the futures we were promised

flying cars

hyperloop

jetpacks

self-driving cars

BY
Andrew Zaleski

ILLUSTRATIONS BY
Tavis Coburn

JETPACKS AND FLYING CARS might seem more at home parked in the pages of sci-fi novels (and, uh, some magazines) than in your garage. In 1924, *PopSci* predicted that airborne autos were just 20 years away, but that wide-eyed optimism wasn't without reason: Inventors have been tinkering their way toward revolutionary transit for more than a century. The Hyperloop's ancestry starts in the 1870s. Cruise control debuted in the 1950s. The first air-car prototypes took flight in the same decade. And, in the '60s, Bell Labs prototyped jet-powered backpacks. These modes of future commuting are still navigating mass-market expectations: Is it safe? Reliable? Cheap? Here's a realistic assessment of our people-moving dreams.

flying cars

CONCEPTS & PROTOTYPES

We may not have mass-market flying cars yet, but we've been working out the kinks for decades.

1949

Although the precursor to the FAA certified Moulton Taylor's **Aerocar** as safe to fly, it never entered production. Makes sense: The driver had to affix a propeller and 15-foot wings before taking flight.

2000

Paul Moller's **M400 Skycar** figured prominently in our March 2000 magazine. The single-seat machine flew on the strength of four fans and could "take off from your backyard." It still hasn't landed.

2018

The **Uber Air** multirotor flyer vertically takes off and lands. The company aims to deploy fleets of air taxis in LA and Dallas in 2020, but the vehicles will be restricted to specific launch zones in the cities.

YEARS AWAY 0 5 10 15 20 25

WHAT'S THE HOLD-UP?

THE POINT OF FLYING CARS is convenience: to go up and over traffic instead of sitting in it. That means the craft's propulsion technology must be powerful enough to soar, but also safe, quiet, and nimble enough to land in a suburban driveway.

While startups have developed clever flight schemes, none has found the happy medium between auto and airplane. Silicon Valley company Opener has a single-seater that takes off vertically using eight rotors, but the contraption has no wheels, which means it is more like a personal helicopter than a road-ready rover. Boston-area startup Terrafugia makes the Transition, a two-seat vehicle with folding wings. With its fins deployed, it can fly up to 400 miles at altitudes of 9,000 feet. But there's a catch: In order to take off, you need a runway.

Even when the tech comes together, red tape could keep cars grounded. The National Highway Traffic Safety Administration and the Federal Aviation Administration have to clear flying autos. Michael Hirschberg, of the Vertical Flight Society engineering consortium, says approval is at least a decade away. Terrafugia is the closest to finishing its paperwork, and Opener has clearance in Canada only.

PHOTO CREDITS ON P. 122

PROMISING TECHNOLOGIES

1

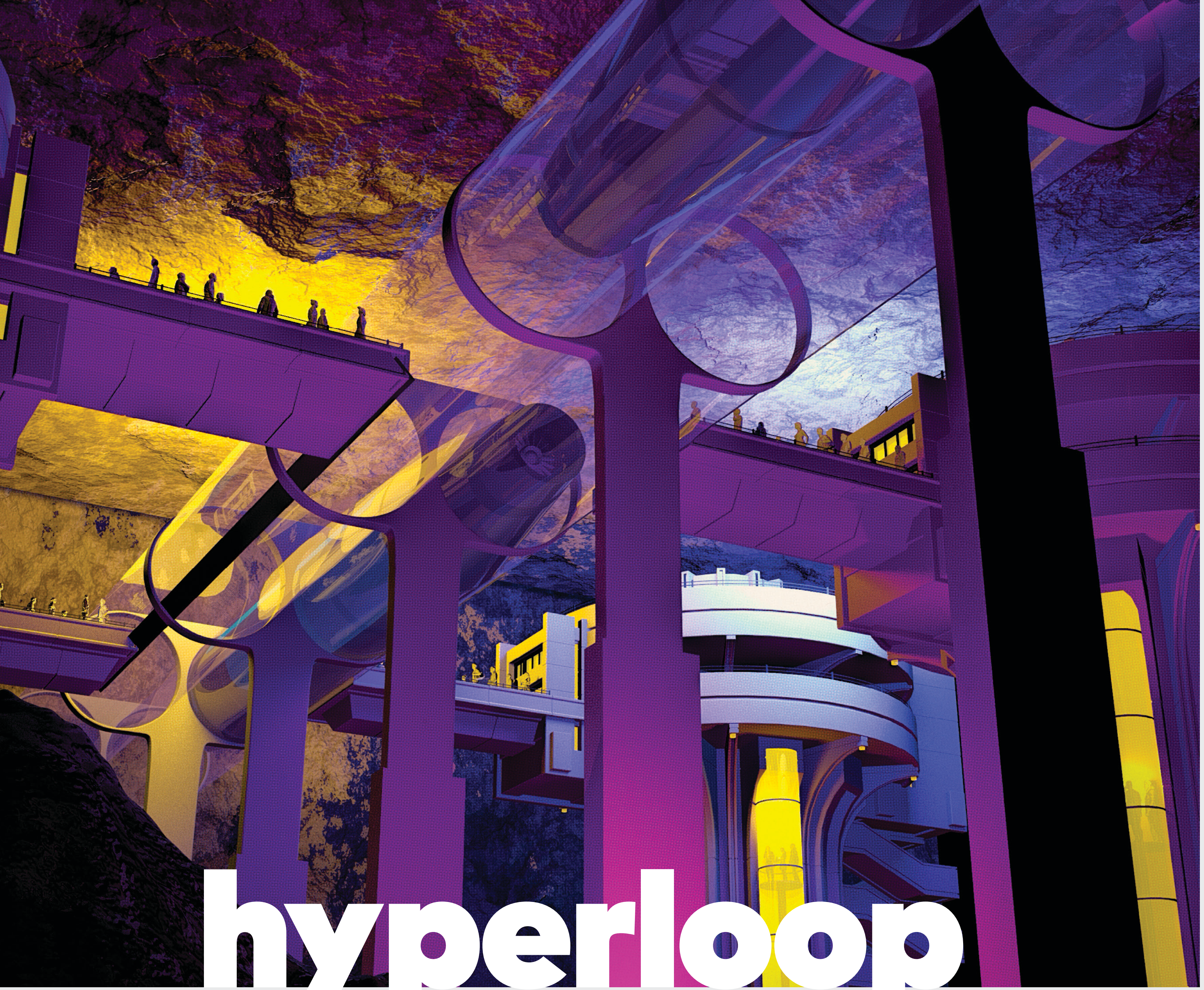
BETTER BATTERIES

Flying cars need to run on electricity, lest their engine noise rattle suburbanites. But today's best cells—such as the lithium-ion phosphate ones Terrafugia uses—have just 2 percent of the energy density of fuel. Most startups add more packs, but that loads weight onto things that need to hover. The leap for air sedans will be a battery tech called solid-state. Solids can take higher temps, and hotter batteries tote more energy. Trouble is, nobody's made one that can hold a charge.

2

MORE POWER

Vertical takeoff makes the most sense for airborne autos cars. However, using a single motor or engine to hoist a chassis plus passengers would devour energy. For its upcoming Nexus hybrid craft, Bell Aerosystems is borrowing an efficient liftoff scheme popularized by drones: quadrotors. In the setup, multiple props both share the load and help stabilize the craft. A planned air taxi from Uber will take off the same way, then cruise aloft fixed wings.



hyperloop

YEARS AWAY 0 5 10 15 20 25

PROMISING TECHNOLOGIES

1

CRAFTY LEVITATION

Hyperloops will float above the tracks via levitation schemes like Inductrack rails. Rather than relying on two sets of repelling magnets to lift a capsule, the setup arranges one group on the bottom of the train at right angles—a matrix called a Halbach array—and places wire coils in the rails. At low speeds, motors slide capsules along the track. At about 45 mph, an electromagnetic field between the car and coils forms, raising the train.

2

REAL VIBRANIUM

Regularly traveling at Mach 1 would cause many materials to buckle or crack. Instead, Hyperloop Transportation Technologies covers its capsules in a patented composite it calls Vibranium. (Yes, just like the fictional ore that powers Wakanda in *Black Panther*.) Not only is the carbon-fiber-based compound 10 times stronger than steel, it's also one-fifth the weight. Plus, sensors laced throughout check structural integrity.

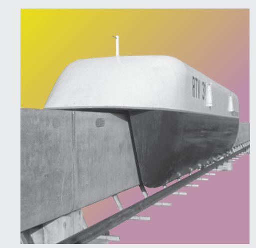
CONCEPTS & PROTOTYPES

The dream of zippy commutes through underground vacuum tubes is nearly 150 years old.

1870

Inventor Alfred Ely Beach earned a patent for his **Pneumatic Transit** tech, which got power from large fans at opposite ends of buried vacuum tubes. He secretly built a demo tunnel in New York City.

1970



The **Tracked Hovercraft** was supposed to cut the trip from London to Edinburgh to 90 minutes. Oscillating magnetic fields would have allowed the abandoned concept to zip at 100 mph or more.

2010

Max Schlienger's **Vectorr** train floats along magnetic tracks, powered by air pressure from vacuum pumps. He's got a one-sixth-scale model running through his Napa, California, vineyard.

WHAT'S THE HOLDUP?

HYPERLOOP CAPSULES ZOOM at the speed of sound along magnetic rails through underground pneumatic tubes. Or as Elon Musk tweeted during his 2013 unveiling: "A cross between a Concorde and a rail gun."

Musk anticipated his ambitious idea would have a greater chance at success if several groups worked on it concurrently, so he made the project open-source. Also helpful: Versions of the requisite hardware were already out there. Electric motors will send the capsules down aluminum tracks, magnets will provide levitation, and bunches of conventional vacuum pumps will suck all the air out of Hyperloop tunnels to create a nigh-frictionless atmosphere.

The biggest physical challenge is digging the passageways, though it's more a financial woe than a technical one. Musk's venture for this grunt work, the Boring Company, quotes each mile of tunnel at $1 billion, but that might be a lowball: Consider that New York City spent $2.5 billion per mile to build its Second Avenue subway line.

Hyperloop projects have also had false starts. The Boring Company scrapped plans in West LA rather than chew through a legal dispute with locals. Yet some companies are optimistic. Hyperloop Transportation Technologies will break ground in China and the United Arab Emirates this year, and CEO Dirk Ahlborn is already talking launch dates. Ebullience is good, but we still haven't seen so much as a test run.

jetpacks

YEARS AWAY 0 5 10 15 20 25

WHAT'S THE HOLD-UP?

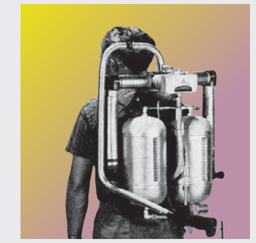
IN 1958, *POPULAR SCIENCE* predicted humankind's "age-old dream of flying like a bird...may be nearer than we think." Within three decades, jetpack test pilot William Suitor hovered over the opening ceremony of the 1984 Los Angeles Olympics. Even so, our prediction was a bit overblown: Suitor's moment of glory—bogged down by inefficiency and 120 pounds of kit—lasted 20 seconds.

Jetpacks have inched toward liftoff since Suitor's stunt. His model used pressurized hydrogen peroxide for fuel, while today's rocket suits rely on more-efficient kerosene or diesel to fly for 10 to 20 minutes. But modern crafts have made only marginal leaps on other issues. Being literal rockets, the packs are noisy; Suitor's belt screeched at 130 decibels, and Jetpack Aviation's current model is a slightly muffled 120 decibels. They're heavy too. The machine Jetpack Aviation CEO David Mayman used to buzz the Statue of Liberty in 2015 is 85 pounds—better, but still crushingly large. And, even if your body can carry the weight, your wallet might collapse under the cost. Entry-level packs run around $250,000.

CONCEPTS & PROTOTYPES

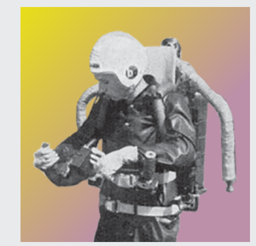
Getting jetpacks off the ground was the easy part. Keeping them aloft takes some work.

1958



The U.S. Army commissioned **Project Grasshopper**—a crude rocket belt—from Utah-based Thiokol Chemical Corporation. The device got one minute of flight from five canisters of nitrogen gas.

1961



Pilot Harold Graham zoomed to 112 feet wearing the **Small Rocket Lift Device**. Developed at Bell Aerosystems, the device's propellant was stored in off-the-shelf air canisters.

2009

Raymond Li's **Jetlev-Flyer** was the first water-powered pack to go on sale. The catch: The 30-pound rig was tethered via hose to a boat, which housed an engine to pump the water for thrust.

PROMISING TECHNOLOGIES

1

FLY-BY-WIRE CONTROL

Winged vehicles steer via adjustable flaps. In the past, the systems used mechanical hardware such as pulleys and cables, but newer "fly-by-wire" tech replaces that with electric switches and motors. Crafts are lighter and nimbler, and pilots no longer need to yank cables to maneuver. Go left? Turn a stick or push a button. Martin Aircraft's packs use the tech. "When I'm hovering, I can almost completely let go of the controls," test pilot Paco Uybarreta says.

2

MINI MOTORS

Propelling human flight for longer than 20 seconds requires something better than pressurized fuel. Turbojets are miniaturized gas- or diesel-powered engines that generate thrust by compressing air through a turbine. Their power-to-weight ratios help trim down packs. Those on Jetpack Aviation's suits weigh 20 pounds and generate 180 pounds of thrust—enough to put the engine, plus the added heft of fuel, flight systems, and a pilot, into the air.

self-driving cars

YEARS AWAY 0 5 10 15 20 25

WHAT'S THE HOLDUP?

IN EARLY 2018, it seemed like autonomous cars were ready to hit public roads. Then a self-driving Uber struck and killed a woman one night in Tempe, Arizona. The incident got folks worried (more on p. 44) and also highlighted this tech's big flaw: It cannot reliably recognize hazards in all conditions. Even an untimely glare can mess with a car's perception.

All-the-time autonomy relies on a suite of tech. GPS tells the car the best route, while sensors—radar, lidar, and cameras—spy obstacles. An artificially intelligent computer processes those inputs to make rapid decisions: slam the brakes for a person, or go through a leaf.

Vehicles must train for hundreds of thousands of hours to learn every hazard in every condition. Automakers can log that time more quickly by putting prototypes on the road. This was Uber's approach, but after the 2018 accident, it hit the brakes. It's rolling out a more conservative relaunch in Pittsburgh sometime this year. Cars will drive only during the day, in clear weather, and below 25 mph. While Uber reboots, Waymo—the Google spinoff—might win the race: It's testing in 25 cities, and launched a robo-taxi service this past December in greater Phoenix.

Still, run-anytime models are decades away. "For a car that can drive up to 65 mph in rain and snow, it will be a long time," says Huei Peng, director of autonomous vehicle testing at the University of Michigan. Waymo's CEO recently made a bleaker forecast: It may never happen.

PROMISING TECHNOLOGIES

1 CHEAPER SENSORS

Electronic eyes provide a full picture of the road, but the combined cost of high-res cameras, radar, lidar, and other sensors totals (conservatively) $75,000. Optics engineers are working on less-spendy versions. Waymo, for one, has claimed it's made a rooftop spinning lidar for just $7,500. Autonomous vehicle companies keep in-house development hush-hush, but, as engineers keep tinkering, the costs will drop further.

2 BRAINIER MOBILE BRAINS

Driverless cars parse sensor data into navigational cues with a type of AI called a neural network. The brainlike system must ID every view of a jaywalker amid every combination of weather and lighting, and then—within milliseconds—swerve, brake, or plow ahead. Programmers have been training networks to drive since the '80s, but on old, slow chips. Today, thanks in part to video games, graphics processors are speedy enough to read the road.

CONCEPTS & PROTOTYPES

Robots have been in driver's ed since the midcentury, but they're still not ready to graduate to public roads.

1958

Engineers measure autonomy from zero (full human control) to five (total robo driver). The first step is taking your feet off the pedals, as drivers did when cruise control debuted on late-'50s **Chryslers**.

1989

As autos reach level 2, they learn to see the world and recognize basic hazards. Sensors and a computer brain on **Carnegie Mellon's ALVINN**, a retrofitted ambulance, let it navigate the campus.

2007

To reach levels 3 and up, cars must handle routes without much (if any) help. The **Carnegie Mellon Boss** mastered a 55-mile course filled with traffic signals—and other vehicles.