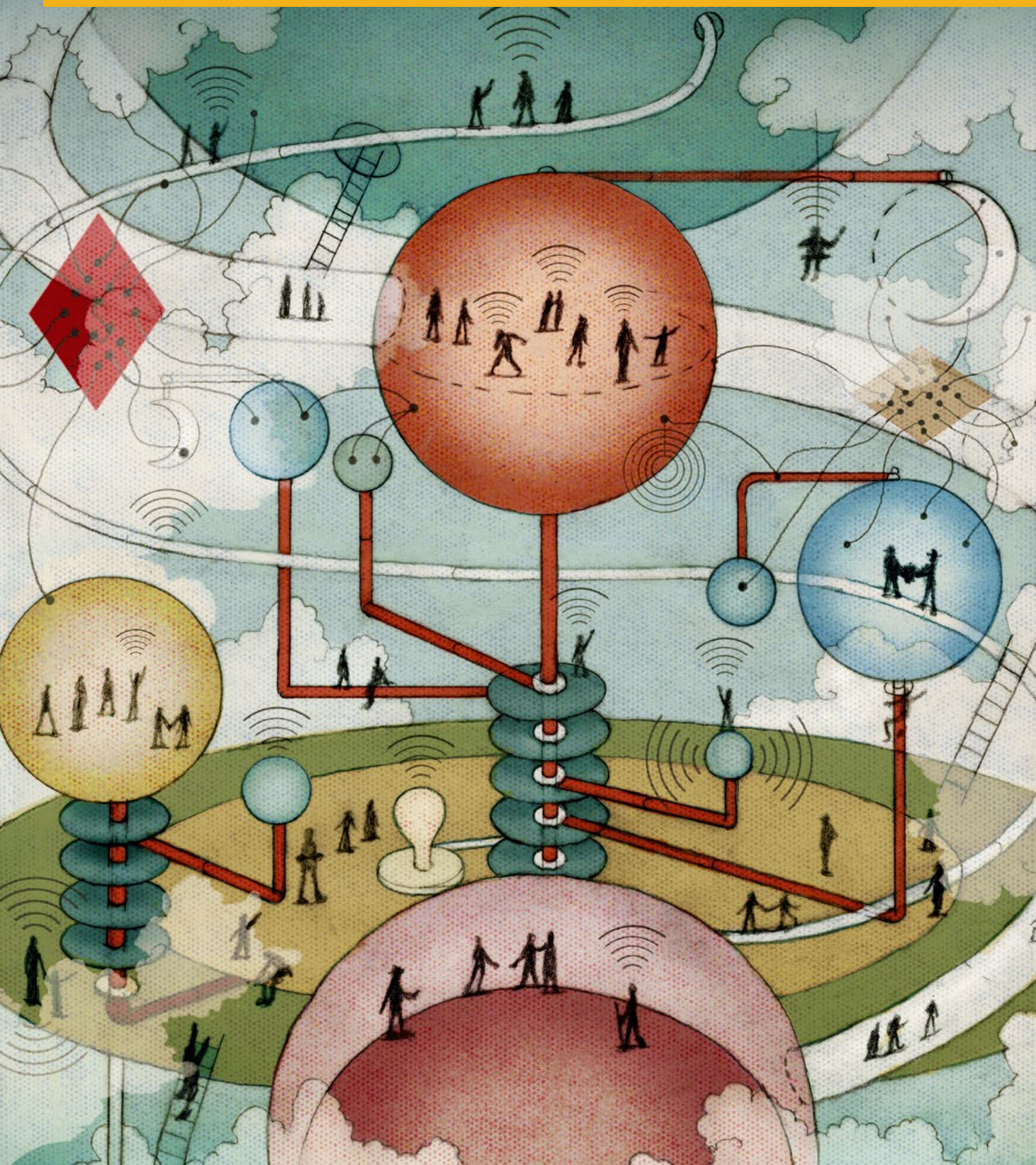
TECHONOMY

YEAR-END EDITION 2014



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REBECCA GREENFIELD

Techonomy's David Kirkpatrick kicks off the Techonomy Detroit conference at the Detroit Institute of Arts' Rivera Court.

Rousing Appropriate Awe

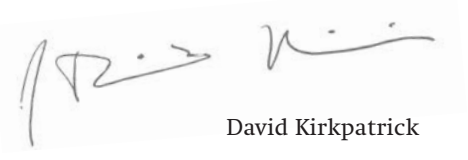
THESE ARE wondrous times. Transformation is cascading across society. It's invigorating to step back and observe the process. It's easy to take my iPhone for granted, but occasionally I rouse an appropriate awe. The information abundance at our fingertips at all times is astonishing. Could such magical devices, with technology only seven years old, really be spreading to much of humanity? What will that lead to next?

One of the signature manifestations of tech's growing capability and affordability is a global increase in entrepreneurship. New companies are tackling old problems with surprising success in nearly every sector. Big incumbents are at an odd juncture—more productive and profitable than ever, yet at risk of irrelevance if they do not keep pace with ideas emerging from college dorm rooms. Three stories in this issue of Techonomy look at the growing corporate obsession with innovation.

Our magazine aims to underscore our optimism even as it highlights some of the challenges. No matter how grim and shrill the daily news, the irrefutable bigger-picture reality is that people almost everywhere are living better, longer, healthier lives. We see technology as a lever for progress, and aim relentlessly to underscore how leaders might better use it.

We're publishing to coincide with our annual flagship Techonomy conference. We report here on our Techonomy Bio and Techonomy Detroit conferences. Program Director Simone Ross looks back at our first five years. Articles touch on the fraught intersection of tech innovation and government policy, the business of space, and the consumer-empowerment revolution in healthcare. We explain how we define a "techonomic" company. And we profile a TE14 speaker: an inventor of high-tech prosthetics from Sierra Leone.

We're not just interested in tech, and we don't see it as disconnected from larger, longer traditions. We believe in the importance of art and culture as much as tech. The combination invigorates us.



David Kirkpatrick

Program Director Simone Ross Looks Back at Our First Five Years

I THINK OF OUR CONFERENCES as a live version of my favorite magazine. I want information and intelligence, style and substance, blending short and long form to pace the experience and narrative. Our programs are not simply about the intersection of tech and the economy. They are about the application of tech, and its global economic and social impact. Ultimately we explore whether or not tech moves us towards a better world and consensus on the values of society.

Since the first Techonomy in 2010, we've talked every year about the impact of tech on jobs and on urbanization. In 2012 we even added a conference, Techonomy Detroit, specifically around those topics. "Big data" and "cyber-security" weren't mentioned once at TE10, but have featured heavily ever since. Fitbit was first mentioned at TE11, as was MakerBot, during a BioPunks session. China, digital currency, and payments are among themes we've touched on repeatedly.

Sessions on bio and life sciences at TE10 kick-started a growing curiosity. We discussed "Democratizing DNA" at TE11, "Life 2.0" at TE13, and launched a new conference, Techonomy Bio, this year. Why? Because the rapid advances being made in biological and life sciences have huge potential for global social and economic benefit. Soon we will be able to create anything synthetically. It's not just about pharmaceuticals and devices. It's about energy, agriculture, manufacturing, sustenance. Life.

Unsurprisingly, the impact of social and mobile on how we live and work is another recurrent theme. There's no question about the empowerment these forces bring, but society is still struggling with the bigger picture. Be it in corporations or countries, tech alone has limits, with leaders needed to actively shepherd change. At TE11 Jared Cohen of Google Ideas said, "Revolutions will happen faster, but they're going to be just as hard to finish. Technology doesn't create new leaders. It means you can mobilize without having a plan."

The intersection of tech, politics, and policy is another area of constant intrigue. The theme is often woven into our program, including a post-election session at TE12 called "What Have We Done?!" and "The Future of American Elections" at TE13, where we convened a Google engineer, a top Colorado elections official, an app developer, and a civil rights and election law expert to explore how tech could help fix America's broken voting system. We're planning a new conference for next year, Techonomy Policy, to further discuss this nexus.

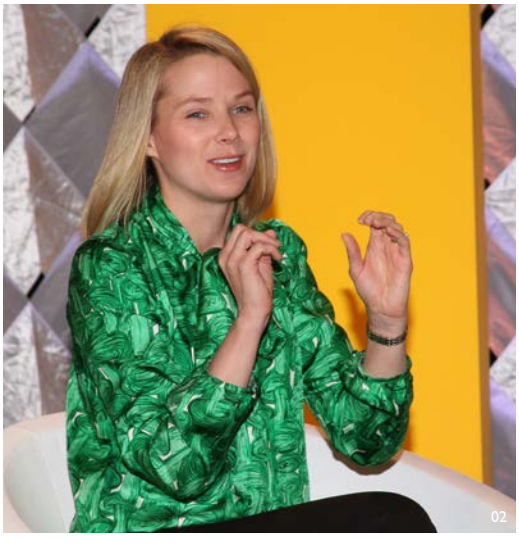
It's tough to identify a favorite session, but here are a couple. "Cities as a Solution" at TE10, with urban sociology expert Saskia Sassen, Padmasree Warrior of Cisco, and Stewart Brand, set the stage for subsequent sessions on our urbanized future. That conversation has evolved from how you build a physical, technologically enhanced "smart" city to the role individuals, institutions, open data, and tech-enhanced civic engagement play in the evolution of urban centers.

Our TE12 session with Harvard's David Keith and Andrew Parker on geo-engineering was another highlight. The intentional manipulation of the Earth's ecological systems is controversial and, amazingly, no international regulations govern it. As in the bio realm, there is huge potential for benefit, but also formidable barriers and fear. Weather warfare could become a reality. But geo-engineering could also slow or potentially reverse climate change. As Keith said, "The hard problems here are not technology. They are all about governance and managing symmetric risk and threat."

The next five years? I suspect we'll spend more time discussing the accountability of the tech industry to society. (In 10 years we'll talk about the accountability of tech itself.) We'll doubtless be talking about tech-enhanced humans vs. humanity-enhanced tech. We'll still be examining the changing nature of boundaries—physical and virtual—driven by our hyper-connected social, mobile world, and what that means for nation-states, companies, and citizens. And we'll no doubt still be talking about employment and the nature of work.

01 The opening session at TE11
02 Yahoo's Marissa Mayer (then at Google) at TE11
03 Google's Ray Kurzweil at TE12
04 From left, Steve Forbes of Forbes, Revolution's Steve Case, and Walmart's Dan Bartlett (then at H+K Strategies) at TE12
05 Tim O'Reilly of O'Reilly Media (left) and Max Levchin of HVF LLC at TE13

01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Photographs by Robert Hines (1,2) and Asa Mathat (3-5)

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Cover Illustration by Jonathon Rosen for Techonomy

Photograph by Rebecca Greenfield

The opening reception for Techonomy Detroit gets underway in the stunning Rivera Court of the Detroit Institute of Arts. Diego Rivera spent 11 months starting in April 1932 painting the murals, commissioned by Ford Motor Co. President Edsel Ford.

REDEFINE
HYBRID CLOUD

EMC²

WHAT IS A TECHONOMIC COMPANY?

Here at Techonomy we think every business needs to reorient itself around the cascading change in tools, systems, processes, and philosophies being driven by the Net and tech. We have our favorite adjective to describe companies that are ahead in this never-ending transformation. Here are three examples.

MasterCard Labs has experimented with Google Glass.

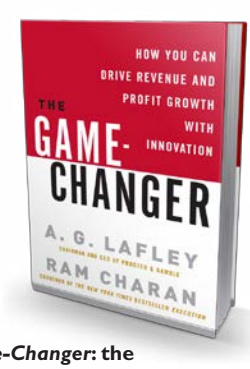
MasterCard

Like its rival Visa, MasterCard has rethought its business in recent years as countless payment innovations emerged from startups globally. It's changing how it develops and markets products, manages people, and partners with outsiders. CEO Ajay Banga calls MasterCard "a technology company that's in the payments business." (Customers spent $2.7 trillion with 1.7 billion cards in 2013.) It started an in-house incubator, MasterCard Labs, in 2010.

In a program it calls Innovation Express, company engineers and others periodically hole up in a hotel. They're given a product-development challenge and must come out two days later with a prototype, a marketing plan, and a video demo. This year the method came to Cornell, where four mixed groups of students and employees competed on ideas for a product for young people. MasterCard has launched numerous new payment methods in recent years. Some succeeded and some did not. But that's OK. "We want to fail fast, fail cheap, and learn from the failure," MasterCard Chief Innovation Officer Garry Lyons said in a recent interview.

Procter & Gamble

There's a reason P&G, founded in 1837, is still a colossus ($84 billion in 2013 revenue). It learned long ago to be responsive to change. Since James Gamble's first patent for molding candles, innovation has been prized in company culture. The company got interested in open innovation and crowdsourcing as early as 2001, well before it became trendy. It was an early supporter of pioneer Innocentive, whose global community of scientists solves complex chemistry and other problems. Now P&G has its own crowdsourcing platform. CEO A.G. Lafley in 2008 co-wrote a book with strategist Ram Charan on innovation for business success. The company consistently jumps early on technologies like using simulated 3-dimensional stores for market research. Today it's experimenting with cognitive science in marketing. And it has won awards with a program that provides clean water to children in emerging countries.



***Game-Changer*: the P&G CEO looks at innovation.**

Warby Parker's frames start at around $95.

Warby Parker

The New York company started with an Internet focus, aiming to bring lower prices and convenience to an eyeglasses industry overwhelmingly dominated by one giant corporation, Italy's Luxottica. It's hard to buy a decent pair of glasses most places for less than $250 (and you can easily pay into the thousands), but Warby Parker's start around $95. They can be configured online and delivered by mail. A popular program donates a pair in emerging countries for every one sold. Warby was an early pioneer in data science. It builds much of its own software, but gives innovations away as open source. It has also been outspoken in its commitment to fairness for workers in factories in China and elsewhere that produce its products.

Techonomists on the World's Biggest Challenges (and How Tech Might Help)

We asked Techonomy 2014 participants a few questions in advance. One was about big global challenges. Inequality was cited most, which some might find ironic since techies are perceived as the biggest beneficiaries of unequally distributed wealth. Climate change and terrorism were also big concerns. These techonomists were generally not optimistic that tech and communications would be sufficient to bring people together and prevent growing discord. (Those inside each circle cited that challenge. Responses continue on pages 16 and 32.)

"The biggest challenge is **extremism**–which we see increasing in politics, media, terrorism, and many more pockets in our society. It is creating polarization that needs to be lessened. I'm hopeful that technology can help to bridge such differences by increasing communication and enabling understanding."

GLOBAL SECURITY

Debby Hopkins
Citi

Shaygan Kheradpir
Juniper Networks

Michael Miller
PC Mag

Martin Morgan
DMGT

Julio Ottino
Northwestern University

"We need to **drive innovation globally,** from Silicon Valley to the Great Rift Valley and back again. To do that we need to enable a high fidelity, horizontal work model that spans the globe and facilitates innovative thinking. The cloud is the 21st century delivery engine for that innovation."

"**Islamic terrorism.**"

"Terrorism, and the possibility of **nuclear proliferation.**"

TECHNOLOGY

Andrew Keen
Author

Marleen Vogelaar
Shapeways

"People live in bubbles of like-minded people, from neighborhoods, to companies, to social media. Other ideas are filtered or not heard. Consequently, lack of listening, understanding, and empathy for people of other beliefs, countries, and political parties will lead to stark divisions in happiness and wealth and will drive more individuals, organizations, or countries to pursue or fight each other. This is the **negative effect of the personalization power of tech.**"

URBANIZATION

Kevin Eggleston
Hitachi Data Systems

"The **pace of urbanization** is a big one. Technology needs to be leveraged to accelerate the ability of cities and nations to address clean water, sanitation, communications, power, safety, etc."

"**Income inequality.**"

"Ensuring that **the gap between the world's wealthiest individuals and nations and its poorest** doesn't devolve into a nihilistic dualism that pits ever-more-desperate actors on the poor/disadvantaged end against ever-more-greedy actors on the rich/privileged end."

EQUALITY OF OPPORTUNITY

Mark Bonchek
SHIFT Academy

Ali Diab
Collective Health

Margo Georgiadis
Google

Jeremiah Grossman
Whitehat Security

Sai Mandapaty
ThoughtWorks

William Raduchel
DMGT

Cem Sertoglu
Earlybird Venture Capital

Jeff Weiner
LinkedIn

Jonathan Yaffe
Anyroad

"**Inequality and the disruption it spawns** will be the challenge, but facing it will be hard. As a global market economy rewards particular skills and abilities disproportionately, inequality could continue to grow. ISIL/ISIS is really a manifestation of inequality as much as anything. In one sense tech may be driving the inequality, not helping it. As 8 billion people come online, how much global income inequality can we sustain without using force? That is the question of the time."

"How will the middle class in emerging markets, a very large cohort, access **quality healthcare?**"

"The accelerating rate of innovation is outpacing our collective ability to train the workforce to take on the economic opportunities being created by new technologies. One of the biggest challenges will be closing the **growing skills gap** and preparing the workforce for the jobs that will be and not the jobs that once were."

"The scalability of low-cost tech solutions will democratize industries. Add to this the ability to transact globally with a much lower barrier to entry, and we'll see economic development change communities around the globe by **empowering microentrepreneurs.**"

"Everything that is made should go direct to a consumer and not sit in inventory and become obsolete. Less production means less energy, less inventory, less waste. Just-in-time supply chains and transparent inventory practices **reduce waste and decrease carbon output.**"

CLIMATE AND ENERGY

Maria Amundson
Edelman

Liam Casey
PCH International

Sara Greenstein
Underwriters Laboratories

David Liu
XO Group

"**Climate change.** Tech can help in just about every way—clean energy and sustainability (smart grid, smart home, Internet of Things) are the most obvious ways."

CAN GOVERNMENT GET A BETTER GRIP ON TECH?

Leaders in and out of government worry that regulation and policy are not keeping up with the pace of change. **BY DAVID KIRKPATRICK**

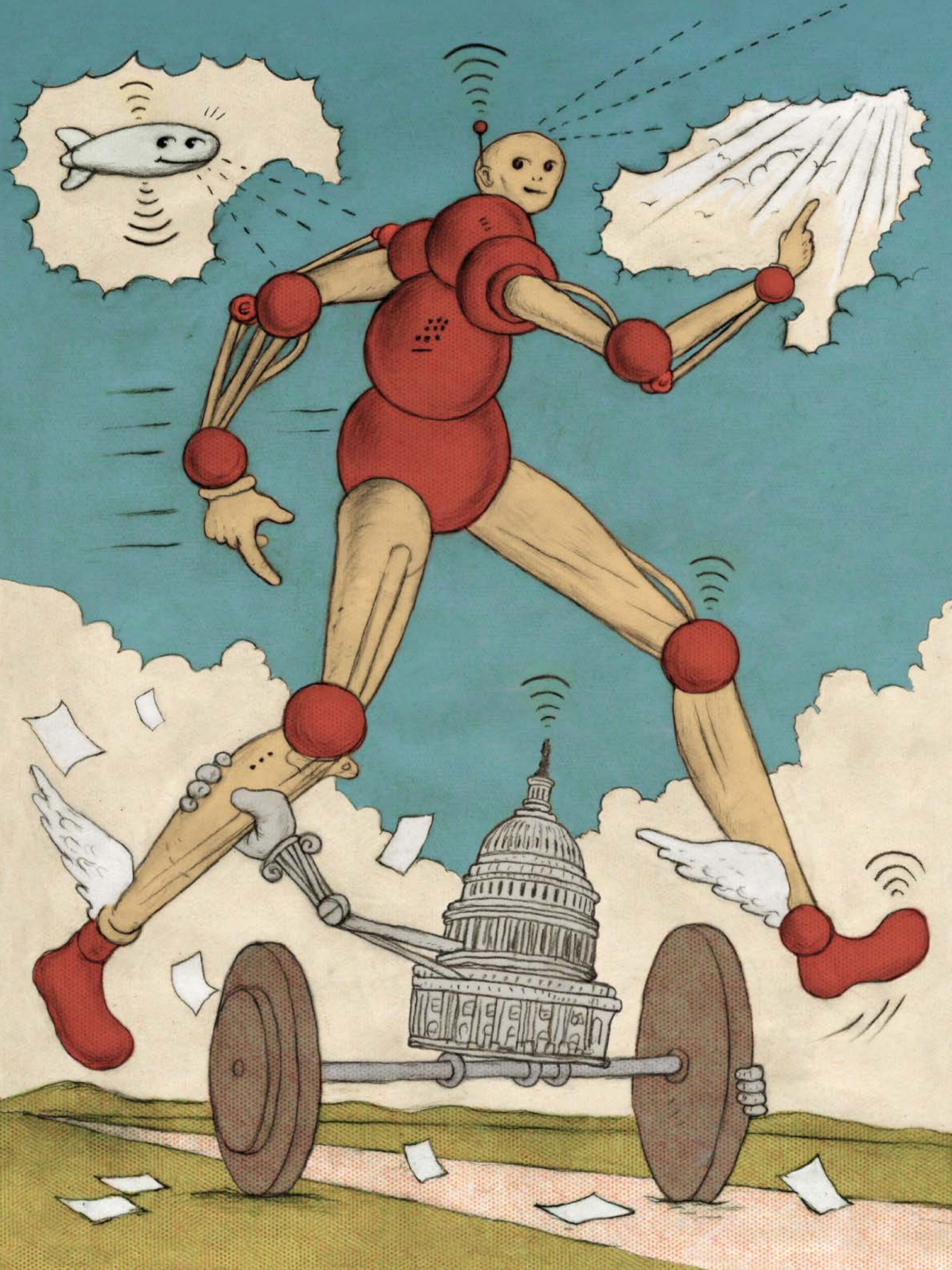
"I'M VERY WORRIED," says Neelie Kroes, who has served as a vice president of the European Commission since 2010. "The changes in technology nowadays are so fast that we have to change our mindset. This is my biggest frustration in the Commission. It takes so much time for governments to know what is at stake. We can't consult 10 times about issues like we did in former times."

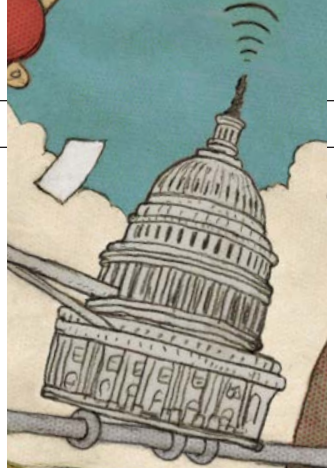
Kroes's concerns are widely shared, especially in the United States. Says Steve Case, who spends as much time as any major tech leader working with leaders of both parties in Washington: "The pace of innovation continues to accelerate and outstrip the ability of governments to react." Technology's influence is spreading into virtually every sector of society and every process of business and human interaction, but few are confident government will respond to the changes with sufficient speed and understanding. Tech-oriented companies are taking aggressive action in transportation, financial services, energy, education, and healthcare. And we're seeing innovations like digital currency Bitcoin; new online systems that exploit the personal data of citizens; self-driving cars, drones, and other developments in robotics; the increasing ubiquity of sensors and cameras controlled by business and individuals; and rapid advances in synthetic biology and genomics that bypass or render irrelevant traditional drug-testing techniques. Every one of these developments poses challenges to existing regulatory regimes, which were designed in a different era.

Worries are growing across the tech industry. Longtime Silicon Valley entrepreneur and investor Reid Hoffman asks, "How do we get smart government that can both find new opportunities and counter threats?" Jeffrey Bleich, a tech industry lawyer, recently returned from four years as U.S. ambassador to Australia. "It was stunning coming back and hearing people in Silicon Valley and Washington talking completely different languages," he says. "The government has sort of lost the plot of what is happening in tech." Says Brad Smith, chief counsel for Microsoft: "Tech advances at different rates in different time periods, and the government moves at different rates as well. But I think we have an especially important and pronounced problem right now, because we're living in a time of rapid technological change, when government in the U.S. is shackled by intensive gridlock."

Part of the problem is the increasingly aggressive nature of tech entrepreneurship. "Today's emerging Internet...stars are trying to change our laws as much as they are trying to change our technology," wrote Ron Klain, chief counsel for Washington-based venture capital firm Revolution LLC, in a recent Fortune article. (President Obama in October appointed Klain his special "czar" for fighting

Illustration by Jonathon Rosen





GOVERNMENT FACES INCREASING PRESSURE FROM ORDINARY CITIZENS, EMPOWERED BY TECHNOLOGY TOOLS.

Ebola.) In an email, Klain notes that companies like Uber and Airbnb are "launching businesses that might not be legal at launch, with the hope that the rules will get changed later." The attitude, he says, is "just do it."

Such aggressiveness was manifest when a senior Uber executive in Europe recently told the Wall Street Journal: "The public are already voting with their fingers, the question is can we get policy makers to kind of catch up to that. We're open for that debate, if they come to us and say we like what you're doing, but here are our concerns." In the past, companies didn't generally ask governments to endorse them before they would submit to regulation. And some in the U.S. tech industry seem determined to drive an even deeper wedge between themselves and Washington. Investor Chamath Palihapitiya, a former senior executive at Facebook, last year called the U.S. government "completely useless," adding, "Stasis in the government is actually good for all of us. It means they can neither do anything semi-useful nor anything really stupid."

But government also faces increasing pressure from ordinary citizens, empowered by the tools made available by technologists. That may disempower regulators and legislators. A young citizen in Beijing, concerned about pollution, began in 2012 to regularly fly a kite carrying an inexpensive data sensor to measure airborne particulate levels. She posted her readings on Sina Weibo, China's version of Twitter. The U.S. embassy shortly began publishing online similar readings taken on its roof. After that the Chinese government finally began publishing its own previously secret pollution data. A similar citizen-driven effort to measure local radiation levels after the Fukushima nuclear meltdown forced the Japanese government to acknowledge the severity of the problem. The so-called Safecast initiative was assisted by the Media Lab at MIT. It now aims to arm citizens globally with sensors to monitor pollution of various sorts. "Low-cost sensors will be the biggest driver in the future for environmental cleanup," says Fred Krupp, president of the Environmental Defense Fund. "It's all about transparency and real democracy." In the past, monitoring was government's job.

Ryan Calo, who teaches law at the University of Washington, worries about a lack of government resources. "There isn't enough technical expertise in government," he says. Calo notes that when a crisis arose in 2009 regarding sudden acceleration in Toyota automobiles, some suggested the problem might lie in vehicle software. But the Department of Transportation did not have the expertise to research it. "So they went and asked NASA to take a break from keeping the space station running and driving robots on Mars to look at this Toyota," marvels Calo. (NASA's report found no software glitch.) Calo now argues for the creation of a new federal agency—"a repository of expertise, which like NASA has a whole bunch of computer scientists, whose job is to advise other agencies and Congress." A similar agency called the Office of Technology Assessment advised Congress after 1972, but was abolished by Republicans in 1995.

Calo studies the legal and ethical implications of robotics, and finds numerous reasons to worry about the U.S. response to them. "This disconnect between knowledge and policy will be harmful," he warns. He notes that Nevada, influenced hastily by Google, passed a law to accommodate self-driving cars in 2011. But the law was written to cover fully autonomous vehicles like Google is developing, not the proliferating partially autonomous ones sold by Audi and others. It had to be repealed and rewritten. The Food and Drug Administration approved the use of robotic surgery techniques, but then safety concerns emerged. "The FDA may have moved too quickly on approving robotic surgery," says Calo, "whereas I and others believe the Federal Aviation Administration is holding up drones unnecessarily." Many in academia were outraged when the FAA in July sent "cease and desist" letters to journalism professors at the University of Nebraska and the University of Montana who used drones in their classes. Public

institutions, the FAA said, must get authorization to operate in public airspace. Meanwhile, anybody can buy a drone from Amazon for $40.

Another senior European Commission official, Robert Madelin, who oversees 1,200 tech experts as director general of Communications Networks, Content, and Technology, believes the pace of change raises questions about the very structure of society's decision-making processes. But he also says things could be worse. "You wouldn't want to live in a society where government could typically get ahead of change," he points out. "That would mean you could only use things if the government said you could."

And in the U.S. there are glimmers of progress. President Obama recently appointed well-liked former Google executive Megan Smith as his new chief technology officer. Tech experts across the federal government are increasingly coming together seeking to nudge policy. And the startup most known for bare knuckles, Uber, in August appeared to foreshadow a more collaborative style when it hired David Plouffe to coordinate global political and policy efforts. He was President Obama's 2008 campaign manager and communications advisor. Amazon, Apple, and Google have all been trooping to the Food and Drug Administration as they seek to develop new health-related products and services. Google, for example, is creating a glucose-monitoring contact lens for diabetics.

Hoffman says he's eager to meet with any congressperson to discuss how tech can solve national problems. "But I've met ministers here in Silicon Valley from the U.K., Singapore, France, and Canada, among others," he says. "Very few congresspeople come through, other than with their hats held out for checks."

Key veterans of the Washington dialogue remain optimistic. Says Microsoft's Smith: "Just as one could look at the beltway and say it doesn't understand Silicon Valley, you can say Silicon Valley doesn't understand the beltway. The only way to get progress is to increase understanding in both places." Adds Steve Case: "If we don't get this right—engage in the right ways, get key things done—it will hurt the U.S. and in the long run hurt the entrepreneurs, too. Getting this right will be a big challenge for the next wave of innovation."

Techonomy aims to encourage this dialogue. Our first Techonomy Policy conference is June 9, 2015, in Washington. Kirkpatrick is Techonomy's CEO.

SPA

THE NEXT FISCAL FRONTIER?

A C E

BY JOSH KAMPEL

WHEN THE U.S. space program suspended human flight in 2011, "we took away the dream of exploration for a generation of kids," grumbles Michael Sims, who worked for NASA for over 15 years at the Ames Research Center and now heads software at Moon Express, a startup that aims to land a craft on the moon.

Lots of adults still have that dream. Jeff Bezos, Richard Branson, and Elon Musk have between them invested close to $1 billion in space companies, respectively Blue Origin, Virgin Galactic, and SpaceX. Blue Origin is working on cost-effective space travel technologies; Virgin Galactic plans to offer flights to "space tourists;" and SpaceX is already launching rockets into space. But it's not only NASA veterans like Sims and billionaire businessmen who care about space. Numerous startups are emerging to capitalize on the opportunity. Chad Anderson, managing director of the Space Angels Network, calculates early-stage space companies raised over $200 million in 2013.

Many new projects are aided by NASA contracts. It recently hired SpaceX to taxi astronauts to the International Space Station (ISS), a role previously performed for the U.S. by Russia, which is now in jeopardy as tension between the countries escalates. SpaceX just completed its fifth ISS cargo mission. It carried, among other things, a new 3D printer specially designed to work in space. The printer's maker, startup Made In Space, is the first to print in zero gravity environments.

Giant tech companies are also paying attention. Google acquired satellite company Skybox Imaging for $500 million to give businesses access to information and high-resolution images of Earth. The search giant also contributed $30 million in prizes for the Lunar XPRIZE. Now 18 teams are competing to land an unmanned spacecraft on the moon by 2016. Techonomy visited two competitors—Moon Express, located at NASA's Ames Research Center in Mountain View, California, and SpaceIL, in a university neighborhood of Tel Aviv. In both cases it's not only the prize money that motivates them. Executives are passionate about inspiring future generations of engineers and scientists. We were shocked to hear how optimistic these relatively small teams were about getting to the moon.

Satellite ownership is also spreading widely. At a 2013 Techonomy event, Peter Platzer, CEO of early-stage company Spire (then called Nanosatisfi), discussed its plan to deploy dozens of tissue-box-sized satellites. The first one launched after a Kickstarter campaign raised $100,000. Spire outfits them with cameras and sensors so customers can collect data. Initial applications monitor illegal fishing, maritime trade, and piracy.

While data and communications satellites have thus far dominated the economics of space, investors have high hopes for other businesses like mining. Planetary Resources Inc. (whose investors include Google's Larry Page and Eric Schmidt) and Deep Space Industries are among those with mining plans. "If the idea works, it is a multitrillion-dollar industry," *Mining the Sky* author John Lewis wrote recently, "making available...more resources than the human race has used to date." While minerals like iron may be abundant, it will initially be costly to bring them down to Earth. More likely they will be used in space construction. But precious metals like platinum could be affordable to send earthward. Longtime tech investor and analyst Esther Dyson says this could both radically expand the availability of such materials and reduce their price.

With all of this activity, it is tempting to ask why we are investing so heavily in space when hunger, poverty, and disease cry out for attention on Earth. Moon Express' Sims has his own matter-of-fact reply: "Realistically, most of those things are a lot harder to address than getting to the moon." Maybe for the next generation working in space will be attractive, or even routine.

Josh Kampel is Techonomy's president.

Photo Montage by Josh Kampel

Techonomists on What CEOs Should Do

We asked TE14 participants what key action they would take as a CEO in the face of tech-driven change. They were not sanguine about the challenges facing CEOs. Reducing their own power and flattening hierarchy was widely recommended. The CEO of the next decade may work hardest at rendering him or herself less necessary for all but the most strategic activities. (Those inside each circle cited that action.)

RECRUIT AND TRAIN

David Liu
XO Group

Martin Morgan
DMGT

William Raduchel
DMGT

Julio Ottino
Northwestern University

"The most important things will happen at intersections. Try to hire people who are adept at **working at intersections.**"

"I would say constantly **look to reinvent.** Get outside your company. Be open."

DISRUPT CORE BUSINESS

Maria Amundson
Edelman

Mark Bonchek
SHIFT Academy

Liam Casey
PCH International

Sai Mandapaty
ThoughtWorks

Hemant Taneja
General Catalyst Partners

Jonathan Yaffe
Anyroad

"As CEO, I'd continue to ask, 'How can I start a new company with unlimited resources to **put my own company out of business?**'"

FIRE A ROBOT

Andrew Keen
Author

"As CEO, I would **replace myself with a machine** for a week. After that, my employees and investors would recognize my value."

INVEST IN ANALYTICS

Ali Diab
Collective Health

Margo Georgiadis
Google

Jeremiah Grossman
Whitehat Security

Henrik Klagges
TNG Technology Consulting

"Put in place a **customer and employee feedback loop** that is as instantaneous as technically and humanly possible."

"The key will be **automation and decision making** based upon large volumes of data collection. Data analytics, and employees with background in these associated tools, will be instrumental for ongoing success."

"I would purposefully **build an artificial intelligence** at the core of my company–'big data with benefits.' I'd have it monitor events and propose decisions during its adolescent learning phase, try to teach it to be benign, and finally let it influence or even make decisions."

FLATTEN HIERARCHY

Maria Amundson
Edelman

Margo Georgiadis
Google

Shaygan Kheradpir
Juniper Networks

David Liu
XO Group

Catherine Porter
OpenTable

Jeff Weiner
LinkedIn

"Flatten management hierarchy; **hire for creativity,** curiosity, collaboration, and courage; create safe zones for experimenting with new products that threaten the core business; build in ongoing learning and exploration at every job function."

"Break silos in decision making (functional and product). **Force more horizontal agility** across organization–real discussion and friction at edges vs. committees and metrics that can just slow you down more!"

"**Solve for agile development globally,** in smaller, empowered, autonomous development teams in remote locations. Relying on development talent in only a few locations isn't sustainable and slows productivity."

"Organizations can best position themselves for the future by creating a **flatter, faster, continuous learning environment** in the workplace to keep the aggregate skills of their employees ahead of the pace."

Running Scared? Big Companies Increase Innovation Spending

Established companies increasingly fund startups and take numerous measures as they seek to create innovative new businesses. **BY LOU KERNER**

JUST BASED on the numbers, you wouldn't think established companies would be scared by the $50 billion invested this year in the U.S. by venture capitalists. The companies themselves will collectively spend over $330 billion this year on research and development, according to R&D Magazine.

Yet VC money is funding aggressive newcomers like Uber and Airbnb, and aims to create the next Teslas, Facebooks, and Googles. Insurgent startups seem to be targeting every industry and even inventing new ones. The startups are wielding the weapons of the Internet—cloud, mobile, social, and data analytics—and deftly taking advantage of connectivity and the flattened business environment it enables.

As we enter the most disruptive period in business history, established companies with deep pockets—the ones you might call the "disruptees"—are waking up and determined to fight back. Many are refocusing their own efforts to innovate and stay relevant. The result is a stunning range of initiatives.

Cash-rich corporations run by smart people are going to try aggressively to adapt—by spending lots of money. The $330 billion in R&D spending should be a great start. But for corporations, there's little correlation between what they spend on R&D and the amount of innovation that results. A recent Booz Allen survey ranked Tesla the ninth most innovative company among the Top 500 global spenders on R&D. That is despite the fact it only spent $300 million in 2013, coming in at No. 377.

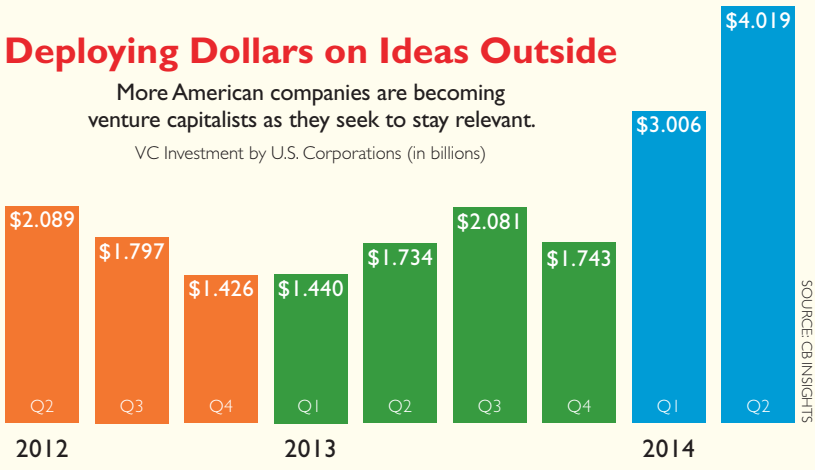
But there are plenty of ways to spend on innovation. The easiest is to acquire it. The impact can be immediate, which makes it appealing. In the second quarter of 2014 U.S. companies announced $625 billion in deals, up more than 58 percent over the same period a year earlier. According to a recent report by PricewaterhouseCoopers, "Transformational" M&A (which generally includes innovation) is now the No. 1 reason for targeting a particular company. But acquisitions are tricky, and the Harvard Business Review recently reported that between 70 and 90 percent of M&A deals fail.

Another rapidly growing trend is ordinary companies investing in the disruptors. That's why corporate VC investment jumped 221 percent in the first half of 2014, to over $7 billion (see chart). Such deals now comprise roughly 30 percent of all VC investing.

Deploying Dollars on Ideas Outside

More American companies are becoming venture capitalists as they seek to stay relevant.

VC Investment by U.S. Corporations (in billions)



SOURCE: CB INSIGHTS

This and the two following stories–on General Electric and on the importance of design–look at aspects of a growing obsession in corporations. They are taking action and trying to innovate faster.

The third way corporations are spending on innovation is by participating in the rapidly growing incubator/accelerator movement, in which teams come together to innovate in special physical spaces fitted out with resources and staffed with experts in entrepreneurship, design, finance, marketing, and other disciplines. Some companies create internal startup incubators. Samsung, Orange, and Turner Broadcasting's Media Camp are examples. Incubation experts are increasingly lending the big guys a hand. Techstars has eight of its own standalone incubators (in Boulder, New York, Austin, London, and elsewhere). Now it is partnering on private incubators with six companies, including Disney, Nike, and Barclays.

Corporate co-parenting is yet another approach, when multiple companies join together to incubate products, services, and startups. Bosch, State Farm, and Panasonic joined together around a common theme to create Plug and Play's Internet of Things Incubator. Other operations focus around a specific industry, like New York Fashion Labs, whose partners include J. Crew, Ralph Lauren, and Kate Spade. In London, MasterCard, Lloyds Bank, and Rabobank joined together in an incubator specializing in financial technology, run for them by Startupbootcamp, which has seven accelerators in Europe and one in Israel.

Xerox PARC (Palo Alto Research Center) opened in Silicon Valley way back in 1970. Now numerous other corporations are setting up their own Silicon Valley innovation centers. Walmart Labs was formed out of the acquisition of Kosmix in 2011, and has focused heavily on mobile strategy.

The ultimate way to stimulate innovation is to change the corporate culture so it begins to happen naturally and regularly.

Ford Motor set up its Lab in Palo Alto in 2012 to focus on "user experience, open innovation, and big data."

Partnerships are yet another way to stimulate innovation. In November 2013 GE announced a partnership with Quirky, which specializes in crowdsourcing innovation and invention. (See following story.) They introduced the Quirky Inspiration Platform, which provides open access to a library of GE patents across several product categories. The partnership's first product, a Wi-Fi-enabled air conditioner, hit retail stores in April 2014. However, GE recently announced it was selling its appliance division to Electrolux. So Quirky loses access to some patents, though the Inspiration Platform will live on. Consumer packaged-goods giant Unilever estimates that 70 percent of its innovation is linked to working with strategic partners. In one program, seven Unilever brands including Hellmann's and Vaseline each awarded $100,000 to a digital media startup that then joined the brand in a pilot marketing program.

The ultimate way to stimulate innovation is to change the corporate culture so it begins to happen naturally and regularly. Google's famous 70/20/10 model encourages employees to spend 70 percent of their time on core business tasks, 20 percent on projects connected to the business (incremental innovation), and 10 percent of time on unrelated ideas (disruptive innovation). This model is hard for most organizations to replicate, so they institute more bite-sized programs. Coke's Startup Weekend is an annual 54-hour event where 100 Coke associates pitch ideas. Hasbro, Accenture, and GM's Chevrolet hold corporate hackathons where hundreds of people from outside the organization gather for a short period of time to advance specific corporate innovation initiatives.

Big companies would love to manage innovation the same way they manage everything else, with metrics and discipline. Unfortunately, it doesn't work that way. Entrepreneurs are willing to take risks in ways most executives simply could not abide.

The sad reality is that most corporate giants have been failing at innovation for years. As the pace of technology change picked up in recent decades, the lifespan of companies in the Fortune 500 radically declined. It took 28 years for half of the 1955 Fortune 500 class to disappear. Half of the class of 1995 were gone 15 years later. You have to innovate—or you die.

Lou Kerner is the founder and manager of The Social Internet Fund, which invests in the primary and secondary shares of private social media, mobile, big data, online video, and ad tech companies.

GE'S COMSTOCK: THE IMPERATIVE IS SPEED

"Be nimble. Move it faster to market and faster to your customer. Your competition may be coming from a startup in China. It may be coming from a totally new digital perspective."

Interviewed by David Kirkpatrick

General Electric Senior Vice President Beth Comstock stopped by Techonomy's office recently to talk about corporate innovation. Besides overseeing all GE's sales and marketing activities, she's responsible for growth and market innovation. She rose through corporate communications to become GE's CMO, then ran sales and digital for NBC Universal before her current job. When we asked about her light bulb experiences, we didn't know that shortly after our meeting CEO Jeff Immelt would give her an additional job leading GE's $3 billion lighting business. We started by asking how someone with a marketing background got so interested in innovation.

COMSTOCK: If my job is to be an advocate for where the market's going, how can you *not* be about innovation? It's not enough just to know about a trend. After a while you get to be...trendy. Why should I care about driverless cars? Well, at GE we're involved in locomotives and airplanes, so how can autonomous vehicles translate?

KIRKPATRICK: Have you had light bulb experiences in this job about innovation in a big company?

COMSTOCK: I work at GE and have a lot of light bulb experiences. A light bulb has gone off for me about the power of partnerships. You can't do it all on your own. You don't have all the good ideas. What are the biggest factors in markets now? Globalization and technology. You can't point to any one technology. They're all interwoven. Is it the Internet or the cloud? Is it mobile?

KIRKPATRICK: How do you broaden who contributes to GE innovation?

COMSTOCK: There has to be a humility. That starts internally. The engineers have to recognize technology isn't everything. Maybe they should work with a marketer to understand customer needs. In the past five years we've also been doing more partnerships and investing in startups. The Quirky partnership is a good example. We co-branded a series of connected consumer products. Quirky does things really fast, and gets ideas from everywhere. We wanted to learn about open innovation. How does their community generate ideas? How can we do it faster? We're launching now at Home Depot a connected light bulb that we got out in a record amount of time thanks to how Quirky worked with our lighting guys.

We've teamed with Local Motors, a manufacturing startup that is making cars. It's an open-source engineering community, but we are excited about their small flexible micro-factories. How can we get smaller factories around the world?

KIRKPATRICK: Marketers didn't get that involved with product development back when products didn't change as quickly.

COMSTOCK: Traditionally marketing was: "Get the product to the market. Launch it. Advertise it." Now we're making sure the market's ready. We're data driven and user-experience driven. It's changed how we think about what a product is. Technology allows us to get customer feedback digitally. You have digital collaboration 24 hours a day. You don't have to wait three weeks for a focus group.

There's a huge shift in the imperative for speed. Be nimble. Move it faster to market and faster to your customer. Your competition may be coming from a startup in China. It may be coming from a totally new digital perspective. We launched something—we like to brand everything—called FastWorks. We're inspired by the concept of lean startups. We create prototypes quickly and ask customers for feedback. It brings everybody to the table, and has allowed us to spend less and to learn earlier.

Photograph by Andrew Eccles

Comstock's marketing team is "data driven and user-experience driven."

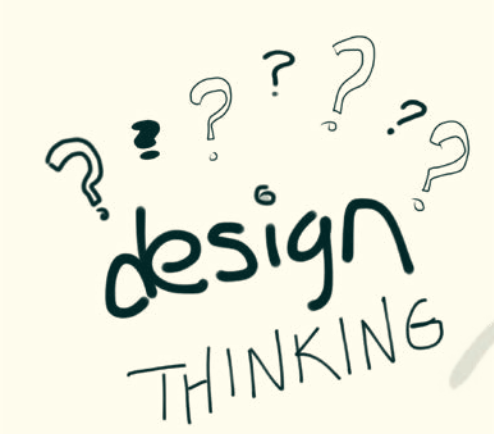
An example is a new industrial gas turbine we developed. By the old process it would have taken five years to get it to market. That's just not acceptable. By then the competition will have something better. We were planning to build five use cases for five different segments. But it turned out that what the Navy and marine operators needed was simple and we actually had it. We got a prototype into that market in less than a year.

KIRKPATRICK: There's an entrepreneurial fervor in the world now. Are you envious of what startups can do?

COMSTOCK: We ask ourselves that, too. We want to embrace our own entrepreneurial spirit. We were started by Thomas Edison, the Steve Jobs of his time. But it's been a while since that happened. What do you envy about a startup? It is that green field, that ability to start from scratch. You have an idea and bring it to fruition. There's a lot you can do without legacy systems or the transparency that comes as a more established company. But a company like ours has scale. We can show up in a market like China and get something launched quickly; a startup can only dream about doing that.

KIRKPATRICK: Do you think about innovating at the scale of the entire company?

COMSTOCK: I love that question. The sum of the parts is what we're really trying to go to. The Industrial Internet is probably the best example of a core competency across the company. We're connecting all our big machines to the Internet—the jet engines, the MRI machines, the locomotives—so you can take the data, derive insights, and generate more productivity for customers. If we left it up to each business to figure out their data and software, we would not be taking advantage of the scale of the company.



The Next CEO Whisperers:

DESIGNERS

Customer-centric companies need a design-oriented corporate culture. The goal is to build products and services driven by empathy. **BY DANE HOWARD**

MORE THAN EVER, we make decisions on the products or services we use based on how something feels. Great design connects us as consumers to the human and emotional side of products. And companies that can do that with their products create a tighter and more direct connection with their customers. Think about the applications you open on your phone, the car you drive, or the hotels you frequent. Chances are that each has won your attention and loyalty based as much on how it makes you feel as on the value it offers. Such products and services are just better designed.

I'm a designer who has the good fortune to sit a few doors from the CEO of a multibillion-dollar company. Few such CEOs understand design. Sure, there's Mark Parker of Nike, and there was Steve Jobs, but it quickly gets hard to name more of them. That's not a bad thing, of course. Many designers have a propensity to take huge risks in the effort to be creative, and I wouldn't want most of them to be my CEO. But design is increasingly important in the executive suite.

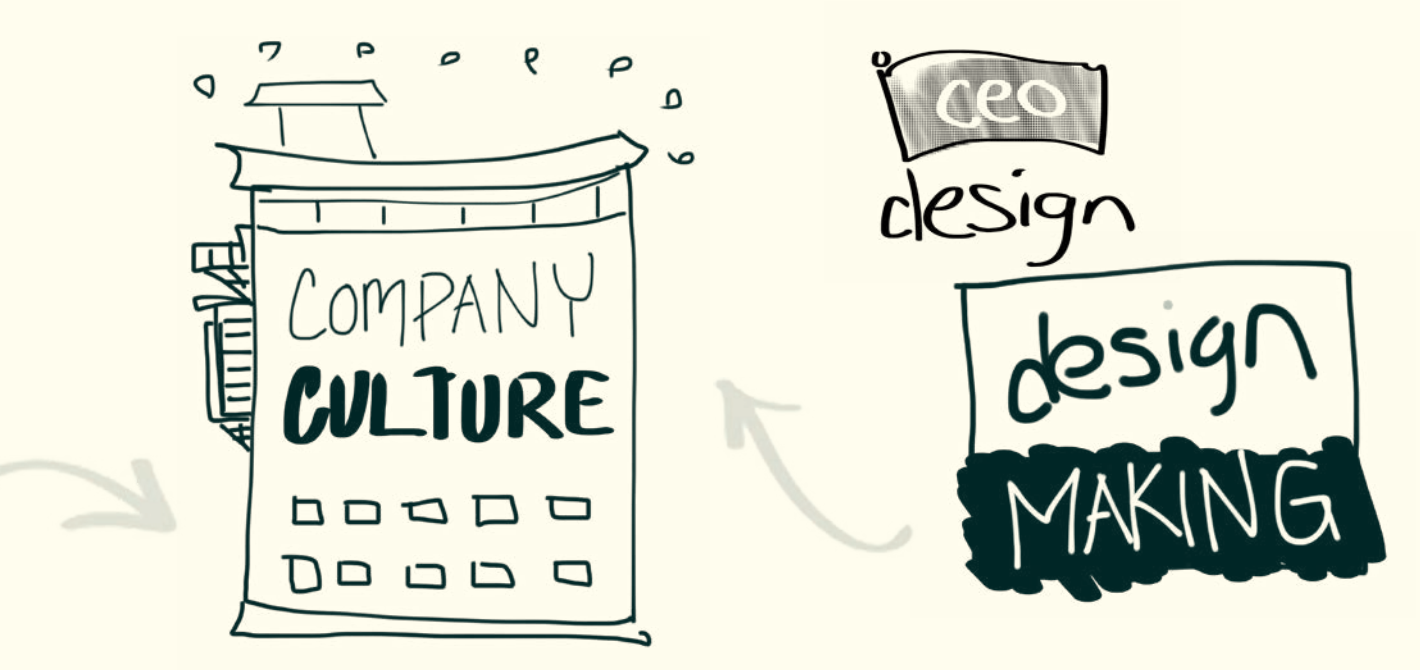
Design should be a factor in the entire end-to-end experience of using a product or service. Every touch point with the customer needs to be considered. And product companies can learn from great service and hospitality companies. Airbnb, a company started by designers who graduated from the Rhode Island School of Design, says that its website is involved in only 5 percent of its customers' "journey" (a term used to describe the entire set of touch points with a customer). If you've ever set up a Sonos sound system or checked into a Four Seasons hotel, you'll see the care and craft they take to get you acclimated quickly and easily. They get you feeling better, sooner.

As more and more companies design for a holistic customer journey, designers have begun to gradually move towards the executive suite. Yves Béhar is the principal and founder of his own company, Fuseproject, but also serves as chief creative officer at Jawbone, which makes Bluetooth-connected consumer electronics. Infor, a large enterprise software company, now aims to differentiate itself from SAP and Oracle with design. It has built a 100-person internal design firm called Hook & Loop in order to drive design consciousness throughout the company.

Inside a large company, the design of the organization itself is itself a major design challenge. Company cultures that are consciously "designed" can be critical to sustainable success. Such companies make better decisions about how and what they do. This is why strategic design firms like IDEO and Frog Design have expanded their offerings so they don't just design products and services but also teach organizations how to behave like they do.

Great companies proactively design their future, and fill it with customer empathy. An industry leader like Apple is proactive about its innovations. Its executive leadership talks continually about design, and has long promoted discipline and excellence in everything they do. Airbnb proactively disrupted the hospitality business by focusing on end-to-end

Drawings by Dane Howard



experiences. Their "Snow White" inspired storyboards map out that customer journey. Each board is like a frame in the Airbnb movie. Everyone in the company knows what part of the movie comes before and after the scene they work on.

"Design making" means fostering and rewarding a culture of experimentation. Some call this "failing fast." The best cultures also "recover fast." How a culture listens and recovers is central to creating a proactive culture of making.

Companies without strong design in their culture make decisions differently. Their criteria are usually more about business performance and less about connecting with customers. Leaders say things like, "We need this to ship in four months." Never mind that it took eight months to make the decision. Much of the customer insight, passion, and empathy is likely to be stripped out of the design process in order to reach such a fixed target. This creates a different set of values in a product. And those same values are likely to be manifested in the culture of the company.

I witnessed a boardroom that was stuck on a conversation about a proposed online product experience. They were looking at spreadsheets, market analysis, and a clunky slide deck. It wasn't until after they saw a carefully crafted product demo and videos of customer testimonies that empathy and emotion filled the room. The story of "what if" became powerful and tangible. Several board members got out of their seats, played with the product prototype, and launched into a different kind of discussion. Several said to the CEO, "Next time, let's lead with the experience. It would save us a lot of time."

Too often agendas are defined by business more than by a customer experience. Conversations are more effective when designers are in the room. They can testify to how long it takes to achieve a quality product. A design-centric culture will inflect market analysis, cost, and roadmap discussions.

Great design thinking starts with empathy and a shared responsibility for owning the customer problem. It can't just be left to market researchers, or those concerned about a competitor's position. Everyone involved in making the product needs to work together, collaboratively.

Designers have a predisposition to make things. The energy that drives their work may come from a place of creative refuge, but should be informed by the collaborations of the team. Designers sometimes have to hide away for a while. They learn by doing, making, and experimenting.

Organizations that successfully incorporate the insights of designers end up attracting and retaining better talent. When a culture of design trusts its designers, it builds a reputation for craft and care in their products. That trust evolves in a positive feedback loop that brings the designers closer to the executive suite. And so the cycle continues.

Dane Howard is a designer and entrepreneur who helps companies design, prototype, and build products. He co-founded VUVOX in 2006, which was acquired in 2008 by eBay, where he is now design leader.

CYBORGS FROM SIERRA LEONE: POLYMATH DAVID SENGEH BRINGS PROSTHETICS TO THE PEOPLE

By Noshua Watson

DAVID SENGEH tells me he'll have to delay our phone interview. "I am sorry to do this but there's a last-minute need for me to attend an Ebola meeting."

Sengeh is a multi-faceted kind of guy. After all, before he started designing prosthetics, he did vaccine research. He grew up in Sierra Leone, where the Ebola epidemic has been harshest. So the 27-year-old MIT PhD student, biomedical engineer, and inventor doesn't hesitate to take a few hours away from talking to Techonomy, not to mention writing his dissertation, looking for a job, leading a youth foundation, designing clothes, making music, or playing soccer.

At MIT's Media Lab, Sengeh designs prosthetics that amputees can wear for extended periods. His designs avoid an otherwise common problem with such devices—constant pain from pressure on the wearer's remaining tissue. He wrote software that uses MRI data to map someone's limb to learn where artificial materials might painlessly create pressure points. Today prosthetic wearers typically endure multiple custom fittings and refittings by hand. With his approach, a prosthesis socket could one day be made anywhere you can plug in a 3D printer.

Sengeh's tools might turn anyone into a kind of Iron Man, manufacturing powerful prosthetics in their garage or their village. He kind of reminds me of Tony Stark himself. That is, if the fictional billionaire do-gooder had dreadlocks, rapped in Krio (a Sierra Leonean language), sold clothes he designed with his mama, and had to defend his thesis by the end of the semester.

Sengeh is part of a research group

Photograph by Allegra Boverman

Sengeh with his prosthetics technology at the MIT Media Lab

at the Media Lab that develops technologies to restore mobility to people who have been injured and invents other tools to give ordinary people what amount to physical superpowers. The lab calls this field biomechatronics, which its website defines as combining biology, mechanical engineering, and electronics to "enhance human physical capability."

"We're just trying to see how we can create comfortable mechanical devices for the body," he explains. "We want to get data from anybody around the world and [use it to] design comfortable interfaces for them." This kind of technology can be used to build lightweight exoskeletons that might eventually help anyone run faster or farther, or lift heavy objects. There's everyday pressure to make these devices work for disabled people, too. His PhD advisor, Hugh Herr, is a double amputee and elite rock climber who takes Sengeh's "homework" with him on weekends to try out.

As a child in Sierra Leone, Sengeh regularly encountered amputees in the wake of that country's brutal 10-year-long civil war in the 1990s. It displaced half of the population. Rebels used amputation

RYAN LASH

Sengeh delivering a TED talk in March 2014

as a weapon of war, intentionally maiming up to 4,000 men, women, and children. At least 10,000 more were permanently disabled by wounds and disease. Despite Sierra Leone's beauty, fertile agricultural land, and teeming natural resources, it remains near the bottom of the United Nations Human Development Index. This reality both drives and inspires him.

He says Sierra Leone's crises and limitations can inspire creative responses. "I feel lucky to have grown up there," he says. He grew up with a constant stream of visitors coming and going in his parents' home. He was expected to share equally with all of them. "My friends weren't friends any more, they were brothers. We had to learn to love and respect them in the same way."

"I WANT TO BE BETTER AT EVERYTHING. EVERY TIME I'M DESIGNING THINGS OR HELPING PEOPLE OR RELAXING, I WANT TO BE BETTER. I WANT TO BE BETTER AT RAPPING."

That may help explain why he's willing to show up for last-minute meetings just to listen to others. When asked about the Ebola crisis, he bristles. "I don't want to be part of the noise. I'm trying to understand the best way to help without being part of the 'I wanna help, what can I do?' crowd, which never goes anywhere." So what's really on your mind, David? "Inaction, people who have a lot of training but don't do shit.

People who are satisfied with the status quo."

He is not a complacent person. "I want to be better at everything. Every time I'm designing things or helping people or relaxing, I want to be better. I want to be better at rapping. I don't feel I'm sufficiently good." Since he published a paper about his prosthetics work he's already changed the design to remove protruding external braces that provided stability and supported the weight. He has instead integrated carbon fiber materials for strength and lightness and improved the algorithm that calculates where pressure occurs.

Every day during breakfast, Sengeh calls his collaborators on the African youth and innovation project he co-founded called Global Minimum. Its InChallenges program organizes competitions and offers funding for youth-oriented solutions to community problems in Sierra Leone, Kenya, and South Africa. Its InLabs arm develops workshops for invention and prototyping in secondary schools. Sengeh Skypes European colleagues before lunch, plugs away at research in the afternoons, and plays a little ping pong in the Media Lab lounge before heading home. His 360 degree world of collaboration and communication ripples through the cybersphere: a TED talk video, the Global Minimum site, his personal site, a CNN television special, his music on SoundCloud, his Facebook page....

In his TED talk, Sengeh tells a story about a military veteran who tested one of his prosthetics at the Media Lab. As Sengeh tells it, the patient said, "It's so soft, it's like walking on pillows, and it's effing sexy."

What does a guy like this do next? Something either commercial or academic, perhaps. "But I want to be in the world," he says. "I don't want to be stuck in the lab." He seeks to scale production of his prosthetics but doesn't know if that means he should commercialize them. In the meantime, "I need to test and validate my design and then do a clinical evaluation of the designs. But I don't know. It depends on what I do next in my life."

Noshua Watson is a business and technology researcher specializing in the role of the private sector in international development. She has worked in media, academia, and the private sector, including for Fortune magazine and the technology consultancy firm Accenture.

HOW MANY HEARTBEATS TODAY?

Are Patients Ready to Become Tech-Empowered Healthcare Consumers?

by Meredith Salisbury

TECHNOLOGY is driving a fundamental shift in how we think about health. In the past our whole system focused on patients—sick people who more or less did what they were told by doctors. Today those patients are turning themselves into consumers, people actively working to improve their health and lifestyle and even to diagnose their own diseases by using the tools around them—often without consulting a physician at all.

Nothing symbolizes this revolution more than Apple's healthcare-oriented Watch, expected in early 2015. Increasingly, ordinary people can utilize devices, apps, medical tests, and data analysis to take charge of their health in a proactive way. Perhaps the most powerful emerging tool is consumer genomics—the still-nascent field of decoding people's genetic data to help them (and their doctors) make decisions about everything from diet to medical treatment.

Until recently, the limited data most of us had was not much more than blood pressure readings and a weight check from our annual physical, or an occasional temperature reading during flu season. And we frequently—sometimes with relief—forgot what we learned. Now that digital and wireless technologies put day-to-day measurement, data, and judgment into their hands, individuals have more information and more responsibility. How many steps

Illustration by Jonathon Rosen

did you take today? Calories did you consume? Hours did you sleep? Heartbeats did you have?

Whether that trend will lead to radically empowered consumers or to hopelessly confused patients depends very much on whom you ask. Experts are splitting into two camps: those who believe people should have unfettered access to more data, and others who contend people are not equipped to deal with all this information without expert guidance.

"It is just morally wrong to deny anybody access to data on themselves, whether it is their medical record or molecular data generated on them," says Eric Schadt, director of a genomics institute at the Icahn School of Medicine at Mount Sinai in New York. "If genetic data is generated on me, I should not only own those data, but I should have the right to choose who I want to share those data with."

The anti-empowerment naysayers tend to be cautious regulators and traditionalists. Last year, the U.S. Food and Drug Administration ordered consumer genetics pioneer 23andMe to stop giving health-related data even to paying customers, because its service had not been reviewed and approved by the agency.

One key virtue of the new world of self-measurement, says Mount Sinai's Schadt, is that it frees us from limiting past conceptions of "health" that were themselves crudely constructed from population averages. He says devices that continually measure heart rate, blood pressure, blood oxygen levels—and track that data over long periods of time—"can help establish reliable baselines for your own personal health, where deviations...may be far more predictive of health-related issues than the population-based guidelines." Schadt compares it to watching the indicators on the dashboard of your car, which can alert you well before a breakdown. Such monitoring, he says, "is not just about avoiding catastrophe. It is about maintaining a more optimal [health] state that can enhance your performance physically and mentally."

WE WILL NEED TO PROTECT HEALTH INFORMATION FROM CRIMINAL THEFT AND MISHANDLING.

Having access to more data can enable consumers to assemble a more accurate picture of their own health—one that may help explain what's going on when they're sick. Sometimes the self-diagnosis has outperformed doctors. Kim Goodsell, a 56-year-old California woman, was diagnosed with two rare diseases. Though doctors insisted these were separate conditions, she refused to accept the astronomical odds of having two unrelated, very rare diseases. Though she's no medical expert, Goodsell spent years combing through genetic research and eventually found a single mutation linked to both rare diseases. Testing confirmed she had what was indeed a single, previously unknown disease. Since then, Goodsell has come up with a dietary program that helps mitigate her symptoms.

Slowly, the biomedical community and regulatory agencies are recognizing that consumers will demand access to this kind of data. "People want the information and there's no reason they're not entitled to it," says William Hoffman, who chronicles the rise of consumer genomics in his recent book, *The Biologist's Imagination*. Indeed, just this year, then-HHS Secretary Kathleen Sebelius ruled that patients should have direct access to lab test results, which had formerly been accessible only to physicians. "Information like lab results," she said at the time, "can empower patients to track their health progress, make decisions with their healthcare professionals, and adhere to important treatment plans."

Concerns and Consequences

But the FDA and others worry about how consumers will respond to health data, particularly when it comes to complex genetic information like that provided by 23andMe. Extensive studies, however, have shown that consumers tend to receive this kind of information calmly, even in potentially high-stress situations like learning they have a genetic risk for an untreatable disease such as Alzheimer's. Mount Sinai's Schadt notes that people can make bad decisions based on any kind of data—financial, political, and so on—but that in most situations we accept that risk because we presume that people do better with more information. If regulators continue to drag their feet, service providers may just move to countries with less stringent guidelines and offer the information online.

That doesn't mean regulation has

no role. As author Hoffman points out, "The FDA does have the responsibility to insist that what companies say about personal health information based on genetic data is accurate and can be verified." That's why many companies offering consumer-oriented tests or devices require that a physician order them and be responsible for presenting the results. Regulatory agencies want a doctor or genetic counselor to be an intermediary. But an increasing challenge is that many medical professionals are themselves not equipped to explain results—particularly from genetic tests. Several studies have found that only a small fraction of physicians feel confident they know when to order a genetic test or can understand the results.

No matter how much health data individuals may be able to handle, it's unclear whether we can trust business to handle it. This is an area where regulators may still need to protect us. Big companies are routinely failing to protect consumer financial data, especially credit card information. Can we trust them when it comes to our (far more personal) health data? Already, marketing firms are selling data linking consumers to health conditions or diseases, often based on information people entered in surveys or online forms. While U.S. law protects medical data shared between a clinician and a patient, fitness information in an app, for instance, is at present legal fair game for marketers. So we will need to protect our health information both from criminal theft and unscrupulous mishandling.

Looking Ahead

Despite these challenges, consumers want to measure and monitor just about anything. More than 20 percent of consumers are already using some sort of self-monitoring technology, according to a study from Accenture. The big future business opportunity may be in helping consumers store and interpret what they gather from devices, sensors, and tests. We could certainly use tools that pull disparate data together and assemble it into a big picture.

Like so many other tech-infused realms, healthcare is heading toward a flattened world of consumer empowerment. "This extreme paternalism that permeates much of medicine must be changed," says Schadt. The most likely result of the explosion in consumer technology will be a healthier society.

Meredith Salisbury is a senior consultant for the life science communications firm Bioscribe and covers the genomics field as a journalist for Techonomy Media. She is a co-founder and organizer of the Consumer Genetics Conference.

Techonomists on Industries That May Be Obsolete by 2024

Many industries of today are under threat, in the view of TE14 participants. Those whose name is inside each circle fear for that industry. Clearly it's not an easy time to be in an established business.

HEALTHCARE

Julio Ottino
Northwestern University

Catherine Porter
OpenTable

William Raduchel
DMGT

"**Diagnostics.**"

"**Health insurance** and healthcare management."

"**Consumer banking** is at risk due to emerging technologies and platforms that are driving new expectations for transparency, online, social, and personalized financial solutions."

"**Venture capital.**"

BANKING AND FINANCE

Ali Diab
Collective Health

Debby Hopkins
Citi

Derek Schoettle
Cloudant

Cem Sertoglu
Earlybird Venture Capital

Hemant Taneja
General Catalyst Partners

Jonathan Yaffe
Anyroad

"By 2024, the **foreign exchange and global remittance industries** will be obsolete. Alternative currencies and increased transparency over digital currency services will drive remittance commissions down and open new channels to moving currency."

"What may be obsolete within the time period (if not already) is the **'all-in-one' information franchise** that a newspaper once represented. Many newspapers will thrive in some form in the years to come, but they will be just one of many sources for your daily download of what's happening. Aggregation and curation will always be valued to some degree."

MEDIA PUBLISHING

Sara Greenstein
Underwriters Laboratories

Jim Kennedy
AP

Colleen Lacter
Symantec

Michael Miller
PC Mag

Martin Morgan
DMGT

"Print publishing and **local TV.**"

TRANSPORTATION

Mark Bonchek
SHIFT Academy

Liam Casey
PCH International

Colleen Lacter
Symantec

Dominique Turcq
Boostzone Institute

"With shared rides and flexible renting, **vehicle ownership** is becoming less compelling."

"**Taxi dispatch.**"

"**Delivery services** like UPS and FedEx."

"**Gas- and driver-based automobiles.**"

NON-RENEWABLE ENERGY

Bonolo Matjila
Spiruteens

Leroy Mwasaru
Human Waste Bioreactor

Dominique Turcq
Boostzone Institute

"**Traditional electric power grid,** because the centralization it implies, at a time where energy can be produced at local scale for local scale, will reduce the need for large non-intelligent grids and allow for a real sharing economy of energy."

EDUCATION

Maria Amundson
Edelman

José-Marie Griffiths
Bryant University

Sai Mandapaty
ThoughtWorks

"It's not just because of **online ed and technology.** For many the payoff today is unclear, the product becomes obsolete quickly, and the model doesn't work well for many learning types."

"Multiple industries may face significant disruption due to the major shifts in the **nature of work itself.** Work is increasingly becoming more automated, fractionalized, and on-demand. The number of temporary workers as a percentage of the U.S. workforce is at its all-time high; and services such as Uber and Airbnb are disrupting legacy industries by efficiently utilizing excess capacity to meet just-in-time consumer needs." **–Jeff Weiner,** LinkedIn

"It's not industries that are becoming obsolete, it's **business models** and thus people. So any industry that pays a premium for specialized human labor (medicine, academia, and consultancy) is in trouble. It's not software that's eating the world, but the machine. And it's we–you and I–who are being consumed."
–Andrew Keen, Author

"**No industry is immune to disruption** in the next decade. People will still need food, shelter, transportation, healthcare, recreation.... None will become obsolete but all of those face massive change. For example, much of healthcare treats chronic conditions. What if we find cures? The better question is the reverse: are any industries immune to change over the next decade?"
–William Raduchel, DMGT

FROM LEFT, author Andrew Keen, Brian Forde of the White House Office of Science and Technology Policy, Marlin Page of Sisters Code, Google's Chris Genteel, Unitive's Laura Mather, and Indiegogo's Danae Ringelmann

Tech's Challenge for

Our third annual conference on how to keep the country and its cities competitive, employed, and inclusive

Detroit, and the U.S.

Photographs by Rebecca Greenfield

TECHONOMY KICKED OFF our third Detroit conference with a reception at the amazing Detroit Institute of Arts. There we interviewed Dan Gilbert, CEO of Quicken Loans, real estate baron, and all-around downtown Detroit savior, in front of a massive Diego Rivera mural depicting Detroit's robust 1930s auto industry, back when the city was the Silicon Valley of its day.

The next day's conference at Wayne State University gathered a range of voices on forces transforming American businesses, communities, and livelihoods. How can new business and social structures enabled by tech revive industry, jobs, and urban energy in Detroit and across America? We looked at promising tools like the sharing economy, crowdsourcing, sustainable transportation, and start-up-friendly urban ecologies.

The entire economy is shifting under our feet. And in Detroit it is impossible not to see that America's great cities also must be reconceived. Detroit CIO Beth Niblock interviewed Twitter and Square founder Jack Dorsey. He explained on stage how important it is to build technology to "surface what's actually happening in a city in real-time so we can make better decisions about how to...build a stronger economy and a stronger civic society." Examples of that abounded, especially in our session about open data (see p. 40).

A theme of this event from the beginning has been jobs—where will they come from in future? How will they be altered by the relentless march of automation and robotics? Is the United States preparing people for the changes to come? Our opening session tackled the very future of the American Dream (see following story). It may become one of those dreams that is difficult to remember. The challenge is educating Americans in a holistic way to prepare them to surf the upcoming waves of change, and also to keep the historically marginalized communities from being even more disadvantaged. Our failures thus far are alarming.

Albert Wenger, a partner at New York's Union Square Ventures, tackled the question of how we can help the marginalized head-on with a radical proposal—give them money. He presumes that self-driving cars, workplace robots, and ubiquitous intelligent machines are already here. "The only thing we...should be arguing about," he said, "is what will their impact be on the economy?" His view is that what he called today's "economic loop"—in which we work, get paid, then buy stuff that others get paid to make—will be replaced by a loop that leverages the Internet for "creating and sharing and discovering and enjoying." It's going to mean massive job displacement accompanied by massive new opportunities. He suspects we will have to develop ways to directly support people and communities that are left out.

In Detroit, it took private money

to fund a new light rail system, now under construction. Rip Rapson, who heads the Michigan-based Kresge Foundation, explained how it helped organize and fund both that light rail line as well as a campaign that raised money for public pensions so art at the city-owned Detroit Institute of Arts wouldn't be sold. Presumably it would have been hard to take the Rivera frescoes off the wall, but who knows? On that same session, Case Foundation CEO Jean Case said her organization had committed $2 billion to social impact investing nationwide.

Issues of fairness came up repeatedly. One of the most spirited sessions was the one shown on the previous spread—"The Digital Divide: Can the Tech Industry Become More Inclusive?" It's an urgent question in Detroit, a city with a burgeoning tech scene that remains vividly divided by race and economic inequality. Laura Mather of Unitive, which builds software to remove bias from corporate hiring, explained that when a company's job listing says it's looking for "rock stars" or "ninjas," women seldom apply. They interpret such language as code for a macho jock culture.

In a session on education and coding, Brian Forde of the White House Office of Science and Technology Policy mentioned alarming statistics about America's preparedness for the coming world. He said that across Asia, about 21 percent of college graduates get engineering degrees. In Europe the figure is 12 percent. In the United States it's 4.5 percent. This conversation must continue.

TOP LEFT: Ford's Don Butler
TOP MIDDLE: Rip Rapson of the Kresge Foundation
TOP RIGHT: Dan Gilbert of Quicken Loans and Rock Ventures
BOTTOM RIGHT: Jennifer Bradley of the Brookings Institution (left) and Harvard's Susan Crawford
BOTTOM MIDDLE: Jack Dorsey of Twitter and Square
BOTTOM LEFT: TaskRabbit's Stacy Brown-Philpot

Can the American Dream Survive?

SPEAKERS:
Carol Goss
Harvard University & The Skillman Foundation
Danae Ringelmann
Co-founder, Indiegogo
Elizabeth Shuler
Secretary-Treasurer, AFL-CIO
Philip Zelikow
University of Virginia & Markle Foundation Rework America Initiative

MODERATOR:
David Kirkpatrick
Techonomy Media

Unemployment has become a chronic problem. Automation and robotics are changing the nature of work. The U.S. has no national strategy to educate and train its citizens for a changing economy. Will it still be possible to work hard and enter the middle class? The opening session of Techonomy Detroit asked if it still makes sense to talk about the American Dream.

ZELIKOW: We're in the early phases of a new era in the history of America as profound as the Industrial Revolution. Most Americans don't fully grasp how fundamental this will be. This should be a really bright era of possibility. The barriers to starting and growing a business have never been lower. It's never been easier to get the education and training you need, whenever you need it, than it is right now. So why are Americans more pessimistic about the future than they have ever been in the history of the Gallup Poll? The possibilities are very exciting, but our institutions are stuck in the past.

SHULER: The greatest challenge of our time is inequality. The thousands and thousands of people making this country move are the ones feeling the brunt of what's happening in this economy. Think about the folks driving buses and the housekeeper in your hotel room and police officers on the street. Wages have stagnated, if not fallen, for the majority of people. Wealth is being concentrated at the top. People are working part-time jobs, piecing them together. They have to come to work sick or they won't get paid. Do we want to abandon the value set that makes us Americans—fairness, equality, rewarding a hard day's work with a decent level of pay?

GOSS: We haven't prepared everyone to participate. There are neighborhoods of black and brown families with children in failing schools who graduate often without the skills for the technology and the jobs related to that technology. If you live in one of those communities, you're not likely to participate at the same level. We have to be very intentional about making connections between schools and work and internships and apprenticeships—things that create a more level playing field. Entrepreneurship and technology are really important. And yet, how many young people that live in these communities even know entrepreneurs, see that as a possibility, or know about the high-tech jobs?

RINGELMANN: I'm part of an industry driven by entrepreneurs like myself who want to make real change. We're just realizing that business is a more robust way to make sustainable change, and technology is the fastest way to getting to that. I saw a problem, which was that millions of ideas were going unborn, millions of people couldn't get their small businesses off the ground. It wasn't for lack of heart and hustle or a lack of good ideas. It wasn't even for lack of an audience or a customer base. They literally just lacked access to money. The whole financial system has been riddled with what I call gatekeepers, who decide which ideas are worthy and which are not. The traditional system is locking you out because you can't get ap-

FROM LEFT, Techonomy's David Kirkpatrick, Harvard's Carol Goss, Indiegogo's Danae Ringelmann, AFL-CIO Secretary-Treasurer Elizabeth Shuler, and Philip Zelikow of the Markle Foundation

Photograph by Rebecca Greenfield

proval for a bank loan, or a venture capitalist won't call you back because you don't come from the right neighborhood or the right school. At Indiegogo we've used the transparency of the Internet to put the power back into the hands of the people to decide which ideas come to life. All these technologies which have started in the college-educated, tech-loving communities will, in order for those companies to grow, find a way to cross the chasm and get everybody involved.

ZELIKOW: You should immediately distrust anyone who predicts how many jobs there will be 10 or 20 years from now. Nobody knows. What you can bet on, though, is investing in policies that will broaden participation in productive life. Make it easier and more flexible for people to get education and training at any point in their lives, then find ways to credentialize that. Leverage technology in ways that upskill people, rather than just deskill them. The odds of positive outcomes are just bound to go up if you steer your policies deliberately and consciously in this direction. The old structures that made Americans feel secure are eroding. Those structures provided workers with security in the industrial era. In this new networked economy, the new structures may be different. But that doesn't mean that they're necessarily going to be inferior. But if you don't have the conversation, the default mode is a sense of erosion and drift.

SHULER: We can have people going out and creating all these small businesses, but if we don't create demand in the economy by giving people enough money to put in their pockets to buy those products, then it's probably pretty short lived. Henry Ford recognized he needed skilled workers and needed to pay them enough that they could buy the car that they were making. Walmart is pushing forward a model that suppresses wages, whereas Costco is in the same business but paying higher wages. So we know it can be done.

RINGELMANN: We can get young kids to think about solving problems, not waiting for the jobs to come to them. What do they love to do? What they are good at? Then they can lean into the work that's out there. We need to teach them how to always acquire new skills.

GOSS: I always believed the American Dream was improving one generation over another. I don't think that happens today. There are many young people who are not going to see themselves better off than their parents. I would be hopeful if we had the public will to start making sure every child was ready for kindergarten, that they graduated from high school with the right skillset in reading and math and science.

ZELIKOW: Technology now allows us to personalize education. People don't need to get their education between a given set of ages; they get their education when they're ready for it and when they need it.

Open Data: Government's Mother Lode

SPEAKERS:
Alex Alsup
LOVELAND Technologies
David Behen
CIO, State of Michigan
Joel Gurin
New York University
Governance Lab
Tony Scott
CIO, VMware Inc.

MODERATOR:
Michael Chui
McKinsey & Company

Techonomy Detroit is about how tech is changing the American economy, and its cities. The increasingly sophisticated use and sharing of data is one of the most central shifts underway.

ALSUP: At LOVELAND Technologies we take property data—the legal boundaries of every property in the city—and put it online for people to explore. So when I think of open data, I think of making that information helpful. In Detroit that means being able to understand not only what you owe in property taxes, but the picture of property taxes around you. It's taking specific data that may be relevant to you and making it publicly available, so you can see the context of that information citywide.

BEHEN: At the State of Michigan, we call it customer-centric government—how do we bring the services to our citizens instead of our citizens having to come to the service. In old-school government you had to go to a building. We believe data will fundamentally change the way we do business. We have Michigan.gov/opendata, where you can go and look at the datasets. With Code Michigan, we take our open data, put it out for people, and have a weekend hackathon. Actually, last year one of the winners was LOVELAND. And we have a transparency site that shows how we're spending the dollars, because the only way we can get better at it is by having dialogue.

GURIN: Open data means a lot of things, but the part we're focusing on at the Governance Lab is the intersection of government, the private sector, and civil society. A lot of it is about government accountability, transparency, and helping citizens understand how their city or state or federal government works. We're looking at how open data becomes a public asset and resource.

I run a study at NYU called the Open Data 500. We've been identifying close to 600 U.S.-based companies that use open government data as a key business driver. These companies are showing up in every sector of the economy: energy, education, healthcare, finance. So this asset really has economy-wide implications. A number of these for-profit companies actually also have a civic mission, and are using data in ways that not only are profitable to them, but help citizens or a city. For example, NextBus uses municipal transportation data to help commuters figure out when the next bus is coming. They're very much about making public transportation a more attractive alternative, which helps the environment and helps avoid traffic congestion.

SCOTT: It's a pretty powerful force when used correctly. But you also worry about the flipside, the risks from corrupt or inaccurate data. And the provenance of data—where it came from—is pretty important. Is it a trustworthy source? We're really becoming a network of things. Industries are linking together, cities and government institutions are linking together. One of the biggest challenges with the whole open-data movement is how we take advantage of these ecosystems. Today there's no place where that's aggregated together

FROM LEFT, McKinsey's Michael Chui, Alex Alsup of LOVELAND Technologies, State of Michigan CIO David Behen, NYU's Joel Gurin, and VMware's Tony Scott

Photograph by Rebecca Greenfield

in a useful way. So I still have to do a bunch of work.

ALSUP: There's this notion that data is gold. Data is not gold, it's more like ore—crude, unrefined sludge that you need to put through a laborious process to make usable. There's no higher authority than the city or state. They are the god of that data. If God is flawed, the only thing they can do is solicit the public to tell them what's wrong with it. We need a formal relationship with the relevant department to update that data inside of their system. You need to make sure that there's version control, that you're building up muscle memory between private companies collecting this information and government, which ultimately has to be the keeper of that information.

GURIN: That question of how you improve the data is central. We think of the two steps as release and then use the data. But cleaning and improving the data is really in the middle there. With the Open Data 500, we bring together providers and users for a dialogue about which datasets are really working, which ones are not. There are opportunities for structured programmatic interactions between civil society, the private sector, and government. Our experience at the federal level is that agencies love that. You have really smart, committed tech people taking over the data functions in agencies where these horrible systems have built by accretion over 30 years.

BEHEN: In Michigan, we have an enterprise information management program. The governor issued an executive directive to all the agencies that said, "You have to share data." So how do all these organizations work together to make sure the data's correct?

CHUI: How do you get the data out there, how do you make it open, what are some of the challenges?

GURIN: Companies like OpenGov.com or Govini are taking city data and putting it on common platforms. That helps town hall meetings and city managers, for example, say, "We have a level of police overtime here that's twice as high as our neighboring city. Why is that?" So those become important dashboards for city management. SpotCrime is an application mapping levels and types of crime around the country, both for city comparability and for city management. We're seeing a number of applications that are looking at traffic patterns and traffic flow. You're seeing people come up with apps looking at trends in employment. OnDeck is using open data to help small businesses get loans by doing due diligence lenders don't have time to do.

SCOTT: If you want to know the stock price of a company, you don't go to that company's website, you go to data from somewhere else. We rely on huge amounts of public and open data and shared research. The availability of data and tools for using it will probably provide the greatest economic opportunity of anything in the last hundred years.

Andrew Hessel of Autodesk

Photographs by Steve Kepple

THE NEXT TRANSFORMATIONS WILL COME FROM BIOLOGY

Internet and IT people need to know that biology also changes the world

AT OUR FIRST TECHONOMY BIO conference on June 17 in Mountain View, Calif., we wanted to understand why people keep saying, "Genomics is advancing faster than Moore's Law." Is biology really the next frontier for business and social transformation? What is the role of digital technology in biological progress? To find out, we brought leading researchers and experts in the life sciences together with IT and Internet thinkers and business generalists.

Drew Endy is one of the world's leaders in synthetic biology. The Stanford professor said on stage that he had never seen such a group in one place. "People in other sectors of technology simply don't know very much about biology and biology's economic impact," he continued. Like literally every expert at the event, he was supremely optimistic about the potential of life sciences: "The biotech that exists right now is sort of the snowflake on the tip of the iceberg. There's so much more to make." Andrew Hessel of software-maker Autodesk crisply defined synthetic biology, calling it "genetic engineering done with digital tools." Hessel wants to use the plummeting cost of DNA sequencing—another central technology in our discussions—to build individually customized cancer drugs. He says it could happen soon. Nancy J. Kelley, the founding director of the New York Genome Center, extolled the varied potential of synthetic biology outside of medicine. She says it can, for instance, help feed a planet whose food supply is not growing proportionately to its population.

Stewart Brand, whose ties to the IT industry go back so far he actually coined the label "personal computer," showed enthusiasm for biology at past Techonomy conferences and helped convince us to plunge in despite our own ignorance. "These self-accelerating technologies, if they keep doing it decade after decade, change everything," he said on Techonomy Bio's closing panel. "We saw it with communication technology, with digital code. So now we're looking at bio code." But he added that since digital technology is all human-engineered, it is in many ways easier to work with. "Biological code," as he put it, on the other hand, is unengineered and thus harder to work with: "It's kludges and patches all the way down."

Floyd Romesberg of The Scripps Research Institute explained his recently published breakthrough work creating a partly artificial *E. coli* that is the first human-synthesized life ever to reproduce. Romesberg added two new synthetic "letters" to the bacteria's four basic letters of DNA code. "It tells you that evolution, that life, is a lot more plastic maybe than we thought," he said.

Despite all the enthusiasm there were at least two basic categories of concerns. The first was that public fears about a field most people understand so little poses the threat of slowing progress. Said Jim Flatt, who heads Genovia Bio, which uses algae to make fuels, food, and agricultural chemicals: "The industry collectively has not done as good a job as it can to communicate the

TOP LEFT: Xconomy's Alex Lash (left) and Stanford's Drew Endy
TOP RIGHT: Attendees mingle (and thumb through the Techonomy magazine)
BOTTOM RIGHT: From left, Techonomy's David Kirkpatrick, Eri Gentry of the Institute for the Future, Ryan Bethencourt of Berkeley Biolabs, and David Haussler of UC Santa Cruz
BOTTOM LEFT: From left, Beth Seidenberg of Kleiner Perkins, Lindy Fishburne of Breakout Labs, and Draper Fisher Jurvetson's Steve Jurvetson

benefits from a societal perspective, whether it's genetically modified crops or what have you. Why should a consumer care?" Kelley noted recent calls by anti-GMO activists to regulate an engineered ingredient in laundry detergent designed to replace palm oil, the production of which is now blamed for destruction of rain forests. "The opposition is educating the public and we just can't let that happen," she said. Kelley also expressed another pressing concern. "What is at stake here is the future competitive advantage between countries," she said. "The United States, despite its early entry into this area, currently lacks a coordinated...and strategic approach to leadership on a global level."

Investors are writing checks for good ideas. Said Steve Jurvetson of venture capital firm Draper Fisher Jurvetson: "We're sitting on a can of miracles, and no one seems to know about it." He and Kleiner Perkins' VC Beth Seidenberg were both mobbed by entrepreneurs when they got offstage.

We're already planning a longer, more ambitious Techonomy Bio event in Silicon Valley in spring 2015. –DAVID KIRKPATRICK

How Systems of Life Impact Business and Society

SPEAKERS:
Stewart Brand
Global Business Network
& The Long Now Foundation
Jim Flatt
Synthetic Genomics, Inc.
& Genovia Bio
Steve Levine
Dassault Systèmes
Floyd Romesberg
The Scripps Research Institute

MODERATOR:
David Kirkpatrick
Techonomy Media

The closing session at Techonomy Bio was the essential one. If synthetic biology and genomics are changing healthcare, food and agriculture, energy, and even manufacturing, what do we all need to be thinking about?

KIRKPATRICK: How big a change will biological science create in society in coming years?

BRAND: The inklings are huge. These self-accelerating technologies, like digital technology, if they keep on doing it decade after decade, change everything. We saw it with communication technology, with digital code. Is bio code the same? In some ways. On the other hand, all the digital code we know and work with is engineered, and almost none of the biological code we work with is engineered. You can't reverse engineer what was never engineered in the first place. It's kludges and patches all the way down, over three-point-something billion years. We're trying to make biology engineerable, because right now it ain't. Is there anything really equivalent to Moore's Law in biotech? I'm not sure yet. There's a lot of money there. The market that is drawing this technology towards it is absolutely in play, in the same way it was for digital technology. So the prospects are enormous.

ROMESBERG: We're just scratching the surface. When I started in molecular biology as a post-doc you had to make all your own solutions. Now everything's a kit. Technology has provided acceleration just for the day-to-day tasks of doing things. It used to be that sequencing [the genetic code for] something would take days. Now it's cheap and takes almost no time at all. All of this accelerating of techniques is pretty dramatic. The tools are unbelievably powerful.

FLATT: The potential is unlimited. We're going to see an exponential increase in the adoption of synthetic biology and the impact it has in multiple fields. But two things will limit or at least constrain that. Synthetic biology is a tool to solve problems, whether it's better healthcare or more economical, nutritious food, or ultimately fuels or chemicals. But there has not been in the biotech community a good and grounded understanding of the industries we're trying to transform. Each one of those industries has its own dynamics and infrastructure. That's why there was a boom and then a bust with biofuels.

The second issue is that while we're developing a lot of great tools to do bioprogramming, we're still just scratching the surface of our understanding of the design rules and what to build. We've made a lot of advances in making DNA analysis and assembly and creating biological structures faster, cheaper, and more accurate. But we often run into the issue of how to actually design something better than nature has already provided.

LEVINE: Rather than looking at the detailed biology, at Simulia we use 3D digital technology to look at the end product, which is typically the human body. We're creating digital organs, fully functioning body parts that work on the computer. If you're building medical devices that you're putting in the body, you want a test environment. Today the test environment is a human. We call them clinical trials. We think that that's a little

FROM LEFT, Techonomy's David Kirkpatrick, Floyd Romesberg of The Scripps Research Institute, Global Business Network's Stewart Brand, Jim Flatt of Synthetic Genomics, and Steve Levine of Dassault Systèmes

Photograph by Steve Kepple

archaic. By building digital organs, body parts, and ultimately full bodies, digital laboratories can house all that. It's a new perspective on managing healthcare and health data.

KIRKPATRICK: How will the accelerating pace of biological advances change the political-social landscape, in the United States in particular?

FLATT: Looking at how genetic and genomic technologies have been accepted or not accepted in different geographies and industries, it really comes down to a couple of things. The first is transparency and motivation. The second is around benefit. The industry collectively has not done as good a job as it can to communicate the societal benefits, whether for genetically modified crops or what have you. Why should a consumer care?

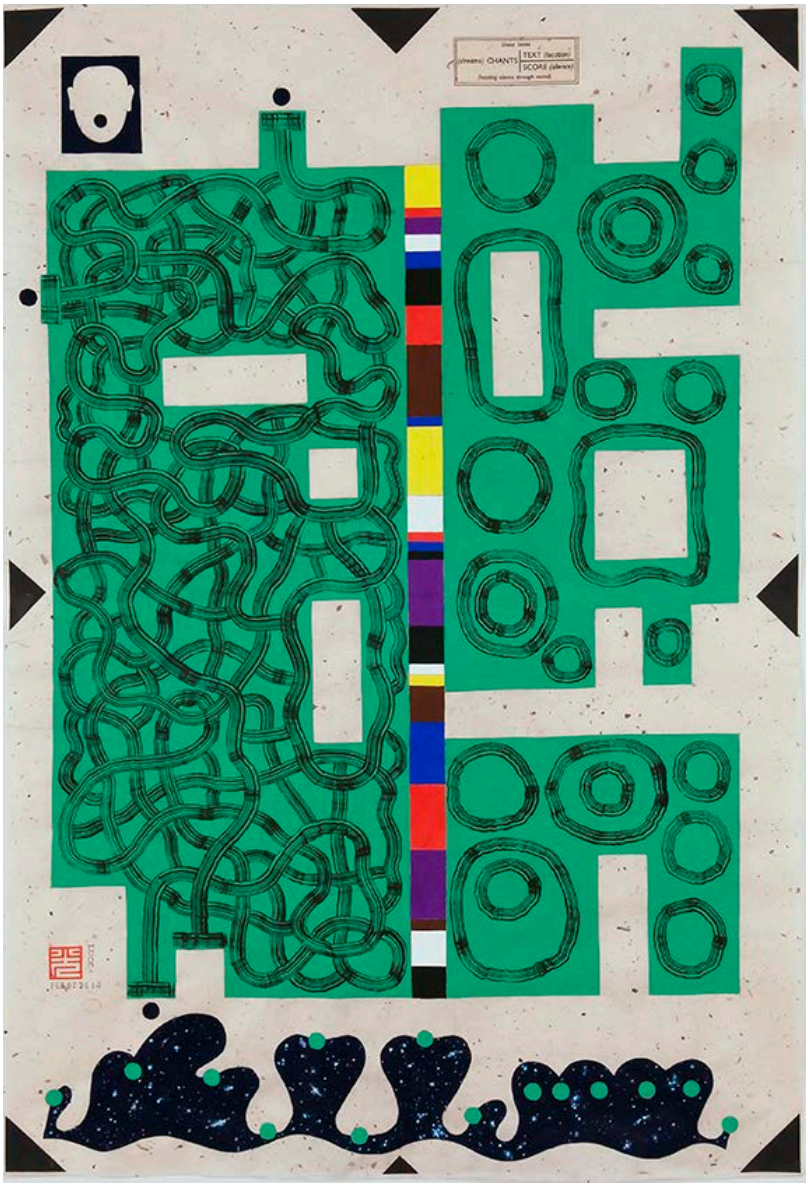
BRAND: In-vitro fertilization came along a while back, and all the "you must not play God" stuff came up. And then the first in-vitro babies were healthy and adorable, and pretty soon they grew up and voted. Suddenly that whole concern evaporated. You could do another kind of socio-cultural economic analysis on what happened with genetically engineered food crops.

KIRKPATRICK: As bio-hacking gets more common, is science becoming more egalitarian? Will it speed progress?

ROMESBERG: One dissenting voice: science is hard. With all the information, the technologies, the genome sequencing—great things are going to come. But still, it is really hard to actually understand how to do it. Biology is the least reductionist of all the sciences, because it's so interconnected and so complex. There's a reason people go to school and get their PhD, focusing for five years and really learning how to think about science. But I love the excitement that this public interest brings. If nothing else, it gets people out there as proponents of doing good science and of not being afraid of science. Society will adapt to it when they start to see it's not evil and that people are benefitting.

AUDIENCE MEMBER: Are there ways to use synthetic biology to produce affordable products for people in shantytowns in Johannesburg or Rio de Janeiro? How can we use this innovation to foster inclusion?

ROMESBERG: You ever heard of penicillin? Another one that's out there now is flood-proof rice.



ABOVE:
Charles Luce
Lhasa Series Chant/Text, 2013
Gouache/Paper
27" x 39"

TOP RIGHT:
Charles Luce
Animal Silhouette, 1996
Khadi Paper/Gouache
18" x 16"
(Art photography by Nick Ghiz)

Taking Advantage of Our New White Walls

IN SEPTEMBER Techonomy invited friends to Manhattan's West 22nd Street to celebrate our new office and to enjoy some beautiful art installed there. People from tech, business, nonprofits, and the art world mingled amid paintings and constructions by New York artist Charles Luce.

Luce has shown his paintings, drawings, sculpture, and installations around the world since 1979. He is also an educator who chairs the art department at Saint Ann's School in Brooklyn. He says his art is an investigation into the psyche, combining real and unreal to create schemes rich with energy, reflection, and meaning. The colorful and elegant works evoke elements ranging from stones and water cycles to totems, mazes, and even a planetarium. The exhibition, entitled "A Slice of Time (1988-2014)," was organized by artist Elena Sisto, a close friend of Techonomy. It will remain on display for the remainder of the year.

We moved to our new Flatiron District home after three years in NoHo working alongside the rapidly-growing staff of TV ad-targeting company Simulmedia. Its CEO, Dave Morgan, is our investor and confidant. We will continue to use our big walls to celebrate the intersection of tech, business, and art with ongoing exhibitions organized by Sisto. If you're in the neighborhood, please stop by. –ANN BABE

Photographs by Adam Ludwig

TOP RIGHT: Artist Charles Luce
ABOVE: From left, photographer Paul Mutimear, show organizer Elena Sisto, and artist Eleanor Ray
BOTTOM RIGHT: Techonomy's David Kirkpatrick (left) and our real estate lawyer Jerome Strelov
BOTTOM LEFT: Keely Henderson of the Environmental Defense Fund with entrepreneur and NYC mayoral candidate Jack Hidary
LEFT: From left, investor Richard Fishman with Tim Charters and Simone Ross of Techonomy

Looking forward: the audience at 2014's Techonomy Bio conference.

STEVE KEPPLE

If We Collaborate, We Can Understand More

IT GETS HARDER and harder to know what to expect. We can be more confident about what won't happen. In 10 years, will everyone on the street still be relentlessly staring at a little rectangle of glass in their hands? Certainly not. Communications and media will have evolved even further. What about those bigger 3-dimensional rectangles that are everywhere, the ones made out of sheet metal and glass with rubber tires that clog our cities and spew carbon dioxide into our air? Given how many people are working on this problem, it's easy to expect radical change. Will cars be self-driving? Will they routinely be all-electric?

At Techonomy we're certain of little, but we know there will remain lots to discuss. We're determined to get even better at convening and coordinating discussions that help us all cope. Some dialogue will be online at techonomy.com, and unashamedly in the pages of print magazines like this one. But our forte will continue to be events.

For 2015 we are already planning four major conferences. Our invite-only retreat Techonomy 2015 returns to the Ritz-Carlton Half Moon Bay on November 8-10. We will also host an all-day public Techonomy Bio event in Mountain View on March 25. A new meeting, Techonomy Policy, debuts in Washington June 9. We will focus there on how government and technologists might start working better together. And we return to Detroit in September for further conversation about America's future in a technologized age. We hope you'll help us figure out what comes next.

Techonomy Bio
March 25
Computer History Museum
Mountain View, California
www.techonomy.com/bio

Techonomy Policy
June 9
Council on Foreign Relations
Washington, DC
www.techonomy.com/policy

Techonomy Detroit
September 15
To Be Announced
Detroit, Michigan
www.techonomy.com/detroit

Techonomy 2015
November 8-10
The Ritz-Carlton
Half Moon Bay, California
www.techonomy.com/te15

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