Publication: Pew Research Center Online
Date: 28 October 2019
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3. Humanity is at a precipice; its future is at stake

By Kathleen Stansberry, Janna Anderson and Lee Rainie

The following sections share selections of comments from technology experts and futurists who elaborate on the ways internet use has shaped humanity over the past 50 years and consider the potential future of digital life. They are gathered under broad, overarching ideas, rather than being tied to the specific themes highlighted above. Many of the answers touch on multiple aspects of the digital future and are not neatly boxed as addressing only one part of the story. Some responses are lightly edited for style and readability.

The cautious optimism expressed by many of the experts canvassed for this report grew out of a shared faith in humanity. Many described the current state of techlash as a catalyst that will lead to a more inclusive and inviting internet. Some of these comments are included below.

Micah Altman, a senior fellow at the Brookings Institution and head scientist in the program on information science at MIT Libraries, wrote, "The late historian Melvin Kranzberg insightfully observed, 'Technology is neither good nor bad; nor is it neutral.' In the last 50 years, the internet has been transformative and disruptive. In the next 50, information, communication and AI technology show every sign of being even more so. Whether historians of the future judge this to be good or bad will depend on whether we can make the societal choice to embed democratic values and human rights into the design and implementation of these systems."

Juan Ortiz Freuler, a policy fellow, and Nnenna Nwakanma, the interim policy director for Africa at the Web Foundation, wrote, "Unless we see a radical shift soon, the internet as we know it will likely be recalled as a missed opportunity. History will underline that it could have been the basis for radically inclusive societies, where networked communities could actively define their collective future. A tool that could have empowered the people but became a tool for mass surveillance and population control. A tool that could have strengthened the social fiber by allowing people to know each other and share their stories, but out of it grew huge inequalities between the connected and not-connected, both locally and across countries."

Steven Miller, vice provost and professor of information systems at Singapore Management University, said, "Overall, the future will be mostly for the better. And if it is not mostly for the better, the reasons will NOT be due to the technology, per se. The reasons will be due to choices that people and society make – political choices, choices per how we govern society, choices per how we attend to the needs of our populations and societies. These are people and political issues, not technology ones. These are the factors that will dominate whether people are better off or worse off."

Paul Jones, professor of information science at the University of North Carolina, Chapel Hill, responded, "While the internet was built from the beginning to be open and extensible, it relies on communities of trust. As we are seeing this reliance has strong downsides – phishing, fake news, over-customization and tribalism for starters. Adding systems of trust, beginning with the promises of blockchain, will and must address this failing. Will the next internet strengthen the positives of individualism, of equality and of cooperation or will we become no more than Morlocks and Eloi? I remain optimistic as we address not only the engineering challenges, but also the human and social challenges arising. All tools, including media, are extensions of man. 'We shape our tools and thereafter our tools shape us,' as McLuhan is credited for noticing. Nothing could be more true of the next internet and our lives in relation to information access. Can we create in ways now unknown once we are less reliant on memorization and

calculation? Will we be better at solving the problems we create for ourselves? I answer with an enormous 'Yes!' but then I'm still waiting for the personal jetpack I was promised as a child."

Ray Schroeder, associate vice chancellor for online learning at the University of Illinois, Springfield, wrote, "On the scale of the discovery of fire, the wheel and cultivation of crops, the interconnection of humans will be judged as a very important step toward becoming the beings of the universe that we are destined to be."

Charlie Firestone, communications and society program executive director and vice president at the Aspen Institute, commented, "Fifty years from now is science fiction. There really is no telling with quantum computing, AI, blockchain, virtual reality, broadband (10G?), genetic engineering, robotics and other interesting developments affecting our lives and environments…. It's just too far ahead to imagine whether we will be in a digital feudal system or highly democratic. But I do imagine that we could be on our way to re-speciation with genetics, robotics and AI combined to make us, in today's image, superhuman. I understand that there are many ways that the technologies will lead to worse lives, particularly with the ability of entities to weaponize virtually any of the technologies and displace jobs. However, the advances in medicine extending lives, the ability to reduce consumption of energy, and the use of robotics and AI to solve our problems are evident. And we have to believe that our successors will opt for ways to improve and extend the human species rather than annihilate it or re-speciate."

Edward Tomchin, a retiree, said, "Human beings, homo sapiens, are a most remarkable species which is easily seen in a comparison with how far we have come in the short time since we climbed down out of the trees and emerged from our caves. The speed with which we are currently advancing leaves the future open to a wide range of speculation, but we have overcome much in the past and will continue to do so in pursuit of our future. I'm proud of my species and confident in our future."

Garland McCoy, founder and chief development officer of the Technology Education Institute, wrote, "I hope in 50 years the internet will still be the Chinese fireworks and not become the British gunpowder."

Angelique Hedberg, senior corporate strategy analyst at RTI International, said, "If we choose a future we want in 50 years, and work toward creating it, there is a nonzero probability we will reach a version of that future. In that vein of thought, we will see waves of platform companies that change the way we live and enjoy our lives. The platform companies that exist today will fade, as will the ones that follow. This is not because they fail, but rather, because they succeed. We will find a way to make decisions in a network of decisions. In 50 years, multiple generations of a family will gather for dinner and share sights, smells, sounds, tastes and touches, even if they are in different hemispheres, countries and time zones. You'll be at a child's social activity and they will hear the voices [of] all of those who love (and critique) him. You will say goodbye to aging loved ones, even if they cannot hear you. This will all happen with the assistance of technology (some embedded in our brain) that know our wants and needs better than we know our own. The definition of what it means to be human will evolve and the laws and regulation will follow, albeit in a less than direct manner. We will value governments in new and different ways, and we will expect more from our technology platforms. The deluge of data will provide new inputs into the decision models for platforms, bringing greater clarity to the short-term benefits and long-term risks, in return making the financial decisions more social, environmental and moral. Where laws and regulations can put a bottom line, they will. Where law and regulations cannot, the planet will step in and regulate the excess."

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Daniel Riera, a professor of computer science at Universitat Oberta de Catalunya, commented, “Everything will be connected; automation will be everywhere; most of the jobs will be done by machines. Society will have fully changed to adapt to the new reality: Humans will need to realize the importance of sustainability and equality. In order to reach this point, technology, ethics, philosophy, laws and economics, among other fields, will have done a big joint effort. We have a very good opportunity. It will depend on us to take advantage of it. I hope and trust we will. Otherwise, we will disappear.”

Geoff Livingston, author and futurist, commented, “This is a great period of transition. The internet forced us to confront the worst aspects of our humanity. Whether we succumb or not to those character defects as a society remains to be seen.”

Brad Templeton, chair for computing at Singularity University, software architect and former president of the Electronic Frontier Foundation, responded, “It’s been the long-term arc of history to be better. There is the potential for nightmares, of course, as well as huge backlashes against the change, including violent ones. But for the past 10,000 years, improvement has been the way to bet.”

Mary Chayko, author of “Superconnected: The Internet, Digital Media, and Techno-Social Life” and professor in the Rutgers School of Communication and Information, said, “The internet’s first 50 years have been tech-driven, as a host of technological innovations have become integrated into nearly every aspect of everyday life. The next 50 years will be knowledge-driven, as our understandings ‘catch up’ with the technology. Both technology and knowledge will continue to advance, of course, but it is a deeper engagement with the internet’s most critical qualities and impacts – understandings that can only come with time, experience and reflection – that will truly come to characterize the next 50 years. We will become a ‘smarter’ populace in all kinds of ways.”

Yvette Wohn, director of the Social Interaction Lab and expert on human-computer interaction at New Jersey Institute of Technology, commented, “Technology always has and always will bring positive and negative consequences, but the positives will be so integral to our lives that going back will not be an option. Cars bring pollution, noise and congestion but that doesn’t mean we’re going back to the horse and buggy. We find newer solutions, innovation.”

Bob Frankston, software innovation pioneer and technologist based in North America, wrote, “For many people any change will be for the worse because it is unfamiliar. On the positive side, the new capabilities offer the opportunity to empower people and provide solutions for societal problems as long as we don’t succumb to magical thinking.”

Matt Mason, a roboticist and the former director of the Robotics Institute at Carnegie Mellon University, wrote, “The new technology will present opportunities for dramatic changes in the way we live. While it is possible that human society will collectively behave irrationally and choose a path detrimental to its welfare, I see no reason to think that is the more likely outcome.”

Stuart A. Umpleby, a professor and director of the research program in social and organizational learning at George Washington University, wrote, “In the future people will live increasingly in the world of ideas, concepts, impressions and interpretations. The world of matter and energy will be mediated by information and context. Already our experiences with food are mediated by thoughts about calories, safety, origins, the lives of workers, etc. Imagine all of life having these additional dimensions. Methods will be needed to cope with the additional complexity.”

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John Markoff, fellow at the Center for Advanced Study in Behavioral Sciences at Stanford University and author of “Machines of Loving Grace: The Quest for Common Ground Between Humans and Robots,” wrote, “Speculation on the nature of society over timespans of half a century falls completely into the realm of science fiction. And my bet is that science fiction writers will do the best job of speculating about society a half century from now. As someone who has written about Silicon Valley for more than four decades I have two rules of thumb: technologies aren’t real until they show up at Fry’s Electronics and the visionaries are (almost) always wrong. I actually feel like the answer might as well be a coin toss. I chose to be optimistic simply because over the past century technology has improved the quality of human life.”

An executive director for a major global foundation wrote, “The internet will rank among the major technology movements in world history – like gunpowder, indoor plumbing and electricity. And like all of them (with the possible exception of indoor plumbing), its eventual weaponization should have been less of a surprise.”

Bryan Johnson, founder and CEO of Kernel, a leading developer of advanced neural interfaces, and OS Fund, a venture capital firm, said, “Humans play prediction games, but the exercise is inherently unproductive. A more useful exercise would be to think about what deeply influential technology can we invest our current time in that will give us the tools we need to thrive in such a highly complex future. Forecasting to 2050 is thought junk food. It is what people most like to daydream about, but is not what we should think about for the health of the species and planet.”
Ethics and the bigger picture loom large in the digital future

Optimistic and pessimistic respondents alike agree that human agency will affect the trajectory of digital life. Many respondents said their biggest concern is that everyone’s future in the digital age depends upon the ability of humans to privilege long-term societal advancement over short-term individual gain.

William Uricchio, media scholar and professor of comparative media studies at MIT, commented, “‘Changes in digital life’ are human-driven; technology will only amplify the social structures that created it. My pessimism ensues from the polarization of power, knowledge and wealth that characterizes much of the world at the start of the 21st century, and by the rapidly growing pressures evident in population growth and ecological degradation. Digital technologies have the capacity to be terrific enablers – but the question remains, enablers of what? Of whose vision? Of what values? These, it seems to me, are the defining questions.”

Jonathan Swerdloff, consultant and data systems specialist for Driven Inc., wrote, “In the first 50 years of connected internet, humanity rose from no access at all to always-on, connected devices on their person tracking their life signs. I expect the next 50 years will see devices shrink to tiny sizes and be integrated within our very persons. Then there will be two inflection points. The first will be a split between the technology haves and have-nots. Those who have the technology will benefit from it in ways that those who do not are unable to. The more advanced technology gets the more this will be the case. While I would like to believe in a utopic vision of AI fighting climate change and distributing food and wealth so that nobody goes hungry – the ‘Jetsons’ future, if you will – history doesn’t support that view. The second will be a moral evolution. Privacy as conceived in the era before the advent of the internet is nearly dead despite attempts by the European Union and California to hold back the tide. The amount of information people give up about their most private lives is growing rapidly. A commensurate evolution of morals to keep up with the technological developments will be required to keep up or chaos will ensue. Moral structures developed when people could hide their genetics, personal habits and lives at home are not aligned with an always-on panopticon that knows what someone is doing all day every day. Human nature is nearly immutable –

morals will need to catch up…. Anything that happens in society can be magnified by technology. I hope that my pessimism is wrong. There is some evidence of the moral evolution already – Millennials and the generation behind them freely share online in ways which Boomers and Gen X look at as bizarre. Whether that will lead to a significant moral backlash in 50 years remains to be seen."

Susan Mernit, executive director, The Crucible, and co-founder and board member of Hack the Hood, responded, "I am interested in how wearable, embedded and always-on personal devices and apps will evolve. Tech will become a greater helping and health-management tool, as well as take new forms in terms of training and educating humans. But I wonder how much humans' passivity will increase in an increasingly monitored and always-on universe, and I wonder how much the owners and overlords of this tech will use it to segment and restrict people's knowledge, mobility and choices. I want to believe tech's expansion and evolution will continue to add value to people's lives, but I am afraid of how it can be used to segment and restrict groups of people, and how predictive modeling can become a negative force."

Charles Ess, a professor expert in ethics with the Department of Media and Communication, University of Oslo, Norway, said, "My overall sense of the emerging Internet of Things and its subsequent evolutions is of an increasing array of technologies that are ever more enveloping but also ever more invisible (advanced technology is magic, to recall Arthur C. Clarke), thereby making it increasingly difficult for us to critically attend to such new developments and perhaps re-channel or obviate them when ethically/socially indicated."

Stavros Tripakis, an associate professor of computer science at Aalto University (Finland) and adjunct at the University of California, Berkeley, wrote, "Misinformation and lack of education will continue and increase. Policing will also increase. Humanity needs a quantum leap in education (in the broad sense) to escape from the current political and economic state. Fifty years is not enough for this to happen."

Kenneth R. Fleischmann, an associate professor at the University of Texas, Austin School of Information, responded, "The key questions are, 'Which individuals?' and 'Better/worse in which ways?' The impacts on different people will be different, and each person will interpret these changes differently. One major factor is what people value or consider important in life. If people value privacy and they are subject to a digital panopticon then, in that way, their lives may be worse; however, they also likely value convenience, and may find substantial improvements in that regard. Different people will make that tradeoff differently depending on what they value. So, understanding the impact of the technology is not only about predicting the future of technology, it is also about predicting the future of what we value, and these two considerations are of course mutually constitutive, as technologies are shaped by values, and at the same time, over time (especially generations), technologies shape values."

Justin Reich, executive director of MIT Teaching Systems Lab and research scientist in the MIT Office of Digital Learning, responded, "Shakespeare wrote three kinds of plays: the tragedies where things got worse, the comedies where things got better, and the histories, with a combination of winners and losers. Technological advances do little to change net human happiness, because so much of happiness is determined by relative comparisons with neighbors. The primary determinants of whether life for people improves will be whether we can build robust social institutions that distribute power widely and equally among people, and whether those institutions support meaningful relationships among people."

Michiel Leenaars, director of strategy at NLnet Foundation and director of the Internet Society's Netherlands chapter, responded, "What the internet will look like in 50 years will greatly depend on how we act today. Tim Berners-Lee in his 2018 Turing speech referred to the current situation as 'dystopian,' and this seems like an adequate overall description. The

industry is dominated by extremely pervasive but very profitable business practices that are deeply unethical, driven by perverse short-term incentives to continue along that path. A dark mirror version of the internet on an extractive crash course with democracy and the well-being of humanity at large itself. That is a future I'm not very eager to extrapolate even for another 10 years. My target version of the internet in 50 years – the one I believe is worth pursuing – revolves around open source, open hardware, open content as well as in helping people live meaningful lives supported by continuous education and challenging ideas. Permissionless innovation is a necessary precondition for serving the human potential, but so are critical reflection and a healthy social dialogue avoiding personalized bubbles, AI bias and information overload. The openness of the web and the mobile ecosystem in particular are abysmal, and attention and concentration are endangered human traits. But that can be reversed, I believe. Every day we can start to re-imagine and re-engineer the internet. The information age can and should be an era that brings out the best in all of us, but this will not happen by itself. So, I hope and believe the internet in 50 years is going to be as challenging as the early internet – and hard work for many people that want to see this future emerge."

Simon Biggs, a professor of interdisciplinary arts at the University of Edinburgh, said, "Given our history as a species, and our current behavio with the internet, I suspect that our activities (within a more advanced form of the internet) will consist of virtual simulated sex (in the form of interactive pornography – so not really sex but power-play) and killing virtual players in massive online gaming environments (more power-play). In that sense things will be similar to how they are now. Given current trends it is likely that the internet will no longer be 'the internet,' in the sense that it was intended as the network of all networks. Networked information and communications technology will be territorialized, broken up and owned, in walled environments (this process is already well advanced). Access will be privileged, not for the consumer but for the producer. The first period of the internet was marked by a democratization of access to the means of production, but this will not be the case in the future. The vast bulk of internet users will be passive consumers who are offered an illusion of agency in the system to deliver them as a resource to those who profit from consumer playbour. We already see this with Facebook and other companies. The manner in which user data from Facebook and elsewhere has been exploited in the democratic process to affect the outcomes to the benefit of those paying for the data is indicative of where the internet is going. I expect the internet to be far more pervasive than it is today, our experience of our lived life mediated at all times. The only question is to what degree our experiential life will be mediated. I suspect it will be more or less total by 2030. Primarily, my reasoning is predicated on the expectation that human behaviour will lead to negative consequences flowing from our technological augmentation. These consequences could be quite severe. Do I think our survival as a species is threatened by our technological evolution? Yes. Do I think we will survive? Probably, because we are a tenacious animal. Do I think it will be worth surviving in a world like that? Probably not. Do I think the world would be better off if, as a species, we were to not survive? Absolutely. That is one thing we might hope for – that we take ourselves out, become extinct. Even if we are replaced by our machines the world is likely to be a better place without us."

Robert Bell, co-founder of Intelligent Community Forum, had a different view from Biggs, predicting, "We created something that became a monster and then learned to tame the monster."

Jeff Johnson, computer science professor at the University of San Francisco, previously with Xerox, HP Labs and Sun Microsystems, responded that it is important to take a broader view when assessing what may be coming next. He wrote, "Technological change alone will not produce significant change in people's lives. What happens alongside technological change will affect how technological change impacts society. The future will bring much-improved speech-controlled user interfaces, direct brain-computer interfaces, bio-computing, advances in AI and much higher bandwidth due to increases in computer power (resulting from quantum

computing). Unless national political systems around the world change in ways to promote more equitable wealth distribution, the future will also bring increased stratification of society, fueled by loss of jobs and decreased access to quality education for lower socio-economic classes. Finally, rising sea levels and desertification will render large areas uninhabitable, causing huge social migrations and (for some) increased poverty."

An associate professor of computer science at a U.S. university commented, "Humans have adapted poorly to life in a technological society. Think of obesity, time wasted on low-quality entertainments, addictions to a whole range of drugs and more. As the noise in the information stream increases, so does the difficulty for the average person to extract a cohesive life pattern and avoid the land mines of dangerous or unhealthy behaviors. Genetics, cultural change, social and legal structures do not change exponentially, but aggregate knowledge does. This mismatch is a crucial realization. As Reginald Bretnor noted in 'Decisive Warfare,' kill ratios for weapons not only increase, but so does their ability to be wielded by the individual. So it is with most things in a technologically advanced society. But have people cultivated the requisite wisdom to use what is available to better themselves? Looking at American society, I would generally conclude not."

The chief marketing officer for a technology-based company said, "I am all-in for innovation and improving the standard of living for all humanity. However … we need to become more vigilant about our fascination with technology and self-indulgence. Yes, it does paint a darker picture and forces a more cautious approach, but some of us are required to do this for the sake of a more balanced and fair future for all humanity. I'm one of the lucky ones, born in Europe with a very high standard of living. Same goes for the people behind this research. Let's be vigilant of our actions and how we shape the future. We have been in a constant battle with nature and resources for the past 100 years. In historical terms it was a momentous leap forward in education, connectivity, traveling, efficiency, etc. But, at the same time, we are all committing an environmental suicide and behave like there is no tomorrow – only the instant pleasure of technology. There will not be a tomorrow if we continue to ignore the cause and effect of our unipolar obsession with technology and self-indulgence."

Miguel Moreno-Muñoz, a professor of philosophy specializing in ethics, epistemology and technology at the University of Granada, Spain, said, "Mobility and easy access to affordable databases and service platforms for most citizens will become more important; e-government systems, transparency and accountability will be improved. The development of certain applications, if paralleled by the development of new types of intellectual property licensing and management systems, can revolutionize education and access to knowledge and culture. But this requires an open framework for international cooperation, which in many ways is now under threat."

Sam Gregory, director of WITNESS and digital human rights activist, responded, "My perspective comes from considering the internet and civic activism. We are at a turning point in terms of whether the internet enables a greater diversity of civic voices, organizing and perspectives, or whether it is largely a controlled and monitored surveillance machine. We are also swiftly moving toward a world of pervasive and persistent witnessing where everything is instantly watched and seen with ubiquitous cameras embedded in our environment and within our personal technologies, and where we are able to engage with these realities via telepresence, co-presence and vicarious virtual experience. This is a double-edged sword. The rise of telepresence robots will enable us to experience realities we could never otherwise physically experience. This remote experiencing has the potential to enable the best and the worst in our natures. On the one hand, we will increasingly have the ability to deliberately turn away from experiencing the unmitigated pain of the world's suffering. We might do this for the best of reasons – to protect our capacity to keep feeling empathy closer to home and to exercise what is termed 'empathy avoidance,' a psychological defense mechanism which

involves walling ourselves up from responding emotionally to the suffering of others. We may also enter the middle ground that Aldous Huxley captured in 'Brave New World,' where narcotizing multisensory experiences, 'feelies,' distract and amuse rather than engage people with the world. Here, by enabling people to experience multiple dimensions of others' crises viscerally but not meaningfully, we perpetuate existing tendencies in activism to view other people's suffering as a theatrum mundi played out for our vicarious tears shed in the safety of our physically walled-off and secure spaces. On the other hand, we will increasingly be presented with opportunities through these technologies to directly engage with and act upon issues that we care about. As we look at the future of organizing and the need to better support on-the-ground activism, this becomes critical to consider how to optimize. We also have a potential future where governments will thoroughly co-opt these shared virtual/physical spaces, turning virtual activism into a government-co-opted 'Pokémon Go,' a human-identity search engine, scouring virtual and physical spaces in search of dissidents. In a brighter future, virtual/physical co-presence has the exciting potential to be a massive amplifier of civic solidarity across geographical boundaries, defying the power of national governments to unjustly dictate to their citizens."

Marc Rotenberg, director of a major digital civil rights organization, commented, "There is no question that the internet has transformed society. We live in a world today far more interconnected than in the past. And we have access almost instantaneously to a vast range of information and services. But the transformation has not been without cost. Concentrations of wealth have increased. Labor markets have been torn apart. Journalism is on the decline, and democratic institutions are under attack. And there is a growing willingness to sacrifice the free will of humanity for the algorithms of machine. I do not know if we will survive the next 50 years unless we are able to maintain control of our destinies."

Adam Popescu, a writer who contributes frequently to the New York Times, Washington Post, Bloomberg Businessweek, Vanity Fair and the BBC, wrote, "Either we'll be in space by then, or back in the trees. Pandora's box may finally burn us. No one knows what will happen in five years, let alone 50. It's now obvious that the optimism with which we ran headfirst into the web was a mistake. The dark side of the web has emerged, and it's come bringing the all-too-human conditions the web's wunderkinds claimed they would stamp out. Given the direction in the last five years, the weaponization of the web, it will go more and more in this direction, which ultimately means regulation and serious change from what it is now. Maybe we won't be on the web at all in that period – it will probably be far more integrated into our day-to-day lives. It's a science fiction film in waiting. With email, constant-on schedules and a death of social manners, I believe we have reached, or are close to, our limit for technological capacity. Our addictions to our smartphones have sired a generation that is afraid of face-to-face interaction and is suffering in many ways psychologically and socially and even physically in ways that we've yet to fully comprehend. This will impact society, not for the better. Manners, mood, memory, basic quality of life – they're all affected negatively."

Policy changes today will lay the foundation of the internet of tomorrow

Many respondents to this canvassing described the next several years as a pivotal time for government regulation, adjustments in technology company policies and other reforms. They say such decisions being made in the next few years are likely to set the course for digital life over the next half century. Some warn that regulation can be more harmful than helpful if its potential effects are not carefully pre-assessed.

Mark Surman, executive director of the Mozilla Foundation, responded, "I see two paths over the next 50 years. On the first path, power continues to consolidate in the hands a few companies and countries. The world ends up balkanized, organized into blocks, and societies are highly controlled and unequal. On the other path, we recognize that the current consolidation of power around a few platforms threatens the open global order we've built,

and we enact laws and build technology that promotes continued competition, innovation and diversity."

Laurie Orlov, principal analyst at Aging in Place Technology Watch, wrote, "The internet, so cool at the beginning, so destructive later, is like the introduction of the wheel – it is a basis and foundation for the good, the bad and the ugly. As the wheel preceded the interstate highway system, so the internet has become the information highway system. And, just like roads, it will require more standards, controls and oversight than it has today."

Juan Ortiz Freuler and Nnenna Nwakanma of the Web Foundation wrote, "Allowing people to increasingly spend time in digital environments can limit unexpected social encounters, which are key to the development of empathy and the strengthening of the social fibres. In a similar way that gentrification of physical neighborhoods often creates barriers for people to understand the needs and wants of others, digital environments can thicken the contours of these bubbles in which different social groups inhabit. In parallel, this process enables a great degree of power to be amassed by the actors that design and control these virtual environments. Whereas in the past there was concern with the power of media framing, in the future the new brokers of information will have more control over the information people receive and receive a steady stream of data regarding how individuals react to these stimuli. It is becoming urgent to develop processes to ensure these actors operate in a transparent way. This includes the values they promote are in line with those of the communities they serve and enabling effective control by individuals over how these systems operate. Government needs to update the institutions of democracy if it wants to remain relevant."

Leonardo Trujillo, a research professor in computing sciences at the Instituto Tecnológico de Tijuana, Mexico, responded, "I am worried that the digital ecosystems being developed today will limit people's access to information, increase surveillance and propaganda, and push toward limiting social interactions and organization, particularly if current policy trends continue."

Joly MacFie, president of the Internet Society's New York Chapter, commented, "Today will be seen as an inflection point – the end on the initial 'open' era, and the start of the second."

A professional working on the setting of web standards wrote, "Looking ahead 50 years, I expect that AI will either be more evenly and equitably integrated throughout societies, or that there will have been AI-driven disasters that jeopardize human and other animal life, or may have already destroyed life. On the more positive side, and focusing on medical research, I would expect AI-driven research and simulation of artificial life including cognition would have provided the tools to cure most disease, as well as to advance human capabilities through bionic augmentation. On the negative side, I would expect that AI combined with rapidly increasing capabilities of bioengineering, and with persistent socio-pathological tendencies of a small minority of the population, could have led to uncontained AI-driven cyberwarfare or biological devastation. A key determining factor differentiating these two futures might be the magnitude of social investment in a robust ethical framework for AI applications, and continued emphasis on development of a just society, with social safety nets, to help mitigate the risks of development of sociopathic behaviors that would be especially dangerous with easy access to AI."

Benjamin Shestakofsky, an assistant professor of sociology at the University of Pennsylvania specializing in digital technology's impacts on work, said, "1) The 'Uber-ization' of everything will not proceed as rapidly, nor as evenly, as many now predict. Platform companies that facilitate the exchange of goods and services will continue to confront the reality that funneling idiosyncratic human activity through digital platforms is a complicated and costly endeavor. 2) Employers will continue to increase their use of connected technologies to monitor their

workforces. However, workers will also continue to find ways to subvert employer surveillance and control. In many workplaces, employers will find it difficult to convert big data about employee activities into actionable insights. Nonetheless, legislators should act to limit the scope of employee surveillance and threats to employees' privacy."

A professor of information science wrote, "When I'm feeling dystopian, I see a world that looks a little too much like 'Mr. Robot' or 'Person of Interest,' with government or private organizations knowing too much about us and having too much control over us. I'd like to believe that interconnectivity could, instead, provide us with more ubiquitous access to information and with the ability to establish connections and deliver services across space and time."

Stephen McDowell, a professor of communication at Florida State University expert in new media and internet governance, commented, "The area of law and policy is already showing some major stresses in dealing with networked connected data systems, apart from AI systems. Law and policy is often dealt with on a case-by-case and issue-by-issue basis, treating questions and legal traditions and precedents in isolation. These issues might include speech, privacy, property, informed consent, competition and security. This has weaknesses already in a networked world where large teach firms offer platforms supporting a wide range of services and track user behavior across services…. If we add systems with more learning and predictive power to this mix, it will be important to develop new concepts that go beyond the segmented approach to law and policy we are trying to use to govern internet-based interactions presently. We need to grapple with the totality of a relationship between a user and a service provider, rather than react to isolated incidents and infringements. We need to address the trade-off between offering free services and users allowing data to be collected with minimal understanding of their consent. We should also consider stronger limits on the use of personal data in machine learning and predictive modeling. Companies that automate functions to save on input costs and to allow services to be offered at scale to reap the private benefits of innovation must also take on responsibility for unintended consequences and possibilities they have created."

Toby Walsh, a professor of AI at the University of New South Wales, Australia, said, "Like the Industrial Revolution before it, the Internet Revolution will be seen to have improved people's social, economic and political lives, but only after regulation and controls were introduced to guard against the risks."

Jonathan Taplin, director emeritus at the University of Southern California's Annenberg Innovation Lab, wrote, "The answer to this question depends totally on the willingness of regulators and politicians to rethink their ideas about antitrust policies in the digital age. If current consumer welfare standards continue to be used, the existing internet monopolies (Facebook, Google and Amazon) will get more dominant in the AI age. They would be bigger and have more data than any government or other mediating institution. They would be beyond control. They would determine our future and politics would be of little use…. I can envision a world in which technology is a boon to human progress, but it cannot come about as long as the internet is dominated worldwide by three firms (with two Chinese competitors in Asia). It is possible that the current efforts around blockchain or the new work of Tim Berners-Lee may lead to a more decentralized web. Count me as skeptical."

Doug Schepers, chief technologist at Fizz Studio, said "The technology is less important than the laws, policies and social norms that we as a society will adopt to adapt to it."

Randy Goebel, professor of computing science and developer of the University of Alberta's partnership with DeepMind, wrote, "A challenge for an increasingly connected and informed world is that of distinguishing aggregate from individual. 'For the greater good' requires an

ever-evolving notion and consensus about what the 'greater' is. Just like seat belt laws are motivated by a complex balance of public good (property and human costs) we will have to evolve a planet-wide consensus on what is appropriate for 'great' good."

William Dutton, professor of media and information policy at Michigan State University, commented, "We are still in a transitional period, when so much of our time and effort is focused on getting connected and using technical advances. I could imagine so many devices that complicate contemporary life, such as the mobile smartphone, disappearing as they become unnecessary for accomplishing their functions. That said, the future will depend heavily on wise policy responses, even more so than technical advances."

Luis Pereira, associate professor of electronics and nanotechnologies, Universidade Nova de Lisboa, Portugal, responded, "By virtue of the interconnection of the new tools there will be widespread data collection on people, their activities, connections, the environment and the Internet of Things. There will be increased promotion of gig-economy platforms and the focused targeting of individuals with consumerism and ideology. Unless moral values and ethical rules are put in place for application designers, product sellers, data users and autonomous software and robots, people will be forced into cluster drawers. A competitive and increasing AI race for control of profits and policies will sprout, including a digital weapons race, unless a way is found to promote collaboration instead, on the basis of regulated and overseen commitments (similar to global climate agreements) for the benefit of humanity and the planet. Certification methods for software that complies with such commitments need to be developed. People will be teaching machines how to replace themselves and others at increasing levels of cognition. Security will be a major concern. Technological developments will surpass human adaptability and raise issues we do not have the wherewithal to comprehend or address."

Hari Shanker Sharma, an expert in nanotechnology and neurobiology at Uppsala University, Sweden, said, "Technology is a tool for making life better. A goal of life is happiness, satisfaction. Both require a set of values to remain good or become evil. The internet has brought the world together. Apps are tools to perform tasks easily. The Internet of Things will connect all living and nonliving things. But the dark side of human nature – the hunger for power, possession and control that has brought wars and terrorism – cannot be corrected by the internet or apps. There is a need to identify the evil in human nature and protect the simple, good and well-meaning from becoming its prey. Evil often moves ahead of good. Perhaps it can be predicted by features that check the psychology of individuals, crime records and other past behaviors to block certain actions or warn others. Biometric identification is already used for e-security – for instance, facial recognition – and it might be possible to have bio-feature readers to detect the evil-minded or those who are likely to become evil-minded and put safety checks in place at places of danger. Expert systems for face reading, feature reading, nature reading and analysis might give warning. Trackers could be established for isolated nodes and feed details to law-enforcement agencies. No evil-monger would agree on such checks and caution, but people need to be protected from online financial fraud, rapes by social media stalkers, murders by e-system users, etc., that unchecked because no efficient warning system exists. The law today is not helpful. E-crime should be dealt with and punished without boundary. The internet needs global law and global governance to become user friendly. Global connectivity becomes a tool of criminals while those who are simply good have no power to handle evil."

Amy Webb, founder of the Future Today Institute and professor of strategic foresight at New York University, commented, "I hope historians' verdict 50 years from now will be that we made the right choice in the years 2018-2020 to rethink access to the internet, data ownership and algorithmic transparency, thus setting all of humanity on a better course for the future."

Publication: Pew Research Center Online
Date: 28 October 2019
Headline: 3. Humanity is at a precipice; its future is at stake

A director for an internet registry responded, “There will be ongoing radical development by which biology, at physical and molecular/genetic scales, will become integrated with digital technology. We can assume that this will be pervasive throughout society, but both the applications and the costs and conditions under which they may be accessed are unpredictable. The greatest determining factor in the overall result will be political rather than technological, with a range of outcomes between utopian and utterly dystopian.”

Andrea Romaoli Garcia, an international lawyer active in internet governance discussions, commented, “The cloud is a new world and is navigating in international waters. And because it is new, laws must follow the innovation. However, I have watched all countries make laws with their minds focused on traditional models of regulation. This is wrong. Laws must be international. The interpretation of the innovation scenario should be applied by introductory vehicles of new laws. The word ‘disruptive’ must be interpreted to apply to new laws. When we use old models of laws and only we are doing changes to force fit into the new model of doing business or everyday life, we are creating a crippled creature that moves in a disgusting way. I nominated this as a ‘jurisdicial Frankenstein.’ This means laws that will apply to the cloud environment but will never be perfect, and legal security will be threatened.”

Stuart A. Umpleby, a professor and director of the research program in social and organizational learning at George Washington University, wrote, “The Congressional Office of Technology Assessment was eliminated by Newt Gingrich in order to put companies, rather than Congress, in charge of technology. Given unrestrained advancements in digital and biological technology, we now need such an office more than ever.”

Divina Frau-Meigs, professor of media sociology at Sorbonne Nouvelle University, France, and UNESCO chair for sustainable digital development, responded, “Currently there is no governance of the internet proper. Cases like Cambridge Analytica are going to become more and more common. They will reveal that the internet cannot be entrusted uniquely to monopoly corporations and their leaders who are not willing to consider the unintended consequences of their decisions, which are mostly market-competition-driven). A global internet governance system needs to be devised, with multi-stakeholder mechanisms, that include the voices of the public. It should incorporate agile consultations on many topics so that individuals can have an influence over how their digital presence can affect, or not, their real life.”

Jennifer J. Snow, an innovation officer with the U.S. Air Force, wrote, “The internet will continue to evolve in surprising ways. New forms of governance, finance and religion will spring up that transcend physical Westphalian boundaries and will pose challenges to existing state-based governance structures. The internet will fracture again as those founders who seek to return it to its original positive uses establish and control their own ‘walled gardens,’ inviting in only a select few to join them and controlling specific portions of the Net separately from nation-states. New policy and regulations will be required to address these changes and the challenges that come with them. New types of warfare will arise from internet evolutions but also new opportunities to move society forward together in a positive manner. States will no longer have the premium on power and nonstate actors, corporations and groups will be able to wield power at the state, national and regional level in new and unexpected ways. It will be a disruptive time and dangerous if not navigated smartly but may also result in some of the greatest advances yet for humanity.”

Peng Hwa Ang, professor of communications at Nanyang Technological University and author of “Ordering Chaos: Regulating the Internet,” commented, “We know that the future is not linear, which means that to be accurate I will be painting with broad brush strokes. 1) Laws – It is finally being recognized that laws are essential for the smooth functioning of the internet. This is a sea change from the time when the internet was introduced to the public more than 20 years ago. In the future, governments will be increasingly feeling empowered to regulate

the laws to their own political, cultural, social and economic ends. That is, countries will regulate the internet in ways that express their own sovereignty. There will be a large area of commonality. But there will also be a sizable area where the laws diverge across borders. 2) Within 50 years, there should be one common trade agreement for the digital economy. It is difficult to see China carrying on its own terms. Instead, it is more likely that China will allow foreign companies to operate with little censorship provided that these companies do not 'intrude' into the political arena. 3) It is difficult to see Facebook continuing to exist in 50 years. 4) The harm from being always on will be recognized, and so users will spend less time online. Some of the time currently spent by users will be taken over by AI bots."

Devin Fidler, futurist and founder of Rethinkery Labs, commented, "Over the last 50 years we have built a basic nervous system. Now, the challenge is to evolve it to best support human society. A great place to start is with the many positive and negative externalities that have been documented around network deployment. Simply amplifying the positive benefits to society for network activity and curbing network activities that impose an unfunded burden on society as a whole may be a great framework for creating a networked society that lives up to the enormous potential these tools unlock. Expect increased regulation worldwide as societies struggle to balance this equation in different ways."

David A. Banks, an associate research analyst with the Social Science Research Council, said, "The character and functionality of the internet will continue to follow the political and social whims of the major power players in the industry. If these companies continue to engage in monopolistic practices without competent and reflective regulation, then we can expect an ossified and highly commercialized digital network. If something major changes then we can expect something radically different."

Luis German Rodriguez Leal, teacher and researcher at the Universidad Central de Venezuela and consultant on technology for development, said, "The new internet will be blended with human-machine interfaces, AI, blockchain, big data, mobile platforms and data visualization as main-driven technologies. They will set up a robust and widely accessible Internet of Things. On the other hand, these will imply a disruptive way of facing everyday activities such as education, government, health, business or entertainment, among many others. Therefore, innovative regulation frameworks are urgently required for each of them."

Julian Jones, a respondent who provided no identifying details, said, "Data security will be vital as is privacy. It is essential that individuals can have more control over the context in which their data is used. In the absence of this legislation the consequences for society could be catastrophic."

Fred Baker, independent networking technologies consultant, longtime leader in the Internet Engineering Task Force and engineering fellow with Cisco, commented, "I suspect that the expansion of telephone technology and law will inform this discussion. The United States' 1934 Communications Act was designed to tame a regulated monopoly carrier and prevent the worst of what that carrier might do with the technology at its disposal. Over the past few decades, the Federal Communications Commission has tried to interpret the internet through the lens of that regulation. That has failed, for the most part, for at least two reasons. First, the internet is not a regulated monopoly. It is a set of companies trying to accomplish various things, some of which (notably Google, Facebook and their kin) have become very powerful and may require appropriate regulation or regulatory action to steer in the public interest. A law designed to regulate a monopoly, and experience with it, may inform a future law, but is not a substitute for it. Second, the FCC [Federal Communications Commission] tries desperately to understand the internet to be one two things: a way to carry messages from ingress to egress without inspecting or changing them (a telecom service), or a way to access an application (an information service). It is neither, and it is both. Until we have a law that can

follow that difference in service model in the internet, we will find differences between the internet as implemented and the internet as regulated."

Jennifer Jarratt, owner of Leading Futurists consultancy, commented, "We need new regulation now that can protect users and the digital world from themselves and itself. With those we could also have a fully digital government that might be able to handle some of the planet's big problems. Expect also new activism and new social orders. In the next 50 years, technological change will produce significant change – but maybe not as much as we expect or would like. The world will have become more difficult to live in by then, so we'd better hope tech has some answers."

Oscar Gandy, emeritus professor of communication at the University of Pennsylvania, responded, "The whole notion of connectivity is bound to be redefined in the not-too-distant future. When we extend the processes through which miniaturization married with processing speed, and divorce from personal device-based memory, the possibilities for connectivity/interactivity/control, and what we mean by intelligence are beyond the ability of any but authors of science fiction novels (I guess that excludes those among us who consider themselves to be 'futurists'). I think the most interesting possibilities are those that actually eliminate (or seem to eliminate) the need to possess devices to make use of what we currently refer to as connectivity. This means that all we need is access to the intelligent network – a level of access that will not require manual action of any kind; I can even imagine that use of this network will not even depend upon requests made vocally – thought will be enough. So, I don't know what the requisite 'interface' will be, but I believe that something akin to sensors interacting with implanted chips will be commonplace, without the chips, with sensing of the brain from what we would characterize as a reasonable conversational distance from the sensor(s) would be sufficient. Of course, for a privacy scholar, this is quite a leap from our present thinking about access to and control over our private thoughts. This will, therefore, be an area of much work with regard to law, regulation and control of these developments and their use by others for specified legitimate purposes."

Jennifer King, director of privacy at Stanford Law School's Center for Internet and Society, said, "The last 10 years have demonstrated the risks with unleashing the internet on society with little accounting for public responsibility. I predict in Western democracies, we will see a greater push for more regulation and corporate responsibility for the effects of technology. In totalitarian states, we will see concentrated social control through technology. And across the board, I suspect it will become increasingly difficult to live a life outside of the reach of technology."

Tracey P. Lauriault, assistant professor of critical media and big data in the School of Journalism and Communication at Carleton University, commented, "We are already seeing platform convergence and the resale of platform data to third parties with whom we do not have a direct relationship. We already know that data brokerage firms are not regulated and there is very little regulation when it comes to credit scoring companies. In addition, we are already beginning to see erroneous social science hiding behind algorithms, not unlike what we saw at the beginning of the Enlightenment, and we have not even begun to address the social-technical and political outcomes of junk AI/social sciences (i.e., finding gay people or criminals in facial recognition – harkening on the bad old days of eugenics and skull measuring). The European Union's General Data-Protection Regulation on the right to access information will help, but, for the moment, there is little individual and aggregate protection. Also, will private sector companies who aggregate, buy and sell our data, who create individual data shadows or data doppelgangers that become our representatives in this data world, know more about us than we know about ourselves? What influence will they have on larger political decision-making? Decision-making over our lives? How do we correct these systems when they are wrong? How do we adjudicate and context egregious 'data-based decisions' in the

courts with current intellectual property law? And what of personal sovereignty and state sovereignty? What of other decision-making systems such as social scores in China? How with the poor, elderly and disabled be protected from automated decision-making about social welfare and supports if they do not have assurances that the decision-making about them are correct? And what of junk coding that persists and does not get removed and just keeps generating bad decisions? Who audits? Who is accountable? And will these become the new governors? The future is here and we do not know how to deal with it. The EU is beginning to address these and holding these companies to account, but our citizens in North America are not as well versed, and arguably, our governors seem generally less interested in our well-being, or perhaps are more ignorant of the implications."

Andreas Kirsch, a fellow at Newspeak House, formerly with Google and DeepMind in Zurich and London, wrote, "Regulation will force open closed platforms. Information will flow more freely between services. Internet services will become more decentralized again as network bandwidths will not be sufficient for the data volumes that users will produce by then. Applications and services will not be coupled to devices anymore but will follow us freely between different contexts (shared car, home, work, mobile devices)."

Anonymous respondents said:

"It is not about the technology itself … it is about the lack of regulation by the institutions and their lack of understanding of the general public."

"With each advance there are concerns about privacy and political abuses and these will need to be addressed with technology and with innovation in policy and laws."

"The executives of Facebook will be indicted and their trial will begin the process of reform. Once we get over the idea that tech executives can commit heinous crimes and we hold them accountable, the tech world will begin the process of change."

Internet everywhere, like the air you breathe

When asked to look ahead to 2069, respondents largely agreed that connectivity will be both more pervasive and less visible. A large share predicted that humans and networked devices will communicate seamlessly and the concept of "going online" will seem archaic. They anticipate that the internet will "exist everywhere," turning planet Earth into a cybersphere where connectivity is as natural as breathing.

Alf Rehn, a professor of innovation, design and management in the school of engineering at the University of Southern Denmark, commented, "The curious thing will in all likelihood be how unaware we'll be of the internet in 50 years. Today, the only time we really reflect on electricity and plumbing is when they break down. At other times, they're just there, as self-evident as air. I believe we will look to digital tools in much the same way. We walk into a room and turn on our digital streams much like we turn on a light. We wonder how much money is in our bank account, and just ask the air, and the wall replies ('You're slightly overdrawn. Shouldn't have bought those shoes. I told you.'). We start cooking, and our kitchen gently suggests we stop doing the Thai fish stew, because we forgot to tell the kitchen we wanted to do that, so it hasn't ordered fresh lemongrass. We'll do a Mediterranean trout dish instead. The only time we reflect over any of this is when the Net, for whatever reason, cuts out. It usually lasts only a few minutes, but for those minutes we become like children, stumbling around unsure what to do when not surrounded by endlessly helpful technology."

Scott Burleigh, software engineer and intergalactic internet pioneer, wrote, "Machine-to-machine network communications will become ubiquitous, and computing hardware will have access to all human information; to the extent that hardware becomes intelligent and volitional it will replace humans in essentially all spheres. Humans' ability to benefit from this advance

will be limited mainly by our inability to come up with adequate interfaces – graphical user interfaces are a dead end, voice is simply annoying and nobody types fast enough. The hardware will know everything and won't be able to convey it to us."

Adam Powell, senior fellow at the University of Southern California Annenberg Center on Communication Leadership and Policy, wrote, "Predicting 50 years out is inherently risky (see all of those flying cars overhead?). But, barring a catastrophe – epidemic, war – extrapolating from recent history suggests the internet will become more pervasive, more powerful and less expensive. Think of electricity, or electric motors; they are ubiquitous, noticed mainly when they cease to function."

John Laird, a professor of computer science and engineering at the University of Michigan, responded, "The internet infrastructure will disappear from public view. It will be ubiquitous, always on, always available and invisible. Access will be worldwide. What will change will be our means of interacting with it. Augmented reality will be ubiquitous (much sooner than 50 years), with essentially everything interconnected, including the human body – and possibly the human mind. There are many risks, and many ways in which ubiquitous connectivity can and will be abused, but overall, it will enhance people's lives. We will go through ups and downs, but there will be significant advances in security."

A senior data analyst and systems specialist expert in complex networks responded, "This is an area where I think a few science fiction writers, such as John Brunner, have seen the future. The future version of the internet will be more ubiquitous and more seamless (building on the Internet of Things), but it will also be much less secure, with people suffering damage from various kinds of hacking on a daily basis. However, this lack of security will gradually become the 'new normal,' and the outrage will fade."

Nigel Hickson, an expert on technology policy development for ICANN based in Brussels, responded, "I do not think we will be talking about the internet in 50 years' time. As the internet becomes ubiquitous it is simply an enabling force like air or water; it's what we do with it that becomes more important – is the power used for good, to improve society, enhance freedom and choice, or is it used to enslave? The internet cannot be divorced from the progress of society itself. In an enlightened democracy the effect of the internet will have been positive, enhancing freedom and choice, but in a dictatorship the opposite could well be true."

From the 'Internet of Things' to the 'Internet of Everything'

In 1982, graduate students in the computer science department at Carnegie Mellon University connected a Coke vending machine to the ARPANET, creating the first "smart device." The rise of networked devices, collectively known as the "Internet of Things," was a dominant theme in the 2014 Pew Research Center-Imagining the Internet report on the Impacts of the Internet by 2025. When asked four years later to look ahead to 2069, these expert respondents predicted the further rise of networked devices and extended the concept to include the technical hybridization of the natural world.

Edson Prestes, a professor and director of robotics at the Federal University of Rio Grande do Sul, Brazil, wrote, "I believe the internet will no longer exist in the way we see today. It will not be possible to see the internet as a huge network of connected devices, but instead it will be something unique that works in a pervasive and transparent way – like air that exists everywhere so we forget about its existence. We will use the environment to transmit information, via plants, soil, water, etc. We will develop new processes to take advantage of all resources available in the environment, e.g., we might use biochemical processes of plants to give support to data processing. Humans will be naturally adaptable to this pervasive environment. Some people will use prostheses to get/transmit/visualize and process information, maybe plugged directly in the brain and working in unison with the brain lobes.

Publication: Pew Research Center Online
Date: 28 October 2019
Headline: 3. Humanity is at a precipice; its future is at stake

The information received from the environment can be seen as a 'new sensory input.' Thus, all interfaces and tools will be totally reshaped: no mouse, no menus, no 'blue screens of death.' Others, from the 'old school,' will use plug-and-play wearable gadgets."

Valarie Bell, a computational social scientist at the University of North Texas, commented, "In the coming decades, we'll have one 'device' if any at all. Everything will be voice-print-activated and/or bio-scanner-activated (retinal scan) so passwords and login details become irrelevant. This will make identity theft more difficult but not impossible, as no matter what system or technology people create, other people will immediately develop ways to deviate or breach it. All domiciles' powered devices will likely be solar-powered or powered in a way other than 20th century electricity. Personal credit cards, driver's licenses and other portable documentation that you'd carry in your wallet would become synced to a single cloud-based account accessible via bio-scannable systems. To buy groceries, simply use your home grocery 'app' to open your account as your pantry, freezer, and fridge order what you're out of. Then robots will pack your order and self-driving cars with robot delivery staff will restock your kitchen. Later, groceries will appear in your kitchen in much the same way Capt. Kirk and Mr. Spock used to beam up to the Enterprise on 'Star Trek.' Instead of you teaching your young children to read, tie their shoes, do their homework or clean their room, aids like Alexa that are more developed and can operate in multiple rooms of the house will do those things. People continue to abdicate their duties and responsibilities to devices and machines as we've become more selfish and self-obsessed. Social networking sites like Facebook will be holographic. People will likely have one or more implants to allow them to access the internet and to access whatever the future computer will be. People won't type on computers. Perhaps you'll be able to think what you want to type and your system will type it for you while you eat lunch, watch TV, walk in the park or ride in your self-driving car. It's also important to remember that past projections from 50 years ago never predicted the internet but did predict lots of technology that even now we still don't have. So we can expect the same with our predictions."

Stephen Abram, principal at Lighthouse Consulting Inc., wrote, "We will be well beyond apps and the web in 50 years. The networked information, entertainment and social world will be fully integrated into biology and networked appliances (not toasters but a full range of new appliances that may be stand-alone like Google Home but are more likely fully integrated devices into architecture and spaces)."

Lee McKnight, associate professor, School of Information Studies, Syracuse University, commented, "The internet will reach close to 100% of humans, forests, fields and streams, as well as most non-human species, in 2069. The Internet of Things will grow to trillions of things – and all factories, cities and communities…. I do expect pop-up networks will permit people even in the most remote locations, or communities with limited means, to access and share services and internet bandwidth from literally anywhere on this planet, as well as from our Mars colonies and moon bases. What, you thought there would be just one? Forecasting the way we interact with software and hardware is too limited a starting point, as we must assume biochemistry (wetware) will also increasingly take its place in human-machine interaction environments and platforms. While science fiction is comfortable imagining all kinds of scenarios, the future-realist in me can only see good, bad and ugly wetware interacting with all of us, at all times, in 2069."

Mícheál Ó Foghlú, engineering director and DevOps Code Pillar at Google, Munich, said, "Looking forward 50 years is almost impossible. I think the biggest trend we can anticipate from today's frame is that the huge increase in machine-to-machine intercommunication, the Internet of Things, will transform the landscape. This will mean all electronic devices will have some form of built-in intelligence and many systems will layer on top of this massively interconnected intelligent mesh."

Publication: Pew Research Center Online
Date: 28 October 2019
Headline: 3. Humanity is at a precipice; its future is at stake

Peter Eachus, director of psychology and public health at the University of Salford, UK, responded, “The most fundamental change will be the way in which we interact with this connected technology. There won’t be tablets or smartphones or screens. We will be able to just think of a question and the answer will immediately come to mind! The Mindternet is the future!”

A professor and director at a major U.S. university said, “While the Internet of Things will be touted as time-saving and labor-saving it will present additional challenges due to distraction and reduce the quality of intrapersonal relations in addition to adding security vulnerabilities.”

A member of the editorial board of the ACM Journal for Autonomous and Adaptive Systems commented, “I envision billions of devices, objects locally interacting with each other, learning from their activities, usages and users’ feedback and providing instant, on-demand services not pre-coded or pre-designed. These services are the result of collective interactions happening locally with no central servers. Ethics and privacy [are] granted by default. When a user’s request or need cannot be met, devices/objects provide themselves the missing software (self-coding) or request any missing hardware.”

Additional anonymous respondents said they expect:

“We will be much less aware of the internet because it will be mostly seamlessly woven into our everyday lives.”
“A total integration of human inputs (perceptions) and outputs (actions) with the internet and the objects and tools around them.”
“Free internet access worldwide will be regarded as a basic human right.”
“People will be seamlessly and continuously interconnected without having to use a device of any kind.”
“Everything will be stored in cloud storage. Sensors will be everywhere, from parking lots to agricultural fields.”
“More and more of our spheres – even our bodies – will be more and more integrated into the network.”
“There will be a cashless society. E-shopping will dominate people’s lives. The Internet of Things will become a part of us – embedded, for instance, in clothes, thermoses, heating systems, etc.”
“Due to the lack of transparency and understanding of algorithmic systems and their owners, humans’ individual autonomy and agency is going to decrease.”
“More connected objects and connected experiences will allow to get over the digital divide and allow everyone to profit from the digital lifestyle. At the same time advances in green tech will also allow the connectivity not to be made at the expense of the environment.”
“Your report card could be connected to, say, a restaurant’s app which will make reservations for you when you get good grades.”

It will be impossible to unplug

A share of respondents explored the possibilities and challenges of living in a fully networked world where it is difficult, or even impossible, to disconnect. The following comments illuminate some of their expectations in the future of constantly connected life.

Steven Polunsky, director of the Alabama Transportation Policy Research Center, University of Alabama, said, “We all know where this is going. We are at the earliest stages of making devices like electric and water meters ‘smart’ and integrating home accessories with internet functionality. The issue is whether people will be allowed, by regulation or by practical exercise, to opt out, and what the effects of that action will be, as well as what efforts will be required to bring services to those at the fringes. Does government have an obligation, such

as led to the creation of the Rural Electrification Administration or Essential Air Service, that extends to the requirement or provision of broadband and beyond to the services it enables?"

Helena Draganik, a professor at the University of Gdansk, Poland, responded, "The rules/law of internet communication will be unified between many countries, which will limit the freedom of expression. There will grow to be even more dependence upon big platforms (e.g., Facebook) and a deepening of the monetization of our customs and habits. The marketing industry will grow. The internet will just be one more, marketing-dependent medium – as press or TV. Yes, in the future there will be many information technology and artificial intelligence applications and commodities to simplify our lives. But it is possible that we will not be able to function properly without them."

An expert on converging technologies at for a defense institute wrote, "The internet 50 years from now will look nothing like it does today. Physical infrastructure will be entirely pervasive and wireless (perhaps non-electronic) and digital elements will be directly interfaced with human brains. And the minds of different individuals may be directly linked. This will be a new era for humankind, which is difficult to hypothesize about."

Christopher Yoo, a professor of law, communication and computer and information science at the University of Pennsylvania Law School, responded, "If I had to predict (and undertake the concomitant risk and inevitable likelihood that some of these predictions will turn out to be wrong), I would expect more users to become increasingly reliant on their mobile devices and to rely on them for mobile payments and other functions. Just as cloud computing disintermediated PC operating systems and created new key intermediaries, such as hypervisor leader VMWare, these new functions will shake up existing industries and inevitably displace incumbents that are too slow to innovate."

Nancy Greenwald, a respondent who provided no identifying details, wrote, "I started on the early internet in 1983-84 on 'Dialog,' with a dial-up connection. Now I talk with my devices, giving instructions, dictating, etc. What I expect to see is a growing number of tasks we can complete through the internet, continual increases in collaborative platforms with an increase in a greatly improved 'open API' type of program integration, and an increase in the ways we connect with the technology (our wearable technology is crude) so that we are continuously connected. I already have the feeling that one of my senses is cut off when I am unable to connect to the internet. I expect that sense of enabling/dependence to increase."

A well-known writer and editor who documented the early boom of the internet in the 1990s wrote, "We will take omniscience over the state of the world for granted because we will be connected to everything, always. We are therefore all the more likely to be distracted from asking questions that really matter. On balance, greater knowledge leads to greater happiness – though there is a lot of distraction to get through along the way."

A professor of electronic engineering and innovation studies who is based in Europe commented, "A radical change will occur in the way the people see human-machine and human-human interactions. Humans will be entirely dependent on information systems, just like our generation got used to being dependent on electricity or transport systems. Also, expect radical innovations in neural connection (i.e., human brains integrated with computers). The effects of this remain highly unpredictable."

Slowing the pace of internet innovation

Although a significant majority of survey respondents expected the rate of technological advancement to remain steady or increase in the next 50 years, a vocal minority argued that humanity may be entering a cooling-off period when it comes to digital evolution.

Publication: Pew Research Center Online
Date: 28 October 2019
Headline: 3. Humanity is at a precipice; its future is at stake

Lee Smolin, a professor at Perimeter Institute for Theoretical Physics and Edge.org contributor, responded, “Many technologies evolve fast until they reach functional maturity, after which how they function for us evolves slowly. I suspect the internet has already reached, or will shortly reach, that state.”

Ken Birman, a professor in the department of computer science at Cornell University, responded, “Technology booms take the form of ‘S’ curves. For any technical area, we see a slow uptake, then a kind of exponential in which the limits seem infinite, but by then things are often already slowing down. For me, the current boom in cloud computing has created the illusion of unbounded technical expansion in certain domains, but in fact we may quickly reach a kind of steady state. By 2050, I think the focus will have shifted to robotics in agriculture and perhaps climate control, space engineering, revolutionary progress in brain science and other biological sciences. This is not to say that we will cease to see stunning progress in the internet and cloud, but rather that the revolutions we are experiencing today will have matured and yielded to other revolutions in new dimensions they will surely leverage the network, but may no longer be quite so network-centric.”

Zoetanya Sujon, a senior lecturer specializing in digital culture at University of Arts London, commented, “Based on the cyclical histories of the printing press, telephone, internet, virtual reality and artificial intelligence, I believe that all technologies are subject to waves, often characterized by ferment/early development, great claims and excitement whether positive or negative, and if they reach the mainstream, they will also experience an era of maturity marked by institutionalization and ‘an era of dominant design.’ After this point, technologies are likely to become obsolete, adapt or converge, or follow through incremental change – all rather like knowledge and product cycles.”

A lead QA engineer at a technology group said, “Twenty years ago someone told me that in the future all of our applications and data would be online. I did not believe it … and here we are today. The advances in technology are based on continued availability of electricity that makes technology and connectivity possible. I have a feeling that while many advances are made, some in our society will want to separate themselves. Like in the 1950s the big thing was canned goods, instant meals, and now 50 years later many are going back to cooking from scratch.”

An internet pioneer wrote, “If history is a guide, the 10 most valuable companies in the world will be different 50 years from now than they are today. These new players will have succeeded in re-centralizing something that earlier generations had de-centralized. Perhaps we return to desktop/mobile phone single-vendor dominance. Combined with human-computer interfaces, the prospect of single-vendor control over the operating system of a substantial portion of your brain is rather frightening. As to the core internet itself – I suspect it won’t actually change a lot. Just like railroads or highways, infrastructure sees short periods of time of great innovation, and then a long plateau. I don’t think the internet has seen much change in the last 10 years aside from being bigger, colder, harsher and filled with more bad actors, so I suspect that plateau will continue more or less for another 50.”

A principal researcher for one of the world’s top five technology companies commented, “What technology makes possible in 50 years depends on what technology exists in 50 years. Will Moore’s Law and related semiconductor accelerations be extended through quantum, optical, or some other computing? A breakthrough there in the next 20 years would lead to unimaginable consequences in 50 years. But it seems more likely that they won’t, so we can expect a slow realization of the full capabilities of technology that is not qualitatively different from today’s. That leaves substantial room for increased capability as cloud computing and the Internet of Things get worked out with modest assists from data science and machine

learning, and as our attentional balance shifts from novelty and eye-catching visual design to utility and productivity."

Visions of the future: 'Brave New World,' '1984' or 'The Jetsons'

A number of respondents shared colorful descriptions of what they expect the world might look like in 2069.

Garland McCoy, founder and chief development officer of the Technology Education Institute, wrote, "On the first day there was analog voice and, behold, it was good. On the second day there was human-generated data/content, and it was pleasing to the people. On the third day machines began to talk directly to machines and this was seen as excellent indeed. On the fourth day, machines began to design their own network of networks (e.g., LoRaWAN, a device-to-device architecture), and behold great efficiency spread out upon the land. On the fifth day humans began to leave their homes and assemble at the town square to talk among themselves face-to-face and this brought great joy to the multitudes. On the sixth day, just as the wise men from the Semiconductor Industry Association had predicted, the world was unable to generate enough electricity to feed all of the chips/devices the wise men had created and darkness descended upon the land. On the seventh day the people rested because that was all they could do. And so endeth the lesson."

Baratunde Thurston, futurist, former director of digital at The Onion and co-founder of the comedy/technology startup Cultivated Wit, wrote, "With land and servers, Amazon was able to accelerate the merger of the space formerly referred to as 'the internet' and the realm once called 'meatspace,' or 'in real life,' such that there is no longer a distinction – it is all referred to now as 'The Prime Network.' … Once it was proven in 2045 that a hybrid human-networked intelligence could manage and draft legislation far better than inconsistent and infinitely corruptible humans, the U.S. Congress was replaced with a dynamic network model accounting for the concerns of citizens yet bound by resource constraints and established laws. This happened too late to save Miami, which is now only accessible by automated submarine, historical tours or VR re-creations, but it did help rally the resources required to halt The Ten-Year Burn in California and restore much of Lower Manhattan. Americans now spend roughly 30 percent of their waking hours in SR (simulated reality) environments. Many spend this time reliving revised personal histories which make them the most popular students in high school even though industrial school farms were abolished 25 years ago and replaced by personalized Mental Training Plenaries that dynamically adjusted to the learning styles and needs of each student. Another 20% of waking hours are spent passively consuming immersive narratives customized to each person. In order to maintain social cohesion, however, these personalized narratives have overlapping characters, plot points and themes so that people have something to talk about when they encounter their fellow humans. Americans split the rest of their time between eating, picking up litter and serving on the obligatory Algorithmic Oversight Committees. Advertising has been banned. Once we launched the 360 Accounting Project to measure the impact of nearly all human endeavors and score them on various elements, the practice of advertising was found to have a negative social, financial, emotional, ecological and moral return on investment. Any human or hybrid engaged in advertising is disconnected from The Prime Network for six hours on a first offense, one day for a second offense and permanently for a third offense. Amazon is exempt from the advertising ban per the Terms of Service that govern all Prime citizens."

Jamais Cascio, research fellow at the Institute for the Future, wrote, "I imagine three broad scenarios for AI in 50 years. No. 1, EVERYWARE, is a crisis-management world trying to head off climate catastrophe. Autonomous systems under the direction of governance institutions (which may not be actual governments) will be adapting our physical spaces and behaviors to be able to deal with persistent heat waves, droughts, wildland fires, category 6 hurricanes, etc. Our routines will be shaped by a drive to a minimal footprint and a need to make better

longer-term decisions. This may not be 'green fascism' precisely, but that will be a common invective. The dominant design language here is *visible control* – of public spaces, of economic behavior, of personal interactions, etc. AI is a climate-protective Jiminy Cricket with an attitude. No. 2, ABANDONWARE, is also crisis-driven, but here various environmental, economic and political crises greatly limit the role of AI in our lives. There will be mistrust of AI-based systems, and strong pushback against any kinds of human-displacement. This likely results from political and economic disasters in the 2040s-ish linked to giving too much control to AI-based systems: institutional decisions driven by strategies to maximize profits and control, while minimizing uncertainty and risk. AIs messing around with elections, overriding community decisions and otherwise pushing aside fuzzy emotional thinking with algorithmic logic goes swiftly from being occasionally annoying to infuriatingly commonplace. The dominant design language for AI here is submissive. AI is still around, but generally whimpering in the corner. No. 3, SUPERWARE, is the world described in the first answer (AI common but largely invisible) turned up to 11. In this scenario, AI systems focus on helping people live well and with minimal harm to others. By 2069, the only jobs performed by humans in the post-industrial, post-information world require significant emotional labor, unique creative gifts or are simply done out of the pleasure of doing them. The newly developed world is still adapting, but what amounts to the end of 19th century industrial capitalism forces this change. AI-based systems are dealing with climate, global health, and the like, but in ways meant to increase human well-being over the long term. Most people born before 2020 hate this, seeing it as 'robo-nanny state socialism' and 'undermining human dignity' even as they take advantage of the benefits. The dominant design language for AI here is 'caring.' Machines of Loving Grace, whether you like it or not."

Ebenezer Baldwin Bowles, author, editor and journalist, responded, "The next 50 years? A time frame ending in 2069? As grandpa would say, 'I can't imagine.' But we must try or else fall silent. 1) The best and brightest will communicate brain-to-brain through implants linked to synapses altered by quantum surgery. Encrypted and delivered by carbon-silicone hybrid technology, this radical expression of the desire to communicate will create new systems of power and control by the planet's ruling class. 2) Global nation-states, empowered by iron-fisted control of electronic media and financial systems, protected by police drones and robots through continuous surveillance systems, and sustained by a willing populous, will oversee legions of workers dedicated to the maintenance of the ruling class of the 1%. 3) The development of no-cost neighborhood-based replicator stations will provide unlimited access for everyone to nutritious food, comfortable clothing suitable to local climates, every imaginable item necessary to maintain a household, and personal necessities linked to popular concepts of comfort and entertainment. The replicator system, an advanced expression of today's 3D printing technology, will serve as a means of control of the working and professional classes – a chicken in every pot times 10. So, robots and drones with the Evil Eye to watch and control the people. Unlimited food, clothing and shelter to cow the masses into happy servitude. Total reliance on AI and its tendrils to supply the necessities of life. What a wonder to behold in 2069. Think back to 1969. Even the most imaginative thinkers missed the one crucial aspect of digital control of everyday life in 2018: the surveillance camera. Who back then could imagine the total loss of privacy and personal independence we live with today? We are swallowed up by digital influences now. In 50 years the influences shall morph into total control, and the world we know now shall be devoured by electric ones and zeroes, one after another in the rapid march to dissolution."

Jerry Michalski, founder of the Relationship Economy eXpedition, said, "Most internet-connected devices have been p0wn3d and are in the Dark Net, making most systems scary and unstable. Super-small drones changed warfare and policing, making it difficult and expensive to hide. Anyone who feels at risk travels in a self-sufficient chamber to avoid infiltration. Meanwhile, a quarter of humanity has figured out how to hear one another and live in abundance, but they have to keep below the radar…. Over 50 years many more things will

change, but the forces at play are shoving society in negative directions. People who want better will achieve progress, but I see a dystopian future for the majority of humanity."

A research scientist who works for Google said, "You want a 50-year prediction? I'm not sure what to say. Google is only 20 years old – would you have predicted that (and all of the side effects) back in 1968 (50 years ago)? Likewise, Amazon is 24 years out. My point is that predicting tech changes in the online/software space is really, really hard. Remember the rise (and fall, and rise?) of walled gardens? Did anyone predict the fall of AOL back when it was the biggest company around? A few things I can predict with confidence: 1) There will be new business models that we do not yet know about. Amazon was enabled by a host of technologies that didn't exist in 1968. Play that same tune forward. 2) There will be a backlash against the Internet of Things. Just sayin'. 3) Eventually, we'll figure out how to do sufficiently high frame-rate and precision registration so that VR/AR actually works. Both will be interesting; both have the possibility of being world-changers. (But I don't know how that will happen yet. Probably, it will happen in a way we don't yet understand.) 4) Bandwidth will eventually make it into the entire third world. That will change the online landscape as much as when the ARPANET became open for commercial purposes. (That is, dramatically.) 5) The social effects of connectivity (especially in the third world) + bandwidth + radicalized pockets of folks will make the current internet battles seem tame. AI will be important, but it's not going to be the big driver."

The chief marketing officer for a technology-based company said, "The Internet of Things and AI will exponentially help to automate and organize society and the world at large by enhancing existing infrastructure and innovating new ones."

An anonymous respondent wrote, "Widespread networked computing will have collapsed 50 years from now, as will society."