The Internet at 50: Pioneers, Engineers, and Influencers on Its Past and Future

©shutterstock/Alexander Supertramp

When the original founders of the Internet look back over the first 50 years of its existence, what do they think? What are their hopes and fears? How do their perspectives compare with those of investors, academics, entrepreneurs, and influencers? Charles Corbett, Uday Karmarkar, and Christopher Tang offer their own reflections along with a lively summary of a one day event held at UCLA to celebrate the 50th birthday of the Internet.

Charles J. Corbett,
Anderson School of Management, UCLA

Uday S. Karmarkar,
Anderson School of Management, UCLA

Christopher S. Tang,
Anderson School of Management, UCLA

Half a century ago, when a primitive computer network flickered to life in Leonard Kleinrock's research laboratory at 3420 Boelter Hall at UCLA and sent a digital message to another lab at Stanford, none of the people who made it happen fully understood how completely a broader network of computer networks would alter the way that billions of people around the world worked, played, and communicated. The infant network was called ARPANET, Advanced Research Projects Agency Network. It was rooted in Kleinrock's mathematical theory of packet switching and it would mature into the Internet we know today.

On October 29, 2019, the 50th anniversary of ARPANET's inception, Kleinrock, along with the UCLA Samueli School of Engineering and the Computer Science Department, hosted a colloquium at which leaders in the field recounted the Internet's development so far and forecast its future. They all agreed that the Internet's influence will almost certainly increase—to both our benefit and out detriment—as data pools grow, computing power increases, and algorithms become more powerful. For more information about the panelists, see appendix below.[1]

The event, titled **"50: From Founders to Futurists,"** convened panels of today's eminent entrepreneurs, technologists, policymakers, and executives, as well as scientists who presided over the birth of the Internet, to discuss its past and future. Mayor Eric Garcetti presented Leonard Kleinrock with the Key to the City of Los Angeles in recognition of his extraordinary achievements.

A common theme at the conference, which was emceed by journalist and author Patt Morrison, was that the Internet has grown much faster than Kleinrock and others in the field imagined in 1969 and has morphed in unforeseen and sometimes unfortunate ways. The trailblazers did not anticipate that their creation's free, open, shared, decentralized, trust-based culture, designed to serve scientists, poets, and charities, would also become a global stage for bullies, criminals, and political extremists.

Today's Internet is as much a gossip and shopping machine as a digital library or forum for civil discourse.

Indeed, today's Internet is as much a gossip and shopping machine as a digital library or forum for civil discourse. Its convivial environment has become competitive and antagonistic. From a democratic network which allows anyone to communicate to millions, hackers and exploiters have emerged. And the network shows no signs of growing out of this phase; instead it seethes with malicious botnets, denial-of-serve attacks, and international money laundering.

Governments have begun to erect boundaries to control the network, regulating or curbing the open flow of information. At the UCLA colloquium, Kleinrock opposed such restrictions in his opening remarks. Governments should address system-wide cyber-attacks and security, he said, but individuals should be able to create their own privacy policies. "Citizen-users need to hold websites responsible for what they're doing to you," Kleinrock said. "When was the last time Facebook came to you to ask about what kind of privacy policy you would like to have applied to you? Probably never." He insisted that customized privacy is feasible, despite companies' assertions that they cannot accommodate billions of individual users. "That is baloney," Kleinrock said. "They already give you customized ads every time you turn on the Internet."

Our purpose here is to offer a summary of each of the panel sessions along with a discussion of the colloquium's key themes. Most or all of what was said (and hence everything reported here) has been said before. What made this event unique was the diversity of its participants and their correspondingly diverse perspectives. We hope that this summary provides a thought-provoking introduction to the tangled web of societal benefits and unforeseen consequences that is the Internet.

Panel 1: Before the Beginning
Moderator: John Markoff
Panelists: Leonard Kleinrock, Vint Cerf, Steve Crocker, William Duvall, Charley Kline

So that participants could better understand how the Internet got where it is today and discuss where it might go in the future, conference organizers began by assembling some of the engineers who launched the technology in 1969 for the first panel, entitled, "Before the Beginning," and moderated by New York Times journalist John Markoff.

The panel included seminal figures in the design and development of the Internet and of its predecessor, ARPANET. All of them contributed to the underlying design of the Internet and to the Transmission Control Protocol/Internet Protocol (TCP/IP), fundamental protocols still in use today.

They reminisced about developing ARPANET, and about how that Department of Defense project laid the foundation for the Internet. Panelists recalled the generosity of ARPA, the Advanced Research Projects Agency, which, in the early 1960s funded good research centers

wherever it found them. Researchers were encouraged to proceed with little oversight, guided by the directive to "create something great."

Even as an MIT doctoral student, Kleinrock recognized that no one seemed to be working on networking, which he was convinced would be a significant advance. Over time, he realized that resource sharing could be dynamically optimized by applying the mathematics of queueing theory—practically, by chopping messages into fixed lengths (packets) and reassembling them at their destination. He came to UCLA in 1963 to develop the idea and ARPA funded his work.

The result was ARPANET, an electronic link whose initial achievement was connecting two computers, one at UCLA (with Kleinrock's network research group) and another at SRI (with Doug Engelbart's research group). The first ARPANET transmission, on October 29, 1969, was the single word "login." The transmission failed when a buffer overflow at SRI crashed the system after only two letters. Engineers corrected the protocol and later that evening the full message was transmitted.

By the end of 1969, ARPANET had expanded to include computers at UC Santa Barbara and the University of Utah. As researchers started to circulate typewritten notes, documenting and sharing protocol designs, Steve Crocker suggested that the notes sounded too authoritarian. Worried that they might discourage discussion, he proposed that they be called "Requests for Comments" and that they be numbered to make the information easier to find. He became the first RFC editor, believing he was presiding over a stopgap fix until someone could devise a more formal documentation solution. Half a century later, RFCs are still around. There are now more than 8,800 of them.

ARPANET researchers paid frequent visits to one another's laboratories. At SRI, Doug Engelbart's group introduced them to the computer mouse, graphic interfaces, hypertext, and links—in short, the future of the Internet.

Panel 2: Winner Take All?
Moderator: Krisztina "Z" Holly
Panelists: Jamie Dimon, Eric Schmidt

Big tech firms—Amazon, Apple, Facebook and Google—have been both praised and panned for their extraordinary revenue growth, market value, and influence. Legislators around the world are trying to determine whether Big Tech is good or bad—a monument to innovation or a monopoly which inhibits competition.

Two well-known business leaders, Jamie Dimon and Eric Schmidt, tackled this question in the second panel of the day, "Winner Take All?" They discussed the tension between large firms which evolved with the Internet, and small, more recent startups. Both agreed that the Internet was "going to double in size" and that new technologies such as artificial intelligence (AI) would inevitably bring further disruption.

"You get decentralization and recentralization at the same time. That is why it is so hard for people to sort this out."

According to Schmidt, digital technology has long been associated with democratization, liberalism and optimism. These associations grew as innovation decentralized computing power from mainframes to PCs to smartphones. At the same time, big data, big companies, and huge server farms represent a new kind of centralization. "So you get decentraliza-

tion and recentralization at the same time," Schmidt said. "That is why it is so hard for people to sort this out."

He went on to point out that computing will never be entirely evenly distributed, nor will it swing completely back to large centralized systems. In describing the growing practice of analyzing data and formulating solutions in the field, where the data is generated, Schmidt said, "intelligence is on the edges."

Next, Holly pointed out how big data and technology are driving the growth of the gig economy. She asked whether that model of labor would lead to a kind of neo-feudalism, particularly as the wealth gap widens. Schmidt and Dimon both felt that globalization and digitization are the primary drivers of income inequality, not the gig economy. "Digitization means far more efficient systems and globalization means many more players," Schmidt said. "In general, these things are positive." Nonetheless, they both stressed that society should think about how to make the system work better for the middle class — "I want more happy people, more productive people, more wealth generated in those segments," Schmidt said.

So the panelists agreed that some regulation is necessary, but also that it is important not to introduce too much too soon. Social media clearly does need regulation, but it can be difficult to identify bad actors or to distinguish a citizen from a foreign agent. Dimon and Schmidt agreed that regulators should first focus on extreme dangers, such as election interference.

Panel 3: Breakthrough Disruptions
Moderator: Ellen Levy
Panelists: Mark Cuban, Meg Whitman, Preethi Kasireddy, Bud Tribble, Ashton Kutcher

The third panel asked five notable tech figures to identify and discuss "Breakthrough Disruptions" that may shake the Internet in coming years. Mark Cuban took a broad view and suggested climate change. "If we don't solve it, none of those things (cryptocurrencies, artificial intelligence and other potentially revolutionary technologies) will matter," he said.

Meg Whitman felt that the flood of data now being collected and collated represents an ongoing challenge as a potential disruptor. While it may help us to combat climate change and address many social issues, she said, it also drives new problems, not the least of which is unauthorized snooping and the selective exposure of personal information. Preethi Kasireddy foresaw a role for cryptography in domains where it is not yet commonly used.

All the panelists agreed that tech companies should adopt and enforce industry standards for data collection, data encryption, data storage and other practices which could be intrusive. They believed that if the industry does not regulate itself, governments will step in and write the rules. "If companies don't take responsibility, regulators will," as Ashton Kutcher put it, "and they will come in with a hatchet, not a scalpel."

Kutcher, who cofounded a nonprofit organization that uses technology to track human trafficking and child pornography online, used encryption to illustrate the moral dilemmas that tech companies face. He pointed out that while encryption provides security and privacy for millions of users—as well as a new form of value storage in cryptocurrencies— it is also used to conceal the distribution of child pornog-

raphy. "Should there be a back door for all encryption?" Kutcher asked. "Should it be available for monitoring by regulatory bodies or for security purposes?"

Whitman added that the effect of artificial intelligence upon society is already growing. Machines have demonstrated that they can analyze medical images faster and more accurately than humans. "You are going to see a whole field of medicine (radiology) that is going to be disrupted," she said. "How do we manage society through these enormous shifts in how people make their livings?"

The panelists discussed how technology might be employed to minimize "dark uses" of the Internet, such as theft, fraud, defamation, and ballot rigging. Many of the technologies that allow foreign agents, domestic terrorists, and other dark users to conceal their identities and activities are also used by freedom fighters and legitimate activists. If everyone had to use their true identity on the Internet, it might restrict bad actors, but it would also expose activists to authoritarian regimes.

"We have not yet suffered a huge worldwide cyber disaster, but it could happen at any time."

The panel ended with the disquieting thought that, going forward, disruptions will be more common, faster, and far larger. When Bud Tribble pointed out that we have not yet suffered a huge worldwide cyber disaster but it could happen at any time, the whole panel agreed. If that disaster happens, the fallout will shock the many people who under-

estimate how much we depend on the Internet.

Fireside Chat: Privacy Gone?
Moderator: Radia Perlman
Panelist: Tom Leighton

The next panel also focused on internet boundaries.

Perlman began by asking Leighton if, in his view, privacy is good or bad.

"To provide security, you need to look at what users are doing."

"Privacy generally is a pretty good thing," Leighton answered with a laugh. "That said, you do need to use user data for certain functions. For example, to provide security, you need to look at what users are doing."

Such surveillance goes beyond recording what users buy, which movies they watch, or how much time they spend on YouTube. It includes remotely observing and recording musculoskeletal data, such as how individual users hold their smartphones and move a mouse.

"That's about as personal as it gets," Leighton said, "but because we can see that and use that, we can prevent someone from stealing your bank account" even after they have stolen your smartphone and passwords.

Moreover, people value price over privacy. They are willing to allow companies to gather a lot of data for unknown reasons as long as they do it through free services such as browsers and email. "We all like things that are 'free,' and don't cost us money," Leighton said. "I don't know how much people think about what's happening under the covers and how that information is being used. They might not like it if

they really thought about it or really knew."

More and more users are aware that malware can spread if they click on a link or an email attachment from someone they do not know. Fewer people recognize that legitimate websites can unwittingly carry ads or other third-party content that steers users to sites infected with malware. Users may not realize that if their browser ingests malware, it could be instructed to transmit their credit card data to a criminal organization. "This is happening at a massive scale," Leighton said. "And you didn't do anything wrong."

Some of today's abuses are unintended consequences of decisions made by engineers and system architects half a century ago. "From the very beginning days of the Internet, security was not incorporated into it in a heavy way," Leighton said. "And to this day, the core protocols are not really secured. So you have to build security on top of it. That is what big companies do."

Ideally, we would also build security in from the ground up, but "that is not happening now," Leighton said. Countries and companies around the world have installed roughly twenty billion devices which make up the Internet of Things (IoT), but many of these networked sensors, actuators, and other tools have no security. As Leighton put it, "We're giving bad guys an enormous edge in accessing the Internet."

Panel 4: The Irresponsible Internet

Moderator: Katie Hafner
Panelists: Judy Estrin, Rick Wilson, Molly Burke, Eugene Volokh

Since its birth in 1969, the Internet has enabled billions of people to communicate directly through email, SMS (short message service), video conferencing, and other applications, and to express themselves through YouTube, Instagram and more. This ease of communication has leveled the playing field of free speech, making it easier for anyone, regardless of wealth or status, to share ideas and opinions.

Very rapidly, however, people also began using the Internet to anonymously distribute deceptive, odious, and disturbing content, such as child pornography, hate speech, and murder videos. Other bad actors spread lies in the form of fake news articles which misinform the public, sometimes with fatal consequences. In 2018, vigilantes in India lynched about twenty people after Facebook and WhatsApp spread rumors of roving kidnappers.[2] Researchers at Ohio State University, meanwhile, have concluded that fake news probably had a "substantial impact" on the 2016 presidential election.[3]

Criminal and antisocial activity of this kind is termed the dark side of the Internet. Hosted by Katie Hafner, the fourth panel, called "The Irresponsible Internet," explored the nature and extent of this darkness and discussed what might be done to discourage bad practices without impeding good ones.

"I believe in technology; I believe in its benefits—but not until we address these deep structural problems," said Judy Estrin, who worked with Vint Cerf on the Transmission Control Protocol project at Stanford.

Rick Wilson, said, "We have seen how the Internet has been weaponized to manipulate low-information voters—and high-information voters for that matter—in ways that are increasingly effective." And, he added, artificial intelligence will make it worse.

Governments use a variety of tactics to reduce the Internet's dark side. China engages in extensive surveillance and censorship of social media. Russian censors initially blocked access to child pornography, drug production, and other illegal activity, and now also block material labeled extremist. As of this writing, the United States has not defined acceptable limits on free speech or decided how to protect minors or police illegal activity on the Internet.[4]

The panelists agreed that, in the absence of clear regulation or social norms, it is incumbent upon parents to educate their children about the Internet, monitor their online activity, and, as always, help them to develop moral and ethical value systems. Meanwhile, Facebook and other social media firms must become more nimble in detecting and blocking offensive content. Yet disability rights activist Molly Burke warned that YouTube's restrictions on advertising have affected many of her friends.

Panelist Eugene Volokh pointed out that it is important that regulators, industry leaders, and users remember that political speech, whether delivered from atop a soapbox or in a targeted internet ad, has always been used to persuade others—"sometimes by fair means, sometimes by foul."

> "It amplifies the natural human tendencies to say false things as well as true, and believe false things as well as true."

"If there is something I am passionate about, it is not to get too focused on the notion that somehow [the Internet] creates a set of maladies that are new," he said. "What it does is it amplifies the natural human tendencies to say false things as well as true and believe false things as well as true."

Debate: Has True Innovation Stalled?

Moderator: Leonard Kleinrock
Panelists: Peter Thiel, Robert Metcalfe

Around the world, Silicon Valley success stories have powerfully reinforced the idea that the United States is an inexhaustible font of innovation. Peter Thiel disagrees. He presented his case in a debate with Robert Metcalfe. Kleinrock refereed this rhetorical wrestling match.

Thiel is the provocative cofounder of PayPal and creator of Palantir Technologies, a data-analysis firm. "My general thesis is that since the 1970s innovation broadly has stalled," he began. "The world of atoms has been slow; the world of bits has continued (to innovate). There has been a narrow cone of progress around computers, internet, mobile internet, and software." When the Internet was born, people expected that it would be quickly followed by supersonic planes, rockets, underwater cities, wonder drugs, and a green revolution in agriculture. "Today," he said, "the word technology—the word itself—has shrunk to mean only information technology because this is the only thing we see progressing."

The number of patent applications had, in 2018, grown for the ninth year in a row, reaching more than 3.3 million.

Metcalfe is a coinventor of Ethernet and cofounder of 3Com as well as the Murchison Fellow of Free Enterprise in the Cockrell School of Engineering at the University of Texas. He measures innovation in terms of freedom and prosperity. He pointed out that the number of patent applications had, in 2018, grown for the ninth year in a row, reaching more than 3.3 million, and that 2019 had begun with the lowest rate of extreme poverty ever recorded in human history—less than 8 percent.[5]

Thiel countered that some improvements have as much to do with globalization bringing jobs to developing economies as they do with innovation in developed countries. "The inputs (in developed economies) keep going up, but the outputs have been badly stalled," he said. "That is the opposite of technology. Tech is about doing more with less, and we are doing less with more."

Metcalfe stood firm. "True innovation has not stalled," he said, reeling off a string of advances in fields outside IT including nuclear fusion, geothermal energy, genome editing, immunotherapy, rechargeable batteries, and reusable rockets.

Panel 5: The Internet Megaphone

Moderator: Raffi Krikorian
Panelists: Patrisse Cullors, Bran Ferren, Jameela Jamil, Katelyn Ohashi

For anyone with a network connection and a smartphone, tablet, or computer the Internet provides a digital megaphone through which to speak to the world on any topic, including government policies and corruption.

This megaphone works through sites that host essays, videos, blogs, podcasts, Tweets and so forth, often without disclosing the authors' names. In theory, anonymity encourages people to comment on contentious topics or propose controversial solutions without worrying about retaliation or official persecution. "The Internet Megaphone" panelists described anonymity as essential to the launching of social movements such as #metoo, #blacklivesmatter and #freehongkong.

But panel members had also found that internet anonymity has had some unintended consequences. As a co-founder of the Black Lives Matter movement Patrisse Cullors said that anonymity on social media platforms has made the Internet "a sinister place" for many people, allowing bad actors to bul-

ly, intimidate, and threaten others with impunity. What was initially, as Cullors said, "a place where the lost and forgotten could be seen," connecting rich and poor communities worldwide, quickly became what Jameela Jamil describes as "this insidious or scary place, especially for young people and impressionable people."

The panelists, moderated by Raffi Krikorian, acknowledged that bedrock internet values like free access and free speech make it difficult for social media platforms to control access and content. At the same time, social platforms in search of profit have developed mechanisms such as the "like" button to retain and engage users. By doing so, they encourage users to post purely for self-validation rather than genuine expression, defeating the original intent of social media.

Social media should scrap the "like" button and develop other mechanisms to retain and engage users.

To fight these forces, panelists suggested that social media platforms should develop socially responsible mechanisms to monitor, filter, and control user access and content. Some proposed that social media should scrap the "like" button and develop other mechanisms to retain and engage users.

"We're at a moment in society now where people are realizing that perhaps some sense of responsibility or some sense of direction or oversight—rather than being harmful—is, in fact, necessary," said Bran Ferren.

Ferren brushed aside the notion that calumnies, canards, and lies are part of the price of free speech and that internet contribu-

tors should be able to write or say anything, leaving the marketplace of ideas to sort truth from fiction. "People should not be allowed to hurt people," Ferren said. "People should not be allowed to spread disinformation."

Panel 6: Future Internet Technology

Moderator: Ron Conway
Panelists: Henry Samueli, Steven Walker, Eric Haseltine, Danny Hillis, Daniela Rus

At the final conference panel, "Future Internet Technology," ARPANET pioneers and leading technologists shared their thoughts on what they expected from the Internet by its centennial.

Samueli expects that, because integrated circuits bump against the outer limits of physics, most innovation over the next fifty years will be internet applications rather than hardware. He explained that in 1970 state-of-the-art chips might have had 10,000 transistors whereas today they have 10 billion. "Unfortunately, the party is over," he said. "We're not going to see another factor of one million in the next 50 years. It's just not going to happen."

Yet Samueli did not see his prediction as entirely bad news. Over the last fifty years, computing power has grown far faster than our ability to define boundaries for its use. Slower growth could give society a breather in which to consider what to do about personal privacy, data ownership, defamation, cyberbullying, child pornography, fake news, fraud, and more.

Several panelists mentioned that they are already working on symbiosis between humans and machines, in which digital devices can communicate directly with human brains, particularly those of medical patients. One of the goals

of DARPA's (Defense Advanced Research Projects Agency) "AI Next" campaign, which was launched when Walker was the agency's director, was to allow brain signals to directly control prosthetic limbs. "These are the superpowers you get by putting people and machines together, bringing the Internet into the physical world," said Rus.

And according to Haseltine, technology is not the biggest obstacle to introducing and expanding internet applications. Instead, it is a lack of properly trained people. "We just don't have enough programmers in this world to write the software that has to be written to implement the vision that we are all talking about," he said.

Ambivalence About the Internet

Scientists and engineers were not the only speakers to express mixed feelings about some of the ways that people use the Internet. Werner Herzog made a surprise appearance that afternoon. In 2016, he had made a documentary entitled "Lo and Behold: Reveries of the Connected World" that examined Kleinrock's work and the birth of the Internet.

At the UCLA colloquium, Herzog said he found it difficult to fully embrace a technology that successfully crowd-sourced an enzyme structure that had stumped supercomputers knowing that the same technology has also enabled the "tragic life" of a young person who compulsively sends thousands of SMS texts every day.

A Broad Vision for the Future

Garry Kasparov closed the conference by encouraging Americans to dream big, to innovate broadly and boldly.

He pointed out that the first message to travel between two computers was not the only his-

torical achievement in engineering in 1969. In the same year, Boeing's double-decked 747 jumbo jet took its maiden flight and two Americans walked on the moon. The 747 was a literally gigantic achievement. Standing on end it would be taller than a six-story building. The first twin-aisle wide-body airliner, it could seat more than 400 passengers and weigh more than 300 tons at takeoff. It was also the first commercial aircraft to use powerful but thrifty high-bypass turbofan engines.[6] Meanwhile, the Apollo 11 moon mission allowed humans, for the first time, to walk on a celestial body other than Earth. It produced the first radio and TV transmissions from another celestial body and brought home the first non-terrestrial geological samples.

When President Kennedy promised to send humans to the moon and return them safely to Earth before the end of the 1960s, there was no guarantee that NASA (National Aeronautics and Space Administration) could deliver. But he knew that succeeding at such an arduous and uncertain task was not as important as having the courage to try. Kasparov emphasized this point by reading an excerpt from a speech Kennedy delivered at Rice University in 1962:

"We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard; because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one we intend to win, and the others, too." [7]

Kasparov said that sometimes breakthroughs depend on big, impractical dreams. Patience helps too. Seven years before UCLA transmitted the famously truncated message "LO" to SRI, J. C. R. Licklider, director of the

Information Processing Techniques Office at ARPA, proposed the idea of an "Intergalactic Network" of computers.

New big dreams range from a human mission to Mars to the introduction of practical flying cars, Kasparov said. Governments and universities should establish stronger ties so that the bright minds of academia could more easily create breakthrough technologies for the benefit of all, just as the Internet was created at UCLA 50 years ago.

In his closing remarks, Leonard Kleinrock agreed. "We have to get back to the ethos that we talked about earlier – freedom, open, shared, trusted," he said. "And we have to embrace the rest of the planet that's not yet on this system. Now these sound like lofty words, and they are, and naïve sounding. But we're talking about 50 years of vision going forward. So we want to think large."

"The worst mistake we can make is to set our sights too low, burdened with the constraints of today, and not the possibilities of tomorrow."

"The worst mistake we can make is to set our sights too low, burdened with the constraints of today, and not the possibilities of tomorrow," he continued. "If we can't return to the Internet I knew, let's direct it to the world we're willing to inhabit. See you in 50 years."

Emerging themes and closing thoughts

In that single day's colloquium at UCLA, panelists covered an enor-mous amount of ground. Several themes recurred throughout the day.

- *Who should be allowed to use the Internet as a megaphone?* By allowing people to broadcast to a much wider audience, the Internet benefits vulnerable groups but also creates new dangers.
- *As the Internet became increasingly commercialized, the focus shifted from content to engagement.* This focus on maximizing engagement hamstrings any incentive to produce accurate content.
- *Humans often value convenience over privacy and security,* which were not built into the Internet at the beginning. Some of the mechanisms that increase security do so at the expense of privacy.
- *While most agree that the Internet should somehow be regulated, we do not agree on what that regulation should look like.* Regulation often has unintended side effects and can do more harm than good.
- *The Internet consumes vast amounts of human talent and energy.* Yet our future prosperity depends on devoting some of these resources to other fields such as climate change, medical research, and more.

The potential of artificial intelligence and the Internet of Things will inspire engineers and scientists just as the Apollo program did in the 1960s.

While the event at UCLA could have given the impression that the Internet has produced only problems, it is important to remember the incredible and countless opportunities that the Internet has created and will continue to create. Perhaps most notably:

- Mobile internet is changing the way fundamental economics work in emerging markets by enabling mobile payments, making mobile financial services available to 2 billion unbanked people, and fighting corruption.
- As the Internet evolves toward Industry 4.0 and 5G wireless technology, it will continue to develop new capabilities, using drones for search and rescue missions, providing smart transportation for the elderly, making healthcare faster, through better communication with experts, cheaper, by reducing manual steps, and better, by combining AI with human judgment.

The potential of artificial intelligence and the Internet of Things will inspire engineers and scientists just as the Apollo program did in the 1960s. Rather than going to the moon, this generation will be able to achieve greatness right here on Earth, addressing seemingly insoluble problems such as climate change, water shortages, and failed economies.

Author Bios

Charles J. Corbett is IBM Chair in Management and a professor of operations management and sustainability at the UCLA Anderson School of Management. He holds a joint appointment at the UCLA Institute of the Environment and Sustainability. He is a Fellow of the Production and Operations Management Society (POMS) and of the Manufacturing and Service Operations Management Society (MSOM)

Uday S. Karmarkar is UCLA Distinguished Professor and LA Times Chair of Technology and Strategy at the UCLA Anderson School of Management. His interests include the digital economy, technology management, and operations strategy in manufacturing and service firms. He is a Fellow of the Manufacturing and Service Operations Management Society (MSOM).

Christopher Tang is a distinguished professor at UCLA. He holds the Edward W. Carter Chair in Business Administration at the UCLA Anderson School of Management. His current research interests are socially responsible operations and online platforms. He is a Fellow of the Institute for Operations Research and the Management Sciences (INFORMS), the Manufacturing and Service Operations Management Society (MSOM), and the Production and Operations Management Society (POMS).

Appendix: moderators and panelists[1]

- Burke, Molly: motivational speaker, YouTuber, disability rights advocate
- Cerf, Vint: ARPANET pioneer, Google vice president and chief Internet evangelist
- Conway, Ron: angel investor, philanthropist, founder and co-managing partner of SV Angel
- Crocker, Steve: ARPANET pioneer, Shinkuro CEO
- Cuban, Mark: chairman and CEO of AXS TV and owner of the Dallas Mavericks
- Cullors, Patrisse: artist and co-founder of the Black Lives Matter movement
- Dimon, Jamie: JP Morgan Chase chairman and CEO
- Duvall, William: ARPANET pioneer, formerly at Stanford Research Institute
- Estrin, Judy: JLABS CEO
- Ferren, Bran: Applied Minds co-founder and chief creative officer
- Hafner, Katie: New York Times journalist and author
- Haseltine, Eric: neuroscientist, futurist, author
- Herzog, Werner: film director, screenwriter, author, actor
- Hillis, Danny: Applied Invention co-founder
- Holly, Krisztina "Z": entrepreneur
- Jamil, Jameela: I Weigh founder, actor, activist
- Kasireddy, Preethi: TruStory founder and CEO
- Kasparov, Garry: chess grandmaster, writer, political activist
- Kleinrock, Leonard: ARPANET pioneer, UCLA distinguished professor of computer science
- Kline, Charley: ARPANET pioneer
- Krikorian, Raffi: Emerson Collective, managing director; former VP of engineering, Twitter
- Kutcher, Ashton: actor, entrepreneur, tech investor, producer
- Leighton, Tom: Akamai Technologies CEO and co-founder
- Levy, Ellen: Silicon Valley Connect, co-founder
- Markoff, John: New York Times, journalist
- Metcalfe, Robert: UT Austin, Professor of Innovation and Entrepreneurship
- Ohashi, Katelyn: UCLA NCAA Gymnastics champion and viral sensation
- Perlman, Radia: Dell EMC fellow, networking pioneer
- Rus, Daniela: MIT Andrew (1956) and Erna Viterbi Professor of electrical engineering and computer science, director of Computer Science and Artificial Intelligence Laboratory (CSAIL)
- Samueli, Henry: Broadcom co-founder and chairman of the board
- Schmidt, Eric: Google and Alphabet Inc. former CEO
- Thiel, Peter: PayPal entrepreneur, investor and cofounder, creator of Palantir Technologies
- Tribble, Bud: Apple VP of software technology
- Volokh, Eugene: UCLA School of Law distinguished professor of law
- Walker, Steven Lockheed Martin vice president and chief technology officer, former director of DARPA
- Whitman, Meg: Quibi CEO, former president and CEO of Hewlett Packard Enterprise
- Wilson, Rick: political consultant, best-selling author

Endnotes

1. For details, see https://samueli.ucla.edu/internet50-looking-toward-the-future/ and https://samueli.ucla.edu/internet50-speakers/, last accessed, March 31, 2021.
2. Agence France-Presse. "Death by fake news: Indian authorities blame 'irresponsible and explosive messages' on WhatsApp for lynchings," South China Morning Post, July 14, 2018.
3. Gunther et al. "Fake News May Have Contributed to Trump's 2016 Victory," unpublished working paper, Ohio State University, March 8, 2018; available at https://assets.documentcloud.org/documents/4429952/Fake-News-May-Have-Contributed-to-Trump-s-2016.pdf, last accessed February 9, 2020.
4. Farrar, T. "The State of Internet Censorship in 2019," https://freethepeople.org/the-state-of-internet-censorship-in-2019/, last accessed on October 30, 2019.
5. World Intellectual Property Organization statistics database for patent applications. Brookings Institution report "Rethinking global poverty reduction in 2019" for poverty data.
6. Museum of Flight; Boeing.
7. See https://er.jsc.nasa.gov/seh/ricetalk.htm, last accessed, March 31, 2021.