HAPIfork and the Haptic Turn in Wearable Technology

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> Bits are not edible; in that sense, they cannot stop hunger.
> —Nicholas Negroponte, *Being Digital*, 1995

Midway through an advertisement for a smart fork designed to quietly and invisibly change the way we eat, three ladies are shown lunching at a sidewalk café. They smile, laugh, and engage in the flow of casual conversation as they eat, the rhythm of their chatting interspersed with sips and chews and swallows. One of them is discreetly attuned to another rhythm, stealing subtle glances at the screen of the smartphone lying on the table to the left of her salad bowl. Blue network signals appear over the image, drawing viewers' attention to the real-time synchronization of information between the phone and the woman's digitized utensil. The fork's metal tines spear her food as efficiently as those of her friends, but the thicker diameter of its handle hints at the sensor hardware encased within: a 3-axis accelerometer to monitor the motion of food to mouth; a memory chip to record this pattern, as well as meal time and duration; and a vibrotactile actuator rigged to give its handler a buzz when she too quickly reaches for another mouthful.

> "Oops, too fast!" the smartphone alerts, in red.
> "Good timing," in green (see figure 2.5.1.).

Feel the Data

In 1995, MIT's famed Media Lab had established itself as a rich site of experimentation in the digitization of human experience, its faculty and students designing some of the earliest "wearable technologies"—from Steve Mann's backpack-mounted video recorder (and, later, webcam headgear) to Thad Starner's head-mounted computing system. Their digital capacities were conceived as a way to better see, know, record, and sometimes transcend the material world.

One twenty-first-century legacy of these experiments are the consumer-grade, mass-market "wearables"—smart wristbands, waistband clips, watches, and pocket sensors—that seemed to appear overnight five years ago in the aisles of Best Buy and storefronts of Amazon.com, inspiring *Forbes* to speculate that 2014 might be "the year of the wearable."[1] By keeping reliable statistical track of bodily metrics and behaviors, these gadgets provided users with an informational scrim to consult as they made decisions about the mundane aspects of daily life: what to eat, when to sleep, whether to take the elevator or stairs. Their purpose was not exactly to help people *transcend* the material realm but to help them move more confidently and knowingly through it.

Early marketing campaigns for these wearable digital compasses appropriated the language of Quantified Self (QS), a community formed in 2009 in the pursuit of "self-knowledge through numbers." Founded by two senior editors of *Wired* magazine, Gary Wolf and Kevin Kelly, the group was organized around the idea that one could use sensor and data technology to track otherwise inaccessible aspects of existence—from temperature to heartbeat variability to feelings—and thereby increase one's self-understanding. "Humans have blind spots in our field of vision and gaps in our stream of attention," wrote Wolf in the *New York Times* in 2010; "If you want to replace the vagaries of intuition with something more reliable, you first need to gather data."[2] Fitbit, the leading consumer wearable company, appropriated the mind-over-matter logic of QS to advertise its wrist-tracker's data dashboard: "Know yourself."

Yet QS cofounder Kevin Kelly—founding editor of *Wired*, former editor of the *Whole Earth Review*, and author of several books (most recently *The Inevitable*, about the technological forces shaping our future)—has come to speak less passionately about the knowledge to be derived from self-tracking technology than about the prospect that we might experience and assimilate our tracked data in an embodied, sensory manner. "Right now all we can do is see the data, the charts, the curves—but in the long term, we want to be able to *feel* them," he told an audience in New York in 2012, recalling Marshall McLuhan's 1964 prediction that the future of electronic media would be defined by touch rather than by vision.[3] He praised the belt that a San Francisco hackathon team had devised, whose onboard electronic compass (equipped to sense direction through a magnetometer) and eight vibrators could, over a short period of time, entrain a sense of "north" by acting haptically on the wearer's body. "It translates numbers into something you can feel; numbers become a sense." Instead of a new self-understanding, the belt affords a kind of sixth sense that Kelly calls an "exosense"—whereby an otherwise undetectable aspect of being (in this case, one's position relative to magnetic north) becomes haptically available.[4]

Kelly delivered his comments during an onstage interview at the 2012 Living by Numbers conference (an event organized by *Wired* magazine and the Robert Wood Johnson Foundation), prompting the moderator, author and data entrepreneur Thomas Goetz, to ask if it was important for self-quantifiers to be consciously aware of their own data-monitoring as it was happening. "That's an inherent tension," responded Kelly. "You want to be tracking as easily as possible so that you don't have to pay attention to it, and yet oftentimes the benefit comes from paying attention to it." Sporting his usual Amish beard, he spoke of a future in which artificial intelligence would be employed to do the work of paying attention to the "the huge universe of data we're collecting and then alerting us when the patterns are there—putting on a red light or giving us a green light, *bringing us to attention when we need to have some attention*." While processes of data computation would, of course, continue to underlie self-tracking, he predicted that devices would find a way to "bury the numbers," as he put it, by converting them into new ways of sensing somatic phenomena such as glucose levels, heart arrhythmias, or brain waves—or behavioral phenomena such as sitting, sleeping, or breathing. Instead of extracting machine-readable data from bodies and presenting it for cognitive digestion in a tabulated, graphical format, sensor-derived output would be converted into and delivered as "body-readable" impulses, such as the fork's vibration in the opening scene. "We can now see charts or curves but in the future we want to be able to feel or hear it. That's the long-term destiny."

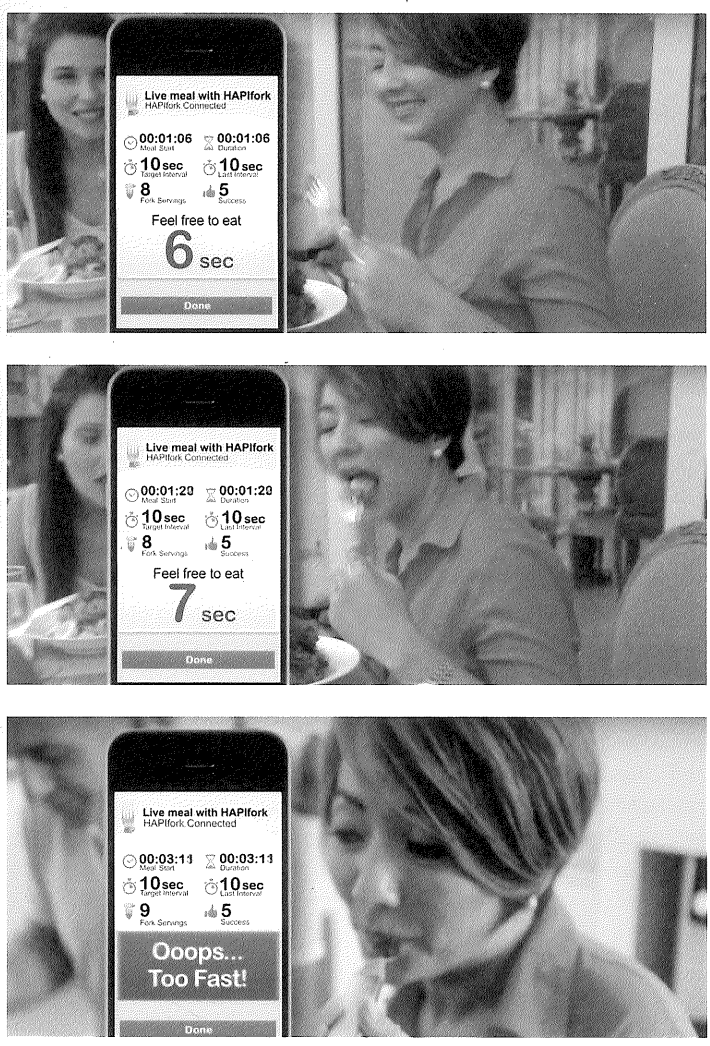

Figure 2.5.1: Stills from a HAPIfork advertisement in which the protagonist lunches with friends (and later, dines with her husband) while using the smart utensil (https://www.youtube.com/watch?v=Lt403H_ry0w).

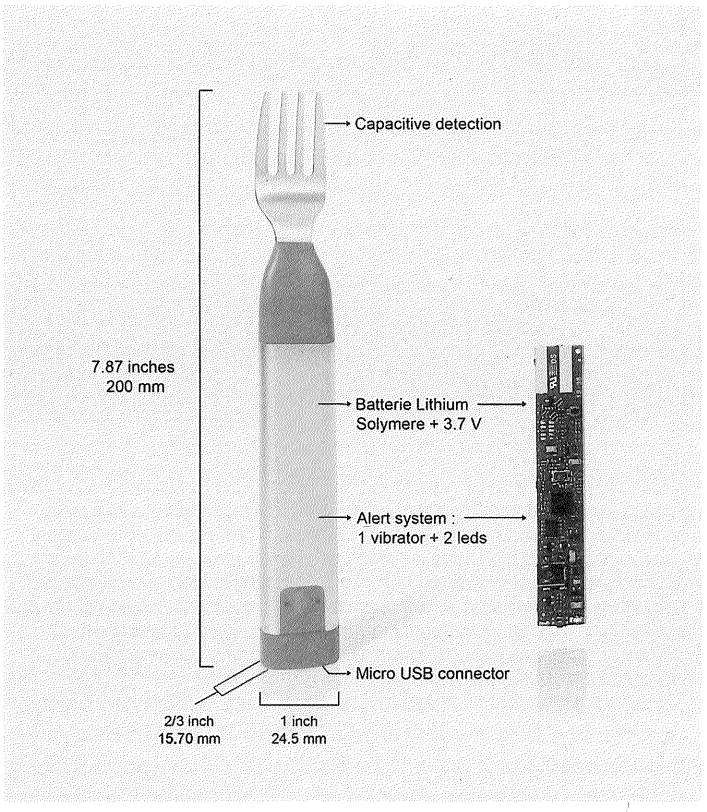

Figure 2.5.2: HAPIfork design

Bury the Numbers

Kelly's prediction in 2012 characterizes well the direction that consumer self-tracking technology has since taken. Designers have increasingly sought ways to "bury the numbers" in haptic effects that people can more directly assimilate than they can numerical information presented on screens. The Jawbone UP wristband was the first to vibrate when wearers had been idle for too long during waking hours, signaling that they should stand up or move. A range of posture-correcting devices has been introduced in the past few years to straighten the backs of office-desk slouchers without interrupting their work flow, with such features as "posture alert mode": "Through the app, you can control when you're buzzed, how you're buzzed, and even how intensely it buzzes," inform the instructions for the Lumo Lift pin. A small, stonelike device called the Spire helps people regulate their breath—and, by extension, their stress levels—by subtly vibrating when their respiration becomes shallow or erratic. The Apple Watch "taps" users instead of notifying them with beeps and chimes: "Get a feeling for what's going on." After selecting a walking destination on a map, you can head off without paying attention to the directions, knowing that "the Taptic Engine can give you a gentle tap" when it's time to turn left or right.

Materiality is triply at stake in these digital technologies: they act on material aspects of daily life related to basic subsistence—eating, drinking, stepping, breathing; they are physical forms worn against the skin; they are not simply passive casing for the conveyance of information but a buzzing, tapping, vibrating force. The wearables first digitize and then "rematerialize" our physiological and behavioral data, feeding it back to us in a tangible form we can assimilate. In most cases, Deborah Lupton notes, "digital data are invisible and intangible," describing "a wholly immaterial phenomenon that does not engage the senses: there seem to be nothing to look at, touch, hear, smell or taste."[5] The sensorial interventions of haptic wearables cover over (or bury, to use Kelly's word) the abstract, computational processes, transducing insensible corporeal states and behavioral patterns into palpable signals. By way of algorithms paired to actuators, the devices function as a kind of "algorithmic skin" that "does not only sheathe but animates and orders the body."[6]

This genre of wearables communicates with wearers at the point of purchase, so to speak, calling them to attention at the moment when an action is required to get them back on track. Users may, of course, still review their collected data to reflect on past behavior and make their own decisions about future behavior, but doing so becomes increasingly optional; instead, they can dispense with self-reflection and simply wait for a buzz. Matter, here, takes precedence over mind.

The Fork

Bits "may not be edible," Negroponte conceded—and yet bites can become bits.[7] The HAPIlabs website explains that its smart utensil "contains an electronic key with a circuit that links the fork tines with the handle. When you put the fork in your mouth, it closes the electric circuit" (see figure 2.5.2). Unlike self-management technologies that focus on the weight of food or its caloric or nutritional value,[8] the fork's object of concern is the *pace* of eating—which it tracks by sensing and monitoring two parts of the body in time: "your mouth and your hand."

The HAPIfork's 3-axis accelerometer monitors the motion of food to mouth; a memory chip records this pattern, as well as meal time and duration; and a vibrotactile actuator buzzes its handler when she too quickly reaches for another mouthful.[9]

As described in the opening scene of this paper, the fork lengthens the chewing interval by vibrating when it is placed too quickly (that is, in fewer than ten seconds) in one's mouth following the previous bite. "You are advised to take about 10–20 chews," read the product instructions. "If you trigger the HAPIfork's alarm [by eating too fast], don't panic. Set the fork down at the side of the plate and wait until the light turns green again, signaling that it is safe to take another bite" (see figure 2.5.1). The utensil has a kind of metronomic function, keeping time for the eater. The company recommends placing smart phones in view so users can see their data as it is collected in real time; as they feed themselves, their data is fed back to them, deepening the fork-person circuit and reinforcing the vibrotactile intervention of the fork.

The distinctive workings of the fork are illuminated by comparison with another device, an invention of the sixteenth-century Venetian physician Sanctorius,[10] who believed that health depended on maintaining a constant weight. To that end he devised several tools, including a table and bed that doubled as scales and a contraption he called the "static chair" that hung from the beams of his home (see figure 2.5.3); seated there he took all his meals. Sanctorius advised would-be weighers that, prior to sitting in the chair to eat, they place at the opposite end of the hanging beam a weight equivalent to that of the food and drink they wished to consume—so that, once the meal had been consumed, the seat would drop below the level of the table, "sanctioning the end of the meal."[11] In this sense, the chair was not only a tool for weighing but also for behavioral regulation; it "mechanically enforced the control of ingestion,"[12] removing the eater as a deciding agent—indeed, his eating action was simply foreclosed by the apparatus. The static chair did not entrain; it constrained.

In contrast, the fork is small and portable, not architectural and fixed; it accompanies one's body into the world and monitors all eating events. While the static chair places the eater at a physical remove from his food to mandate the meal's termination, the fork introduces vibratory friction so as to down-regulate the speed of ingestion—not cease it altogether.[13] The HAPIfork performs its digital dressage by way of proprietary "slow control" technology[14] similar to that used in rhythm-based games where players are encouraged to synchronize their play response with the game tempo—except that the aim, in the game of HAPIfork eating, is not to keep up with a quick-paced action stream but to slow one's pace.[15] Over time, promises HAPIlabs, the utensil "subtly guides you into a perfect rhythm, improving your overall health and well-being" (see figure 2.5.4).[16]

The slow-eating agenda of the fork prompted comedian Stephen Colbert to remark: "What is the point of consumer technology that keeps you from consuming? Frankly, it's un-American" (see figure 2.5.5).[17] It would seem to be un-American in another sense as well, if one considers the country's long tradition of self-help approaches that emphasize the cultivation of inner restraint and self-control and that reject reliance on external forces (whether human or technological).[18] Of relevance here is the

Figure 2.5.3: In the famous frontispiece to his guide to the arts of static medicine (*De statica medicina*, 1615), Sanctorius is shown seated, arms outstretched; just out of reach are a half-eaten loaf of bread, a partially filled goblet of wine, some remaining bites of meat, and a knife and fork. An apparatus consisting of weights and pulleys is fixed to the beams of the roof and connects to the chair, which has just dropped below the table, pulling Sanctorius away from his meal at the precise moment that his prescribed intake of food has been met. (https://commons.wikimedia.org/wiki/File:Sanctorius;_Ars_de_statica_medicina_Wellcome_M0006325.jpg)

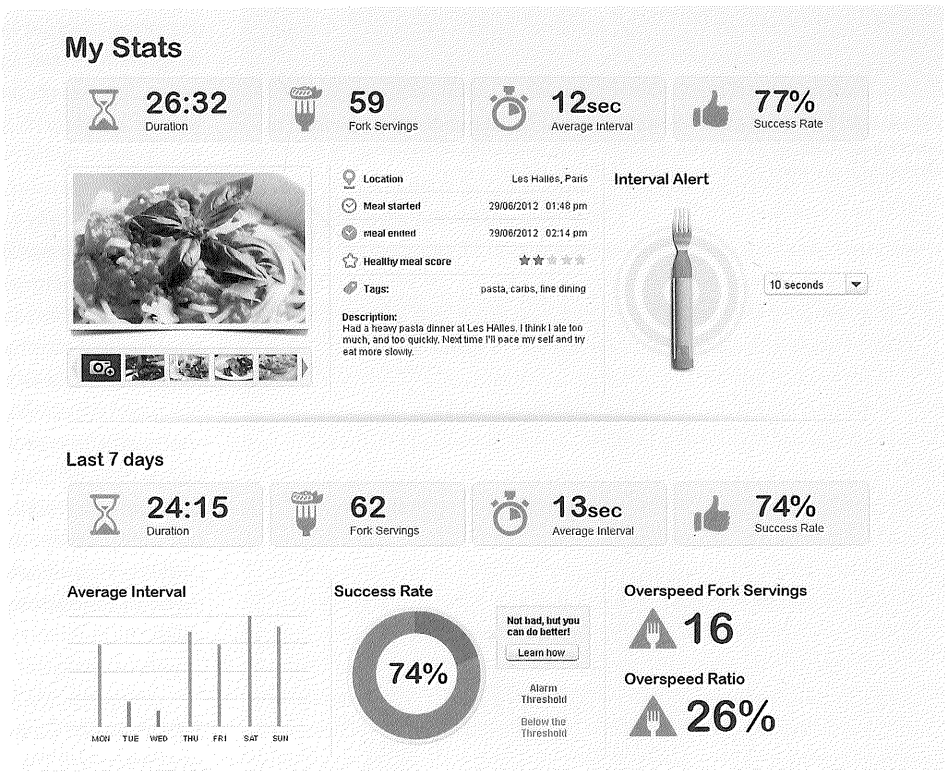

Figure 2.5.4: The HAPIfork dashboard presents an arrangement of informatic tiles with options to quickly analyze a given meal or to reveal trends over time. One may choose to upload a photograph of one's meal and a description of the eating experience, which are displayed alongside numerical indices of the meal's duration, number of fork servings, and the average length of time or interval between bites. Intervals that exceed the fork's ten-second "alarm threshold" are used to calculate the "overspeed ratio," which will ideally approach zero. One's overall "success rate" is determined by the ratio of well-timed servings to the total number of servings, with the most successful meal being a meal free of (bad) vibrations. (https://www.pcworld.com/article/2035647/hands-on-with-the-hapifork.html)

Figure 2.5.5: "What is the point of consumer technology that keeps you from consuming? Frankly, it's un-American," said the comedian Stephen Colbert in a segment of "Tip of the Hat / Wag of the Finger" on *The Colbert Report*, January 10, 2013 (http://www.cc.com/video-clips/35sqrd/the-colbert-report-tip-wag---hapifork---kevin-garnett).

Progressive-era fad of Fletcherism (also called the "chew-chew cult" in its day), a method of eating led by the health enthusiast Horace Fletcher, who espoused the doctrine that all food must be deliberately masticated—at a rate of no less than thirty to one hundred times per minute depending on the substance—such that it turned to liquid before being swallowed.[19] The Great Masticator, as he came to be known, promised his followers many of the same benefits that HAPIlabs advertises on its website today, including the regulation of weight gain, digestive problems, and gastric reflux. Like the fork itself, Fletcher was deliberately agnostic about which foods people chose to eat; the success of his system rested on the rate of eating. Yet it was essential that eaters themselves set this rate. While he could have encouraged his followers to make use of mechanical timers and bells or perhaps a metronome, a critical aspect of his system was to *pay attention to one's own chewing*, to mindfully internalize the masticatory dogma without the supportive entrainment of a device.[20]

Why not do it Fletcher's way today? Atop its list of frequently asked questions, the HAPIlabs product website anticipates the gadget-free appeal of mindful eating: "*If I want to eat more slowly, can't I do this by myself?*" The response they offer demonstrates the degree to which distraction today is the expected—and accepted—subjective state of eaters: "When we want to control the pace at which we're eating, we have to focus on counting the bites or watching the time. When we are sharing a meal with friends or being distracted by TV, it is very difficult to remain conscious of the pace at which we're eating." The fork leaves our ears and eyes free to attend to whatever compelling stimuli absorb us and relays its nudges at the site of the mouth that has bitten too soon; it "pays attention *for* us," to use Kevin Kelly's earlier words, "bringing us to attention when we need to have some attention."

Actuated Attention, Actuated Agency

But to what kind of attention are people brought by the fork and its haptically driven kin?

To answer that question, it is instructive to briefly consider "biofeedback" devices designed with the explicit goal of cultivating self-attention in users.[21] As the makers of a breath-focused device called Breeze explain: "Biofeedback is meant to make explicit a physiological signal, in such a way that it becomes more noticeable. The feedback shifts people's attention to their internal processes, raising awareness of body and mind."[22] An inflatable pendant worn on a necklace, Breeze extracts the signal of breath from the body, digitizes it, and feeds it back to the person via the oscillation of its inflation and deflation. This display, when noticed by the wearer, serves as a trigger and reference point for self-adjustment. The gadget works both as a sensor of a breath-state and a conveyor of that state to wearers, so that they can shift their breath if they wish. As Annemarie Mol notes, it can happen that "an apparatus helps to increase a person's physical self-awareness, encouraging one to better attune to the subtle signals of one's body."[23] With John Law she has written of "the use of measurement machines to train inner sensitivity" to blood sugar levels by hypoglycemia patients—a technically inflected form of bodily attunement they call "introsensing" (evoking "interoception" or the capacity to sense one's inner states).[24]

Haptically driven consumer wearables tend to be designed according to a different model of attunement. Unlike Breeze, which inflates and deflates continuously with one's breath and calls no attention to itself (such that, for it to have an effect, users must notice it), the vibrations of the HAPIfork, buzzes of the Lumo postural pin, or taps of the Apple watch are abrupt and discontinuous, fracturing the flow of experience in which the person is otherwise engaged. The point of these devices is not to cultivate ongoing self-attention but rather to snap wearers to momentary attention—what I call *actuated attention*—and then release them back to an un-self-attentive, unvigilant state.

During the discrete intervals in which subjects receive haptic cues, they are not only brought to a delimited kind of attention but also prompted to exercise a limited kind of agency. Although the body is continuously "participating" in the human-machine loop as the source of tracked data and receiver of its prompts, the acting subject only participates when buzzed—and her participation is tightly configured. Unlike biofeedback practitioners or quantified selfers who notice and make sense of their data,[25] HAPIfork and Lumo Lift users receive *sense-already-made* by algorithms that invisibly extract their data, filter it through preset thresholds, and deliver it to them in a number-burying haptic actuation.[26] The role of humans in a loop of this design is short-circuited in the sense that it is limited to reflex-like reaction rather than self-reflexive response,[27] amounting to a kind of *actuated agency*—abrupt, discrete, and fleeting.

A one-star Amazon customer review of the HAPIfork notes that the form its particular actuation takes is mildly punishing: "Metal vibrating on your teeth is perhaps the worst sensation

ever."[28] The buzzing of fork tines in the mouth is punitive by design; eaters are not so much rewarded for slow eating as they are dissuaded from fast eating, recalling the anatomopolitics of "discipline and punish."[29] Yet disciplinary power is an inadequate model for grasping the specificity of this mode of self-governance, for subjects are not expected to *internalize* the behavioral rules to which they are subjected and vigilantly enact them. Instead, the suite of devices at stake in this essay present themselves as sentinels that remain on watch at all times; self-vigilance is not required.[30] While people could, theoretically, use the fork as a training device "to force focus on a particular behavior, help us reflect on patterns or triggers, and develop sensitivity to specific aspects of our lifestyles,"[31] there is no suggestion in its marketing that users will learn to eat self-attentively such that they can eventually stop using it.[32] The logic is one of ongoing dependency on the haptic actuations of the device.

"I don't want to track—I want it to be done for me," said Leslie Ziegler, a health technology designer and longtime self-tracker, in 2014.[33] "Insert a chip in my mouth and have it record the calories for me!" Ziegler's plea suggests that mainstream consumers, unlike QSers or the Media Lab's wearable pioneers before them, are not seeking a technology that helps them cultivate greater self-awareness or the ability to transcend the material world but, rather, one that can help them maintain a weight, maintain a rhythm, maintain just enough self-attention to stay healthy. As market research has confirmed, people are wary of adding more self-regulative labor to their lives and instead want devices to do that work *for* them.[34]

Nevertheless, users retain a transient agency—momentary, triggered by the stimulus of a device, and quick to pass. In this sense, the fork's agentic affordances distinguish it both from Sanctorius's static chair and from another smart utensil, the Liftware fork. Designed to exert continuous friction to counteract involuntary hand tremors (see figure 2.5.6), the fork treats its users as dependent on its ongoing ministrations; they are not invited into the loop as choice-making subjects. HAPIfork users, in contrast, ultimately *decide* to slow their eating when prompted—or, if they wish, to ignore (or "chew though," as it were) the fork's buzzing remonstrations. No matter how constrained their field of choice, they remain in the position of choosing consumer.

Evoking the "inherent tension" between self-awareness and automation that Kevin Kelly identified earlier in this essay, the actuated subjects of haptic wearables at once wish to make responsible choices *and* to delegate the labor involved. The HAPIfork and its haptically driven kin present themselves as an answer to this wish, offering to automate the daily load of entrepreneurial selfhood. Departing from the world-transcending aspirations of a generation of wearables pioneered in the heyday of Negroponte's Media Lab, their role is not to maximize or even to optimize human potential—but to help us abide the material functions of life in a context of continual distraction and multiple demands on attention. These new "pastors of the soma,"[35] likely to have been spurned in Fletcher's day, are considered permissible adjuncts to self-regulation in a governmental climate of so-called "libertarian paternalism" and the nudge, in which freedom is understood to operate within—and through—constraints, as a brief, and specific, call to action.[36] ◎

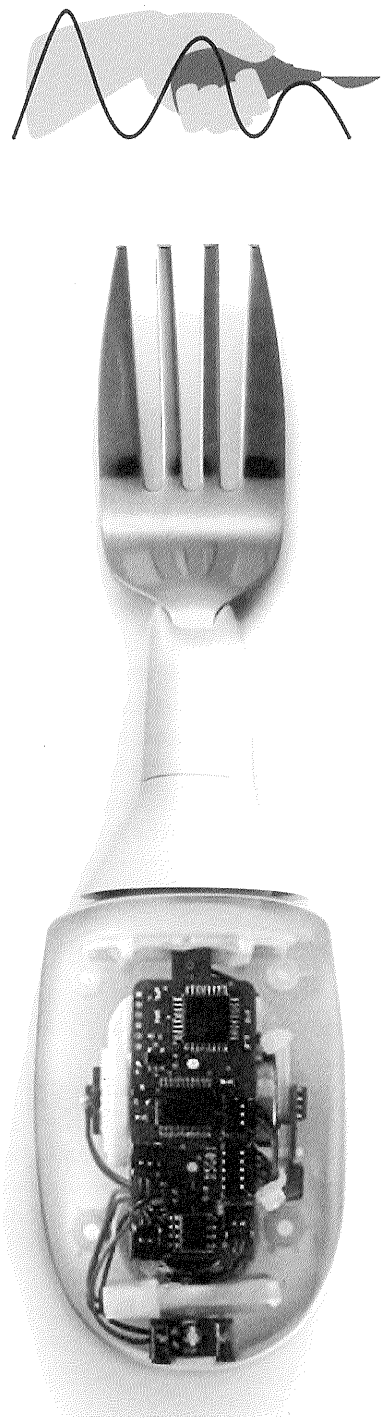

Figure 2.5.6: The Liftware smart utensil can distinguish between intentional and involuntary hand tremors (such as those caused by Parkinson's disease) and offset the latter with haptic vibration. Both the HAPIfork and the Liftware fork seek to regulate the eating process—the latter using continuous friction to *counteract* involuntary behaviors, the former using intermittent, discretely applied friction to *slow its tempo* of eating. (Image from https://www.liftware.com/steady/)

1. Ewan Spence, "2014 Will Be the Year of Wearable Technology," *Forbes*, November 2, 2013.

2. Gary Wolf, "The Data-Driven Life," *New York Times*, April 28, 2010.

3. "Final Agenda Announced for First-Ever Wired Health Conference: Living by Numbers, Featuring Keynote Speakers Michael Graves and Stephen Wolfram," *Wired*, October 15, 2012, https://www.wired.com/2012/10/1693/.

4. Lupton similarly proposes the term "datasense" to describe "entanglements of human senses and digital sensors with sense making." Deborah Lupton, "Feeling Data: Touch and Data Sense," in "Haptic Digital Media," special issue of *New Media and Society*, ed. D. Parisi, M. Paterson, and J. Archer (2017). Sun-ha Hong, "Data's Intimacy: Machinic Sensibility and the Quantified Self," *communication +1* 5, no. 1 (2016): article 3, 18, uses the term in a more specific way to mean "an internalization of machinic temporalities, rhythms, patterns of communication, into user-subjects' phenomenological equipment." Earlier, Kang and Cuff wrote: "It is as if human beings are granted an additional 'sense' in addition to sight, hearing taste, smell, and touch—a sort of sixth sense, a datasense." Kang Lang and Dana Cuff, "Pervasive Computing: Embedding the Public Square," *Washington and Lee Law Review* 62 (2005): 110.

5. Lupton, "Feeling Data."

6. Ben Williamson, "Algorithmic Skin: Health-Tracking Technologies, Personal Analytics and the Biopedagogies of Digitized Health and Physical Education," *Sport, Education and Society* 20 (2015): 147.

7. Nicholas Negroponte, *Being Digital* (New York: Knopf, 1995).

8. Natasha D. Schüll, "Loselt! Calorie Tracking and the Discipline of Consumption," in Jeremy Wade Morris and Sarah Murray, eds., *Appified: Mundane Software and the Rise of the Apps* (Ann Arbor: University of Michigan Press, 2018). See also S. Boztepe and M. Berg, "Connected Eating: Servitising the Human Body through Digital Food Technologies," in Deborah Lupton and Zeena Feldman, eds., *Digital Food Cultures* (London: Routledge, forthcoming).

9. See https://www.kickstarter.com/projects/1273668931/hapifork-the-smart-fork-that-tracks-your-eating-ha-0.

10. Sanctorius of Padua (March 29, 1561–February 22, 1636), author of *De statica medicina* (1615).

11. Lucia Dacome, "Balancing Acts: Picturing Perspiration in the Long Eighteenth Century," *Studies in History and Philosophy of Biological and Biomedical Sciences* 43, no. 2 (2012): 381. See also Schüll, "Loselt!"

12. Lucia Dacome, "Living with the Chair: Private Excreta, Collective Health and Medical Authority in the Eighteenth Century," *History of Science* 39, no. 4 (2001): 467.

13. Elsewhere I argue that self-tracking technology marks a shift from forms of governance that aim to regulate the biological material of life to one that aims to regulate consumer behaviors, habits, and rhythms—in other words, a shift from biopolitical governance to what I call "governance by micronudge." Natasha D. Schüll, "Data for Life: Wearable Technology and the Design of Self-Care," *BioSocieties* 11 (2016): 317–333.

14. See http://www.slowcontrol.com/en/.

15. Elsewhere I discuss the incorporation of haptics into slot machine technology as a way to modulate and guide the gambling experience. "Touchscreens that touch back" are meant to affirm play gestures and thus extend continued gambling or "time on device"—in this case, as a way to increase the revenue a machine draws from a player. Natasha D. Schüll, *Addiction by Design: Machine Gambling in Las Vegas* (Princeton, NJ: Princeton University Press, 2012), 63–68.

16. Jacques Lepine, a founder of HAPIlabs and slow-control technology, made this statement at a company workshop (http://workshop-iot-responsible-behaviors.univ-grenoble-alpes.fr/index.php/intervenant/).

17. Colbert made the comment during a segment of "Tip of the Hat / Wag of the Finger" on *The Colbert Report*, January 10, 2013.

18. For accounts of America's long relationship with self-control, see: Robert Crawford, "A Cultural Account of Health: Control, Release, and the Social Body," in John B. McKinlay, ed., *Issues in the Political Economy of Health Care* (London: Tavistock, 1984), 60–103; Hillel Schwartz, *Never Satisfied: A Cultural History of Diets, Fantasies and Fat*, Anchor Books, 1986.

19. Horace Fletcher, *Fletcherism: What It Is or How I Became Young at Sixty* (1913; Whitefish: Kessinger Publishing, 2009).

20. For a lengthier discussion of the historical waxing and waning of agency in systems of healthy eating in the West, see Schüll, "Loselt!" and Schwartz, *Never Satisfied*.

21. The term "biofeedback" came into existence in 1969 to name a movement that joined humanistic psychology and the human potential movement with behaviorism and cybernetics in the name of giving people greater awareness and control over their internal states through information-conveying devices. See Donald Moss, "Biofeedback, Mind-Body Medicine, and the Higher Limits of Human Nature," in Moss, ed., *Humanistic and Transpersonal Psychology: A Historical and Biographical Sourcebook* (Westport, CT: Greenwood Publishing, 1998).

22. Jérémy Frey, May Grabli, Ronit Slyper, and Jessica R. Cauchard, "Breeze: Sharing Biofeedback through Wearable Technologies," in *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (New York: ACM, 2018), 1–12.

23. Annemarie Mol, "What Diagnostic Devices Do: The Case of Blood Sugar Measurement," *Theoretical Medicine and Bioethics* 21, no. 1 (2000): 19–20.

24. Annemarie Mol and John Law, "Embodied Action, Enacted Bodies: The Example of Hypoglycaemia," *Body and Society* 10 (2004): 48.

25. A Danish self-tracker tells anthropologist Dorthe Kristensen about the "sharpening of senses" and "production of new senses" that came with his tracking, elaborating on the specific kinds of self-attention that arose: "*What happens with your blood sugar after you have eaten, and when you are eating? Do you get tired? What is happening? Do you feel any tickling? Any coating on the tongue?*" Dorthe Brogaard Kristensen and Minna Ruckenstein, "Co-evolving with Self-Tracking Technologies," *New Media and Society* 20, no. 10 (2018): 3624–3640. He would not have noticed these things, he says, had he not interacted with his exteriorized data—or, as he puts it, "without the loop with the instrumentalization."

26. Smith and Vonthethoff write that "sensemaking is increasingly outsourced to and performed by auxiliary codifying mechanisms." G. J. D. Smith and B. Vonthethoff, "Health by Numbers: Exploring the Practice and Experience of Datafied Health," *Health Sociology Review* 26 (2017): 9.

27. Stiegler has distinguished between technologies that "short-circuit" attention and those that "lengthen" the self-technology circuit, allowing users to register their experience and act in a self-attentive rather than compulsively driven mode. Bernard Stiegler, *Automatic Society: The Future of Work*, trans. D. Ross (Cambridge, UK: Polity Press, 2017).

28. Amazon customer review by Sarah, July 16, 2014. A rather more cynical customer comment stated that "it only vibrates once you have it in your mouth, so hopefully you like your fillings rattled loose by a sub-standard Chinese fork which gives you a headache and broken teeth" (Amazon customer review by etrain450 on November 4, 2013).

29. Michel Foucault, *Discipline and Punish: The Birth of the Prison*, trans. Alan Sheridan (New York: Pantheon Books, 1977).

30. See Natasha D. Schüll, "The Sense Mother," in "Theorizing the Contemporary," *Cultural Anthropology*, October 31, 2018.

31. This is how one tech enthusiast (Sean Brennan, "Awareables: The Technology of Superhumans," Wired, March 9, 2015) imagines the design of what he calls "awareables"—as opposed to wearables of an "always on" design.

32. This "device for life" logic is similar to the "data for life" logic I explore elsewhere (see Schüll, "Data for Life")—a phrase meant to paraphrase Dumit's idea of "drugs for life." Joseph Dumit, *How Pharmaceutical Companies Define Our Health* (Durham: Duke University Press, 2012).

33. Comments made by Ziegler while moderating the panel "Track-a-holism: A Disorder Worth Having" at the Digital Health Summit panel stream of the 2014 Consumer Electronics Show.

34. According to a 2014 report by industry analysts, one third of wearable owners discontinued tracking within the first six months. Dan Ledger, "Inside Wearables, Part 2," and Dan Ledger and Daniel McCaffrey, "Inside Wearables: How the Science of Human Behavior Change Offers the Secret to Long-Term Engagement," Endeavour Partners, Cambridge, Industry Report, 2014.

35. Brad Millington, "'Quantify the Invisible': Notes toward a Future of Posture," *Critical Public Health* 26 (2016): 412, citing Nicolas Rose, *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century* (Princeton, NJ: Princeton University Press, 2007).

36. See Schüll, "Data for Life," for a fuller discussion of the governance logic of the "nudge." As with the governmental nudge (itself a kind of algorithmic governance device), the haptic nudge is riddled with questions: Who or what decides when people "need to have some attention"—advertisers? governments? peer statistics? their own preset decisions?