

# Public Health 2030: Technology and Information System Advances Driver Forecasts

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## Forecast Summaries

### *Expectable: Benefits are distributed unevenly and security remains problematic*

- Intelligent devices and biomonitoring tools get connected to ubiquitous health records and early warning and response systems; internet-based systems like Google Flu and its successors are free and broadly used by local health departments and well-integrated for epidemiology and surveillance
- Big data use spreads, intelligent agents (Doc Watson, Siri) integrate personal data to provide culturally adept health coaching; “groupnets” merge friend networks, Match.com, and intense connection to aid in work, play, and health enhancement
- Public has the right to immediate access to and monitoring of data; intelligent Internet, citizen science, crowdsourced research, big data, and social networks are used to improve health; people who do not wish to have their information available in the government cloud can, except during emergencies, collect and keep their data in their personal clouds
- Misuse and unauthorized access to private health data increases, as do problems with misinformation, slander, discrimination, and issues in mental health from cyberbullying; the Internet remains insecure with “black hat” (malicious) vs. “white hat” (benevolent) hackers
- Low-income individuals have diminished access, lower quality biomonitoring and other devices, and less health improvement in comparison to others; services and benefits are biased towards people with greater connectivity, access and bandwidth are tiered

### *Challenging: Large variations in quality and access*

- Advances in health monitoring and surveillance technology coalesce with a heightened connectivity to the Internet, cloud services, and social networks, but access to and use of these capabilities is unequal and unevenly distributed and advocacy for equity is largely ignored
- Intelligent and networked wearable devices are nearly ubiquitous, but highly tiered in terms of quality and cost, as are gamification and education modules
- Consumers use unregulated, inexpensive, poorly made pharmaceuticals and products, or instructions for at-home 3D printing of these products, often with health and safety consequences
- Health “netizen science” advances prove effective for the highly affluent and privileged; Groupnets are only available to the upper class, further enhancing gaps in health and knowledge
- Cybersecurity concerns override the efforts to create an Internet Bill of Rights; citizens cannot legally access information collected about themselves

### *Aspirational: Greater citizen engagement, empowerment, and collaboration for all*

- A new culture of equity, alternative economics, and crowdsourcing encourages collaboration and actively creates access to tech advances and connectivity
- Groupnets enhance health across socioeconomic strata
- The Internet promotes public discussion, debate, and crowdsourced polling, input, and collaboration
- Widespread intelligent avatars and high-quality gamification help users learn how to use their devices for their own best benefit and for the benefit of their local communities and the nation
- Intelligent avatars, biomonitoring, environmental sensing tools, and wearable devices are linked to early warning and response systems

## Driver Background

The growing capabilities and ubiquity of the Internet and web over the last two decades and in particular of social media, web services, and mobile over the last decade are among the most important technological developments that have shaped how we work, live, learn, and communicate. Information and communications technologies, which have seen by far the greatest price-performance improvements in recent decades (“Moore’s law” effects), will continue to have an outsized impact on how public health organizations work, what work they do, and how they fulfill the ten essential public health services. Innovations and developments in a wide range of information, communications, sensor, and automation technologies between now and 2030 will affect what public health does and how it is achieved. The following advances in and uses of technology can be considered important drivers of public health:

- Epidemiology and surveillance platforms and technologies (early warning and response systems, sensors, diagnostics)
- Environmental health (food, toxins, pollution) and compliance monitoring technologies
- Web (cloud) services, software as a service, platforms as a service (Google Apps, eGovt)
- Internet and mobile technologies (access, bandwidth, reliability, affordability)
- Social networking and social media (Google Hangouts, Facebook, Google+, Twitter, YouTube), gamification, and peer-to-peer health and patient support networks (PatientsLikeMe, Quantified Self, Groupnets)
- Crowdsourced and open ideation, innovation and research (Spigit, citizen science)
- Knowledge management, structured data, and big data (Factual, Quid)
- Conversational interfaces and intelligent agents (Watson, Google Now, Siri, CyberTwins)
- Decision support, analytics, and prediction technologies (Palantir, Recorded Future)
- Wearable communications, health, fitness technologies (Google Glass, Dexcom, Fitbit)
- Automation and robotics technologies (lab on a chip, smart kitchens, smart prosthetics, drones)

All stakeholders, including individual citizens, local and state health departments, public health agencies, non-governmental organizations, and the federal government will be affected by continued advances in these technologies. How well these technologies are developed, distributed, used, and monitored will determine how equitable and ideal public health becomes.

The following forecasts explore advances in these technologies and how they are used, with the underlying assumption that user connectivity to the Internet, cloud services, and social media will prove the most relevant determinant of how these technologies and advances will impact the effectiveness and reach of public health activities and education. The Internet has been used to make health information more broadly and widely available (e.g., WebMD). More recently, social media has been used by individuals and organizations to share health tactics, warnings, and information (e.g., Facebook posts that include links to health articles or tips, Twitter updates from local health departments or public health groups, YouTube videos that demonstrate how to properly use condoms or take various

prescriptions). Social networks have also been used to track disease outbreaks.<sup>1</sup> Websites like PatientsLikeMe and CureTogether allow people with similar health issues to collaborate and share information, knowledge, support, ideas, and best practices. Virtual health consultations via video platforms (Google Hangout, Skype) are being used by providers and patient support groups. Online health games exist for children and adults, and more are on the horizon. Simulation platforms (e.g., Second Life) have been used recently to provide counseling for patients. Smartphones and now wearable devices (Google Glass), in combination with publicly editable GIS maps, are bringing location-specific health information to the mobile user. Virtual health agents (avatars) are in development (NextIT) that offer conversational health education and customer support. There is potential for crowdsourcing sites such as Kickstarter to contribute to public health by providing user-generated and user-funded innovations and products that improve health. Thus, the Internet, social media, and virtual technologies can and have been used for public health education, messaging, training, research, and support. However, some have raised questions of negative impacts on public health via the Internet and social media, such as “Internet addiction”<sup>2</sup> and cyberbullying. Discussions of the technologies as “drivers” of public health are placed within the context of the development of informatics between now and 2030, and levels of equity in access to information via developments in Internet, social media, and virtual technologies.

## Forecasts

### *Expectable Forecast*

Advances in technology combined with a heightened connectivity to the Internet, cloud services, and social networks. While more people and devices were connected at higher speeds with fewer disruptions, access to these capabilities was unequal and unevenly distributed. Many rural areas and low-income individuals and families were not able to enjoy the benefits these technologies and services offered.

An “Industrial Internet”<sup>3</sup> had arisen by 2023, which included a national network of intelligent devices and machines (including robots, sensors, and monitoring devices) that cooperated, connected, and communicated with users. This Industrial Internet was used in tandem with social networks, big data, crowdsourced research contributions, and citizen science to galvanize efforts to map, expose, discuss, and solve major social, health, and environmental problems. Social networks like Facebook, Google Plus, LinkedIn, and Twitter have all flourished, and specialized health and fitness networks like PatientsLikeMe, CureTogether, WeightWatchers, and InsideTracker have grown greatly in size, features,

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<sup>1</sup> See <http://www.pri.org/stories/health/global-health/monitoring-infectious-diseases-online-on-twitter-gives-early-warning-of-outbreaks-13493.html>. Accessed 18 April, 2013.

<sup>2</sup> See [http://www.huffingtonpost.com/michael-friedman-lmsw/internet-addiction-should\\_b\\_851684.html](http://www.huffingtonpost.com/michael-friedman-lmsw/internet-addiction-should_b_851684.html). Accessed 18 April, 2013.

<sup>3</sup> See <http://gigaom.com/2012/11/28/the-future-of-the-internet-is-intelligent-machines/>. Accessed 29 March, 2013

and use. Most offer a free level of services, but all now also offer tiered subscription access to advertising-minimized, professionally-staffed sub-networks. Equity in terms of levels of access and effectiveness of use remains an issue. Electronic health records are ubiquitous among health care providers, many of who provide individual patients with personal access. Many other individuals have effective personal health records, though connections between personally maintained systems and health provider record systems are costly.

A major development in social networks is the “Groupnet,” a group of individuals with wearable phones connected live via instant message, audio, and video (mostly still pictures, taken every few seconds) for many hours during the day. Groupnets began as entertainment, as entrepreneurship, and as a social experiment by behavioral and psychological support groups led by licensed professionals, then progressed to fitness and performance coaching, and then moved into the wider workplace and schools. Most Groupnets are peer-selected, with a mean size of 15 in the group. Aided by pattern-recognition software tools, users watch each other’s activities remotely, send information, ask or answer questions, and offer advice or encouragement, often unobtrusively into the earpiece or the virtual display of the group member. While the monitoring features of Groupnets have helped with many early Internet problems, like Internet addiction and cyberbullying, they have introduced new problems of their own. Groupnets can prevent change when all members share the same poor health habits or the same narrow points of view. The leading Groupnet platforms put users in contact with potential friends in the local area and users then compare the recommended people to their existing friends (the main component of our Groupnets). Those users that allow only their current personal friends in their groups have measurably narrower views, lower performance (in their professional groups), and less ability to change undesired behaviors. Professional help with group composition has proven important for behavior change. Group traits like openmindedness, self- and ethical awareness, cognitive diversity, empathy, nonviolent communication, and self-forgiveness have all been shown to aid thought and behavior change. In the 2010’s Framingham Heart Study data suggested that individuals tend to become overweight and obese if their friends and friends of friends did<sup>4</sup>. The data were poor at the time<sup>5</sup>, but understanding of this link expanded in the 2020’s. New rules and social etiquette for Groupnets are being negotiated and litigated, though equity of access remains an issue. Most youth, workers, athletes, retirees, and patients use Groupnets for a few hours a day for such tasks as learning, exercise, weight loss, rehabilitation, elder care, homeless and mentally ill support, and reintegration after release from prison. Some individuals use them during their entire waking hours.

Heightened connectivity had rapidly resulted in a range of health and security developments, including both public health advances (online patient collaboration, widely and quickly disseminated public health messaging and education, disease monitoring and warnings, etc.) and new challenges (misuse and unauthorized access to private health data by insurers, providers, and cybercriminals; increases in mental health issues from cyberbullying; health misinformation; large and intense online debates and conflicts; and a proliferation of “extreme” interactions that included homophobic, racist, sexist,

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<sup>4</sup> See [Connected: The Surprising Power of Our Social Networks and How they Shape Our Lives](#), 2011.

<sup>5</sup> See [Catching Obesity from Friends May Not Be So Easy](#), Gina Kolata, New York Times, Aug 8, 2011.

xenophobic, and other forms of slander, discrimination and hate). To combat these abuses, a U.S. Internet Bill of Rights<sup>6</sup> (IBR) was established. The IBR establishes the rights of individuals to privacy, to a digital copy of their own data (except in cases of safety and security), and the right of access to, challenge of, and arbitration of all publicly available personal information. Cybersecurity is legally ensured by this Internet Bill of Rights, and supported by a “cyberdraft” of “white hat” hackers, programmers who register to follow a code of good cyberconduct and are paid modestly to expose security problems. Unfortunately, the Internet remains exploitable by “black hat” hackers as a highly secure version of the Internet was never deployed. Mental and psychological health advocates strongly supported the IBR, as did many patients who had their genomic data available on certain social networks. The public also has the right to immediate access to and monitoring of data produced from the latest regulatory technologies, such as those used in food safety, trace elements reading, geoenvironmental assessments, and GMO monitoring (all of which are enabled and operated through a mix of public-private processes and statutes).

Intelligent and networked machines contribute much to the provision of epidemiology and surveillance information over the Internet, and many of these machines provide Internet access themselves. Internet syndromic surveillance systems (successors of Google Flu Trends) are free and broadly used by local health departments and are well integrated with departmental health surveillance, enterprise resource management, and planning systems developed by both large and small vendors. Networked environmental sensors, embedded computers, and drones collect health, security, and environmental information about communities and this information is edited collectively and displayed in easily accessible and visual forms (symptom maps, toxin maps, noise maps, accident maps). The distributions strongly influence local political initiatives and budget allocations. Some health care providers and nonprofits give free Internet services in exchange for allowing health data collection from their users, research recruitment, and extremely fast health messaging.

The Internet and web services are increasingly accessed via intelligent and networked wearable information devices (such as information glasses and jewelry that succeeded Google Glass) and health biomonitoring tools. Some biomonitoring devices are equipped with environmental sensing capacities. Users may choose to share anonymous biomonitoring and environmental monitoring data via their social networks in order to contribute to “big data” health and environmental assessments conducted by relevant local, state, and federal government agencies. This data is uploaded to and accessed via the publicly available government clouds, where anonymity and security are protected and where data can be mined for health and safety reasons. Users who do not wish to have their information available in the government cloud can, except during emergencies, collect and keep their data in their own personal clouds or clouds offered by the companies that sell their “smart” networked devices.

Personal biomonitoring tools are dominated by wearable bracelets, belts, glasses, shoes, and other standard apparel items but also include implants, epidermal electronics (temporary personalized

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<sup>6</sup> See <http://www.pewinternet.org/Reports/2008/Whither-the-internet.aspx> for results of a discussion regarding a potential Internet Bill of Rights.

biomonitoring tattoos are popular<sup>7</sup>), networked exoskeletons, and non-contact biomonitoring and diagnostic devices (such as “tricorders”<sup>8</sup>). Some of these biomonitoring and environmental sensing tools and wearable devices are also linked to early warning and response systems (EWRs) so that during emergencies the appropriate authorities can notify and advise all connected individuals immediately. EWRs use available technologies to collect information and signs to make hazard forecasts (mainly health and environmental) so that the proper authorities can issue warnings to the appropriate populations. The growth of wearable devices, wireless sensors, and real-time updates reaches a far wider and more diverse audience than 20<sup>th</sup> century early warning systems (e.g., loud sirens in the case of a hurricane or tornado). Linguistically and culturally adept knowledge technologies that emerged from conversational interfaces (Google Now, IBM’s Watson, Apple’s Siri) and intelligent agents, including personal digital “health avatars,” are also linked to EWRs.

However, many low-income users have less effective biomonitoring tools and others have none at all. Thus, “citizen science” for health (a broad term that refers to [1] networked citizen science with a focus on public health, [2] the use of apps for health monitoring, analysis, and research, and [3] crowdsourced, open-access research and development) is biased towards those who already enjoy better health and incomes and neglects those who cannot afford intelligent and networked devices.

Low-income individuals also tend not to be able to afford the highest quality Internet and mobile service (and thus cannot receive emergency warnings from EWRs as quickly as the more affluent). Citizen science has advanced for the middle class and the affluent, and this participation gap has become highly visible via social networks, Groupnets, and netizen<sup>9</sup> advocacy. Some health sites, services, and networks are only available to certain affluent members of society, and netizen advocates and “hacktivists” (hacker activists) use social media outlets to spread knowledge of and protest against the problem of biased gaps in health netizen science. People who have the most advanced connected tools, such as networked biomonitoring tools, or who have the most online influence tend to come from more affluent backgrounds so that health netizen science does not serve the greater purpose of health equity. Health gamification (using games and simulations to train and educate people), high quality mobile health apps for phones (over 80 percent of the U.S. population that has a phone uses a smart phone by 2020), and education are also biased towards those with greater connectivity, and access and bandwidth are tiered and unequal. While the government does offer good basic gamification platforms for civic engagement, health awareness, and education, the most individually tailored, needs-attentive gamification and education modules are private, and are only accessible to the affluent and some upper-middle class individuals and families.

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<sup>7</sup> See <https://www.scientificamerican.com/article.cfm?id=skin-electronic-patch> and <https://www.sciencemag.org/content/333/6044/838.abstract>. Accessed 29 March, 2013.

<sup>8</sup> See [http://reviews.cnet.com/biometric-devices/scanadu-scout/4505-3506\\_7-35567911.html](http://reviews.cnet.com/biometric-devices/scanadu-scout/4505-3506_7-35567911.html); <http://www.scanadu.com/>; and <http://www.gizmag.com/scanadu-developing-medical-tricorder/20974/>. Accessed 29 March, 2013.

<sup>9</sup> “Netizen science” is essentially citizen science but online, and typically conducted by netizen advocates. Netizen = Net + citizen.

### *Challenging Forecast*

Advances in health monitoring and surveillance technology (personal biomonitors, sensor technologies, EWRs, knowledge technologies, robotics, etc.) coalesced with a heightened connectivity to the Internet, cloud services, and social networks. These technologies have all demonstrated a great capacity to improve public health. However, access to and use of these capabilities is unequal and unevenly distributed. Many rural areas and low-income individuals and families are not able to enjoy the benefits of using these devices and the highest quality services, and advocacy to include them is largely ignored.

Many had hoped for some kind of Internet Bill of Rights, but the federal government and several private corporations overrode this hope due to cybersecurity concerns and private corporations' desire to profit from tiered, fractionalized, boutique networks and connectivity capacities.<sup>10</sup> Citizens cannot legally access information collected about them via Internet and web services use, purchases, and smart phone location monitoring without paying large sums of money. Nor can they access information collected about their communities via environmental sensors and devices (whether these devices and sensors are "rogue" or are government-issued and registered). Privately-issued and manufactured rogue drones and "swarms" of microdrones (bird and even insect-sized flying machines) collect information (often private or confidential), can provide network connectivity (and sometimes disrupt networks or nearby electronics), and are poorly regulated. Privacy is impossible to maintain. Cybersecurity is not ensured, and the local and national economies, as well as governments, companies, and individuals are frequently victims of innovative and destructive cyberattacks and identity theft. Spam remains over 80 percent of all email,<sup>11</sup> and individuals continue to fall prey to malware, online addictions, and scams. Many consumers use unregulated offshore sites offering inexpensive, poorly made pharmaceuticals and products, or instructions for at-home 3D printing of these products, often with health and safety consequences. Wealthy corporations suffer less by hiring the best hackers and programmers, but the cost of security is high since there are so many threats. Only the very wealthy are able to afford intelligent, networked machines that also provide Internet access and are capable of self-analysis and correction.<sup>12</sup>

Intelligent and networked wearable devices (such as information glasses and jewelry and biomonitors tools) are nearly ubiquitous, but highly tiered in terms of quality and cost. These devices allow users to upload health and environmental information to private clouds or the government cloud to contribute to "big data" assessments. However, users who cannot afford "private cloud" access tend to be wary of uploading their data to the public cloud, which is less secure than the independent private clouds backed by large companies who employ the best programmers. Most biomonitors and environmental sensing tools and wearable devices are also linked to early warning and response systems (EWRs), but

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<sup>10</sup> See <http://www.internetsociety.org/internet/how-it%E2%80%99s-evolving/future-scenarios> for information on the "Boutique Networks Scenario." Accessed 29 March, 2013. See also: *The Master Switch*, Tim Wu, 2011.

<http://www.amazon.com/Master-Switch-Information-Empires-Vintage/dp/0307390993>

<sup>11</sup> See [http://news.cnet.com/8301-1009\\_3-10249172-83.html](http://news.cnet.com/8301-1009_3-10249172-83.html). Accessed 11 May 2013.

<sup>12</sup> See <http://gigaom.com/2012/11/28/the-future-of-the-internet-is-intelligent-machines/>. Accessed 29 March, 2013

individuals with the most expensive packages for wearable devices receive individualized advice based on their personal profiles (which include habits and personal health data). Information collected and organized from the use of conversational interfaces (IBM's Watson, Google Now, Apple's Siri) and intelligent agents is also linked to EWRSS, to alert individuals via their computers and communications devices. However, low-income users and those who do not have access to any of these technologies (or who can only afford low-end, unreliable devices) are unable to receive advice and warnings as quickly as others (if at all), and the advice of the free versions often lacks critical personalization and context.

With gaps in quality of and access to health information technologies and applications, health netizen science thus advances most effectively for the highly affluent and privileged. Some advances are made for lower-income individuals, but not at such a high rate as for the affluent, and the inputs and outputs for lower-income health information users prove to be of much lower quality and use than those for higher-income groups. This quality gap has become highly visible via social networks and netizen advocacy, feeding sharp resentment from those who are not benefitting from netizen science and health platforms, yet feel that they have a right to these activities, tools, and information. Connection is fractionalized and tiered, so better gamification and apps tend to be costly and partisan; they are frequently used for propaganda training purposes by various political and private groups. Gamification for applications in civic engagement, health awareness, and education is not widespread. The government has not been able to invest in good quality gamification platforms. Individually tailored, needs-attentive gamification and education modules with proven behavior change capacity are private and only accessible to affluent individuals and families.

### *Aspirational Forecast*

Advances in technology combine with a heightened connectivity to the Internet, cloud services, and social networks. A variety of for-profit and nonprofit Personal Data Locker and Electronic Health Record services exist, and some are free services, funded by state governments. The leading services are independent of providers, giving patients unprecedented new ability to "fire their doctors" and switch to new physicians or provider networks if they are unhappy with their level of service.

A new culture of equity, shared-economics, and crowdsourcing encourages collaboration and actively creates access to these technology advances and connectivity. Leading social networks have adopted self-imposed codes of conduct pledging that their free tier services have excellent privacy control, personalization, education, civic engagement, and collaboration capacities, and they seek to maximize free access to disadvantaged groups. The latest evidence-based research on diet, exercise, environment, self-maintenance, and health care is quickly summarized and disseminated on social networks, and the true lifespan and morbidity cost of various unhealthy behaviors is public knowledge. Near-free peer-to-peer health care is common in underserved areas, often led by nongovernmental organizations.<sup>13</sup>

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<sup>13</sup> See [http://www.ted.com/talks/vikram\\_patel\\_mental\\_health\\_for\\_all\\_by\\_involving\\_all.html](http://www.ted.com/talks/vikram_patel_mental_health_for_all_by_involving_all.html) Accessed 11 May 2013.

Quantified Self communities offer free and cost-only health diagnostic services and obtaining numerical measures of one's brain and body fitness relative to one's cohort is a common pastime.

Groupnets have become a new area of health care and social science research. Strong ethical principles exist around their voluntary use, privacy, and informed consent. A wide variety of previously intractable mental health, general health, chronic disease, criminality, and social disadvantage problems are being helped by lasting thought and behavior change when individuals join intimate digital groups that look out for each other's interests, work to break bad habits, and help each other develop healthier habits, all in real-time – something never before possible, as individuals previously had to be in the physical presence of each other or had to rely on virtual health communities and social networks with users hoping that others would be online or would reply to their health queries later.

Beyond these voluntary practices, the U.S. Internet Bill of Rights (IBR) is satisfactory to the majority of the public and groups because it was created via an open government initiative involving extended public discussion, debate, and crowdsourced polling, input, and collaboration. It includes periodic review requirements and establishes a threshold of support needed to propose amendments.

Foreshadowed by Finland's guarantee to their citizens of growing Internet access and bandwidth (1 mbps in 2009, 100 in 2015) as a legal right,<sup>14</sup> the IBR establishes that all Americans have a right to Internet access of standard speed and quality. To ensure this, a practical compromise was reached between those who argued for "ambient connectivity,"<sup>15</sup> (i.e. that Internet access should be ubiquitous and that telecommunications companies should not be providing tiered Internet service packages) and those who argued that ISPs and telecommunications companies should be allowed to offer different levels of speed and quality to consumers. Providers can offer Internet packages for those willing to pay for extra services, while public Internet and person-to-person (P2P) sharing or renting of Internet<sup>16</sup> is also allowed. Internet sharing via safe wifi rentals has become so widespread by 2030 that many individuals set up and maintain multiple wifi networks in rural areas and areas with unsafe or unreliable connections as part-time jobs. The IBR ensures every citizen the right to privacy, control over their own data (except in cases of safety and security), and the right to all publicly available information, including the right to know what information the government and marketers have collected on the individual user. Cybersecurity is demanded and ensured by the IBR and a secure Internet 2.0,<sup>17</sup> demonstrated at universities in the 2010s and funded nationally in the 2020s, ensures that all users have real identities. Digital subpoenas can be instantly served in cases of crime, hacking, and other cyberattacks which are greatly reduced from the "wild west" days of Internet 1.0. Spam has dropped to negligible levels due to easy enforcement and penalty administration. The vast majority of users and commercial sites are exclusively on Internet 2.0, allowing them to use a variety of voluntary reputation measures and develop

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<sup>14</sup> See <http://www.cnn.com/2009/TECH/10/15/finland.internet.rights/>. Accessed 11 May, 2013.

<sup>15</sup> See <http://frankston.com/public/?n=iac> and <http://www.theinternetofthings.eu/content/ambient-connectivity>. Both accessed 29 March, 2013.

<sup>16</sup> See <http://idealab.talkingpointsmemo.com/2012/03/keywifi-wants-to-get-the-worlds-other-5b-people-online-renting-your-internet.php> for further details. Accessed 19 April, 2012. Also see <http://www.triplepundit.com/2012/03/keywifi-opens-door-peer-peer-wifi-rental/>. Accessed 10 April, 2012.

<sup>17</sup> See <http://www.networkworld.com/news/2010/010410-outlook-vision.html>. Accessed 11 May, 2013.

strong communities of trust. Netizens also have the right to immediate access to and monitoring of data produced from the latest regulatory technologies. Crowdsourced citizen science allows people to conduct their own analyses and to hold regulatory bodies and companies accountable for any actions or analyses.

A major new development is the “CyberTwins” (commonly called “Twins”), which are intelligent avatars using conversational interfaces that model their user’s preferences and values based on archived email and smartphone logs and guide the user’s purchases, learning, communication, feedback, and even voting activities in ways that seek to further and protect the user’s interests. Twins are still primitive, but they are good at answering simple questions and offering simple advice. Many people, walking in a supermarket or driving on the street, will reach past one brand of product or drive past one type of store to another, guided there verbally or visually by their Twin, which is seeking a better match with their expressed values and preferences. Many companies build Twins, but companies with the best records of respecting privacy and empowering users are the most popular. Many people allow their Twin’s record of their preferences to be public, so that other individuals, companies, and groups that share their preferences can easily find them. Sharing and modifying of preference files between Twins can be done automatically or manually, as desired. Ads are more personalized (and useful) than ever before. Intelligent and networked machines contribute to ubiquitous and equitable Internet provision. The Internet and cloud services are accessed via intelligent and networked wearable devices, along with intelligent and networked biomonitoring devices that many people use to monitor their health. Almost all biomonitoring devices are equipped with simultaneous environmental sensing capacities. Home and industrial robotics have delivered new “smart kitchens” with refrigerators that monitor food spoilage and microcomposters for food waste. Commercial and home food dehydration units allow otherwise wasted and uneaten restaurant and home food to be used in local farms as fertilizer and livestock feed (when appropriate), with part of the savings dedicated to global famine and poverty relief. The rise of widespread food recycling has added new disease management and surveillance challenges, but sensors and systems have so far prevented major problems.

Low-cost neighborhood industrial prototyping facilities (FedEx Office for complex physical objects) and personal 3D printers (for simpler objects) allow inexpensive local and limited production of many custom products. Social networks and sensors enable mass sharing and renting of objects like personal automobiles (Getaround) and personal home items (Neighborgoods). The first inclination is often to share or rent an object or barter a service from one’s local community or Groupnet, with purchasing or renting from outside the community often done only when local sourcing fails.

Widespread, high-quality gamification also helps users learn how to use their devices for their own best benefit and for the benefit of their local communities and the nation. In addition to one’s Twins, all biomonitoring and environmental sensing tools and wearable devices are also linked to early warning and response systems (EWRs), and critical interoperabilities are funded and mandated so that in cases of emergency the appropriate authorities can notify and advise all connected individuals immediately.

“Citizen science” is ubiquitous, with technological capacities being available to many communities and with a collaborative culture of crowdsourcing and equity that aims to improve the conditions of those with the fewest means and resources. This culture is augmented via social networks online and in the cloud. Users create free, open-access games and apps to promote civic engagement, health and environmental awareness, education, etc. These games and apps are frequently interoperable with various digital health avatars. Crowdsourced research and social health networks create free gamification platforms and apps for users with very sensitive and specific needs, profiles, and concerns. Long-term evaluation and assessment is conducted by the government and via crowdsourcing with the aim to improve these capacities.

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Learn more about the Public Health 2030 project by the Institute for Alternative Futures at [www.altfutures.org/publichealth2030](http://www.altfutures.org/publichealth2030).