



THE STATE
OF THE
FUTURE

THE STATE OF THE FUTURE



Foreword Message

For those of us who live in Dubai, the word “Future” has become ubiquitous.

The two syllables have come to almost form a suffix – and, at other times, a prefix – that accompanies the names of organizations both at the local and federal levels.

Ever since His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, announced the formation of the “Government of the Future” in February 2016, organizations and programs such as the Dubai Future Foundation and the Dubai Future Accelerators program, to name but a few, have been proliferating with one shared objective: making the future a reality today.

Our own ministry was even renamed “The Ministry of Cabinet Affairs and the Future”. The three-word segment that was added at the end of our appellation now serves as a mantra that guides us in any endeavor we undertake.

This forward-thinking vision is the culmination of a policy that has accompanied the UAE since its birth.

**Mohammed Abdullah Al Gergawi,
Minister of Cabinet Affairs and the Future,
Vice Chairman of the Board of Trustees and
Managing Director of Dubai Future Foundation**

Our Founding Fathers set out to build a nation that doesn’t wait for the future to come to it, but rather invests all of its resources and capabilities in building that future. And that is exactly the nation we have become today.

In this “State of the Future Report”, tier-one experts and researchers from around the world put their insights and expertise to work, synergistically collaborating in an effort to anticipate the technological trends that will shape the future of strategic sectors, and that stand to drastically affect people’s lives all over the world.

The following pages contain not only projections as to what technologies we can expect to see in the upcoming few years, but also optimal opportunities to employ these advancements to the benefit and betterment of mankind.

THE STATE
OF THE
FUTURE

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THIS YEAR IN **Energy**

While it can't be created or destroyed, energy does create careers, civilizations, and a host of controversies. Our current means of energy production have led to a global rise in temperature and the destruction of countless habitats, but new innovations that transform how we power our world are leading to a brighter tomorrow.

THIS YEAR IN ENERGY

As scientists, politicians, and entrepreneurs increasingly band together and push for energy sources other than fossil fuels, we enter a brave new world populated by smaller and cleaner devices. In 2016, advancements in wind, solar, and water power gave us a cleaner way to live and helped us better understand the forces of nature. Likewise, advances in fusion energy helped us better grasp the fundamental physics of our universe and move towards limitless sources of power.

BY THE NUMBERS

\$2.6 BILLION

WHAT TESLA PAID FOR
SOLAR CITY

440+

ACTIVE NUCLEAR REACTORS

150,000,000° C

TO SUSTAIN NUCLEAR FUSION

1.3 BILLION

PEOPLE WITHOUT ELECTRICITY

40 BILLION

TONS OF HUMAN CO₂ EMISSIONS

EXPERT CONTRIBUTORS



Gregg Maryniak
Energy & Environment Chair
Singularity University

Gregg Maryniak is an internationally recognized expert on energy and risk management. Today, Gregg's work focuses on new techniques to increase the percentage of renewable resources used to power society, improve energy storage, enhance energy networks, and realize carbon free power from space.



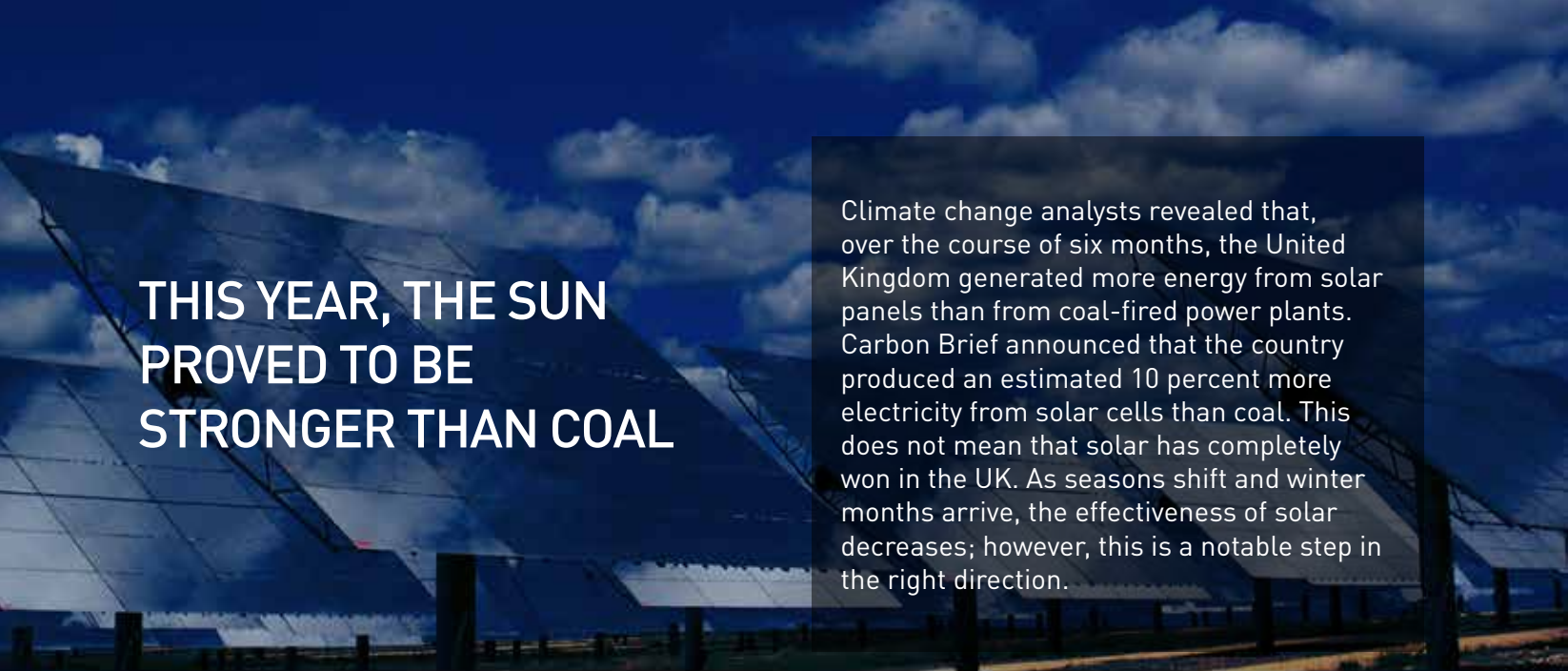
Laurence Kemball-Cook
Founder and CEO
Pavegen

Laurence Kemball-Cook leads a clean-tech company that has pioneered a technology that generates electricity from kinetic energy. After graduating from Loughborough University with first-class honors in Industrial Design and Technology, Kemball-Cook launched Pavegen and filed his first patents in 2009.




Senthil Balasubramanian
Co-Founder
Sistine Solar

Senthil Balasubramanian worked with Astonfield Renewables, a utility-scale PV power plant developer, to help raise \$15 million to build one of India's earliest solar power plants under the country's National Solar Policy. Before joining Astonfield, Senthil spent a number of years at GE, holding a finance-focused role in the clean water and infrastructure sectors.



THIS YEAR, THE SUN PROVED TO BE STRONGER THAN COAL

Climate change analysts revealed that, over the course of six months, the United Kingdom generated more energy from solar panels than from coal-fired power plants. Carbon Brief announced that the country produced an estimated 10 percent more electricity from solar cells than coal. This does not mean that solar has completely won in the UK. As seasons shift and winter months arrive, the effectiveness of solar decreases; however, this is a notable step in the right direction.



Sundrop Farms in South Australia started using a combination of solar power and seawater to produce food in the middle of a desert, and it operates completely independent of nonrenewable resources. Every day, seawater is pumped 2 km to the 20-hectare farm. The water is then run through a desalination system that produces up to one million liters of fresh water every day, which is then used to irrigate 18,000 tomato plants inside a greenhouse. This innovative practice is helping to make sustainable farming a reality.

WE USED OUR STAR TO TRANSFORM AN ARID AND BARREN LAND



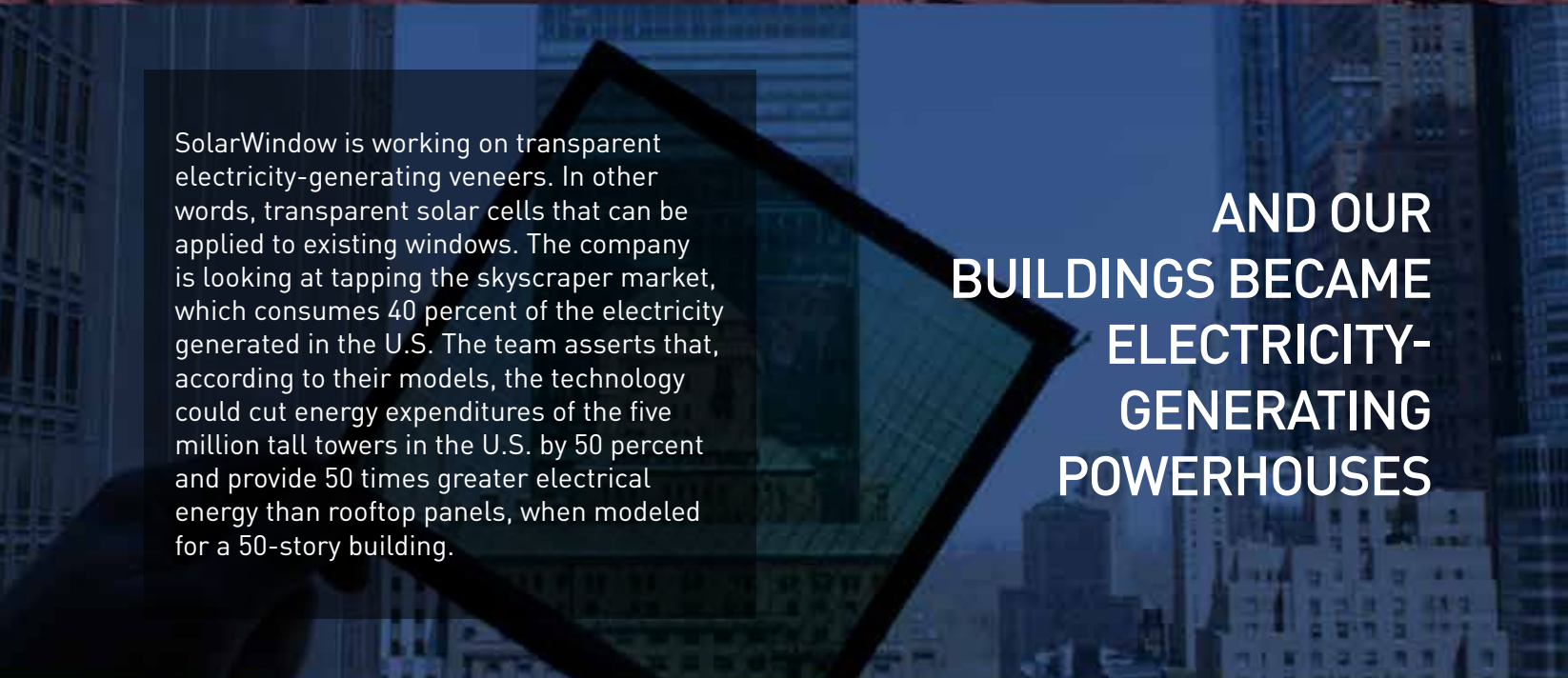
AND WE INNOVATED INGENIOUS WAYS OF POWERING THE TECH THAT WE WEAR

Engineers from South Korea developed very thin, flexible solar cells that can wrap around an average pencil. Photovoltaics like this could be used to power wearable electronics, such as fitness trackers, heart monitors, and similar products. Notably, the photovoltaic cell is 1 micrometer thick, or just about a millionth of a meter, which is thinner than the average human hair. Tests show that it is as efficient as thicker solar cells and comparably less fragile.



OUR SEAS BECAME HOME TO VAST SOLAR FARMS

In 2016 the world's largest floating solar farm opened off the coast of London. The farm consists of 23,000 solar panels that float on the Queen Elizabeth II reservoir. The project took 5 years to plan and finished in early March. It is estimated that it will generate enough electricity to power Thames Water's local water treatment plants for decades.



SolarWindow is working on transparent electricity-generating veneers. In other words, transparent solar cells that can be applied to existing windows. The company is looking at tapping the skyscraper market, which consumes 40 percent of the electricity generated in the U.S. The team asserts that, according to their models, the technology could cut energy expenditures of the five million tall towers in the U.S. by 50 percent and provide 50 times greater electrical energy than rooftop panels, when modeled for a 50-story building.

AND OUR BUILDINGS BECAME ELECTRICITY-GENERATING POWERHOUSES



GREGG MARYNIAK
ON CARBON EMISSIONS


There are ways to power megacities without any carbon. For example, we could power Beijing or New York with a single large artifact in space, one that sees power all the time and sends it to a collection mechanism on the ground. We know how to do it today. The trick is to get cost down, and

the way to do that is to build using material that doesn't have to get launched from the Earth, like using either raw material from the Moon or from asteroids. When the demand is really there for clean, carbon-free energy, there are lots of ways we will get it, both terrestrially and extra-terrestrially.

A large, jagged iceberg floats in a dark blue sea under a clear sky. The iceberg's surface is textured with various ridges and peaks.

WE REALIZED THAT WE'RE STILL A FEW STEPS BEHIND OUR ENERGY GOALS

Antarctica, the last station on Earth without a 400 parts per million carbon dioxide reading, finally reached the milestone in September. The South Pole Observing Station reports that this is its highest level in 4 million years. Most carbon pollution originates in Earth's Northern Hemisphere, where most of the world's population lives, which is why it took years before the 400 ppm threshold was breached in the Southern Hemisphere.

A large, bright orange and yellow explosion or fireball is shown against a dark, cloudy sky. The fireball is surrounded by thick, dark smoke that fills the upper portion of the frame. In the foreground, the silhouettes of two people are visible, looking towards the explosion.

The International Criminal Court declared that it would start treating cases involving environmental destruction, misuse of land, and illegal dispossession of lands as crimes against humanity. The Hague-based court, established in 1998 by the Rome Statute, made the announcement in a policy document released by the ICC's prosecutor.

SO WE DEVELOPED NEW POLICIES TO BRING US TOWARD THE FUTURE WE WANT



SENTHIL BALSUBRAMANIAN
ON DESIGN

Design has the potential to get people excited about a technology in ways that engineering alone cannot. Look at what Apple has done with the iPhone and what Tesla is doing with its cars. When you

integrate beautiful technology with beautiful design, you get intelligent technology. Then people are much more likely to fall in love with a product, so I see a future where the solar panel can appear with whatever image you want it to appear.

A LIMITLESS SOURCE OF CLEAN ENERGY FINALLY APPEARED ON THE HORIZON

Chinese physicists announced that their nuclear fusion reactor, the Experimental Advanced Superconducting Tokamak (EAST), produced and sustained hydrogen plasma at 49.99 million degrees Celsius for 102 seconds, a new world record.

To put that into context, the team, which hails from China's Institute of Physical Science, states that they were able to create hydrogen plasma by heating the element to conditions mimicking what we find at the center of stars, and they sustained that remarkably intense condition for a minute.

This milestone represents a proof of concept for controlled nuclear fusion. Through these experiments, scientists could eventually come to manipulate the plasma away from the walls of the reactor and harness the energy that it releases. If these records can be outclassed in the future, it would go a long way to achieving clean, limitless energy for our needs.


Nuclear fusion hasn't replaced most of our nuclear power plants due to the technical challenges that must be overcome to make it a reality. While nuclear fission also requires heating in order to occur, the scale needed to achieve fusion is much larger, a few hundred degrees for fission compared to millions of degrees for fusion.

The ultimate goal is to achieve 100 million degrees Celsius and maintain it for around 1,000 seconds, a solution that seems achievable but that is still a few steps away.

A robot named Lucy, a heliostat, is shown in a room. It has a spherical body with a transparent section revealing internal components. The robot is positioned on a green, circular, four-legged stool. The background shows a room with a bed and a window.

ROBOTS GAVE US A WAY TO POWER TOMORROW AND CLEAN THE PRESENT

A bioinformatics PhD student at Cambridge University developed a prototype for Lucy, a robot that brings sunlight to you. In this respect, Lucy is a heliostat, which means that the robot reflects sunlight indoors throughout the day without you ever having to do anything. A proprietary algorithm allows it to track the Sun, and it constantly adjusts itself to maintain a perfect angle of reflection throughout the day. Purely solar powered, Lucy can reduce your carbon footprint by up to one ton per year. It has the brightness of 13 light bulbs, equivalent to 10,000 lumens of natural light.

A close-up shot of a person's foot stepping on a small, square, white tile embedded in a dark floor. The tile is part of a Pavegen V3 system, which generates renewable energy from foot traffic.

In August 2015, Pavegen launched its V3 tiles, which generate renewable energy by converting the downward force of a footstep into electricity through a flywheel mechanism. The new model can generate five watts of energy from each person in motion. While not enough to power a city, it could provide lighting solutions for schools and offices and help stores generate power while tracking users' movements.

AND WE WALKED INTO A REMARKABLE NEW WORLD OF ENERGY PRODUCTION



**LAURENCE KEMBALL-COOK
ON RENEWABLES**

Renewable energy is a really risky business. There are a lot of costs in it, it's really capital-intensive, and there are a lot of skeptics out there. However, there are big rewards.

For example, if we could harness just a tiny portion of the sea's energy, we could power the world 10 times over. So the biggest challenge is really all about getting people invested to help accelerate the change.

FUSION ENERGY

POWERING THE FUTURE

Fusion is what powers the Sun and all the stars in the universe. Reproducing it on Earth, even on a small scale, would mean a clean, cheap, and inexhaustible source of power.

HOW IT'S GENERATED



HEAT

Fusion fuel must be heated to 100,000,000 C (180,000,000 F)



COMPRESS

It must be dense enough and confined long enough for nuclei to fuse



IGNITE

Ignition happens when enough fusion reactions take place to create a self-sustaining process



ENJOY

Once ignition is achieved, the net energy yield is four times that of nuclear fission

BRINGING IT TO LIFE

Scientists have devised three approaches to harness fusion energy.



MAGNETIC CONFINEMENT

This method involves confining and controlling plasma with magnetic fields. The most promising of these designs is the Tokamak.



INERTIAL CONFINEMENT

Laser beams are focused onto a pellet of deuterium-tritium fuel, heating its outer layers and creating an implosion that compresses the inner layers. This method, also known as "fast ignition," is deemed more practical and is part of a newer line of research.



HYBRID FUSION

Fusion can be combined with fission to create a hybrid nuclear reactor, where the blanket surrounding the core is composed of fissile materials. This technique can significantly multiply the energy yield of the fusion reaction.

THE CHALLENGES WITH FUSION



CREATING THE CONDITIONS

Man-made reactors can't achieve the extreme pressures inside the Sun. They can compensate by generating temperatures 10 times hotter than the Sun, but generating such heat is a major trial.



CONTROLLING THE REACTION

Due to the intense heat, producing a controlled and sustained fusion reaction is extremely challenging. Fusion researchers are working hard to find a way to confine the plasma using magnetic fields—but there's still much work to be done.



MAINTAINING THE TECHNOLOGY

Fast-flying neutrons constantly erode the reactor chamber wall and fill it with radioactive dust. If we're to create a successful fusion reactor, we'll need major advances in materials technology to confine and withstand the dangerous effects of the reaction.

THE TIMELINE

2020



Renewable Energy Generation Takes Over

By 2020, the electricity generated from renewable sources will be greater than the current combined demand of China, India, and Brazil, which are among the world's most populous countries.

Senthil Balasubramanian

2020

Solar as Cheap as Coal

"Solar will become as cheap as coal, or as cheap as your regular utility bill, in the next five years. With the subsidies, at least a third to half the states in the United States will rely on it.

Senthil Balasubramanian



2025



Solar Sees Unprecedented Growth

"In 10 years, drops in the cost of solar will result in dramatic solar growth. It will have swept at least 15 to 20 percent of households.

Senthil Balasubramanian

2023

Decentralized Power Networks

"We will begin to see cities with decentralized power networks. The energy from footsteps could actually power entire public areas in urban spaces. There will be no need to grid-connect streets — every streetlight will be self-powered.

Laurence Kemball-Cook



2030



Solar Walls and Windows

"We will eventually see solar being rolled onto pretty much every surface, every building, and every wall that's available and facing the Sun. And that's something that we're very excited about.

Senthil Balasubramanian

2027

Oil Demand Reaches its Peak

OPEC asserts that alternative fuel cars will likely be ubiquitous by the late 2020s, and after this point, the demand for oil will begin to decline.



2035



The Era of the Electric Car

"Electric cars will be 90 percent deployed, but we'll be using energy from vehicles braking to power the city, and the roads themselves will be starting to generate power.

Laurence Kemball-Cook

2030

Global Per Capita Demand for Energy Will Peak

By 2030, the global demand for energy per capita will peak. New technology and stricter governmental policy will cause energy consumption to begin to fall across the fields of transport, heating, and electricity.



2035



The Fourth Generation of Nuclear Power

By this point, our technologies will have advanced so that a nuclear fission runaway chain reaction, as happened with Chernobyl, will be prevented. No error, human or otherwise, will ever produce a meltdown.

2040

We Will Recycle Energy

"Humanity will use a lot more energy than it does now, but we will recycle atoms, and we will upcycle and recycle a lot more than we have in the past because it will finally be economically possible to do that.

Gregg Maryniak



2040



Computers Use More Electricity Than We Can Generate

By 2040, if we continue on our current trend with no breakthroughs in innovation, current levels of energy production will not be able to meet the demand that our computer usage will require.

2040

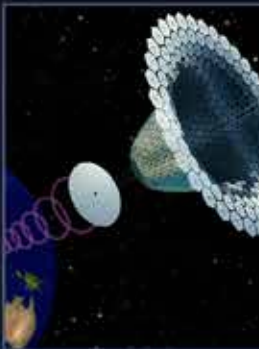
Energy Islands Are Commonplace

"Hexagonal islands that combine offshore power generation with desalination plants will be floating off our coasts, where conditions are ideal for ocean thermal energy conversion.

Laurence Kemball-Cook



2040



Orbital Solar Power

After years of scaling, energy generated from space-based solar power will finally be commercially viable and be added to the grid.

2044

Ubiquitous Energy Generation

"Every bridge will be generating energy. That may be through kinetic vibration harvesting or heat energy. Our roads will be our power sources.

Laurence Kemball-Cook



2050



Nuclear Fusion Finally Realized

By 2050, we will have the technologies to create and sustain the excessive temperature associated with nuclear fusion, supplying the world with a virtually limitless source of energy.

2053

Singular Energy Efficiency Revolution

"We will have the ability to send power as easily as we can send data, so every device can be powered from a cellular array. It could power someone's cell phone across the road, so all of our energy production will be completely decentralized.

Laurence Kemball-Cook





SCON complete

THIS YEAR IN Health

Years of dedicated research have culminated in remarkable advances in regenerative medicine, 3D-printed prosthetics, and CRISPR gene editing, gradually leading humanity into an era in which we can dictate the course of human biology.

THIS YEAR IN HEALTH

A host of new breakthroughs are transforming the human body and the foundation of what it means to be human. In 2016, we uncovered information that brings us one step closer to mastering the human genome and eradicating disease itself. Simultaneously, a marriage between personally curated plastics and smart health monitoring is leading us into a new era of personalized medicine.

BY THE NUMBERS

2,356
GENE THERAPY CLINICAL TRIALS

\$50
COST OF 3D-PRINTED HAND

\$70,000
COST OF REWALK EXOSKELETON

67
COUNTRIES WITH ZIKA

122
OLDEST PERSON EVER

EXPERT CONTRIBUTORS



Aubrey De Grey

Chief Science Officer
SENS Research Foundation

Aubrey De Grey is the Chief Science Officer of the SENS Research Foundation. He is also the Editor-In-Chief of the academic journal Rejuvenation Research. His research focuses on ways that regenerative medicine can halt aging and rejuvenate the human body.



Arthur Caplan

Professor of Bioethics
NYU Langone Medical Center

Arthur Caplan is the Founding Director of NYU's Langone Medical Center's Division of Medical Ethics. Caplan has made many contributions to public policy. He established the National Marrow Donor Program, advised the National Organ Transplant Act of 1984, and worked with prominent physicians to hold researchers accountable for their experiments.



Liz Parrish

Founder and CEO
BioViva Sciences USA Inc

Liz Parrish is the CEO of BioViva, a company that is committed to extending the expected human lifespan using gene therapy. As a strong proponent of the advancement of gene therapy, she serves as a motivational speaker and works to get governments to classify aging as a disease.

WE USED GENE EDITING TO ENTER A NEW CHAPTER IN THE FIGHT AGAINST ONE OF THE WORLD'S DEADLIEST DISEASES

CRISPR is the gift that keeps on giving. When it's not fighting blindness, tackling HIV, or being used to record real-time immune responses, it is taking on the emperor of all maladies: cancer.

In 2016, for the first time in history, the National Institute of Health's Recombinant DNA Research Advisory Committee in the USA approved the use of CRISPR gene editing as a human cancer therapy, marking a monumental step forward in both our use of gene-editing technology and our fight against cancer.

Thanks to funding from the Parker Immunotherapy Foundation, physicians at the University of Pennsylvania School of Medicine are working on the T-cells of 18 patients who have melanoma, sarcoma, or myeloma by performing three distinct CRISPR edits:

- **Offensive:** T-cells will be modified to have a gene that produces a protein that will help the T-cells identify and target cancer cells.
- **Removal:** T-cells will be modified so that they do not have a protein that is theorized to inhibit cancer cell identification and targeting.
- **Defensive:** T-cells will have a gene removed so that they will no longer produce a certain protein that identifies them as immune T-cells, thereby preventing cancer cells from inhibiting them.

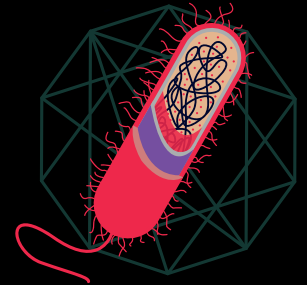
Although it may seem like approving this experimental therapy is a “no-brainer,” human gene therapy trials have been on a bumpy road since 1999 when it was discovered that members of a research initiative hid data from previous animal experiments because they had a financial stake in the success of their gene therapy study. Ultimately, the work resulted in the death of 18-year-old Jesse Gelsinger. This event made many skeptical of gene therapy as a whole.

CRISPR/Cas9

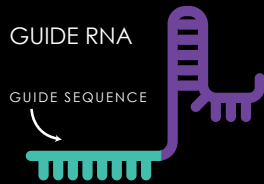
The Miracle Medical Tool

Inspired By Nature

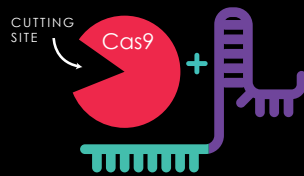
CRISPR/Cas-9 is a revolutionary new gene editing technique that allows us to manipulate specific segments of DNA without harming other genes. Originally evolved to enable certain bacterial species to remove viral genetic sequences, CRISPR/Cas-9 has given us the ability to modify any region in the genome of any species with unprecedented precision and accuracy.



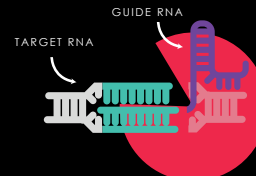
How It Works



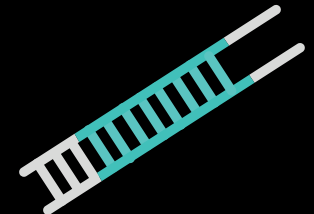
1. Design a "guide RNA" that matches the DNA sequence you want to edit or modify.



2. Insert this guide RNA into a cell with a Cas9 enzyme, a kind of molecular, genome-editing scissors.



3. The Cas9 enzyme uses the guide RNA as a template to seek out the specified DNA sequence and snip it out.



4. The desired DNA snippet is then slipped into the area once occupied by the excised sequence, and enzymes automatically repair the cuts.

Potential Applications



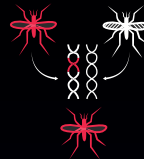
Medicine

Edit diseases and harmful mutations out of the human genome.



Agriculture

Easily and inexpensively create new crop strains that can resist diseases, pests, and drought.



"Gene Drives"

Eradicate specific organisms (such as disease carrying pests) by spreading defective genes throughout the population.



Enhancing Humans

The power to easily remake the human species in order to add muscle, height, change eye color, and combat aging.

Current Roadblocks



Fears of military or bioterrorism applications.



The lack of national or international guidelines for the use and regulation of CRISPR technology.



Some errors in gene editing, despite the accuracy of CRISPR's targeting system.



AUBREY DE GREY ON GENE THERAPY

The next step needed in gene therapy is to make it capable of genetically modifying a higher proportion of cells in tissues than it currently can, and doing so without correspondingly increasing the “off-target” effects.

In other words, we need to minimize the unintended changes to the genome that may occur as a result of gene editing. We’re working on that using a special kind of virus that exists in bacteria that can introduce DNA into the genome at a very specific location. It’s a rather new approach, but it seems to be very promising.

WE ALSO MADE SIGNIFICANT STRIDES IN THE WAR AGAINST AGING

Ambrosia, a startup based in Monterey, California, started a clinical trial aimed at rejuvenating people over the age of 35 by injecting them with blood obtained from younger individuals. In the trial, participants undergo plasma transfusions from donors less than 25 years old. Ambrosia tested their blood before the trials began, with the goal of tracking over 100 unique biomarkers. Participants will be retested one month after the procedure to note any improvements in “aged” cells.

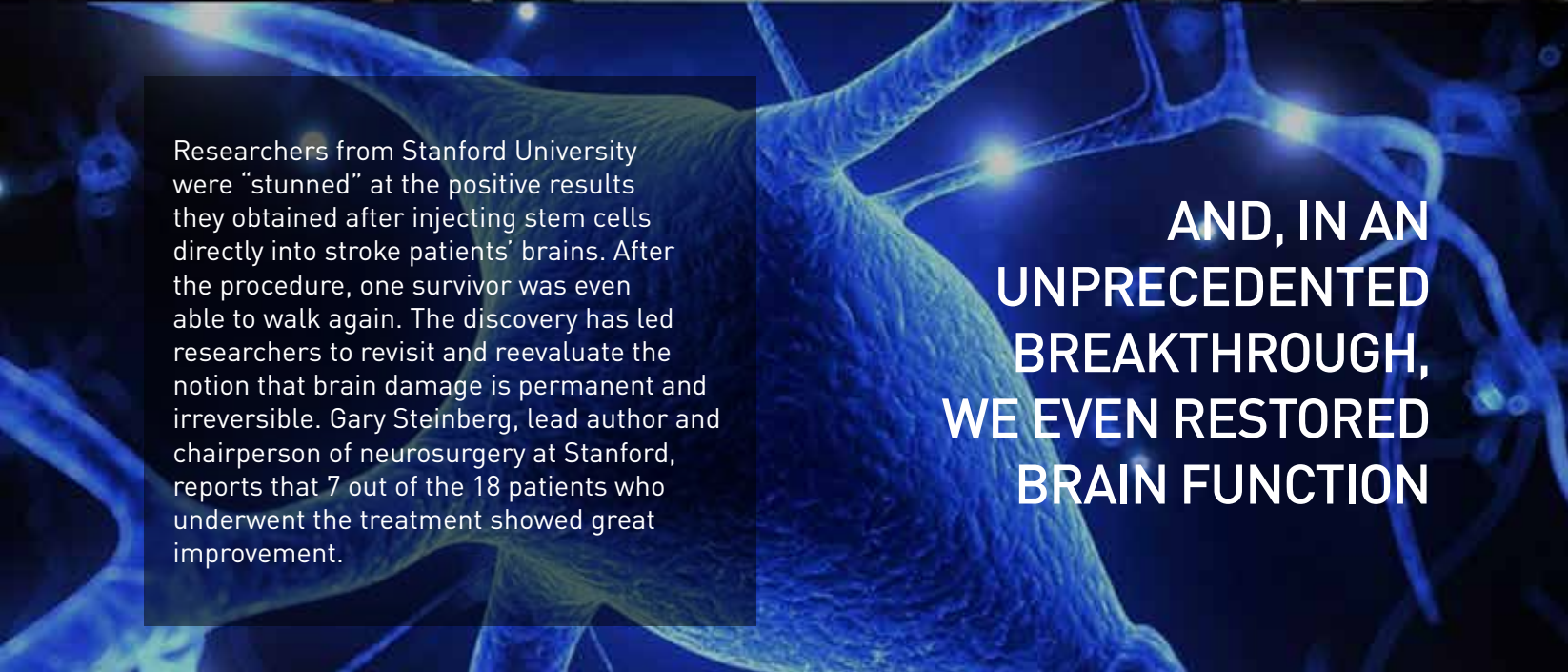
Helmut Schiessel and his team confirmed that a second layer of information exists in DNA. The team used the genomes of baker’s yeast and fission yeast to find correlations between the mechanics and the actual folding structure of DNA in the two organisms. This led the group to the “second layer” of information, i.e., the conclusion that genetic mutations are not just caused by a change in the sequence of codes, but also by a change in the way the strands are folded.

AND SIMULTANEOUSLY, WE MOVED TOWARD A BETTER UNDERSTANDING OF WHAT MAKES US, US



WE MADE LIFE EASIER FOR COUNTLESS INDIVIDUALS BY RESTORING LOST LIMBS

A new method that offers a wide range of motion and comfort for amputees became available this summer thanks to a pioneering surgical technique developed by researchers from Johns Hopkins Applied Physics Laboratory. This is a “first” in the field of prosthetics, which has always faced problems when dealing with sockets (the place where the prosthesis attaches to the body). The new procedure is called “osseointegration,” and it can be used to attach implants directly to bones.



Researchers from Stanford University were “stunned” at the positive results they obtained after injecting stem cells directly into stroke patients’ brains. After the procedure, one survivor was even able to walk again. The discovery has led researchers to revisit and reevaluate the notion that brain damage is permanent and irreversible. Gary Steinberg, lead author and chairperson of neurosurgery at Stanford, reports that 7 out of the 18 patients who underwent the treatment showed great improvement.


AND, IN AN UNPRECEDENTED BREAKTHROUGH, WE EVEN RESTORED BRAIN FUNCTION



ARTHUR CAPLAN ON AI IN MEDICINE

Artificial intelligence is another thing that is already making a big impact on healthcare, and it’s doing it in a very interesting way: the electronic medical record. We now have computerized a good portion of information. We can analyze data much more quickly to see whether a treatment works, or actually doesn’t have any efficacy despite the fact it

may have been done for decades. You can also get your medical record and actually read it, as we got rid of bad penmanship. The bad news? It takes a long time to punch in the information, so patients will often say, “Where’s the doctor now?” And his or her head is stuck in the computer, entering data. So we clearly have to get more intelligent than we are, but we are on our way.




Gouping Feng, a professor of brain and cognitive sciences from the Massachusetts Institute of Technology, led a team of researchers that successfully reversed autism in mice. Through their work, they managed to “turn off” the gene called Shank3 and then turn it back on at a later point in life. The technique has been shown to reverse behavioral symptoms of autism in mammals, and this may be translated to human patients in order to develop a viable long-term cure.

**WE TOOK REMARKABLE
STEPS TOWARD GIVING
PEOPLE BACK THEIR
LIVES**



**WE HELPED PEOPLE
REGAIN CONTROL OF
THEIR MOVEMENTS**

A clinical trial led by Ottawa Hospital hematologist Harold Atkins successfully halted the progression and reversed the effects of multiple sclerosis (MS), a disease in which the immune system begins to attack parts of the body, leading to disability and even death. The team utilized a new technique to wipe out the patient’s immune system entirely, thereby eradicating the problem. Afterwards, they reintroduced stem cells, which caused the patient to grow a brand-new immune system.



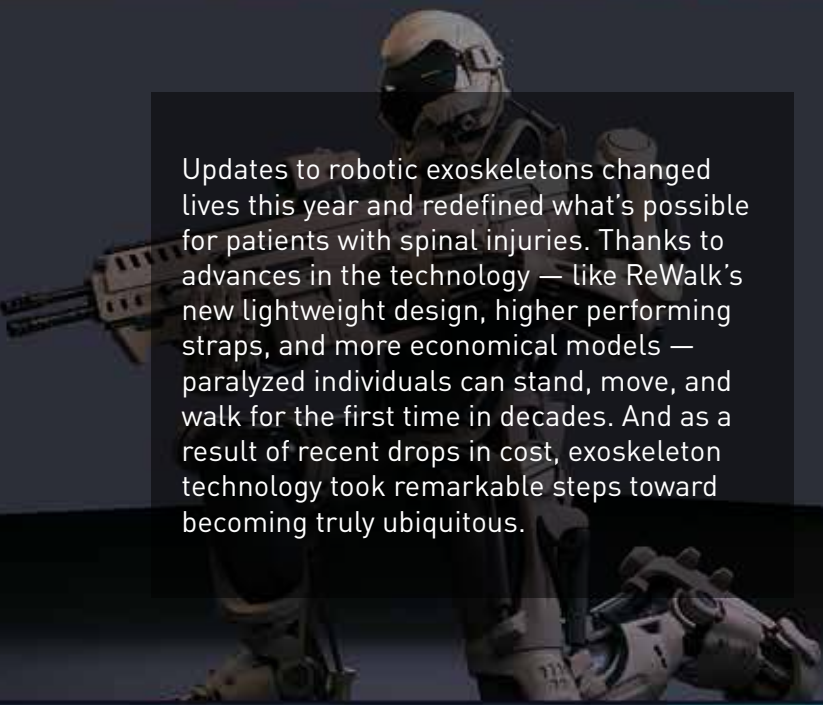
Full Genomes Corporation made genetic sequencing technology affordable for the everyday individual. The company’s primary objective is to make genetic sequencing viable in the direct-to-consumer market, with a current focus on the Y chromosome. They started offering packages that include interpretation for just a few hundred dollars. Traditionally, such services cost thousands of dollars and, as a result, were far more expensive than most could afford.

**AND WE HELPED
PEOPLE UNCOVER
THEIR OWN GENETIC
HISTORY**



WE USED 3D PRINTING TO CUSTOMIZE SOLUTIONS TO FIT WHO WE ARE

A South Korean man facing a foot amputation was given a new chance at mobility thanks to 3D printing. The patient suffered from a form of bone cancer that was isolated in his foot but had the potential to spread throughout his body. However, rather than removing his foot in order to prevent this eventuality, physicians replaced his bone with a 3D-printed version of a heel bone.



Updates to robotic exoskeletons changed lives this year and redefined what's possible for patients with spinal injuries. Thanks to advances in the technology — like ReWalk's new lightweight design, higher performing straps, and more economical models — paralyzed individuals can stand, move, and walk for the first time in decades. And as a result of recent drops in cost, exoskeleton technology took remarkable steps toward becoming truly ubiquitous.

AND CREATED NEW TECHNOLOGIES THAT ALLOW US TO BECOME THE PEOPLE WE WANT TO BE



LIZ PARRISH ON PERSONALIZED MEDICINE

Medical care has changed a lot in recent years. Today, we're working toward personalized medicine that enables us to treat people as individuals instead of statistics because we know that the latter doesn't work.

We can tailor treatments and technologies to a specific person. Ultimately, this level of personalized treatment is totally changing the game and moving us forward.

THE TIMELINE

2020



Fully Functioning Bionic Eyes

Bionic eye researchers at the University of New South Wales in Australia predict there will be a fully functioning artificial eye available in just 4 year's time.

2020

Affordable At-Home Cancer Tests Will Be Widely Available

A simple, noninvasive, saliva test will be available for around \$20 in just 4 years time. The test will be able to detect tumor signatures in a subject's saliva.



2025



Laboratory Progress in Enhancing Humans

At this point in time, we'll see gene therapy, gene editing, and building organs as replacements for human bodies come into mainstream science.

Liz Parrish

2025

Nanoparticles Aid in The Fight Against Cancer

Nanoparticles will be attached to antibodies that are attracted to molecules expressed by cancer cells. There will be early trials to use these to target and kill cancer.



2028



Personalized Genetic Engineering to Combat Disease

"By 2028, I think we will be at a time in human history where gene engineering is used to fix diseases in our bodies.

Arthur Caplan

2026

Laboratory Progress Slowing Aging in Mammals

"10 years from now, we will extend the lives of mice by maybe three times more than we can today.

Aubrey De Grey



2033



Primary Human Aging Therapies for Adults

"20 years from now is the minimum time frame at which we will have a combination of damage repair therapies working on adult humans, though I think it's going to be very experimental at that point.

Aubrey De Grey

2030

Reversing and Blocking Alzheimer's

By 2030, we will be able to inject proteins like IL-33 into patients in order to decrease the amount of toxic amyloid plaque buildup, which will allow us to combat the symptoms of Alzheimer's.



2035



Embryonic Engineering to End Genetic Disease Transmission

"By 2035, we will have embryo engineering to prevent the inheritance of genetic diseases. We'll not only cure, say, hemophilia in you, but we're going to make sure it's out of the human species completely.

Arthur Caplan

2042



Womb Tanks for Childbirth

"Childbirth in artificial environments will come in the early-2040s. It's safer. We can control and optimize nutrition, prevent exposure to alcohol, viruses, or whatever that can do harm.

Arthur Caplan

2048



Global Distribution of Gene Therapies

"I believe that gene therapies will be given like immunizations and will be distributed probably nearly free by most governments during the second half of the 2040s.

Liz Parrish

2057



Dramatic Increase in Longevity

"There will be enough people who have had enough of a therapy for enough time that they will be living substantially longer than anyone who lived before. We will start to see the reality of all these scenarios that we have been anticipating and trying to prepare for.

Aubrey De Grey

2040

Cardiovascular Disease Eradicated

New treatment options such as stem cell therapy, heart muscle regeneration, and microRNA inhibitors will wipe out nearly all heart disease.



2045

Post-Aging Therapies

"30 years from now, we've got a good chance of really having anti-aging therapies working, though lots of the things will be highly expensive, and they will be invasive. There will be surgery involved, and it won't be easy, but basically, we will be entering the post-aging era.

Aubrey De Grey



2054

Individualized Healthcare via Avatars

"By this time, you won't be going to the doctor. You'll just be looking at an avatar. You'll have sensors and chips that you can either wear all the time or put on to augment and protect your health.

Arthur Caplan



2059

First Model of Optimal Human Health

"We will have the first model for a homeostasis in the human body. It may not be a perfect model, but it will be the first model of what optimal human health with minimal entropy looks like.

Liz Parrish



THIS YEAR IN Education

Our society never stops changing, and we never stop learning. As a result, our education systems are under constant pressure to incorporate new ideas and new technologies, which ultimately allows us to develop innovative means of inspiring the next generation.



THIS YEAR IN EDUCATION

In 2016, advances in our curriculums and educational policies allowed us to educate individuals in ways that were unattainable in previous eras. Simultaneously, through developments in information access and breakthroughs in computing technologies, we gave the next generation the opportunity to learn without limits and innovate the world that they want to live in.

BY THE NUMBERS

750+ MILLION

ADULTS WHO ARE ILLITERATE

8%

COMPANIES NOW USING MOOCS

6.7%

OF THE WORLD HAS A DEGREE

\$107 BILLION

GLOBAL E-LEARNING MARKET

256

ACTIVE PROGRAMMING LANGUAGES

EXPERT CONTRIBUTORS



Jeremy Johnson

Co-Founder
CEO of Andela

Jeremy Johnson founded Andela with the goal of training 100,000 world-class software developers in Africa over the next 10 years. Prior to Andela, Jeremy co-founded 2U, one of the fastest growing education technology startups in history, which creates online degree programs for top-tier universities.



Reshma Patel

Executive Director
Impact Network


Reshma Patel uses Impact Network to empower teachers across Zambia by providing them with daily lessons delivered through a tablet and projector. Impact Network serves over 2,100 students at a cost of only \$3 a month per student (a fraction of the cost of government schools).



Zach Sims

Co-Founder
CEO at Codecademy

Zach Sims is the Co-Founder and CEO of Codecademy, which has taught millions of people how to program through its online portal. Ultimately, they hope to use their team to shape the online learning experience of the future.



At the Summit on Computer Science Education in September, the White House announced a new initiative that will give every student from kindergarten through high school access to a computer science education. Specifically, the program will provide each student with the in-demand computer science skills that are needed to join the world's workforce and, thus, help prepare them to build the world of tomorrow.

THE AGE OF THE COMPUTER LED TO A NEW AGE IN EDUCATION



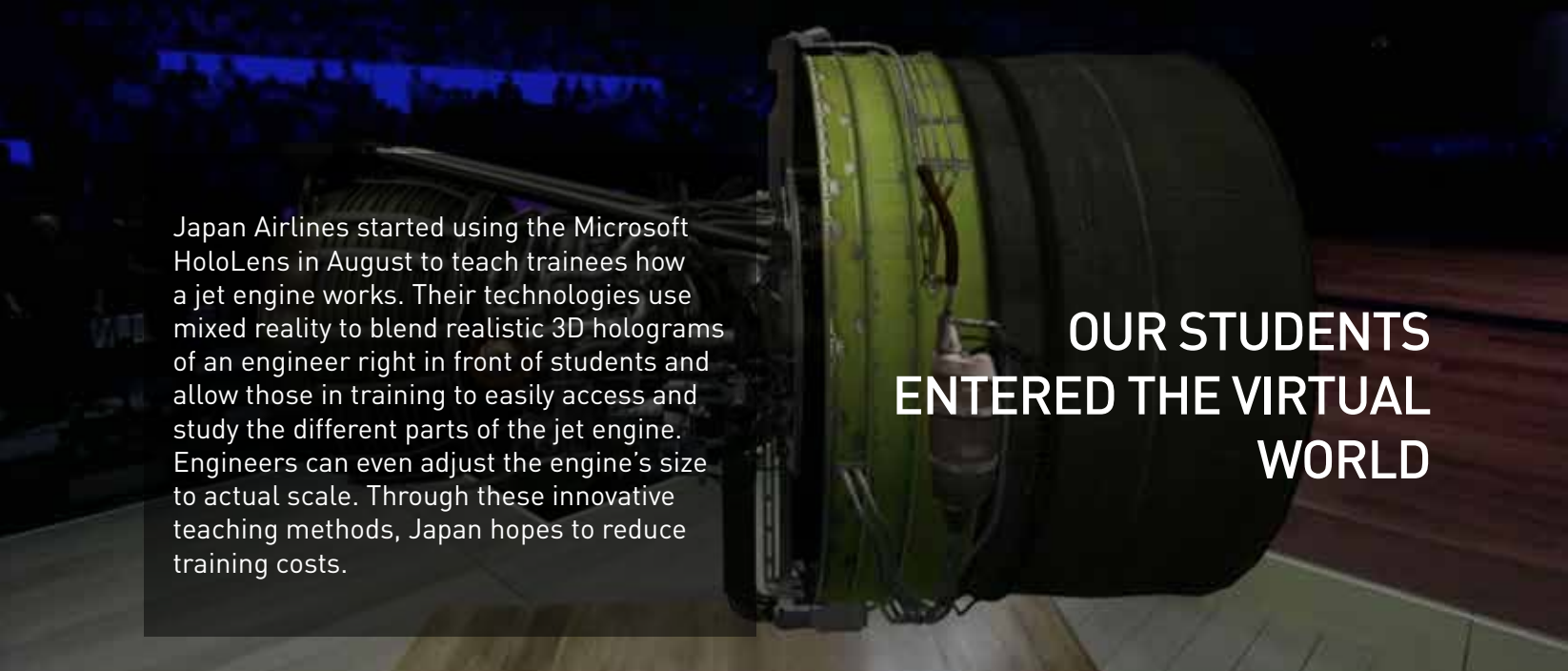
NEW LANGUAGES WERE BORN

In 2016, lawmakers revolutionized education by adding another fundamental to the three conventional skills of reading, writing, and arithmetic: programming. A number of proposals were put forth in various countries that enabled students to enroll in courses on programming languages such as JavaScript and Python instead of enrolling in traditional foreign language courses.

In what has been called a "life-changing decision," the European Union's ministers of Science, Innovation, Trade, and Industry decided to give individuals free access to science papers. This would legally only impact research supported by public and public-private funds, which are a vast portion of the papers produced annually; however, the goal is to make all science freely available by 2020. Ultimately, the commitment rests on three main tenets: sharing knowledge freely, open access, and reusing research data.




AND KNOWLEDGE BECAME FREE FOR ALL



Japan Airlines started using the Microsoft HoloLens in August to teach trainees how a jet engine works. Their technologies use mixed reality to blend realistic 3D holograms of an engine right in front of students and allow those in training to easily access and study the different parts of the jet engine. Engineers can even adjust the engine's size to actual scale. Through these innovative teaching methods, Japan hopes to reduce training costs.

OUR STUDENTS ENTERED THE VIRTUAL WORLD



AND STUDENTS EVEN TOOK TO THE SKIES

The European Emergency Number Association, a nonprofit trade body that is supported by DJI, a Chinese drone maker, started a drone school in Copenhagen that aims to help government agencies transform drones from recreational toys to life-saving tools. Ultimately, the school launched a six-month trial that is the world's largest and most widespread experiment with unmanned aircraft.



JEREMY JOHNSON ON EDUCATION


Education is important because it is one of the most powerful forces for bringing people together and helping them connect. So increased access to education translates

into increased humility and understanding that our culture is not **the** culture, that there are a lot of different ways to approach the world. In short, education leads to increased tolerance.



OUR CLASSROOMS LITERALLY DISAPPEARED

In February, the SP Jain School of Global Management announced plans to launch its undergraduate and graduate classes in virtual reality. The school's president explained that the decision to have courses with virtual reality as a major component was prompted by the changing needs of business. The school notes that, as virtual reality becomes more ubiquitous, students need to learn how to work in the virtual world as well as know how to work the old-fashioned way — and that means being fully immersed in the virtual world throughout schooling.



A new study published in the journal *Molecular Psychiatry* indicated that DNA could be used to accurately predict an individual's academic achievement, which could prove useful in helping us identify children that could have learning difficulties and develop solutions before they fall behind. The work was based on a genome-wide association study that examined almost 10 million single nucleotide polymorphisms and identified 74 genetic variants.

AND WE FOUND A NEW WAY TO TACKLE LEARNING DISABILITIES



ZACH SIMS ON RESEARCH DATA

Codecademy is building a database of all student actions taken, so that we can draw more accurate conclusions from the data about how people learn. There has not been too much consistency in a lot of education


research precisely because of a lack in data, which is why most of the interesting stuff will come after we establish new products that are able to collect data.

THE WORLD'S INFORMATION BECAME AS CLOSE AS A KEYBOARD AWAY

MIT's OpenCourseWare website is leading a revolution in education. And this year, it turned 15 years old. The website hosts over 2,300 courses from MIT — it has video lectures from professors, course materials, study guides, and even full textbooks available for free and instant viewing.


If that's not impressive enough, the website is still growing. Each year, the school adds an additional 120 courses and a host of new interactive features in an attempt to provide individuals worldwide with free access to an education. The school also has a host of materials that are focused on engaging elementary and high school students.

MIT's courses are focused on science, technology, engineering, and math (STEM). And given the increasing influence of science and technology on our lives, having a sound understanding of the STEM fields is a vital part of being an effective and productive member of society. Those working in STEM and associated careers have unanimously welcomed this commitment, as it doesn't just make for a more educated population — open access courses also allow us to make better workers.



TECHNOLOGIES CREATED NEW WAYS FOR STUDENTS TO SEE AND SPEAK

The Urban Arts Partnership, an organization that works with thousands of students to help ensure that they have the skills necessary for life post-graduation, brought a host of students together at a “Future Forward” event to discuss how art and technology could be united to make more effective students. Ultimately, the project seeks to push the boundaries of what’s possible in creative expression, allowing students to really expand their minds by using art and technology to find new ways to speak and be heard.



Ahshok Goel, a professor at Georgia Institute of Technology, revealed in May that he has been employing a robot as one of his teaching assistants. “Jill Watson” did the work of a regular teacher’s assistant for Goel, answering students’ questions in a forum, reminding students of upcoming important dates over email, and communicating on a daily basis. Notably, the AI did so in a way that was so human, students never realized that they were talking to a robot. To train the robot, Georgia Tech researchers exposed Jill to over 40,000 postings in the discussion forum “Piazza,” and he taught her to use previous responses to reply to related questions.

AND THROUGH TECHNOLOGY, WE EVEN RE-CREATED OUR TEACHERS



RESHMA PATEL ON EDUCATION TECHNOLOGY

There’s a lot being done with different advancements in technology that could help create better assessments in the future. For example, responsive assessments. Students could come to class, take a test at the beginning of the day, and software creates customized education plans for that student for that day based

on how they did on the test. So if a student took a test on fractions, and they’re having trouble with getting fractions down to common denominators, the lesson would be all focused around improving that aspect.

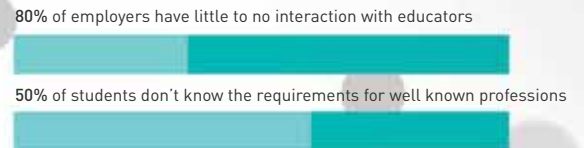
THE NEXT EVOLUTION of LEARNING

YOUNG PEOPLE ARE POISED TO ENTER A CUTTING-EDGE DIGITAL WORKFORCE

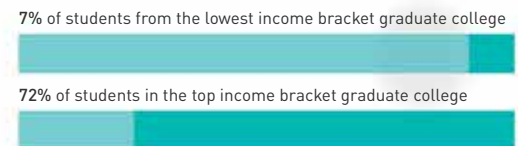


HOW EDTECH STARTUPS ARE DEMOCRATIZING EDUCATION

WHAT IF EMPLOYERS WERE MORE ENGAGED WITH THE EDUCATION SYSTEM?



WHAT IF WE COULD CLOSE THE COLLEGE COMPLETION GAP?



TODAY'S CLASSROOMS ARE MORE CONNECTED THAN EVER BEFORE.

of teachers have one or more computers in the classroom every day



of those computers have access to the internet

EDTECH STARTUPS



DonorsChoose

DonorsChoose is a nonprofit organization that connects high need classrooms with individuals who are willing to donate to fulfill those needs. To date, well over one million citizen philanthropists have made contributions



Code.org

Code.org is a nonprofit that encourages and enables students to learn computer science. The organization has partnered with everyone from Disney to Microsoft to make coding more fun and more accessible



Coursera

Coursera provides universal access to the world's best education by partnering with top universities, organizations, and governments to offer free courses online. Partners include Duke, Penn, John Hopkins, and Stanford



edX

edX began as a joint venture between MIT and Harvard to offer free online courses from top universities. The nonprofit now features classes from Berkeley, Georgetown, and the University of Texas too



VR for Good

Launched by Facebook and Oculus, vr for good is a program that connects students with professional virtual reality filmmakers to create 360 films about their communities. For the pilot, vr for good will partner with nine SF Bay-area schools with underrepresented STEM programs



DreamWakers

Co-founded by Monica Gray and Annie Medgalia, DreamWakers is a nonprofit that uses free video chat services like Skype and Google Hangouts to bring diverse and dynamic leaders into high-need public school classrooms

THE TIMELINE

2022



Students Learn in the Virtual World

"The Earth's atmosphere, what it's like on the Moon, what the landscape in Germany looks like...soon, kids will put on VR goggles and really see that. They will actually experience these things in a virtual world.

Reshma Patel

2020

All Scientific Papers Become Free Under EU Proposa

All publicly funded scientific papers published in Europe could be made free to access by 2020 under a reform ordered by the EU's science chief, Carlos Moedas.



2025



Dramatic Increase in Remote Learning Experts

Experts predict that virtual reality and augmented reality will increase remote learning and, as a result, classrooms will start to disappear.

2024

Grading Goes to Smart-Devices

All students and parents will have an app that allows them to immediately see all grades and all of the learning progress. This may come even sooner, as smartphones are already ubiquitous.



Jeremy Johnson

2030



Human Brains Connect to the Cloud

The ability to back up our thoughts and memories using computers will increase our learning potential dramatically. This will all be possible via nanorobots in the capillaries of our brains.

2026

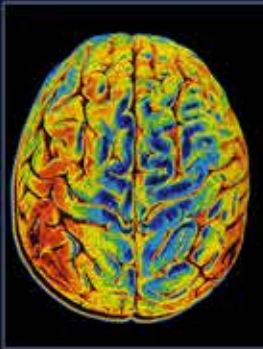
Worldwide Education Access

"In 10 years, we will have a world where everyone will have access to internet. Lots of institutions will continue to make their content available and MOOCs will be commonplace.

Zach Sims



2030



Brain Imaging Revolutionizes Our Teaching

The use of brain imaging will allow us to fine-tune education by testing what modes of teaching work best. This will be possible, as the images will allow us to actually see how various ways of teaching alter the brain.

2030

We Will Enhance our Minds with Chemistry

Predictions assert that, by 2030, advances in chemistry will allow us to use drugs and similar methods to alter and improve our students' minds to optimize their brains for learning.



2031



Personalized Life-Long Education

"You're going to start seeing dramatically enhanced personalization. Students will spend a lot of time individually engaging teachers, and it'll feel like one-on-one tutoring, but it will all be virtual.

Jeremy Johnson

2031

Our Teachers Become AI

Computer scientist Eric Cooke notes that, in the next 15 years, intelligent machines will largely replace human teachers.



2035



Artificial Microbes Give Us On-Demand Information

Artificial microbes will give us specific and temporary comprehension capabilities: i.e. they could permit an individual to temporarily understand and speak a foreign language fluently.

2036

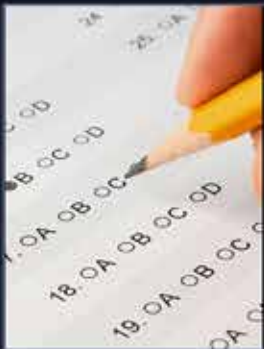
Significant Reduction in Traditional Classrooms

"In 20 years, you'll see a lot of brick and mortar education institutions go away. Top universities will be fine, but the middle-tier institutions will be in trouble.

Zach Sims



2036



Exams Become Nearly Obsolete

Over the next 20 years, experts predict that traditional methods of testing will be abandoned, and we will begin to focus on more holistic assessments.

2043

A New Model of Education

"Education will be a pervasive part of our lives. We have constant access to all the world's information through our devices, so education will become more omnipresent as we continue to evolve.

Jeremy Johnson



2050



Brain Imaging Revolutionizes Our Teaching Methods

By 2050, futurists assert that schools will no longer teach children to read and write. Brain-computer-interfaces will make those skills outdated and useless.

2059

Direct Neural Interface to Information

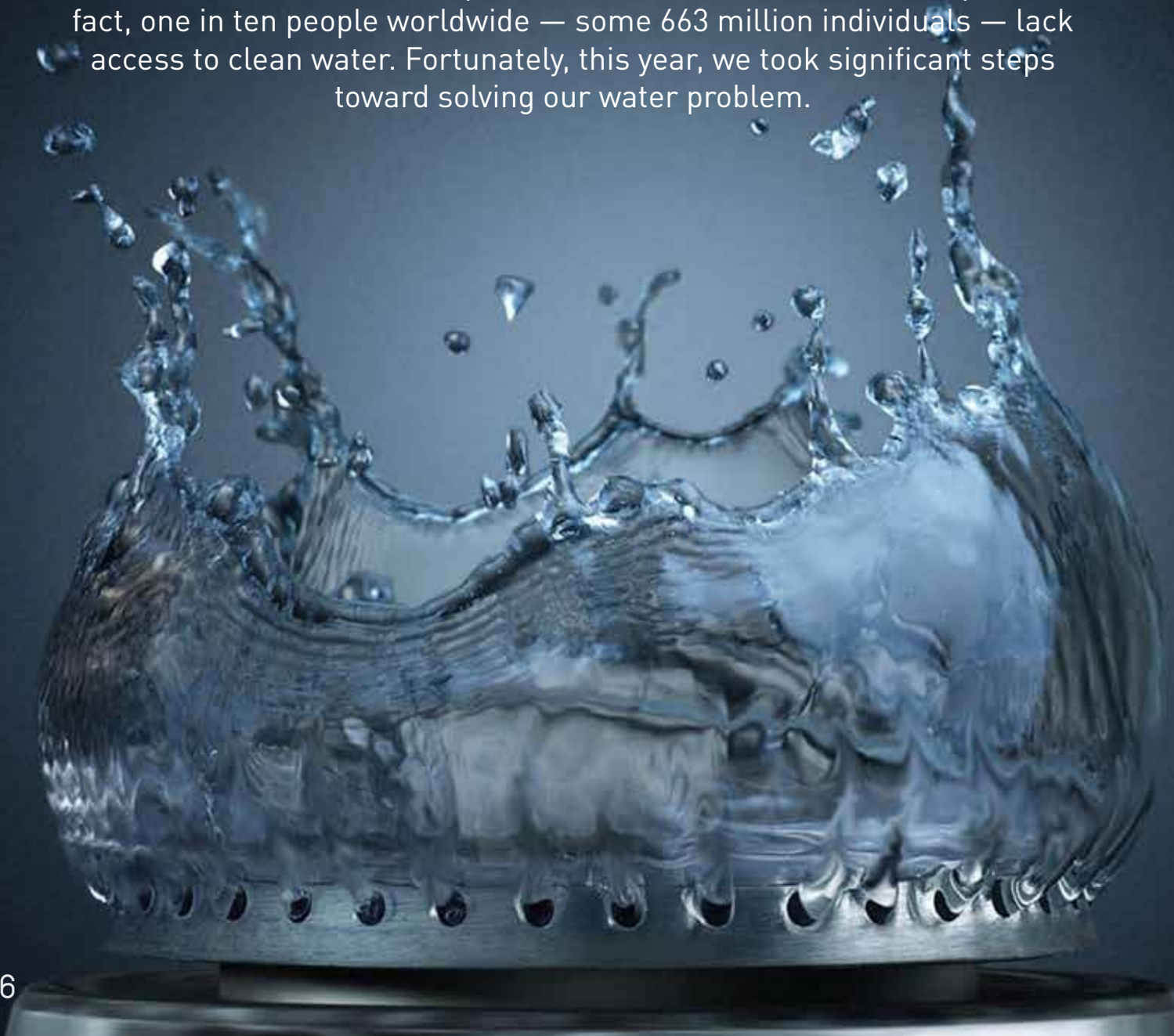
"You will have a direct link to Wikipedia in your brain, and as a result, memorization will become irrelevant.

Jeremy Johnson



THIS YEAR IN **Water**

Water is a fundamental component of life as we know it, but despite this fact, one in ten people worldwide — some 663 million individuals — lack access to clean water. Fortunately, this year, we took significant steps toward solving our water problem.



THIS YEAR IN WATER

In 2016, advances in water purification allowed us to clean water faster and cheaper than ever before, while breakthroughs in desalination helped us to create drinkable water from the sea. New sensor technologies assisted us in conserving our most precious natural resource and, in so doing, allowed us to save countless lives. We even used water to power our world.

BY THE NUMBERS

1.33 BILLION km³
TOTAL WATER ON EARTH

21%
GLOBAL HYDROPOWER USAGE

1.25 BILLION
USERS OF HYDROPOWER ENERGY

724
ACTIVE HYDROGEN STATIONS

96.5%
OF ALL WATER IS SALINE

EXPERT CONTRIBUTORS



Callum Clench

Executive Director
International Water Resources
Association

Callum Clench is the head of the International Water Resources Association, an international body of multidisciplinary experts on water resources. It is a non-profit, non-governmental, educational organization that connects individuals and institutions who are concerned with the sustainable use of the world's water resources.



Christoph Gorder

President and Chief Global
Water Officer
Charity: Water


Christoph Gorder leads Charity Water, a non-profit organization bringing clean and safe drinking water to people in developing countries. He also spent the last 15 years at AmeriCares, bringing medicine, medical supplies, and healthcare to people in crisis around the world.



John Lienhard


Professor
Massachusetts Institute of
Technology - MIT

John Lienhard currently serves as director of the Abdul Latif Jameel World Water and Food Security Lab. He is also the director of both the Center for Clean Water and Clean Energy and Rohsenow Kendall Heat Transfer Laboratory.



In an effort to clean the world's oceans, experts from The Ocean Cleanup foundation are launching a 100-kilometer-long floating barrier that will collect trash from the North Sea. The plan is to eventually deploy a barrier in the Pacific Ocean and cut the size of the notorious Great Pacific Garbage Patch in half in the next 10 years. The floating barrier was designed so that it doesn't interfere with wildlife, and it can survive extreme storms.

WE LOOKED TO THE FUTURE BY RIDDING OUR OCEANS OF TRASH



AND LOOKED AFTER OUR HEALTH BY RIDDING OUR WATER OF GERMS

A team of researchers from Stanford University and SLAC National Laboratory developed a tiny device that can disinfect water in just 20 minutes. Remarkably, it does so using sunlight. Measuring in at just 1 cm by 2 cm — about half the size of a postage stamp — the little purifier can harness a broad spectrum of the Sun's rays to maximize its disinfecting abilities. The device is made from a layer of copper and molybdenum disulfide, which creates a disinfectant that kills microbes.



CALLUM CLENCH ON WATER CHALLENGES

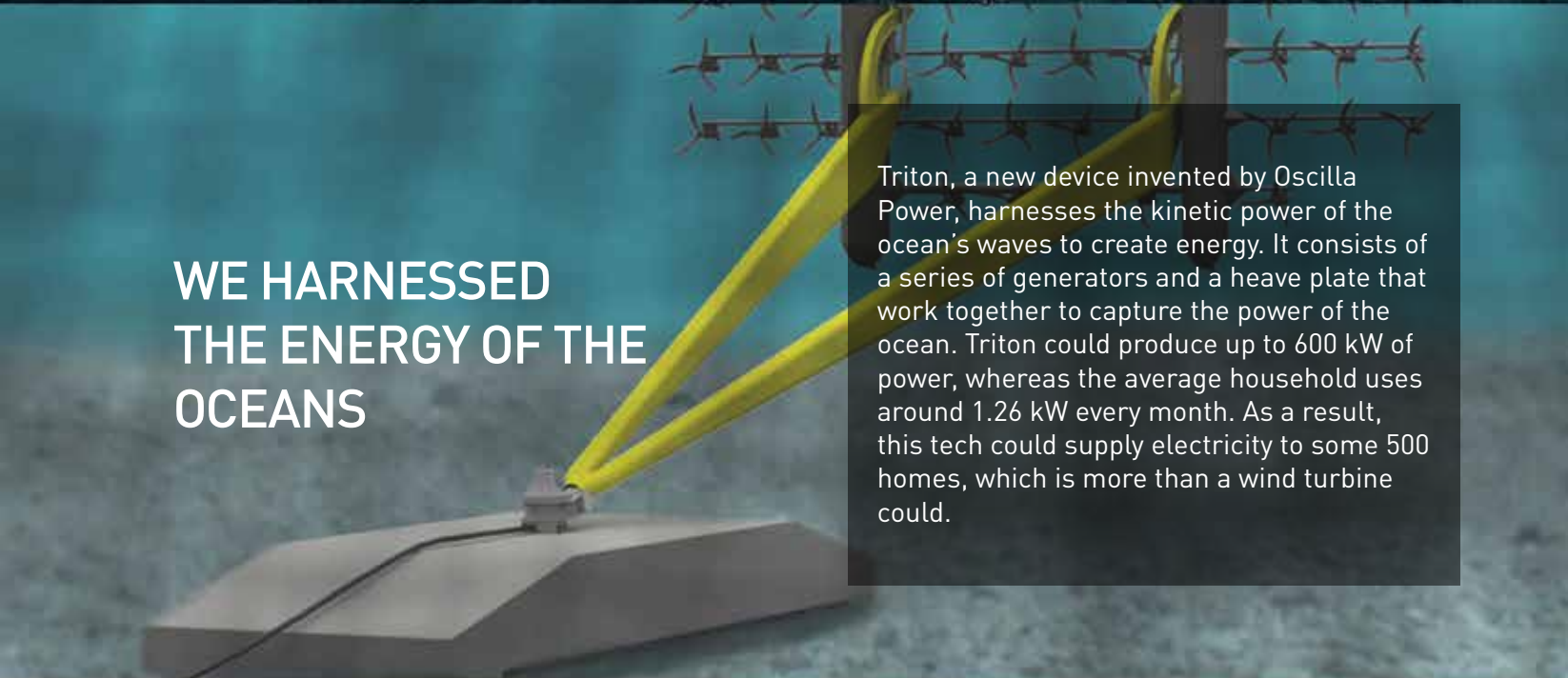
One of the biggest challenges we face in this sector is water contamination. Things like corroding pipes poison the population consuming that water. And this is in the U.S., so if the U.S. can get it wrong, you can imagine the difficulties when dealing with countries that have fewer resources.

And in fact, in some places, things are severely wrong, which ultimately leads to conflict. We're seeing conflict in places like Yemen, and it's fundamentally over water. So water contamination is something that we need to take much more seriously than we do.



"The Pipe" was designed for the 2016 Land Art Generator Initiative in California. Not only does it look dazzling on the horizon, it also desalinates seawater using the power of the Sun. The device is composed of solar panels that provide 10,000 Mwh of power per year. It also pumps seawater through an electromagnetic filtration process, generating 1.5 billion gallons of drinking water.

**WE FOUND NEW WAYS
TO USE WATER TO
POWER OUR LIVES AND
OUR BODIES**



**WE HARNESSSED
THE ENERGY OF THE
OCEANS**

Triton, a new device invented by Oscilla Power, harnesses the kinetic power of the ocean's waves to create energy. It consists of a series of generators and a heave plate that work together to capture the power of the ocean. Triton could produce up to 600 kW of power, whereas the average household uses around 1.26 kW every month. As a result, this tech could supply electricity to some 500 homes, which is more than a wind turbine could.



Unveiled by SunGlacier in July of this year, the solar-powered WaterCube produces drinking water out of thin air. This compact cube is basically a 0.5 meter refrigeration device. Its solar cells cool off an inverted cone to create condensation. The collected condensation then drips into a glass for drinking. The hotter the air, the more H₂O the WaterCube can generate, making it perfect for desert and drought climates.

**AND EVEN CREATED
WATER FROM AIR**

WE FOUND A WAY TO SIMULTANEOUSLY PRODUCE CLEAN WATER AND POWER

What were you doing when you were 18 years old? Probably not turning wastewater into electricity, but that's just what one teen from British Columbia in Canada is doing.

Austin Wang is a Vancouver high school student who wants to turn one billion liters of wastewater into water that we can all consume. And if that's not enough, he also hopes to use it to power our homes and cities. Specifically, Wang is looking to utilize the billions of liters of water that get flushed down our toilets and sent down our sink drains every day. This water, he asserts, could be used for a number of purposes.

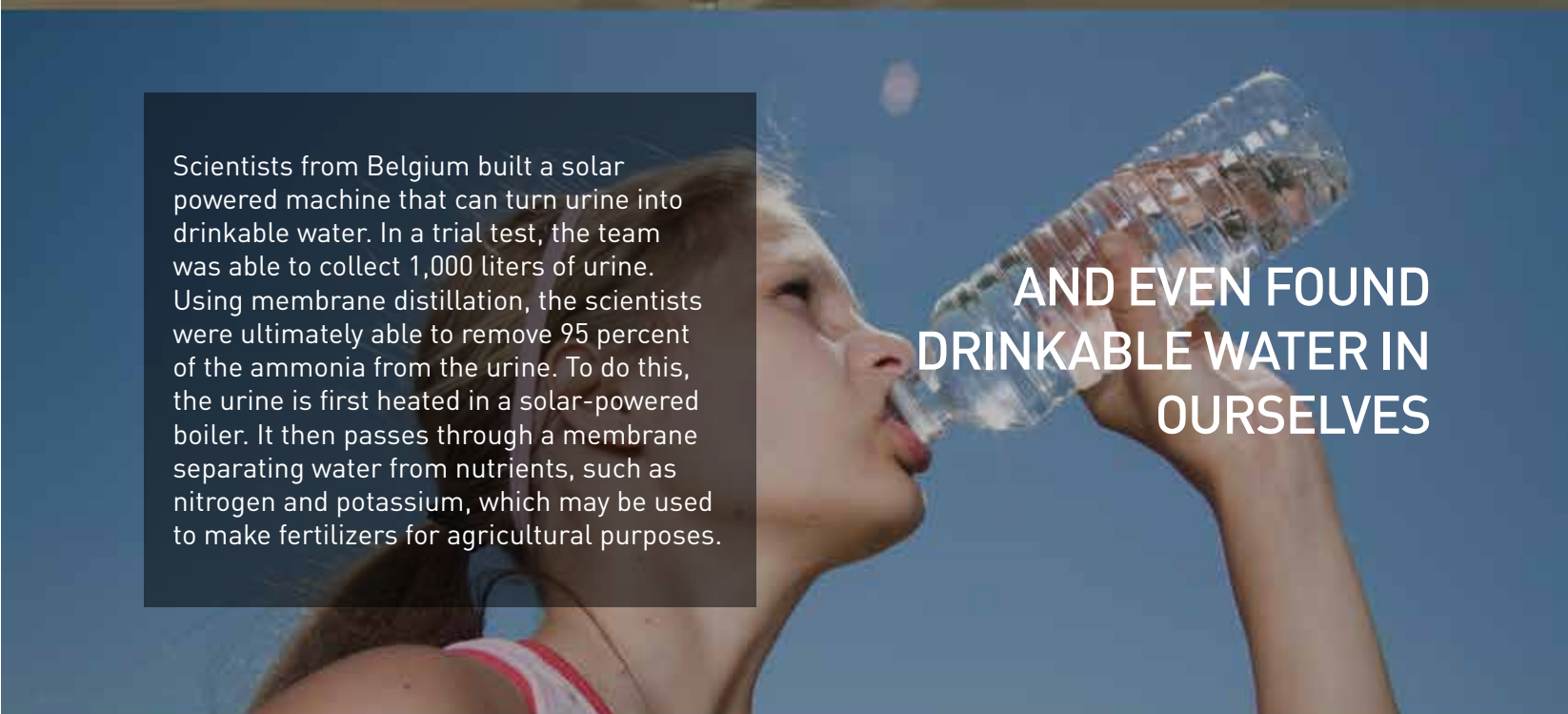
To that end, the 18-year-old found a way to genetically modify microorganisms so that they could clean the wastewater and generate electricity at the same time. If proven effective, it is estimated that this method could generate up to 600 gigawatts of energy from waste biomass.

According to BC Hydro and Power, an electric company in Canada, an average household in the province uses around 900 kilowatt-hours per month. To that end, Wang's idea could provide power to a number of houses and give us a new solution to our water shortages. Whether or not his system will actually be implemented remains to be seen, but it is an inspiring idea.



WE FOUND A WAY TO GENERATE DRINKABLE WATER FROM A COMPUTER

A prototype of Watly, a 15-ton thermal dynamic computer, could be the key to resolving major developmental challenges in Africa — namely, access to clean water, electricity, and internet connectivity. The Watly unit comes equipped with photovoltaic solar panels that produce heat and solar power. Water is then pumped into its tank, and the device produces clean water following a vapor compression distillation process — a method that employs solar thermal energy to vaporize water and segregate contaminants (from sea salt to poisons). A single machine can purify up to three million liters of water annually and has a lifespan of up to 15 years.



Scientists from Belgium built a solar powered machine that can turn urine into drinkable water. In a trial test, the team was able to collect 1,000 liters of urine. Using membrane distillation, the scientists were ultimately able to remove 95 percent of the ammonia from the urine. To do this, the urine is first heated in a solar-powered boiler. It then passes through a membrane separating water from nutrients, such as nitrogen and potassium, which may be used to make fertilizers for agricultural purposes.

AND EVEN FOUND DRINKABLE WATER IN OURSELVES



CHRISTOPH GORDER ON INFRASTRUCTURE

When it comes to water access and distribution, financing is the biggest challenge we face. It is a serious issue for big cities that grow up quickly in the developing world without proper infrastructure; however, it's also a challenge in cities like London and the United States,

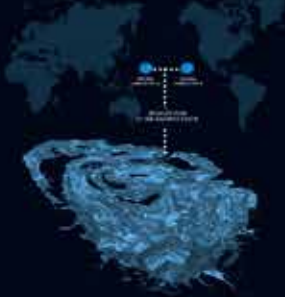
where the infrastructure is old. So to that end, in terms of water distribution, I would say financing is really where we need some new ideas or innovations, as the engineering is quite understood.

Oceans of Plastic

CAN WE CLEAN UP OUR MESS?

Plastic is an indispensable part of our modern civilization—but its outsized impact on the environment is having unexpected consequences for our planet and its future. Here's a look at the problem confronting us and some potential solutions.

NORTH PACIFIC GARBAGE PATCH



The North Pacific Garbage Patch is an immense gyre of microscopic marine debris floating in the northern Pacific Ocean. Estimates of its extent range from the size of Texas to twice the size of the continental United States.

A GLOBAL PROBLEM

GLOBAL MARINE POLLUTION



80% FROM LAND-BASED RESOURCES

GLOBAL MARINE POLLUTION



60% - 95% IS PLASTIC DEBRIS

MARINE PLASTIC DEBRIS



70% SINKS TO THE BOTTOM OF THE OCEAN

PROPOSED SOLUTIONS

THE OCEAN CLEANUP PROJECT



Ocean currents bring debris to the V-shaped array

Floating barriers, not nets, collect debris without entangling wildlife

The array funnels material into a central collection point

The biggest passive ocean cleaning effort to use technology to clean up and intercept future pollutants.

BRIDGES PROJECT



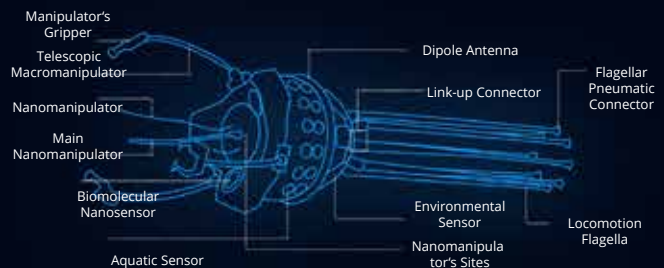
Underwater gliders able to reach up to 5,000 meters below the surface to monitor pollution and map the ocean floor.

PLASTIC MUNCHING MICROORGANISMS



Engineering organisms to consume plastics and other waste.

GRAPHENE COATED NANOBOTS




Can clean up to 95% of waste from water.



NEW TECHNOLOGIES ALLOWED US TO PROTECT OUR OCEANIC ECOSYSTEMS

Coral reefs are home to many species and protect coastlines from waves and tropical storms, but they are in danger of disappearing as a result of climate change. This year, the Caribbean island of Bonaire printed pieces of artificial coral that bear the same shape, texture, and even chemical makeup as organic coral in order to attract floating baby coral polyps and other species that rely on coral reefs for protection, including algae, crabs, and other fish species. In doing so, they made great strides toward reversing the negative effects of climate change.



In a spectacular victory for conservationists, in September 2016, President Barack Obama created the Atlantic Ocean's first United States marine monument, banning oil and gas exploration as well as drilling. In so doing, he preserved an expanse of water off the New England coast that is roughly 8,800 square kilometers in size, increasing the amount of protected ocean habitat off of the continental United States by 20 percent.

AND WE HELPED ENSURE OUR MOST PRECIOUS RESOURCE IS STILL AROUND FOR FUTURE GENERATIONS



**JOHN LIENHARD
ON SENSORS**

One of the most important ways that we can improve water conservation and water use efficiency — and provide more drinking water to the people — is through sensors that enable us to better localize leaks and problems in water distribution systems. Unfortunately, many systems around the

world leak 20 to 50 percent of the water initially put into the pipe. New sensors help guide the end user to improved efficiency locally, and such sensing technologies also help improve the efficiency and management of the entire piped network.

THE TIMELINE

2022



Nature and Tech Unite for Clean Water

"Cameras are already looking at the movements of fish. If the fish alter their habits, the computer will eventually be able to analyze this and raise an alarm. So fish and computers will work together to help provide secure drinking water.

Callum Clench

2020

Hyper-Efficient Water Quality Testing

"Consumers are going to have real-time access to data about the water quality in their house. Currently, we can send the water away for testing, but new technology will allow everyone to know what they are drinking.

Christoph Gorder



2025



Half of the Great Pacific Garbage Patch Cleaned

The Ocean Cleanup project is developing advanced technologies to rid the world's oceans of plastic. One passive system could theoretically remove about half the Great Pacific Garbage Patch in 10 years.

2025

Closed-Loop Water Recycling

"One thing we're already seeing in urban environments is aquaponics. We have some closed-loop systems where all the water is recycled. By the mid-2020s, these will become more commonplace and we will start reusing all our water.

Callum Clench



2030



Dramatic Increase in Water Quality

China recently announced an action plan that includes a list of measures to tackle water pollution, with the aim of improving the quality of the water in our environment and removing pollutants by 2030.

2025

We Mine Water From Space

According to Planetary Resources, by the mid-2020s, we will likely be mining asteroids and getting our water from sources beyond the bounds of Earth.



2030



Water Becomes Most Valuable Resource

Experts report that, due to the continued increase in population, water will likely become a more significant source of contention than energy or minerals in 15 years.

2030

Most of the World's Seafloor Finally Mapped

The General Bathymetric Chart of the Oceans, an organization that is affiliated with the UN, hammered out an ambitious plan to map most of the world's seafloor in the next 15 years, allowing us to understand our water as never before.



2032



Vertical Farming Decreases Our Water Demand

"With the limited space that we will have in megacities around the world, vertical farming will really take off, and those vertical farms will probably have closed-loop systems to recycle all of their water, which will decrease water demands for our agriculture.

Callum Clench

2034

International Clean-Water Economy

"We are going to see the developing world come online with a lot of growth in the middle classes, we'll see a growing demand for clean water, and most notably, we will see a growing economic capacity for it.

Christoph Gorder



2035



Genetics Breakthroughs Revolutionize Our Water Use

The NIC claims that, in the next 20 years, breakthroughs in molecular biology and genetics will allow us to produce crops that are no longer threatened by droughts.

2040

Ice Vanishes From the Arctic Ocean

Satellite images taken since 1979 show that ocean ice cover in the Arctic region has declined steadily, with an estimated 61,000 square km being lost every year. Computer models predict that sea ice could vanish from the Arctic ocean completely as early as 2040.



2040



Global Individual Access to Clean-Water

"We will see a lot of growth and innovation in household treatment and access to clean water around the world. By this point, we will reach every single person on the planet and give them access to clean water from a protected source.

Christoph Gorder

2046

Cost-Effective Desalination Techniques

"We'll have figured out cost-effective ways to use desalination processes at scale. More than 96% of our water is saline water in the oceans. So there's an enormous amount of water on the planet, but it would be very difficult and expensive for us to try to use it today.

Christoph Gorder



2050



More Plastic Than Fish

By 2050, the World Economic Forum asserts that, if we keep producing (and failing to properly dispose of) our trash at current rates, plastics in the ocean will outweigh fish pound for pound.

2050

Worldwide Water Conflict Ends

As a result of cost-effective desalination techniques and water purification systems, global conflicts over water resources will be eradicated.





THIS YEAR IN Transport

Who we are is often defined by how far we go. But traveling in the modern age is about much more than the destination or the mode of transport — it's about venturing farther than ever before using less power than we ever dreamed and doing so safely.

THIS YEAR IN TRANSPORT

In 2016, a host of innovators created inspiring technologies that allow us to go faster, reach farther, and live greener lives. With advancing solutions in driverless cars, rural medical deliveries, and drones that function as car-plane hybrids, we acquired safer transportation methods that could help save lives. Thanks to developments in electric and hydrogen fuel cell technologies, we reduced carbon emissions, helped curb climate change, and raced into the next generation of transport.

BY THE NUMBERS

85,000

TESLAS BUILT IN 2016

230M+ km

DRIVEN ON AUTOPILOT

70

COUNTRIES WITH UBER

460,000+

DRONES APPROVED BY FAA

1,200 km/s

HYPERLOOP SPEED

EXPERT CONTRIBUTORS



Jackie Birdsall

Senior Engineer

Toyota Motor Engineering

Jacquelyn Birdsall is a Senior Engineer at Toyota Motor Engineering, specializing in hydrogen infrastructure, high pressure hydrogen systems, and associated codes and regulations. Birdsall is currently on assignment at the Toyota headquarters in Japan, supporting the development of the next generation fuel cell vehicle.



Andreas Raptopoulos

Founder and CEO

Matternet

Andreas Raptopoulos is a designer, inventor, and entrepreneur. He is working to launch a new paradigm for transportation using networks of Unmanned Aerial Vehicles, which could push us forward in our medical transport networks.




Ari Teman

Founder


Founder of FutureNYC

Ari Teman is known for co-creating FutureNYC—a plan for NYC to incorporate automated cars and give roads back to humans. Ari is also the CEO and founder of several companies that deal with data in the healthcare and internet security sectors.

A long, thin solar-powered aircraft with a dark blue body and white wings, flying against a clear blue sky with a bright sun in the upper left corner.


WE MADE PLANES THAT ARE POWERED BY THE SUN

For the first time in history, a solar-powered plane circumnavigated the world, revealing the remarkable potential of renewable energy. The plane, known as Solar Impulse 2, has more than 17,000 solar cells on its wings and is wider than a Boeing 747. It began its journey in March of 2015 and completed its journey in August of this year, using absolutely no fossil fuels.

A sleek, white electric aircraft with long, thin wings and a pointed nose, flying against a dark blue background.

NASA started building an all-electric plane called the X-57, nicknamed "Maxwell." It has long, thin wings that are lined with 12 electric motors and two larger engines on each wing tip. Once complete, the aircraft will be able to operate on battery power alone. NASA asserts that an electrically powered plane will reduce noise, fuel use, and emissions, leading us into a new era in aviation.

AND PLANES THAT ARE POWERED BY ELECTRICITY

A small, white, windowless aircraft with a propeller, shown in a dark environment with a glowing green and yellow light source behind it.


AND IN OUR QUEST TO CONQUER THE SPACE, WE EVEN PRINTED PLANES

Airbus, a leading aircraft manufacturer, unleashed THOR, a miniature aircraft constructed from 3D-printing technology. The windowless, pilotless, and propeller driven THOR weighs in at 21 kg and measures less than 4 meters long. Since it is lighter than most aircrafts, it requires less fuel, reducing the amount of carbon emissions and other pollutants that are released into the environment. As air traffic is expected to double in the next 20 years, reducing our carbon footprint is a priority.

A sleek, blue and white flying car, the Aeromobil 3.0, is shown in flight against a blurred background of a building with large windows.

WE GAVE WINGS TO AN OLD FRIEND

In August, Aeromobil, an advanced technology company in Slovakia, revealed the latest model of their flying car: Aeromobil 3.0. As a car, it fits into any standard parking space, uses regular gasoline, and can be driven on the road just like any other car. As a plane, it can use any airport in the world, and it can also take off and land using any grass strip or paved surface that's a few hundred meters long. The Aeromobil 3.0 is set to go commercial in 2017.

A blue Google self-driving car is shown on a road. The car has a yellow sensor dome on its roof and the text "self-driving car" on its side.

The National Highway Traffic Safety Administration (NHTSA) released a letter to Google stating that their driverless car system could meet the requirements necessary to be recognized as a legal driver. The note from the NHTSA came in response to a petition filed by the director for Google's autonomous driving car project, Chris Urmson. This is a big victory for autonomous vehicles as the government moves toward legalizing driverless cars.

AND REALIZED THAT OUR TECHNOLOGIES SHOULD BE ABLE TO THINK FOR THEMSELVES



JACKIE BIRDSALL ON QUALITY OF LIFE

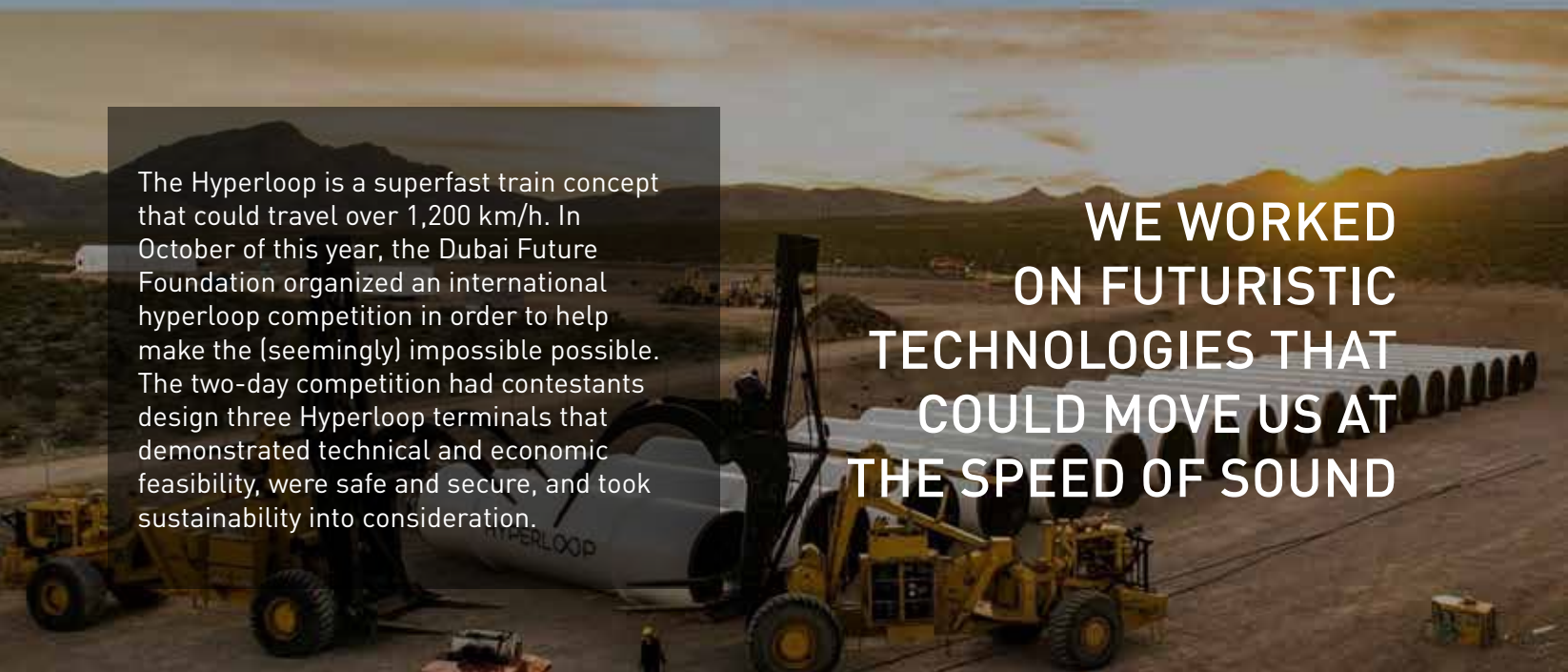
“We are facing an aging population in a society built around personal mobility. We are also aware of the damage we cause our environment by burning fossil fuels. Addressing these issues will take innovation and determination.

Luckily, we have great momentum through the introduction of electric vehicles, both battery and fuel cell, and the increased autonomy of vehicles to create a society that not only maintains, but improves, our quality of life.



WE BROUGHT MEDICAL SUPPLIES TO THOSE IN NEED

Zipline, a San Francisco-based startup, began using drones to deliver medicine and blood to patients in Rwanda in April of this year. Since Rwanda has a very poor infrastructure, this work could save many lives. Following this, in August, Zipline announced that they were set to begin testing their drone delivery system to deliver medical supplies to remote areas of the United States.



The Hyperloop is a superfast train concept that could travel over 1,200 km/h. In October of this year, the Dubai Future Foundation organized an international hyperloop competition in order to help make the (seemingly) impossible possible. The two-day competition had contestants design three Hyperloop terminals that demonstrated technical and economic feasibility, were safe and secure, and took sustainability into consideration.

WE WORKED ON FUTURISTIC TECHNOLOGIES THAT COULD MOVE US AT THE SPEED OF SOUND



ARI TEMAN ON PUBLIC TRANSPORT

Because of new forms of transport, cars are going to start to disappear. You're not going to see streets used for parking; you're going to see them used for walking and biking.

As that happens, you're going to see the physical layout of the cities moved back to a communal-focused infrastructure. You're no longer going to design cities for cars, but for the people.

AT LONG LAST, WE LET OUR CARS DRIVE US

As part of their bid to build a transportation technology empire, Uber launched partially self-driving taxis in September of this year. A fleet of them started rolling along the streets of Pittsburgh, and passengers who took a ride in the experimental self-driving cars got their trip for free.

Notably, since this was a first-ever trial, an engineer had to be in the driver's seat to get things started and issue corrections if the car made a error. However, despite that, the car was actually doing the driving; humans were just needed for oversight.

Passengers entered all of the trip details through a touch screen located in the backseat of the taxi, and a liquid-cooled computer was also onboard, recording trip and map data.

Notably, Uber plans to install self-driving kits into existing vehicles rather than build fully autonomous cars from the ground up. To that end, in August, Uber acquired Otto, a company that retrofits heavy-duty freight haulers on the highway in order to turn them into self-driving trucks.

Otto's LIDAR (light detection and ranging) sensor technology detects infrared emissions to help monitor speed, and it will be adapted for use in Uber's autonomous vehicles.

UBERATC.COM

DRIVING INTO THE FUTURE

THE TECHNOLOGIES THAT POWER SELF-DRIVING CARS

GPS

Accurate to within 1.9 meters, it pinpoints the macro location of the car; combined with readings from tachometers, altimeters and gyroscopes it provides more precise positioning.

STEREO VISION

Two windshield-mounted cameras create real-time 3D images of the road ahead, looking for potential hazards.

LIDAR

Ranging system comprising 64 lasers emits pulses of light to take in 360° view of surroundings, identifying nearby objects and obstacles with an accuracy of up to 2 cm.

LANE GUIDANCE

Cameras behind rear-view mirror focus on lane markings and distinguish between road surface and boundary lines.

RADAR

Detects obstructions in car's blind spots; serves as accident-prevention system that triggers alerts.

INFRARED CAMERA

Infrared beams emitted from headlamps and picked up by camera extend vision for night driving, producing illuminated image in dashboard display.


CENTRAL COMPUTER

Analyzes all information from the sensors; processes and translates data on-the-spot to control and adjust steering, accelerating and braking in response to real-time driving conditions.

ULTRASONIC SENSORS

Rack and measure positions of objects very close to the car like curbs and sidewalks, as well as other cars when parking.

Sensors on wheels take measurements of car velocity as it drives and maneuvers through road traffic.

A large, white, four-rotor passenger drone with a glass cockpit is shown in flight against a blue sky background.

The first passenger drone that has the ability to autonomously fly humans was approved for testing in Nevada. Ehang unveiled their electric passenger drone, Ehang 184, at CES in January 2016. Subsequently, they partnered with the Nevada Institute for Autonomous Systems and the Governor's Office of Economic Development to put the drone through testing and regulatory approval, which was obtained in June.

TAXIS TOOK TO THE SKIES

A person wearing a large, complex jetpack is shown in flight against a blue sky background.

AND WE GAVE HUMANITY WINGS

Jetpack Aviation entered talks with the U.S. Special Forces in June for the development of a militaristic jetpack. The company obtained a research and development agreement with the U.S. Special Operations Command for the development of a four turbine jetpack that can lift 317 kg, which is twice the weight of their current models.



ANDREAS RAPTOPOULOS ON AUTONOMOUS VEHICLES

“The biggest proliferation created out of “small computing” — or computing technologies that are very affordable — are capabilities for controlling vehicles autonomously, and multiplying those capabilities at a fraction of the price that we could do it before.

There has been a thousand-fold decrease in the price of drone systems that can fly all by themselves. This year, we saw amazing new self-navigating capabilities, and it's all thanks to cheap computing.

THE TIMELINE

2020



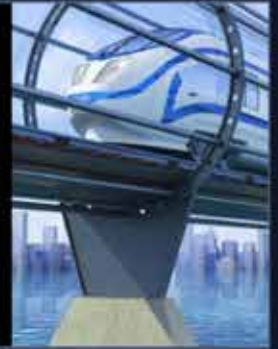
Uber Uses Vertical Takeoff Planes

Uber products head Jeff Holden has said he believes the company could have a flying rideshare option in service by the end of the decade.

2020

The First Hyperloop Is Ready for Use

According to Chris Vasquez, the director of product development for Hyperloop One, the company's hyperloop system could be in place in Dubai as soon as 2020.



2021



Uber and Volvo Release Their Fully Autonomous Car

The two companies have signed a pact to develop a fully autonomous car that will be ready for the road by 2021.

2021

Lyft No Longer Employs Human Drivers

Lyft president John Zimmer predicts that a majority of Lyft's fleet will be autonomous and completely driverless by the year 2021.



2025



Mainstream Aerial Delivery System

"Drones are going to be a significant portion of on-demand delivery for e-commerce. If you think about the numbers today, lightweight e-commerce accounts for 35 percent of the traffic. So these packages will ship through the air and free our roads.

Andreas Raptopoulos

2025

Americans No Longer Own Cars

Experts predict that personal ownership of cars will be a thing of the past, at least in America, by 2025.



2028



Flying Cars Are Available for Purchase

Terrafugia plans to have its fully autonomous flying TF-X ready for release by 2028. This is a car and a plane all in one.

2025

Renewables Take Over Transport

"In the next 10 years, we're going to see big rigs and heavy industry go electric and renewable. And we're not going to see streets used for parking; you're going to see them used for walking and biking.

Ari Teman



2028



Big Data Breakthroughs in Transport

"We are in a race to solve complex problems created by a century of fossil fuels and an aging society reliant on personal mobility. However, we are collecting an unprecedented amount of data, and we will innovate a new, smart mobile society.

Jackie Birdsall

2030

A New Generation of Aeroplanes

Hypersonic airliners with a cruising speed of 6,100 km/h (Mach 5) and excellent fuel efficiency enter widespread commercial use.



2035



Roads are Made in a Factory

"Our cities will largely be made in a factory. A truck comes in, marks the section of street that needs to be replaced, and lifts up that section. We will have a sort of Lego system for transport in our cities and towns.

Ari Teman

2036

Autonomous and Electric Car Revolution

"Most of the cars on the road will be autonomous, most of the cars on the road will be electric, and I would expect that someone who wants to drive their own car will be the exception to the rule as opposed to the mainstream user.

Andreas Raptopoulos



2036



Air Travel Is Free of Turbulence

Brian Tillotson, a senior technical fellow at Boeing, has said the company is developing tech that could lead to turbulence-free flights in the next 20 years.

2040

No One Will Own a Car

"We are going to see a demand for public transportation. We're going to see more shared vehicles, and in 25 years, nobody's going to own a car. You're going to use a shared car, and in fact, it's going to become a public service.

Ari Teman



2050



Passengers Fly Aboard Planes With Transparent Cabins

Airbus has predicted that planes in 2050 will have "intelligent" cabin wall membranes that passengers can see through.

2050

Point to Point Transport

According to Virgin Galactic CEO companies and government agencies will likely have tackled the technological challenges that will enable point-to-point rocket transportation.





THIS YEAR IN Technology

Technology allows us to extend our reach and remake the world around us. Thanks to remarkable advances in things like artificial intelligence, robotics, 3D printing, and computing, the face of technology is changing rapidly, and human progress is along for the ride.

THIS YEAR IN TECHNOLOGY

3D printing became more accessible than ever, allowing us to create affordable structures and cutting-edge prosthetics. Simultaneously, advances in artificial intelligence opened new doors in our understanding of the human mind (and the human body), while new uses for AR/VR helped the legally blind see, Olympic athletes train, and individuals secure justice.

BY THE NUMBERS

40%
OF WORLD WITH INTERNET

455,772
3D PRINTERS SHIPPED

93 PETAFLUPS
FASTEST SUPERCOMPUTER

1 NANOMETER
WORLDS SMALLEST COMPUTER

6.4 BILLION
NUMBER OF IOT DEVICES

EXPERT CONTRIBUTORS



Alex Lightman

Chairman of the Board
Everblaze

Alex Lightman serves as Chairman of the Board at Everblaze, a solar photovoltaic systems company he co-founded. Alex has also been involved in international policy and diplomacy, having organized over 17 international conferences with engineers, scientists, and government officials. He is currently completing a national innovation plan for the U.S. government.



David Orban

Founder & Managing Partner
Network Society Ventures

David Orban is an entrepreneur and global technology analyst. He was previously the CEO of the technology platform and services company Dotsub and helped found WideTag, a tech company providing infrastructure necessary for an open internet. He is also a faculty member at Singularity University.



Samuel Cassatt


Chief Strategy Officer
ConsenSys

Sam Cassatt is a key figure at Consensusys, a venture production studio building decentralized applications. Previously, he served as the Principal Design Engineer of Sensorstar Labs, where he designed, managed, and implemented backend code for a mobile app serving more than 100,000 users.



WE PRINTED ROBOTS THAT COULD SAVE OUR LIVES

Engineers developed the first Single Actuator Wave-like robot that can move forward or backward in a snake-inspired, wave-like motion. This movement allows the 3D-printed robot to overcome unstable terrain, traverse rubble, and even swim. It is five times faster than similar robots and can climb easily through tunnels, even when it is touching both sides. These SAW robots can be used for search and rescue missions, specifically those following natural catastrophes.



Dubai installed the world's first 3D printed office building. The 250-square-meter space houses Dubai's Museum of the Future and is made of an innovative cement mixture. The structure took just 17 days to print and two days to install. The process saved up to 50 percent in labor costs, with only one worker required to supervise the printing process, seven workers to install the building, and 10 electricians and mechanics to manage specialized connections and equipment.

WE PRINTED OFFICES THAT COULD CHANGE HOW WE WORK



AND OUR CHILDREN EVEN PRINTED NEW BODY PARTS

Calramon Mabalot, a nine-year-old child from San Diego, built a mechanical hand with fully articulated fingers for his local high school teacher. For the project, he used a downloadable open-source code, 3D printed the necessary parts, and assembled the hand himself. Thanks to the tech, the teacher is even able to write and draw now.

WE MADE ARTIFICIALLY INTELLIGENT SYSTEMS THAT DIAGNOSE OUR DISEASES

IBM's artificial intelligence system, Watson, saved the life of a Japanese woman by correctly identifying her disease. For some time, her illness went undiagnosed using conventional methods, and doctors were stumped. Watson looked at the woman's genetic information and compared it to 20 million clinical oncology studies. After doing so, it determined that the patient had an exceedingly rare form of leukemia. The AI's positive identification allowed doctors to develop a treatment for the woman in question, ultimately saving her life.

The AI can review huge numbers of records and medical images far faster than humans can, and they are less subject to errors. To that end, experts agree that one of the greatest areas of potential for AI is in support of healthcare professionals.

Satoru Miyano, a professor at the University of Tokyo's Institute of Medical Science, noted the significance of Watson's work: "Watson's solid detection and treatment solution to this is a proof that the AI is really changing the world." Seiji Yamada, professor at the National Institute of Informatics and chairman of the Japanese Society for Artificial Intelligence, added, "This is the first time in the history of the nation when an AI system has saved a human life." He also said that "in the field of the medical and healthcare, this is the most practical application for artificial intelligence."

We saw similar advances in AI in other nations. For example, in the United States, AI is in use to support treatment procedures for leukemia and brain tumors.



**ALEX LIGHTMAN
ON 5G TECHNOLOGY**

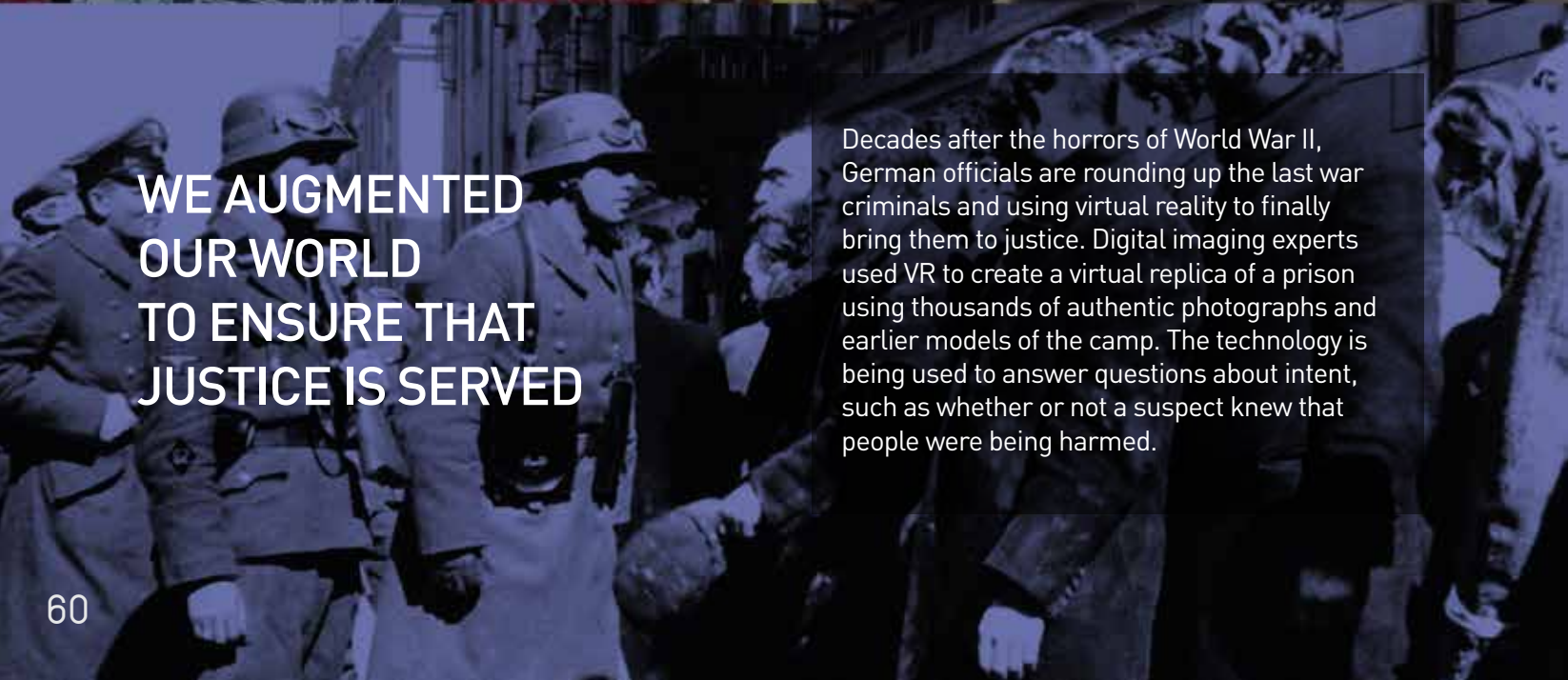
5G technology will make it a lot easier for us to transmit video through our eyes so that we can see what other people are seeing. We'll have 6 billion people who can really walk a mile in each other's moccasins, and

they will be able to see what other people are seeing in real time. And that will give us empathy, as well as a sense of what's going on. So we'll care as much about our neighbors as we do about ourselves.



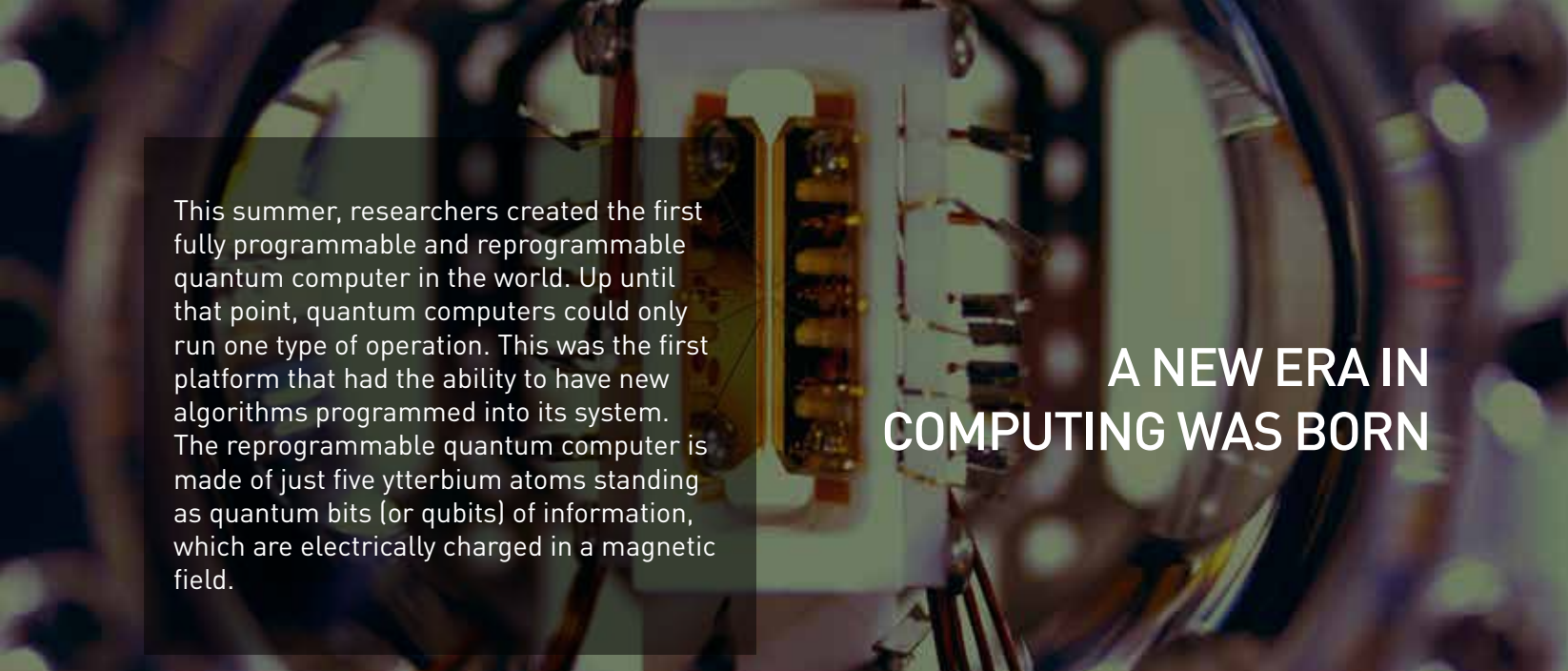
Jamie Soar is legally blind due to a condition known as retinitis pigmentosa. He lives with various optical disabilities, and in low light, he must navigate using a cane. However, after putting on a virtual reality headset loaded with a demo, Soar was able to see clearly. This is because the VR headsets, along with the images they are flashing, are uniquely designed to be able to trick the eyes, creating a sense of depth that Jaime is otherwise missing.

**VIRTUAL REALITY
PRESENTED US WITH
A POSSIBLE END
TO BLINDNESS**



**WE AUGMENTED
OUR WORLD
TO ENSURE THAT
JUSTICE IS SERVED**

Decades after the horrors of World War II, German officials are rounding up the last war criminals and using virtual reality to finally bring them to justice. Digital imaging experts used VR to create a virtual replica of a prison using thousands of authentic photographs and earlier models of the camp. The technology is being used to answer questions about intent, such as whether or not a suspect knew that people were being harmed.



This summer, researchers created the first fully programmable and reprogrammable quantum computer in the world. Up until that point, quantum computers could only run one type of operation. This was the first platform that had the ability to have new algorithms programmed into its system. The reprogrammable quantum computer is made of just five ytterbium atoms standing as quantum bits (or qubits) of information, which are electrically charged in a magnetic field.

A NEW ERA IN COMPUTING WAS BORN



AND OUR COMMUNICATIONS STARTED TO BECOME HACK-PROOF

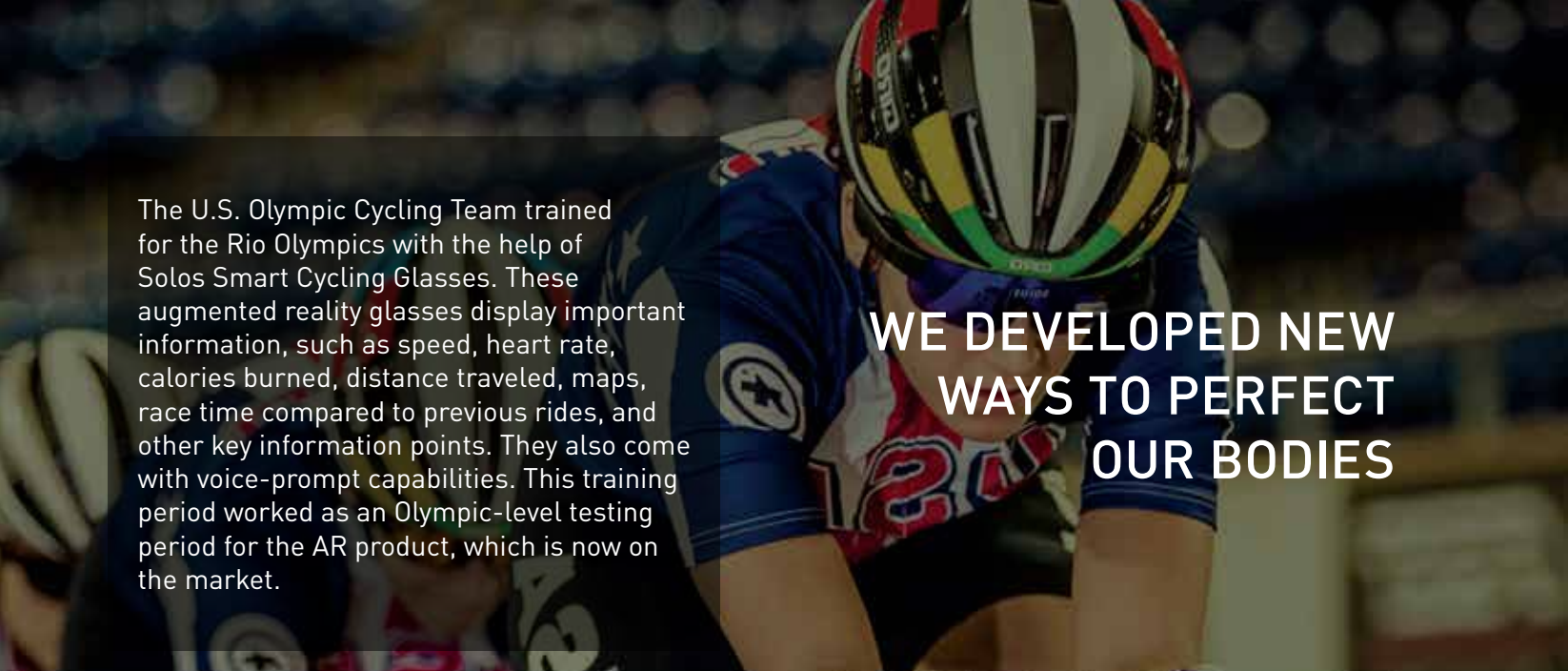
The coming dawn of the quantum computer has brought with it fear, but this year, China launched the world's first quantum satellite, which was designed to demonstrate a series of advanced technologies, such as hacker proof communications. A quantum computer could theoretically be powerful enough to crack every encryption method currently in use. The solution would be quantum networks (networks that rely on the fragile quantum state). Any attempt to copy, clone, or even measure the quantum state of a particle would result in a change in that state, erasing the information in the process. This technological advance is thought to be the key to a global quantum network.



**DAVID ORBAN
ON TECHNOLOGY**

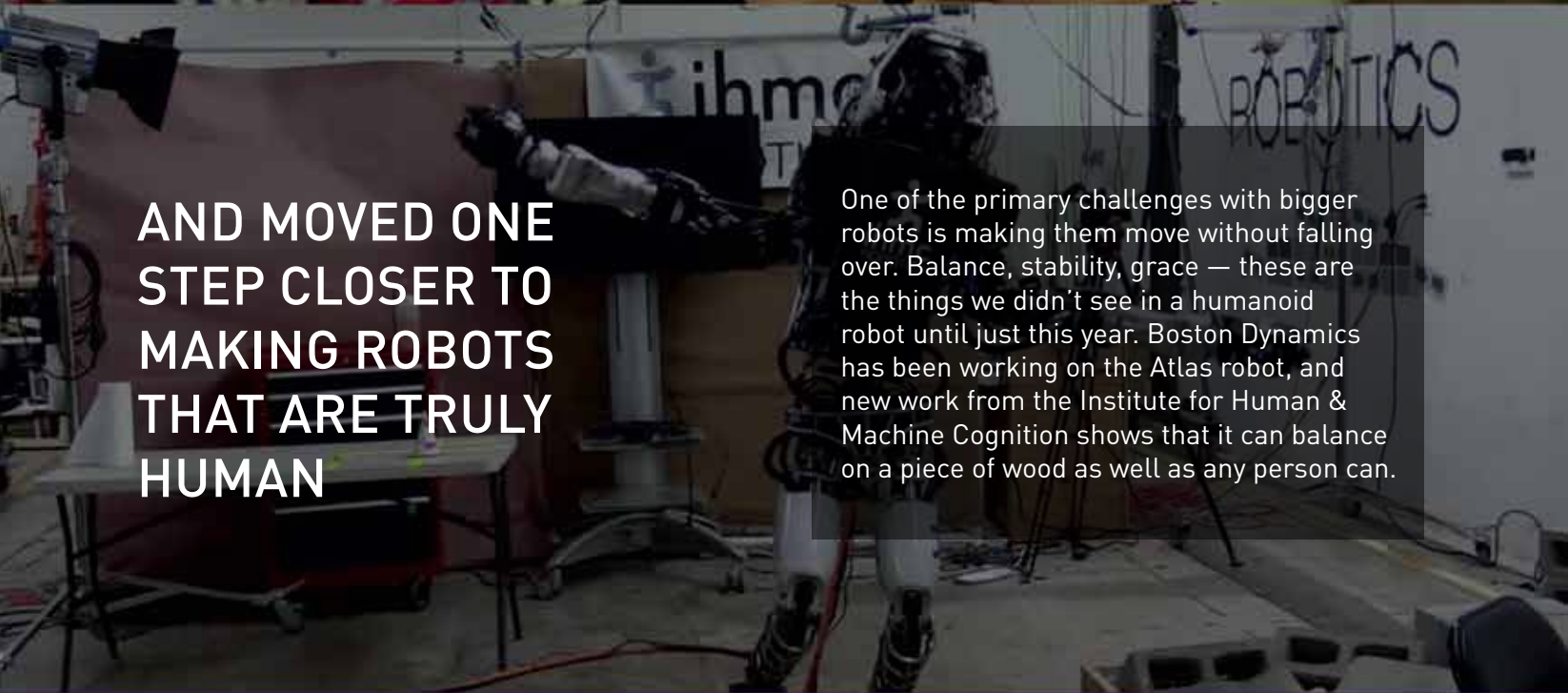
Everybody has to understand that technology is a positive thing. We have a 100,000-year history to show that technology is a positive force in our evolution. Of course, this is a statistical mean. There are fluctuations, and there are disasters, accidents, missteps,

false starts—but at the meta level, these tools help us along, and we can be empowered by them. We just need to move forward and continue to focus on the useful and fruitful futures.



The U.S. Olympic Cycling Team trained for the Rio Olympics with the help of Solos Smart Cycling Glasses. These augmented reality glasses display important information, such as speed, heart rate, calories burned, distance traveled, maps, race time compared to previous rides, and other key information points. They also come with voice-prompt capabilities. This training period worked as an Olympic-level testing period for the AR product, which is now on the market.

WE DEVELOPED NEW WAYS TO PERFECT OUR BODIES



AND MOVED ONE STEP CLOSER TO MAKING ROBOTS THAT ARE TRULY HUMAN

One of the primary challenges with bigger robots is making them move without falling over. Balance, stability, grace — these are the things we didn't see in a humanoid robot until just this year. Boston Dynamics has been working on the Atlas robot, and new work from the Institute for Human & Machine Cognition shows that it can balance on a piece of wood as well as any person can.

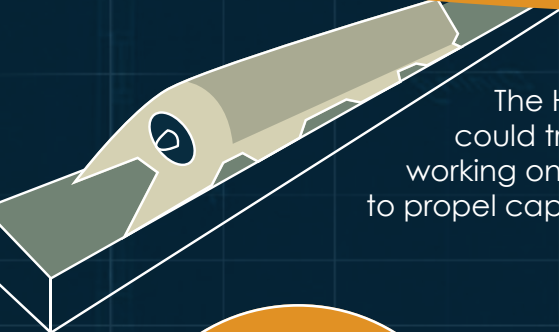


SAM CASSATT ON ARTIFICIAL INTELLIGENCE

There are jobs that are going to change because of artificial intelligences, and we're definitely going to have some restructuring of the labor force. If you look at the Industrial Revolution as an example, people thought, "Well, what am I going to do with all my free time now that machines will do everything?"

Of course, that wasn't the case. Instead, what happened was that people with the capital to buy the machines were the ones who benefitted from this, and I think that's one trend we'll see with AI — the people who can afford them are the ones who really benefit.

AN INTRODUCTION TO THE HYPERLOOP



The Hyperloop is a high-speed transportation system that could travel over 1,200 km/h. A number of nations are currently working on the technology, which uses partially vacuumized tubes to propel capsules along a cushion of air.



THE IDEA

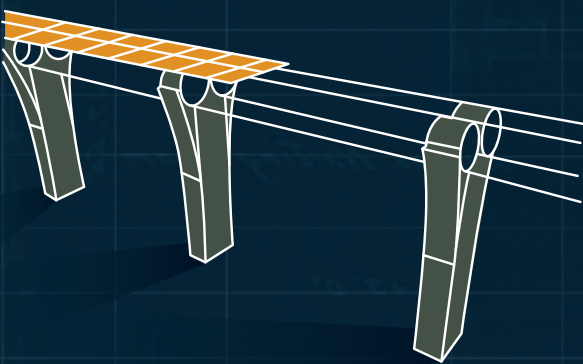
Elon Musk, the CEO of SpaceX and Tesla, first mentioned this "fifth mode of transport" in July 2012, naming it the Hyperloop. He noted that such a technology would be immune to weather, never crash, and be twice as fast as a typical jet.

VACTRAIN CONCEPT

The vactrain concept could eliminate the problems of friction and air resistance by magnetically levitating trains in airless (or partially airless) tubes and tunnels, but the high cost and difficulty of maintaining a vacuum over long distances has prevented this system from being built. The Hyperloop concept is similar to a vactrain system, but operates at approximately one millibar (100 Pa) of pressure.



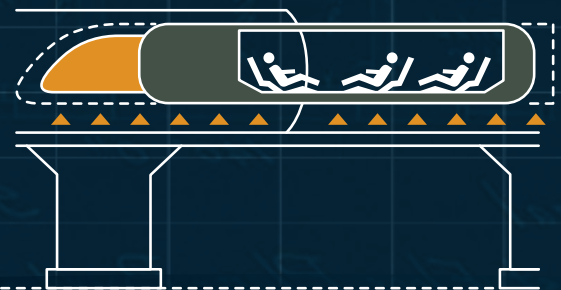
DESIGN



The Hyperloop will use passenger and cargo "pods" that run through a steel tube maintained in a partial vacuum. The passenger pods will be 2.23 metres in diameter and are projected to reach a top speed of 1,220 km/h.

OPERATION

Linear induction motors located along the tube would accelerate and decelerate the capsule, with the capsules theorized to glide for the bulk of the journey. An inlet fan and air compressor would be placed at the nose of the capsule to transfer high pressure air from the front to the back of the vessel; there will be no sonic boom even at Mach 1 speeds due to the warm, low-pressure air inside the tubes.



THE TIMELINE

2020



The AR/VR Market Reaches \$150 Billion

According to Michael D. Gallagher, President and CEO of Entertainment Software Association, the AR/VR industry is drawing millions of dollars in investments and will be a \$150 billion market by 2020.

2020

Drones Replace Soldiers as Primary Ground Troops

Armed quadcopters and microtanks will largely replace human soldiers on the front lines. At first they will be piloted, but overtime they will be granted the ability to make kill decisions on their own.



2025



Virtual Reality Is Independent of Computer Systems

Jesse Schell, professor at the Carnegie Mellon University Entertainment Technology Center, predicts that, unlike today's Oculus and Vive, which need a personal computer to work, by 2025 VR systems will work independently of PCs.

2021

Transistors Stop Shrinking, Bringing an End to Moore's Law

A report by The Semiconductor Industry Association predicts that, within the next five years, it will no longer be economically legitimate to sustain the traditional transistor miniaturization in microprocessors.



2026



Blockchain Corporate Incorporation

"Pieces of blockchain code that are able to disperse funds and logically behave according to inputs will function like corporations, and they will behave on the timescale of seconds.

Sam Cassatt

2025

Mixed-Reality Immersion

"Within the next 10 years, attention markets will emerge as the line blurs between normal reality and mixed reality, and our world will become totally augmented.

Sam Cassatt



2030



Long-Distance Communication Doesn't Feel Long-Distance

Ray Kurzweil predicts that communication technology will be so advanced by the 2030s that two people could be hundreds of miles apart but feel like they are in the same room and even be able to touch one another.

2026

The IoT Is a Multi-Trillion Dollar Industry

The Berkman Center for Internet & Society at Harvard University reported this year that the IoT market will likely be in the trillions of dollars within the next decade, significantly changing how people interact with each other and inanimate objects.



2030



International Identification System Implemented

"The UN has a directive to give ID to everyone by 2030. They've partnered with a number of companies in the identity space to give people blockchain-based identities, which can identify you and give you access to the global financial system.

Sam Cassatt

2036

Everyone Has a Robot

Daniela Rus, head of the Computer Science and Artificial Intelligence Laboratory at MIT, asserts that robots will be "pervasively integrated" into daily life 20 years from now, with personal assistive robots being the norm.



2037



Quantum Computers are Widely Available

NIST asserts that advancements in engineering and our understanding of quantum mechanical phenomena will result in viable, widespread quantum computing capabilities in the 2030s.

2040

Machines Commit More Crimes Than Humans

Tracey Fellows of The Future Laboratory predicts that the increasing use of artificial intelligence in daily life will lead to machines committing a majority of crimes by the year 2040.



2042



Artificial Intelligence Executive Boards

"Capital allocation currently done by the venture capital community and private equity community can be more efficiently done by AI. We will align AI with our value systems and they will start to take over.

Sam Cassatt

2045

Half of the Global Workforce is Automated

During the annual meeting of the American Association for the Advancement of Science, research was presented that predicts that 50 percent of the workforce will be replaced by robots by 2045.



2048



Super Organisms Emerge

"There's going to be a blurring of the lines between humans, robots, and AI, and there will be a larger form of life. We'll be able to form collectives, and we will be much more merged.

Alex Lightman

2050

Smart Homes Are the Norm

Engineer Ian Pearson predicts that tech will be seamlessly integrated into our homes by mid-century, with robots cleaning and cooking for us while our furnishings automatically adapt to our body shapes and temperatures.



The background of the entire page is a composite image. The top half shows a dark blue space filled with numerous white stars of varying sizes. The bottom half shows a view of the Earth from space, with the blue atmosphere and brownish-green landmasses visible. A bright sunburst effect emanates from the horizon line of the Earth, with rays of light spreading out across the sky.

THIS YEAR IN Space

With remarkable strides being made in space exploration, astrobiology, astrophysics, and commercialized space flight, we have propelled ourselves into a new era, making great leaps towards becoming a truly interplanetary species.

THIS YEAR IN SPACE

Our voyage into the final frontier is accelerating faster than ever before. This year we traveled to the edge of our solar system with NASA's New Horizons spacecraft, and we discovered that (seemingly) dead worlds could hold the keys to alien life. We found an ocean of new alien planets, and finally found evidence of the shockwaves of supermassive collisions that shake the fabric of spacetime itself—gravitational waves.

BY THE NUMBERS

2,030
PLANETS DISCOVERED, KEPLER

39
ACTIVE NASA MISSIONS

6
REUSABLE ROCKETS LANDED

\$9 MILLION
PRICE OF FALCON 9 LAUNCH

400
ISS YEAR-ONE INVESTIGATIONS

EXPERT CONTRIBUTORS



CHRIS IMPEY

Astronomer
University of Arizona

Chris Impey is an Astronomer, Professor, and the Deputy Head in the Department of Astronomy at the University of Arizona. His research focuses on observational cosmology—using telescopes and other instruments to study the large-scale structure and evolution of our universe.



CHRIS LEWICKI

President and CEO
Planetary Resources


Chris Lewicki is an Aerospace Engineer and the CEO of asteroid mining company Planetary Resources. He also worked extensively on NASA's Mars Exploration Rovers, serving as Flight Director for the rovers Spirit and Opportunity and as the Surface Mission Manager for Phoenix.



BRIAN KOBERLEIN

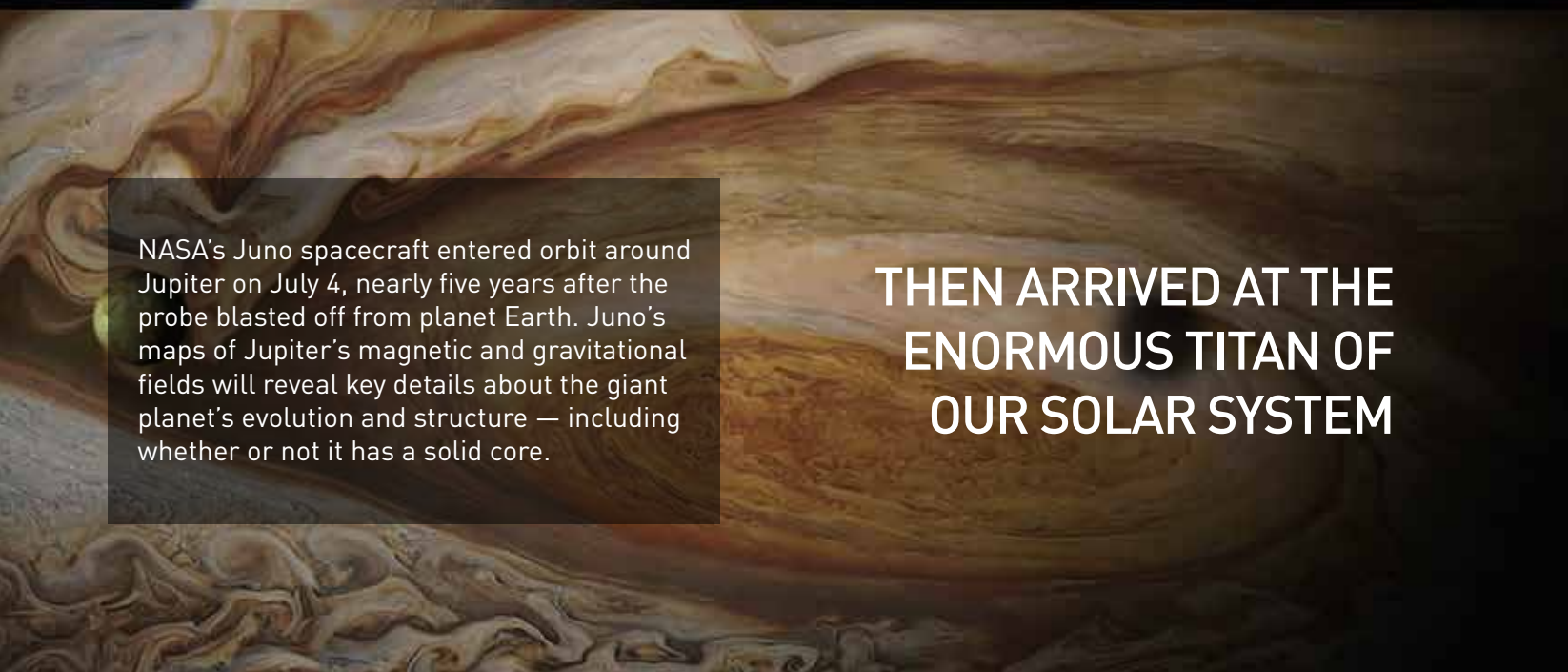
Astrophysicist
Rochester Institute of Technology

Brian Koberlein is an Astrophysicist and Senior Lecturer of Physics and Astronomy at the Rochester Institute of Technology. He is also a popular science communicator, with books published through Cambridge University Press and an astronomy website that he founded, *One Universe at a Time*.

The New Horizons spacecraft is shown in a golden-yellow hue, orbiting the dwarf planet Pluto. The planet's surface is dark and textured, with a prominent white polar ice cap. A large, dark, spherical object, likely Charon, is visible in the upper right corner of the frame.

WE BEGAN BY UNCOVERING SECRETS OF A TINY WORLD STRIPPED OF ITS TITLE

New Horizons, in its expected year-long data dump process, sends back new high-resolution images of the surface of Pluto, revealing important insights into the true nature of this small world. The photos show a multi-layered atmosphere and moving icebergs, leading some experts to argue that, based on its unique and extensive features, Pluto is really more akin to a fully fledged planet than a dwarf planet.

A close-up view of Jupiter's atmosphere, showing intricate, swirling patterns of white, orange, and brown. The Great Red Spot is partially visible on the left side of the frame.

NASA's Juno spacecraft entered orbit around Jupiter on July 4, nearly five years after the probe blasted off from planet Earth. Juno's maps of Jupiter's magnetic and gravitational fields will reveal key details about the giant planet's evolution and structure — including whether or not it has a solid core.

THEN ARRIVED AT THE ENORMOUS TITAN OF OUR SOLAR SYSTEM

A large, dark blue sphere representing the hypothetical Planet Nine is shown against a starry background. The sphere has a few bright spots on its surface, and a bright star is visible in the lower right corner.

AND WE EVEN DISCOVERED A NEW SIBLING

Astronomers set out to prove that the hypothetical Planet Nine does not exist. But they did the exact opposite. Extensive mathematical modeling and computer simulations reveal that there is, indeed, a ninth planet in our solar system. It has a mass about 10 times that of Earth and orbits about 20 times farther from the Sun than Neptune.

WE FELT THE REVERBERATIONS OF AN ANCIENT AND CATASTROPHIC COLLISION

Scientists at LIGO (Laser Interferometer Gravitational-Wave Observatory) found a “window onto the universe,” detecting gravitational waves for the first time in history. The detection stemmed from the merger of two black holes that occurred almost 13.2 billion years ago.

Experts assert that the significance of the find cannot be overstated, as it will utterly transform how we view the cosmos. “I couldn’t believe it,” noted David Reitze, Executive Director of the LIGO Laboratory, at the time of discovery. “We’re opening a window onto the universe, a window of gravitational wave astronomy.”

The detection was initially made on September 14, 2015. The ensuing months were spent grappling with the arduous task of confirming a signal that was, at first, considered too good to be true. But the researchers finally verified the findings in early 2016, and the results are unequivocally conclusive. “It was definitely not a blind injection,” said Gabriela González, spokeswoman for the LIGO Scientific Collaboration, referring to false signals occasionally injected into the data to ensure accurate detections.

Ultimately, the nature of the event was made clear by running computer simulations and finding which ones produced a signal that coincided with the September 14 event.

Notably, the signals exactly matched predictions from Einstein’s General Theory of Relativity regarding what happens when supermassive objects collide and merge. To that end, the new discovery has enormous implications, many of which will require decades to be worked out. However, its first and most important is confirming Einstein’s predictions.

While it’s an astonishing independent confirmation of the fundamental truth and power of Einstein’s equations, it also opens human understanding up to an entirely new dimension of astronomical observation. Whereas, when we looked out at the cosmos previously, we were restricted to what we could see through electromagnetic radiation, we can now observe the very ripples of spacetime itself.

GRAVITATIONAL WAVES

A NEW ERA OF PHYSICS

RIPPLES IN SPACE

On September 14, 2015, sensors at the LIGO Project picked up signals from the merging of two black holes 1.3 billion light-years away. On February 11, 2016, the announcement was made. We had finally found gravitational waves—distortions in the fabric of spacetime produced by the most violent phenomena in the universe.



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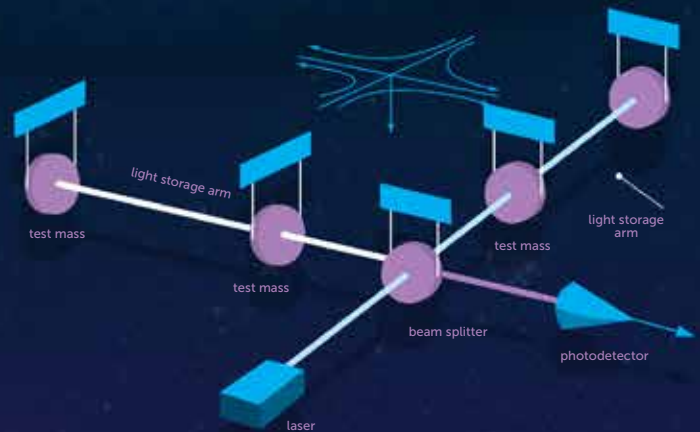
Detected: September 14, 2015

Details: Two black holes, 36 and 29 solar masses, merged 1.3 billion years ago to produce a black hole with 62 times the Sun's mass.

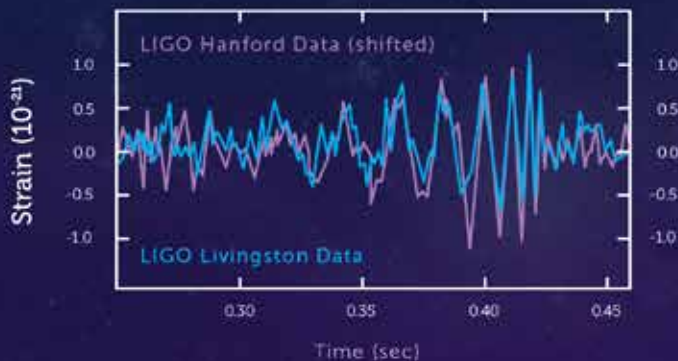
Status: Confirmed

HOW IT WAS DONE

Two LIGO observatories—in Livingston, Louisiana and Hanford, Washington—use interferometers and beam splitters to detect gravitational waves. Laser beams are split and then recombined. An event is detected when the passing waves cause the beams to no longer cancel each other out.



THE FIRST SIGNAL



WHY IT MATTERS

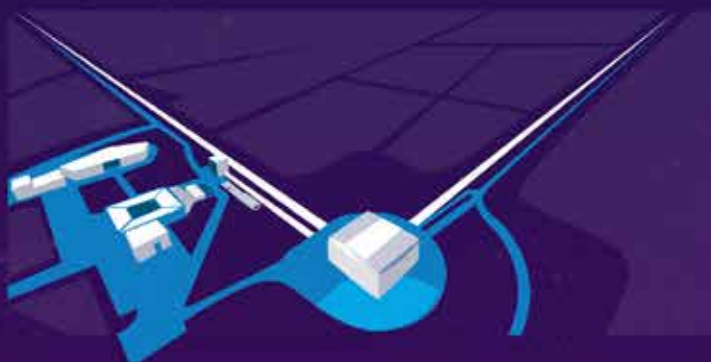


The discovery could allow us to locate the elusive graviton, discover the true nature of elementary particles, and even verify String Theory. It will also let us peer into the hearts of stellar explosions and refine our understanding of the speed of cosmic expansion.

WHAT'S NEXT

VIRGO

This European detector will enable the location of future detections to be triangulated in the sky.



LISA

This space-based Laser Interferometer Space Antenna will furnish us with our most detailed view of the gravitational wave sky yet.



WE TOOK A SECOND LOOK AT FAMILIAR WORLDS

Saturn's elusive moon, Enceladus, set the scientific world afire in 2015 when data released by NASA indicated that it's actually an ocean world covered in a thick layer of ice. Studies had suggested that the ice shell ranged from 30 km to 60 km and covered the entire surface of the moon. However, after taking into account tidal forces acting on Enceladus, scientists now predict that the ice sheets may be as thick as 20 km and just 5 km thick at its pole—bolstering the possibility of life on the moon and our ability to reach it.



**BRIAN KOBERLEIN
ON ALIEN LIFE**

For basic life, Mars or the moons of Jupiter and Saturn are the big bets. I lean a little towards life being detected on Mars first, but I'm more interested in the moons. Mars and Earth have exchanged meteorites, so it's possible there has been cross contamination. We might find that life on Mars and Earth share a common origin.

Life on the outer moons, however, would almost certainly be independent, so finding it there would tell us if life can arise easily in the Universe. As for intelligent life, I'm not very hopeful. We know on Earth that species can survive for a very long time without ever developing into a civilization, so there's no reason to presume that intelligent life is a necessary byproduct of life in general.



CHRIS LEWICKI ON COMMERCIALIZING SPACE

As we have gotten better at going at space over the last 50 years, we have solved more of the problems, made them routine, and quite literally turned them into a science instead of a guess of how things work. We've seen this for several decades now, many different commercial and business

opportunities where, rather than having something funded by tax dollars, where there's really no risk or no downsides to mistakes, commercial ventures are coming in and finding economies and the normal risk and return on investment dynamics that you have in a lot of different industries.

After four unsuccessful attempts to land one of its rockets on a floating drone platform, SpaceX finally nailed a perfect landing. The Falcon 9 rocket successfully delivered cargo to the International Space Station before safely returning to Earth. The event marks a major milestone for space travel, ushering in a new era of cheaper, reusable rockets.

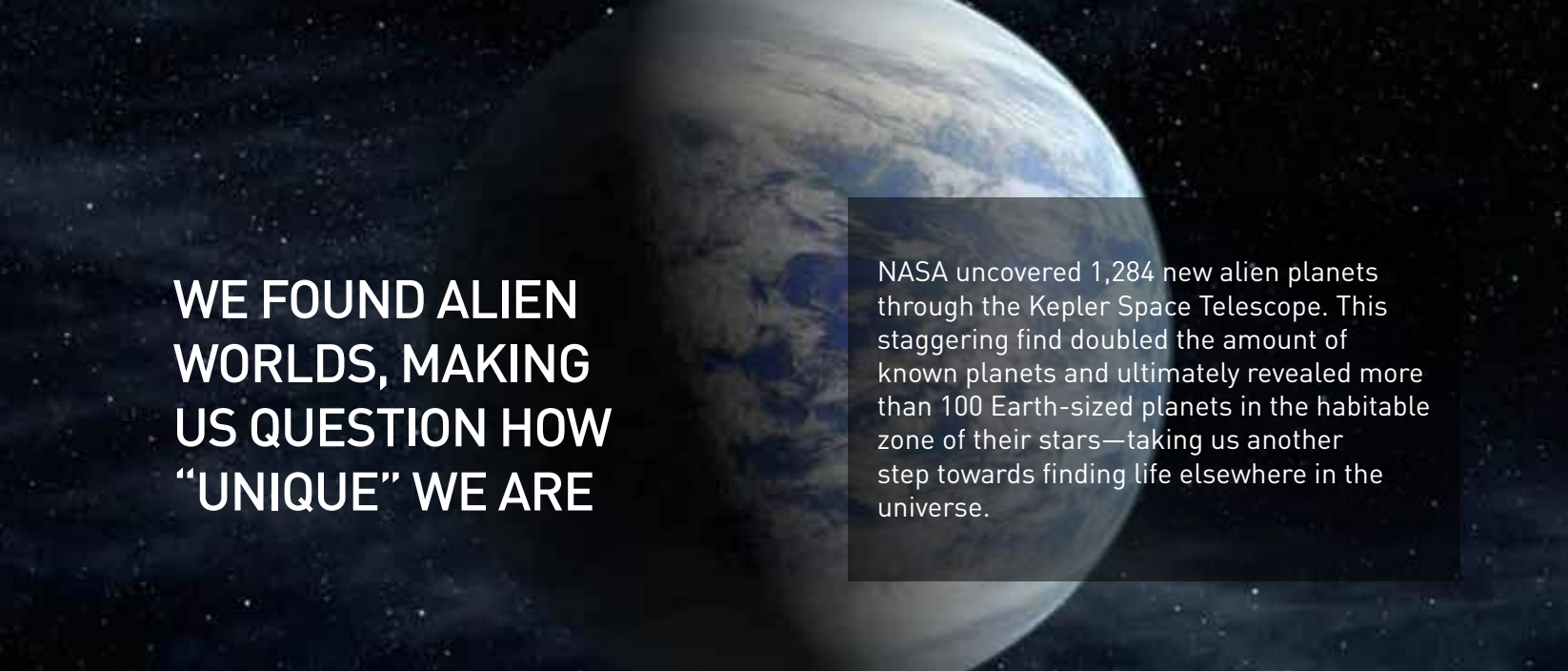


WE ENTERED A NEW ERA IN SPACEFLIGHT




AND ESTABLISHED AN ECONOMICALLY VIABLE SPACE INDUSTRY

Luxembourg dedicated hundreds of millions of dollars to develop technologies for space mining. The country also partnered with asteroid mining company Planetary Resources to scour regions near Earth for viable asteroids. Ultimately, they hope this joint effort will allow us to easily identify the presence of water and water-bearing minerals on asteroids.



WE FOUND ALIEN WORLDS, MAKING US QUESTION HOW “UNIQUE” WE ARE

NASA uncovered 1,284 new alien planets through the Kepler Space Telescope. This staggering find doubled the amount of known planets and ultimately revealed more than 100 Earth-sized planets in the habitable zone of their stars—taking us another step towards finding life elsewhere in the universe.



Europe's ExoMars orbiter launched in March 2016 to search for the biochemical fingerprints of life on Mars. The Orbiter reached the Red Planet in October. Over the course of its mission, it will perform detailed, remote observations of the Martian atmosphere, searching for evidence of gases that have biological significance.

AND WENT NEXT DOOR TO SEARCH OLD FRIENDS FOR NEW LIFE



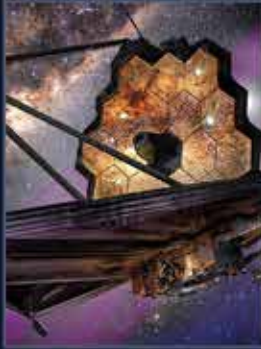
CHRIS IMPEY ON SPACE COLONIZATION

“Yeah, it's definitely possible. Mars is a stretch goal; it's just so far away, and so difficult...the expense, even dangerous. It seems a little mundane, given that we've been there, and haven't been back for nearly half a century, but the Moon is the easiest place to have a base, a colony, and just learn how to operate in space so that we

know how to do that. And also, there are technologies that are pretty well demonstrated, like you can take that arid-looking lunar soil, and get water and oxygen out of it, so you could drink the water, you can grow crops and the oxygen you breathe, or make rocket fuel. The Moon's not quite as barren as you might think.

THE TIMELINE

2018



James Webb Creates a New Era in Astronomy

The James Webb will be the most powerful telescope ever created. Launching in 2018, it will be 100 times more sensitive than any telescope that came before, allowing us to see the earliest moments in our universe's history.

Chris Lewicki

2018

SpaceX Launches Its "Red Dragon" Mission to Mars

Elon Musk, SpaceX's CEO, asserts that, in 2018, his company will land its Dragon capsule on Mars in preparation for human colonization.



2020

China Launches Tiangong 3

In 2020, the Chinese space station will launch, and it will have the ability to provide 40 days of life support for a crew of three.



2023

We Start Mining Asteroids for the First Time

"We already have two spacecrafts in orbit around asteroids, and in the first half of the 2020s, Planetary Resources plans to be landing on the surface of the nearest asteroid and extracting the first really demonstrable amount of asteroid resources on site.

Chris Lewicki



2024

NASA Returns First Asteroid Sample to Earth

NASA's OSIRIS-REx craft launched in September of 2016. It is heading to the asteroid Bennu and is set to return to Earth with the first-ever asteroid sample in 2023.



2024

SpaceX Sends Its First Humans to Mars

By 2024, SpaceX plans to send the first human colonists to the Red Planet in the hopes of establishing a long-term colony.



2025

NASA Arrives at Europa, Jupiter's Water World

Europa is a moon that has three times more water than Earth. In the mid-2020s, NASA plans to send an orbiter and possibly a lander to search for signs of life in its icy seas.



Astrophysicists Finally Figure Out Dark Matter

"We'll figure out what dark matter is within 10 years, by 2020 at least. It's almost certainly a subatomic particle, and there are a number of experiments that are already probing into the nature of dark matter.

Chris Impey



2030



The European Space Agency Establishes a Moon Colony

ESA scientists are planning a series of human missions to the Moon starting in the early-2020s, and they assert that this will scale up to a full colony by 2030.

2030

The High-Definition Space Telescope Could Be Completed

The HDST would be capable of resolving structures 330 light-years across when the cosmos was just 3 billion years old, and if approved by NASA, it will be done in the early 2030s.



2033



We Will Find Alien Life for the First Time in History

"We will have our first taste of life beyond the Earth. It may happen sooner, but in 20 years, I'm very confident. The discovery will likely come from a biomarker experiment on an exo-Earth.

Chris Impey

2036

Nanoscale Spacecrafts Powered by Light Head for the Stars

Breakthrough Starshot plans to create and launch thousands of tiny, nanoscale crafts that are powered by lightsail technology by 2036. These would take just 30 years to reach the closest star to the Sun.



2040



New Horizons Leaves the Solar System

New Horizons flew by Pluto in the summer of 2015, and astronomers estimate that it will take another 25 years before it travels far enough to leave the solar system.

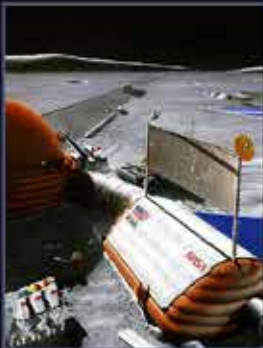
2045

Deadline for Russia's Lunar Colony

Roscosmos, the Russian space agency, plans to have a large lunar settlement established by 2045, and they are already planning manned missions in order to prepare for the colony.



2045



The First Self-Sufficient Colonies Established Off World

"I'd say thirty years, by 2045, that's a good timeframe for believing we'll have a viable colony on either the Moon or Mars, possibly both.

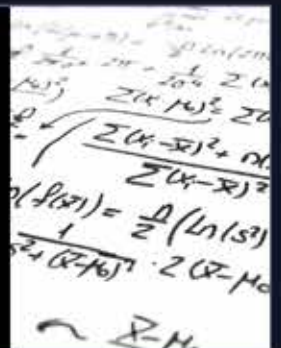
Chris Impey

2050

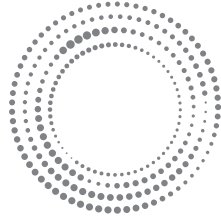
Smart Homes Are the Norm

"There's a significant chance that we've got something very big very wrong in physics. Case in point, we don't know what dark energy is, but by 2050, we will have had a breakthrough that will solve these problems.

Chris Impey



AN INITIATIVE OF



مؤسسة دبي للمستقبل
DUBAI FUTURE FOUNDATION





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