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Digital Life in 2025

The Internet of Things Will Thrive by 2025

Many experts say the rise of embedded and wearable computing will bring the next revolution in digital technology. They say the upsides are enhanced health, convenience, productivity, safety, and vastly more useful information for people and organizations. The downsides: challenges to personal privacy, over-hyped expectations, and tech complexity that boggles us.

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About This Report

This report is the latest research report in a sustained effort throughout 2014 by the Pew Research Center to mark the 25th anniversary of the creation of the World Wide Web by Sir Tim Berners-Lee ([The Web at 25](#)).

A [February 2014 report](#) from Pew Internet tied to the Web’s anniversary looked at the strikingly fast adoption of the Internet. It also looked at the generally positive attitudes users have about its role in their social environment.

A [March 2014 *Digital Life in 2025*](#) report issued by Pew Internet in association with [Elon University’s Imagining the Internet Center](#) looked at the Internet’s future. Some 1,867 experts and stakeholders responded to an open-ended question about the future of the Internet by 2025. They said it would become so deeply part of the environment that it would become “like electricity” — less visible even as it becomes more important in people’s daily lives.

To a notable extent, the experts agree on the technology change that lies ahead, even as they disagree about its ramifications. Most believe there will be:

- A global, immersive, invisible, ambient networked computing environment built through the continued proliferation of smart sensors, cameras, software, databases, and massive data centers in a world-spanning information fabric known as the Internet of Things.
- “Augmented reality” enhancements to the real-world input that people perceive through the use of portable/wearable/implantable technologies.
- Disruption of business models established in the 20th century (most notably impacting finance, entertainment, publishers of all sorts, and education).
- Tagging, databasing, and intelligent analytical mapping of the physical and social realms.

This current report is an analysis of opinions about the likely expansion of the Internet of Things (sometimes called the Cloud of Things), a catchall phrase for the array of devices, appliances, vehicles, wearable material, and sensor-laden parts of the environment that connect to each other and feed data back and forth. It covers the over 1,600 responses that were offered specifically about our question about where the Internet of Things would stand by the year 2025. The report is the next in a series of eight Pew Research and Elon University analyses to be issued this year in which experts will share their expectations about the future of such things as privacy, cybersecurity, and net neutrality. It includes some of the best and most provocative of the

predictions survey respondents made when specifically asked to share their views about the evolution of embedded and wearable computing and the Internet of Things.

These technologists, including the majority of the expert respondents here, predict the Internet of Things will be evident in:

- **Bodies:** Many people will wear devices that let them connect to the Internet to get feedback on their activities, health, and fitness. They will also monitor others (their children or employees, for instance) who are also wearing sensors, or moving in and out of places that have sensors.
- **Homes:** People will be able to control nearly everything remotely, from how their residences are heated and cooled to how often their gardens are watered. Homes will also have sensors that warn about everything from prowlers to broken water pipes.
- **Communities:** Embedded devices and smartphone apps will enable more efficient transportation, and give readouts on pollution levels. “Smart systems” might deliver electricity and water more efficiently and warn about infrastructure problems.
- **Goods and services:** Factories and supply chains will have sensors and readers that more precisely track materials to speed up and smooth out the manufacture and distribution of goods.
- **Environment:** There will be real-time readings from fields, forests, oceans, and cities about pollution levels, soil moisture, and resource extraction that allow for closer monitoring of problems.

Expert respondent **Patrick Tucker**, author of *The Naked Future: What Happens In a World That Anticipates Your Every Move?* provided a nice working description of the Internet of Things, writing: “Here are the easy facts: In 2008, the number of Internet-connected devices first outnumbered the human population, and they have been growing far faster than have we. There were 13 billion Internet-connected devices in 2013, according to Cisco, and there will be 50 billion in 2020. These will include phones, chips, sensors, implants, and devices of which we have not yet conceived.”

Tucker went on to forecast the benefits of all this connected computing: “One positive effect of ‘ubiquitous computing,’ as it used to be called, will be much faster, more convenient, and lower-cost medical diagnostics. This will be essential if we are to meet the health care needs of a rapidly

aging Baby Boomer generation. The Internet of Things will also improve safety in cities, as cars, networked to one another and their environment, will better avoid collisions, coordinate speed, etc. We will all be able to bring much more situational intelligence to bear on the act of planning our day, avoiding delays (or unfortunate encounters), and meeting our personal goals. We are entering the telemetric age—an age where we create information in everything that we do. As computation continues to grow less costly, we will incorporate more data-collecting devices into our lives.”

Others we cite in this report are less sanguine about the surveillance and tracking that is involved in making the Internet of Things work. Their views are also extensively covered in this report.

This report is a collaborative effort based on the input and analysis of the following individuals.

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About the Imagining the Internet Center at Elon University

The [Imagining the Internet Center's](#) mission is to explore and provide insights into emerging network innovations, global development, dynamics, diffusion and governance. Its research holds a mirror to humanity's use of communications technologies, informs policy development, exposes potential futures and provides a historic record. It works to illuminate issues in order to serve the greater good, making its work public, free and open. The center is a network of Elon University faculty, students, staff, alumni, advisers, and friends working to identify, explore and engage with the challenges and opportunities of evolving communications forms and issues. They investigate the tangible and potential pros and cons of new-media channels through active research. The Imagining the Internet Center sponsors work that brings people together to share their visions for the future of communications and the future of the world.

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Overview

The vast majority of respondents to the 2014 Future of the Internet canvassing agree that the expanding networking of everything and everyone—the growth of the Internet of Things and embedded and wearable devices—will have widespread and beneficial effects by 2025. They say the opportunities and challenges resulting from amplified connectivity will influence nearly everything, nearly everyone, nearly everywhere.

We call this a canvassing because it is not a representative, randomized survey. Its findings emerge from an “opt in” invitation to experts who have been identified by researching those who are widely quoted as technology builders and analysts and those who have made insightful predictions to our previous queries about the future of the internet. (For more details, please see the section “About this Canvassing of Experts.”)

Some 1,606 experts responded to the following question:

***The evolution of embedded devices and the Internet/Cloud of Things** —As billions of devices, artifacts, and accessories are networked, will the Internet of Things have widespread and beneficial effects on the everyday lives of the public by 2025?*

Eighty-three percent of these experts answered “yes” and 17% answered “no.” They were asked to elaborate on their answer and a handful of grand themes ran through their answers:

Theme 1) The Internet of Things and wearable computing will progress significantly between now and 2025.

These experts believe infrastructure and adoption of the Internet of Things will substantially progress in the next decade. Many believe there will be clear advantages as that happens. Some believe it will happen, but disagree that the benefits will be great or outweigh the problems. A modest minority flatly disagree and many see a mixed picture, where the technology advances that add to life also create problems. Even most of those who worry about the trend towards the Internet of Things do not challenge the notion that more objects, appliances, cars, and other parts of the environment will be connected.

JP Rangaswami, chief scientist for Salesforce.com, was particularly pointed in describing the benefits that will emerge in this new environment: “The proliferation of sensors and actuators will continue. ‘Everything’ will become nodes on a network. The quality of real-time information that becomes available will take the guesswork out of much of capacity planning and decision-making. We will really understand what it means to move from ‘stocks’ to ‘flows,’ as in the Hagel-Seely

Brown-Davison model.¹ The net effect will be to reduce waste everywhere: in physical flows and logistics, in the movement of people and goods; in logical flows and logistics, in the movement of ideas and information; decisions will be made faster and better, based on more accurate information; prior errors in assumption and planning will be winkled out more effectively. ‘Inventory’ will be reduced, as will the waste associated with the decay that is an intrinsic part of inventory. This will affect the food you buy and cook and eat; the fuel you use to power yourself, your devices, and your vehicles; the time you take to do things; and, as you learn to live longer, the burden of care will reduce as a result of far better monitoring of, and response to, your physical and emotional state, in terms of healthcare. Our notions of privacy and sharing will continue to evolve as a result, with new tradeoffs needing to be understood and dealt with. People will engage with information using all of their senses: touch and feel, sight, sound, smell, and taste—using them in combination, more often than not. Wearable, connected devices will become embedded more and more in our bodies, more like implants, as in the [Google] Glass becoming more like contact lenses. As that happens, our ability to use nerve impulses to engage with information will expand dramatically. We will see today’s connected devices become smaller and smaller and slowly merge into the part of the body from where the particular sense related to that device operates.”

Paul Saffo, managing director of Discern Analytics, wrote, “Most of our devices will be communicating on our behalf—they will be interacting with the physical and virtual worlds more than interacting with us. The devices are going to disappear into what we wear and/or carry. For example, the glasses interface will shrink to near-invisibility in conventional glasses. The devices will also become robustly inter-networked (remember the first conversations about body networks of a decade ago?). The biggest shift is a strong move away from a single do-everything device to multiple devices with overlapping functions and, above all, an inter-relationship with our other devices.”

An iconic example that many cite is that milk cartons—themselves carrying sensors or perhaps sitting on “smart” refrigerator shelves in people’s homes—will send signals to the homeowner or grocery stores when they are nearing empty and this information will be conveyed to the homeowner when she is conveniently near a store. Some respondents liked that; others thought that kind of progress would be less than cosmic.

Other examples of Internet of Things activities that some of our respondents mentioned:

¹ In their 2009 book, *The Power of Pull*, prominent business analysts John Hagel, John Seely Brown, and Lang

- Subcutaneous sensors or chips that provide patients’ real-time vital signs to self-trackers and medical providers.
- Remote control apps that allow users’ phones to monitor and adjust household activities from pre-heating the oven to running a bath to alerting users via apps or texts when too much moisture or heat or .
- Smart cities where ubiquitous sensors and GPS readouts allow for vastly smoother flows of traffic; warnings and suggestions to commuters about the best way to get around traffic—perhaps abetted by smart alarm clocks synched to their owners’ eating and commuting habits and their day-to-day calendars.
- Sensored roadways, buildings, bridges, dams and other parts of infrastructure that give regular readings on their state of wear and tear and provide alerts when repairs or upgrades are needed.
- Vastly improved productivity in manufacturing at every stage, as supply chain logistics are coordinated.
- Paper towel dispensers in restrooms that signal when they need to be refilled. Municipal trash cans that signal when they need to be emptied. Alarm clocks that start the coffee maker,
- Smart appliances working with smart electric grids that run themselves or perform their chores after peak loads subside.

Many expect that a major driver of the Internet of Things will be incentives to try to get people to change their behavior—maybe to purchase a good, maybe to act in a more healthy or safe manner, maybe work differently, maybe to use public goods and services in more efficient ways. **Laurel Papworth**, social media educator, explained, “Every part of our life will be quantifiable, and eternal, and we will answer to the community for our decisions. For example, skipping the gym will have your gym shoes auto tweet (equivalent) to the peer-to-peer health insurance network that will decide to degrade your premiums. There is already a machine that can read brain activity, including desire, in front of advertising by near/proximity. I have no doubt that will be placed into the Big Data databases when evaluating hand gestures, body language, and pace for presenting social objects for discussion/purchase/voting.”

Minority view: Not so fast

Many respondents added to their portrait of the emerging benefits of the Internet of Things with warnings about the problems that would accompany the tech advances. Some were generally less optimistic about how far the Internet of Things would advance and whether the benefits would be as extensive as their peers envision. A typical version of this line was offered by **Bill St. Arnaud**, a self-employed green Internet consultant, who wrote, “The Internet of Things has been in the red zone of the hypometer for over a decade now. Yes, there will be many niche applications, but it will

not be the next big thing, as many pundits predict. If the Internet of Things had any true validity, you would think you would start to see evidence of its presence on early adopter Internet networks.”

One critical unknown is the degree to which people will outsource their attention to devices and appliances in the Internet of Things, or focus on devices that display all these data, at the expense of activities taking place in their vicinity. **Karl Fogel**, partner at Open Tech Strategies, president at QuestionCopyright.org, wrote in response to this question, “No, yuck, we don’t need this, and most people aren’t asking for it. I’ve never been quite clear on where the demand is supposedly coming from. The scarce resource will continue to be human attention. There is a limit to the usefulness of devices that are worn in public but that demand attention because it is often socially and practically unacceptable to give those devices enough attention to make them worth the trouble of configuring and interacting with.”

The co-founder of a consultancy with practices in Internet technology and biomedical engineering wrote, “Inter-networked wearables will remain a toy for the wealthy. They will possibly serve special purposes in environments like prisons, hospitals, and the battlefield. Inter-networked devices are a lovely convenience and the cost of building Bluetooth, NFC, RFID, WiFi, etc. into new devices is reasonable—but the effect on everyday lives is negligible. If my bathroom scale tells my smartphone how much I weigh, that is handy but hardly life-changing. There are tremendous upsides of networked devices for special-purpose roles, but, in my humble opinion, not for benefiting everyday life in a revolutionary way. Compare the Samsung watch and Google Glass to calculator watches of the 1970s—useful proof of concept, but more of a fad than a trend, of interest to a few, and ridiculed by many others. Gaze tracking is a mature technology and we do not have any killer app for it now—I wouldn’t expect it to dominate the hearts and minds of the public after another 11 years.”

Theme 2) The realities of this data-drenched world raise substantial concerns about privacy and people’s abilities to control their own lives. If everyday activities are monitored and people are generating informational outputs, the level of profiling and targeting will grow and amplify social, economic, and political struggles.

Nick Wreden of the University of Technology Malaysia in Kuala Lumpur, wrote, “There will be absolutely no privacy, not even in the jungle, away from civilization. I don’t like this, but people have shown over and over again that they are willing to trade away their souls for a ‘\$1 off’ coupon. Conversation, which includes not only words, but also movement, eye contact, hearing, memory and more, is such a holistic, pleasurable experience that people will not give it up easily.”

Peter R Jacoby, a college professor, wrote, “The effects will be widespread but pernicious. We might as well inject ourselves into the Internet of Things. By 2025, we will have long ago given up our privacy. The Internet of Things will demand—and we will give willingly—our souls. Whether intended or not, the Internet of Things may be the ultimate affirmation of Juvenal’s observation in Satire 2 all that was really needed to keep the entire Roman Empire under control by the Emperor was as simple as *‘panem et circenses (bread and circuses),’* which Juvenal mused was the formula for the well-being of the population, and thus, a political strategy. This formula offered a variety of pleasures, such as: the distribution of food, public baths, gladiators, exotic animals, chariot races, sports competition, and theater representation. It was an efficient instrument in the hands of the Emperor to keep the population peaceful, and at the same time, give them the opportunity to voice themselves in these places of performance. It worked quite well for a few hundred years. Now, we have tacos and TV. Wearables and scannables by 2025? Same thing.”

Frank Pasquale, a law professor at a large U.S. university, responded, “As Rivera’s film *Sleep Dealer* shows, the workplace plugged into the Internet of Things will be more productive and more prison-like (or, to be more accurate, more like an ‘ankle monitor’ of the mind that upgrades scanning not merely to location, but also to observable ‘outputs’ like typing and eye movements). Jonathan Crary’s *24/7* is also an essential guide to this future. It sets the stage for extraordinarily targeted monitoring and manipulation of these individuals. There will be a small class of ‘watchers’ and a much larger class of the experimented upon, the watched. Rules that govern institutional research boards should be applied here, too.”

Some analysts warn that the perpetual feedback and stimulation loop accompanying always-available computing can lead to other social ills.

Justin Reich, a fellow at Harvard University’s Berkman Center for Internet & Society, said, “It will have widespread beneficial effects, along with widespread negative effects. There will be conveniences and privacy violations. There will be new ways for people to connect, as well as new pathways towards isolation, misanthropy, and depression. I’m not sure that moving computers from people’s pockets (smartphones) to people’s hands or face will have the same level of impact that the smartphone has had, but things will trend in the similar direction. Everything that you love and hate about smartphones will be more so.”

A related strain of argument ties to fears that algorithms cannot necessarily be trusted to make the appropriate decisions. For instance, **Aaron Balick**, a PhD, psychotherapist, and author of *The Psychodynamics of Social Networking*, predicted, “Positive things may be tempered by a growing reliance on outsourcing to technologies that make decisions not based on human concerns, but instead on algorithms (however influenced by our own past choices). We may begin to lose sight of our own desires or our own wills, like many of these drivers who we hear about who, because their

GPS told them to, end up in the most unlikely places in the face of all sorts of real-world, contrary evidence. What will happen to our own senses of intuition, let alone our capacity to venture into the unknown, learn new things, and our ability to be still and quiet without being in constant relationship to one device or another.”

Quite a few survey respondents mentioned that it will be necessary to find ways for people to be able to disengage from the network, to stop being a node that constantly sends and receives data.

Theme 3) Information interfaces will advance—especially voice and touch commands. But few expect that brain-to-network connectivity will be typical in most people’s daily lives by 2025

Per Ola Kristensson, lecturer in human-computer interaction at the University of St. Andrews, UK, sees advances in small-screen communications but shared doubts about the brain-computer interface. “In 2025,” he predicted, “we will be able to write on mobiles as fast as we can on a full-screen keyboard, wherever we are. Wearable sensors and mobile eye tracking will be used by systems to learn about users’ context: where are they, what are they doing, and what are they likely communicating? Better sensors, more advanced machine learning algorithms, and a better understanding of humans’ capabilities and limitations will result in gesture and speech recognition having evolved so much that users will fluidly be able to express themselves quickly, even if they are mobile or encumbered. Systems will be able to take users’ context into account and enable users to combine several modalities such as speech, gesture, and eye movement, and systems will fluidly combine these modalities, providing users maximum flexibility, robust recognition results, and fast-text input. Brain-Computer Interaction (BCI) will, however, not be feasible for able-bodied users, most likely because efficient BCI will remain requiring invasive equipment to be installed and the signal-to-noise ratio remaining low.”

Paul Jones, a professor at the University of North Carolina and founder of ibiblio.org, predicted that body movements may evolve into commands. “The population curve ... will cause much of the monitoring and assistance by intelligent devices to be welcomed and extended,” he said. “This is what we had in mind all along—augmented life extension. Young people, you can thank us later. We look like kung fu fighters with no visible opponents now, but soon, the personalized interface issues will settle on a combination of gestures and voice. Thought-driven? Not by 2025, but not yet out of the question for a further future. Glass and watch interfaces are a start at this combination of strokes, acceleration, voice, and even shaking and touching device-to-device. The key will be separating random human actions from intentional ones, then translating those into machine commands—search, call, direct, etc.”

Theme 4) There will be complicated, unintended consequences: ‘We will live in a world where many things won’t work and nobody will know how to fix them.’

Some participants anticipate that the kind of complexity caused by such a large network will be too difficult to maintain and evolve well.

Howard Rheingold, a pioneering Internet sociologist and self-employed writer, consultant, and educator, responded, “The 1992 novel *Snowcrash* described a world of ubiquitous wearables, where it became possible to auction, eBay style, captured images of any specified time and place. In regard to increasingly semi-sentient objects in the environment, I warned in my 2002 book *Smart Mobs* that a new kind of animism (first voiced by Mark Pesce) might arise: what child will be able to know that a doorknob that recognizes their face doesn’t also know many other things? We will live in a world where many things won’t work, and nobody will know how to fix them.”

Jerry Michalski, founder of REX, the Relationship Economy eXpedition, wrote, “The Internet of Things (IoT) is too complex. It will break, over and over. Given my reply to the cyberwarfare question, most of the devices exposed on the Internet will be vulnerable. They will also be prone to unintended consequences: they will do things nobody designed for beforehand, most of which will be undesirable. We aren’t evolved enough as a species or society to create apps and services that are useful to humanity in the Internet of Things. We’ll try to create efficiencies but be thwarted by Nature’s complexity. False positives from contextual movements will break people’s willingness to have devices track their expressions and thoughts. Try using speech recognition in a crowded room. Now, imagine that it is your thoughts being tracked, not merely speech. Google Glass has already attracted backlash, before a thousand people are in the world using it. Our surveillance society feels oppressive, not liberating. No comfortable truce will be found between the privacy advocates and the ‘screen everything’ crowd.”

Theme 5) The unconnected and those who just don’t want to be connected may be disenfranchised. Consider the ramifications of digital divides.

Miguel Alcaine, International Telecommunication Union area representative for Central America, responded, “The Internet of Things will add to the comfort of people living in developed countries by 2025. It will also have a measurable impact in utilities markets like energy and water. Unfortunately, it might not help people in developing countries with developmental issues, mainly because of the tendency in many developing countries to focus on the short term and not on the long term. People with disabilities could be the most favored by such devices. Also, micro-devices using biometrics for identification may be accepted by populations worried with deteriorating security conditions.”

K.G. Schneider, a university librarian, wrote, “Right now, Google Glass follows the pattern of other technology adoptions, where what I see are a handful of first-world white men touting their shiny new toys. Put this in context with someone struggling to get by on a daily basis—in the US or

in other countries: what these devices primarily signify is a growing gulf between the tech haves and have-nots. That said, I'm not boycotting these devices—I see them as interesting and important. But just as students today are burdened if they don't have home Internet—and at the university where I work, that is true of some of our commuter students, much as people might find that hard to believe—there will be an expectation that successful living as a human will require being equipped with pricey accoutrements... Reflecting on this makes me concerned that as the digital divide widens, people left behind will be increasingly invisible and increasingly seen as less than full humans.”

Theme 6) Individuals' and organizations' responses to the Internet of Things will recast the relationships people have with each other and with groups of all kinds.

Technology could empower people with tools that protect their privacy

Doc Searls, journalist and director of ProjectVRM at Harvard's Berkman Center for Internet and Society wrote:

First, the nature of the Internet, with its end-to-end architecture, welcomes everything—literally—in the world, in addition to the people, machines, and organizations connected today, by 2025, countless trillions of things will be online.

Second, it isn't necessary for everything to have onboard intelligence, or to be connected full-time to the Net. Intelligence and connectivity can be abstracted away from things themselves to their own Clouds. This means everything is already in a position to have a Cloud of its own. This is all early stuff, but it already proves several things:

1. That the intelligence of a thing can be abstracted to its own Cloud
2. That its Cloud can have its own operating system
3. That it's possible to program relationships between things, and what events (such as scanning) can trigger
4. That the Cloud of a thing can live within the Cloud of a person, and both run the same operating system

People's Clouds of Things can be as personal and private as their houses (and, when encrypted, even more so). They can also be far more social than any 'social network' because they won't involve centralized control of the kind that Facebook, Google, and Twitter provide. Instead, they can connect to each other in a fully distributed way. Logical operations can be programmed among and between anybody and anything in the world, with full respect for the permissions others provide voluntarily.

For example, one could program (or have programmed for them) this kind of logic:

- If my phone scans the QR code I've put on my cable modem, a message will go to the cable company saying that's just happened. The cable company could note the message and its source, check against a trouble ticket database, and text back a message such as, "We see there is an outage in your area. Service should be back up within two hours." Or,
- If a cable company technician scans the same QR code, it will get access, with my permission, to whatever data I have chosen to flow into the Cloud of the cable modem. In fact, the Cloud for the modem could have data in it from both the cable company and myself.

Several additional points are worth noting here:

1. All kinds of logic can be written and executed in this scenario: *if, then, and, or, else, nor*, and so on.
2. There will be a hefty business in providing, provisioning, and programming Clouds for things and people, and making it all easy.
3. Products themselves become platforms for relationships between customers and companies. This opens huge service opportunities. (See more in [this piece I wrote for HBR.](#))

Today, all customer-service frameworks are provided by companies, and not by customers. All are also different from each other and require that each of us maintain separate relationships with all of them. (Even when many companies use the same back-end Cloud, as they do with Salesforce, what faces the customer is different for each company.) In the new system we see emerging above, customers will own—and standardize—the relationships they have with companies. (One small example of this is the ability to change one's contact information one time for all company relationships, rather than separately for all of them.)

We will wear smart clothes and smart things. The world will also be thick with smart things as well, including products for sale that communicate what they are, what they cost, and much more. Moderating between ourselves and the rest of the world will be systems of manners. So, for example, we might wear devices that signal an unwillingness to be followed, or to have promotional messages pushed at us without our consent. Likewise, a store might recognize us as an existing customer with an established and understood relationship. Google Glass today is a very early prototype and has little, if any, social manners built-in, which is why it freaks people out. New manners-friendly systems, and the protocols to go with them, will be worked out over the next five or so years. (Some paths in this direction are outlined in my blog post, [Searls Glasses—http://blogs.law.harvard.edu/doc/2014/01/29/searls-glasses-vs-google-glass/.](http://blogs.law.harvard.edu/doc/2014/01/29/searls-glasses-vs-google-glass/))

Personal space will expand and contract

Bryan Alexander, senior fellow at the National Institute for Technology in Liberal Education, presented a vivid picture of how adoption is likely to evolve.

“First,” he said, “we should never underestimate the power of convenience. Wearable computing can make things easier for users, and that’s enough to drive adoption. Second, companies, old and new, have much to gain from the Internet of Things, starting with customer data, and moving on to shaping services based on that data. Expect people in driverless cars to talk to their personal shoppers (Artificial Intelligence, probably) through their glasses or armbands, while businesses jockey for their attention, based on minute data advantages. Third, we will socialize in new ways, changing more. Our sense of personal space will both expand (to cover the world) and contract (to not be rude to other multitaskers). Our sense of belonging will continue to redistribute globally and by affiliation. Public and private spaces will acquire a new layer of interaction and mediation, with Twittering car tires, writing on fridges, and projection on cabinets...

Our deep desires to be entertained and connected will lead us to accept these devices. Younger folks will lead the way. Our will to create will make us want these devices ready and on-hand. Naturally, there will be a backlash. We’ve already seen it with the ‘Glassholes’ meme.² Expect more neoLuddites to hanker for computing as humanity was intended to have it, on keyboards!”

² Some of the early adopters of Google Glass are called “Glassholes.”

The Gurus Speak

Some of the most prominent and respected technology experts and analysts made far-ranging predictions about the Internet of Things. Their answers:

Continuous monitoring will be a “powerful element in our lives”

Vint Cerf, vice president and chief Internet evangelist for Google, gave a response that touches on many of the key likely issues. “The benefit is that these appliances will be coordinated to improve our daily lives,” he wrote. “The risk is that inimical forces may gain control and create serious problems. Wearables will monitor health and also draw computers into the context of our daily lives, conversations, and activities. A big opportunity for AI [Artificial Intelligence] awaits. Privacy will be hard to come by. Barriers to the Internet of Things include failure to achieve sufficient standardization and security. Interaction modes will have expanded beyond mouse/keyboard to include voice conversations and gestures. Automatic scene analysis will allow computers to recognize objects in a field of view, identify buildings and other elements of the environment. With Google Glass, the computer sees what you see and hears what you hear, opening up serious artificial intelligence opportunities. Continuous monitoring is likely to be a powerful element in our lives: health monitoring, environment and security controls, traffic management, flow of materials. Also, note that 3D printing will bring transformation for many products: ship raw materials and designs versus assembled products. Google Glass and similar devices will draw computing power into context of your interactions with other people and the environment. This gives a new foothold for artificial intelligence. The machine becomes part of the conversation!”

It will create a world in which “people are always able to get information about essentially anything they encounter”

David Clark, a senior research scientist at MIT’s Computer Science and Artificial Intelligence Laboratory, noted, “Devices like Google Glass may become popular, or may fail to prove their worth. But in more than 10 years, I suspect some sort of device that gives a cyber-overlay on the real world will be in use. I am ambivalent about this future. Ten years ago, I would not have predicted that ‘everyone’ would walk around with ear buds, listening to their own world. Today, we see people walking around, looking at the display on their mobile devices. If some sort of projection display like Google Glass can be made to work, it is possible that the mobile device will become modularized, with a head-mounted display, separated from the processor and wireless interface and from the input device. But the heads-up display still has to prove its utility, and the successor to the touch screen needs to emerge.... The ability to put a scan tag on ‘anything’ will create a much more fluid and interwoven linkage between things in the ‘real world’ and their cyber-counterparts. This ability will provide many conveniences and benefits. By analogy, GPS has

created a world in which people no longer ‘get lost.’ A scannable world will be one in which people are always able to get information about essentially anything they encounter.”

The line between humans and machines is “blurring”

John Markoff, senior writer for the Science section of the New York Times, wrote, “The concept of the *Star Trek* Borg comes to mind. The blurring of the line between humans and their machines is well underway. That said, 2025 will look more like today than it will look like either *Neuromancer*, *Snowcrash*, or *The Diamond Age*—or *Accelerando*, for that matter. As Paul Saffo has noted: ‘Never mistake a clear view for a short distance.’ I personally think that Google Glass is a hideous fashion statement that will come back to haunt its wearers in a cyberpunk world, where the streets remain dystopian. Speech synthesis and voice recognition will trump glasses. We will talk to our machines, and they will speak to us.”

Look for more “socially unintrusive smart devices”

Jason Pontin, editor in chief and publisher of MIT Technology Review, observed, “We’re carrying powerful, socially accepted computers around in our pockets, in the form of phones, and it’s not clear that devices like Google Glass will be accepted in the same way. Still, I anticipate that secondary devices that interact with our phones (like smart watches and personal-quantification devices) will be unremarkable by 2025. By 2025, Google Glass will be an important tool for vertical business uses like inventory control or library services. It will not be worn for civilian use. On the other hand, almost all non-mechanical watches will be smart watches. There will be other, not-yet-invented socially unintrusive smart devices, too.”

“We will all have cyberservants”

Hal Varian, chief economist for Google, wrote, “We will eventually be able to interact via thoughts, but it won’t be common by 2025. However, verbal interaction will be commonplace. We will talk to devices in essentially the same way we talk to other people. Yes, you will be permanently connected to the network via wearable devices. You will interact with these devices mostly by voice, as you would interact with another person. Centuries ago, rich people had servants, and in the future, we will all have cyberservants.”

“Computication” (computer-to-computer artificial communication) will emerge

Stowe Boyd, lead researcher for GigaOM Research, referred to the capability for artificial-intelligence-enhanced communication as “computication” in his prediction. “All sensors will talk in 2025, and some will converse.... A sociometric algorithm will monitor how people interact in the office, based on ID cards, and will suggest to some individuals that they are spending too much time with others and need to spend some alone time on long-format work, while coaxing others to

head over to the cafe to chat with a group of engineers and marketing folks, right now ... Goggles—like Google Glass—will replace flat screens ... Desktop computers will be in museums, although a certain cadre will not give up their keyboards and will resist learning how to subvocalize or sign. People who talk to their goggles are considered infantile, since most people give up on that technique before starting school. Most people have wrist or finger devices that talk with their goggles, even when the goggles are off (in bed, exercising, in the shower, etc.), giving notifications, and allowing a subset of computation capability.”

Health apps will produce big changes

Jim Hendler, a professor of Computer Science at Rensselaer Polytechnic Institute, wrote, “Health apps will be the most significant change. Things such as the Fitbit will evolve to allow passive monitoring of blood sugar, caloric intake, etc., as well as to be specialized for specific ailments in individuals—these will allow those who want to improve their health to do so. Household objects online will have ways of being part of a broadcast network that can allow owners to be informed in case of recalls, problems, etc. Over time, there will be more direct inputs to the digital world. Technologies that can improve health monitoring will also allow a certain amount of signaling to computers—implanted chips for control will be just coming along in the 2025 timeframe (evolving in part from better prosthetic controllers), so I expect wearables, more than implantables, to be part of life by 2025.”

Healthier living through tech, peer support, feedback – but also new, traumatic illnesses

David-Michel Davies, executive director, The Webby Awards and Co-Founder of Internet Week, said, “Our overall health - lifespan, disease rate and quality of life - will greatly improve by 2025 due in large part to the Internet of Things. One of the big opportunities it will provide is the ability to close our own feedback loop - to incorporate real-time biometric feedback into our lives. Even today, in 2014, relatively rudimentary and simple apps like Nike + and 24/7 (an app that uses the Motion x chip in the iPhone to passively tracks steps, sleep pattern etc.) is supporting improved fitness and quality of life for millions of people. When these technologies are not constrained to your smart phone, but part of a powerful biometric monitoring program that keeps track of your vital signs every second of the day and is accessible to you, your personal medical community and sophisticated computational power and software that can not only help you view the information and understand it, but also compare it to vast sets of other data so that it becomes not just an indicator of health or sickness, but even predictive - we will live much, much longer.... What's interesting to me is what happens when we look like a fifty year old at the age of 85? What happens when we have healthy hearts and bodies when we are 90? The societal implications and opportunities are incredible but also scary. One can imagine becoming a wiser society, with elderly and experienced people remaining active long after they retire today, their perspective and life

experience around longer with a greater opportunity to impact the world and shape their families. A traditional three generational family extending into four generations more consistently. That is exciting! But longer lives could also mean new kinds of diseases and sicknesses, ones that our bodies have not dealt with yet because we have, to date, died before their onset. These ailments may be worst - more traumatic, more costly and more damaging to society - than the ones we face today.”

There will be “de-skilling” in workplaces and personal “anti-video firewalls” to protect people from spying

Marcel Bullinga, futurist and author of *Welcome to the Future Cloud—2025 in 100 Predictions*, responded, “There will be benefits and threats at the same time, of course. Two major areas of impact will be work and education. There will be diminished work skills ... There will also be diminished educational skills: less need of knowing facts, as they present themselves on the spot in real-time on your glasses. A major global megatrend here is *de-skilling*—our children will learn less and achieve more. Of course, they will also suffer from major social media stress traumas. The rise of the body-as-key and the body-as-interface is highly likely because the advantages are clear in terms of better decision-making on the spot, but it will also raise major social distress, not because of the augmented reality part, but because of the video-capture feature. We will not only have Google Glass-free zones everywhere, but also *personal anti video firewalls* around our body, protecting us from spying.”

“Technology Shabbats” might be habit-forming

Tiffany Shlain, creator of the AOL series, *The Future Starts Here*, and founder of The Webby Awards, responded, “‘Can we talk?’ will have new meaning. Finally, the refrigerator will talk to my smartphone to tell it I need to order milk before I am out. Finally, my toothbrush will tell my dentist if it detects something that needs fixing. There will be ‘blinking’ instead of ‘clicking,’ of course. But what will not change is focused attention on the people that you love. I personally unplug one day a week with my family for what we call our ‘technology Shabbats.’ These will become much more essential as there are less boundaries for when people are “on.”

The problem: “Users are just another category of things”

Marc Rotenberg, president of the Electronic Privacy Information Center, urged, “The problem with the Internet of Things is that the users are just another category of things. It is worth thinking more deeply about in the future. By 2025, the more interesting question will be how the Internet is interacting with people, not how people are interacting with the Internet. Google Glass is already part of Google’s sensory network, with all images and sounds that the user obtains sent onto Google’s servers for storage and analysis.”

There may be a “prototype” for thought control by 2025

danah boyd, a research scientist for Microsoft, responded, “We will not just be turning to the computers in our pocket (aka phones). Instead, computing will be all around us. I’m not sure that these technologies will be seamless by 2025, but I hope so. (Google Glass is, after all, popularizing technology that was first created in the 1990s and first imagined in the 1960s.) I think we’re a long way from thought-control, but there may be a prototype for basic things by 2025. And hopefully, there will be technology for paraplegics.”

In our effort to make devices easier to use today, we may have over-complicated our future interfaces

Amy Webb, a digital media futurist and the CEO of strategy firm Webbmedia Group, wrote: “We will soon have hundreds of computer-powered devices that we can command just with our voices: our phones, our clocks, our cars. Unfortunately, the future won’t materialize as it did in Star Trek, where a single galactic federation of developers and linguists contributed to a gigantic matrix of standard human-machine language to build a Universal Translator. In the real world, the people working on human-to-machine voice interfaces can’t even decide on an acronym. Depending on the researcher, it could be called SR (speech recognition), or STT (computer speech recognition to text) or ASR (automatic speech recognition). Today, we’re creating a problem that won’t be fully realized until 2025. Voice controls are being developed independently by entrepreneurs and large corporations, and that means we won’t have a single standard. This will result in our having to know myriad voice commands, or in effect, having to learn how to speak different computer dialects. There’s a push to get more uniformity across platforms, but for the most part that kind of standardization is only within a company, such as Google or Microsoft, not across all the platforms and devices that are coming into existence.”

About this Canvassing of Experts

The expert predictions reported here about the impact of the Internet over the next ten years came in response to one of eight questions asked by the Pew Research Center Internet Project and Elon University's Imagining the Internet Center in an online canvassing conducted between November 25, 2013, and January 13, 2014. This is the sixth *Future of the Internet* study the two organizations have conducted together. For this project, we invited more than 12,000 experts and members of the interested public to share their opinions on the likely future of the Internet and 2,551 responded to at least one of the questions we asked. Nearly 1,600 responded to this open-ended question about the Internet of Things and wearables.

The Web-based instrument was fielded to three audiences. The first was a list of targeted experts identified and accumulated by Pew Research and Elon University during the five previous rounds of this study, as well as those identified across 12 years of studying the Internet realm during its formative years. The second wave of solicitation was targeted to prominent listservs of Internet analysts, including lists titled: Association of Internet Researchers, Internet Rights and Principles, Liberation Technology, American Political Science Association, Cybertelexcom, and the Communication and Information Technologies section of the American Sociological Association. The third audience was the mailing list of the Pew Research Center Internet Project, which includes those who closely follow technology trends, data, and themselves are often builders of parts of the online world. While most people who responded live in North America, people from across the world were invited to participate.

Respondents gave their answers to the following prompts:

The evolution of embedded devices and the Internet/Cloud of Things—As billions of devices, artifacts, and accessories are networked, will the Internet of Things have widespread and beneficial effects on the everyday lives of the public by 2025?

Please elaborate on your answer. Describe the evolution of the uses of embedded devices, “wearables,” and scannables by 2025—where will commercial and social applications of the Internet of Things most commonly and vividly be felt? What social and political difficulties will accompany the rise of the Internet of Things? If you answered “no” please discuss what you believe the barriers are to the spread of the Internet of Things and the benefits that are claimed for it.

Bonus question: Consider the ways in which people will most commonly interact with the Internet in 2025 and tell us what you think the fate of wearable connected devices such as Google Glass and the Samsung watch will be. What do you think of the future

prospect that people will interact via their thoughts or other bodily signals such as eye movements?

Since the data are based on a non-random sample, the results are not projectable to any population other than the individuals expressing their points of view in this sample. The respondents' remarks reflect their personal positions and are not the positions of their employers; the descriptions of their leadership roles help identify their background and the locus of their expertise. About 84% of respondents identified themselves as being based in North America; the others hail from all corners of the world. When asked about their "primary area of Internet interest," 19% identified themselves as research scientists; 9% said they were entrepreneurs or business leaders; 10% as authors, editors or journalists; 8% as technology developers or administrators; 8% as advocates or activist users; 7% said they were futurists or consultants; 2% as legislators, politicians or lawyers; 2% as pioneers or originators; and 33% specified their primary area of interest as "other."

About half of the expert respondents elected to remain anonymous. Because people's level of expertise is an important element of their participation in the conversation, anonymous respondents were given the opportunity to share a description of their Internet expertise or background.

Here are some of the key respondents in this report:

Rob Atkinson, president of the Information Technology and Innovation Foundation; **Fred Baker**, Cisco Systems Fellow; **danah boyd**, a social scientist for Microsoft; **Stowe Boyd**, lead at GigaOM Research; **Bob Briscoe**, chief researcher for British Telecom; **Robert Cannon**, Internet law and policy expert; **Vint Cerf**, vice president and chief Internet evangelist at Google; **David Clark**, senior scientist at MIT's Computer Science and Artificial Intelligence Laboratory; **David-Michel Davies**, executive director, The Webby Awards; **Glenn Edens**, research scientist at PARC and IETF area chair; **Jeremy Epstein**, a senior computer scientist at SRI International; **Bob Frankston**, Internet pioneer and technology innovator; **Jonathan Grudin**, principal researcher for Microsoft; **Joel Halpern** a distinguished engineer at Ericsson; **Jim Hendler**, Semantic Web scientist and professor at Rensselaer Polytechnic Institute; **Jeff Jarvis**, director of the Tow-Knight Center at the City University of New York; **Michael Kende**, professional economist; **Mike Liebhold**, distinguished fellow at the Institute for the Future; **Geoff Livingston**, author and president of Tenacity5 Media; **Isaac Mao**, chief architect of Sharism Lab; **John Markoff**, senior writer for the Science section of the *New York Times*; **Ian Peter**, pioneer Internet activist and Internet rights advocate; **Raymond Plzak**, former CEO of the American Registry for Internet Numbers, now a member of the board of ICANN; **Jason Pontin**, editor in chief and publisher of MIT Technology Review; **JP Rangaswami**, chief scientist for

Salesforce.com; **Howard Rheingold**, pioneering Internet sociologist and self-employed writer, consultant, and educator; **Mike Roberts**, Internet Hall of Famer and longtime leader with ICANN; **Marc Rotenberg**, president of the Electronic Privacy Information Center; **Paul Saffo**, managing director of Discern Analytics and consulting associate professor at Stanford; **Henning Schulzrinne**, a member of the Internet Hall of Fame, IETF leader, and professor at Columbia University; **Doc Searls**, director of ProjectVRM at Harvard's Berkman Center; **Patrick Stack**, manager for digital transformation at Accenture; **Hal Varian**, chief economist for Google; **Amy Webb**, CEO of strategy firm Webbmedia Group; and **David Weinberger**, senior researcher at Harvard's Berkman Center.

Here is a selection of other institutions at which respondents work or have affiliations:

Yahoo; Intel; IBM; Hewlett-Packard; Nokia; Amazon; Netflix; Verizon; PayPal; BBN; Comcast; US Congress; EFF; W3C; The Web Foundation; PIRG; NASA; Association of Internet Researchers; Bloomberg News; World Future Society; ACM; the Aspen Institute; Magid; GigaOm; the Markle Foundation; The Altimeter Group; FactCheck.org; key offices of US and European Union governments; the Internet Engineering Task Force; the Internet Hall of Fame; ARIN; Nominet; Oxford Internet Institute; Princeton, Yale, Brown, Georgetown, Carnegie-Mellon, Duke, Purdue, Florida State and Columbia universities; the universities of Pennsylvania, California-Berkeley, Southern California, North Carolina-Chapel Hill, Kentucky, Maryland, Kansas, Texas-Austin, Illinois-Urbana-Champaign, the Georgia Institute of Technology, and Boston College.

Complete sets of for-credit and anonymous responses to this question can be found here:

http://www.elon.edu/e-web/imagining/surveys/2014_survey/2025_Internet_of_Things.xhtml

http://www.elon.edu/e-web/imagining/surveys/2014_survey/2025_Internet_of_Things_credit.xhtml

http://www.elon.edu/e-web/imagining/surveys/2014_survey/2025_Internet_of_Things_anon.xhtml

Main Report: An In-depth Look at Expert Responses

A large majority of the technology experts and engaged Internet users who responded to this canvassing—83%—agreed that the Internet/Cloud of Things and embedded and wearable computing will have widespread and beneficial effects by 2025.

Most of the responses shared in this report are from people who took credit for their remarks, but a few of them are from anonymous participants. Slightly more than half of the respondents to this question elected to remain anonymous. Because people’s expertise is an important element of their participation in the conversation, anonymous respondents were given the opportunity to share a description of their Internet expertise or background and when they chose to do so their quotes are credited in that way and that material is cited here.

This report is built around an extensive sampling of the most thoughtful, provocative, and contrarian commentaries from respondents, which totaled over 200 pages of material. They are grouped under the major themes in the responses.

Theme 1) The Internet of Things and wearable computing will progress significantly between now and 2025.

A significant number of respondents said the Internet of Things is well under way already now and there will be much more development by 2025. **Joel Halpern**, a distinguished engineer at Ericsson, responded to our questions, “As devices become smaller, lower power, and easier to interact with, the effect will be pervasive. The environment itself will be studded with sensors that can provide accurate and useful information. People moving through the environment will find it easy to find information, objects, people, and situations of interest. This is likely to result in far more efficient resource utilization and far more robust environments. For example, bridges with sensors will know how much they are being used, how much they are wearing out, and will provide real-time information to people about conditions. At the same time, this amplifies... problems.... If everything is connected and communicating, everything we do is potentially known. We will likely have to accept somewhat (maybe even much) less privacy, even as I hope we take steps to ensure we do have some privacy. And the current email spam problem will be dwarfed by the efforts of business interests to provide us ‘information’ guiding us towards their commerce. One of the other challenges is... there is significant risk that these tools can heighten the degree to which those with resources are in an advantageous position to control and manipulate more resources, relative to those without.”

Mike Roberts, Internet pioneer and longtime leader with ICANN and the Internet Society, responded, “There is a long list of areas where public and private welfare will be enhanced by

instant, two-way access via the Net. Health applications are legion and beginning to attract attention. Progress will be greatly aided by subcutaneous sensors capable of doing ‘vital signs’ and transmitting that information to medical professionals. It could impact almost everything to do with transportation—think of millions of hours of commute waiting that can be improved. The currently stalled ‘automatic train control’ system based on Internet GPS access, among other things, will measurably improve safety, reliability, on-time performance, etc. I could go on and on. Consider the millions of almost nanoscale micro lenses we already have in digital cameras. Manufacturing will be brought to astounding levels of precision and performance for pennies. I had a dream the other night that my electronic avatar was telling me his tactile skin fabric was ‘itchy.’ Consider also the high level of scholarly inquiry and research into the nature of what we call self-awareness or consciousness. This is clearly an electronic construct within our maze of neurons. In other words, most of what it is to be a carbon life form called homo sapiens will be disclosed within living human lifetimes, and non-carbon based electronic analogs will not be far behind.”

Alex Halavais, an associate professor of social and behavioral sciences at Arizona State University, predicted, “More than any other change to our information environment in the next ten years, the increase in embedded and worn technologies will mean vast increases in information about our daily lives is made available. Harnessing that data will be a greater challenge. At a personal level, this will vastly change how we tackle problems and remember things. Just as today we no longer remember telephone numbers, in the coming years, we will find it harder to place other sorts of information that are more easily stored and transmitted via sensor networks. At the social level, this means new kinds of predictive analytics in a range of institutions, from consumer behavior to health.”

David Weinberger, senior researcher at Harvard’s Berkman Center for Internet and Society, pithily observed, “Everything is a sensor for everything else.”

Robert Cannon, Internet law and policy expert, wrote, “Will it have beneficial effects? Certainly. Will it be beneficial on balance when weighing the negatives—that’s another question. But what we already see in the Internet of Things is an empowerment of humans who wish to do something to get that something done. Humans seeking exercise are now greeted by a plethora of devices that can help monitor their progress, mark their achievements, and show their improvements. This technology can build on these goals, placing the humans in communities of like-minded individuals seeking the same goals, reinforcing the culture. It makes technology ubiquitous, so that the advantages of technology are in the field and not just on the desktop. Sensor nets can be used to measure progress for social policy goals (is this road moving traffic efficiently; are these lights working; where is the storm causing problems?). Cars will be able to interact, sharing information on traffic conditions, reducing traffic problems and fuel consumption.”

Mike Liebhold, senior researcher and distinguished fellow with the Institute for the Future, predicted, “Adaptive ensembles of wearable and embedded devices will be commonly applied by 2025 for fashion, entertainment, communications, health, fitness, productivity, facilities, and the environment. Both Google Glass and Samsung watches are very early, crude prototypes for much more interesting and useful devices that will be widely used by 2025.”

The publisher of *Innovation Watch* wrote, “Everything will have intelligence, increasing economic efficiency and productivity, and reducing risk through real-time sensing of the environment. Robots will become mainstream. An economic revolution will result, with both positive and negative consequences. A radical, new economy will emerge. Many new jobs will be created, but many more will be destroyed. Economic inequality will increase as entrepreneurs are rewarded and wage pressure and unemployment continues to hollow out the middle class. This will increase the level of social unrest. The next convergence is brain-machine interfaces, where people will be able to control devices with their thoughts. Silicon chips may be embedded to repair or augment the brain. Internet traffic between connected devices (including robots) will far outweigh the traffic that is generated by people.”

Patrick Stack, manager for the digital transformation group of Accenture Interactive, predicted, “Nearly everything in daily life will have a connected application associated with it. We can think of each person as a plug and each part of life as a socket—when you move from your bedroom to your kitchen to your car to your workplace and back again, each step along the way will be able to recognize your common identifier and tailor your experience accordingly. Marketing applications will be more restricted and subtle due to strong consumer resistance to in-your-face advertising, but experiences associated with already-purchased products will be ever-present. The transition will be relatively seamless and accompanied by little resistance, with the exception of very loud annoyance at marketers who intrude too far.”

Jason Pontin, editor in chief and Publisher of MIT Technology Review, responded, “Sensors and embedded devices in the ordinary fabric of life (the ‘Internet of Things’) will become commonplace sooner than widespread acceptance of the wilder wearable devices. That’s because the Internet of Things has clear economic advantages and is already changing our urban structures.”

A computer-training director said, “Embedded technology in each ‘thing’ will obviate the need for specialized devices to interact with them.”

The co-founder and principal of a business strategies firm said, “The Internet of All Things will allow ubiquitous information to be obtained at any time ... With universal access to information, societies will be compelled to change in ways that will normalize human rights and dignity and will

eradicate most forms of discrimination, beginning with access to education for all girls worldwide.”

Amy Webb, a digital media futurist and the CEO of strategy firm Webbmedia Group, said, “The real benefit of M2M interactions will be realized once artificial intelligence and smarter predictive algorithms are applied, since that combination will ultimately bring consumers greater efficiencies for everyday living. IoT’s promise isn’t just about the refrigerator and milk carton talking to each other and alerting the consumer that she needs to visit the grocery store. Rather, it’s the refrigerator knowing that a consumer is out of milk and querying her real-time personal health records to infer whether Amazon should same-day deliver 2% or skim. And then making the milk appear before she returns home from work.”

Avery Holton, an assistant professor and researcher at the University of Utah, wrote, “Imagine a watch that can calculate your location (GPS), tell you how far you’ve run, at what pace, how many calories you’ve burned, what your sleep cycle is, how hydrated you are, etc. Oh wait, we already have those. Now integrate that with text capabilities and phone capabilities. We already have that, too. Now add in tailored information and wearable devices that can sense harm, such as threatening weather, criminals in the area, or even health issues....that’s the future of these devices. They have to become more seamless as wearable items, meaning they don’t stick out quite as much. They must also find a way to address security and privacy issues, which continue to plague their adoption.”

A former DuPont electrical engineer responsible for electro-mechanical product safety compliance commented, “Our bodies will contain all our personal information once security means and methods can be worked out. Those security methods will involve biological interfaces (eye scans, body recognition, etc.) before they can be widely adopted. I’ll have the ability to communicate with anyone, securely, at a moment’s notice, as well as give them information about me, what I’m doing, and where I am.”

Jeremy Epstein, a senior computer scientist at SRI International, responded, “The benefits will be all the things now being discussed—medical monitoring, perhaps crime-fighting, maybe things like eliminating cashiers in stores. Go in a store and try on a shirt; if you wear it out of the store it gets automatically detected and charged to your account, having been implicitly purchased. Of course, there will be fraud, as some people will figure out how to get out of a store without the detection, but this will be wrapped into the cost, just as theft is today—thieves will have to go upscale in how they attack detection systems. There will be some pushback for privacy reasons, but eventually, consumers will give in, since it will drive costs down.”

Frank Feather, CEO and chief trend tracker for Future-Trends.com, wrote, “The Internet of Things will become pervasive, creating an almost totally-connected society, including globally. We will be close to a situation where all the global population will have access to all the world’s information—and to everyone else—using any device, including wearables. In an anyplace/anytime/real-time world, anyone will be able to access any public database, any product/service provider, any government agency or politician, and everything that belongs to them personally, via such devices. This will be fairly commonplace by 2025. All devices will be multi-lingual, instantly translating any conversation or text to ease clear communication, as well. Everything will be decentralized across a global network. A university degree will be able to be taken ad hoc, one course here and there, from any online learning institution on the planet. Social movements will spring up and disband with ease. Governance systems will be under serious pressure to modernize and become agile and innovative.

Robert Furberg, an international senior clinical informaticist, wrote, “For the first time in many areas of social and behavioral sciences, investigators will face new types of data from never-before-seen quantities of information, enabling dramatic progress in advancing the core methods of these disciplines. We will need to develop new ways of capturing, curating, analyzing, interpreting, visualizing, and protecting these huge volumes of data that will be produced; however, the same forces that present such a tremendous opportunity pose critical challenges to our modern day processes, research ethics, and policies.”

Nicole Ellison, an associate professor in the School of Information at the University of Michigan, predicted, “As wearable data collection devices become cheaper, smaller, and more sophisticated, they will be used increasingly to provide micro-feedback to users about the health, economic, and environmental implications of their actions. The information will be used to decide between everyday behavior choices, for which the consequences are now obfuscated. For instance, should I turn my car off while I do a quick errand, or let it run? Which of these two brands of coffee treats its workers better? Which of these two lunch options is best for my specific health profile? With more ‘just in time’ information, consumers will be able to make more informed ethical, economic, and health-related decisions.”

Michael Kende, professional economist, wrote, “Having been an early adopter of the Pebble, there is no question that wearable devices will be significant, but they may need another generation or two of growth to be truly usable. Combined with AI and smart agents, they will be able to output key information for us, without requiring detailed input from us, by combining an understanding of our environment (where we are, what we are doing) with a detailed understanding of our habits, preferences, and activities (from our calendar, emails, etc.). On a technical side, this will require a move to IPv6, so there are enough IP addresses for the new devices, alongside a comprehensive privacy structure regarding the use of this new information.”

Jonathan Grudin, principal researcher for Microsoft Research, responded, “The greatest challenge in utilizing embedded devices is powering them. As power requirements drop and efforts to harvest energy efforts bear fruit, we could see a breakthrough by 2025. Inexpensive light-powered ‘solar energy’ hand calculators were common 25 years ago, so we should get there. Until we do, wearable devices can harvest energy from our movements, which will also take us close to data collection points for transmission or scanning.... Any device run on electricity represents an opportunity for sensors and effectors to assist or work symbiotically. The commercial potential is great—providing new services or encouraging upgrades to existing devices and services.”

Bob Kominski, a demographer and sociologist who works for the US government predicted, “These objects will only become more ubiquitous over time. To know where your child is at any moment; to have immediate assistance wherever you are; to be able to instantly access any piece of information—including your own personal information—these are all things many people want and will pay for. The key is ‘pay for’—no too many people want a \$3,000 phone—just about everyone will use a \$10 phone. And the more we move to 100% acceptance, the more powerful/useful the integrated system becomes to everyone. So, in essence, getting everyone to ‘buy in’ is the greatest challenge *and* greatest utility.”

Stuart Chittenden, founder of the conversation consultancy Squishtalks, wrote, “From automated payment systems that diminish personal theft, to inbuilt medical devices monitored and mediated by automated controls and response systems, to personal lifestyle data collectors, and educational things—these are all sorts of commercially exploitable opportunities. My main concern is that the question asks about ‘beneficial effects,’ which I can see with such devices, though the diminution of the human experience, our uniqueness, and interaction with the world around us, may be at risk, too. Many things will be wired into the Internet. We won’t carry the Internet around in our pockets (i.e., smart phones); we will live our lives ‘within the Internet.’ I don’t mean a scenario like *The Matrix* films, but rather everything around us will be designed with the Internet woven into it, whether in our interactions with it, its modulation of itself and our environment, or its capturing and data collection of the environment.”

Pamela Wright, chief innovation officer for the US National Archives, predicted, “Previously acceptable social lies will become more difficult to impossible because you will be constantly tracked and known by the Internet. ‘Hey, you said you were out of town this weekend, but your bed reported that you got eight hours of quality sleep Saturday night at home. And your wine bottle confirmed it.’ We will know more about our society as a whole based on statistical data flowing out of the wearable and embedded devices. Data points about our health, spending habits, everything we do, will provide a clearer picture of our needs as a society. Poverty, public health, crime, and much more will be easily tracked. In general, we will have more facts to inform our decisions. Politicians will probably twist those facts as much as they always have. People will be

able to know more very easily. When they look at a monument, rather than wondering who the guy on the horse is, and what did he do, they will easily see information that provides historical depth and knowledge about it. Same for everything from trees to buildings—all things will have more information available, including historical data. The ignorance that we live with now will be unacceptable to those in the future, and they will look on this time as we look on the time before the written word.”

Alf Rehn, chair of management and organization at Åbo Akademi University, Finland, wrote, “Some Google Glass-like product will be ubiquitous, making social life even more annoying than it is today. On the plus side, things will be ever easier to find. The killer app will be the global UmbrellaNet. It always knows where your umbrella is. At some point, user interfaces become too neat and friction-free. There is still much to be said for old-school controllers and keyboards. The future looks more like an Xbox controller than *Minority Report*.”

Glenn Edens, research scientist at PARC and IETF area chair in networking, distributed systems and security, wrote, “This is the most exciting development space in the entire Internet ecosystem. Devices are becoming powerful on their own, or able to use Cloud-based services to add computing power. There is now enough computing power to provide better and more responsive user interfaces. This will happen faster than progress in AI and robots.”

The biggest impact by 2025 will be found in machine-to-machine interfaces, where devices talk to each other, rather than in human-centered communication.

A noteworthy share of respondents argued there will be a big increase in the use of the Internet to accomplish tasks that keep things flowing for humans but are not obvious most or all of the time to the general public—in machine-to-machine or M2M interfaces.

Rob Atkinson, president of the Information Technology and Innovation Foundation, responded, “The biggest impact will not be wearables, but rather, things in the physical world connected to the Internet. As the world becomes intelligent, things like transportation, infrastructure, logistics, health care, etc., will all improve. I don’t believe that there will be any social difficulties. There may be political ones, as neo-Luddites resist such technologies.”

Henning Schulzrinne, a member of the Internet Hall of Fame, technology developer, and professor at Columbia University, observed, “The likely impact may well be pervasive—and small. Many of the applications will be behind the scenes—i.e., a towel dispenser or trashcan that alerts maintenance personnel that it needs attention, or a way to track public transit arrivals, or replacements for ‘dumb’ temperature and air quality sensors in commercial buildings.”

Bob Briscoe, chief researcher in networking and infrastructure for British Telecom, wrote, “The vision of the disappearing computer is unlikely to have been realised by 2025 because we will still be in the early, clunky days, when interaction with the Internet of Things will still be unnatural and stilted. The most likely areas where the Internet of Things will be realised will be in supply chain logistics and automating workforce administration—i.e., dispensing healthcare, logging materials used in fitting and service of goods, vehicles, etc., as well as the administration of cleaning, catering, and hospitality tasks. Industrial and commercial applications are much more likely to have taken hold than these attention-grabbing consumer widgets, which have only superficial economic effect. Regarding interaction via thoughts and bodily signals, see my earlier answer about killer apps, which said that linked intelligence (based on the blurring of the division between local and remote senses) could have developed by 2025.”

Mícheál Ó Foghlú, CTO of FeedHenry, wrote, “The Internet of Things is more likely to impact where the devices talk to each other, rather than to people—in the automation of construction, in smart buildings, and so on, where sensors communicate in a network and only alert people when needed—i.e., earthquake alerts.”

Some respondents reported that they expect that wearable computing that is visible could be seen as “uncool” by 2025.

Bright Simons, president of Psynthax Corporation, wrote, “It is yes and no, really. In many ways, more powerful peripheral devices, superior bandwidth capacity, and massively powerful Cloud-based applications should all work together to enhance the holographic elements of personal artefacts, to the point where wearable computing looks increasingly outdated as a way of harnessing the new forms of computing power. What we will see more of is ‘seamless services’ that enable people to move digital into the unobtrusive background, not accentuate our seeming dependence on devices. The wearable computing focus is misguided. People will find it more and more uncool to flaunt commodities, which is how these devices increasingly come across. Greater personalisation and emphasis on style should shift the augmentation of personal and home computing to the background, with a greater emphasis on seamless services, such as nutrition, hygiene, and lifestyle, rather than on the features of devices.”

Minority view: Not so fast. There are hurdles to be overcome and a group of respondents argued there is likely to be only slow progress by 2025, despite today’s trends and enthusiasts’ optimism.

Some respondents were less optimistic—saying the 2025 advances mentioned in our question will be unevenly achieved—and a few pooh-poohed the Internet of Things. They shared a variety of reasons for their pessimism.

Joe Touch, director of the USC/ISI Postel Center, pointed out the difficulty in establishing universally accepted, standardized, secure systems. “The Internet will continue to be more deeply integrated into our daily lives,” he observes, “but we will increasingly expect to be able to control that integration. Right now, many ‘Internet of Things’ devices derive their connectivity through commercial servers that both track and create security vulnerabilities; unless Internet of Things evolves to a true ‘Internet’ of things—rather than a set of walled gardens, each requiring logins—I am skeptical it will continue to evolve.”

John Senall, principal and founder of Mobile First Media, LLC, predicted that there will be trust issues, saying, “Wearables will gain traction in adoption, but for years it will likely be for more trivial uses, doing far less to increase personal or corporate productivity. Leaders in the field will offer beneficial apps for usage of wearables in time to create enough demand for continued evolution in the field. The safety risks and privacy concerns, however, will delay much adoption in the early years.”

Isaac Mao, chief architect of Sharism Lab, wrote, “No doubt, there are more problems to be solved first before wearable things are to be adopted. The conflicts between devices, function redundancy, safety, health, etc., would be very relevant.”

Fred Hapgood, a self-employed science and technology writer, responded “The Internet of Things will, in time, be huge, but working out the interfaces and then standardizing them is a huge job. Institutions, especially educational institutions, would love to have central control over all the door locks in their structures, and there are companies that perform that service, but I have never run into an actual installation.”

Brad Templeton, a leader with the Electronic Frontier Foundation and Singularity University, responded, “There will be many effects, though they won’t be huge—not on the scale of what the Internet brought to society. Rather, they will be improvements in convenience and efficiency. Software and devices will work better, more smoothly. In some cases, that will make a big shift, as sometimes it takes making things easy to use before there is wide adoption.”

The word “hype” was emphasized by several of the Internet of Things doubters, including **Bill St. Arnaud**, a self-employed green Internet consultant. He was skeptical of most of the form factors now being predicted to be most popular in the next decade, writing, “The Internet of Things has been in the red zone of the hypometer for over a decade now. Yes, there will be many niche applications, but it will not be the next big thing, as many pundits predict. If the Internet of Things had any true validity, you would think you would start to see evidence of its presence on early adopter Internet networks, such as R&E networks, universities, research labs, etc. The Internet of Things is headed to the dustbin, along with Semantic Web, virtual spaces, etc. Google Glass and

the Samsung watch are gimmicks, and in the case of Google Glass, are likely to be banned for safety reasons. Interacting with thoughts or eye movements will be worse than voice interaction. Remember all the hype a decade ago that we would all be talking to our computers or tablets? We are still waiting for that technology to work—never mind hand gestures and/or thoughts. Complete silliness.”

Fred Baker, Internet pioneer, longtime leader in the IETF and Cisco Systems Fellow, responded, “In my view, the Internet of Things is both very real and the subject of an incredible degree of hype. For example, I can replace the control system for lighting and air conditioning in a building with communicating devices, and in coming years, will likely do so. However, that does not mean that I will open my home or office to unauthorized use of the capability, but instead, I will very likely put it in the hands of a local controller that an authorized party might access remotely, if at all. So, yes, there will be billions of communicating devices, but no, they will not be communicating amongst themselves in an uncontrolled fashion. The place in which we can expect to see social issues—and are starting to see them now with Google Glass—relates to trust, and privacy. If engines such as those being developed by Face++ can use crowdsourcing to impose continuous, pervasive surveillance as a social reality, expect people to push back on obvious sources of information useful to crowd-sourced data mining.”

Steve Jones, distinguished professor of communication at the University of Illinois-Chicago, responded, “Most everything that can have some sort of connectivity, whether it’s RFID or Bluetooth or whatever, will do so. Managing it will be an interesting challenge, from the standpoint of the technology (i.e., doling out bandwidth, IP addressing, frequency, and other forms of communication conflicts, etc.). From the standpoint of users, the issue will be how to get all of it to work, what to do when it doesn’t work, whether to rely on it, etc. And from the standpoint of the social-political-economic, the issue will be will it be secure, can it be tracked, will certain brands/devices go out of business/no longer be supported, etc. This is potentially more fraught than the diffusion of the Internet because most of this technology will operate without direct user input, with users unaware.”

David Hughes, an Internet pioneer, who from 1972 worked in individual to/from digital telecommunications, said the advances mentioned in the question can be achieved by 2025 if development evolves efficiently. “Yes,” he wrote, “though there will have to be a ‘parallel’ to the current ‘communications’ Net—an Internet to link up all the devices people will buy to make their lives better for ‘life, liberty, and the pursuit of Happiness.’ ... An endless need for improvement in connectivity, reliability, and power will spawn a huge industry.”

Kathryn Campbell, managing partner at Primitive Spark is hopeful that the details of connectivity painted in the question’s 2025 scenario can be worked out, observing, “We’re already

experiencing the benefits of connected devices related to health and wellness, and these individual successes will continue. The challenge will be—as it always is—with the connectivity between devices. Will our consumer electronics manufacturers, auto makers, and building contractors agree on industry standards, and thereby create a boom for all, or continue to fight territorial battles over proprietary technologies in which everyone (including consumers) loses? It’s been decades since the ‘imminent’ success of smart homes and connected televisions were first heralded, yet each is still struggling to gain traction for this reason. Increased connectivity is inevitable, and by 2025, all of our personal devices will be ‘smart.’ Data collection that now requires bulky physical sensors will be embedded within our bodies, and screens will be replaced by ubiquitous surfaces, upon which any data desired can be projected.”

People will continue to say ‘no’ to the programmable fridge and just say ‘yes’ to keyboards; wearables and the Internet of Things are not likely to have widespread *visible* effects on people’s everyday lives.

While the majority of participants said connectivity will be advanced through the Internet of Things and embedded and machine-to-machine computer networks in the coming decade, there were quite a few people who predicted humans’ points of contact will not change significantly by 2025. Many picked on previous prognostications for networked appliances.

Bob Frankston, Internet pioneer and technology innovator, responded, “Actually, the Internet of Things is a joke, as I explained in <http://rmf.vc/CILight>. Wearables are a very old idea, and many of the stories are—like the talking toasters in the future circa 1960. WTF do you think the Internet is? This is old, old news.”

A principal engineer at Cisco wrote, “Smart toasters, fridges, roadways, etc., are not a long-term play. People just really aren’t that geeky.”

An information science professional complained, “What I worry about is that the data will be used and manipulated by larger interests—insurance, etc. I’d love to have my refrigerator text me when I was low on something, but if I had a car accident, would my beer consumption (fridge stats, grocery loyalty cards) be used against me? (You’d be surprised if you knew me to hear me be as negative and nervous about corporate Big Brothers and nanny states as I am being in this survey, but I worry about the arc of the Internet’s future.)”

Jonathan Sterne, a professor at McGill University, responded, “Few innovations in consumerism over the last 50 years have greatly improved people’s lives in terms of happiness, security, comfort, or life expectancy (there are a few exceptions). The fact that my fridge can tell me it’s out of milk will not transform humanity. If instead, you asked what would improve people’s

lives around the world, I don't think gadgets would be the first answer from a concerned person's lips."

When theorizing on the likely form of future computing interfaces, some respondents said the effectiveness and efficiency of the traditional keyboard can't be replaced by anything on the horizon right now.

Tim Bray, an active participant in the IETF and technology industry veteran, wrote, "I really don't sense that many really life-changing benefits from putting what we now think of as dumb devices online. The central unsolved problem is input. At the moment, nothing is remotely competitive with a nice modern keyboard for pouring your words into the networked continuum. Since I tend to agree with Chomsky that human intelligence is language-based, it's the words that matter. I have no urge to start talking to computers, and the notion of interacting based on anything other than language seems wrong-headed."

Christopher Wilkinson, a retired European Union official, board member for EURid.eu, and Internet Society leader, said, "The Internet of Things will be—and should be—essentially, an industrial application. In any event, unless IPv6 is implemented, the Internet of Things will be stillborn. People already interact through body language and eye movements. What's new? The general quality of interaction by mobile and 'smart' devices is deteriorating, mainly because of the difficulty of expressing oneself. I am not interested in an Internet interface where I cannot touch-type several pages of text."

Human attention and human intentions are key to future success of wearables and the Internet of Things.

Human attention is the scarce and rare resource in the world ahead, some participants wrote. They believe that the Internet of Things will reshape human attention and how intentional people are. How users adjust to those new realities will determine how helpful or harmful the Internet of Things is.

Andrew Bridges, a partner and Internet law litigator and policy analyst at Fenwick & West LLP, said, "All sectors of society and the economy will feel the development," he predicted. "The principal social and political difficulties will have to do with ownership of information, privacy/security, and surveillance... Intention will always be a critical part of normal interaction of persons—they will still send texts or make phone calls and not just passively stream their experiences to others.... Given the massive amount of data that all persons will generate, both the most precious commodity and the most dangerous threat will be *attention*: what do people pay attention to? How do they rank the object of their attention compared to rival objects of attention? What attention is welcome, and what attention is unwelcome (surveillance)? Some interactions

may be so low-risk and benign that default settings may always be to communicate the data, but others will be more sensitive, and persons will want to make deliberate choices about them.”

Jerome McDonough, an associate professor at the University of Illinois, said, “Widespread effects are already occurring as companies start aggregating data from a variety of sensors and point-of-sale (POS) systems to improve targeting of advertising. Whether that is ‘beneficial’ probably depends on whom you talk to. People like to feel they are in control of their devices, and critical to any feeling of control of ICT is the ability to *disattend* the communication technology when you want to. The impact of Google Glass and related technologies is to make it difficult for you to disattend, and it is practically impossible for anyone you’re interacting with to disattend. This is not to say people won’t wear them, but I suspect you’re going to see technologies such as Google Glass worn more by people in lower wage jobs, who *have* to wear them as part of their employment, and much less so by people in upper management positions who get the privilege of not having to be connected all the time.”

Tina Glengary, director of strategy for Instrument, wrote, “Wearables will likely provide the greatest value in enhancing the seemingly mundane, and often repetitive, tasks. We will also need to determine personal comfort in making our personal data accessible. These devices and services will become more interconnected, rather than discrete services by specific companies. They will also become much more passive, either working in the background based on preferences or smartly learning our preferences.”

Will the capabilities afforded by the use of digital overlays and hyperconnectivity improve human interactions? Some people don’t think so.

Scott McLeod, director of innovation for the Prairie Lakes Area Education Agency in Iowa, responded, “By 2025, we will take many aspects of the Internet/Cloud of Things for granted. Whether these be wearable computing and/or sensors embedded in our environments, most of us will find that the convenience and empowerment far outweigh privacy/monitoring/tracking concerns. We will be interacting digitally with more aspects of our environment via voice, sight, biometrics, and other traditional, non-digital ways of interaction. In other words, our natural interactions with the world around us will now have a digital aspect overlaid on top that will enhance (and also diminish) those interactions.”

Karl Fogel, partner at Open Tech Strategies, president at QuestionCopyright.org, said, “No, yuck, we don’t need this, and most people aren’t asking for it. I’ve never been quite clear on where the demand is supposedly coming from. The scarce resource will continue to be human attention. There is a limit to the usefulness of devices that are worn in public but that demand attention

because it is often socially and practically unacceptable to give those devices enough attention to make them worth the trouble of configuring and interacting with.”

One thing most respondents agreed upon is a dislike for what has become known as a digital form of “creepiness.”

Annette Liska, a design director for a research and design company, wrote, “By 2025 we will cultivate an Internet—and thus connections—with the people we desire to be in that cloud, and keep away from those that make us vulnerable... The issue of trustworthiness is key; human beings don’t respond well to creepiness, unless it’s confined to art (movies, books, etc.). We may connect superficially with such tools, and the data communicated with them, but sincere trust is not possible if ‘over-mediated,’ which is what Google Glass does to our line of vision and natural sensory perception. Today, those with missing limbs or loss of control of their bodies are already testing prototypes to move or control their bodies with thoughts or impulses. Eye-tracking tools to study technology use have been widely available for years. Finding opportunities to further refine such tools in safe and social scenarios is likely a matter not of ‘if,’ but instead, ‘when.’ The success of such tools depends upon how much we are still able to naturally trust our own sensory instincts, instead of having them trumped by technology.”

Wearable computing will not cut it.

A cohort of respondents argued that issues related to wearable devices would hold back at least that portion of the advancement of the Internet of Things.

Ian O’Byrne, an assistant professor at the University of New Haven, wrote, “The future of wearables is in the awkward adolescent stage. I have a feeling we’ll be here for awhile. At some point, a product will come out that ‘just makes sense,’ and people will flock to have and use it. Until then, we’re all busy carrying around our Palm Treo.... I mean Google Glass.”

JD Lasica, CEO for Cruiseable.com and founder of Socialmedia.biz, responded, “I don’t want or need my refrigerator to order milk for me. Smart watches may catch on but will never approach the number of smartphones. Google Glass will be a commercial disappointment at the outset but will gain wider acceptance when it’s incorporated into existing fashion.”

Mary Joyce, Internet researcher and digital activism consultant, predicted, “Trivial wearable tech will be pervasive but will merely facilitate navel-gazing and consumption.”

Some participants said advanced, wearable, and highly networked computing technology may be developable but human factors will slow it all down.

Thomas Lenzo, a self-employed consultant for 30-plus years in the areas of training, technology, and security, wrote, “The first difficulty ... will be the end users. First, they have to be willing to integrate these things into their lives. That takes time, effort, and some cost. The second difficulty questions, ‘Who is scanning me, why are they scanning me, and what are they doing with the information?’”

Clifford Lynch, executive director for the Coalition for Networked Information (CNI) and adjunct professor at the School of Information at the University of California-Berkeley, said, “I see the use of embedded and wearable devices as quite separate from the Internet of Things but I believe that we will see both moving ahead. I am not sure about how the social norms here will evolve, and this could be a determining factor on adoption rates. I am also skeptical about how beneficial many of the effects will be for the average consumer. You may see much heavier use of embedded and wearable interface devices in work and business settings, at least early on, where the payoff is easier to see and the social norms are less relevant or easy to change (given a payoff in efficiency or capability).”

John Anderson, director of broadcast journalism at Brooklyn College, wrote, “The intersection of things with people is at the heart of this question. There are some constitutive norms regarding the use of this sort of technology that society still hasn’t settled on yet. From a purely consumptive standpoint, the technologies that permit mobile payment and subscriptions will advance to make that process more frictionless, but I have a hard time coming to grips with the idea of always-on monitoring checking Facebook on my sleeve. We’re approaching a threshold in cybernetics that might allow us to shorten the era of wearables. In addition to its most obvious medical applications, cybernetics will include devices for information access/retrieval and augmented realities. How we’ll grapple with that as a society is beyond me, though I think the gradual de-emphasis on 20th century notions of privacy will have significant implications here.”

While Samsung and Google were applauded by many participants for their experiments with wearable networked computing, many said the devices are not likely to be impacting most people’s daily lives by 2025.

Jonathan Grudin, principal researcher for Microsoft Research, responded, “I would not invest in Google Glass or the Samsung watch. I had friends 10 to 15 years ago who confidently predicted that by now we would all be walking around with dangling ear buds, and that has not happened. I can imagine very lightweight, thin, and, perhaps, flexible phones that attach aesthetically to sleeves, allowing a larger display than a watch, which fewer people are used to wearing anyway. Machines will certainly be able to utilize an awareness of our gaze direction, but I don’t expect people to delegate responses to eye movements, or thoughts to technology mediators. Severely disabled people will continue to benefit from these technologies, and detection could be part of the

care of the elderly or infants, but for routine communication by 2025, I would be surprised. Keep in mind that a decade essentially spans the advance of technology from the iPod to the iPhone 4, or Windows XP to Windows 8.”

John E. Savage, chair in computer science at Brown University and a fellow of the IEEE, and the ACM, wrote, “The relationship between humans and their environments has not changed as much as one would expect, given the ubiquity of computers and networks. The Internet of Things will have an impact on daily life, but it will not be a revolutionary one. Some services will be expedited and delivered in new ways, but the need to work, eat, sleep, and exercise will be the same and only marginally affected by the Internet of Things or the Cloud. Google Glass will continue to be a novelty. Technology of this kind has been in the experimental stage for at least 10 years without creating a compelling market for it. The Samsung watch will have a role to play, but it will not be a revolutionary one. Both the Google Glass and the Samsung watch will be in widespread use, but they will not revolutionize work or play because their screens are too small. Cursors on the Glass will be difficult to position and activate, and to operate the watch, one hand has to be disabled to read the screen.”

An anonymous respondent wrote, “You will never lose your car keys again—if you live long enough to experience the true ‘Internet of Things.’ Google Glass will fail. Google Retina Implants on the other hand....”

Of course, why buy a device by Samsung or Google if you can make a more personalized choice?

Rui Correia, director of Netday Namibia, wrote, “The Internet of Things is already happening—the extent to which such technologies become ubiquitous will be dictated by commodity adoption.... With the advent of personal 3D printers and diversification of material choice, I imagine a world where wearable, connected devices will be more personalised than ever before—the choice to make one’s own device may move many of us away from buying branded product—look at the rapid diversification of the uses of Raspberry Pi, for example—why should I buy Samsung if I could make my own?”

The daily lives of many will be enhanced by embedded sensors and wearable, networked devices, especially in regard to personal health.

In 2013, Pew Research [reported](#) that 72% of U.S. Internet users looked for health or medical information online at least once in the past year and 77% said they began their quest with a search engine. The experts in this canvassing clearly expect that by 2025 more people will be likely to consult much more personal results for initial health reports, feedback, and advice thanks to

wearable computing. Advances in sharing health information were clearly a most-mentioned sector of impact.

Rebecca Lieb, an industry analyst for the Altimeter Group and author, responded, “Healthcare is one of the most obvious areas that will benefit enormously from widespread adoption of connected devices, providing health care providers with better, timelier, and more accurate information about patients, as well as individuals with better options for care, monitoring, independence, and security. Consumers will benefit from easier shopping, with richer layers of data and information about products and services. All this comes, of course, with privacy and security concerns, as well as questions around what happens when these systems falter and/or fail once we’ve come to rely upon them.”

Larry Press, a writer, consultant, blogger and part-time professor, said, “There will be a decentralization in health care—tools for monitoring health and medical diagnosis will increasingly be in the hands of consumers, and there will be online services for them to report and analyze data. Today, we typically have a thermometer, scale, and, perhaps, a blood-pressure cuff at home. We will see online services for storing and analysing the data coming from these devices, and our routine doctor visits will often be done online. Google Glass-like devices will be used in all sorts of specific situations... Interaction via thoughts and bodily signals will be too slow and low-resolution for use by the general public in general-purpose applications, but they will be used by handicapped people.”

Rashid Bashshur, senior advisor for eHealth for the University of Michigan Health System, observed, “Embedded devices will become much smaller, less expensive, and less intrusive as a result of miniaturization and digitalization. These devices will have immense benefits in early and precise diagnosis and treatment of various diseases, as well as monitoring health status indicators of various kinds. Devices will be able to communicate with each other, and they will be capable of processing enormous amounts of information with a highly individualized focus. The forms, shapes, and functions of these devices cannot be predicated with any precision, however, these changes are inevitable. Various sensors will be developed to detect chemical, biological, and behavioral indicators of various kinds. These sensors will be much smaller, more versatile, and less expensive.”

S. Rodriguez, COO for MC&S IB and digital consultant, responded, “Basically, because they facilitate the day-to-day life of human beings, they will be increasing the efficiency. This includes the development of intelligent systems that allow people with serious injuries and sequelae of disease or injury to regain much of their former life, even in extremely severe cases. Also, they will allow humans to move in places or situations that are hostile or currently difficult to access, such

as extreme weather or outer space, the depths of water, or particularly inhospitable places. Likewise, they will facilitate telemedicine and telecare, education, and distance training.”

Breanne Thomlison, founder and president of BTx2 Communication, said, “The wearable device will track everything and be customized to how you want to see data, which data, and what to do with the data. Customers will have a choice to connect to corporations that are interested in their data and will ‘feed’ them products based on their results. For example, a kid who plays basketball will track how many shots he or she misses, and a shoe company may offer him or her new shoes to improve his or her shot. The Internet of Things will most be felt for consumers, who will call the shots on how they want all of their information. The social and political difficulties will blend. I expect that the consumer will have control and based on the evolution, there will be laws in place to protect privacy and ensure consumers are aware of what data is being used for what. Without that, there will be no support for global innovation. People will be ‘born online.’ They won’t know anything different. Eventually Google Glass and the Samsung watch will be obsolete, and people will have devices implanted in them and/or their clothes. Innovation will allow us to interact through thoughts and signals. This will be the key to helping treat people with mental health issues.”

Katie Derthick, a PhD candidate in human-centered design and engineering at the University of Washington, responded, “Ubiquitous computing will allow us to return our attention to the present moment, the environment, and ourselves—to the material and tangible aspects of living that are earth and company, rather than devices and form factors, and the intangible aspects that are spirit and relationship, rather than records and profiles. Boom boxes on shoulders were the future iPods with ear buds; laptops balanced on one arm were the future Charlie Brown-glance at the smartphone. Google Glass is the future virtual retinal display contact lens—for the privileged, of course. I think system interaction via thoughts at a fluid and workable state is more than 22 years off. But maybe it isn’t; 22 years is a long time in technology. A different paradigm for interaction will be a long time coming—automatic washing machines aren’t very different from wash basins, after all—but, yes, one day it will be more than waving your hands in the empty air; it will be smarter about who you are, where you are, and what you’re doing or trying to do, without you having to tell it.”

Beth Bush, senior vice president for a major healthcare professional association, wrote, “Healthcare will predominate. Applications/tools will be expected to be implantable and wearable to enhance life. The challenge will be how to upgrade and maintain. Identification will no longer be password-driven. A combination of intellectual and biological identifiers will become the genre.”

Linda Neuhauser, clinical professor at the School of Public Health at the University of California-Berkeley, responded, “People will be most interested in what these ‘wearables’ will

deliver in terms of their own lives. For some people, this will be the first time they have been able to manage an important health condition. They will aggressively seek these applications.”

Celia Pearce, an associate professor of digital media at the Georgia Institute of Technology, wrote, “Ubiquitous and wearable computing is already happening, and it will continue to expand... The greatest promise in this area that I see is in medical applications, and this will mostly go towards applications for senior citizens, to improve longevity and quality of life.”

Daniel Castro, director of the Center for Data Innovation, wrote, “The biggest impact from the Internet of Things will probably be in healthcare, where more data can enable better diagnostics and treatment. This will likely lead to better health care services that allow individuals to manage their own care, often with less direct intervention by doctors. Predictive analytics will help provide users the right information at the right time. This will involve interpreting lots of data including body movements, location, and voice commands.”

Some participants warned that the picture in regard to the measurement of health is not all rosy.

Deborah Lupton, a research professor on the faculty at the University of Canberra, Australia, responded, “Only certain individuals will want to voluntarily take up wearable tech to quantify the self... I am concerned about the dissemination of wearable technologies and other self-monitoring devices in medicine and healthcare, which I believe will grow particularly in response to economic imperatives to save money on healthcare. While these technologies have much to offer, they may begin to displace the human interaction and emotional support that so many people desire and need from the doctor-patient relationship. There are also significant implications for health insurance related to the use of wearable and embedded tech for health monitoring. If health insurance companies continue to incorporate these technologies and to charge higher premiums to those who either choose not to use them or do not meet set goals related to fitness and body weight etc., this raises major ethical and social discrimination concerns, given what we sociologists know about the social determinants of health and illness states.”

Karen Sulprizio, a marketing and business consultant, wrote, “Consumers want ease-of-use and are not accustomed to the kind of technology for instant information and gratification. The next generation of easy-to-use technologies will be the ‘wearables’ and ‘scannables.’ However, with that said, this will also open up the potential for cyber attack, if the security is not included/embedded in the devices. This topic is already being considered with wireless, Net-based medical devices. Remote access to these can allow a ‘hacker’ to control everything from heartbeat, release of insulin, as well as control of artificial limbs.”

Theme 2) The realities of this data-drenched world raise substantial concerns about privacy and people’s abilities to control their own lives. If many everyday activities are monitored and people are generating informational outputs, the level of profiling and targeting will grow and amplify social, economic, and political struggles.

A notable number of respondents posed future scenarios in which they described a continuing evolution of tech adoption for convenience’s sake, all at the cost of abandoning privacy, often for the sake of meeting corporate needs rather than larger public goods.

Larry Gell, director-general of the International Agency for Economic Development, wrote, “The public is not that dumb. The ‘Cloud’ sounds nice but is only a corporation’s huge bank of servers collecting your information. People will rebel against this (some are already), but if the corporations beat them to the game of locking them into their software and allow for no escape from their ‘Cloud,’ the corporations and governments win. I am betting on the corporations and governments winning that game. Why not, if someone can create the devices and make them work so people must have them? Peter Drucker said, ‘The only function of a company is to create a customer.’ The ultimate goal is get all people on a minute-by-minute-monitoring data-collection system. *Big data!* Of course, they will be billed monthly for such great and convenient service.”

John Hopkins, a university educator in social informatics, art, and activism, responded, “The Internet of Things, as another in a string of concepts that is posited as being the bringer of greater freedom, will simply allow those controlling the communication protocols to access and parse more and more detailed information on those participating in the system. Who will dictate the protocols that subsequently re-form people’s lives? Certainly not the general population, and this raises serious questions as to the meaning of freedom in general.”

Brenda Michelson, a self-employed business-technology consultant said, “As we willingly connect more data emitting things to third-party and public services, there is a greater likelihood that data can be used against us by bad actors, law enforcement, government agencies, and even insurers, contracted to act on our behalf.... Critical factors for the success of the Internet of Things at scale are an informed public, sensible policy, and trusted service providers.”

Greg Lastowka, a professor of law at Rutgers University, observed, “I can see the downsides of ubiquitous networks much more clearly than I can the upsides. If current popular uses of network technologies are any guide, wearable computing technologies will serve those offering the devices and controlling their algorithms just as much as they serve the wearers.”

Yalda T. Uhls, senior researcher at UCLA’s CDMC@LA, and regional director of Common Sense Media, wrote, “As a society we need to think through the implications of being tracked by the Internet 24/7 by wearing connected devices that will allow corporations to find you anywhere... The capital growth of the companies that focus on social media is spurred by aggregating data and audience in order to sell product. Online communities, where children practice social learning and develop youth identity, are owned and operated by major corporations, who push image and status, conferred by audience size and likes, as a means to sell product. In this kind of community, a superficial image becomes one’s identity, and when you are in the throes of building identity, the marketplace, through satisfying developmental needs for popularity and belongingness, may be shaping that identity. That, to me, is not a good thing.”

Mikey O’Connor, an elected representative to ICANN’s GNSO Council, representing the ISP and Connectivity Provider Constituency, wrote, “The Internet of Things will expand dramatically, largely funded by Google, Amazon, and other private-sector actors who are motivated to increase their markets and economic power. These things will be powerful additions to the surveillance portfolio they already wield, both for themselves and for their governmental partners. The public will cheerfully adopt this technology, trading off their privacy and control over their lives for the convenience offered by those inter-networked things. A privately controlled Cloud that can monitor and record the thoughts and eye-movements of millions of people will provide the basis for the ultimate in psychological warfare and political control. By 2025, at least one bigoted regime will have completely exterminated a minority population, greatly aided by this capability. This effort will be made possible by multiple informants providing real-time identification and location information about targeted peoples.”

Andrew Chen, associate professor of computer science at Minnesota State University Moorhead (MN), responded, “The danger will be in loss of privacy and the reduction of people into numbers: the dark side of the quantified self... ‘Subliminal advertising’ will take on a whole new meaning when it can invade your thoughts through what you wear. This is the real danger, one that suggests technologies like these be avoided until a good framework can be developed to compensate for these sorts of dangers.”

Anita Salem, a design research consultant, wrote, “The biggest effect will be government-sanctioned spyware in every aspect of our lives.”

David Ellis, PhD, course director for the department of communication studies at York University in Toronto, wrote, “Unfortunately, the Internet of Things will eventually create a perfect storm from three elements: ubiquitous networking platforms; the huge proliferation of addressable things made possible by IPv6; and the out-of-sight-out-of-mind nature of many of the ‘things’ in question. Consumers of digital technology have never been well served by their own

ignorance of how things work, where risks lie, and what end-user licensing agreements say about vendor privileges. Embedded technologies take the problems of consumer protection to a whole new level, given the dramatically increased opportunities they create for surveillance and commercial data collection... The Internet of Things raises obvious questions about heightened risks to privacy and security. But this latter problem isn't strictly about the insidious nature of vast networks of hidden devices. It's also about the values of our consumer culture, in which everything digital is sold as easy, powerful and friendly, the ultimate source of no-effort happiness. Sadly, more digital ignorance will only mean less consumer bliss.... The transition from small, free-standing screens (like those in handhelds) to AR-based screens (like those in Google Glass) will be dramatic, especially since, by 2025, pathways will have opened up to practical kinds of cyberware—i.e., devices implanted in the human body... Embedded technologies lend themselves to insidious purposes like tagging and other forms of passive data collection, providing tempting opportunities for abuse... Given the fate suffered in recent years by general-purpose computing, in favor of apps and walled gardens, however, consumer empowerment is far from a foregone conclusion for the future Internet of Things.”

Laurel Papworth, social media educator, wrote, “Basically, every part of our life will be quantifiable, and eternal, and we will answer to the community for our decisions. For example, skipping the gym will have your gym shoes auto tweet (equivalent) to the peer-to-peer health insurance network that will decide to degrade your premiums. There is already a machine that can read brain activity, including desire, in front of advertising by near/proximity. I have no doubt that will be placed into the Big Data databases when evaluating hand gestures, body language, and pace for presenting social objects for discussion/purchase/voting.”

William Schrader, co-founder and CEO of PSINet, the first commercial ISP, said, “For the hundreds of millions of individuals willing to share their interests, locations, and network of friends with everyone watching, including governments and Big Data, the wearable and scannable devices will be easily adopted. For those less willing to share, they will not be used except in the ‘private setting,’ if one exists. And, everyone will know that even information collected under ‘private’ settings will be delivered to governments and Big Data... Some devices, such as a galvanic skin response (GSR) monitor, intended to aid the wearer in telling him when he is nervous, can also be remotely monitored by Big Data (read: governments) in real time to detect lying. Intrusion by anyone wishing to harm another person will be much easier when self-monitoring devices are worn routinely, which are also broadcast to the wearer’s smart phone, which can be remotely monitored by others in real-time. In short, if people fear nothing and trust everyone, they will wear these devices easily. For those who are vigilant in protecting their privacy, it will be difficult, if not impossible, to sell a device to them... The pros and cons of advanced devices are *always* intrusive.

The proof will be when the military requires them to be worn at all times by soldiers; that alone will be convincing that they tell more than the wearer wants to be telling.”

George Lessard, information curator and media specialist for MediaMentor, wrote, “The powers that be’ will build in backdoor, remotely controlled ‘off-switches’ that they will use to turn them off whenever they think they need to be shut down, making them mere toys. Of course, there will be more ways of connecting to these devices because they will be used in the workplace more and more—like the use of drones.”

Oscar Gandy, an emeritus professor at the Annenberg School, University of Pennsylvania, wrote, “I fully expect to see a great expansion in the area of personal health monitoring. No doubt, ‘incentives’ incorporated into ‘insurance’ packages for all sorts of valuables, and relationships, will push individuals toward consent. Local governments, in order to comply with state and federal regulations, will acquire, or contract for, a great variety of environmental sensors—i.e., pollution, traffic, and noise—to assess/report compliance. Certainly, concerns will be expressed about privacy, consent for scanning, and the impact on inequality that results from increased granularity in the ability of actors to differentiate between, and discriminate among, persons, places, and things on the basis of those assessments. What is the degree or level of agency implied in reference to ‘will interact?’ It is one thing to say that their interactions/opportunities/requirements will be shaped in response to the information being exchanged and/or captured through these devices; it is quite something else to say they will be consciously and actively choosing how their behavioral and bodily cues will influence their options. I have no doubt that options will be altered. I’m not so sure about how much control or influence the wearers will actually have.”

Luis Hestres, a doctoral candidate and graduate research assistant at American University School of Communication, responded, “Inevitably, there will be a race to deploy this technology to further eliminate any friction from our daily lives—a trend that is not necessarily healthy for society.”

Aziz Douai, a professor of new media at the University of Ontario Institute of Technology in Canada, responded, “These innovations will continue to pose significant issues/questions about privacy, as well as further blur and erode the public and private realms.”

Fernando Botelho, a social entrepreneur, wrote, “No, there will not be widespread and beneficial effects. For most people, omnipresent tracking of persons and things will bring more evil than good. These technologies are being implemented in a way that centralizes information and, thereby, power. For this reason, they will become predominantly negative in their social impact.”

Pamela Rutledge, PhD and director of the Media Psychology Research Center, responded, “Wearables and scannables ... raise the specter of Big Brother and will further the debate over commercial manipulation and national safety versus individual privacy and rights.”

Internet researcher **Kate Carruthers** wrote, “The Internet of Things is already here. We are already wearing, using, and connecting devices. The issues that arise are around privacy and security. Social acceptance will continue, and politicians will seek to control this arena. The attempts at control are likely to fail, due to the decentralised nature of the technology and utility it provides to users.”

Raymond Plzak, former CEO of the American Registry for Internet Numbers, and current member of the Board of Directors of ICANN, wrote, “The answer is ‘no’ [to widespread and beneficial effects by 2025] if there continues to exist manner and means to exploit data stored in the Cloud and to invade privacy, no matter how much of it is voluntarily surrendered in the social media world.”

Geoff Livingston, author and president of Tenacity5 Media, wrote, “Many, many things will be easier and more intuitive for consumers. I really see retail loyalists, people that frequent specific brands, as the true beneficiaries. They will get things they regularly order and want—how they want it, when they want it—in a much more expedited fashion. The real difficulty will be getting people to provide their data to allow brands to provide these kinds of services. There will be major moments of creepiness where people will object. And those moments will probably create legislated movements. I really see pornography and abuses that occur via wearable cameras as the most likely source of problems on a personal level. On a business level, trade secrets will need to be protected. Wearable computing hype will move away from the head to the wrist. Google Glass is too awkward and clunky to be anything more than a niche product. Meanwhile, Nike+, FuelBand, and Fitbit continue to show how wearable computing can quietly be accepted in day-to-day life. Expect Apple and Samsung to take advantage of the form factor and define the market. In the long term, it’s hard not to envision embeddable chips and other forms of ‘native’ computing that occur within a person’s actual body.”

What happens if current “always-on” trends extend?

Evan Michelson, a researcher exploring the societal and policy implications of emerging technologies, predicted this 2025 scenario, “The ‘quantified self’ will be expanded greatly. Computers attached onto or into the skin will take real-time respiratory, body temperature, and other measurements that could help to identify potential pain points or bodily breakdowns before they happen. People will use real-time measurements for all services (heat/AC, refrigeration, etc.) to greatly reduce energy consumption. Micro-solar panels on cars, backpacks, and phones will

help to power up devices more readily. Google Glass will become Google Contacts, with digital displays interwoven into contacts and other rather invisible devices. This will be linked to Facebook, Instagram, Pinterest (and their successor services) to allow for immediate geolocation and interpersonal interaction. Privacy will take on a new concept all together.”

Marti Hearst, a professor at the University of California-Berkeley wrote, “Having connectivity of many devices on the Internet will have widespread impact. Monitoring aspects of your home, office, pet, etc., remotely will be useful and widespread. However, I do not think wearable computing will take off in the sense implied here. Google Glass is problematic, both for the ‘dork’ factor and for privacy reasons. People will use tools like this for specialized tasks, such as surgery, marching bands, skiing, and so on, but socially, it will fail. We will, however, be assaulted by hidden cameras and microphones, unless and until laws make their surreptitious use illegal, and until then, we will have a lot of social problems.”

A social worker for a non-profit organization said, “Social skills are already being broken down by technology. People are less likely to converse, relate, laugh, and cry together. Intimacy and human contact has already been damaged by the way technology has integrated into our lives, so much so that people don’t know how to interact with each other in a positive, community-oriented way.”

Mike Cushman, an independent researcher, wrote, “I’m confident the use of wearables and the Internet of Things will be widespread but much less confident they will be beneficial. They will create new must-haves and forms of life more distant from direct external experience.”

Paul M.A. Baker, associate director of the Center for 21st Century Universities (C21U) at the Georgia Institute of Technology, predicted, “Adoption of embedded devices, pervasive computing, and expanded wireless information flow will no doubt continue but will most likely be evolutionary and patchy by sector and use. The ‘quantified self’ movement gives indications of what might be possible, but it faces a potential backlash due to social exhaustion with perpetual feedback, as well as stimulation due to always-available computing. Benefits will continue to expand, but the uptake will also vary significantly as a factor of economic situation, availability of wireless bandwidth to support ever more dense information flow, and changes in the expectations people have about privacy in public places.”

Marjory Blumenthal, a US government technology policy analyst, wrote, “There will be widespread effects, for sure. Beneficial effects are likely, but they are not the only ones... Google Glass, and other technologies for capturing, sharing, and streaming images, can have a chilling effect... and can have unintended consequences (i.e., disclosure of the location of domestic violence victims who have escaped their tormentors). Benign interactions will increase; it’s how to deal with the others that’s a challenge.”

Tony Siesfeld, director of the Monitor Institute wrote, “It will permit like-minded, like-interested people to join together, further Balkanizing geographic communities rather than encouraging interactions among people of diverse backgrounds, interests, and beliefs.”

Ben Fuller, dean of the faculty of humanities at the International University of Management in Windhoek, Namibia, wrote, “Problems will arise. Here in Namibia, we have talked about the problems of connectivity on different social issues. Cyber-bullying comes to mind. We have also discussed how increased connectivity makes it easier for criminals to contact people and take advantage of their innocence. Human trafficking comes to mind. Socially, we will still have the problems of etiquette, as people forget to turn off or silence devices. Privacy of the data transmitted will become a major issue.”

Jim Warren, longtime online freedom and privacy advocate and editor/publisher of microcomputer periodicals, noted, “Embedded and wearable devices will also cause more than a little widespread harm. Just look at how many vehicular accidents and deaths have already been caused by even the most primitive cell-phones.”

Dominic Pinto wrote, “The Internet of Things will rise and develop, but it is likely the negative effects will outweigh the positive. More and more people just have to have the latest gizmos, especially if they seem to ease your life and/or give pleasure: linking with your PlayStation, etc., pornographic entertainments—pretty well the degeneracy and excess commercialism and consumerism of lives will be significantly enhanced and tying in with any physiological reactions will be almost de rigueur.”

Brad Berens wrote, “We’ve already seen how mobile phones enable the rise of helicopter parenting: with embedded technologies, apron strings will grow longer, privacy will be harder to achieve, and new forms of criminal mischief will become available as individuals find their pacemakers vulnerable to hacking and the like.”

Jane Vincent, fellow at the Digital World Research Centre, responded, “I have written about ‘electronic emotion’—the emotions that we live, re-live, and are created as a result of interacting with machines. We hold our smartphones and our tablets, and we think about loved ones or about problems at work. Our feelings can be managed and stimulated by these machines in ways we may not like, or want, to feel as well as positive feelings. There is, I believe, no need to have wearables and scannables to do this, but I can imagine that it won’t be long before more than just niche products emerge that leverage our electronic emotions.”

Can algorithms be trusted to make the appropriate decisions for humanity? People will want to be able to ‘switch off.’

A number of people wrote about the ways in which subtle—even invisible—devices programmed to quietly execute tasks could come to be troublesome. A retired software engineer and IETF participant responded, “The Internet of Things may well become pervasive, but the effects will be primarily to increase the level of control and monitoring of citizens to further de-skill jobs. It could be more dystopian than the Borg.”

Mark Lockwood, a researcher, wrote, “There are clearly major ethical considerations that need to be addressed ... The Internet of Things could be a major threat to society as we know it and, possibly, to our continued existence as a species on this planet. As it stands now, our laws and policies are not advancing as quickly as technology develops. This leaves us vulnerable at the macro and micro level. One concern is the question of who will be controlling the Internet of Things. This could be an incredible, powerful tool for controlling populations. With the current blurred lines between governments and corporations, the Internet of Things could result in a global ‘cult of personality’-type government, as exists in North Korea.”

A professor of telecommunications at Pennsylvania State University wrote, “What about widespread and detrimental effects? ... Wearable, connected visual devices—ie, Google Glass or some contact lens version thereof—will be the gateway to integrating the real and virtual worlds, backed up by AI...This raises all kinds of safety and social issues that will need to be addressed.”

A long-time scholar and activist focused on the commons said, “The unilateral introduction of smart sensors and wearable devices—usually to advance some company’s business strategy, not necessarily to advance a collective good—will provoke social disruptions and disorientation, and perhaps, backlashes ... Conventional policy structures are ill equipped to deal with this trend, and disaggregated individuals are similarly powerless. While there are indeed useful purposes that could be served by these various technologies and the Internet of Things, most are being proposed in gee-whizz, socially naive ways and without serious concern for the long-term social implications or for social consent. Where is the US Office of Technology Assessment when we really need it? Who can host a more intelligent, or even dissenting, dialogue on this issue? Should these technologies be presumptively deployed just because they offer some focused, new benefit, and some company can make money from them?”

A developer of technological systems that assist the development of the whole human wrote, “Will there be AI systems that question our understanding of ideas?”

Andrew D. Pritchard, a PhD candidate and instructor in media-and-society issues at North Dakota State University, wrote, “The growth of the omnipresent ‘network of everything’ seems likely to profoundly undermine the independent sense of self required for the individual to assert him- or herself against the mass public. Many superb thinkers have articulated the consequences

of the absorption of the individual into a collective identity, so I will only add that I have not seen any benefits promised from perpetual instant connectedness that strike me as outweighing the harm of the loss of individualism.”

One respondent said he finds technology to be more reliable than humans. A network scientist with BBN technologies observed, “I’ll grant that Internet of Things technologies will be beneficial but probably not dramatically so. I suspect that, for the most part, the Internet of Things will help more things go right and help more dumb things do smarter things. Anywhere there’s currently a human in the loop, there’s an opportunity for failure, as well as an opportunity for a device to make sure things go right. And, new, smarter devices will be able to do more things right—i.e., the new security devices that can learn their users patterns of living.”

Quite a few people mentioned that it will be necessary to find ways for people to be able to disengage from connectivity, to stop being a node that constantly sends and receives data.

Valerie Bock, technical services lead for Q2 Learning, LLC, wrote, “This is where the crisis of privacy is going to be fought out—in our offices and our living spaces. We will continue to experiment with how much privacy to give up in order to facilitate convenience, and we will eventually hit a wall where we’ve decided that it was an error to give up too much. Perhaps we’ll even develop well-accepted, workable norms about when communication with those outside the room is to be shut down. I expect wearables will become as common as wristwatches once were but that they’ll be outfitted with signaling to let the world know when they are switched on. And I expect we’ll have a whole protocol around switching off—akin to today’s handshake.”

An Internet law expert responded, “We will see the proliferation of Internet-tech-free zones that people will voluntarily enter to have breaks from the totalizing effects of being Internet-connected 24/7. What happens in these zones will remain in these zones, and that is why people will seek them out. Enough will use them to make them viable, but these same people will learn to seek out, and need to separate from, the electronic leash from time to time.”

Theme 3) Information interfaces will advance—especially voice and touch commands. But few expect that brain-to-network connectivity will be typical in most daily lives in 2025.

Computation capabilities have been growing and accelerating research into human-computer interfaces and the development of human-like artificial intelligence are expected by many experts to advance communications capabilities over the next decade. Because they were specifically asked in our follow-up query, “What do you think of the future prospect that people will interact via their

thoughts?” many incorporated their answer to that question in their overall response on wearable interfaces.

The most often mentioned interface is voice recognition and speech synthesis. They are seen as likely to see more widespread use because they would win a prize for “most improved” interface over the past few years. A Web manager based in Australia wrote, “We will interact via voice more than keyboard in future, and this will on the diversity of languages around the world as English (probably with a U.S. accent) becomes the standard, due to being best supported by voice interaction technology.”

Among the newly emerging experimental interaction triggers in human-computer interaction (HCI) today are eye- or glance-based indicators. Respondents were split on the implementation of eye movements in HCI, and most were doubtful that the brain-computer interface will arrive by 2025.

Niels Ole Finnemann, a professor and director of Netlab, DigHumLab Denmark, wrote, “I see three forms of interaction: some based on bodily signals, be they emotional or cognitive, some based on coded bodily signals (push buttons, etc.), and some based on speech. Eye movements will be very difficult to use regularly, as we use our eyes both spontaneously and consciously, and both under our own control and beyond our control. You hear something and turn your eyes.”

Olivier Crepin-Leblond, managing director of Global Information Highway Ltd. in London, UK, predicted, “The research for interfacing with our bodies will continue. It is likely that the use of any interfacing, such as thoughts and eye movements, might at some point emerge to interfacing using invasive technologies such as electrode implant.”

Alex Halavais, associate professor of social and behavioral sciences at Arizona State University, said, “Over the next decade, we will see substantial innovations in the ways in which we interact with digital systems, beyond the screen/mouse/keyboard we are now familiar with. Yes, this may include things like the grail-like brain-machine interface, but I suspect that this will be one of a number of ways we communicate, rather than something that replaces the rest. Text will still exist, as will keyboards. Glance, position, hand signal, voice, near-field identification devices, and other forms of sensors will make our interactions with machines both context-aware and appropriate to our task.”

Gesture- and movement-based computing were also seen by some as advancing to new levels.

Mark Nall, a program manager for NASA, responded, “Gestures, including facial expression, will start becoming significant over the next decade. Voice will be much more context-capable and natural; however, keyboards and mice won’t be gone.”

Sean Mead, senior director of strategy and analytics for Interbrand, wrote, “Wearable active clothing and electronic paper will be widely and cheaply available. Fashion will drive the most talked about uses, integrating unique personal styles with activators that enable a wide variety of social enhancements and social activity. A wide variety of interfaces will be available to suit different tastes and purposes. Contacts that project displays will be common, as will interfaces between networks and the mind. The former will be frequently used, while the latter will not. Many connection devices will provide highly active and adaptable AIs and will blend in like ornamentation, rather than phones.”

Nigel Cameron, a futurist and consultant with the Center for Policy on Emerging Technologies, predicts there will be progress made on brain-machine interfaces by 2025. “There will be huge disruption,” he wrote, “which will be greater because of such little forethought, especially in the United States. Glass and, ahem, watches, are clunky first steps. Brain-machine interfaces will be emerging by then.”

Gary Kreps, director of the Center for Health and Risk Communication at George Mason University, wrote, “Eventually, we will become less dependent on computer hardware and will use biotechnology that integrates our brains and bodies with computer software. Perhaps this will be accomplished with implantable computer chips or some other technology that augments our existing physical information and communication capacities with the use of advanced technologies.”

There were those who disputed the likelihood that thought-driven online activity would exist in 2025.

Stewart Baker, a partner at Steptoe & Johnson, a Washington law firm, wrote, “Wearables will become less kludgy and offer more value than Glass or the Samsung device. But eye and thought and tongue controls will still be mostly for the disabled.”

Fred Zimmerman of Pagekicker.com wrote, “Yes, Net-enabled devices will be ubiquitous, although I am skeptical about the benefit of Dick Tracy iWatches and malware-infested rice cookers. They’ll be obsolete, as will most 10-year-old technology. Haptics are coming. Thought-controlled typewriters are a bit further off.”

Adrian Schofield, manager of applied research for the Johannesburg Centre for Software Engineering, wrote, “Convenience is the name of the game. Connected ‘Things’ will be monitored, will initiate repair or replenishment, and will balance loads. People will ‘wear’ devices that enable access to information, capturing and transmitting data, and executing transactions. Headgear will provide the audiovisual experience, probably combining eyewear—i.e., prescription lenses and

light protection. A watch or pendant would contain the processor. Communication by thoughts—no. Eye movements—yes.”

Quite a few participants do expect that people will wear contact lenses or even implant devices that enable them to interact with networked information and tools.

Thomas Haigh, historian of information technology and associate professor of information studies at the University of Wisconsin-Milwaukee, wrote, “Human ingenuity is hard to predict. Scanning/recognizing people and being prompted with data about them will probably be the basis of many successful applications. I suspect that Google Glass will be a niche product for a while, rather than spread as quickly as smartphones to near-ubiquity: more of a geek subculture product or something for service industry people than a mainstream item. In the long term, something like this, a contact lens, or an implanted device, probably will become a standard part of being human.”

Marc Prensky, *Practical Visionary* author and speaker, said, “Embedded chips and implanted devices in our bodies will become mainstream far more quickly than many expect—they will be ‘functional tattoos,’ and most people will have them. As The Last Pre-Internet Generation and its old attitudes dies off, things will change a lot, and quickly—and although there will be some glitches and resistance, the changes will be almost entirely for the better.”

David Orban, CEO of Dotsub, predicted the advance of “emotional computing,” writing, “The radically increasing number of smart, connected devices are going to need, and take advantage of, the AI systems becoming available in order to function in total autonomy. Self-deployment, monitoring, and aggregating sensor data and functions will lead to actions and alerts, reaching human levels in vanishingly small numbers. The Internet of Things will be notable for being invisible. The increase in computing power will allow a much higher degree of understanding of the human communication spectrum. Emotional computing will allow the reading and writing of human emotions, and we will naturally project anthropomorphizing ideals on computers, perceiving them as empathic. Computing will cease to be characterized by a given form factor, as all personal preferences, and what we today call applications, will be available in the environment, transparently.”

Others say the technology will surround people rather than being embedded in or carried or worn by people.

Joe Kochan, chief operating officer for US Ignite, observed, “Sensors are getting smaller and will be embedded in nearly everything by 2025. I am not certain that the Internet of Things will come to be in the same way in which it is envisioned today, but small, networked sensors will be a part of most, if not all, of the things we buy and use by 2025. Heads-up displays in cars, houses, and

elsewhere will become more common. I find that Corning's *A Day Made of Glass* visualization/video seems to be a very plausible vision of the future. It's less likely that we will be wearing our screens and more likely that our screens will follow us wherever we go and will appear on the devices/surfaces around us once we are in proximity."

Brad Berens, a research fellow at the USC Annenberg Center for the Digital Future, wrote, "Hardware will start to disappear by 2025, as we will no longer need to carry a bunch of technology with us. Instead, whether via biometrics or wearable devices, we will interact with common appliances proximate to us at all times."

Micha Benoliel, CEO co-founder of Open Garden, posited this scenario for 2025, "Embedded devices, wearables, and scannables generate such a high level of information that it becomes possible to forecast with a good level of accuracy the impact we have on climate and adjust, almost in real-time, our impact. *Big data* is used to regulate consumption of energy and flow of populations to avoid natural disasters. Sensors and technology become the DNA of every commonly used devices, objects, or materials of our environment. As new, low-power, wireless technologies and dynamic wireless power generators take off, everything interacts with you. Every surface becomes a display, and objects are all sensing. How to communicate your identity, or what are your preferences for a short period of time, and protect your privacy, becomes a key element of the ecosystem."

Many respondents said that while HCI experiments will continue to help interactions evolve, the old standbys—today's typical keyboard-screen combo—will continue to thrive.

Seth Finkelstein, a programmer and consultant and winner of a Pioneer of the Electronic Frontier Award for groundbreaking work in analyzing censorware, wrote, "People's wrists are rather harsh environments for expensive screens—it's too easy to scratch the face, or soak it. The keyboard, in some form (I'm including the touchscreen), has proven to be a surprisingly durable interface over decades. It seems to be the sweet spot of the combination of fine motor control with what's cost-effective in terms of resolution from consumer devices. While all sorts of exotic technology has been shown in prototype, it never seems to be robust in widespread use or practical in terms of widespread manufacturing. I could see a specialized (and expensive) interface for people with severe physical disabilities that can be used, i.e., laser tracking of eye movements. And there will be 'Kinect'-like interfaces in contexts where only a few choices are needed. But the fact is, using eye movements or gestures, or anything other than typing, is simply too tiring or error-prone where there's a high amount of information needed. There's already enough of a problem with repetitive strain injury as it is; other body parts are even less adapted to such tasks."

And **David P. Collier-Brown**, a system programmer and author, pointed out a problem with all of this distracting interfacing with technology, writing, “By 2025 there will be slightly enhanced communications limited by the physical interface like tiny screens and touch and the need to not walk into the street while nerding and be killed by a streetcar. I’d love a thought link, but if it was too easy and immersive, traffic accidents would depopulate the planet!”

Theme 4) There will be complicated, unintended consequences:
‘We will live in a world where many things won’t work and nobody will know how to fix them.’

Some participants anticipate that the kind of complexity caused by such a large network will be too much. **Ian Peter**, pioneer Internet activist and Internet rights advocate, wrote, “[The effects] will be widespread, yes, but beneficial, perhaps not.” The grants coordinator at academic center for digital inclusion said, “We too often jump before we think, so there are bound to be numerous unforeseen consequences to all these embedded devices.”

Howard Rheingold, a pioneering Internet sociologist and self-employed writer, consultant, and educator gave a more extended answer than we cited earlier: “Google Glass is going to be released to the public in 2014. Who can doubt that Apple and Samsung are already preparing competing devices? We know that technologies evolve rapidly in power and form factor. Look at the Apple II, and look at the iPhone. We will witness social collisions between technology and privacy. Until the smartphone, nobody with a camera went into a bar because bars contain people who don’t want to be seen in bars. That norm has dissolved—how many people are taking pictures with their phones in bars at this moment? The 1992 novel *Snowcrash* described a world of ubiquitous wearables, where it became possible to auction, eBay style, captured images of any specified time and place. In regard to increasingly semi-sentient objects in the environment, I warned in my 2002 book *Smart Mobs* that a new kind of animism (first voiced by Mark Pesce) might arise: what child will be able to know that a doorknob that recognizes their face doesn’t also know many other things? We will live in a world where many things won’t work, and nobody will know how to fix them.”

Karen Riggs, a professor of media arts and studies at Ohio University, responded, “Some of these prosthetic devices and networks will create stronger filters between individuals as subjects and their external worlds. They will contribute to transforming understanding of what it means to have subjectivity, what it means to be a person in one’s relationships to all institutions, including the family. Unintended consequences of such technologies such as Google Glass and subsequent killer apps will present physical and mental dangers in addition to opening up creative and immersive delights.... An increasingly important concern is identity theft, and wearable technologies, through such means as optical movement and physiological activity, will provide means of mitigating it. Of

course, malevolent technologies will create vulnerabilities that will again mean that protective technologies must be invented. Smart watches will create deeper manifestation of an always-on existence, permeating every instant of waking life and disrupting moments that are not intended to be part of waking life. The seduction of access to one's world will offer new channels of participation, as well as new channels of external control. Google Glass, in addition to the aforementioned factors, will have the capacity to put individuals and those around them in increasing danger as we go from a society of distraction (i.e., texting while driving) to one in which the wearable technology will supercede attention to the outside world. Walking down the street or driving a car will become riskier, and face-to-face communication will become secondary to technically mediated communication. Changes in meaning of sexual, parenting, and friend relationships will occur."

The CEO for a company that builds intelligent machines wrote, "We need to get away from von Neumann's perceptions about what input and output are supposed to be, and instead, open our minds to the myriad ways we communicate as humans with one another, as well as the similarly complex ways our bodies communicate with our conscious and unconscious selves."

Mattia Crespi, president of Qbit Technologies LLC, predicted there could be invisible in-body connectivity at the DNA level and he suggested that a new approach to policy structures that takes accelerating change into account will have to be formulated. "We will eventually reach a point, likely around 2025, when we will be able to bypass our body and connect directly to our brain; when bits and atoms will have the same form. By this time, connection will happen at the DNA level, with no more devices, but the possibility for a full immersive connection, temporary or full time, in parallel environments. The sharing of information across dimensions (planetary, smart-cities, people, micro) will enable new forms of prevention, cure of diseases, and social issues. All disciplines will benefit from a new level of availability of information on a new scale. Policy makers will be faced with great challenges and will have to come to define not only new policies, but also a truly new and functional scheme for high and quick adaptation of policies and of the policies system itself to new discoveries. This is due to the speed to which availability of data and the ability to process it, will convert into new procedures for social interaction."

A professor of business and economics and technology consultant agreed, writing, "If the technologies are used wisely, most people will be better off; yet ignoring the good potential from fear of change, or making poor use of the technology potential, could hurt billions of people. As in all of human history, the paths available have many opportunities and threats. Mankind must strive for improved governance systems to encourage gains for the many, and not for today's increasing rewards to only the already wealthy and connected."

Some participants expressed concern over the acceleration of already-worrying trends. A professor specializing in surveillance wrote, “These technologies already mess up everyday life and tamper with social relations—why not in 2025, when there is no sign yet that the ideology in place now will be altered? The Internet will be even more driven by consumption and standardisation—to control commerce and people.” A social science research supervisor warned, “The capacity to have every movement tracked forges ahead into an almost Orwellian atmosphere: destructive.” A retired defense systems executive observed, “In the social environment, there will be nowhere to hide.” An anonymous respondent wrote, “The continued evolution of this area just increases Big Brother.”

Theme 5) The unconnected and those who just don’t want to be connected may be disenfranchised. Consider the ramifications of digital divides.

Many expert respondents used the terms “gap,” “haves and have-nots,” and “divides” while describing concerns about the impact of the Internet by 2025. An anonymous respondent wrote, “All this technology will be unaffordable for the majority of people who will be struggling to keep a roof over their heads and food on their table. People in survival mode don’t have money for high-tech toys.”

An anonymous participant commented, “We’ll get directions, check in at work, have meetings, post documents, share pictures and other creative pursuits, manage our health and finances, control the heat and light in our houses, manage housework, etc. This also means the digital divide will grow ever sharper. People without the Internet will be kind of like the people who live outside *The Matrix* or below the streets in *Demolition Man*.”

An anonymous respondent predicted, “We will see major differences in how different social classes are able to interact with the concrete world, as well as the Internet of Things, due to differences in the connectivity technology they are able to afford.”

An information science professional wrote, “It suggests a further digital divide between rich and poor, the intelligent and stupid, as well as the educated and uneducated. People will have these devices because they have the money to buy them and the education to use them. What is the future for the others? How can society empower the unskilled to get into the main stream, rather than into drugs and other crimes, to earn money? Many old people will also be left behind, even though they may have the money to purchase the devices. Public education needs to be reformed to teach skills for the coming world and how to think and protect oneself to live and work in it.”

Some participants see any level of additional connectivity to be vital, even in the less developed regions of the world.

Ben Fuller of the International University of Management in Windhoek, Namibia, wrote, “The Internet of Things is already here. The impacts are already real. For example, I help support a rural, poor family in Northern Namibia. They depend on agriculture for much of their subsistence, and this year has seen the worst drought in thirty years. Here in Windhoek, I would transfer money to Meme Helena’s account—she lives about ten kilometers outside a small town near the Angolan Border. Once the funds are in her account, the bank sends her an SMS, so she knows that the money will be there if she takes the time and expense to travel to town. The impact of the Internet of Things is major in a country like Namibia, where the population is small and widespread. Information about health, education, finances, and family now flows with an immediacy that was unthinkable 10 years ago. The impacts will only increase over the next 12 years. Anywhere there is the need for communication, we will see the development of both social and commercial applications.”

Some people expressed grudging acceptance that the tech train is on the tracks, already moving, and tough to stop.

Rajnish Singh, regional director in the Asia-Pacific region for the Internet Society, wrote, “This is largely a matter of how society evolves over time. We will embrace new technology, and we will embed it in our everyday lives with the intention of doing what we need to do better, faster, and cheaper. By the time that future becomes common reality, I expect I either won’t be around, or it won’t have my sanity intact—either way, here’s to a mind-meld future!”

Theme 6) Individuals’ and organizations’ responses to the Internet of Things will recast the relationships people have with each other and with groups of all kinds.

In some of the more wide ranging and impressive answers another overarching thought emerged: Responses to the Internet of Things will affect the relationships people have with each other and with groups of all kinds. The extended answers below from some important respondents explain sweeping changes in the human experience on many fronts.

Technology could empower people with tools that protect their privacy

Doc Searls, journalist and director of ProjectVRM at Harvard’s Berkman Center for Internet and Society wrote:

First, the nature of the Internet, with its end-to-end architecture, welcomes everything—literally—in the world, in addition to the people, machines, and organizations connected today, by 2025, countless trillions of things will be online.

Second, it isn't necessary for everything to have onboard intelligence, or to be connected full-time to the Net. Intelligence and connectivity can be abstracted away from things themselves to their own Clouds. This means everything is already in a position to have a Cloud of its own. This is all early stuff, but it already proves several things:

1. That the intelligence of a thing can be abstracted to its own Cloud
2. That its Cloud can have its own operating system
3. That it's possible to program relationships between things, and what events (such as scanning) can trigger
4. That the Cloud of a thing can live within the Cloud of a person, and both run the same operating system

People's Clouds of Things can be as personal and private as their houses (and, when encrypted, even more so). They can also be far more social than any 'social network' because they won't involve centralized control of the kind that Facebook, Google, and Twitter provide. Instead, they can connect to each other in a fully distributed way. Logical operations can be programmed among and between anybody and anything in the world, with full respect for the permissions others provide voluntarily.

For example, one could program (or have programmed for them) this kind of logic:

- If my phone scans the QR code I've put on my cable modem, a message will go to the cable company saying that's just happened. The cable company could note the message and its source, check against a trouble ticket database, and text back a message such as, "We see there is an outage in your area. Service should be back up within two hours." Or,
- If a cable company technician scans the same QR code, it will get access, with my permission, to whatever data I have chosen to flow into the Cloud of the cable modem. In fact, the Cloud for the modem could have data in it from both the cable company and myself.

Several additional points are worth noting here:

1. All kinds of logic can be written and executed in this scenario: *if, then, and, or, else, nor*, and so on.
2. There will be a hefty business in providing, provisioning, and programming Clouds for things and people, and making it all easy.
3. Products themselves become platforms for relationships between customers and companies. This opens huge service opportunities. (See more in [this piece I wrote for HBR.](#))

Today, all customer-service frameworks are provided by companies, and not by customers. All are also different from each other and require that each of us maintain separate relationships with all of them. (Even when many companies use the same back-end Cloud, as they do with Salesforce, what faces the customer is different for each company.) In the new system we see emerging above, customers will own—and standardize—the relationships they have with companies. (One small example of this is the ability to change one’s contact information one time for all company relationships, rather than separately for all of them.)

We will wear smart clothes and smart things. The world will also be thick with smart things as well, including products for sale that communicate what they are, what they cost, and much more. Moderating between ourselves and the rest of the world will be systems of manners. So, for example, we might wear devices that signal an unwillingness to be followed, or to have promotional messages pushed at us without our consent. Likewise, a store might recognize us as an existing customer with an established and understood relationship. Google Glass today is a very early prototype and has little, if any, social manners built-in, which is why it freaks people out. New manners-friendly systems, and the protocols to go with them, will be worked out over the next five or so years. (Some paths in this direction are outlined in my blog post, [Searls Glasses](http://blogs.law.harvard.edu/doc/2014/01/29/searls-glasses-vs-google-glass/)—<http://blogs.law.harvard.edu/doc/2014/01/29/searls-glasses-vs-google-glass/>.)

Personal space will expand and contract

Bryan Alexander, senior fellow at the National Institute for Technology in Liberal Education, presented a vivid picture of how adoption is likely to evolve.

“First,” he said, “we should never underestimate the power of convenience. Wearable computing can make things easier for users, and that’s enough to drive adoption. Second, companies, old and new, have much to gain from the Internet of Things, starting with customer data, and moving on to shaping services based on that data. Expect people in driverless cars to talk to their personal shoppers (Artificial Intelligence, probably) through their glasses or armbands, while businesses jockey for their attention, based on minute data advantages. Third, we will socialize in new ways, changing more. Our sense of personal space will both expand (to cover the world) and contract (to not be rude to other multitaskers). Our sense of belonging will continue to redistribute globally and by affiliation. Public and private spaces will acquire a new layer of interaction and mediation, with Twittering car tires, writing on fridges, and projection on cabinets...

Our deep desires to be entertained and connected will lead us to accept these devices. Younger folks will lead the way. Our will to create will make us want these devices ready

and on-hand. Naturally, there will be a backlash. We've already seen it with the 'Glassholes' meme.³ Expect more neoLuddites to hanker for computing as humanity was intended to have it, on keyboards!"

New limits on machines will emerge

Lee McKnight, a professor of entrepreneurship and innovation at the iSchool at Syracuse University, observed:

"Extending from the Cloud to the Things is a work in progress, but it will largely be a solved problem by 2025. The smartphone may be better thought of as an aggregation of a sensor thing and a viewing thing and a networking thing, while the Cloud of Things is digital information—about the things, and their inter-communication and sense-making patterns. Smart social machines are what people will find all around them in 2025; and they will be in and on them. Embedded RFID chips and robotic milking machines already permit cows to, essentially, milk themselves.

By 2025, that kind of capability will be familiar for many in their daily life, as the machines in and on them interact with other neighboring devices—hopefully for the objectives of the user. As to which area of the economy will be most affected, while there are more glamorous applications, eldercare of all the (remaining) aging Boomers will be a task only a robot (and a business) could love. Beyond those devices, which we all already wear, new wearables will be refined for an array of social and professional use contexts.

As to political and social difficulties, new issues on rights to privacy will need to be rethought for a social machine-rich environment. We will want, and need, the machines to talk behind our backs in 2025. But maybe there are some social and ethical limits that will need to be in place in order for the public to become comfortable socializing, while knowing the machines are listening, watching, and analyzing our every move. Google Glass and the Samsung watch are just first nearly-commercially acceptable and new things. Neither will be quite the mass success some may have hoped for, but both will find uses.

More common in 2025 will be embedded (literally) devices/sensors/things tracking, or improving, our health. With regard to use of eye movements and thoughts for user-experience purposes, both will be added to the array of tools already in widespread use. There is a reason fighter pilots use heads-up displays; others will have reasons to interact with the digital world while keeping their heads up, while not keeping their thoughts to themselves."

³ Some of the early adopters of Google Glass are called "Glassholes."

Our lives will become living movies

Barry Chudakov, futurist, consultant, and principal with Sertain Research, predicted:

“By 2025, we will have eaten and digested the technology that, today, we experience from the remove of a screen. This technology will be a part of us, as well as everything that touches us—and especially everything that we reach out and touch. Products on shelves will know when we pass them and choose them; location awareness will be built into everything, so we will experience a new sense of place from where we buy gasoline to the street we walk to work.

This place will be layered, changing, alive: we will scan the place, and the place will monitor us. Our sense of the unknown effectively disappears: moving through experience will become i-experience, a living movie—a world within a world. With this technology, we will have crossed a threshold, gone deeper into the oldest of human endeavors—exploration itself.

The social and political implications of ubiquitous ‘wearables’ and ‘scannables’ are that we all become the watcher and the watched. Watching our world in this enhanced way becomes spying. Our tools will enable forms of watching previously imagined only in dreams, but we will not consider seeing people via enhanced watching to be dream-like. We will assume these people, brought to us by lenses and digital connections, are there for us. We will not calibrate the economies that brought them to us—we are interested only in watching them. This urge to watch is so compelling that we will adopt its logic—as we do with all our tools—and we will easily move from watching what we can see, to watching what we could see.

Whether adopted for so-called security reasons or for more personal rationales, our lives will all be on YouTube in a running docu-presentation that is not just an adjunct commentary to who we are and what we do; in some measure, it will be who we are and what we do. ‘Connected intelligence,’ Derrick de Kerckhove’s excellent phrase, will define the merger of the virtual and physical worlds. We will no longer think of reality as something out there—a store far from us, a person across the world or across the street; we will ingest reality as we now snack on corn chips. These wearable, connected devices will connect our minds and intentions and direct our attention.

There is little doubt that, eventually, people will react and interact via their thoughts and other bodily signals, such as eye movements, but it is doubtful that we will have developed, perfected, and implemented this technology and made it commonplace in a decade. Having said that, even now, we are headed towards what we might describe as ‘active thinking’—creating tools and networks that we can think through and into in order to act in the world without performing overt physical actions.”

News and other content will become much more personalized

Jeff Jarvis, director of the Tow-Knight Center for Entrepreneurial Journalism at the City University of New York Graduate School of Journalism, wrote:

“We are just beginning to imagine the possibilities of ubiquitous, inexpensive connectivity and the proliferation of sensors in the physical environment. I can imagine profound impacts on maintaining efficient supply chains of inventory; on sensing the need for repair in machines and avoiding breakdown and loss; on finding ‘lost’ people; on tagging physical locations with information; on gathering new kinds of data from the many sensors people already carry with them; and on giving new feedback loops to people and organizations.

But that’s just the beginning. Google Glass is to the future of Internet interaction as Newton was to the iPhone: a bare glimmer of possibility. Sliced apart, Glass enables three kinds of interaction: instruction (i.e., directions); alerts (i.e., you have a message); and recording (and optionally sharing what you see and hear). Each is valuable and will likely breed new devices and new capabilities of the devices we carry or interact with. I think voice may have more impact on interaction than new and wearable devices, for voice can operate through many devices ...

Just as the Web disintermediated physical media products, voice disintermediates the page. What will media do then? More important than the device I carry or wear will be how I establish, project, and protect my identity, so that when I do shout, ‘OK, Google,’ it can act on my behalf. Note also that Google’s notion of utopia is finding the way to intuit our intent—to know what we want before we know it and give it to us (without creeping us out). Thus, intuitive interfaces will depend less on eye movements or jerking one’s head up and down, as required by Glass, but instead on our signals given to an algorithm and its ability to analyze them and return information, suggestions, and actions that make us say, ‘Thanks, how’d you know?’

This is one reason why I have been arguing that media must stop seeing themselves as manufacturers of content and should instead begin to build relationship businesses.

Because I use Google’s maps and its newly acquired traffic app, Waze, to navigate every day, Google has intuited (accurately) where I live and where I work, allowing it to serve more relevant content and advertising and commerce with less noise and waste. My own local newspaper doesn’t know any of that. So, my newspaper continues to give me the same 300 pieces of content it gives everyone else, treating me still as a mass. Google treats me as an individual because it knows me as an individual. Therein lie the most important factors in new user interactions with machines and the companies behind them: identity and signals.”

*In the face of likely ethical and commercial implications
a healthy dose of humility is required*

Susan Etlinger, a technology industry analyst for the Altimeter Group, wrote:

“We are now seeing a period of intense interest in the idea of machines we can wear, that can track information and suggest action, that can learn from external signals, and that can communicate with other such devices to present an aggregate view of an ecosystem, whether they are medical devices, communication devices, a home appliance, or a fleet of vehicles ...

The challenge, as usual, is less in the collection, processing, and interpretation of the data these devices produce, and more in the conclusions that we make—and the actions that we take—based upon it. The real challenges are essentially human: understanding and behavior. We’re already seeing the ethical and commercial implications of these choices in industries such as finance, health care, and retail. So, the challenge continues to be: what will we learn? And how will we act for the benefit, both of shareholders and of society as a whole? For this, we need to put as much effort into understanding privacy and ethics as we do into building better algorithms. More than anything, Google Glass is a proof of concept for the idea that we can wear a device that chronicles our actions and communicates with others.

There’s no real limit to how we can imagine embedding that technology into human bodies and devices. But collecting and automating communication is a far cry from understanding human behavior. It’s time for technologists to collaborate with neuroscientists, social scientists, bioethicists, and others, to promote understanding—to the extent we can ever crack *that* code. And it’s also time for a healthy dose of humility when it comes to understanding human behavior; we need to keep asking questions, as scientists do. But we won’t always have all the answers.”