**Improvements ahead: How humans and AI might evolve together in the next decade**

**BY**[**JANNA ANDERSON**](https://www.pewresearch.org/staff/janna-anderson)**AND**[**LEE RAINIE**](https://www.pewresearch.org/staff/lee-rainie)

Other questions to the experts in this canvassing invited their views on the hopeful things that will occur in the next decade and for examples of specific applications that might emerge. What will human-technology co-evolution look like by 2030? Participants in this canvassing expect the rate of change to fall in a range anywhere from incremental to extremely impactful. Generally, they expect AI to continue to be targeted toward efficiencies in workplaces and other activities, and they say it is likely to be embedded in most human endeavors.

The greatest share of participants in this canvassing said automated systems driven by artificial intelligence are already improving many dimensions of their work, play and home lives and they expect this to continue over the next decade. While they worry over the accompanying negatives of human-AI advances, they hope for broad changes for the better as networked, intelligent systems are revolutionizing everything, from the most pressing professional work to hundreds of the little “everyday” aspects of existence.

One respondent’s answer covered many of the improvements experts expect as machines sit alongside humans as their assistants and enhancers. An **associate professor at a major university in Israel**wrote, “In the coming 12 years AI will enable all sorts of professions to do their work more efficiently, especially those involving ‘saving life’: individualized medicine, policing, even warfare (where attacks will focus on disabling infrastructure and less in killing enemy combatants and civilians). In other professions, AI will enable greater individualization, e.g., education based on the needs and intellectual abilities of each pupil/student. Of course, there will be some downsides: greater unemployment in certain ‘rote’ jobs (e.g., transportation drivers, food service, robots and automation, etc.).”

This section begins with experts sharing mostly positive expectations for the evolution of humans and AI. It is followed by separate sections that include their thoughts about the potential for AI-human partnerships and quality of life in 2030, as well as the future of jobs, health care and education.

**AI will be integrated into most aspects of life, producing new efficiencies and enhancing human capacities**

Many of the leading experts extolled the positives they expect to continue to expand as AI tools evolve to do more things for more people.

**Martijn van Otterlo**, author of “Gatekeeping Algorithms with Human Ethical Bias” and assistant professor of artificial intelligence at Tilburg University in the Netherlands, wrote, “Even though I see many ethical issues, potential problems and especially power imbalance/misuse issues with AI (not even starting about singularity issues and out-of-control AI), I do think AI will change most lives for the better, especially looking at the short horizon of 2030 even more-so, because even bad effects of AI can be considered predominantly ‘good’ by the majority of people. For example, the Cambridge Analytica case has shown us the huge privacy issues of modern social networks in a market economy, but, overall, people value the extraordinary services Facebook offers to improve communication opportunities, sharing capabilities and so on.”

Vint Cerf, Internet Hall of Fame member and vice president and chief internet evangelist at Google, said, “I see AI and machine learning as augmenting human cognition a la Douglas Engelbart. There will be abuses and bugs, some harmful, so we need to be thoughtful about how these technologies are implemented and used, but, on the whole, I see these as constructive.”

Mícheál Ó Foghlú, engineering director and DevOps Code Pillar at Google’s Munich office, said, “The trend is that AI/ML models in specific domains can out-perform human experts (e.g., certain cancer diagnoses based on image-recognition in retina scans). I think it would be fairly much the consensus that this trend would continue, and many more such systems could aid human experts to be more accurate.”

Craig Mathias, principal at Farpoint Group, an advisory firm specializing in wireless networking and mobile computing, commented, “Many if not most of the large-scale technologies that we all depend upon – such as the internet itself, the power grid, and roads and highways – will simply be unable to function in the future without AI, as both solution complexity and demand continue to increase.”

Matt Mason, a roboticist and the former director of the Robotics Institute at Carnegie Mellon University, wrote, “AI will present new opportunities and capabilities to improve the human experience. While it is possible for a society to behave irrationally and choose to use it to their detriment, I see no reason to think that is the more likely outcome.”

Mike Osswald, vice president of experience innovation at Hanson Inc., commented, “I’m thinking of a world in which people’s devices continuously assess the world around them to keep a population safer and healthier. Thinking of those living in large urban areas, with devices forming a network of AI input through sound analysis, air quality, natural events, etc., that can provide collective notifications and insight to everyone in a certain area about the concerns of environmental factors, physical health, even helping provide no quarter for bad actors through community policing.”

Barry Hughes, senior scientist at the Center for International Futures at the University of Denver, commented, “I was one of the original test users of the ARPANET and now can hardly imagine living without the internet. Although AI will be disruptive through 2030 and beyond, meaning that there will be losers in the workplace and growing reasons for concern about privacy and AI/cyber-related crime, on the whole I expect that individuals and societies will make choices on use and restriction of use that benefit us. Examples include likely self-driving vehicles at that time, when my wife’s deteriorating vision and that of an increased elderly population will make it increasingly liberating. I would expect rapid growth in use for informal/non-traditional education as well as some more ambivalent growth in the formal-education sector. Big-data applications in health-related research should be increasingly productive, and health care delivery should benefit. Transparency with respect to its character and use, including its developers and their personal benefits, is especially important in limiting the inevitable abuse.”

Dana Klisanin, psychologist, futurist and game designer, predicted, “People will increasingly realize the importance of interacting with each other and the natural world and they will program AI to support such goals, which will in turn support the ongoing emergence of the ‘slow movement.’ For example, grocery shopping and mundane chores will be allocated to AI (smart appliances), freeing up time for preparation of meals in keeping with the slow food movement. Concern for the environment will likewise encourage the growth of the slow goods/slow fashion movement. The ability to recycle, reduce, reuse will be enhanced by the use of in-home 3D printers, giving rise to a new type of ‘craft’ that is supported by AI. AI will support the ‘cradle-to-grave’ movement by making it easier for people to trace the manufacturing process from inception to final product.”

Liz Rykert, president at Meta Strategies, a consultancy that works with technology and complex organizational change, responded, “The key for networked AI will be the ability to diffuse equitable responses to basic care and data collection. If bias remains in the programming it will be a big problem. I believe we will be able to develop systems that will learn from and reflect a much broader and more diverse population than the systems we have now.”

Michael R. Nelson, a technology policy expert for a leading network services provider who worked as a technology policy aide in the Clinton administration, commented, “Most media reports focus on how machine learning will directly affect people (medical diagnosis, self-driving cars, etc.) but we will see big improvements in infrastructure (traffic, sewage treatment, supply chain, etc.).”

Gary Arlen, president of Arlen Communications, wrote, “After the initial frenzy recedes about specific AI applications (such as autonomous vehicles, workplace robotics, transaction processing, health diagnoses and entertainment selections), specific applications will develop – probably in areas barely being considered today. As with many new technologies, the benefits will not apply equally, potentially expanding the haves-and-have-nots dichotomy. In addition, as AI delves into new fields – including creative work such as design, music/art composition – we may see new legal challenges about illegal appropriation of intellectual property (via machine learning). However, the new legal tasks from such litigation may not need a conventional lawyer – but could be handled by AI itself. Professional health care AI poses another type of dichotomy. For patients, AI could be a bonanza, identifying ailments, often in early stages (based on early symptoms), and recommending treatments. At the same time, such automated tasks could impact employment for medical professionals. And again, there are legal challenges to be determined, such as liability in the case of a wrong action by the AI. Overall, there is no such thing as ‘most people,’ but many individuals and groups – especially in professional situations – WILL live better lives thanks to AI, albeit with some severe adjustment pains.”

Tim Morgan, a respondent who provided no identifying details, said, “Algorithmic machine learning will be our intelligence amplifier, exhaustively exploring data and designs in ways humans alone cannot. The world was shocked when IBM’s Deep Blue computer beat Garry Kasparov in 1997. What emerged later was the realization that human and AI ‘centaurs’ could combine to beat anyone, human or AI. The synthesis is more than the sum of the parts.”

Marshall Kirkpatrick, product director of influencer marketing, responded, “If the network can be both decentralized and imbued with empathy, rather than characterized by violent exploitation, then we’re safe. I expect it will land in between, hopefully leaning toward the positive. For example, I expect our understanding of self and freedom will be greatly impacted by an instrumentation of a large part of memory, through personal logs and our data exhaust being recognized as valuable just like when we shed the term ‘junk DNA.’ Networked AI will bring us new insights into our own lives that might seem as far-fetched today as it would have been 30 years ago to say, ‘I’ll tell you what music your friends are discovering right now.’ AI is most likely to augment humanity for the better, but it will take longer and not be done as well as it could be. Hopefully we’ll build it in a way that will help us be comparably understanding to others.”

Daniel A. Menasce, professor of computer science at George Mason University, commented, “AI and related technologies coupled with significant advances in computer power and decreasing costs will allow specialists in a variety of disciplines to perform more efficiently and will allow non-specialists to use computer systems to augment their skills. Some examples include health delivery, smart cities and smart buildings. For these applications to become reality, easy-to-use user interfaces, or better yet transparent user interfaces will have to be developed.”

**David Wells**, chief financial officer at Netflix, responded, “Technology progression and advancement has always been met with fear and anxiety, giving way to tremendous gains for humankind as we learn to enhance the best of the changes and adapt and alter the worst. Continued networked AI will be no different but the pace of technological change has increased, which is different and requires us to more quickly adapt. This pace is different and presents challenges for some human groups and societies that we will need to acknowledge and work through to avoid marginalization and political conflict. But the gains from better education, medical care and crime reduction will be well worth the challenges.”

**Rik Farrow**, editor of ;login: for the USENIX association, wrote, “Humans do poorly when it comes to making decisions based on facts, rather than emotional issues. Humans get distracted easily. There are certainly things that AI can do better than humans, like driving cars, handling finances, even diagnosing illnesses. Expecting human doctors to know everything about the varieties of disease and humans is silly. Let computers do what they are good at.”

**Steve Crocker**, CEO and co-founder of Shinkuro Inc. and Internet Hall of Fame member, responded, “AI and human-machine interaction has been under vigorous development for the past 50 years. The advances have been enormous. The results are marbled through all of our products and systems. Graphics, speech [and] language understanding are now taken for granted. Encyclopedic knowledge is available at our fingertips. Instant communication with anyone, anywhere exists for about half the world at minimal cost. The effects on productivity, lifestyle and reduction of risks, both natural and man-made, have been extraordinary and will continue. As with any technology, there are opportunities for abuse, but the challenges for the next decade or so are not significantly different from the challenges mankind has faced in the past. Perhaps the largest existential threat has been the potential for nuclear holocaust. In comparison, the concerns about AI are significantly less.”

**James Kadtke**, expert on converging technologies at the Institute for National Strategic Studies at the U.S. National Defense University, wrote, “Barring the deployment of a few different radically new technologies, such as general AI or commercial quantum computers, the internet and AI [between now and 2030] will proceed on an evolutionary trajectory. Expect internet access and sophistication to be considerably greater, but not radically different, and also expect that malicious actors using the internet will have greater sophistication and power. Whether we can control both these trends for positive outcomes is a public policy issue more than a technological one.”

**Tim Morgan**, a respondent who provided no identifying details, said, “Human/AI collaboration over the next 12 years will improve the overall quality of life by finding new approaches to persistent problems. We will use these adaptive algorithmic tools to explore whole new domains in every industry and field of study: materials science, biotech, medicine, agriculture, engineering, energy, transportation and more. … This goes beyond computability into human relationships. AIs are beginning to understand and speak the human language of emotion. The potential of affective computing ranges from productivity-increasing adaptive interfaces, to ‘pre-crime’ security monitoring of airports and other gathering places, to companion ‘pets’ which monitor their aging owners and interact with them in ways that improve their health and disposition. Will there be unseen dangers or consequences? Definitely. That is our pattern with our tools. We invent them, use them to improve our lives and then refine them when we find problems. AI is no different.”

**Ashok Goel**, director of the human-centered computing Ph.D. program at Georgia Tech, wrote, “Human-AI interaction will be multimodal: We will directly converse with AIs, for example. However, much of the impact of AI will come in enhancing human-human interaction across both space (we will be networked with others) and time (we will have access to all our previously acquired knowledge). This will aid, augment and amplify individual and collective human intelligence in unprecedented and powerful ways.”

**David Cake**, an leader with Electronic Frontiers Australia and vice-chair of the ICANN GNSO Council, wrote, “In general, machine learning and related technologies have the capacity to greatly reduce human error in many areas where it is currently very problematic and make available good, appropriately tailored advice to people to whom it is currently unavailable, in literally almost every field of human endeavour.”

**Fred Baker**, an independent networking technologies consultant, longtime leader in the Internet Engineering Task Force and engineering fellow with Cisco, commented, “In my opinion, developments have not been ‘out of control,’ in the sense that the creation of Terminator’s Skynet or the HAL 9000 computer might depict them. Rather, we have learned to automate processes in which neural networks have been able to follow data to its conclusion (which we call ‘big data’) unaided and uncontaminated by human intuition, and sometimes the results have surprised us. These remain, and in my opinion will remain, to be interpreted by human beings and used for our purposes.”

**Bob Frankston**, software innovation pioneer and technologist based in North America, wrote, “It could go either way. AI could be a bureaucratic straitjacket and tool of surveillance. I’m betting that machine learning will be like the X-ray in giving us the ability to see new wholes and gain insights.”

**Perry Hewitt**, a marketing, content and technology executive, wrote, “Today, voice-activated technologies are an untamed beast in our homes. Some 16% of Americans have a smart speaker, and yet they are relatively dumb devices: They misinterpret questions, offer generic answers and, to the consternation of some, are turning our kids into a\*\*holes. I am bullish on human-machine interactions developing a better understanding of and improving our daily routines. I think in particular of the working parent, often although certainly not exclusively a woman, who carries so much information in their head. What if a human-machine collaboration could stock the house with essentials, schedule the pre-camp pediatrician appointments and prompt drivers for the alternate-side parking/street cleaning rules. The ability for narrow AI to assimilate new information (the bus is supposed to come at 7:10 but a month into the school year is known to actually come at 7:16) could keep a family connected and informed with the right data, and reduce the mental load of household management.”

**John McNutt**, a professor in the school of public policy and administration at the University of Delaware, responded, “Throwing out technology because there is a potential downside is not how human progress takes place. In public service, a turbulent environment has created a situation where knowledge overload can seriously degrade our ability to do the things that are essential to implement policies and serve the public good. AI can be the difference between a public service that works well and one that creates more problems than it solves.”

**Randy Marchany**, chief information security officer at Virginia Tech and director of Virginia Tech’s IT Security Laboratory, said, “AI-human interaction in 2030 will be in its ‘infancy’ stage. AI will need to go to ‘school’ in a manner similar to humans. They will amass large amounts of data collected by various sources but need ‘ethics’ training to make good decisions. Just as kids are taught a wide variety of info and some sort of ethics (religion, social manners, etc.), AI will need similar training. Will AI get the proper training? Who decides the training content?”

**Robert Stratton**, cybersecurity expert, said, “While there is widespread acknowledgement in a variety of disciplines of the potential benefits of machine learning and artificial intelligence technologies, progress has been tempered by their misapplication. Part of data science is knowing the right tool for a particular job. As more-rigorous practitioners begin to gain comfort and apply these tools to other corpora it’s reasonable to expect some significant gains in efficiency, insight or profitability in many fields. This may not be visible to consumers except through increased product choice, but it may include everything from drug discovery to driving.”

**A** **data analyst for an organization developing marketing solutions** said, “Assuming that policies are in place to prevent the abuse of AI and programs are in place to find new jobs for those who would be career-displaced, there is a lot of potential in AI integration. By 2030, most AI will be used for marketing purposes and be more annoying to people than anything else as they are bombarded with personalized ads and recommendations. The rest of AI usage will be its integration into more tedious and repetitive tasks across career fields. Implementing AI in this fashion will open up more time for humans to focus on long-term and in-depth tasks that will allow further and greater societal progression. For example, AI can be trained to identify and codify qualitative information from surveys, reviews, articles, etc., far faster and in greater quantities than even a team of humans can. By having AI perform these tasks, analysts can spend more time parsing the data for trends and information that can then be used to make more-informed decisions faster and allow for speedier turn-around times. Minor product faults can be addressed before they become widespread, scientists can generate semiannual reports on environmental changes rather than annual or biannual.”

**Helena Draganik**, a professor at the University of Gdańsk in Poland, responded, “AI will not change humans. It will change the relations between them because it can serve as an interpreter of communication. It will change our habits (as an intermediation technology). AI will be a great commodity. It will help in cases of health problems (diseases). It will also generate a great ‘data industry’ (big data) market and a lack of anonymity and privacy. Humanity will more and more depend on energy/electricity. These factors will create new social, cultural, security and political problems.”

There are those who think there won’t be much change by 2030.

**Christine Boese**, digital strategies professional, commented, “I believe it is as William Gibson postulated, ‘The future is already here, it just not very evenly distributed.’ What I know from my work in user-experience design and in exposure to many different Fortune 500 IT departments working in big data and analytics is that the promise and potential of AI and machine learning is VASTLY overstated. There has been so little investment in basic infrastructure, entire chunks of our systems won’t even be interoperable. The AI and machine learning code will be there, in a pocket here, a pocket there, but system-wide, it is unlikely to be operating reliably as part of the background radiation against which many of us play and work online.”

**An anonymous respondent** wrote, “While various deployments of new data science and computation will help firms cut costs, reduce fraud and support decision-making that involves access to more information than an individual can manage, organisations, professions, markets and regulators (public and private) usually take many more than 12 years to adapt effectively to a constantly changing set of technologies and practices. This generally causes a decline in service quality, insecurity over jobs and investments, new monopoly businesses distorting markets and social values, etc. For example, many organisations will be under pressure to buy and implement new services, but unable to access reliable market information on how to do this, leading to bad investments, distractions from core business, and labour and customer disputes.”

**Mario Morino**, chairman of the Morino Institute and co-founder of Venture Philanthropy Partners, commented, “While I believe AI/ML will bring enormous benefits, it may take us several decades to navigate through the disruption and transition they will introduce on multiple levels.”

**Daniel Berninger**, an internet pioneer who led the first VoIP deployments at Verizon, HP and NASA, currently founder at Voice Communication Exchange Committee (VCXC), said, “The luminaries claiming artificial intelligence will surpass human intelligence and promoting robot reverence imagine exponentially improving computation pushes machine self-actualization from science fiction into reality. The immense valuations awarded Google, Facebook, Amazon, Tesla, et al., rely on this machine-dominance hype to sell infinite scaling. As with all hype, pretending reality does not exist does not make reality go away. Moore’s Law does not concede the future to machines, because human domination of the planet does not owe to computation. Any road map granting machines self-determination includes ‘miracle’ as one of the steps. You cannot turn a piece of wood into a real boy. AI merely ‘models’ human activity. No amount of improvement in the development of these models turns the ‘model’ into the ‘thing.’ Robot reverence attempts plausibility by collapsing the breadth of human potential and capacities. It operates via ‘denialism’ with advocates disavowing the importance of anything they cannot model. In particular, super AI requires pretending human will and consciousness do not exist. Human beings remain the source of all intent and the judge of all outcomes. Machines provide mere facilitation and mere efficiency in the journey from intent to outcome. The dehumanizing nature of automation and the diseconomy of scale of human intelligence is already causing headaches that reveal another AI Winter arriving well before 2030.”

**Paul Kainen**, futurist and director of the Lab for Visual Mathematics at Georgetown University, commented, “Quantum cat here: I expect complex superposition of strong positive, negative and null as typical impact for AI. For the grandkids’ sake, we must be positive!”

The following one-liners from anonymous respondents also tie into AI in 2030:

* **An** **Internet Hall of Fame member**wrote, “You’ll talk to your digital assistant in a normal voice and it will just be there – it will often anticipate your needs, so you may only need to talk to it to correct or update it.”
* **The director of a cognitive research group** **at one of the world’s top AI and large-scale computing companies** predicted that by 2030, “Smartphone-equivalent devices will support true natural-language dialog with episodic memory of past interactions. Apps will become low-cost digital workers with basic commonsense reasoning.”
* **An** **anonymous** **Internet Hall of Fame member**said, “The equivalent of the ‘Star Trek’ universal translator will become practical, enabling travelers to better interact with people in countries they visit, facilitate online discussions across language barriers, etc.”
* **An Internet of Things researcher** commented, “We need to balance between human emotions and machine intelligence – can machines be emotional? – that’s the frontier we have to conquer.”
* **An anonymous respondent** wrote, “2030 is still quite possibly before the advent of human-level AI. During this phase AI is still mostly augmenting human efforts – increasingly ubiquitous, optimizing the systems that surround us and being replaced when their optimization criteria are not quite perfect – rather than pursuing those goals programmed into them, whether we find the realization of those goals desirable or not.”
* **A research scientist who works for Google** said, “Things will be better, although many people are deeply worried about the effects of AI.”
* **An** **ARPANET and internet pioneer** wrote, “The kind of AI we are currently able to build as good for data analysis but far, far away from ‘human’ levels of performance; the next 20 years won’t change this, but we will have valuable tools to help analyze and control our world.”
* **An artificial intelligence researcher working for one of the world’s most powerful technology companies** wrote, “AI will enhance our vision and hearing capabilities, remove language barriers, reduce time to find information we care about and help in automating mundane activities.”
* **A manager with a major digital innovation company**said, “Couple the information storage with the ever-increasing ability to rapidly search and analyze that data, and the benefits to augmenting human intelligence with this processed data will open up new avenues of technology and research throughout society.”

Other anonymous respondents commented:

* “AI will help people to manage the increasingly complex world we are forced to navigate. It will empower individuals to not be overwhelmed.”
* “AI will reduce human error in many contexts: driving, workplace, medicine and more.”
* “In teaching it will enhance knowledge about student progress and how to meet individual needs; it will offer guidance options based on the unique preferences of students that can guide learning and career goals.”
* “2030 is only 12 years from now, so I expect that systems like Alexa and Siri will be more helpful but still of only medium utility.”
* “AI will be a useful tool; I am quite a ways away from fearing SkyNet and the rise of the machines.”
* “AI will produce major benefits in the next 10 years, but ultimately the question is one of politics: Will the world somehow manage to listen to the economists, even when their findings are uncomfortable?”
* “I strongly believe that an increasing use of numerical control will improve the lives of people in general.”
* “AI will help us navigate choices, find safer routes and avenues for work and play, and help make our choices and work more consistent.”
* “Many factors will be at work to increase or decrease human welfare, and it will be difficult to separate them.”

**AI will optimize and augment people’s lives**

The hopeful experts in this sample generally expect that AI will work to optimize, augment and improve human activities and experiences. They say it will save time and it will save lives via health advances and the reduction of risks and of poverty. They hope it will spur innovation and broaden opportunities, increase the value of human-to-human experiences, augment humans and increase individuals’ overall satisfaction with life.

**Clay Shirky**, writer and consultant on the social and economic effects of internet technologies and vice president at New York University, said, “All previous forms of labor-saving devices, from the level to the computer, have correlated with increased health and lifespan in the places that have adopted them.”

**Jamais Cascio**, research fellow at the Institute for the Future, wrote, “Although I do believe that in 2030 AI will have made our lives better, I suspect that popular media of the time will justifiably highlight the large-scale problems: displaced workers, embedded bias and human systems being too deferential to machine systems. But AI is more than robot soldiers, autonomous cars or digital assistants with quirky ‘personalities.’ Most of the AI we will encounter in 2030 will be in-the-walls, behind-the-scenes systems built to adapt workspaces, living spaces and the urban environment to better suit our needs. Medical AI will keep track of medication and alert us to early signs of health problems. Environmental AI will monitor air quality, heat index and other indicators relevant to our day’s tasks. Our visual and audio surroundings may be altered or filtered to improve our moods, better our focus or otherwise alter our subconscious perceptions of the world. Most of this AI will be functionally invisible to us, as long as it’s working properly. The explicit human-machine interface will be with a supervisor system that coordinates all of the sub-AI – and undoubtedly there will be a lively business in creating supervisor systems with quirky personalities.”

**Mike Meyer**, chief information officer at Honolulu Community College, wrote, “Social organizations will be increasingly administered by AI/ML systems to ensure equity and consistency in provisioning of services to the population. The steady removal of human emotion-driven discrimination will rebalance social organizations creating true equitable opportunity to all people for the first time in human history. People will be part of these systems as censors, in the old imperial Chinese model, providing human emotional intelligence where that is needed to smooth social management. All aspects of human existence will be affected by the integration of AI into human societies. Historically this type of base paradigmatic change is both difficult and unstoppable. The results will be primarily positive but will produce problems both in the process of change and in totally new types of problems that will result from the ways that people do adapt the new technology-based processes.”

**Mark Crowley**, an assistant professor, expert in machine learning and core member of the Institute for Complexity and Innovation at the University of Waterloo in Ontario, Canada, wrote, “While driving home on a long commute from work the human will be reading a book in the heads-up screen of the windshield. The car will be driving autonomously on the highway for the moment. The driver will have an idea to note down and add to a particular document; all this will be done via voice. In the middle of this a complicated traffic arrangement will be seen approaching via other networked cars. The AI will politely interrupt the driver, put away the heads-up display and warn the driver they may need to take over in the next 10 seconds or so. The conversation will be flawless and natural, like Jarvis in ‘Avengers,’ even charming. But it will be tasks-focused to the car, personal events, notes and news.”

**Theodore Gordon**, futurist, management consultant and co-founder of the Millennium Project, commented, “There will be ups and downs, surely, but the net is, I believe, good. The most encouraging uses of AI will be in early warning of terror activities, incipient diseases and environmental threats and in improvements in decision-making.”

**Yvette Wohn**, director of the Social Interaction Lab and expert on human-computer interaction at the New Jersey Institute of Technology, said, “One area in which artificial intelligence will become more sophisticated will be in its ability to enrich the quality of life so that the current age of workaholism will transition into a society where leisure, the arts, entertainment and culture are able to enhance the well-being of society in developed countries and solve issues of water production, food growth/distribution and basic health provision in developing countries.”

**Ken Goldberg**, distinguished chair in engineering, director of AUTOLAB’s and CITRIS’ “people and robots” initiative, and founding member of the Berkeley Artificial Intelligence Research Lab at the University of California, Berkeley, said, “As in the past 50+ years, AI will be combined with IA (intelligence augmentation) to enhance humans’ ability to work. One example might be an AI-based ‘Devil’s Advocate’ that would challenge my decisions with insightful questions (as long as I can turn it off periodically).”

**Rich Ling**, a professor of media technology at Nanyang Technological University, responded, “The ability to address complex issues and to better respond to and facilitate the needs of people will be the dominant result of AI.”

**An anonymous respondent**wrote, “There will be an explosive increase in the number of autonomous cognitive agents (e.g., robots), and humans will interact more and more with them, being unaware, most of the time, if it is interactivity with a robot or with another human. This will increase the number of personal assistants and the level of service.”

Fred Davis, mentor at Runway Incubator in San Francisco, responded, “As daily a user of the Google Assistant on my phone and both Google Home and Alexa, I feel like AI has already been delivering significant benefits to my daily life for a few years. My wife and I take having an always-on omnipresent assistant on hand for granted at this point. Google Home’s ability to tell us apart and even respond with different voices is a major step forward in making computers people-literate, rather than the other way around. There’s always a concern about privacy, but so far it hasn’t caused us any problems. Obviously, this could change and instead of a helpful friend I might look at these assistants as creepy strangers. Maintaining strict privacy and security controls is essential for these types of services.”

Andrew Tutt, an expert in law and author of “An FDA for Algorithms,” which called for “critical thought about how best to prevent, deter and compensate for the harms that they cause,” said, “AI will be absolutely pervasive and absolutely seamless in its integration with everyday life. It will simply become accepted that AI are responsible for ever-more-complex and ever-more-human tasks. By 2030, it will be accepted that when you wish to hail a taxi the taxi will have no driver – it will be an autonomously driven vehicle. Robots will be responsible for more-dynamic and complex roles in manufacturing plants and warehouses. Digital assistants will play an important and interactive role in everyday interactions ranging from buying a cup of coffee to booking a salon appointment. It will no longer be unexpected to call a restaurant to book a reservation, for example, and speak to a ‘digital’ assistant who will pencil you in. These interactions will be incremental but become increasingly common and increasingly normal. My hope is that the increasing integration of AI into everyday life will vastly increase the amount of time that people can devote to tasks they find meaningful.”

L. Schomaker, professor at the University of Groningen and scientific director of the Artificial Intelligence and Cognitive Engineering (ALICE) research institute, said, “In the 1990s, you went to a PC on a desktop in a room in your house. In the 2010s you picked a phone from your pocket and switched it on. By 2030 you will be online 24/7 via miniature devices such as in-ear continuous support, advice and communications.”

Michael Wollowski, associate professor of computer science and software engineering at Rose-Hulman Institute of Technology and expert in the Internet of Things, diagrammatic systems, and artificial intelligence, wrote, “Assuming that industry and government are interested in letting the consumer choose and influence the future, there will be many fantastic advances of AI. I believe that AI and the Internet of Things will bring about a situation in which technology will be our guardian angel. For example, self-driving cars will let us drive faster than we ever drove before, but they will only let us do things that they can control. Since computers have much better reaction time than people, it will be quite amazing. Similarly, AI and the Internet of Things will let us conduct out lives to the fullest while ensuring that we live healthy lives. Again, it is like having a guardian angel that lets us do things, knowing they can save us from stupidity.”

Steve King, partner at Emergent Research, said, “2030 is less than 12 years away. So … the most likely scenario is AI will have a modest impact on the lives of most humans over this time frame. Having said that, we think the use of AI systems will continue to expand, with the greatest growth coming from systems that augment and complement human capabilities and decision-making. This is not to say there won’t be negative impacts from the use of AI. Jobs will be replaced, and certain industries will be disrupted. Even scarier, there are many ways AI can be weaponized. But like most technological advancements, we think the overall impact of AI will be additive – at least over the next decade or so.”

Vassilis Galanos, a Ph.D. student and teaching assistant actively researching future human-machine symbiosis at the University of Edinburgh, commented, “2030 is not that far away, so there is no room for extremely utopian/dystopian hopes and fears. … Given that AI is already used in everyday life (social-media algorithms, suggestions, smartphones, digital assistants, health care and more), it is quite probable that humans will live in a harmonious co-existence with AI as much as they do now – to a certain extent – with computer and internet technologies.”

Charlie Firestone, communications and society program executive director and vice president at the Aspen Institute, commented, “I remain optimistic that AI will be a tool that humans will use, far more widely than today, to enhance quality of life such as medical remedies, education and the environment. For example, the AI will help us to conserve energy in homes and in transportation by identifying exact times and temperatures we need, identifying sources of energy that will be the cheapest and the most efficient. There certainly are dire scenarios, particularly in the use of AI for surveillance, a likely occurrence by 2030. I am hopeful that AI and other technologies will identify new areas of employment as it eliminates many jobs.”

Pedro U. Lima, an associate professor of computer science at Instituto Superior Técnico in Lisbon, Portugal, said, “Overall, I see AI-based technology relieving us from repetitive and/or heavy and/or dangerous tasks, opening new challenges for our activities. I envisage autonomous mobile robots networked with a myriad of other smart devices, helping nurses and doctors at hospitals in daily activities, working as a ‘third hand’ and (physical and emotional) support to patients. I see something similar happening in factories, where networked robot systems will help workers on their tasks, relieving them from heavy duties.”

John Laird, a professor of computer science and engineering at the University of Michigan, responded, “There will be a continual off-loading of mundane intellectual and physical tasks on to AI and robotic systems. In addition to helping with everyday activities, it will significantly help the mentally and physically impaired and disabled. There will also be improvements in customized/individualized education and training of humans, and conversely, the customization of AI systems by everyday users. We will be transitioning from current programming practices to user customization. Automated driving will be a reality, eliminating many deaths but also having significant societal changes.”

Steven Polunsky, director of the Alabama Transportation Policy Research Center at the University of Alabama, wrote, “AI will allow public transportation systems to better serve existing customers by adjusting routes, travel times and stops to optimize service. New customers will also see advantages. Smart transportation systems will allow public transit to network with traffic signals and providers of ‘last-mile’ trips to minimize traffic disruption and inform decision making about modal (rail, bus, mobility-on-demand) planning and purchasing.”

Sanjiv Das, a professor of data science and finance at Santa Clara University, responded, “AI will enhance search to create interactive reasoning and analytical systems. Search engines today do not know ‘why’ we want some information and hence cannot reason about it. They also do not interact with us to help with analysis. An AI system that collects information based on knowing why it is needed and then asks more questions to refine its search would be clearly available well before 2030. These ‘search-thinking bots’ will also write up analyses based on parameters elicited from conversation and imbue these analyses with different political (left/right) and linguistic (aggressive/mild) slants, chosen by the human, using advances in language generation, which are already well under way. These ‘intellectual’ agents will become companions, helping us make sense of our information overload. I often collect files of material on my cloud drive that I found interesting or needed to read later, and these agents would be able to summarize and engage me in a discussion of these materials, very much like an intellectual companion. It is unclear to me if I would need just one such agent, though it seems likely that different agents with diverse personalities may be more interesting! As always, we should worry what the availability of such agents might mean for normal human social interaction, but I can also see many advantages in freeing up time for socializing with other humans as well as enriched interactions, based on knowledge and science, assisted by our new intellectual companions.”

Lawrence Roberts, designer and manager of ARPANET, the precursor to the internet and Internet Hall of Fame member, commented, “AI voice recognition, or text, with strong context understanding and response will allow vastly better access to website, program documentation, voice call answering, and all such interactions will greatly relieve user frustration with getting information. It will mostly provide service where no or little human support is being replaced as it is not available today in large part. For example, finding and/or doing a new or unused function of the program or website one is using. Visual, 3D-space-recognition AI to support better-than-human robot activity including vehicles, security surveillance, health scans and much more.”

Christopher Yoo, a professor of law, communication and computer and information science at the University of Pennsylvania Law School, responded, “AI is good at carrying out tasks that follow repetitive patterns. In fact, AI is better than humans. Shifting these functions to machines will improve performance. It will also allow people to shift their efforts to high-value-added and more-rewarding directions, an increasingly critical consideration in developing world countries where population is declining. Research on human-computer interaction (HCI) also reveals that AI-driven pattern recognition will play a critical role in expanding humans’ ability to extend the benefits of computerization. HCI once held that our ability to gain the benefit from computers would be limited by the total amount of time people can spend sitting in front of a screen and inputting characters through a keyboard. The advent of AI-driven HCI will allow that to expand further and will reduce the amount of customization that people will have to program in by hand. At the same time, AI is merely a tool. All tools have their limits and can be misused. Even when humans are making the decisions instead of machines, blindly following the results of a protocol without exercising any judgment, can have disastrous results. Future applications of AI will thus likely involve both humans and machines if they are to fulfill their potential.”

Joseph Konstan, distinguished professor of computer science specializing in human-computer interaction and AI at the University of Minnesota, predicted, “Widespread deployment of AI has immense potential to help in key areas that affect a large portion of the world’s population, including agriculture, transportation (more efficiently getting food to people) and energy. Even as soon as 2030, I expect we’ll see substantial benefits for many who are today disadvantaged, including the elderly and physically handicapped (who will have greater choices for mobility and support) and those in the poorest part of the world.”

### The future of work: Some predict new work will emerge or solutions will be found, while others have deep concerns about massive job losses and an unraveling society

A number of expert insights on this topic were shared earlier in [this report](https://www.pewresearch.org/internet/2018/12/10/concerns-about-human-agency-evolution-and-survival/#displacement). These additional observations add to the discussion of hopes and concerns about the future of human jobs. This segment starts with comments from those who are hopeful that the job situation and related social issues will turn out well. It is followed by statements from those who are pessimistic.

#### Respondents who were positive about the future of AI and work

Bob Metcalfe, Internet Hall of Fame member, co-inventor of Ethernet, founder of 3Com and now professor of innovation and entrepreneurship at the University of Texas at Austin, said, “Pessimists are often right, but they never get anything done. All technologies come with problems, sure, but … generally, they get solved. The hardest problem I see is the evolution of work. Hard to figure out. Forty percent of us used to know how to milk cows, but now less than 1% do. We all used to tell elevator operators which floor we wanted, and now we press buttons. Most of us now drive cars and trucks and trains, but that’s on the verge of being over. AIs are most likely not going to kill jobs. They will handle parts of jobs, enhancing the productivity of their humans.”

Stowe Boyd, founder and managing director at Work Futures, said, “There is a high possibility that unchecked expansion of AI could rapidly lead to widespread unemployment. My bet is that governments will step in to regulate the spread of AI, to slow the impacts of this phenomenon as a result of unrest by the mid 2020s. That regulation might include, for example, not allowing AIs to serve as managers of people in the workplace, but only to augment the work of people on a task or process level. So, we might see high degrees of automation in warehouses, but a human being would be ‘in charge’ in some sense. Likewise, fully autonomous freighters might be blocked by regulations.”

An anonymous respondent wrote, “Repeatedly throughout history people have worried that new technologies would eliminate jobs. This has never happened, so I’m very skeptical it will this time. Having said that, there will be major short-term disruptions in the labor market and smart governments should begin to plan for this by considering changes to unemployment insurance, universal basic income, health insurance, etc. This is particularly the case in America, where so many benefits are tied to employment. I would say there is almost zero chance that the U.S. government will actually do this, so there will be a lot of pain and misery in the short and medium term, but I do think ultimately machines and humans will peacefully coexist. Also, I think a lot of the projections on the use of AI are ridiculous. Regardless of the existence of the technology, cross-state shipping is not going to be taken over by automated trucks any time soon because of legal and ethical issues that have not been worked out.”

Steven Miller, vice provost and professor of information systems at Singapore Management University, said, “It helps to have a sense of the history of technological change over the past few hundred years (even longer). Undoubtedly, new ways of using machines and new machine capabilities will be used to create economic activities and services that were either a) not previously possible, or b) previously too scarce and expensive, and now can be plentiful and inexpensive. This will create a lot of new activities and opportunities. At the same time, we know some existing tasks and jobs with a high proportion of those tasks will be increasingly automated. So we will simultaneously have both new opportunity creation as well as technological displacement. Even so, the long-term track record shows that human societies keep finding ways of creating more and more economically viable jobs. Cognitive automation will obviously enhance the realms of automation, but even with tremendous progress in this technology, there are and will continue to be limits. Humans have remarkable capabilities to deal with and adapt to change, so I do not see the ‘end of human work.’ The ways people and machines combine together will change – and there will be many new types of human-machine symbiosis. Those who understand this and learn to benefit from it will proposer.”

Henry E. Brady, dean of the Goldman School of Public Policy at the University of California, Berkeley, wrote, “AI can replace people in jobs that require sophisticated and accurate pattern matching – driving, diagnoses based upon medical imaging, proofreading and other areas. There is also the fact that in the past technological change has mostly led to new kinds of jobs rather than the net elimination of jobs. Furthermore, I also believe that there may be limits to what AI can do. It is very good at pattern matching, but human intelligence goes far beyond pattern matching and it is not clear that computers will be able to compete with humans beyond pattern matching. It also seems clear that even the best algorithms will require constant human attention to update, check and revise them.”

Geoff Livingston, author and futurist, commented, “The term AI misleads people. What we should call the trend is machine learning or algorithms. ‘Weak’ AI as it is called – today’s AI – reduces repetitive tasks that most people find mundane. This in turn produces an opportunity to escape the trap of the proletariat, being forced into monotonous labor to earn a living. Instead of thinking of the ‘Terminator,’ we should view the current trend as an opportunity to seek out and embrace the tasks that we truly love, including more creative pursuits. If we embrace the inevitable evolution of technology to replace redundant tasks, we can encourage today’s youth to pursue more creative and strategic pursuits. Further, today’s workers can learn how to manage machine learning or embrace training to pursue new careers that they may enjoy more. My fear is that many will simply reject change and blame technology, as has often been done. One could argue much of today’s populist uprising we are experiencing globally finds its roots in the current displacements caused by machine learning as typified by smart manufacturing. If so, the movement forward will be troublesome, rife with dark bends and turns that we may regret as cultures and countries.”

Marek Havrda, director at NEOPAS and strategic adviser for the GoodAI project, a private research and development company based in Prague that focuses on the development of artificial general intelligence and AI applications, explained the issue from his point of view, “The development and implementation of artificial intelligence has brought about questions of the impact it will have on employment. Machines are beginning to fill jobs that have been traditionally reserved for humans, such as driving a car or prescribing medical treatment. How these trends may unfold is a crucial question. We may expect the emergence of ‘super-labour,’ a labour defined by super-high-added-value of human activity due to augmentation by AI. Apart from the ability to deploy AI, super-labour will be characterised by creativity and the ability to co-direct and supervise safe exploration of business opportunities together with perseverance in attaining defined goals. An example may be that by using various online, AI gig workers (and maybe several human gig workers), while leveraging AI to its maximum potential … at all aspects from product design to marketing and after-sales care, three people could create a new service and ensure its smooth delivery for which a medium-size company would be needed today. We can expect growing inequalities between those who have access and are able to use technology and those who do not. However, it seems more important how big a slice of the AI co-generated ‘pie’ is accessible to all citizens in absolute terms (e.g., having enough to finance public service and other public spending) which would make everyone better off than in pre-AI age, than the relative inequalities.”

Yoram Kalman, an associate professor at the Open University of Israel and member of The Center for Internet Research at the University of Haifa, wrote, “In essence, technologies that empower people also improve their lives. I see that progress in the area of human-machine collaboration empowers people by improving their ability to communicate and to learn, and thus my optimism. I do not fear that these technologies will take the place of people, since history shows that again and again people used technologies to augment their abilities and to be more fulfilled. Although in the past, too, it seemed as if these technologies would leave people unemployed and useless, human ingenuity and the human spirit always found new challenges that could best be tackled by humans.”

Thomas H. Davenport, distinguished professor of information technology and management at Babson College and fellow of the MIT Initiative on the Digital Economy, responded, “So far, most implementations of AI have resulted in some form of augmentation, not automation. Surveys of managers suggest that relatively few have automation-based job loss as the goal of their AI initiatives. So while I am sure there will be some marginal job loss, I expect that AI will free up workers to be more creative and to do more unstructured work.”

Yvette Wohn, director of the Social Interaction Lab and expert on human-computer interaction at the New Jersey Institute of Technology, commented, “Artificial intelligence will be naturally integrated into our everyday lives. Even though people are concerned about computers replacing the jobs of humans the best-case scenario is that technology will be augmenting human capabilities and performing functions that humans do not like to do. Smart farms and connected distribution systems will hopefully eliminate urban food deserts and enable food production in areas not suited for agriculture. Artificial intelligence will also become better at connecting people and provide immediate support to people who are in crisis situations.”

A principal architect for a major global technology company responded, “AI is a prerequisite to achieving a post-scarcity world, in which people can devote their lives to intellectual pursuits and leisure rather than to labor. The first step will be to reduce the amount of labor required for production of human necessities. Reducing tedium will require changes to the social fabric and economic relationships between people as the demand for labor shrinks below the supply, but if these challenges can be met then everyone will be better off.”

Tom Hood, an expert in corporate accounting and finance, said, “By 2030, AI will stand for Augmented Intelligence and will play an ever-increasing role in working side-by-side with humans in all sectors to add its advanced and massive cognitive and learning capabilities to critical human domains like medicine, law, accounting, engineering and technology. Imagine a personal bot powered by artificial intelligence working by your side (in your laptop or smartphone) making recommendations on key topics by providing up-to-the-minute research or key pattern recognition and analysis of your organization’s data? One example is a CPA in tax given a complex global tax situation amid constantly changing tax laws in all jurisdictions who would be able to research and provide guidance on the most complex global issues in seconds. It is my hope for the future of artificial intelligence in 2030 that we will be augmenting our intelligence with these ‘machines.’”

A professor of computer science expert in systems who works at a major U.S. technological university wrote, “By 2030, we should expect advances in AI, networking and other technologies enabled by AI and networks, e.g., the growing areas of persuasive and motivational technologies, to improve the workplace in many ways beyond replacing humans with robots.”

The following one-liners from anonymous respondents express a bright future for human jobs:

* “History of technology shows that the number of new roles and jobs created will likely exceed the number of roles and jobs that are destroyed.”
* “AI will not be competing with humanity but augmenting it for the better.”
* “We make a mistake when we look for direct impact without considering the larger picture – we worry about a worker displaced by a machine rather than focus on broader opportunities for a better-trained and healthier workforce where geography or income no longer determine access not just to information but to relevant and appropriate information paths.”
* “AI can significantly improve usability and thus access to the benefits of technology. Many powerful technical tools today require detailed expertise, and AI can bring more of those to a larger swath of the population.”

#### Respondents who have fears about AI’s impact on work

A [section earlier in this report](https://www.pewresearch.org/internet/2018/12/10/concerns-about-human-agency-evolution-and-survival/#displacement) shared a number of key experts’ concerns about the potential negative impact of AI on the socioeconomic future if steps are not taken soon to begin to adjust to a future with far fewer jobs for humans. Many additional respondents to this canvassing shared fears about this.

Wout de Natris, an internet cybercrime and security consultant based in Rotterdam, Netherlands, wrote, “Hope: Advancement in health care, education, decision-making, availability of information, higher standards in ICT-security, global cooperation on these issues, etc. Fear: Huge segments of society, especially the middle classes who carry society in most ways, e.g., through taxes, savings and purchases, will be rendered jobless through endless economic cuts by industry, followed by governments due to lower tax income. Hence all of society suffers. Can governments and industry refrain from an overkill of surveillance? Otherwise privacy values keep declining, leading to a lower quality of life.”

Jonathan Taplin, director emeritus at the University of Southern California’s Annenberg Innovation Lab, wrote, “My fear is that the current political class is completely unprepared for the disruptions that AI and robotics applied at scale will bring to our economy. While techno-utopians point to universal basic income as a possible solution to wide-scale unemployment, there is no indication that anyone in politics has an appetite for such a solution. And because I believe that meaningful work is essential to human dignity, I’m not sure that universal basic income would be helpful in the first place.”

Alex Halavais, an associate professor of social technologies at Arizona State University, wrote, “AI is likely to rapidly displace many workers over the next 10 years, and so there will be some potentially significant negative effects at the social and economic level in the short run.”

Uta Russmann, professor in the department of communication at FHWien der WKW University of Applied Sciences for Management & Communication, said, “Many people will not be benefitting from this development, as robots will do their jobs. Blue-collar workers, people working in supermarkets stacking shelves, etc., will not be needed less, but the job market will not offer them any other possibilities. The gap between rich and poor will increase as the need for highly skilled and very well-paid people increases and the need for less skilled workers will decrease tremendously.”

Ross Stapleton-Gray, principal at Stapleton-Gray and Associates, an information technology and policy consulting firm, commented, “Human-machine interaction could be for good or for ill. It will be hugely influenced by decisions on social priorities. We may be at a tipping point in recognizing that social inequities need to be addressed, so, say, a decreased need for human labor due to AI will result in more time for leisure, education, etc., instead of increasing wealth inequity.”

Aneesh Aneesh, author of “Global Labor: Algocratic Modes of Organization” and professor at the University of Wisconsin, Milwaukee, responded, “Just as automation left large groups of working people behind even as the United States got wealthier as a country, it is quite likely that AI systems will automate the service sector in a similar way. Unless the welfare state returns with a vengeance, it is difficult to see the increased aggregate wealth resulting in any meaningful gains for the bottom half of society.”

Alper Dincel of T.C. Istanbul Kultur University in Turkey, wrote, “Unqualified people won’t find jobs, as machines and programs take over easy work in the near future. Machines will also solve performance problems. There is no bright future for most people if we don’t start to try finding solutions.”

Jason Abbott, professor and director at the Center for Asian Democracy at University of Louisville, said, “AI is likely to create significant challenges to the labor force as previously skilled (semi-skilled) jobs are replaced by AI – everything from AI in trucks and distribution to airlines, logistics and even medical records and diagnoses.”

Kenneth R. Fleischmann, an associate professor at the University of Texas at Austin’s School of Information, responded, “In corporate settings, I worry that AI will be used to replace human workers to a disproportionate extent, such that the net economic benefit of AI is positive, but that economic benefit is not distributed equally among individuals, with a smaller number of wealthy individuals worldwide prospering, and a larger number of less wealthy individuals worldwide suffering from fewer opportunities for gainful employment.”

Gerry Ellis, founder and digital usability and accessibility consultant at Feel The BenefIT, responded, “Technology has always been far more quickly developed and adopted in the richer parts of the world than in the poorer regions where new technology is generally not affordable. AI cannot be taken as a stand-alone technology but in conjunction with other converging technologies like augmented reality, robotics, virtual reality, the Internet of Things, big data analysis, etc. It is estimated that around 80% of jobs that will be done in 2030 do not exist yet. One of the reasons why unskilled and particularly repetitive jobs migrate to poor countries is because of cheap labour costs, but AI combined with robotics will begin to do many of these jobs. For all of these reasons combined, the large proportion of the earth’s population that lives in the under-developed and developing world is likely to be left behind by technological developments. Unless the needs of people with disabilities are taken into account when designing AI related technologies, the same is true for them (or I should say ‘us,’ as I am blind).”

Karen Oates, director of workforce development and financial stability for La Casa de Esperanza, commented, “Ongoing increases in the use of AI will not benefit the working poor and low-to-middle-income people. Having worked with these populations for 10 years I’ve already observed many of these people losing employment when robots and self-operating forklifts are implemented. Although there are opportunities to program and maintain these machines, realistically people who have the requisite knowledge and education will fill those roles. The majority of employers will be unwilling to invest the resources to train employees unless there is an economic incentive from the government to do so. Many lower-wage workers won’t have the confidence to return to school to develop new knowledge/skills when they were unsuccessful in the past. As the use of AI increases, low-wage workers will lose the small niche they hold in our economy.”

Peggy Lahammer, director of health/life sciences at Robins Kaplan LLP and legal market analyst, commented, “Jobs will continue to change and as many disappear new ones will be created. These changes will have an impact on society as many people are left without the necessary skills.”

A European computer science professor expert in machine learning commented, “The social sorting systems introduced by AI will most likely define and further entrench the existing world order of the haves and the have-nots, making social mobility more difficult and precarious given the unpredictability of AI-driven judgements of fit. The interesting problem to solve will be the fact that initial designs of AI will come with built-in imaginaries of what ‘good’ or ‘correct’ constitutes. The level of flexibility designed in to allow for changes in normative perceptions and judgements will be key to ensuring that AI driven-systems support rather than obstruct productive social change.”

Stephen McDowell, a professor of communication at Florida State University and expert in new media and internet governance, commented, “Much of our daily lives is made up of routines and habits that we repeat, and AI could assist in these practices. However, just because some things we do are repetitive does not mean they are insignificant. We draw a lot of meaning from things we do on a daily, weekly or annual basis, whether by ourselves or with others. Cultural practices such as cooking, shopping, cleaning, coordinating and telling stories are crucial parts of building our families and larger communities. Similarly, at work, some of the routines are predictable, but are also how we gain a sense of mastery and expertise in a specific domain. In both these examples, we will have to think about how we define knowledge, expertise, collaboration, and growth and development.”

David Sarokin, author of “Missed Information: Better Information for Building a Wealthier, More Sustainable Future,” commented, “My biggest concern is that our educational system will not keep up with the demands of our modern times. It is doing a poor job of providing the foundations to our students. As more and more jobs are usurped by AI-endowed machines – everything from assembling cars to flipping burgers – those entering the workplace will need a level of technical sophistication that few graduates possess these days.”

Justin Amyx, a technician with Comcast, said, “My worry is automation. Automation occurs usually with mundane tasks that fill low-paying, blue-collar-and-under jobs. Those jobs will disappear – lawn maintenance, truck drivers and fast food, to name a few. Those un-skilled or low-skilled workers will be jobless. Unless we have training programs to take care of worker displacement there will be issues.”

### The future of health care: Great expectations for many lives saved, extended and improved, mixed with worries about data abuses and a divide between ‘the haves and have-nots’

Many of these experts have high hopes for continued incremental advances across all aspects of health care and life extension. They predict a rise in access to various tools, including digital agents that can perform rudimentary exams with no need to visit a clinic, a reduction in medical errors and better, faster recognition of risks and solutions. They also worry over the potential for a widening health care divide between those who can afford cutting-edge tools and treatments and those less privileged. They also express concerns about the potential for data abuses such as the denial of insurance or coverage or benefits for select people or procedures.

Leonard Kleinrock, Internet Hall of Fame member and co-director of the first host-to-host online connection and professor of computer science at the University of California, Los Angeles, predicted, “As AI and machine learning improve, we will see highly customized interactions between humans and their health care needs. This mass customization will enable each human to have her medical history, DNA profile, drug allergies, genetic makeup, etc., always available to any caregiver/medical professional that they engage with, and this will be readily accessible to the individual as well. Their care will be tailored to their specific needs and the very latest advances will be able to be provided rapidly after the advances are established. The rapid provision of the best medical treatment will provide great benefits. In hospital settings, such customized information will dramatically reduce the occurrence of medical injuries and deaths due to medical errors. My hope and expectation is that intelligent agents will be able to assess the likely risks and the benefits that ensue from proposed treatments and procedures, far better than is done now by human evaluators, such humans, even experts, typically being poor decision makers in the face of uncertainty. But to bring this about, there will need to be carefully conducted tests and experimentation to assess the quality of the outcomes of AI-based decision making in this field. However, as with any ‘optimized’ system, one must continually be aware of the fragility of optimized systems when they are applied beyond the confines of their range of applicability.”

Kenneth Grady, futurist, founding author of the Algorithmic Society blog and adjunct and advisor at the Michigan State University College of Law, responded, “In the next dozen years, AI will still be moving through a phase where it will augment what humans can do. It will help us sift through, organize and even evaluate the mountains of data we create each day. For example, doctors today still work with siloed data. Each patient’s vital signs, medicines, dosage rates, test results and side effects remain trapped in isolated systems. Doctors must evaluate this data without the benefit of knowing how it compares to the thousands of other patients around the country (or world) with similar problems. They struggle to turn the data into effective treatments by reading research articles and mentally comparing them to each patient’s data. As it evolves, AI will improve the process. Instead of episodic studies, doctors will have near-real-time access to information showing the effects of treatment regimes. Benefits and risks of drug interactions will be identified faster. Novel treatments will become evident more quickly. Doctors will still manage the last mile, interpreting the analysis generated through AI. This human in the loop approach will remain critical during this phase. As powerful as AI will become, it still will not match humans on understanding how to integrate treatment with values. When will a family sacrifice effectiveness of treatment to prolong quality of life? When two life-threatening illnesses compete, which will the patient want treated first? This will be an important learning phase, as humans understand the limits of AI.”

Charles Zheng, a researcher into machine learning and AI with the National Institute of Mental Health, commented, “In the year 2030, I expect AI will be more powerful than they currently are, but not yet at human level for most tasks. A patient checking into a hospital will be directed to the correct desk by a robot. The receptionist will be aided by software that listens to their conversation with the patient and automatically populates the information fields without needing the receptionist to type the information. Another program cross-references the database in the cloud to check for errors. The patient’s medical images would first be automatically labeled by a computer program before being sent to a radiologist.”

A professor of computer science expert in systems who works at a major U.S. technological university wrote, “By 2030 … physiological monitoring devices (e.g., lower heartbeats and decreasing blood sugar levels) could indicate lower levels of physical alertness. Smart apps could detect those decaying physical conditions (at an individual level) and suggest improvements to the user (e.g., taking a coffee break with a snack). Granted, there may be large-scale problems caused by AI and robots, e.g., massive unemployment, but the recent trends seem to indicate small improvements such as health monitor apps outlined above, would be more easily developed and deployed successfully.”

Kenneth Cukier, author and senior editor at The Economist, commented, “AI will be making more decisions in life, and some people will be uneasy with that. But these are decisions that are more effectively done by machines, such as assessing insurance risk, the propensity to repay a loan or to survive a disease. A good example is health care: Algorithms, not doctors, will be diagnosing many diseases, even if human doctors are still ‘in the loop.’ The benefit is that healthcare can reach down to populations that are today underserved: the poor and rural worldwide.”

Gabor Melli, senior director of engineering for AI and machine learning for Sony PlayStation, responded, “My hope is that by 2030 most of humanity will have ready access to health care and education through digital agents.”

Kate Eddens, research scientist at the Indiana University Network Science Institute, responded, “There is an opportunity for AI to enhance human ability to gain critical information in decision-making, particularly in the world of health care. There are so many moving parts and components to understanding health care needs and deciding how to proceed in treatment and prevention. With AI, we can program algorithms to help refine those decision-making processes, but only when we train the AI tools on human thinking, a tremendous amount of real data and actual circumstances and experiences. There are some contexts in which human bias and emotion can be detrimental to decision-making. For example, breast cancer is over-diagnosed and over-treated. While mammography guidelines have changed to try to reflect this reality, strong human emotion powered by anecdotal experience leaves some practitioners unwilling to change their recommendations based on evidence and advocacy groups reluctant to change their stance based on public outcry. Perhaps there is an opportunity for AI to calculate a more specific risk for each individual person, allowing for a tailored experience amid the broader guidelines. If screening guidelines change to ‘recommended based on individual risk,’ it lessens the burden on both the care provider and the individual. People still have to make their own decisions, but they may be able to do so with more information and a greater understanding of their own risk and reward. This is such a low-tech and simple example of AI, but one in which AI can – importantly – supplement human decision-making without replacing it.”

Angelique Hedberg, senior corporate strategy analyst at RTI International, said, “The greatest advancements and achievements will be in health – physical, mental and environmental. The improvements will have positive trickle-down impacts on education, work, gender equality and reduced inequality. AI will redefine our understanding of health care, optimizing existing processes while simultaneously redefining how we answer questions about what it means to be healthy, bringing care earlier in the cycle due to advances in diagnostics and assessment, i.e. in the future preventative care identifies and initiates treatment for illness before symptoms present. The advances will not be constrained to humans; they will include animals and the built environment. This will happen across the disease spectrum. Advanced ‘omics’ will empower better decisions. There will be a push and a pull by the market and individuals. This is a global story, with fragmented and discontinuous moves being played out over the next decade as we witness wildly different experiments in health across the globe. This future is full of hope for individuals and communities. My greatest hope is for disabled individuals and those currently living with disabilities. I’m excited for communities and interpersonal connections as the work in this future will allow for and increase the value of the human-to-human experiences. Progress is often only seen in retrospect; I hope the speed of exponential change allows everyone to enjoy the benefits of these collaborations.”

An anonymous respondent wrote, “In health care, I hope AI will improve the diagnostics and reduce the number of errors. Doctors cannot recall all the possibilities; they have problems correlating all the symptoms and recognizing the patterns. I hope that in the future patients will be interviewed by computers, which will correlate the described symptoms with results of tests. I hope that with the further development of AI and cognitive computing there will be fewer errors in reports of medical imaging and diagnosis.”

Eduardo Vendrell, a computer science professor at the Polytechnic University of Valencia in Spain, responded, “In the field of health, many solutions will appear that will allow us to anticipate current problems and discover other risk situations more efficiently. The use of personal gadgets and other domestic devices will allow interacting directly with professionals and institutions in any situation of danger or deterioration of our health.”

**Monica Murero**, director of the E-Life International Institute and associate professor in sociology of new technology at the University of Naples Federico II in Italy, commented, “In health care, I foresee positive outcomes in terms of reducing human mistakes, that are currently still creating several failures. Also, I foresee an increased development of mobile (remote) 24/7 health care services and personalized medicine thanks to AI and human-machine collaboration applied to the field.”

**Uta Russmann**, professor in the department of communication at FHWien der WKW University of Applied Sciences for Management & Communication, said, “Life expectancy is increasing (globally) and human-machine/AI collaboration will help older people to manage their life on their own by taking care of them, helping them in the household (taking down the garbage, cleaning up, etc.) as well as keeping them company – just like cats and dogs do, but it will be a much more ‘advanced’ interaction.”

**Lindsey Andersen**, an activist at the intersection of human rights and technology for Freedom House and Internews, now doing graduate research at Princeton University, commented, “AI will augment human intelligence. In health care, for example, it will help doctors more accurately diagnose and treat disease and continually monitor high-risk patients through internet-connected medical devices. It will bring health care to places with a shortage of doctors, allowing health care workers to diagnose and treat disease anywhere in the world and to prevent disease outbreaks before they start.”

**An anonymous respondent** said, “The most important place where AI will make a difference is in health care of the elderly. Personal assistants are already capable of many important tasks to help make sure older adults stay in their home. But adding to that emotion detection, more in-depth health monitoring and AI-based diagnostics will surely enhance the power of these tools.”

**Denis Parra**, assistant professor of computer science in the school of engineering at the Pontifical Catholic University of Chile Chile, commented, “I live in a developing country. Whilst there are potential negative aspects of AI (loss of jobs), for people with disabilities AI technology could improve their lives. I imagine people entering a government office or health facility where people with eye- or ear-related disabilities could effortlessly interact to state their necessities and resolve their information needs.”

**Timothy Leffel**, research scientist, National Opinion Research Center (NORC) at the University of Chicago, said, “Formulaic transactions and interactions are particularly ripe for automation. This can be good in cases where human error can cause problems, e.g., for well-understood diagnostic medical testing.”

**Jean-Daniel Fekete**, researcher in human-computer interaction at INRIA in France, said, “Humans and machines will integrate more, improving health through monitoring and easing via machine control. Personal data will then become even more revealing and intrusive and should be kept under personal control.”

**Joe Whittaker**, a former professor of sciences and associate director of the NASA GESTAR program, now associate provost at Jackson State University, responded, “My hope is that AI/human-machine interface will become commonplace especially in the academic research and health care arena. I envision significant advances in brain-machine interface to facilitate mitigation of physical and mental challenges. Similar uses in robotics should also be used to assist the elderly.”

**James Gannon**, global head of eCompliance for emerging technology, cloud and cybersecurity at Novartis, responded, “AI will increase the speed and availability to develop drugs and therapies for orphan indications. AI will assist in general lifestyle and health care management for the average person.”

**Jay Sanders**, president and CEO of the Global Telemedicine Group, responded, “AI will bring collective expertise to the decision point, and in health care, bringing collective expertise to the bedside will save many lives now lost by individual medical errors.”

**Geoff Arnold**, CTO for the Verizon Smart Communities organization, said, “One of the most important trends over the next 12 years is the aging population and the high costs of providing them with care and mobility. AI will provide better data-driven diagnoses of medical and cognitive issues and it will facilitate affordable AV-based paratransit for the less mobile. It will support, not replace, human care-givers.”

**John Lazzaro**, retired professor of electrical engineering and computer science, University of California, Berkeley, commented, “When I visit my primary care physician today, she spends a fair amount time typing into an EMS application as she’s talking to me. In this sense, the computer has already arrived in the clinic. An AI system that frees her from this clerical task – that can listen and watch and distill the doctor-patient interaction into actionable data – would be an improvement. A more-advanced AI system would be able to form a ‘second opinion’ based on this data as the appointment unfolds, discreetly advising the doctor via a wearable. The end goal is a reduction in the number of ‘false starts’ in-patient diagnosis. If you’ve read Lisa Sander’s columns in the New York Times, where she traces the arc of difficult diagnoses, you understand the real clinical problem that this system addresses.”

**Steve Farnsworth**, chief marketing officer at Demand Marketing, commented, “Machine learning and AI offer tools to turn that into actionable data. One project using machine learning and big data already was able to predict SIDS correctly 94% of the time. Imagine AI looking at diagnostics, tests and successful treatments of millions of medical cases. We would instantly have a deluge of new cures and know the most effective treatment options using only the data, medicines and therapies we have now. The jump in quality health care alone for humans is staggering. This is only one application for AI.”

**Daniel Siewiorek**, a professor with the Human-Computer Interaction Institute at Carnegie Mellon University, predicted, “AI will enable systems to perform labor-intensive activities where there are labor shortages. For example, consider recovery from an injury. There is a shortage of physical therapists to monitor and correct exercises. AI would enable a virtual coach to monitor, correct and encourage a patient. Virtual coaches could take on the persona of a human companion or a pet, allowing the aging population to live independently.”

**Joly MacFie**, president of the Internet Society, New York chapter, commented, “AI will have many benefits for people with disabilities and health issues. Much of the aging baby boomer generation will be in this category.”

The overall hopes for the future of health care are tempered by concerns that there will continue to be inequities in access to the best care and worries that private health data may be used to limit people’s options.

**Craig Burdett**, a respondent who provided no identifying details, wrote, “While most AI will probably be a positive benefit, the possible darker side of AI could lead to a loss of agency for some. For example, in a health care setting an increasing use of AI could allow wealthier patients access to significantly-more-advanced diagnosis agents. When coupled with a supportive care team, these patients could receive better treatment and a greater range of treatment options. Conversely, less-affluent patients may be relegated to automated diagnoses and treatment plants with little opportunity for interaction to explore alternative treatments. AI could, effectively, manage long-term health care costs by offering lesser treatment (and sub-optimal recovery rates) to individuals perceived to have a lower status. Consider two patients with diabetes. One patient, upon diagnosis, modifies their eating and exercise patterns (borne out by embedded diagnostic tools) and would benefit from more advanced treatment. The second patient fails to modify their behaviour resulting in substantial ongoing treatment that could be avoided by simple lifestyle choices. An AI could subjectively evaluate that the patient has little interest in their own health and withhold more expensive treatment options leading to a shorter lifespan and an overall cost saving.”

**Sumandra Majee**, an architect at F5 Networks Inc., said, “AI, deep learning, etc., will become more a part of daily life in advanced countries. This will potentially widen the gap between technology-savvy people and economically well-to-do folks and the folks with limited access to technology. However, I am hopeful that in the field of healthcare, especially when it comes to diagnosis, AI will significantly augment the field, allowing doctors to do a far better job. Many of the routines aspects of checkups can be done via technology. There is no reason an expert human has to be involved in basic A/B testing to reach a conclusion. Machines can be implemented for those tasks and human doctors should only do the critical parts. I do see AI playing a negative role in education, where students may not often actually do the hard work of learning through experience. It might actually make the overall population dumber.”

**Timothy Graham**, a postdoctoral research fellow in sociology and computer science at Australian National University, commented, “In health care, we see current systems already under heavy criticism (e.g., the My Health Record system in Australia, or the NHS Digital program), because they are nudging citizens into using the system through an ‘opt-out’ mechanism and there are concerns that those who do not opt out may be profiled, targeted and/or denied access to services based on their own data.”

**Valarie Bell**, a computational social scientist at the University of North Texas, commented, “Let’s say medical diagnosis is taken over by machines, computers and robotics – how will stressful prognoses be communicated? Will a hologram or a computer deliver ‘the bad news’ instead of a physician? Given the health care industry’s inherent profit motives it would be easy for them to justify how much cheaper it would be to simply have devices diagnose, prescribe treatment and do patient care, without concern for the importance of human touch and interactions. Thus, we may devolve into a health care system where the rich actually get a human doctor while everyone else, or at least the poor and uninsured, get the robot.”

The following one-liners from anonymous respondents also tie into the future of health care:

* “People could use a virtual doctor for information and first-level response; so much time could be saved!”
* “The merging of data science and AI could benefit strategic planning of the future research and development efforts that should be undertaken by humanity.”
* “I see economic efficiencies and advances in preventive medicine and treatment of disease, however, I do think there will be plenty of adverse consequences.”
* “Data can reduce errors – for instance, in clearly taking into account the side effects of a medicine or use of multiple medications.”
* “Human-machine/AI collaboration will reduce barriers to proper medical treatment through better recordkeeping and preventative measures.”
* “AI can take over many of the administrative tasks current doctors must do, allowing them more time with patients.”

**The future of education: High hopes for advances in adaptive and individualized learning, but some doubt that there will be any significant progress and worry over digital divide**

Over the past few decades, experts and amateurs alike have predicted the internet would have large-scale impacts on education. Many of these hopes have not lived up to the hype. Some respondents to this canvassing said the advent of AI could foster those changes. They expect to see more options for affordable adaptive and individualized learning solutions, including digital agents or “AI assistants” that work to enhance student-teacher interactions and effectiveness.

**Barry Chudakov**, founder and principal of Sertain Research and author of “Metalifestream,” commented, “In the learning environment, AI has the potential to finally demolish the retain-to-know learning (and regurgitate) model. Knowing is no longer retaining – machine intelligence does that; it is making significant connections. Connect and assimilate becomes the new learning model.”

**Lou Gross**, professor of mathematical ecology and expert in grid computing, spatial optimization and modeling of ecological systems at the University of Tennessee, Knoxville, said, “I see AI as assisting in individualized instruction and training in ways that are currently unavailable or too expensive. There are hosts of school systems around the world that have some technology but are using it in very constrained ways. AI use will provide better adaptive learning and help achieve a teacher’s goal of personalizing education based on each student’s progress.”

**Guy Levi**, chief innovation officer for the Center for Educational Technology, based in Israel, wrote, “In the field of education AI will promote personalization, which almost by definition promotes motivation. The ability to move learning forward all the time by a personal AI assistant, which opens the learning to new paths, is a game changer. The AI assistants will also communicate with one another and will orchestrate teamwork and collaboration. The AI assistants will also be able to manage diverse methods of learning, such as productive failure, teach-back and other innovating pedagogies.”

**Micah Altman**, a senior fellow at the Brookings Institution and head scientist in the program on information science at MIT Libraries, wrote, “These technologies will help to adapt learning (and other environments) to the needs of each individual by translating language, aiding memory and providing us feedback on our own emotional and cognitive state and on the environment. We all need adaptation; each of us, practically every day, is at times tired, distracted, fuzzy-headed or nervous, which limits how we learn, how we understand and how we interact with others. AI has the potential to assist us to engage with the world better – even when conditions are not ideal – and to better understand ourselves.”

**Shigeki Goto,** Asia-Pacific internet pioneer, Internet Hall of Fame member and a professor of computer science at Waseda University, commented, “AI is already applied to personalized medicine for an individual patient. Similarly, it will be applied to learning or education to realize ‘personalized learning’ or tailored education. We need to collect data which covers both of successful learning and failure experiences, because machine learning requires positive and negative data.”

**Andreas Kirsch**, fellow at Newspeak House, formerly with Google and DeepMind in Zurich and London, wrote, “Higher education outside of normal academia will benefit further from AI progress and empower more people with access to knowledge and information. For example, question-and-answer systems will improve. Tech similar to Google Translate and WaveNet will lower the barrier of knowledge acquisition for non-English speakers. At the same time, child labor will be reduced because robots will be able to perform the tasks far cheaper and faster, forcing governments in Asia to find real solutions.”

**Kristin Jenkins**, executive director of BioQUEST Curriculum Consortium, said, “One of the benefits of this technology is the potential to have really effective, responsive education resources. We know that students benefit from immediate feedback and the opportunity to practice applying new information repeatedly to enhance mastery. AI systems are perfect for analyzing students’ progress, providing more practice where needed and moving on to new material when students are ready. This allows time with instructors to focus on more-complex learning, including 21st-century skills.”

**Mike Meyer**, chief information officer at Honolulu Community College, commented, “Adult education availability and relevance will undergo a major transformation. Community colleges will become more directly community centers for both occupational training and greatly expanded optional liberal arts, art, crafts and hobbies. Classes will, by 2030, be predominantly augmented-reality-based, with a full mix of physical and virtual students in classes presented in virtual classrooms by national and international universities and organizations. The driving need will be expansion of knowledge for personal interest and enjoyment as universal basic income or equity will replace the automated tasks that had provided subsistence jobs in the old system.”

**Jennifer Groff**, co-founder of the Center for Curriculum Redesign, an international non-governmental organization dedicated to redesigning education for the 21st century, wrote, “The impact on learning and learning environments has the potential to be one of the most positive future outcomes. Learning is largely intangible and invisible, making it a ‘black box’ – and our tools to capture and support learning to this point have been archaic. Think large-scale assessment. Learners *need* tools that help them understand where they are in a learning pathway, how they learn best, what they need next and so on. We’re only just beginning to use technology to better answer these questions. AI has the potential to help us better understand learning, gain insights into learners at scale and, ultimately, build better learning tools and systems for them. But as a large social system, it is also prey to the complications of poor public policy that ultimately warps and diminishes AI’s potential positive impact.”

**Norton Gusky**, an education-technology consultant, wrote, “By 2030 most learners will have personal profiles that will tap into AI/machine learning. Learning will happen everywhere and at any time. There will be appropriate filters that will limit the influence of AI, but ethical considerations will also be an issue.”

**Cliff Zukin**, professor of public policy and political science at Rutgers University’s School of Planning and Public Policy and the Eagleton Institute of Politics, said, “It takes ‘information’ out of the category of a commodity, and more information makes for better decisions and is democratizing. Education, to me, has always been the status leveler, correcting, to some extent, for birth luck and social mobility. This will be like Asimov’s ‘Foundation,’ where everyone is plugged into the data-sphere. There is a dark side (later) but overall a positive.”

However, some expect that there will be a continuing digital divide in education, with the privileged having more access to advanced tools and more capacity for using them well, while the less-privileged lag behind.

**Henning Schulzrinne**, co-chair of the Internet Technical Committee of the IEEE Communications Society, professor at Columbia University and Internet Hall of Fame member, said, “Human-mediated education will become a luxury good. Some high school- and college-level teaching will be conducted partially by video and AI-graded assignments, using similar platforms to the MOOC [massive open online courses] models today, with no human involvement, to deal with increasing costs for education (‘robo-TA’).”

**Joe Whittaker**, a former professor of sciences and associate director of the NASA GESTAR program, now associate provost at Jackson State University, responded, “Huge segments of society will be left behind or excluded completely from the benefits of digital advances – many persons in underserved communities as well as others who are socio-economically challenged. This is due to the fact that these persons will be under-prepared generally, with little or no digital training or knowledge base. They rarely have access to the relatively ubiquitous internet, except when at school or in the workplace. Clearly, the children of these persons will be greatly disadvantaged.”

Some witnesses of technology’s evolution over the past few decades feel that its most-positive potential has been disappointingly delayed. After witnessing the slower-than-expected progress of tech’s impact on public education since the 1990s, they are less hopeful than others.

**Ed Lyell**, longtime educational technologies expert and professor at Adams State University, said education has been held back to this point by the tyranny of the status quo. He wrote, “By 2030, lifelong learning will become more widespread for all ages. The tools already exist, including Khan Academy and YouTube. We don’t have to know as much, just how to find information when we want it. We will have on-demand, 24/7 ‘schooling.’ This will make going to sit-down classroom schools more and more a hindrance to our learning. The biggest negative will be from those protecting current, status-quo education including teachers/faculty, school boards and college administrators. They are protecting their paycheck- or ego-based role. They will need training, counseling and help to embrace the existing and forthcoming change as good for all learners. Part of the problem now is that they do not want to acknowledge the reality of how current schools are today. Some do a good job, yet these are mostly serving already smarter, higher-income communities. Parents fight to have their children have a school like *they* experienced, forgetting how inefficient and often useless it was. AI can help customize curricula to each learner and guide/monitor their journey through multiple learning activities, including some existing schools, on-the-job learning, competency-based learning, internships and such. You can already learn much more, and more efficiently, using online resources than almost all of the classes I took in my public schooling and college, all the way through getting a Ph.D.”

**A consultant and analyst** also said that advances in education have been held back by entrenched interests in legacy education systems, writing, “The use of technology in education is minimal today due to the existence and persistence of the classroom-in-a-school model. As we have seen over the last 30 years, the application of artificial intelligence in the field of man/machine interface has grown in many unexpected directions. Who would have thought back in the late 1970s that the breadth of today’s online (i.e., internet) capabilities could emerged? I believe we are just seeing the beginning of the benefits of the man/machine interface for mankind. The institutionalized education model must be eliminated to allow education of each and every individual to grow. The human brain can be ‘educated’ 24 hours a day by intelligent ‘educators’ who may not even be human in the future. Access to information is no longer a barrier as it was 50 years ago. The next step now is to remove the barrier of structured human delivery of learning in the classroom.”

**Brock Hinzmann**, a partner in the Business Futures Network who worked for 40 years as a futures researcher at SRI International, was hopeful in his comments but also issued a serious warning. He wrote: “Most of the improvements in the technologies we call AI will involve machine learning from big data to improve the efficiency of systems, which will improve the economy and wealth. It will improve emotion and intention recognition, augment human senses and improve overall satisfaction in human-computer interfaces. There will also be abuses in monitoring personal data and emotions and in controlling human behavior, which we need to recognize early and thwart. Intelligent machines will recognize patterns that lead to equipment failures or flaws in final products and be able to correct a condition or shut down and pinpoint the problem. Autonomous vehicles will be able to analyze data from other vehicles and sensors in the roads or on the people nearby to recognize changing conditions and avoid accidents. In education and training, AI learning systems will recognize learning preferences, styles and progress of individuals and help direct them toward a personally satisfying outcome.

“However, governments or religious organizations may monitor emotions and activities using AI to direct them to ‘feel’ a certain way, to monitor them and to punish them if their emotional responses at work, in education or in public do not conform to some norm. Education could become indoctrination; democracy could become autocracy or theocracy.”

[Next: About this canvassing of experts](https://www.pewresearch.org/internet/2018/12/10/artificial-intelligence-and-the-future-of-humans-about-this-canvassing-of-experts/)