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IoT's about us

Emerging forms of innovation in the Internet of Things

BY JAMES GUSZCZA, HARVEY LEWIS, AND JOHN LUCKER
> ILLUSTRATION BY ALEX NABAUM

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“We don’t even know what it is yet. We don’t know what it is. We don’t know what it can be, we don’t know what it will be, we know that it is cool.”

— The Social Network (*dialogue by Aaron Sorkin*)¹

THE TRANSMUTATION OF THE COMMONPLACE

The protean inventor Nikola Tesla once made a prediction that must have seemed as fanciful to his Victorian contemporaries as the science fiction of the day. He wrote: “When wireless is fully applied, the Earth will be converted into a huge brain, capable of response in every one of its parts.”²

Today—a century and a digital revolution or two later—there is a sense in which Tesla’s “global brain” is becoming an actuality. Though the Internet is often discussed in terms of aspects of the world entering “virtual reality,” an opposing dynamic is increasingly at play. The Internet is also expanding into the real world thanks to the availability of such inexpensive technologies as wirelessly connected sensors, triggers, actuators, RFID tags, GPS locators, accelerometers, and even printed QR (quick response) codes.³ Everyday objects are therefore increasingly becoming components of the emerging entity known as the Internet of Things (IoT). Roughly five billion of such connected devices will be in use in 2015, increasing to tens of billions in just a few years.⁴ From smart thermostats in our homes, personal fitness bands on our wrists, observational devices in vehicles to noise, efficiency, and vibration sensors embedded in factory machinery and jet engines, these devices, and the insights and predictions emanating from the resulting analytics, will quite literally be everywhere.

At first blush, the obvious implication is that everyday objects can and will become better, more efficient versions of what they already are. For example, complex machines such as airplanes, automobiles, agricultural equipment, and power plants can be tagged to emanate streams of data used to monitor and predict the time to failure of critical parts—which allows replacements and repairs to be conducted before breakage or failure. Medical cargoes can be monitored for environmental changes and safe transport. Smart streetlights use less energy to illuminate neighborhoods. In short, we can make devices “smarter” versions of their current selves thanks to the information flows enabled by cheap and widespread smart components and interconnectivity.

The linking of devices to networks changes the nature of these devices in at least two fundamental ways. First, data and information—long used to achieve efficiencies in the creation, marketing, and distribution of things—increasingly become imbued in the things themselves. For example, T-shirts, eyeglasses, sports equipment, mobile phones, automobiles, and fashion accessories can double as data-capturing and information-delivery devices. They increasingly become media of data products and services. Second, as things become increasingly networked, the networks themselves emerge as new classes of products and services. It is now meaningful to speak of smart homes, smart farms, and smart cities thanks to the flows of information enabling improved efficiencies and coordination amongst linked devices. This gives product companies new opportunities to become providers of information and services.

The IoT is giving rise to what might be called a “transfiguration of the commonplace,” with all of the societal and business model implications that this implies.⁵ The nature and functions of everyday things—and the networked environments they comprise—will continue to evolve, thanks to the infusion of data, information, and network linkages into their basic designs. Things change.

WHAT ABOUT US?

As sweeping as it already is, this device-centric narrative omits a crucial point. Namely, *people* should also be regarded as part of the IoT. The publisher and veteran Internet observer Tim O’Reilly recently made the initially counter-intuitive comment that the crowdsourced taxi company Uber exemplifies the types of changes the IoT has in store for business models and societies. In this case taxi drivers and people seeking rides are the IoT “things,” connected via their mobile devices.⁶

The observation that the IoT encompasses people is deceptively simple. But it holds a number of transformative business and societal implications. First, the data

and information flows continually emanating from both people and everyday devices can be aggregated and analyzed to create fundamentally new types of products, services, and business models. Furthermore (as in the case of Uber) these information flows can be bi-directional: multitudes of small signals from thousands of individuals, aggregated, and analyzed to send personalized data products, recommendations, or services back to individuals.

Second, most of what falls under the term “big data” is in fact the “digital breadcrumbs” collected by the IoT as we go about our everyday activities. This IoT-collected data is to the study of people and organizations what the telescope was to astronomy in Galileo’s time. New varieties of data science are coming to prominence in response to this newfound treasure trove, going by such names as computational social science, social physics, behavioral analytics, and people analytics.⁷ These emerging disciplines afford both deeper and broader understandings of human, organizational, and social network behavior. Domains likely to be affected range from human resources and performance management to behavioral health to employee risk management.

Finally, design thinking—as in behavioral design thinking—is important. The past three decades have ushered in a behavioral revolution in our understanding of the ways people make judgments and decisions. In the wake of these discoveries, there is increasing recognition that products and services are considerably more effective when they are designed to go with, rather than against, the grain of human psychology. To paraphrase Ogilvy’s Rory Sutherland, IoT-connected devices and IoT-delivered services should be designed for the brains of humans, not Vulcans. The IoT is not just about “smart devices”; it is also about devices and services that help us become smarter.

Tim O’Reilly put the matter simply: “The IoT is really about human augmentation.”⁸ It is time to explore the possibilities.

FROM SMART THINGS TO SMART CROWDS

Early IoT applications have typically focused on efficiency gains. For example, in 2008, UPS gathered data from telematics and mobile devices to better understand where efficiency gains could be made and how to achieve them.⁹ Using GPS tracking equipment and vehicle sensors, combined with a driver’s handheld mobile device, UPS captured data about each truck’s route, the time vehicles spent idling or maneuvering, and even whether drivers were wearing their seatbelts. This technology has recently been extended under the On-Road Integrated Optimization and Navigation (ORION) program, which now provides real-time route optimization to help individual drivers determine the most efficient way to deliver and pick

up packages. Under ORION, a reduction of just one mile per driver per day will save UPS up to \$50 million per year when it is rolled out to its entire fleet by 2017. With over 10,000 routes optimized, UPS has so far saved more than 1.5 million gallons of fuel and has reduced carbon dioxide emissions by 14,000 metric tons.

But the opportunities presented by the IoT do not end with the efficiency gains enabled by better monitoring, control, and optimization.¹⁰ In *The more things change*, Michael Raynor and Mark Cotteleer point out that these information flows can be used to create new products, services, and business models.¹¹ One interesting paradigm is discussed by William Eggers and Paul Macmillan under the rubric “billion to one.”¹² The idea is that small bits of information emanating from a crowd of individuals can be amassed, analyzed, and used to return customized bits of content or services back to each individual. The transportation app Waze is one example of this model: The app enables drivers (“the billion”) to instantaneously report experiences (such as road hazards, police activity, and traffic accidents) that, when aggregated and analyzed, result in a continuously updated, real-time model of the driving environment. Individuals (“the one”) can use this information to plan and adjust routes and destinations in real time.¹³

“If you had asked social scientists even 20 years ago what powers they dreamed of having, they would have said, ‘It would be unbelievable if we could have this little tiny Black Hawk helicopter that could be microscopic, fly on top of you, and monitor where you are and who you’re talking to, what you’re buying, what you’re thinking...’”

The “billion to one” model of apps like Waze illustrates one aspect of the IoT that deserves much greater attention than it typically receives. Recall the definition of the IoT as simply the expansion of the Internet into the everyday world. A helpful way of thinking about the Internet is articulated by Thomas Malone, the founder of the MIT Collective Intelligence Center. Malone points out that the Internet enables various forms of “collective intelligence,” which he describes simply as groups of humans acting in ways that seem intelligent.¹⁴ As Malone points out, collective intelligence is nothing new: Teams, families, armies, and businesses have displayed varying degrees of collective intelligence throughout history. What is new is the appearance of new forms of collective intelligence that were impossible before the advent of the Internet. Wikipedia is a classic example: a highly refined—quite literally encyclopedic—product that is produced and continually updated by thousands of dispersed individuals operating with fairly minimal central control.¹⁵

Because the IoT is the expansion of the Internet into the everyday world, it is reasonable to anticipate new products and services centered around the harnessing of collective intelligence in the everyday world. The “billion to one” logic of Waze illustrates how the bi-directional information flows through mobile Internet devices enable multitudes (in this case drivers) to better self-organize and collectively act in a way that seems intelligent. Uber—and the entire “Uberified” sector of the economy—similarly exemplifies the idea. Indeed an “Uber for parking spaces” would be a natural complement to Waze. Waze currently enables the driver to select the best route to her destination. But once she arrives in that neighborhood she often confronts a wasteful and time-consuming hunt for parking. In the future, parking garages will be able to guide the driver to a specific parking spot. Like birds in a flock, IoT-connected cars and drivers can achieve a kind of collective intelligence.

Of course opportunities for IoT-fuelled innovation are not restricted to the private sector. Consider California’s multiyear drought, which many fear is a permanent feature of the environment. In response, California Governor Jerry Brown announced the first mandatory water restrictions in that state’s history.¹⁶ It is likely that the IoT will be part of the solution. A “device-centric” IoT approach would be to attach sensors to elements of the water distribution system to unlock efficiencies akin to those achieved by “smart” hydroponic and irrigation systems. This is yet another example of linking devices to networks to achieve greater monitoring, control, and optimization.

A complementary IoT-enabled idea would be a Waze-like harnessing of collective intelligence: Concerned citizens could install smartphone apps that would enable them to effortlessly report suspected inefficiencies or breakdowns in water distribution and usage to the appropriate authorities. A robust uptick in such signals tagged to a certain location could trigger an investigation. The idea is loosely analogous to the use of Google search data to more efficiently track flu outbreaks.¹⁷ Similar crowdsourcing ideas could be employed to flag potentially unsafe roads, buildings, and workplaces; unhygienic restaurants and food trucks; emerging risks in complex supply chains; hot-spots of crime, violence, and human rights abuses, and so on.¹⁸

MAKING THE INVISIBLE VISIBLE

A sign hanging on Albert Einstein’s door read, “Not everything that can be counted counts, and not everything that counts can be counted.” This motto also belongs on the doors of business and public sector leaders. It is a useful corrective to the twin fallacies, more common than ever in the age of big data, that something is important only to the extent that it can be quantified; and conversely that current modes of quantification capture what is important. The IoT is expanding

the scope of what can be measured in society, just as the invention of the telescope opened new vistas to astronomers. Important traits of individuals, teams, organizations, and populations that have traditionally been hidden from view are coming to the fore thanks to IoT-collected data. This will give the emerging field of “people analytics” greater scope to improve on unaided judgment in making human resource and other decisions that involve employees and teams.

The premise that the IoT encompasses people has an important implication for the notion of “big data”: Most of the data collected by the IoT are in fact *human behavioral data*, often collected continually and at vast scales.¹⁹ These new sources of data enable new forms of analytics, such as people analytics, social network analysis, behavioral health and precision medicine, and behavioral finance. Sandy Pentland of MIT comments:

The power of big data is that it is information about people’s behavior instead of information about their beliefs. It’s about the behavior of customers, employees, and prospects for your new business. It’s not about the things you post on Facebook, and it’s not about your searches on Google, which is what most people think about, and it’s not data from internal company processes and RFIDs. This sort of big data comes from things like location data off of your cell phone or credit card; it’s the little data breadcrumbs that you leave behind you as you move around in the world.²⁰

Using large volumes of behavioral data to better understand the workings of groups and networks is the domain of an emerging, interdisciplinary field known as computational social science (CSS). The medical professor and computational social scientist Nicholas Christakis summarizes the perspective that motivates much CSS research:

If you had asked social scientists even 20 years ago what powers they dreamed of having, they would have said, “It would be unbelievable if we could have this little tiny Black Hawk helicopter that could be microscopic, fly on top of you, and monitor where you are and who you’re talking to, what you’re buying, what you’re thinking, and if it could do this in real time, all the time, for millions of people, all at the same time. If we could collect all these data, that would be amazing.”²¹

Christakis’s point is that the IoT makes yesterday’s data-“science fiction” today’s data-science. A study by the Cornell sociologists Scott Golder and Michael Macy illustrates the possibilities for understanding people and populations in new ways. Golder and Macy analyzed millions of publicly available Twitter messages and were able to measure and quantify the degree to which people awaken in a good mood which subsequently deteriorates throughout the day; and the degree to which the happiness of populations is correlated with varying lengths of daylight.²² Of course

these findings are intuitive. But the point is that such population-level traits and behaviors are now the subject of scientific scrutiny by means other than surveys. (Recall Pentland's comment about measuring people's *behaviors* rather than their *beliefs*.)

Similar methods are used in the business world. For example, analysis of social media data is routinely used to measure changes in public sentiment following entertainment events and advertising campaigns. Computational social science also lends itself to innovations in public health. Christakis and Fowler, for instance, have concluded that obesity is "contagious" in social networks: Otherwise similar people are more likely to become obese themselves if they enter a social situation in which they are surrounded by obese people. Similar effects have been posited for teen pregnancy and smoking. Such insights are useful in the design of environments to prompt healthier behaviors.²³

Other promising applications of CSS methods in the business world are only beginning to attain prominence. Human resources is a domain that has been notoriously slow to adopt data analytic methods.²⁴ Hiring, evaluation, promotion, and coaching decisions are still routinely made largely based on subjective judgments. Now that it is increasingly possible to collect "digital breadcrumbs" of workers as they go about their daily jobs, data-driven methods might be poised to make inroads against reliance on unaided judgment when making decisions about people and teams.²⁵

While such monitoring understandably strikes many as intrusive or "creepy," it is worth considering the shortcomings of the alternative. The use of unaided judgment to evaluate job candidates and employee performance is plagued with cognitive biases such as groupthink, halo effects, the tendency to favor people like oneself, and overgeneralizing from easy-to-remember experiences. The implication of the celebrated book *Moneyball* is that such biases are so endemic to judgment-based hiring decisions that they can lead to inefficient markets for talent. Consistent with this, symphony orchestras began hiring a greater proportion of women after auditions began to take place behind screens so that candidates were evaluated based only on the sound they made, not their appearance.²⁶

One of Sandy Pentland's projects illustrates a more modern approach. Working for a call center outsourcing firm that wished to improve its productivity, Pentland's team set up electronic devices, called sociometers, designed to capture speech patterns of the call center workers as they handled their calls. The devices didn't record the substance of the conversations, only such conversational patterns as tone and pitch. The team found that the degree to which a call center worker's voice fluctuates (indicative of speaking in an inviting or singsong, rather than authoritative, way) was highly predictive of a call's success or failure.²⁷

Pentland's sociometer therefore measures something important that has traditionally been acknowledged only incompletely and inconsistently: the impact of nonverbal communication styles on success. One can envision such technologies being used to coach and train teachers, public safety workers, sales and marketing professionals, and health care workers. Indeed, in his book *Blink*, Malcolm Gladwell reported a study correlating physicians' speech patterns with malpractice suits. The study found that physicians who spoke with warmth were sued for malpractice less frequently than physicians who conveyed an air of authoritativeness. Independent of other risk factors, likeable physicians were found to be sued less often than unlikeable physicians.²⁸

Non-verbal communication ability is an example of an individual-level trait that can be better discerned with IoT-generated digital breadcrumbs. It turns out that sociometric data are also predictive of such group-level traits as the collective intelligence of teams. They can capture whether leaders are domineering or inquiring, the degree to which team members speak and listen in equal measure, whether they use helpful body language and other forms of communication, and so on.²⁹ As digital exhaust brings a kind of data-rich, scientific study of teams into the realm of practical possibility, it is possible that organizations will reconsider whether team-level performance—as opposed to individual-level performance—is even the best unit of analysis to focus on when making hiring decisions and evaluating performance.

Consider for example two hypothetical employees, Alan and Beth. On the surface they are comparable in terms of role, tenure, domain, and so on. But less obvious is the fact that their respective network positions are quite different. Alan is central to a tight-knit cluster of workers; Beth is not central to any particular group, but is practically the only employee with strong connections to people in both the IT and marketing departments. On the surface, Beth might actually appear to be the weaker employee: From the perspective of any particular member of any particular group, her contributions might seem modest or intangible. Yet from the perspective of the organization as a whole, Beth, by virtue of her ability to maintain substantive ties to two disparate groups, fills an important “structural hole” that would otherwise exist in the organization's professional network.³⁰ It is likely that, appearances to the contrary, the loss of Beth to the organization would be more disruptive than the loss of Alan. Typically such facts are at best recognized inconsistently and at worst simply hidden from view when evaluating employees and determining compensation.

Here again, it is reasonable to expect IoT-mediated behavioral data to provide new perspectives. For example, sociometric data, data about who is emailing whom, and other data sources can be combined to create organizational social network graphs.³¹ The above hypothetical Alan/Beth comparison—novel, objective,

and valuable from the perspective of traditional talent management—becomes a straightforward calculation with the social network graph in hand. In this example, Beth's "betweenness centrality" (a standard metric used in social network analysis) would be much higher than Alan's. Various measures of connectedness and centrality could also be used to predict attrition and performance, identify isolated employees or groups that could be connected in strategic ways, and so on. While conceptually straightforward, the implications for people analytics are considerable. For example, network size and position are correlated with attrition risk, and are highly relevant to properly recognizing individuals' contribution to organizational success. Furthermore, email digital exhaust is potentially relevant in the early detection of rogue employees and the prevention of corporate scandals.³²

While our discussion has focused on the potential of people analytics for reinventing various HR functions, behavioral digital exhaust and computational social science methods will continue to leave their mark in a wide variety of domains. For example insurers now realize that personal credit data is highly predictive of who is likely to crash their car; supermarket club card data is predictive of such chronic disease states as diabetes. Social scientists are increasingly able to track the spread of behaviors such as diabetes and smoking through populations; marketers can better understand customers using fine-grained data about both individual behaviors and social network position. In each case, digital breadcrumbs captured by the IoT help us do a better job of counting what counts.

BEHAVIORAL DESIGN FOR A CHANGE

The Waze and Uber examples discussed above illustrate the new forms of collective intelligence that can emerge as a result of connecting people (drivers, passengers, taxi operators) to each other and to things (cars, parking spaces).³³ The bi-directional information flows that we have called "billion to one" give the individual the real-time information he or she needs to make a more informed decision. Analogous to free markets governed by the price system, individual (micro) utility-maximizing behavior results in crowd-level (macro) coordination.

But "well-informed deliberation" and "utility-maximizing rational choice" do not describe how most people go about their daily lives. In *Thinking, Fast and Slow*, psychologist and Nobel laureate Daniel Kahneman discusses how human cognition can be described in terms of a kind of "dual mental process" theory. What he calls Type 1 thinking ("thinking fast"), is rapid, automatic, and prone to narratively coherent stories rather than logically coherent analyses of data. Many of the mental shortcuts ("heuristics") that comprise Type 1 thinking are systematically biased. They are both terrible at statistics and are present-biased in the sense of favoring tangible short-term gains to long-term benefits. In contrast, Type 2 thinking

(“thinking slow”) is the logical, utility-maximizing behavior common to *homo economicus* and Star Trek’s Mr. Spock. It seeks out all available evidence, evaluates said evidence using logic rather than storytelling, and foregoes short-term pleasures to achieve long-term goals.

The Waze example illustrates how the IoT can enable better Type 2 thinking: If an app displays a faster route to work, we are likely to change our plans and take it. Similarly, if it enables us to prepay and be guided to a specific parking spot with the click of a button, there is a good chance we will take the offer rather than search for parking. Waze is an example of augmented intelligence: Presenting someone with the right information will likely prompt an appropriate decision.

But alas, thanks to the ubiquity of Type 1 thinking, not all decisions are so easily improved. Suppose Carl is deciding between an extra doughnut at breakfast and going for a morning swim. And suppose an app on his new smart watch displays side-by-side the number of calories in a typical doughnut together with the estimated number of calories burned by swimming a mile. Will this augmented intelligence prompt Carl to ditch the doughnut and go for the swim? Maybe, but probably not.³⁴ What is needed in this case is not so much augmented *intelligence*, but augmented *behavior*. Carl already knows well enough that swimming is the right choice even without the additional quantification offered by his app. Borrowing the influential term of Richard Thaler and Cass Sunstein, a behavioral nudge might prompt Carl to go “the last mile” from intention to action.

A core concept of the science of behavioral nudges is choice architecture: Try to convey information and design menus of choices in ways that go with, rather than against the grain of human psychology. A general theme of behavioral economics is that people’s choices are influenced not only by the available options, but also by the way those options are presented. For example, a diner in a restaurant might be more likely to order a \$50 entrée if a \$75 entrée is also on the menu: Compared with the more expensive option, the \$50 entrée seems like good value. A clever restaurateur might therefore place a very expensive item on the menu as a “decoy,” primarily to serve as a psychological reference point. This simple example illustrates how a certain kind of design thinking can prompt behavior change.³⁵

One of the most powerful findings of behavioral science is that people dislike violating social norms, and often act more on the basis of “social proof” (what others are doing) than stable sets of preferences. The energy company Opower famously uses this insight to prompt more efficient energy usage. Their letters to customers reflect the finding that informing people that they consume more than comparable neighbors is more effective than either economic or environmental pleas.³⁶

Similar logic can be employed in a broad range of applications. For example:

- Peer comparisons might be similarly effective in prompting California citizens to use less water. This could be a complementary water conservation approach to the connected-device and collective intelligence ideas described above.
- In the realm of behavioral health, self-tracking device apps show not only how well people are doing against their goals but how well they are doing relative to their friends.
- The automobile telematics data captured by insurance companies to more accurately price insurance policies could be used to give both periodic feedback reports containing personalized driving tips (augmented intelligence), as well as peer comparisons serving as behavioral nudges to prompt safer driving (augmented behavior).³⁷
- The behavioral finance company HelloWallet creates various composite measures of individuals' financial health and also makes peer comparisons to help guide people to take better control of their personal finances.
- The DebMed Group Monitoring System is an electronic soap dispenser equipped with a computer chip that records how often health care workers in different hospital wards wash their hands. It compares these results to expectations based on World Health Organization standards and reports the comparisons back to the wards. Clever “social physics” and nudge thinking is built into the conception: Feedback reports are given at the group level rather than individual level. The insight is that no one wants to be “that guy” who lets down the team.³⁸

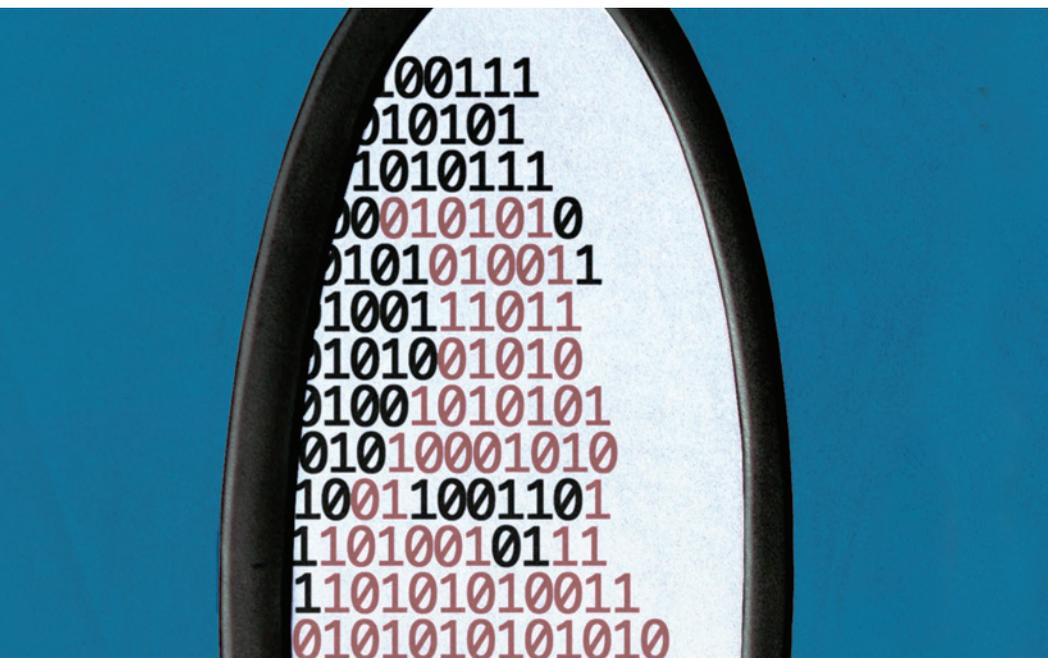
Peer comparisons and clever uses of “social physics” hardly exhaust the many varieties of behavioral science thinking relevant to the design of IoT-connected devices. The variety of possibilities defies easy summary. For example, Beeminder connects self-tracking devices with apps that can be programmed with commitment contracts: By committing ahead of time to pay a fine for not complying with your goals, you make it more likely that you will follow through.³⁹ Companies that offer their customers large numbers of choices (such as mutual fund companies or cable TV carriers) can consider creating data-driven recommendation engines or personalized menus of simplified choices to improve customer engagement by avoiding choice overload.⁴⁰ Finally, health, wellness, and patient compliance is a promising application of digitally enabled behavioral nudge design. For example, Sencio Systems' IbisCare blends applied behavioral economics, data analytics, and IoT technology to improve the medical compliance of senior citizens suffering

WHO OWNS THE DATA?

The implication of the IoT including people is that issues of privacy, transparency, data stewardship, and data ownership are paramount. Many of us enjoy the benefits of smarter homes, cars, and transportation networks. But few relish the thought of Internet companies being able to track our every move and make highly personal inferences and predictions based on the digital breadcrumbs we leave behind as we go about our daily activities. Similarly, customers have long allowed grocery store chains to electronically capture data about shopping behavior in return for personalized promotions and discounts. One could imagine such data also being used for behavioral health and precision medicine applications as well, but many are understandably uncomfortable with the prospect of data brokers or insurance companies being able to amass and analyze such data in ways that are hidden or constantly changing. And more fundamentally, many people simply do not want to live in a world in which their every action is monitored. A trade-off must be struck between the benefits, innovations, and analytic insights that IoT brings with the need to maintain societies that people want to live in.

Observers such as Sandy Pentland and Richard Thaler suggest frameworks for data privacy and ownership that suggest a way beyond this impasse. Pentland calls for a “new deal on data,” which would involve giving people ownership of their data. In Pentland’s scheme, people would possess their data, have full control over how it is used, have a right to distribute the data as they see fit. At the same time, Pentland suggests policies that would encourage individuals to share anonymized data for computational social science applications that promote the common good.⁴¹

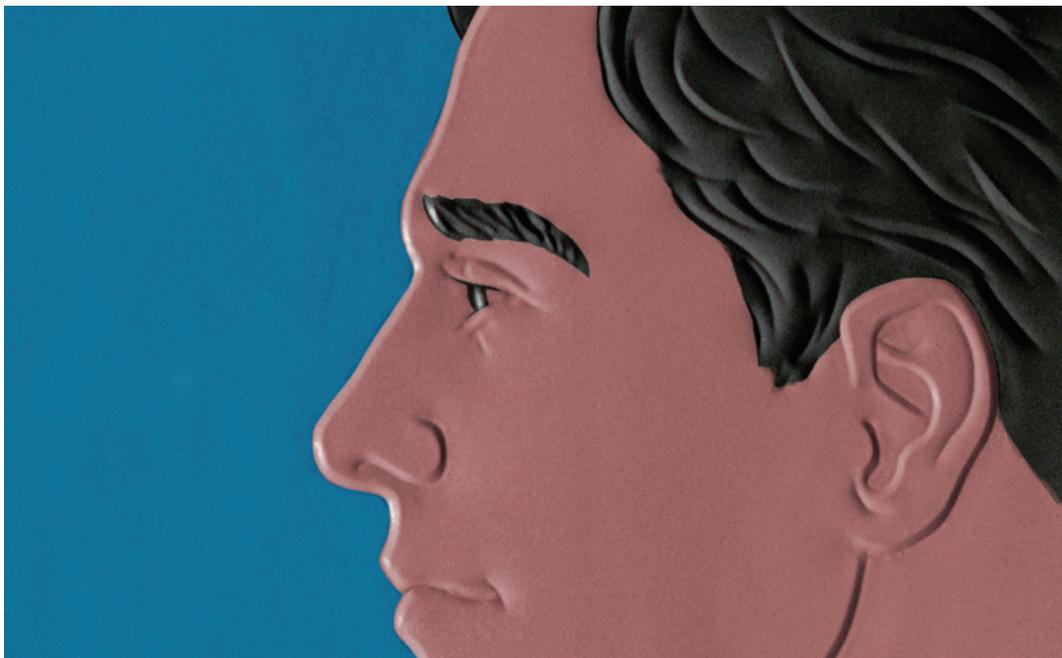
Richard Thaler, the University of Chicago economist and father of behavioral finance, makes consistent suggestions.⁴² He says that while issues of data privacy, veracity, and security are important,



they do not address the larger issue that people should also be able to access the data collected about them. Thaler proposes the guiding principle that, “if a business collects data on consumers electronically, it should provide them with a version of that data that is easy to download and export to another website.” Intuitively: The individual has lent the company (bank, insurer, mobile phone carrier, Internet service) her data; so she should be able to request a copy for her own use.

Thaler’s ideas are being put into practice. For example the UK government has been encouraging banks, energy companies, and mobile phone carriers to comply with a program called “midata” that was modelled on Thaler’s framework. The government recently decided against drafting new regulations requiring compliance after finding that companies have been voluntarily complying reasonably well.⁴³ In the United States, the federal government’s “blue button” program enables individuals to download their medical records in a standard format to share with medical providers whom they trust.⁴⁴

If widely adopted, a framework such as Thaler’s could have the dual effect of defusing some of the distrust currently surrounding industrial and governmental efforts to collect and mine data about people while also spurring the new economies dedicated to helping people make the most of their data. “So let’s level the playing field,” Thaler writes. “Why not give you, the consumer, something in return for participating? Require that the supermarket make your purchase history available to you. Before you know it, a smart entrepreneur is likely to devise an app that will direct you to cheap and healthy alternatives that can slim your tummy and fatten your wallet. Apps could not only save money; they could also warn shoppers with allergies, for example, that they are buying foods that contain ingredients to which they are sensitive, like nuts or gluten.”



from chronic diseases.⁴⁵ In the same genre is David Rose's IoT-connected pill bottle equipped with "GlowCaps" that nudge the patient with a flash of light when it's time to take a pill.⁴⁶

Such ideas illustrate how innovative uses of data from IoT-connected devices, infused with the right kind of behavioral design thinking, can enable traditionally product-centric industries such as insurance, utilities, and banking to modify their business models in ways that make them more customer-centric and less commoditized. More generally, the combination of data science, digital technology, and behavioral design thinking enables a distinctly modern way of "doing well by doing good." Used imaginatively, the digital breadcrumbs pulsing through the IoT can be a force for good, helping us stick to our goals, drive more safely, make better medical, diet, exercise, and financial decisions, and use resources more sparingly.

ALL TOGETHER NOW

It is fitting to close with another Tim O'Reilly remark: "When you think about the Internet of Things, you should be thinking about the complex system of interaction between humans and things, and asking yourself how sensors, cloud intelligence, and actuators make it possible to do things differently."⁴⁷

As O'Reilly suggests, the observation that the IoT includes people implies opportunities for IoT innovation that go well beyond the (already considerable) promise of smarter devices and smarter networks devices. First, the IoT enables new products and services premised around the creation of new forms of collective intelligence; and using aggregated information from "the billion" to provide useful products and services to "the one."

Second, IoT-mediated behavioral digital breadcrumbs, analyzed with the emerging tools of computational social science, will help us better measure—and therefore manage—hitherto hidden traits of individuals, teams, organizations, and populations. Stay tuned for further innovations from such fields as people (HR) analytics, risk management, population health, and elsewhere.

Finally, we suggest that behavioral design thinking is indispensable when envisioning—and building—the 21st century world of complex systems of interactions between people and things that O'Reilly describes. This world must be designed for the minds of humans, not of Vulcans. The point of the IoT should not be to make smarter machines, but to make people smarter. It's about us. **DR**

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Endnotes

1. Hark, "We don't even know what it is yet," sound clip, <http://www.hark.com/clips/blmzfhmmsj-we-dont-even-know-what-it-is-yet>.
2. Nikola Tesla, "The problem of increasing human energy," *Century Magazine*, June 1900. Tesla's article originally predicted a world where electric power could be tapped by anyone at any point on Earth via "wireless transmission."
3. In an IoT interview, the ETH Zurich professor Florian Michahelles commented that, "The *Internet of Things* by itself does not really mean much other than having an Internet expanding into the real world." <http://postscapes.com/iot-voices/interviews/iot-interview-series-8-questions-with-dr-florian-michahelles/>.
4. Gartner, Inc. forecasts that 4.9 billion connected things will be in use in 2015 and will reach 25 billion by 2020, November 2014. See also: <http://www.gartner.com/newsroom/id/2905717>.
5. For a discussion, see the essay *The more things change: Value creation, value capture, and the Internet of Things* by Michael Raynor and Mark Cotteleer in the current issue of *Deloitte Review*. *The Transfiguration of the Common-place* is the title of a book by the late, renowned philosopher and art critic Arthur Danto. We are using the phrase in a much different way.
6. See "Tim O'Reilly explains the *Internet of Things*," *The New York Times*, February 4, 2015, http://bits.blogs.nytimes.com/2015/02/04/tim-oreilly-explains-the-internet-of-things/?_r=0. O'Reilly admits that many will find counterintuitive the idea that Uber is an example of the IoT. He goes on to say that if human drivers were replaced by purely automatic self-driving cars, few would object to such a company being labeled an example of IoT. The point is that leaving humans out of the equation is an arbitrary narrowing of the concept. In an October, 2014 *Harvard Business Review* interview, MIT's Alex "Sandy" Pentland discussed the IoT in similar terms. Interestingly, his motivating illustration also involved taxis: a taxi tracking app he invented several years ago. He commented that when discussing the IoT, we need to count things like mobile phones, self-tracking devices, and so on. And "when you do, you realize that the *Internet of Things* already includes most of humanity," <http://www.datapopalliance.org/blog/2014/10/16/harvard-business-review-interview-with-alex-sandy-pentland-on-big-data-the-internet-of-things-privacy-and-the-new-deal-on-data>
7. See Lazer, et al, "Computational social science," *Science*, February 6 2009, <http://gking.harvard.edu/files/LazPenAda09.pdf>. See also Alex Pentland, *Social Physics*, (Penguin 2014) and Ben Waber, *People Analytics: How Social Sensing Technology Will Transform Business and What It Tells Us about the Future of Work*, (FT Press, 2013).
8. *The New York Times*, "Tim O'Reilly Explains the *Internet of Things*," February 4, 2015.
9. UPS, "ORION fact sheet," 2013, <http://www.pressroom.ups.com/Fact+Sheets/ORION+Fact+Sheet>.
10. In "How smart, connected products are transforming competition," *Harvard Business Review*, November 2014, Michael Porter and James Heppelmann helpfully group the capabilities of "smart," connected devices into a hierarchy of categories: monitoring, control, optimization, and autonomy, <https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition>
11. Raynor and Cotteleer, *The more things change: Value creation, value capture, and the Internet of Things*, *Deloitte Review*, July 2015.
12. Eggers and Macmillan, *A billion to one: The crowd gets personal*, *Deloitte Review*, January 2015, <http://dupress.com/articles/personalizing-customer-experiences-analytics/>.
13. For more information on how Waze works, see <https://www.waze.com/about>.
14. See the edge.org discussion on "Collective intelligence" with Thomas W. Malone, November 21, 2012, <https://edge.org/conversation/collective-intelligence>.
15. We do not mean to suggest that exchanges and aggregation of ideas on the Internet automatically result in collective intelligence. To the contrary, Cass Sunstein and others have long pointed out that Internet-mediated exchanges can result in increased polarization and extreme views. See for example the new book by *Wiser: Getting Beyond Groupthink to Make Groups Smarter* (Harvard University Press, 2014) and "From groupthink to collective intelligence: An interview with Cass Sunstein" in this issue of *Deloitte Review*. Still, well-designed Internet-based applications can promote collective intelligence. Toward the end of their book, Sunstein and Hastie express optimism over the potential of new technologies for promoting collective intelligence.
16. *The New York Times*, "California imposes first mandatory water restrictions to deal with drought," April 1, 2015, http://www.nytimes.com/2015/04/02/us/california-imposes-first-ever-water-restrictions-to-deal-with-drought.html?_r=0.
17. See "The Parable of Google Flu: Traps in Big Data Analysis" by David Lazer et al. both for a description of the innovation, as well as a cautionary tale about how, contrary to certain accounts in the press, the sheer size and scope of "big data" is not a substitute for sound statistical methodology. *Science* March 14, 2014.
18. Atrocitywatch is a specific example. Its mission is to "provide an early warning of precursors to genocide, war crimes, ethnic cleansing, and crimes against humanity through crowd sourcing, big-data, and the impartial presentation of analytic results." Atrocitywatch exemplifies Sandy Pentland's comment that "the *Internet of Things* already includes most of humanity": Mobile phones are common even in developing countries with low median incomes. Simple text messages serve as the early warning signals. Interestingly, Atrocitywatch also harnesses another form of collective intelligence in that it uses hackathons to crowdsource the analysis of this human-generated data, <http://www.atrocitywatch.org/>
19. For more on this theme, see "Two dogmas of big data" by James Guszczka and Bryan Richardson, *Deloitte Review*, July 2014, <http://dupress.com/articles/behavioral-data-driven-decision-making/>.

20. Edge.org, "Reinventing society in the wake of big data," August 30, 2012, <https://edge.org/conversation/reinventing-society-in-the-wake-of-big-data>.
21. Edge.org, "A new kind of social science for the 21st century," August 21, 2012, <https://edge.org/conversation/a-21st-century-change-to-social-science>.
22. Scott A. Golder and Michael W. Macy, "Diurnal and seasonal mood vary with work, sleep, and daylength," *Science*, September 2011, <http://www.sciencemag.org/content/333/6051/1878>.
23. See for example "How might we design for behavior change?" in Tim Brown's *Design Thinking* blog. <http://designthinking.ideo.com/?p=694>. The theme of design thinking in the IoT context is further explored in the next section of this essay.
24. See for example John Sullivan, "HR ranks at the bottom—reasons to adopt metrics and predictive analytics," September 2014, <http://www.ere.net/2014/09/29/hr-ranks-at-the-bottom-reasons-to-adopt-metrics-and-predictive-analytics/>. Interestingly, one of the most celebrated examples of business analytics, *Moneyball* by Michael Lewis, is HR analytics in the sense that it is about the use of data to make better hiring decisions. But the practice has not become as widely used outside of professional sports as comparable applications of data analytics in other domains.
25. Consider, for example, the vexed issue of performance management. A recent Deloitte study found that 58 percent of executives believe their current performance management systems were not an effective use of time. The study went on to say that such systems may in fact be "damaging employee engagement, alienating high performers, and costing managers valuable time." Some observers have long maintained that the current system is so bad that simply replacing it with nothing would be a major improvement. For the Deloitte study, see <http://dupress.com/articles/hc-trends-2014-performance-management/>, and for information on how it has shaped Deloitte's own attempt at data-driven performance management, see <https://hbr.org/2015/04/reinventing-performance-management>. Prominent observers who have long maintained that formalized job appraisals are counterproductive include Lucy Kellaway of the *Financial Times* and Samuel Culbert of UCLA. See Lucy Kellaway's "It's time to sack job appraisals," *Financial Times*, July 11, 2010, <http://www.ft.com/intl/cms/s/0/a72a8ca6-8b8e-11df-ab4d-00144feab49a.html#axzz3WIL5ehYb> and Samuel Culbert, "Get rid of the performance review!" *Wall Street Journal*, October 20, 2008, <http://www.wsj.com/articles/SB122426318874844933>.
26. Claudia Goldin and Celia Rouse, *Orchestrating impartiality: The impact of 'blind' auditions on female musicians*, The National Bureau of Economic Research, <http://www.nber.org/papers/w5903>. On the more general issue of "creepiness," Lucy Kellaway is characteristically perceptive. She observes that what many people see as "big brother at work" could—if implemented in a transparent way—be a boon to individuals: "So long as everyone knew they were being monitored and understood what for, I don't see why it should be such a terrifying idea—except perhaps for those who bully, shout at, or harass others and who have until now been getting away with it. Far from making work less civilized, the arrival of Big Brother could make it more so. Office life could become more transparent and less political. And managers would be freed from having to play the role of policeman all day and allowed to get on with the more important role of helping people do a better job." Kellaway's comment is consistent with the more general point that bringing to bear thoughtfully and consistently collected data can serve as a corrective to the excesses and biases of unaided judgment. See BBC News, "Big Brother at work may be no bad thing," June 16, 2014, <http://www.bbc.com/news/business-27813535>.
27. Mark Buchanan, "The science of subtle signals," *strategy+business*, August 29, 2007, <http://www.strategy-business.com/article/07307?pg=all&tid=27782251>.
28. Levinson, et al., "Physician-patient communication: The relationship with malpractice claims among primary care physicians and surgeons," *Journal of the American Medical Association*, 1997;277(7):553-559.
29. See Sandy Pentland "The new science of great teams," *Harvard Business Review*, April 2012, <https://hbr.org/2012/04/the-new-science-of-building-great-teams>.
30. The study of organizational structural holes was pioneered by the University of Chicago sociologist Ron Burt.
31. For example, companies such as Humanyze and Volometrix enable the practical use of sociometric data and email metadata, respectively, to enable such data-rich forms of people analytics.
32. See Bu Hugh Son, "JPMorgan algorithm knows you're a rogue employee before you do," *BloombergBusiness*, April 7, 2015, for an account investment banks' efforts to use digital exhaust to identify rogue employees before they go astray, <http://www.bloomberg.com/news/articles/2015-04-08/jpmorgan-algorithm-knows-you-re-a-rogue-employee-before-you-do>. An older example related to the Enron scandal: A dataset of Enron emails is publicly available and has given rise to a cottage industry of social network analyses, <https://www.cs.cmu.edu/~lenron/>.

33. The word “emerge” is used deliberately: In such fields as philosophy, biology, sociology, and economics “emergent properties” are properties of complex systems (such as economies, organizational networks, and organisms) that cannot be predicted or described in terms of properties of their constituent parts (such as people or physical particles). The collective intelligence of flocking birds or connected drivers; the spread of behaviors through social networks; and “structural holes” in an organizational network are all examples of macro-level properties that cannot be described in terms of features of constituent members.
34. In fact, research has shown that displaying calorie information in fast food restaurants does not improve the health of orders made by customers. In fact, the knowledge of how unhealthy a desired option may be can invoke an “all in” response that actually makes the average order less healthy. Sample studies can be found at <http://www.ncbi.nlm.nih.gov/pubmed/23865657> and <http://www.ncbi.nlm.nih.gov/pubmed/16227125>.
35. For a more extended discussion, see James Guszczka, *In 3D: Data meets digital meets design*, “The last mile problem: How data science and behavioral science can work together,” *Deloitte Review*, January 2015. <http://dupress.com/articles/behavioral-economics-predictive-analytics/>.
36. See *Harvard Business Review* case study, “OPower: Increasing Energy Efficiency through Normative Influence,” September 2010, <https://hbr.org/product/opower-increasing-energy-efficiency-through-normative-influence-a/911016-PDF-ENG>.
37. This idea is explored in greater depth in our previous *Deloitte Review* essays “The personalized and the personal: Socially responsible innovation with big data” and “The last mile problem.” As discussed in “The last mile,” the UK insurer Ingenie implements elements of the idea of using telematics data to provide personalized feedback reports.
38. *The Economist*, “First, wash your hands,” July 17, 2013, <http://www.economist.com/news/technologyquarterly/21584441-biomedicine-smart-antiseptic-dispensers-promise-save-lives-subtly-encouraging>.
39. See Beeminder, “Mind your goals,” <https://www.beeminder.com>. A commitment contract is literally a contract that the “present self” takes out with his or her “future self.” It was conceived by the Yale economist Dean Karlan as a way of overcoming what behavioral economists call “present bias” or “hyperbolic discounting” and what the rest of us call laziness and inertia. To illustrate, suppose Jim really wants to go swimming three times per week, but also knows that on any given day he will put it off until “tomorrow.” Present Jim can sign a contract promising to donate \$1000 to an organization he loathes in the event that he fails to swim a pre-specified number of laps— as recorded by a self-tracking device—before the end of the month. Karlan, together with his Yale colleague Ian Ayres, founded the company Stickk to market commitment contracts.
40. The classic example of choice overload comes from an experiment run by the Columbia University professor Sheena Iyengar. One day, Iyengar set up a display in an upscale grocery store with 24 flavors of jam. Customers who sampled the flavors received a coupon for \$1 any jar of jam. Another day, Iyengar ran the same experiment, replacing the 24 flavors with 6 flavors. Although the large display attracted more customers than the small display, the grocery store sold only one-tenth as much jam the day 24 flavors were on display.
41. Alex Pentland, “Reality mining of mobile communications: Toward a new deal on data,” *Global Information Technology Report*, 2008-2009, World Economic Forum, http://hd.media.mit.edu/wef_globalit.pdf.
42. Richard Thaler, “Show us the data, (It’s ours, after all),” *The New York Times*, April 23, 2011, http://www.nytimes.com/2011/04/24/business/24view.html?_r=0.
43. Out-Law.com, “Government steps back from threat to legislate on ‘midata,’” July 2014, <http://www.out-law.com/en/articles/2014/july/government-steps-back-from-threat-to-legislate-on-midata/>.
44. Healthit.gov, “Blue button,” <http://healthit.gov/patients-families/your-health-data>.
45. IbisCare, www.IbisCare.net.
46. David Rose, *Enchanted Objects: Design, Human Desire, and the Internet of Things* (Scribner, 2014).
47. Tim O’Reilly, “IOTH: The Internet of Things and humans,” O’Reilly Radar, 16 April, 2014.