it is to tailor their ads to more accurately reflect my style of gender performance. They would much rather send me ads for the combat boots I probably will click through and buy than the diapers or pregnancy tests I won't."

Modified from a photo by Roberto Taddeo

In the next decade, if there's a discrepancy between who you think you are and who you are in the eyes of the algorithm, you might second-guess yourself, not the data.

Basically, a marketing algorithm only cares about these categories to the extent that they help drive clicks and sales, so it will update how it defines gender with every new piece of information it gathers. As the data capture widens to include things such as emotional response data, algorithms will be able to anticipate, track, and adjust to social or market changes before the rest of us are even aware of it.

FINDING YOURSELF IN YOUR DATA

While this convergence of body area network data and powerful algorithms will almost certainly alter important established categories of identity, it will also create completely new categories of identity, based on things such as interests, preferences, or even the different ways our bodies and minds work.

People in the Quantified Self movement have pioneered finding themselves in their data. Among the earliest and most enthusiastic adopters of wearable sensor technology, many in the movement created spreadsheets of data to surface patterns and look for clues about their body's, their mind's, maybe even their soul's personal "operating system."

For example, many quantified selfers compile data on when they slept and for how long, then cross-reference with data about their mood or their productivity. They've formed communities and even self-organized studies with people engaged in similar inquiry.

As our body area networks get more sophisticated…algorithms will be able to anticipate, track and adjust to social change before the rest of us are even aware of it.

A powerful driver of the movement is to move beyond generalized recommendations to uncover more nuanced insights that help *you*, and people like you, to be "better" at whatever you're trying to accomplish—be it productivity, compassion, aging well, or athleticism.

As body area network data collection and analysis become autmated and awareness of their potential grows, we're likely to see much larger swathes of the population begin to find meaningful identities in their data. Going forward, we're likely to see the kinds of identities people discover, and what they want from them, become much more diverse. And for some, they'll find the new affinities they share with other people become more meaningful to them than traditional social categories such as religion or sexual orientation.

ALGORITHMS OPEN AND CLOSE DOORS

The promise of this future is perfectly personalized experiences. Instead of relying on crudely and narrowly defined markers of identity, the state, the market, and other people will have new categories that lend more, or at least different, insight into who we are. And these will be used to give us greater personalization in everything from entertainment to education, from relationships to medicine, from security to safety.

But these same algorithmic identities could also direct our lives in important ways. "The algorithms don't tell you what to do or not to do," James writes, "but open specific kinds of futures for you." Take an algorithmic identity we're all familiar with: the credit score. Our credit scores can provide or deny us access to a home, a car, even certain jobs. James speculates that in the future we're moving toward, we'll have a credit score for everything.

One some level, this is a good thing—people will be given opportunities based on a more accurate understanding of who they are. An algorithm, for instance, would be less likely than a human to deny someone a loan or job opportunity because of their physical appearance. Indeed, we already have companies like JumpGap that attempt to take human bias out of the hiring process by using software to recommend candidates.

Better identity-based targeting will benefit some, but it may reinforce the larger social status quo that creates disparities.

A person whose biological identity is female, but whose gender expression is male, for instance, might simply be male to an algorithm, and therefore, it would give him information, experiences, and opportunities designed for a male audience that might be denied to him in person.

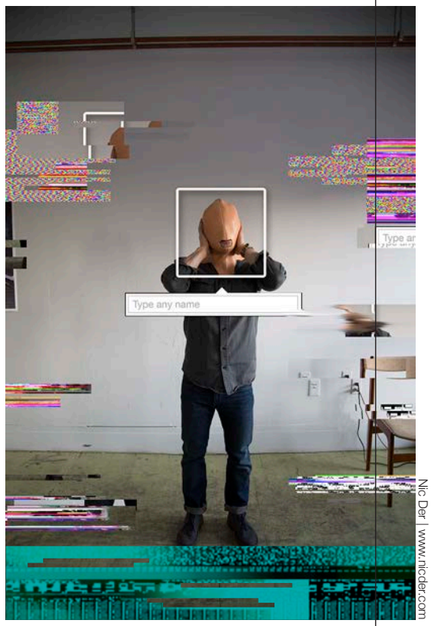
In James' words, "gender [could] become even less and less connected to [biological] sex, but more and more explicitly about privilege and [how we interact with] institutions." That's to say, this kind of identity-based targeting will benefit specific individuals by reducing bias based on visual appearance, but it doesn't touch, or may even reinforce, the larger social status quo that creates these disparities in the first place.

For instance, studies have shown that women are presented with fewer online ads for high-paying jobs than men are, and that black people are shown more ads for legal services. This probably isn't because someone explicitly programmed in such biases, but, instead, the bias is there because larger social inequities exist that make it more likely that black people would need legal services, or that women would be less likely to apply for certain high-paying jobs. And with substantial research showing that people often internalize the images of themselves they're presented with, the consequences could be seriously empowering or disempowering, depending on who you are and what images of yourself you're being shown.

In addition, we're likely to see new categories of advantage or disadvantage emerge that transcend categories such as race and gender.

As this future unfolds, these issues could become major rallying points for activism.

In the next decade, algorithms reading our body area networks will give us even more information to integrate into our sense of self and make our identities more dynamic than ever. They will be able to tell us about how we, as individuals and as a society, are changing. And they can be used to reinforce the status quo, or to push for change that's truly transformative and radical. However they are used, bodies of data together with algorithms will shape who we think we are—and who we will become. ■



Nic Del | www.nicdel.com

West and East Africa

Where Social Innovation Leads the Future

Paul throws the last of his peppers in the basket. **Down the road, he sees the buyer's van, takes out his phone, and enters a code. Immediately a text bounces back telling him the day's market price for peppers. He strolls over to the van, knowing he's going to get a fair price.**

Abeka hears a noise, like someone downstairs. She lives in a part of the city that can't guarantee police will come if she calls. She takes out her phone and sends a blank text to a saved number. Within minutes, she hears voices, friends and neighbors, along with a security agency at her door checking to see if she's okay.

These examples show how mobile data networks are driving change in West and East Africa. While the U.S., Europe, and Asia lead in hardware and supercomputing, in Africa's "high-delta" (or "frontier") markets, social innovation is what's really driving progress. Long before everyday consumers used computers, people have been using their personal networks and hooking up with local micro-entrepreneurs and kiosk-operating business people to pioneer models for operating in this diverse landscape. The technology to distribute and share information simply amplifies these models of social innovation that have been evolving for decades. So as body area networks evolve in West and East Africa over the next decade, we can expect to see similar applications.

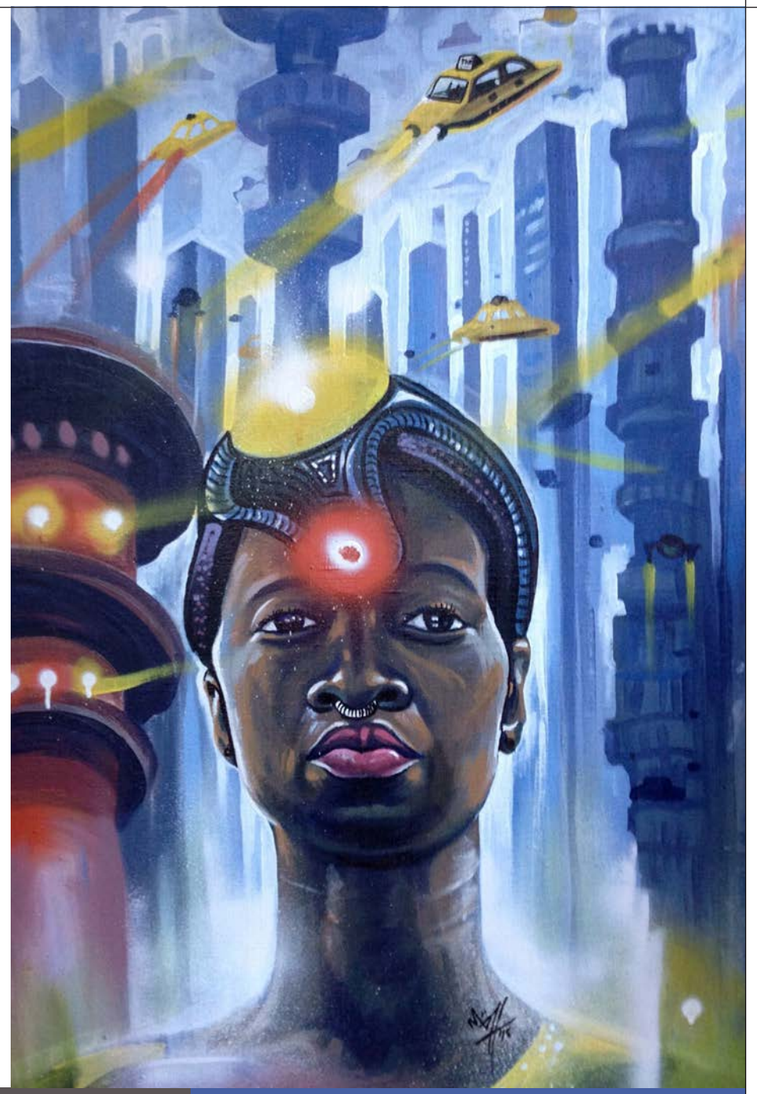
Many services in these areas are using personal data to innovate without relying on sophisticated sensor-based devices like health trackers. Instead, many people with feature phones in different locations simply enter text messages that are centrally accessed, aggregated, and analyzed to create and deliver a streamlined, localized service that people really need.

Although these services use nothing more than a text-enabled smartphone and a personal computer, creative use of the data gives them real impact. Most of the innovation involves process rather than product. And this social process innovation is usually built on a foundation of existing practices and relationships. As they evolve, and patterns in their application emerge, they'll be packaged as services and experiences that the rest of the world can, and should, learn from.

Over the next decade, we can expect body area network technologies to shape services that address many different kinds of needs. But despite this diversity, applications will likely have two things in common: they'll be more lightweight and more user-led than what we'll see elsewhere.

West and East Africa will continue to import high technology from the U.S., Europe, and Asia, smartphones will replace feature phones, and bandwidth will increase to accommodate cloud computing. But the innovation that counts will largely be social and domestic. And the new services and the new service people in Africa will create could become models that the region exports to the rest of the world. ■

JEREMY KIRSHBAUM brings his entrepreneurial experience in west Africa to IFTF, focusing on the future of logistics, distribution, and communications.

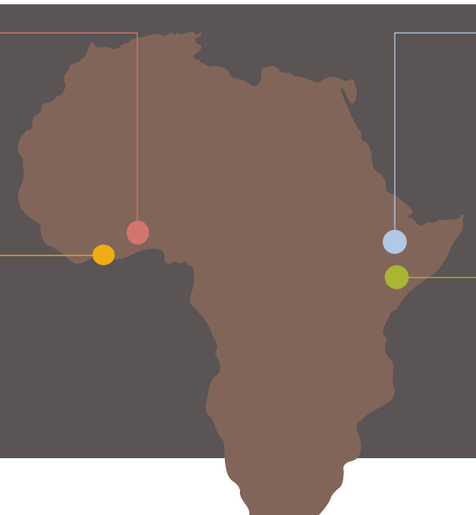


MEDIC MOBILE (NIGERIA)

This simple system over SMS enables people to track health problems and outcomes to increase quality of care to underserved communities. Health workers use Medic Mobile to register pregnancies, track disease outbreaks and essential medicines, and communicate about emergencies. Data is sent to a district hospital to be tracked, promoting efficient and effective care distribution.

HEI JULOR (GHANA)

SOFTtribe's Hei Julor uses community resources to supplement slow or ineffective police response. For about $5 a month, this affordable service provides a number to call or send a blank text and 10 neighbors are immediately notified of any threat at your house. A local radio station is alerted to broadcast a message, and a high-quality security company is dispatched to your home.



M-PESA (EAST AFRICAN REGION)

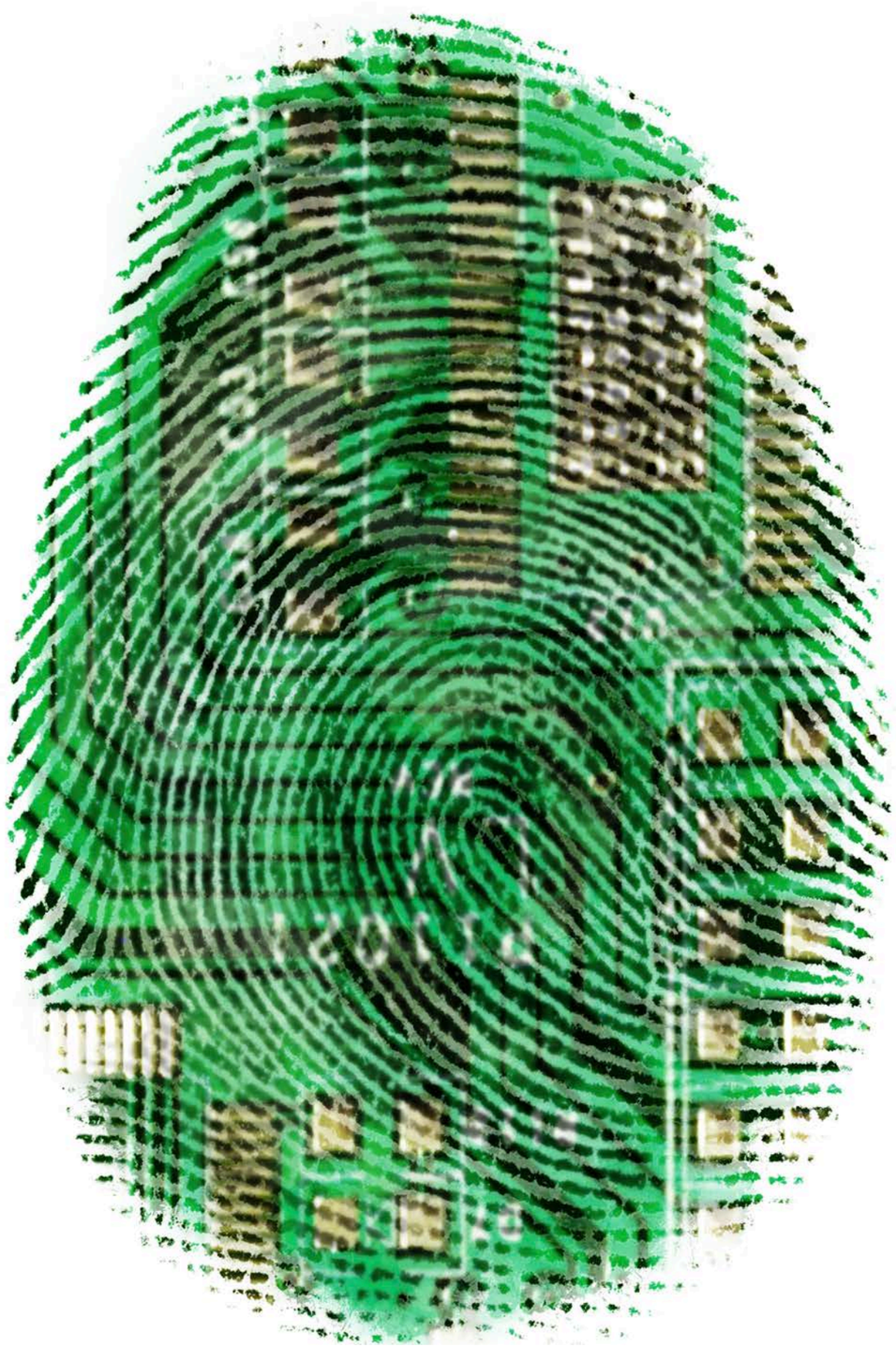
The world leader in mobile money, Kenya, Tarzania, and other countries use M-Pesa for transactions that range from paying for groceries or receiving wages to bribing police. Telecoms hold money that their customers can convert to either currency or mobile airtime. These transaction histories—including mobile airtime top-up behavior—are being analyzed to create credit scores, insurance services, and other complex financial services.

MFARM (KENYA)

Farmers enter the amount of product they have to sell, and sellers at local markets enter their buying prices. This information is aggregated, and smallholder farmers can text to find out prices, preventing middlemen from cheating them. In addition, mFarm uses the data to arrange commercial sales and draw insights on agricultural trends.

IFTF commissioned Ghanian artist Mohammed Abdulraman to create an original painting based on our research.

This is my view of the future, based on the history of where I am from. Generally speaking, the world looks at Africans as if they are not capable of doing things to contribute to the future, so I wanted to create a radically different narrative. People think it is similarly impossible that we could migrate to space everyday, connected easily through sensors. My artwork represents the connection and movement of people through wearable sensors. I wanted to create a future where one day, we will be free to travel anywhere easily, and communicate with anyone anywhere.



Artwork by Trent Kuhn

EASY AS 0010101

Creating Policy for the Next Frontier of Tech Adoption

ToS. RATs. IP. CFAA. ECPA. AML. KYC. HIPAA. The alphabet soup of legalese and regulation surrounding technology is enough to make the most seasoned policymaker cringe. When our devices are implantable, ambient, continuously monitoring and sensing us, keeping us healthy—what happens then? The increasing adoption of wearables, and their interconnection, won't just complicagte things. Body area networks will open up new questions and opportunities for the role public policy will play in the future of digital technologies.

ANDREW TRABULSI
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The debate about which polices will affect our bodies and the technologies we connect to them isn't new, though. Relevant legislation around the world has created important paradigms in every area of our lives from genetic property rights to criminal liabilities when sharing data—even if we don't know it.

A 2014 ruling from the Ontario Superior Court, for example, found that human tissue, once in the possession of a medical institution for testing, is no longer the property of the person it was taken from. Pacemakers and other medical devices have come under scrutiny in recent years for susceptibility to hacking.

In 2014, the United States Food and Drug Administration (FDA), issued guidance for the management of cybersecurity in medical devices. It recommends that manufacturers "address cybersecurity during the design and development of [medical devices]." In 2015, the Federal Trade Commission (FTC) called for an amendment to the Health Insurance Portability and Accountability Act (HIPAA), to increase privacy protections on networked medical devices by minimizing the amount of data device manufacturers can store.

Meanwhile, cybersecurity researchers are concerned that finding vulnerabilities within such devices could make them criminally liable under the Computer Fraud and Abuse Act (CFAA).

As body area networks become a common part of our everyday lives, policymakers will be forced to adapt, erase, or create legislation to fit the desultory use cases digital technologies will generate for our individual and collective well-being. These technologies pose both new risks and new reasons why many existing policy frameworks are insufficient.

To begin, the adoption of body area networks brings a score of new privacy and security risks to the table for individuals, enterprises, and governing bodies alike. In 2011 the late computer security expert Barnaby Jack demonstrated the capacity to wirelessly hack insulin pumps. Just before his death in 2013, it was rumored Jack had developed a method to hack into wireless pacemakers. The problem extends well beyond medical devices, though. Last year, HP's Internet of Things Research Study found that Internet of Things devices contain an average of twenty-five software vulnerabilities—per device. To make matters worse, in an era where our devices are increasingly connected to one another, as they will be within body area networks, a single security concern can multiply to several dozen security issues across devices. If our smartphones or watches are connected to industrial machinery or microbiotic sensors in our guts, how will we know the devices are secure?

A number of industry groups and regulatory bodies around the world are attempting to get ahead of these issues. In the United Kingdom, for example, the Online Trust Alliance (OTA), a technology consortium, has published a draft "Trust Framework for the Internet of Things," which it hopes to pass on to regulators. Recommendations include mandating device manufacturers use HTTPS encryption by default, and conspicuously disclose all personally identifiable data collected to users. Part of the challenge will be getting regulators uniformly on-board, and doing so in a way that transcends international borders, while simultaneously respecting specific sovereignty issues or existing legislation.

To further complicate matters, a range of existing policies are encouraging the use of such connected personal devices before such regulations or standards are being adopted. The Affordable Care Act (ACA), for example, appeals to patients in the U.S. to become bigger players in managing their own health, using personal medical devices to do so. Companies that make personal health devices, in response, are calling on Medicare to incentivize doctors to encourage patients to use them. While ostensibly this poses challenges for cybersecurity legislation relevant only to healthcare, the wider impacts such policies have on data storage and brokerage could have ramifications in industries ranging from financial services to social media.

In addition, it's unclear that end users will have ownership over data generated from such devices. While numerous bills, including the Data Broker Accountability and Transparency Act, have been introduced in the American legislature to regulate such issues, no votes have yet taken place to determine how such regulation will come to life. Nevertheless, the U.S. Supreme Court has held that one cannot expect a reasonable level of privacy over information that is given to third parties, or made available publicly. This is likely a point that will come under scrutiny amongst civil liberty advocates, who seek to protect such data from the grasp of government surveillance programs. Under Supreme Court doctrine today, however, such information falls outside the scope of the Fourth Amendment's protections.

None of this is to say that there is not an opportunity for policymakers to use the rise of body area networks to develop legislation that enhances consumer protections while enabling commercial innovation. Already groups like the FDA are instituting best practices for updating implantable medical devices, allowing companies to build devices that can evolve and be integrated with body area networks. This is a first step. Regulators can extend these types of best practices into broader communication devices that will complement the array of devices within a body area network.

For example, instead of developing medical device classifications for smartphones, which could hinder further hardware innovations, establish such classifications for software, and open it to the broader software community to rigorously and continuously check systems for vulnerabilities. This would provide clarity to developers about levels of encryption and data security such devices must employ, and help detect and patch flaws in software before and after its deployment.

Furthermore, regulators should act to institute data brokerage legislation to allow consumers to transparently understand what components of their personal data are available in the public and commercial domains. Finally, putting forth regulations surrounding encryption and security practices that can continuously and easily be updated for the Internet of Things can help both businesses and consumers know what devices and software should be manufactured and purchased.

As with any policy, striking the balance of flexibility and rigor will be critical. In an age when our devices will be monitoring us, assisting us, and allowing us to perform our daily tasks in ways that we currently are only beginning to understand, doing so could mean the difference between human advancement or standing still. ■

In an era when our devices are increasingly connected to one another a single security concern can multiply to several dozen security issues across devices.

Looking Backwards from 2025

An Anthropologist Explores How Body Area Networks Became Family Area Networks

Today, in 2025, we take it for granted that the networks of smart objects in, on, and around our bodies keep us connected. The new body-wellness information they generate allows us to care for one another deeply and effectively, in ways never imagined before. And it seems like the more data on our everyday behaviors we share, the more we discover new ways of expressing our love to our families, no matter where they are or how we define kinship.

But this, of course, wasn't always the case. Renowned anthropologist Jan English-Lueck was there in the early days, tracking this emerging way of keeping the family together. *Future Now* sat down with Dr. English-Lueck to learn about what these practices looked like as early as 2015 and how we got to where we are today.

How has body area network tech changed how we care for our families?

A decade ago, people were shifting toward urban areas, often away from extended families, creating ever more isolated nuclear families. Yet we imagined that family members would still manage loved ones' finances, education, and health care. Even with computers and smart phones families found it hard to connect.

Now in 2025, with big data, widespread environmental sensing, and a global focus on wellness, self-tracking is a lot easier. Monitoring, health tracking, and coaching enable people to act on family connections at a distance. Family members are coming to understand each other at the microbial, genomic, dietary, and mood level. Fictive kin (as in, the families we choose), pets, and geographically distant relatives can all read our fitness tracker feeds.

It didn't take long to go from laborious food tracking to ubiquitous sensor-based information on what we eat. Workplaces and municipal planners reshaped our environments, encouraging behaviors that promote wellness. All this happened in the highly visible epicenter of big data mining.

Can you give an example of mobilizing these technologies to connect family caregivers?

Increasingly, the isolation of aging populations across Asia has led to new networks of remotely connected, adopted families, who take care of each other through connective technologies. We know from studies of Japan that "embodied empathy" is a core cultural value. Remotely connecting the elderly began to get really sophisticated in about 2020, driven by their need to connect to each other and to younger generations, even to fictive kin, including "adopted" grandchildren.

In China, family area networks further the kinds of behaviors their society wants to encourage, such as sharing. In a country where the one-child policy means most kids don't have siblings, people worried that children from singleton families would grow up self-absorbed, without a moral compass guiding them toward family. Schools focused on connecting to families and soon moved from mobile phone conversations to much more wraparound tracking and continuous communication. A behavior such as sharing can be monitored and assessed like other educational outcomes. That kind of monitoring mirrored others done in health care.

Today, closer monitoring of pregnant mothers gives family members a way to help support the mom—and also opens her up to increased scrutiny. Chinese medicine has a long tradition of taking care of pregnant women through medicinal food, but there was a profound gap between that practice and what "modern" mothers were expected to do to produce the best quality baby. In 2015 this often meant vitamins, supplements, and folic acid.

> "Increasingly, the isolation of aging populations across Asia has led to new networks of remotely connected, adopted families, who take care of each another through connective technologies.

It also meant paying attention to the food chain. Farmer's markets were viewed with suspicion as unmonitored and unscientific. In the last decade, the need to support pregnant women has translated into some robust monitoring and communication among diverse practitioners and family members. The distrust of the food chain—and the need to monitor water pollution and soil fertility—has created a market for trusted food. That information feeds more directly into pregnant women's body area feeds, also informing family members. Mom knows what you're eating.

Flickr user: dodong flores

Families gather to care for one another physically and digitally.

In 2018, you spoke about how hidden knowledge about our genetics, transplantation, and surrogacy was making us rethink what family means. How does information about our secret selves shape today's families?

All kinds of information, from our genetic markers to our parents' reproductive histories, is no longer hidden. This transparency enables new family relationships and connections. When babies have multiple mothers and fathers through donation and surrogacy, new rules of kinship emerge.

Beyond the people you know about, your family extends to this much larger community of people connected at an intimate molecular level. This makes connections much more thorough and complex than they once were. We learned about our DNA relatives' health vulnerabilities, and then we learned to care about them, and then for them. Just as families linked by transplanted organs began to care for each other, these relatives formed communities of care, which is something you see a lot of today. Using body area networks, we connect continuously to help each other emotionally and logistically, often with deliberate health monitoring and intervention. Welcome to networked families. ■

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Animism and Austerity

Japan's Human+Machine Past and Future

Robopets! Exoskeletons for elders! VR romance! Every few months a new tech story comes out of Japan that piques interest around the world and reinforces Japan's image as a land of advanced—but highly quirky—technology. Indeed, as of 2007 Japan had the highest robot density of any country in the world, with 310 robots to every 10,000 human employees, surpassing the rate of its nearest comparisons, Germany at 234 and South Korea at 185.

This might seem to support a stereotype about Asia, and Japan in particular—that these countries pushed ahead in the race towards the future by uncritically embracing technology. But accepting this stereotypical view echoes past attitudes towards the alien "Orient," and prevents us from thinking clearly about innovation and tech adoption in the region.

For instance, while some might think Japan is a country obsessed with high technology at the expense of the natural and organic, this division isn't seen as strongly as in other parts of the world—and that's important when thinking about body area networks.

IT'S ALIVE!

We often assume technology advances rapidly, and culture has to keep up, but that isn't always the case. While the Internet of Things has garnered lots of excitement worldwide, the concept of objects "waking up" isn't new in Japan. Folk belief dictates that everything has a spirit—from rivers, trees, and stones to manmade tools such as hammers or clothing. The average Japanese person today might not believe sneakers have a soul, but the idea of interacting with an inanimate object with its own life has a place in the cultural DNA.

In particular, that as we use a specific tool, we imbue it with a form of life and develop a relationship with it. The idea is that our tools aren't merely disposable material objects, but rather, they have an important relationship with us and should be treated, and disposed of, with reverence and care.

THE AUSTERITY IMPERATIVE

Both the domestic and international press have made much of Japan's "herbivore men." This is a new category of identity in Japan—men who aren't as preoccupied with traditional notions of success, such as consumption or marriage, as previous generations. While much of the focus of attention has been around economics, relationships, sex, and gender, this is also an important technology story. Though many of the so-called herbivores depend heavily on their parents or part-time work for financial support, for the most part their lifestyle is not very costly. They tend to be into activities such as photography, cooking, crafts, hiking, and exploring cities by foot and train. What allows them to do these things without much money is technology—digital cameras, mobile phones, and free YouTube tutorials.

Tezuka Productions

From centuries-old folklore to 20th century pop culture, the idea of inanimate objects coming to life and forming relationships with humans holds a special place in Japan's imagination.

While the attention has focused on the men engaging in these tech activities and practices, women have often pioneered them.

So while technology in Japan has often been associated with conspicuous consumption, there are many diverse motivations for tech adoption—such as living with less.

And it's critical we take all of these motivations into account. If we remain stuck in stereotypes, it blinds us from imagining the truly transformative Human+Machine Symbioses that might lie ahead for the island nation.

For previous generations, Japan's high-tech stereotype may have been a source of pride. For younger generations, though, the need to maintain this image might not be as strong. If young people continue to find more meaning in their chosen activities, and less in traditional jobs, we could see a future of tech-enabled austerity for Japan. ■

BEN HAMAMOTO
Research Manager

Crashing My Own Hotel Room

A Cautionary Tale

It was supposed to be a romantic evening. My wife's business trip to London landed us in one of the nicest hotels of my well-traveled life.

When we arrived, an extremely well-composed blond woman escorted us to our room. Her sole task was training us in how to operate our room. She literally had to teach us how to turn on the lights. For two tech-savvy adults, this seemed almost comical—until we realized that it was necessary. The room had no light switches, no thermostat knobs—all of these analog controls had been abolished in favor of three well-disguised Android tablets. The room had over two dozen connected lights, plus three phones, a TV, electronic curtains, an aromatherapy diffuser, a heated self-defogging bathroom mirror, motion-sensing in-closet lights, a towel warmer, stereo wall-mounted speakers, and, of course, remotely controlled do-not-disturb lights visible from the hall. Every one of these items was—at least in theory—controllable by the three tablets.

My inner environmentalist and disdainer of luxury had been lost somewhere in the elevator—I was smitten by the sophisticated network of devices pandering to my every need.

On the second evening in the hotel, as my wife hopped in the shower, I set out to dial up some mood lighting.

And then…a scream from the shower. The room suddenly went dark, except for the tablet's screen, which read: "Lucernic isn't responding. Do you want to close it? Wait / OK." Before I could click a button or respond to the scream, the entire room "restarted"—very quickly, the lights came back, the curtains opened, the TV came on, and, needless to say, the mood was not romantic.

The next day, I tried it again and, sure enough, the mood lights crashed the room.

As my new-fangled body area network failed me repeatedly, I felt something between frustration and a desire to laugh out loud. If ever there was a "first world problem," this was it.

Out of curiosity, I researched Lucernic, the maker of the home automation system that seemed to be crashing. A message in Mandarin informed me that Lucernic.com no longer existed. Among the remnants of the corporation was a YouTube channel with 19 videos—all posted three years ago.

Was it possible that the M by Montcalm had purchased and installed 296 hotel rooms' worth of hardware and software from a corporation that dissolved before the hotel even opened? If bugs like the ones I experienced could not be fixed, would the offending devices and wiring need to be gutted and replaced? How many tons of e-waste might systems like these generate?

> "I needed tech support. Badly. Dialing zero… 'Thank you for calling the M by Montcalm. You're in Tech City—London's answer to Silicon Valley ... We do appreciate your patience, thank you, we'll be with you as soon as we can…'

As we struggle to understand and reduce the negative environmental and social impacts of e-waste, we simultaneously press onward into a world where we expect everything we own to be "smart" in some way. At the same time, we discard and replace these devices more quickly each year.

One online profile states, "Lucernic is an environment-friendly company. We design and manufacture a new generation of home automation systems." While in theory, smart lighting with motion sensors could save us countless megawatts of electricity, the gains are illusory if these smart systems are effectively disposable. ■

DAVID EVAN HARRIS
teaches futures thinking at UC Berkeley and researches the future of philanthropy, governance and social movements at IFTF.

Evolving Nanoscale Communication

Biology, Engineering, and Robotics Converge with Dr. Ian Akyildiz

Today, networks of smart devices have already transformed our world, and we're just starting to connect our bodies to them in meaningful ways. We see signs that we might be able to create new bio-based networks inside our own bodies and manipulate the ones already there. As molecular biology, nanoscale engineering, and robotics converge, we may be able to use microscopic robots to target specific interactions among many natural nanoscale processes within our bodies' cells. In the next few decades, communications technology could take on a whole new meaning, as we gain the ability to coordinate interactions among these tiny bio-nanobots and natural human bioelectrical functions.

IFTF researcher Michael Liebhold spoke with Dr. Ian Akyildiz, a preeminent researcher in nanoscale networks. A professor at Georgia Institute of Technology and founder of the Nano Communications Center, Dr. Akyildiz has established several highly regarded research centers.

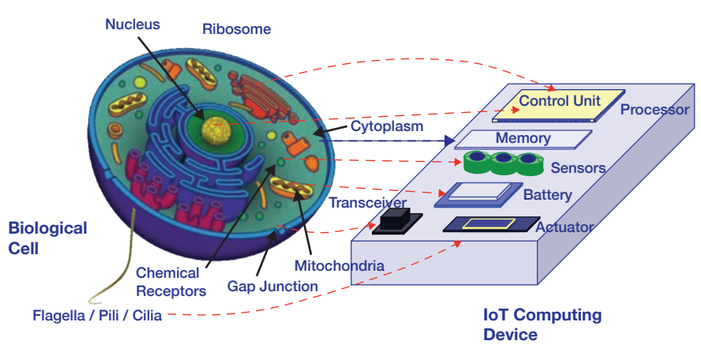
What is the current status of nanoscale communications in the body?

Nanoscale communications will be a reality in the near term. We're already working on bacteria communication, investigating how to engineer synthetic programmable bacteria so they can communicate and help the body attack natural bacteria. The significance of this is that genetically engineered bacteria will be able to fight any bacteria-based illness in the human body. We're investigating cell-to-cell communication among bacteria because as they create and work as colonies—called quorum sensing—billions of bacteria colonies work together.

Can you describe networking and signaling in these environments?

Bacteria communication is based on molecular communication. Bacteria release and diffuse molecules or particles, communicating among bacteria. If you think of bacteria as nanoscale machines, the molecules they release are like messages or packages they use to communicate with other bacteria. Cells use signaling molecules such as calcium ions to control processes. Our investigation involves collaboration among communications, biology, and mechanical engineering teams.

BIO-NANOTHINGS COULD BRIDGE CELLS AND IOT DEVICES



Figures recreated from I.F. Akyildiz et al. IEEE Communications Magazine March 2015

What are some potential uses of nanoscale communications?

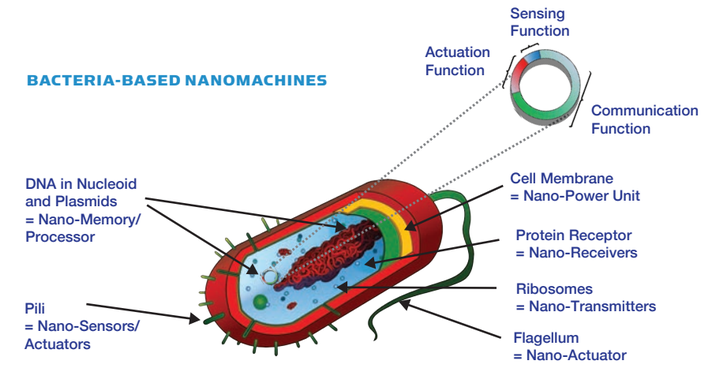
We're looking at how specific components in the body such as calcium, iron, potassium, and astrocytes are communicating. The next step would be to apply our findings on communication to particular illnesses, such as Crohn's disease or Alzheimer's disease.

How can human networks communicate with these nanoscale networks?

From nanoscale networks within the human body, we'll need to create a gateway to the outside. We're thinking about using a type of nanoscale cell phone that will be the gateway to the outside world, like using the Internet for doctor's examinations.

We call this the "Internet of Bio-Nano Things." We can create Bio-Nano Things in the body or in body components as the network, and then we'll have a gateway or multiple gateways outside the body. Eventually we'll be able to genetically engineer human cells and program them. The world will be totally different, with billions of nanoscaled devices circulating in the human body as additional red blood cells or white blood cells. As soon as they detect any tumors or diseases, they'll communicate and attack. In the next 10 to 20 years, practical, wide-scale applications will become a reality. It's a long-term process.

BACTERIA-BASED NANOMACHINES



> "The world will be totally different, with billions of nanoscaled devices circulating in the human body as additional red blood cells or white blood cells.

Can you describe a few highlights from projects in your labs?

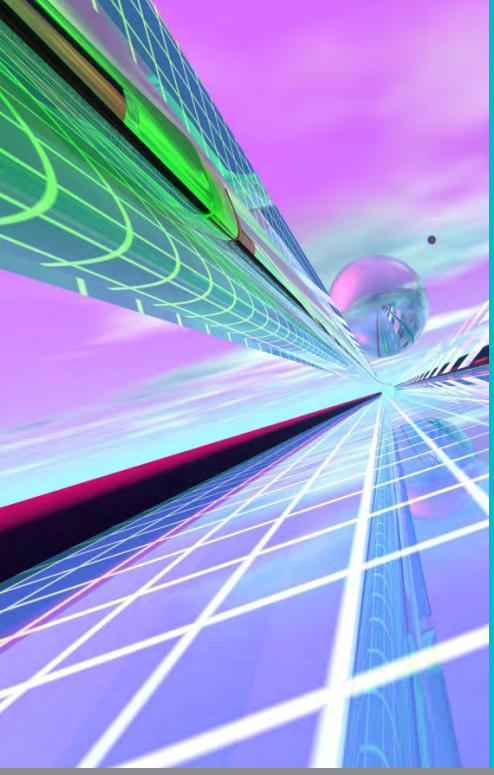
All my research centers in the world are taking one of two tracks. One is intrabody molecular communications, using the communication aspects and the nature of calcium ions and other molecular markers. The other track is nanoscale machines, using nanomaterials like graphene, considered nanomaterials because they're so light and so thin they're almost two-dimensional. Of course, it's three-dimensional, but graphene is harder than diamonds and much stronger than steel. Using such materials, we can create nanoscale machines, like nanoantennas, nanotransceivers, and nanobatteries.

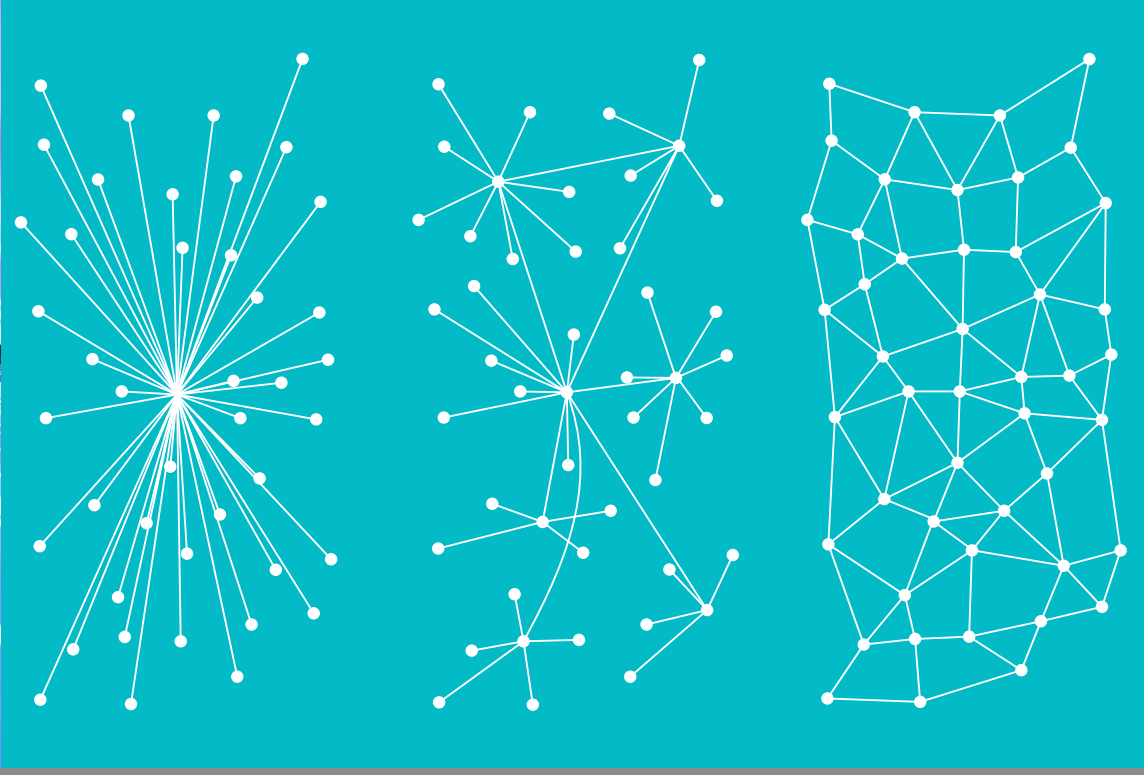
Then we'll be able to create integrated, graphene-based nanoscale machines. We also look at how these machines will communicate. We're already producing integrated devices. All the components—transceivers, antennas, and batteries—even the processors already exist. We're in the process of physically showing that they work.

What are the implications for an interface with neurocommunications?

All these different communications going on within the human body—such as molecular motors, calcium ions, bacteria, neurons, and astrocytes—are now all separate aspects of communication. My research agenda is to learn how these separate islands of communication networks all affect each other. ■

MIKE LIEBHOLD
Distinguished Fellow





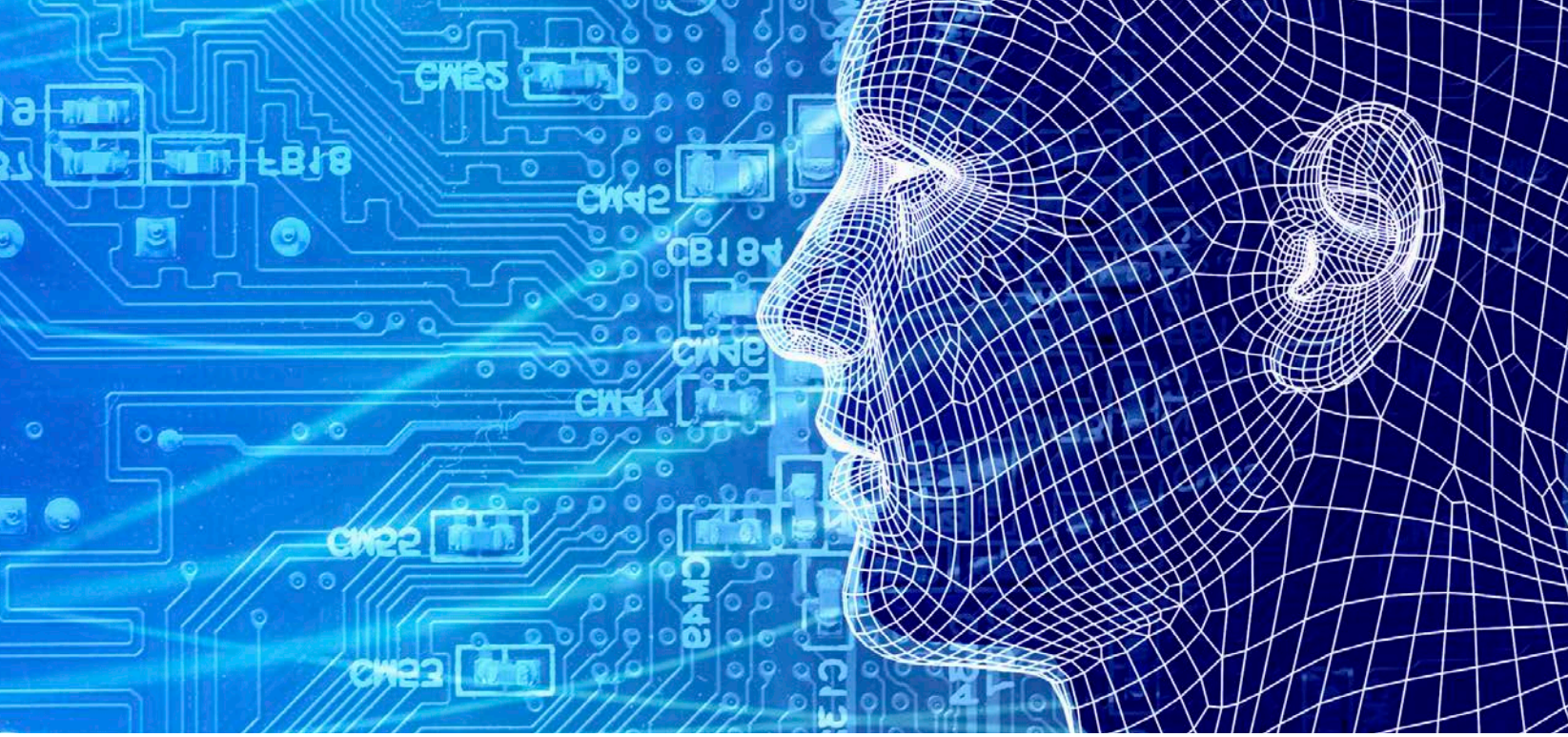
WHEN EVERYTHING IS MEDIA

THE FUTURE OF COMMUNICATION AND TECHNOLOGY

In the 1960s, Paul Baran, one of the founders of the Institute for the Future, envisioned a move from centralized communications to a distributed system—a network architecture that formed the backbone for today's Internet. Looking out to 2025, we can see the outlines of a transformation in communications that will be equally profound: we will be marketing to machines, receiving messages from our bodies, and reinventing how we communicate, collaborate, persuade, and build relationships in a hyperconnected and distributed world where everything is becoming media.

In 2016, join IFTF's Technology Horizons program as we map this transformation and highlight the emerging technologies and strategies we'll use to amplify and connect with each other and world around us.

For membership and other information about Technology Horizons contact Sean Ness at sness@iftf.org or (650) 233-9517



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