Ode to E Pluribus Unum for Sunday January 2022

James Webb Space Telescope over Earth

Image Credit: Arianespace, ESA, NASA, CSA, CNES

There's a big new telescope in space. This one, the James Webb Space Telescope (JWST), not only has a mirror over five times larger than Hubble's in area, but can see better in infrared light.

The featured picture shows JWST high above the Earth just after being released by the upper stage of an Ariane V rocket, launched on Christmas Day from French Guiana.

Over the next month, JWST will move out near the Sun-Earth L2 point where it will co-orbit the Sun with the Earth. During this time and for the next five months, JWST will unravel its segmented mirror and an array of sophisticated scientific instruments -- and test them.

If all goes well, JWST will start examining galaxies across the universe and planets orbiting stars across our Milky Way Galaxy in the summer of 2022.

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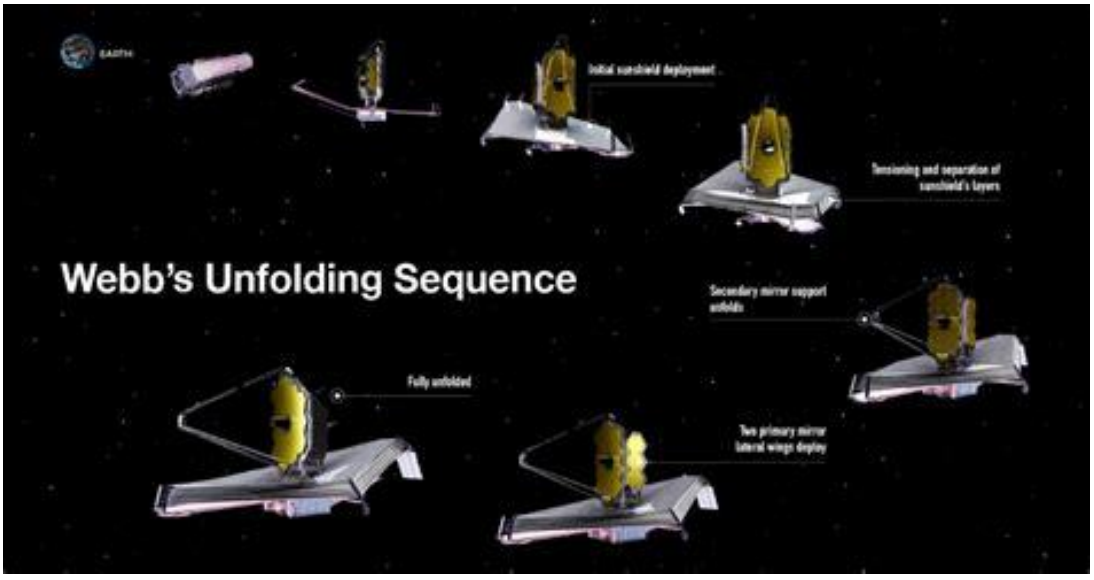
James Webb Space Telescope Nominal Deployment Sequence



https://www.jwst.nasa.gov/content/webbLaunch/whereIsWebb.html

https://www.facebook.com/groups/13771881169/permalink/10159728738711170/

You want to watch and then keep these. Not only do they present a real time Howgozit, they contain links to ongoing videos and information.

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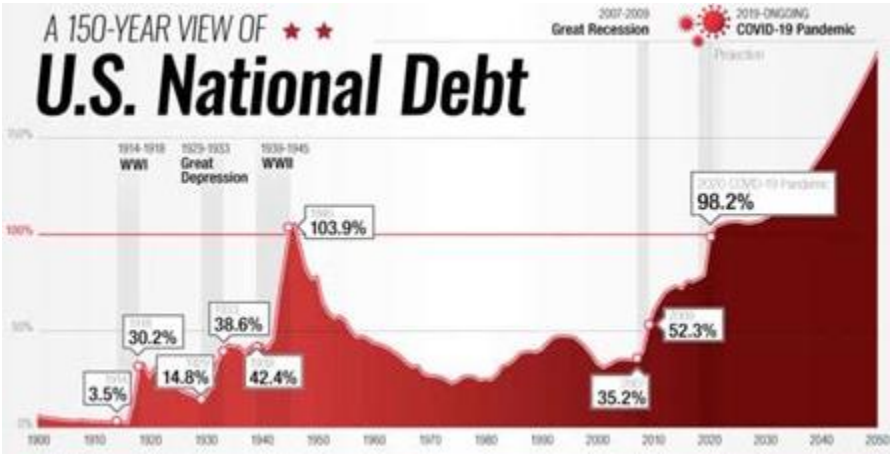
150 Years of U.S. National Debt



https://www.visualcapitalist.com/timeline-150-years-of-u-s-national-debt/

The reckoning.

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Who's Running Your Defense Store?

https://breakingdefense.com/whos-who-2021/?utm_campaign=Northrop%20Grumman&utm_medium=email&_hsmi=198347836&_hsenc=p2ANqtz-9Pmnd8f2-DI_9QLTkVAFbd7tkO-2OTshsovxNvAB-Sro3tjywOGaLYPlF3vsZ31VbXirEIkoCi_YJkcWmBL3MXj308Fw&utm_content=198347836&utm_source=hs_email

Care to know who is responsible for your nation's safety? Here' their background.

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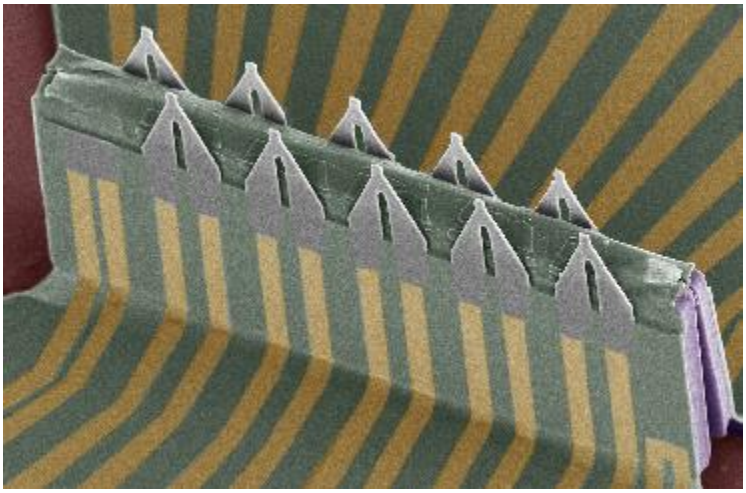
'Pop-up' Electronic Sensors Could Detect When Individual Heart Cells Misbehave



SEM image of the "pop-up" sensors that directly measure speed and movement of electrical signals inside heart cells.
Credit: Yue Gu

Engineers at the University of California San Diego have developed a powerful new tool that monitors the electrical activity inside heart cells, using tiny "pop-up" sensors that poke into cells without damaging them. The device directly measures the movement and speed of electrical signals traveling within a single heart cell—a first—as well as between multiple heart cells. It is also the first to measure these signals inside the cells of 3D tissues.

The device, published Dec. 23 in the journal Nature Nanotechnology, could enable scientists to gain more detailed insights into heart disorders and diseases such as arrhythmia (abnormal heart rhythm), heart attack and cardiac fibrosis (stiffening or thickening of heart tissue).

"Studying how an electrical signal propagates between different cells is important to understand the mechanism of cell function and disease," said first author Yue Gu, who recently received his Ph.D. in materials science and engineering at UC San Diego. "Irregularities in this signal can be a sign of arrhythmia, for example. If the signal cannot propagate correctly from one part of the heart to another, then some part of the heart cannot receive the signal so it cannot contract."

"With this device, we can zoom in to the cellular level and get a very high resolution picture of what's going on in the heart; we can see which cells are malfunctioning, which parts are not synchronized with the others, and pinpoint where the signal is weak," said senior author Sheng Xu, a professor of nanoengineering at the UC San Diego Jacobs School of Engineering. "This information could be used to help inform clinicians and enable them to make better diagnoses."

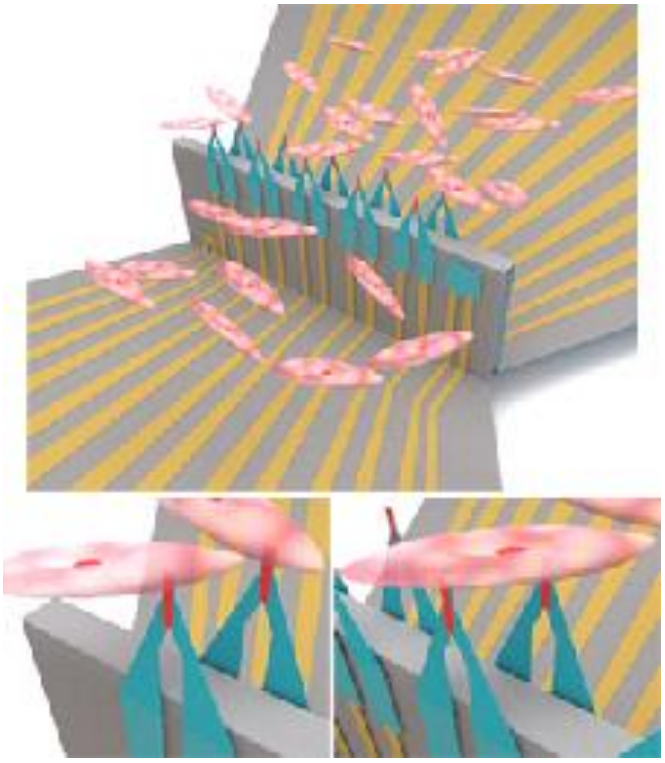


Illustration of the device interfacing with heart cells (top). The sensors can monitor electrical signals in multiple single cells at once (bottom left) and at two sites in one cell (bottom right).
Image adapted from Nature Nanotechnology

The device consists of a 3D array of microscopic field effect transistors, or FETs, that are shaped like sharp pointed tips. These tiny FETs pierce through cell membranes without damaging them and are sensitive enough to detect electrical signals—even very weak ones—directly inside the cells. To evade being seen as a foreign substance and remain inside the cells for long periods of time, the FETs are coated in a phospholipid

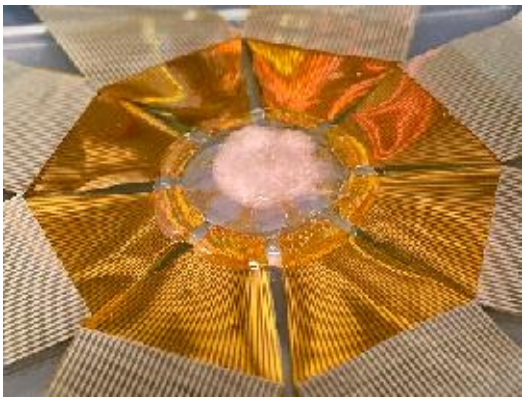
bilayer. The FETs can monitor signals from multiple cells at the same time. They can even monitor signals at two different sites inside the same cell.

"That's what makes this device unique," said Gu. "It can have two FET sensors penetrate inside one cell—with minimal invasiveness—and allow us to see which way a signal propagates and how fast it goes. This detailed information about signal transportation within a single cell has so far been unknown."

To build the device, the team first fabricated the FETs as 2D shapes, and then bonded select spots of these shapes onto a pre-stretched elastomer sheet. The researchers then loosened the elastomer sheet, causing the device to buckle and the FETs to fold into a 3D structure so that they can penetrate inside cells.

"It's like a pop-up book," said Gu. "It starts out as a 2D structure, and with compressive force it pops up at some portions and becomes a 3D structure."

The team tested the device on heart muscle cell cultures and on cardiac tissues that were engineered in the lab. The experiments involved placing either the cell culture or tissue on top of the device and then monitoring the electrical signals that the FET sensors picked up. By seeing which sensors detected a signal first and then measuring the times it took for other sensors to detect the signal, the team could determine which way the signal traveled and its speed. The researchers were able to do this for signals traveling between neighboring cells, and for the first time, for signals traveling within a single heart muscle cell.



Device with a scaled-up FET sensor array for measuring electrical signals in a 3D cardiac tissue construct.
Credit: Yue Gu

What makes this even more exciting, said Xu, is that this is the first time that scientists have been able to measure intracellular signals in 3D tissue constructs. "So far, only extracellular signals, meaning signals that are outside of the cell membrane, have been measured in these types of tissues. Now, we can actually pick up signals inside the cells that are embedded in the 3D tissue or organoid," he said.

The team's experiments led to an interesting observation: signals inside individual heart cells travel almost five times faster than signals between multiple heart cells. Studying these kinds of details could reveal insights on heart abnormalities at the cellular level, said Gu. "Say you're measuring the signal speed in one cell, and the signal speed

between two cells. If there's a very big difference between these two speeds—that is, if the intercellular speed is much, much smaller than the intracellular speed—then it's likely that something is wrong at the junction between the cells, possibly due to fibrosis," he explained.

Biologists could also use this device to study signal transportation between different organelles in a cell, added Gu. A device like this could also be used for testing new drugs and seeing how they affect heart cells and tissues.

The device would also be useful for studying electrical activity inside neurons. This is a direction that the team is looking to explore next. Down the line, the researchers plan to use their device to record electrical activity in real biological tissue in vivo. Xu envisions an implantable device that can be placed on the surface of a beating heart or on the surface of the cortex. But the device is still far from that stage. To get there, the researchers have more work to do including fine-tuning the layout of the FET sensors, optimizing the FET array size and materials, and integrating AI-assisted signal processing algorithms into the device.

This work was supported by the National Institutes of Health (1 R35 GM138250 01).

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How to lose $1B in 10 seconds

A jewelry CEO's 1991 fate should serve as a parable for today's tweet-obsessed business leaders.

By Zachary Crockett

When Gerald Ratner took the stage before 6k high-powered businesspeople, journalists, and dignitaries at London's Royal Albert Hall in April 1991, he had no idea his speech would be a professional death sentence.

His incredible success had led him to this moment.

He'd inherited a struggling chain of jewelry stores and turned it into a £1B enterprise in less than a decade. He'd flipped an elitist industry on its head by making earrings and rings for the working class. And in the process, he'd built his company, Ratners Group, into the UK's biggest, and most recognizable, jewelry chain.

But in a matter of seconds on that fateful night in April, a few jokes would destroy it all.

The rise of a populist jeweler

Gerald Ratner joined his father's small, fledgling jewelry business in 1965, at the age of 15, after being expelled from grammar school for "being too stupid." He spent his youth cleaning up the shop, running errands, and getting to know the "grass roots of the business."

When he inherited the company, Ratners Group (AKA "Ratners"), in 1984, it consisted of 120 bland, traditional storefronts, and was posting annual losses of £350k (US$459k).

In his youth, Ratner had learned a valuable lesson by observing London's street shops: the vendors who "yelled the loudest and had the most garish, eye-catching displays" landed the most sales. He decided to employ the same strategy at Ratners.

Within months, all Ratners locations were plastered with vibrant orange and red posters with all-caps pitches like "Last Chance — Mega Red Star Sale!" And "Sale Sale Sale: Half Price!" Everything in the window was clearly marked with a price tag.

Prior to the 1980s, jewelry had largely been elitist. The average item cost over £300 (about US$950 in today's dollars) — and jewelers thrived on an aura of exclusivity and prestige.

Ratner made a decision to market his chain toward a wider working class demographic, offering earrings, bracelets, and rings for an average price of just £20, and as low as £1. "I put the earrings and chains in the front of the window and diamond rings at the back, and played pop music," he later told the Financial Times.

This approach came at a cost: other jewelers (and the press) constantly berated Ratners for selling "cheap" and "tacky" products.

But Ratner's strategy paid off: by 1990, he grew Ratners from 120 to more than 2k stores, captured 50% of the UK's jewelry market, and had annual sales of £1.2B (US$1.57B) — £125m of which was profit. They bought up competing chains like Jared and Kay Jewelers.

In quick order, Ratners became a household name and the great democratizer of a previously stuffy industry.

"[I] just felt [I] could not fail," said Ratner. Until, of course, he did.

The speech that broke the businessman's back

In 1991, Ratner's success earned him an invitation to speak at the prestigious Institute of Directors annual convention.

Leading up to his speech, Ratner passed a draft by a public speaking consultant, and was given some advice: "I think you should put in a couple of jokes," the man told him. "People like your jokes." Unfortunately, Ratner took it to an extreme.

On the night of April 23, 1991, Ratner began his speech innocently enough, harping on the event's thematic values of quality, choice, and prosperity. Then, about 3 minutes in, he dropped several brutally honest jokes.

"Ratners doesn't represent prosperity — and come to think of it, it has very little to do with quality as well," he began. "We do cut-glass sherry decanters complete with six glasses on a silver-plated tray that your butler can serve you drinks on, all for £4.95. People say, 'How can you sell this for such a low price?' I say, because it's total crap."

Then, several minutes later, just for good measure: "We even sell a pair of [gold] earrings for under £1," he said. "Some people say, 'That's cheaper than a prawn sandwich!'...I have to say, the sandwich will probably last longer than the earrings."

The next morning, Ratner awoke to terrifying news: his comments had made national headlines to the effect of: "Jewelry Ceo Calls His Own Products 'Crap.'" The Sunday Times dubbed him "Gerald Crapner" — a nickname that caught on with disgruntled ex-customers.

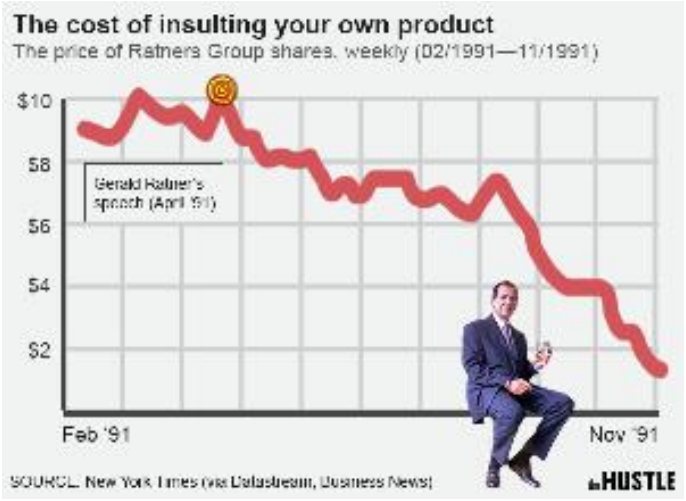
Initially, Ratner tried to play it off by featuring special in-store promotions that put a "humorous twist" on his remarks — but within a few weeks, it was clear that what he'd said had taken an irreparable toll on his business.

The downfall

Within a few days of the speech, Ratners Group shares dropped by £500 million (US$1.8B today); by the end of 1991, its stock was down 80%.

One-time enthusiastic customers boycotted the brand and Ratners, which was quickly losing sales volume, was forced to close down hundreds of stores and lay off a hefty percentage of its 25k-person workforce.

The company claimed there had been a "shift in consumer spending habits," and that the ongoing recession had finally caught up to its bottom line. But stock charts show the company suffered clear consequences from Ratner's speech.



Ratners stock declined by as much as 80% within 10 months of Ratner's comments (Zachary Crockett/The Hustle)

In November of 1992, Ratner was let go as CEO of Ratners Group. The day he left, he sold his shares for "pittance" to pay off the £1B (US$1.3B) he owed the bank, and walked away with nothing.

The Ratner effect

In an age where tweet-happy CEOs are empowered with large digital audiences they can instantly broadcast to, Ratner's story is a worthy parable.

Today, the phrase "Doing a Ratner" is British parlance for any time someone says something stupid that undermines his or her own product or customers — something that tends to play out more often than it should.

We've seen many similarly high-profile stumbles in recent years:

- Matt Barrett, ex-CEO of Barclays, insinuated that customers shouldn't use the bank's credit card products because they could "pile up debts."
- John Pluthero, then-CEO of the telecom giant Cable & Wireless, sent out a memo calling his company an "underperforming business in a crappy industry."
- Michael O'Leary, CEO of Ryanair, called his passengers "idiots."
- Chip Wilson, founder of lululemon, told customers his products "don't work for certain women's bodies."

A Harvard Business School study that analyzed instances of CEO misbehavior between 200 and 2015 found that the average comment (or action) resulted in 250 negative news stories (some of which were cited up to 5 years later), and a 3.1% decline in company stock price.

Though not true "Doing a Ratner" situations, we've also seen a number of business leaders say incredibly stupid things in a very public way, with very real financial consequences: In 2018, Tesla stock fell 4-5% after Elon Musk spoke — once in April, when he joked about going "bankrupt," and again in July, when he called a Thai cave rescuer a "pedo guy."

As for Ratner?

After losing everything, he toiled in misery for years — but he eventually made an improbable comeback. In 1997, he took out a £155k (US$203k) loan on his house, built up a health club business, and sold it for £3.9m (US$5.1m). He then used the profits to start an online jewelry company. (The Ratners Group rebranded as Signet in 1993; today, it is the largest diamond retailer in the world.)

But Ratner is unlikely to ever live down his ill-timed remarks nearly 3 decades ago.

'It doesn't seem to matter that in the '80s I was Britain's largest jeweler, with over 50% of the UK market," he told This Is Money. "My obituary will be all about being a disaster."

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Face it, Ulysses Grant is Ulysses Grant

 Equals 

Ken and his wife Edna went to the state fair every year, and every year Ken would say, “Edna, I'd like to ride in that helicopter”

Edna always replied, “I know Ken, but that helicopter ride is fifty bucks, and fifty bucks is fifty bucks.”

One year Ken and Edna went to the fair, and Ken said, “Edna, I'm 75 years old. If I don't ride that helicopter, I might never get another chance.”

To this, Edna replied, “Ken, that helicopter ride is fifty bucks, and fifty bucks is fifty bucks”

The pilot overheard the couple and said, “Folks, I'll make you a deal. I'll take the both of you for a ride. If you can stay quiet for the entire ride and don't say a word I won't charge you a penny!”

Ken and Edna agreed and up they went. The pilot did all kinds of fancy maneuvers, but not a word was heard. He did his daredevil tricks over and over again, but still not a word...

When they landed, the pilot turned to Ken and said, “By golly, I did everything I could to get you to yell out, but you didn't, I'm impressed!”

Ken replied, “Well, to tell you the truth, I almost said something when Edna fell out, but you know, fifty bucks is fifty bucks!”

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Some Quick Takes

John Travolta tested negative for coronavirus.
Turns out it was just Saturday night fever.

I saw an ad for burial plots and I thought to myself
that's the last thing I need.

Intelligence is like underwear; it is important that you have it
but not necessary that you show it off.

Relationships are somewhat like algebra
Have you ever looked at your X and wondered Y?

A courtroom artist was arrested today for an unknown reason
details are sketchy.

People are making end-of-the-world jokes
like there's no tomorrow.

Whatever you do, always give 100%
unless, of course, you're donating blood!

What do you call a sleepwalking nun?
A Roamin' Catholic.

What did Snow White say when she finally came out of the photo booth?
"Someday my prints will come".

A girl said she recognized me from her vegetarian club,
but I'd never met herbivore.

I've always had an irrational fear of speed bumps
but I'm slowly getting over it.

If you're not supposed to eat at night
why is there a light bulb in the refrigerator?

Don't let your worries get the best of you
remember, Moses started out as a basket case.

Here's a person who sent puns to ten friends, hoping that puns would make 'em laugh
No pun in ten did !

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Football Wisdom

After USC lost 51-0 to Notre Dame, his post-game message to his team was;
"All those who need showers, take them."
John McKay / USC

"If lessons are learned in defeat, our team is getting a great education."
Murray Warmath / Minnesota

"The only qualifications for a lineman are to be big and dumb. To be a back, you only have to be dumb."
Knute Rockne / Notre Dame

"We live one day at a time and scratch where it itches."
Darrell Royal / Texas

"We didn't tackle well today, but we made up for it by not blocking."
John McKay / USC

"I've found that prayers work best when you have big players."
Knute Rockne / Notre Dame

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First Exhale

New creation story
opens spine
of space book
each time-lined
group on earth
has honed a creation myth
today early
a new telling to reel us in
launched from French Guiana
scientific authors from
world wide Webb
in the beginning….
launch successful
goosebumps friction me
learning
of origami enfolded pieces
in the nose
of transported vessel
tasked to unfold
their perfected movements
that over time
days weeks
months
our cosmic origin
catches our breath
to make this
telling possible
time space light fractions
will they tell me who I am?
Origamic features
telescopic eyes
electromagnetic instruments
(is this true?)
if all works as multitudes hope
that beginning scratch of life
may be found

noted
sent back to earthlings
for us to inhale
that first exhale.

By Katherine Holden

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The Year in Math and Computer Science

Mathematicians and computer scientists answered major questions in topology, set theory and even physics, even as computers continued to grow more capable.

https://youtu.be/9uASADiYe_8

Mathematicians and computer scientists had an exciting year of breakthroughs in set theory, topology and artificial intelligence, in addition to preserving fading knowledge and revisiting old questions. They made new progress on fundamental questions in the field, celebrated connections spanning distant areas of mathematics, and saw the links between mathematics and other disciplines grow. But many results were only partial answers, and some promising avenues of exploration turned out to be dead ends, leaving work for future (and current) generations.

Topologists, who had already had a busy year, saw the release of a book this fall that finally presents, comprehensively, a major 40-year-old work that was in danger of being lost. A geometric tool created 11 years ago gained new life in a different mathematical context, bridging disparate areas of research. And new work in set theory brought mathematicians closer to understanding the nature of infinity and how many real numbers there really are. This was just one of many decades-old questions in math that received answers — of some sort — this year.

But math doesn't exist in a vacuum. This summer, *Quanta* covered the growing need for a mathematical understanding of quantum field theory, one of the most successful concepts in physics. Similarly, computers are becoming increasingly indispensable tools for mathematicians, who use them not just to carry out calculations but to solve otherwise impossible problems and even verify complicated proofs. And as machines

become better at solving problems, this year has also seen new progress in understanding just how they got so good at it.

Preserving Topology

It's tempting to think that a mathematical proof, once discovered, would stick around forever. But a seminal topology result from 1981 was in danger of being lost to obscurity, as the few remaining mathematicians who understood it grew older and left the field. Michael Freedman's proof of the four-dimensional Poincaré conjecture showed that certain shapes that are similar in some ways (or "homotopy equivalent") to a four-dimensional sphere must also be similar to it in other ways, making them "homeomorphic." (Topologists have their own ways of determining when two shapes are the same or similar.) Fortunately, a new book called *The Disc Embedding Theorem* establishes in nearly 500 pages the inescapable logic of Freedman's surprising approach and firmly establishes the finding in the mathematical canon.

Another recent major result in topology involved the Smale conjecture, which asks if the four-dimensional sphere's basic symmetries are, basically, all the symmetries it has. Tadayuki Watanabe proved that the answer is no — more kinds of symmetries exist — and in doing so he kicked off a search for them, with new results appearing as recently as September. Also, two mathematicians developed "Floer Morava *K*-theory," a framework that combines symplectic geometry and topology; the work establishes a new set of tools for approaching problems in those fields and, almost in passing, proves a new version of a decades-old problem called the Arnold conjecture. *Quanta* also explored the origins of topology itself with a column in January and an explainer devoted to the related subject of homology.

Opening AI's Black Box

Whether they're helping mathematicians do math or aiding in the analysis of scientific data, deep neural networks, a form of artificial intelligence built upon layers of artificial neurons, have become increasingly sophisticated and powerful. They also remain mysterious: Traditional machine learning theory says their huge numbers of parameters should result in overfitting and an inability to generalize, but clearly something else must be happening. It turns out that older and better-understood machine learning models, called kernel machines, are mathematically equivalent to idealized versions of these neural networks, suggesting new ways to understand — and take advantage of — the digital black boxes.

But there have been setbacks, too. Related kinds of AI known as convolutional neural networks have a very hard time distinguishing between similar and different objects, and there's a good chance they always will. Likewise, recent work has shown that gradient descent — an algorithm useful for training neural networks and performing other computational tasks — is a fundamentally difficult problem, meaning some tasks may be forever beyond its reach. Quantum computing, despite its promise, also suffered a big setback in March when a major paper describing how to create error-resistant topological qubits was retracted, forcing once hopeful scientists to realize that

such a machine may be impossible. (Scott Aaronson highlighted, in a column and video, just why quantum computers are so difficult to work with, and even to talk about.)

The Nature of Infinity

How many real numbers exist? It's been a provocative — and unsolved — question for more than a century, but this year saw major developments toward an answer. David Asperó and Ralf Schindler published a proof in May that combined two previously antagonistic axioms:

A variation of one of them, known as Martin's maximum, implies the other, named (*) (pronounced "star"). The result means both axioms are more likely to be true, which in turn suggests that the number of real numbers is bigger than initially thought, corresponding to the cardinal number ℵ2 rather than the smaller (yet still infinite) ℵ1.

This would violate the continuum hypothesis, which states that no size of infinity exists between ℵ0, corresponding to the set of all natural numbers, and the continuum of real numbers. But not everyone agrees, including Hugh Woodin, the original creator of (*), who has posted new work that suggests the continuum hypothesis is right after all.

This wasn't the only decades-old problem revisited by modern solutions. In 1900, David Hilbert came up with 23 unsolved significant questions, and this year saw mathematicians post incomplete answers to the 12th problem, about the building blocks of certain number systems, and the 13th, about the solutions to seventh-degree polynomials. February also saw the announcement that the unit conjecture is false, meaning that multiplicative inverses actually exist in more complicated structures than mathematicians thought. And in January Alex Kontorovich explored perhaps the greatest unsolved problem in mathematics, the Riemann hypothesis, in an essay and video.

Math and Computers Join Forces

Real-world systems are notoriously complicated, and partial differential equations (PDEs) help researchers describe and understand them. But PDEs are also notoriously difficult to solve. Two new kinds of neural networks — DeepONet and the Fourier neural operator — have emerged to make this work easier. Both have the power to approximate operators, which can transform functions into other functions, effectively allowing the nets to map an infinite-dimensional space onto another infinite-dimensional space. The new systems solve existing equations faster than conventional methods, and they may also help provide PDEs for systems that were previously too complicated to model.

In fact, computers have proved helpful to mathematicians in various ways this year. In January, *Quanta* reported on new algorithms for quantum computers that would allow them to process nonlinear systems, where interactions can affect themselves, by first approximating them as simpler, linear ones. Computers also continued to push mathematical research forward when a team of mathematicians used modern hardware and algorithms to prove that there are no more types of special tetrahedra than the ones discovered 26 years ago, and — more dramatically — when a digital proof assistant named Lean verified the correctness of an inscrutable modern proof.

Math Meets Physics, Again

Physics and mathematics have always overlapped, inspiring and advancing each other. The concept of quantum field theory, a catchall that physicists use to describe frameworks that involve quantum fields, has been enormously successful, but it rests on shaky mathematical ground. Bringing mathematical rigor to quantum field theory would help physicists work in and expand that framework, but it would also give mathematicians a new set of tools and structures to play with. In a four-part series, *Quanta* examined the main issues currently getting in mathematicians' way, explored a smaller-scale success story in two dimensions, discussed the possibilities with QFT specialist Nathan Seiberg, and explained in a video the most prominent QFT of all: the Standard Model.

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Christopher Alvin Stapleton

The American songwriter, singer, guitarist, and record producer went to Nashville to study engineering at Vanderbilt University, but decided on a career in music instead.

As a vocalist, Stapleton sang lead in two bands before he started recording as a solo artist including a bluegrass ensemble from 2008 to 2010 called the SteelDrivers and the Jompson Brothers. After that, he released his solo debut: the critically acclaimed studio album titled Traveller (2015), which reached number one on the US Billboard 200 and was certified triple platinum by the Recording Industry Association of America.

Stapleton's musical influences range from outlaw country and bluegrass to rock and roll and blues.

You Should Probably Leave https://youtu.be/M-MGpJIo2bs
Tennessee Whiskey https://youtu.be/4zAThXFOy2c
Fire Away https://youtu.be/ZI-aPHeUDlk

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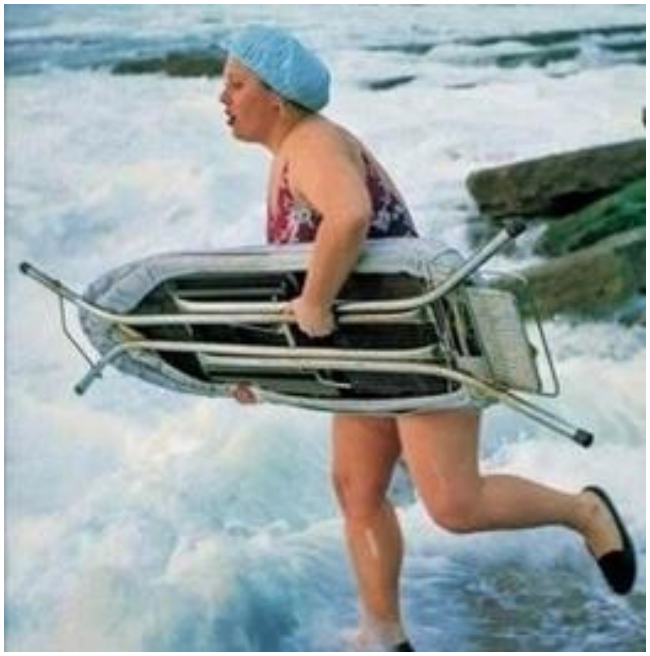
Iron Woman Competition



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Week ago, my Mother-in-law began reading, "The Exorcist". She said it was the most evil book she ever read. So evil in fact, she couldn't finish it, took it over to the beach and threw it into the ocean off a fishing pier.
I went and bought another copy, ran the faucet over it and left it in the night table drawer by her bed.
I'm going to Hell

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Grainger "Lincolnshire Posy" United States Marine Band

Episode 1 https://youtu.be/eUfm6Adsbh0
Episode 2 https://youtu.be/WcJjYhFXYYM
Performance https://youtu.be/JL62wCodJUs

Rehearsals and the performance

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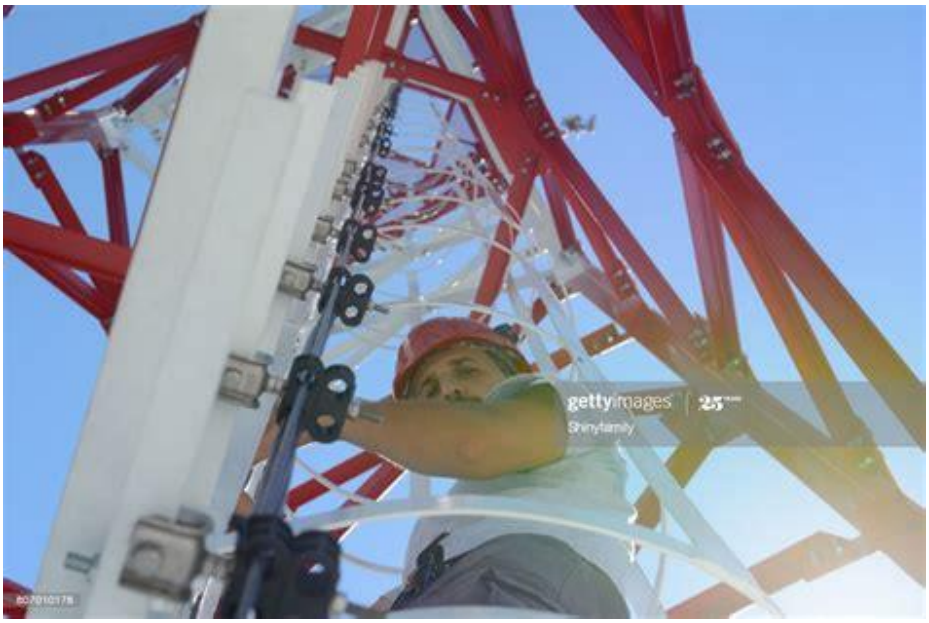
Renewable Energy Is Great—but the Grid Can Slow It Down

Many solar and wind projects face a problem: getting the energy from where it's made to where it's needed.

Gregary Barber for Wired Magazine



photograph: getty images

Say you want to build a wind farm. You find a nice empty knoll in northern Vermont, where the breeze blows steadily and the neighbors don't complain about sullied views. (A damn miracle, in other words.) You line up investors, get the right permits, and prepare to install your turbines. Then you hit snag: power lines. There aren't enough in rural Vermont; they're all in Boston, along with the people and their Teslas. So you've got a problem. The wind is blowing here, but there's no way to get its green energy there.

Since 1889, when the US got its first long-distance power line (it traversed a whopping 14 miles), the grid largely has been set up for energy that's consumed relatively close to where it is produced. There are exceptions—like hydropower that reaches cities from far-flung dams—but for the most part, it has been a century of linking coal and gas plants with people living nearby. But now, with wind farms dotting mountain ridges and solar plants sprawling in the desert, distance is more common.

The wires aren't ready for it. Researchers at Princeton University estimate that the country's high-voltage transmission capacity needs to grow by 60 percent in the next decade to meet its clean energy goals. "The grid that we have wasn't designed for what we do with it now, let alone what we want to do with it, with all sorts of renewables," says Seth Blumsack, an economist who studies the grid at Penn State University.

In many parts of the country, wind and solar are already the cheapest ways to produce energy, but transmission is a limiting factor, explains Kerinia Cusick, cofounder of the Center for Renewables Integration, a nonprofit that advocates modernizing the grid for green energy. That means that in places like rural Vermont, wind farm owners are frequently ordered to shut down when a healthy breeze is blowing—a move known as "curtailment"—because there's too much power coming over the wires.

For plants that are yet to be built, the situation is even worse, because grid constraints mean backers must string new lines, and pay for them, before installing turbines or

solar panels. Each year, hundreds of renewable energy projects stall in advanced planning stages due to delays in upgrading transmission lines and the cost of making those upgrades.

"There's a very likely risk that'll kill your project," says Hudson Gilmer, chief executive of LineVision. Gilmer's company attacks the problem from another angle: make the existing grid carry more power. Even when plans for a new line are approved, there's no guarantee it actually happens. Nobody wants massive power lines draped over their backyard or across an endangered wetland. So Gilmer looks for ways to eke more power out of the lines where congestion is a big problem.

"The grid that we have wasn't designed for what we do with it now, let alone what we want to do with it, with all sorts of renewables."
Seth Blumsack, Economist, Penn State University

That's possible because power lines generally are not used to their fullest. Limits on how much power the lines can carry are typically set in advance, and they're based on assumptions about physics and engineering that were made decades ago. They're conservative—understandably so, in the interest of keeping the lights on reliably and safely. But Gilmer and others argue that technological improvements allow line owners to more closely monitor their system and push through more power. "We're not suggesting that we don't need those new high-voltage lines carrying renewables from the Dakotas or West Texas to urban areas," Gilmer says, alluding to two of the nation's most productive areas for wind power. For that, the country still needs new electron superhighways. But the idea is to get a little more out of the lines where there are bottlenecks, and make room for more of the renewables that are languishing in the queue.

LineVision specializes in a technique called dynamic line rating. One of the physical limits of power lines is the heat they generate as a current flows through them. Too much power and the line will start to sag as the wires get hot and expand, potentially sparking and causing a fire. But nobody actually monitors each line. The limits are based on assumptions meant to avoid a worst-case scenario. There are other factors that affect the line's temperature—for example, the weather. Most days there's a breeze blowing on the wires, and it cools them down—maybe just by a couple of degrees, but enough to theoretically carry more power. So Gilmer's company installs sensors that monitor the lines for sagging, using lidar and other devices. It claims the technology can increase a line's capacity by up to 40 percent.

Renewables—which ebb and flow with the wind and the sun—add more uncertainty into how much power a line needs to carry. "Flexibility is the coin of the realm going forward," says Carl Imhoff, a researcher at Pacific Northwest National Lab who studies so-called grid-enhancing technologies. Among them is a form of power steering for the grid. The way that power will flow through a grid is hard to predict—it changes depending on supply and demand, and it can leave certain lines clogged while others sit unused. The first step is knowing what's happening: The method relies on a network of devices called synchrophasors—electronic sentinels that quickly measure changes in the

power flowing through the lines. Those observations help grid operators understand where there's congestion. That way, they can redirect power through a better route by applying a voltage to the lines, which serves to push or pull a current through them.

A form of that technology is used in the UK, where National Grid, which operates lines across the country, uses power flow devices to push energy from the renewable-rich north of England to power-hungry areas around London. Such tools would be especially useful in places like the Northeast US, explains Terron Hill, who directs clean energy development at National Grid's US-based utility arm. That's because the region is covered by a spider web of transmission lines—but often not as thickly as needed in places that are best for renewables. The wires in those areas are among the country's oldest, notes Hill, after returning from inspecting 80-year-old equipment that was due for maintenance.

It's slow going. The utility has experimented with a variety of grid-enhancing tools, including dynamic line rating to improve capacity in the Hudson Valley and ferry renewable energy south to New York City. But for the most part, the utility follows a straightforward game plan for upgrading transmission: install more wires, even with the challenges of doing so. "You need to change the mindset away from 'build build build' to what's best for customers and how to use your network more efficiently," Hill says.

The reasons for that mindset get wonky, fast. The grid is complicated. The people who most often own and operate the transmission lines—including private utilities that answer to investors, as well as public entities—are often different from the people building renewable plants that will connect to them. The whole system is overseen by a tangle of planners and regulators, helmed nationally by the US Federal Energy Regulatory Commission, or FERC. When a utility wins approval to build a new power line, it's usually part of a plan to handle demand from its customers—and it comes with a guarantee that the utility and its shareholders will recoup that investment and more. When a generator wants to hook up to the grid? That's different. The entities that own the surrounding wires say what upgrades are required and how much it will cost, and the owner of the new solar plant or wind farms pays for it.

Neither of these scenarios leaves much opportunity to make existing lines more efficient. Big investments in new lines mean bigger returns for utilities that put them up. In other words, it's more profitable to spend big. And while utilities may see potential in new technologies, they also come with risks, including safety and reliability problems, and investments in new people and training that might not pay off. "There is a great fear of failure," says Blumsack of Penn State. "If you try something new and it fails, who pays for it?"

Utilities say their caution is rooted in reliability. Use a newfangled device to increase the capacity of the line and you may end up with a problem that results in penalties for the utility and higher prices for customers. "It puts us in a place not to innovate," says Elizabeth Cook, general manager of advanced grid solutions for Duquesne Light Company, a utility in the Pittsburgh area. That's why it's important to test. The region isn't a renewable hot spot or facing much congestion right now, but the utility is

gathering data using a LineVision device. That way it can be prepared to raise the capacity if it needs to.

Incentives from agencies like FERC would help utilities try new technology and gather data, says Hill. The agency is considering such moves, along with new rules to incentivize more efficient grid planning, including cooperation among different players on the grid. Cusick, the grid improvements advocate, also hopes it will give generators more say over transmission improvements, so the default isn't an expensive new line.

But what's needed most, Blumsack says, is a better overall plan for the electric grid. Technologies that enhance the existing grid are one part of a much bigger puzzle. The topology of the old grid is now defunct, and it will take a lot to get it oriented the right way. That means efficiently building new wires not just where they're needed today, but where they'll be needed tomorrow—and using every technology we've got to get more power through them. Without that, the wind can blow and the sun can shine, but the US won't be able to harness them.

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Epic Sea Level Rise Drove Vikings out of Greenland

By Mindy Weisberger

Not even the mighty Vikings could stand against climate change.

Ruins of a church in Hvalsey, a Norse settlement in Greenland. Vikings built the structure around the 14th century.
(getty images)

The Vikings are remembered as fierce fighters, but even these mighty warriors were no match for climate change. Scientists recently found that ice sheet growth and sea level

rise led to massive coastal flooding that inundated Norse farms and ultimately drove the Vikings out of Greenland in the 15th century.

The Vikings first established a foothold in southern Greenland around A.D. 985 with the arrival of Erik Thorvaldsson, also known as "Erik the Red," a Norwegian-born explorer who sailed to Greenland after being exiled from Iceland. Other Viking settlers soon followed, forming communities in Eystribyggð (Eastern Settlement) and Vestribyggð (Western Settlement) that thrived for centuries. (At the time of the Vikings' arrival, Greenland was already inhabited by people of the Dorset Culture, an Indigenous group that preceded the arrival of the Inuit people in the Arctic, according to the University of California Riverside).

Around the 15th century, signs of Norse habitation in the region vanished from the archaeological record. Researchers previously suggested that factors such as climate change and economic shifts likely led the Vikings to abandon Greenland. Now, new findings show that rising seas played a key role, by submerging miles of coastline, according to data presented Wednesday (Dec. 15) at the annual conference of the American Geophysical Union (AGU), held this week in New Orleans and online.

Between the 14th and 19th centuries, Europe and North America experienced a period of significantly cooler temperatures, known as the Little Ice Age. Under these chilly conditions, the Greenland Ice Sheet — a vast blanket of ice covering most of Greenland — would have become even bigger, Marisa Julia Borreggine, a doctoral candidate in the Department of Earth and Planetary Sciences at Harvard University, said in a presentation at the AGU conference.

As the ice sheet advanced, its increasing heaviness weighed down the substrate underneath, making coastal areas more prone to flooding, Borreggine said. At the same time, the increased gravitational attraction between the expanding ice sheet and large masses of sea ice pushed more seawater over Greenland's coast. These two processes could have driven widespread flooding along the coastline — "exactly where the Vikings were settled," Borreggine said.

The scientists tested their hypothesis by modeling estimated ice growth in southwestern Greenland over the 400-year period of Norse occupation and adding those calculations to a model showing sea level rise during that time. Then, they analyzed maps of known Viking sites to see how their findings lined up with archaeological evidence marking the end of a Viking presence in Greenland.

Their models showed that from about 1000 to 1400, rising seas around Greenland would have flooded Viking settlements by as much as 16 feet (5 meters), affecting about 54 square miles (140 square kilometers) of coastal land, Borreggine said. This flooding would have submerged land that the Vikings used for farming and as grazing pastures for their cattle, according to the models.

However, sea level rise was probably not the only reason the Vikings left Greenland. Other types of challenges can cause even long-standing communities to collapse, and a

perfect storm of external pressures — such as climate change, social unrest and resource depletion — may have spurred the Vikings to abandon their settlements for good, Borreggine said.

"A combination of climate and environmental change, the shifting resource landscape, the flux of supply and demand of exclusive products for the foreign market, and interactions with Inuit in the North all could have contributed to this out-migration," she said. "Likely a combination of these factors led to the Norse migration out of Greenland and further west."

Oh no, non-anthropomorphic climate change? What will they think of next?

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NASA's Perseverance Rover 2021 Year in Review

NASA's Perseverance rover has been busy since its harrowing touchdown in Mars' Jezero Crater this past February.

What has NASA's Perseverance rover accomplished since landing on the surface of Mars in February 2021? Surface Operations Mission Manager Jessica Samuels reflects on a year filled with groundbreaking discoveries at Jezero Crater and counts up the rover's achievements. Credit: NASA/JPL-Caltech/MSSS, NASA/JPL-Caltech

https://youtu.be/aQhElFs5B48?list=PLTiv_XWHnOZqCrMU2ppcLjRn1zlDkNx3q

In the 10 months since, the car-size rover has driven 1.8 miles (2.9 kilometers), set a record for the longest rover drive in a Martian day, taken more than 100,000 images, and collected six samples of Martian rock and atmosphere that could eventually be brought to Earth for further study.

And then there's NASA's Ingenuity Mars Helicopter, which hitched a ride to the Red Planet with Perseverance: Proving that powered, controlled flight is possible in Mars'

thin atmosphere, the 4-pound (1.8-kilogram) rotorcraft has logged 18 flights and counting.

In a new video, Jessica Samuels – the Perseverance surface operations mission manager at NASA's Jet Propulsion Laboratory in Southern California – looks back on a year filled with groundbreaking discoveries. She also explains the next phase of Perseverance's mission: to explore the delta that formed in Jezero Crater billions of years ago from sediment that an ancient river carried into the lake that once existed in the crater.

"It feels great to be a part of making history and enabling the start of a Mars Sample Return campaign," said Samuels. "What motivates us as engineers and scientists exploring another planet is the opportunity to learn more."

More About the Mission

A key objective for Perseverance's mission on Mars is astrobiology, including the search for signs of ancient microbial life. The rover will characterize the planet's geology and past climate, pave the way for human exploration of the Red Planet, and be the first mission to collect and cache Martian rock and regolith (broken rock and dust).

Subsequent NASA missions, in cooperation with ESA (European Space Agency), would send spacecraft to Mars to collect these sealed samples from the surface and return them to Earth for in-depth analysis.

The Mars 2020 Perseverance mission is part of NASA's Moon to Mars exploration approach, which includes Artemis missions to the Moon that will help prepare for human exploration of the Red Planet.

JPL, which is managed for NASA by Caltech in Pasadena, California, built and manages operations of the Perseverance rover.

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The 20 Fastest Growing Jobs in the Next Decade

https://www.visualcapitalist.com/the-20-fastest-growing-jobs-in-the-next-decade/

Where the opportunities lie.

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Endangered Birds Experience 'Virgin Birth,' A First for the Species

Female California condors don't need males to have offspring—joining sharks, rays, and lizards on the list of creatures that can reproduce without mating.

Byjason Bittel

“There’s something really confusing about the condor data.”

Those weren’t the words Oliver Ryder wanted to hear as he walked to his car after a long day’s work trying to save California condors, one of the most endangered animals on the planet. When his colleague Leona Chemnick explained what she was seeing, his dread quickly changed to fascination.

For decades, scientists have been trying to coax the California condor back from the edge of extinction. The entire population of these birds crashed to just 22 animals in 1982. By 2019, captive breeding and release efforts had slowly built the total population up over 500. Doing that has required careful management of captive birds, particularly selecting which males and females can breed to produce healthy offspring.

That’s how, as the scientists took a closer at genetic data, they discovered that two male birds—known only by their studbook numbers, SB260 and SB517—showed no genetic contribution from the birds that should have been their fathers. (Read about virgin birth recorded in a reticulated python, the world’s longest snake.)

In other words, the birds came into the world by facultative parthenogenesis—or virgin birth—according to a peer-reviewed paper published October 28 in the Journal of Heredity. Such asexual reproduction in normally sexually reproducing species occurs when certain cells produced with a female animal’s egg behave like sperm and fuse with the egg.

Though rare in vertebrates, parthenogenesis occurs in sharks, rays, and lizards. Scientists have also recorded self-fertilization in some captive bird species, such as turkeys, chickens, and Chinese painted quail, usually only when females are housed without access to a male. But this is the first time it's been recorded in California condors. (Read about a Komodo dragon that reproduced without a mate.)

What's particularly bizarre about the condors, says Ryder, is that SB260 and SB517 had different mothers, each of them housed with males. What's more, both mothers had successfully reproduced with those males before and after.

"Why it happened? We just don't know," says Ryder, director of conservation genetics at the San Diego Zoo Wildlife Alliance. "What we do know is that it happened more than once, and it happened to different females."

"Will it happen again? I rather believe so," he says.

A survival tool?

Only around 300 of this critically endangered species soar through the skies above California, Arizona, and Utah. With such a low population, it's possible the condors may be using parthenogenesis as a survival tool, says Reshma Ramachandran, a reproductive physiologist and microbiologist at Mississippi State University who was not involved in the research.

There's evidence in other species to suggest parthenogenesis can be a life raft of sorts for a species in trouble. For example, the critically endangered smalltooth sawfish may be turning to parthenogenesis as mates become increasingly difficult to find in the wild.

However, that theory may not hold with the California condors. For one, the captive females that produced the male birds in question had access to mates. Secondly, neither of the offspring produced by parthenogenesis survived to reproduce itself. SB260 died after less than two years; SB517 died before reaching eight. In contrast, some California condors can live to a ripe old age of 60. (Read more about how scientists decide to save endangered species.)

Because scientists carefully screen for potential genetic disorders when breeding captive condors, it's possible that these self-fertilized birds carried gene mutations that ultimately caused their early deaths, Ryder says.

Though an interesting idea, "it's too early to really say how meaningful [parthenogenesis] is to the evolution of the species or its conservation," adds Jacqueline Robinson, an evolutionary geneticist at the University of California, San Francisco. "We have so few examples of this rare phenomenon."

To that end, earlier this year, Robinson, Ryder, and colleagues published a study detailing the California condor's whole genome, valuable genetic data that, in the future, could help us better understand how parthenogenesis works in these animals, she says.

More common than we think?

The possibility that parthenogenesis is more widespread than previously thought is what intrigues scientists the most.

Ramachandran, who published a review of parthenogenesis research in birds in 2018, says that although virgin birth is mostly documented in captive animals, there's no reason to think it isn't happening in the wild.

"I'm actually expecting more reports from the wild now," she says. (Learn about a blacktip reef shark that experienced virgin birth.)

Ryder agrees. "The only reason we were able to identify that this had happened [in the condors] is because of these detailed genetic studies," he says. "So, the birds in your backyard, are they occasionally producing a parthenogenetic chick? Nobody's looking in deep enough detail to answer that question."

Regardless of the answer, he says, "it's a reminder that lest you think you understand nature, she's always got surprises."

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My Walking Thoughts

January 2, 2022

It is early afternoon of New Year's Eve as I write this, and to tell the truth there is little going on (or not going on) that differs from any other Friday during the year other than two of five auto repair shops in town are closed in anticipation of what I suspect will prove to be an evening of very understated revelry.

The primary dousing of cold water to this New Year's Eve comes from the most recent spate of virus alarms that have launched us into Year Three of a world in which we may live but don't much interact.

To add an exclamation point to the situation, Ventura County has chosen the Ojai Valley to be its new deputy training ground, which virtually guarantees 'tight ship' behavior by its residents on a night once famed for its silly activities.

From time-to-time throughout the evening the local household critters, along with their outdoor cousins gracing the area's generous amount of wilderness, will respond unfavorably to the sporadic pops of simple fireworks. I suspect these occasional interruptions reflect the time at which their initiators have gotten bored with waiting for something exciting to happen, tossed in the towel, and called it a night to forget.

But, at the stroke of midnight the south portion of the valley will once again be treated to a loud THUMP, produced by a Civil War-era smoothbore 12 pounder 'Napoleon' cannon maintained by a resident whose house sits atop the highest point within the valley proper.

This happening has been going on for at least the thirty-some-odd years I've lived in the valley, and I hope will continue far into the future.

Why? Two reasons I can think of right off the bat:

First, unlike the response to the snapping little fireworks that evince yippings and yelpings throughout the neighborhoods, this marvelous anachronism's booming voice is met with silence…perhaps a matter of its lower frequency range, or (more to my liking) the sense that something profound has been uttered.

Second, every year I am caught by an 'adolescent bug' that dreams of sneaking into the estate and ramming a 12-pound ball into the hoary barrel, and then watching as that phantom projectile streaks into the night, the only certainty to its journey is that it will come to earth…somewhere.

But of course, I will never do such a thing, primarily because I'm a coward at heart, but also because it would summon the ire of the local constabulary who might feel compelled to confiscate the wondrous contraption and melt it down to make something more politically correct.

And that, my friends, is a fate worse than ever meted out by fiery furnaces of hell.

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Root 66

Nope. Maybe next week, but at the moment I have other duties with which to attend.

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