Leading innovators talk about how stories of

HOW FICTION PUTS THE

SOME PEOPLE DISMISS SCIENCE FICTION AS FRIVOLOUS KID STUFF OR A POOR SUBSTITUTE FOR SERIOUS LITERATURE.

It's just as easy to defend the genre by concentrating on how it can "predict" the future. There's a long list of gadgets and inventions that were first discussed in science fiction: geosynchronous communications satellites, computer worms, Segways, wall-mounted home theaters, exoskeletons, flip phones, virtual worlds, and organ harvesting, to name just a random sample. It's said the chief reason Charles Prior Hall could not defend his patent for the waterbed was that Robert Heinlein had first described it more than 25 years earlier.

Science fiction makes imaginary worlds sometimes too real. In 1944, the magazine *Astounding Science-Fiction* published a story that described the workings of an atomic bomb (based on published papers) and illustrated it with a mushroom-shaped cloud. The magazine received a visit from the FBI agents looking for a security breach.

the future inspired them to reimagine the present.

SCIENCE IN ENGINEERING

BY ALAN S. BROWN AND BRITTANY LOGAN

Eye Robot
Television shows inspired Cornell's Hod Lipson to study robotics and 3-D printing.
Image: Jason Koski, Cornell University

Even so, looking at the science fiction that way misses the larger point. "A good science fiction story should be able to predict not the automobile but the traffic jam," Frederik Pohl, a master of the craft, once said.

What makes science fiction valuable is not that it produces predictions, but that it provides inspiration.

It's easy to see this in the names of companies and products. For example, iRobot, maker of the ubiquitous Roomba as well as military robots, is a sly nod toward Isaac Asimov's groundbreaking book, *I, Robot*. (The modem manufacturer U.S. Robotics took its name from a company in that book.) Big data pioneer Palantir Technologies is named after the seeing stones in *Lord of the Rings*. "TASER" was originally an acronym for "Thomas A. Swift's Electric Rifle." Even the terms robot and android were popularized in fiction before they were adopted by technologists.

Science fiction's power of inspiration also comes up in discussions with engineers and innovators. Ask them, and they will tell you how it unlocked their dreams and set free their imaginations.

We know that because we asked. On the following pages, seven engineers and inventors explain how science fiction affected their futures.

ADAM STELTZNER

CURIOSITY LEAD ENGINEER
NASA JET PROPULSION LAB

INFLUENCES: *LUCIFER'S HAMMER, RINGWORLD, CONTACT*
CURRENT FIELD: *AEROSPACE ENGINEER*
BIGGEST SURPRISE: *INTERNET, SMART PHONES*

I could not have predicted the path to my profession at age 18 or age 25. I did poorly in high school, and wanted to be rock star. The head of one school informed my parents that their boys weren't very bright and should go to trade schools.

In my twenties, I became intrigued by the motion of the stars. In class, I had paid so little attention that I missed the part in high school about the Earth rotating and revolving around the sun. Before I could take astronomy, I had to take physics. That's when I discovered that the universe was governed by a set of laws that were ultimately knowable, and I wanted to explore them.

That's when I started reading science fiction. I was a big fan of Larry Niven's *Lucifer's Hammer, Ringworld,* and his *Known Space* stories. I really liked Carl Sagan's *Contact*. I was intrigued by having a job where somebody might put you in a helicopter and send you somewhere exotic because you could tell them what is going on.

Science fiction gave me models of smart people using their smarts, usually in some technical way, to figure out problems and exploit that. That model of a smart guy as a hero motivated me.

Science fiction also allows me to ponder what might be. My favorite stories have me trying to figure out what is far out and what might actually be possible.

If I could have any sci-fi invention, it would be a flying car. It would give me the ability to use all the three-dimensionality of this world to get around all the bumps and wrinkles and curves.

As for the biggest surprise that I didn't see coming, it has to be the Internet and smartphone. It lets us access instantly, from any setting, almost any information created by humanity. If you lived in ancient Rome, you would have had to journey to the library in Alexandria. Now, that information is in your hands. ■

Curiosity Cat: Steltzner demonstrates how a NASA probe would land on Mars. *Image: NASA*

INFLUENCES: STAR WARS
CURRENT FIELD: ROBOTICIST
BIGGEST SURPRISE: INTERNET'S BOOST TO MACHINE INTELLIGENCE

HELEN GREINER

CEO, CYPHY WORKS INC.
CO-FOUNDER AND CHAIRMAN, iROBOT

I saw *Star Wars* when I was 11, and I wasn't enthralled by Princess Leia. I was really, really taken with R2-D2. He was one of the main characters, he had an agenda, he was cute, he was funny, and he was more than a machine.

I decided that I wanted to build R2-D2 and I ended up building robots for a living. It's a pretty direct correspondence. My dad had an early RadioShack computer, so I could see that computer technology could be the basis of building a robot. It had a cassette drive, so I could see how you could control a mechanical device.

But I had no idea how hard building robots would be. At MIT, I learned about everything, from computer chips and electronic design to dynamic controls and real old-school mechanical design. But it gets even harder when you have to integrate all these things while considering price point, user interface, and user experience.

After school, we started a company called iRobot. Our best known products are the Roomba vacuuming robot and the military robot that blows up bombs. I claim that between the two of them, we're closer to R2-D2 than anybody's gotten. That's because the Roomba's got the beeps and boops and a little bit of the personality—people name them—and the military robots are very capable, and can go out and save people's lives.

If I could choose a sci-fi invention to make real, well, I'd like to see R2-D2 invented. There is not a lot that has really surprised me about today's technology, but if I had to pick one thing, it would be the machine intelligence gains through web searching. We are able to use the contents of the entire Internet to provide intelligence for machines, and also, hopefully at some point, for robots. ■

> "I DECIDED THAT I WANTED TO BUILD R2-D2 AND I ENDED UP BUILDING ROBOTS FOR A LIVING.

More Than Machines: Star Wars characters R2-D2 and C-3PO (right) inspired Greiner (inset above) to develop real-life robots that are both capable and personable. *Images: Helen Greiner (inset), iRobot (above), Copyright Lucasfilm Ltd. (right)*

"AT THEIR BEST, BOTH HOLLYWOOD AND ENGINEERING HAVE SIMILAR GOALS—TO EXPLORE WHAT COULD, ONE DAY, BECOME REALITY.

Tea. Earl Grey. Hot: Lipson (inset below) thought he could outdo Star Trek's replicator.

HOD LIPSON

PROFESSOR, MECHANICAL & AEROSPACE ENGINEERING AND COMPUTING & INFORMATION SCIENCE
DIRECTOR, CREATIVE MACHINES LAB
CORNELL UNIVERSITY

INFLUENCES: SIX MILLION DOLLAR MAN, STAR TREK
CURRENT FIELD: ROBOTICS, 3-D PRINTING
BIGGEST SURPRISE: MACHINE INTELLIGENCE

In our apartment building's large back yard, dozens of kids were chasing each other around in a frenzy. But there was something odd about their expressions and the way they moved. They all ran in slow motion, making strange clicking sounds as they awkwardly tried to leap through the air.

It was the late '70s, and we were emulating Steve Austin, the half-human/half-machine *Six Million Dollar Man*. Those episodes paled in comparison to today's lucid animatronics. They left a lot to the imagination, and that, exactly, was their power.

Steve Austin got me thinking about robotics, what I would do if I had access to "bionic" technology, and how I would make it better. Over time, though, realism (and the laws of physics) set in. I realized that fiction sometimes gets it wrong: Some things can't be done, like time machines or *Star Wars*' gravity-defying hovering carts. But there were also good surprises, where fiction underestimated what we could do.

Take 3-D printing. Everyone compares *Star Trek*'s replicator to today's 3-D printers. But I was disappointed as *Star Trek*'s crew used the replicator to make Earl Grey tea or, on a good day, a slice of cheesecake. But why settle for replicating existing things when you have a machine that can make anything? We could do better, and we have.

Robots have an interesting duality in science fiction. On one hand, sci-fi often portrays robots as practical, useful machines for factories, home, remote planets, and intergalactic warfare. But it also portrays robots with a more humanistic nature, intelligent machines that learn, have feelings and opinions, and exhibit empathy, curiosity, and even creativity. These two roles reflect our lab's own research goals, and drive our thinking today.

Perhaps, Hollywood directors, sci-fi writers, and engineering researchers are not that different. At their best, both Hollywood and engineering have similar goals—to explore what could, one day, become reality. ■

GARRETT BROWN

INVENTOR OF THE STEADICAM AND HOLDER OF 50 CINEMATOGRAPHY PATENTS
MEMBER, INVENTORS HALL OF FAME

INFLUENCES: *TOM SWIFT, JULES VERNE, ROBERT HEINLEIN, ISAAC ASIMOV, A.E. VAN VOGT*
CURRENT FIELD: *INVENTOR*
BIGGEST SURPRISE: *JUST ABOUT EVERYTHING*

I was a reader from way back. My grandmother had a wonderful library, where I read everything from *Diary of Samuel Pepys* to the Tom Swift books and Edgar Rice Burroughs. There was not a shred of science in any of their fiction. I also read a lot of Jules Verne with the original illustrations, and later discovered A. E. van Vogt, Robert Heinlein, and Isaac Asimov.

The story that really got to me was Fritz Lieber's "A Pail of Air." Every part of the science was understandable to a 10-year-old kid. The Earth had been wrested away from the sun by an interloping body, and the atmosphere freezes. The only way the protagonists survive is by walling off a space and insulating it, then constructing a fireplace with a miniscule draft and feeding it with pails of frozen oxygen.

The protagonist had invented something he wanted and needed himself. That principle stuck with me. If you try to invent something for money, you're stuck if it doesn't sell. But if you invent it for yourself, at least you have one customer.

Sweet Science: Brown (left) used his first invention, the Steadicam, on location with Sylvester Stallone during the filming of Rocky. *Images: Garrett Brown*

> "EVERY PART OF THE SCIENCE WAS UNDERSTANDABLE TO A 10-YEAR-OLD KID.

After dropping out of school to be a folk-singer, I decided to make videos. So I bought some books, which were all from the 1940s, and taught myself to be a 1940s filmmaker with a huge dolly. My first invention was the Steadicam, because I wanted to ditch the dolly and make something hand-held that was smooth enough to use professionally.

Just about everything I imagined has been so surpassed by reality, it would have shocked me when I was a kid. But if I could have anything from the books I read when I was young, it would be antigravity. I would name my craft *La Gondola*. It would be a polished aluminum disc with windows, and it would be stable enough to have a pool table. ■

Ice Cream Social: There are elements of Star Wars in all of Hong's robots. *Image: UCLA*

> "I FULLY EXPECTED STAR WARS AND STAR TREK TO BE THE FUTURE.

Nothing He Cannae Do: Pettis (inset right) realized that affordable 3-D printing could help bring about a Star Trek-style world.

I grew up with *Star Wars*. I grew up with *Star Trek*. I just fully expected that to be the future.

I've always been a tinkerer just because I'm a tinkerer. So once I realized 3-D printing was possible at an affordable level, I got really excited about it. It meant that we could live in a *Star Trek* world, as if that world was real. You could think it and have it there in a moment.

As for science fiction inventions, I got started as a kid with the Apple II Plus. So for me, the future was already here. Computing existed; the game was on. Of course, I would also like to have human space flight worked out. And time travel would be nice. I would like to explore the worlds they opened up.

What has surprised me? It has to be all the electronics and software that are in the world right now. There are just so many possibilities. And we're just at the beginning. ■

INFLUENCES: *STAR WARS, STAR TREK*
CURRENT FIELD: *TECH ENTREPRENEUR*
BIGGEST SURPRISE: *ELECTRONICS AND SOFTWARE*

Image: Makerbot

BRE PETTIS

LEADER, INNOVATION WORKSHOP, STRATASYS
FORMER ART TEACHER AND PUPPETEER

DENNIS HONG

PROFESSOR, MECHANICAL AND AEROSPACE ENGINEERING
DIRECTOR, ROBOTICS AND MECHANISMS LABORATORY (ROMELA)
UNIVERSITY OF CALIFORNIA, LOS ANGELES

I watched the first *Star Wars* movie when I was seven years old, and it completely blew my mind. Not only the spaceships and all the battles, but really the two robots, R2-D2 and C-3PO. That very day, on the way home in the car, I told my mom and dad that I'm going to become a robot scientist. And I'm here today. If you look at all the robots that I've created, you can see traces of R2-D2 and C-3PO in my work.

I started out with, "Whoa, this is cool stuff!" Now I see them as inspirations for new technologies that can actually benefit people's lives. For example, I'm developing a humanoid disaster relief robot. If there's a nuclear power plant disaster, radiation will keep people away. Instead, we can send in the robot without risking human lives.

On the other hand, the killer robots in *Terminator* led me to raise ethical questions about my work. I do a lot of military projects, but I personally don't build weaponized robots.

I'm not saying that weaponizing robots is necessarily wrong.

INFLUENCES: *STAR WARS, TERMINATOR, ALIENS*
CURRENT FIELD: *ROBOTICS*
BIGGEST SURPRISE: *SMART PHONE*

Some people argue that robots could actually reduce civilian casualties [by identifying and reacting to enemies faster and less emotionally than humans]. I do not disagree. I just personally do not want to build robots that can hurt people. But *Terminator* made me realize that someone could use the firefighting robot I'm building to point a gun instead of a fire hose. Once it leaves my hands, I have no control over the technology.

What sci-fi invention would I want? That's a dangerous question. A time machine is likely to create more headaches than benefits. So maybe an exoskeleton like the one Ripley wears in *Aliens*.

The smartphone is the invention that surprised me. It's mindboggling how much they cram into such a small device. My robots have to obey physical laws, but information does not, so the advancements come much faster. ■

ADRIAN BEJAN

PROFESSOR OF MECHANICAL ENGINEERING
DEVELOPER OF THE CONSTRUCTAL LAW OF DESIGN EVOLUTION
DUKE UNIVERSITY

INFLUENCES: *20,000 LEAGUES UNDER THE SEA, FIVE WEEKS IN A BALLOON, AROUND THE WORLD IN 80 DAYS*
CURRENT FIELD: *DESIGN ENGINEERING*
BIGGEST SURPRISE: *INTERNET AND WEB*

I grew up in Romania under communism, in Galati, a city on the Danube Delta. There were no passports, and we could not leave the country. But I could see ocean-going ships, their names and colors, and the foreign sailors in port. How they nourished my imagination!

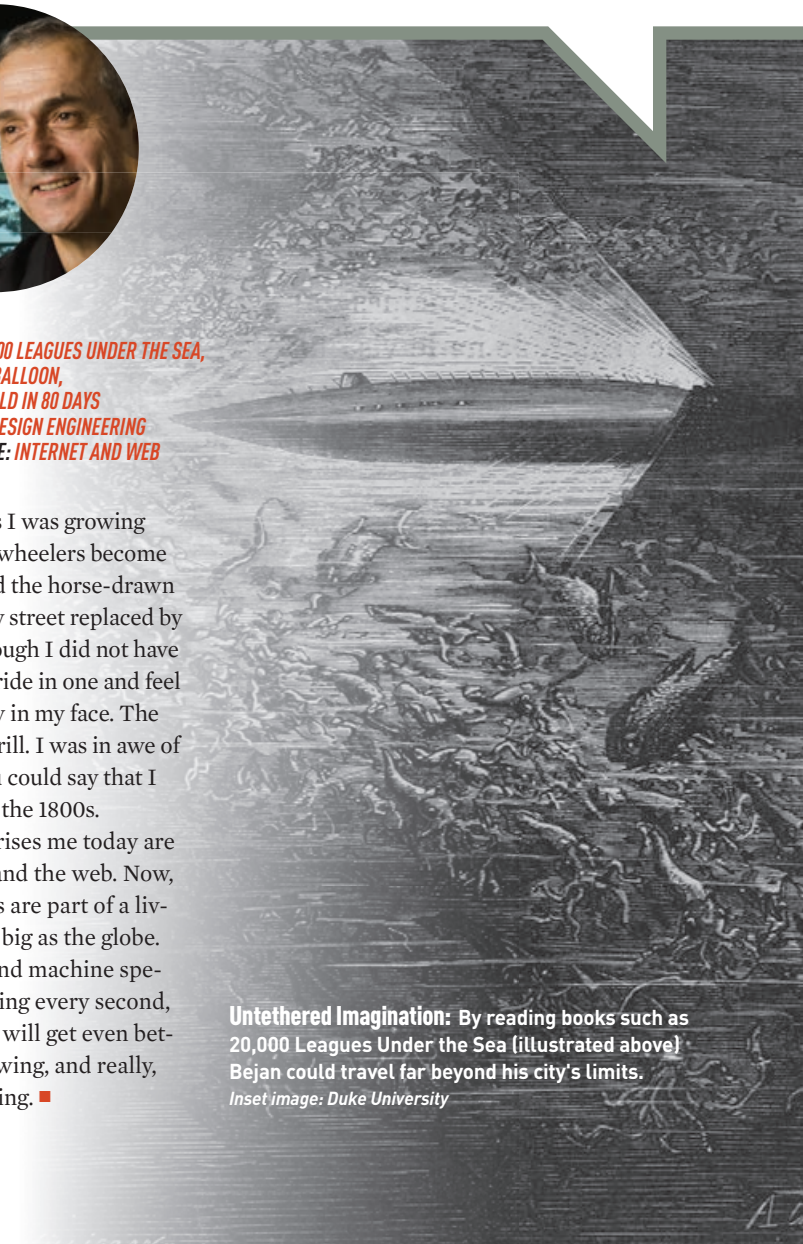
I was deeply into the novels of Jules Verne and other writers of my parents' generation. Under communism, these old novels were the only stuff worth reading. The kids in my neighborhood passed them from hand to hand.

Forget about my imagination! The books by Jules Verne had the original illustrations of Captain Nemo and the *Nautilus*, *Five Weeks in a Balloon, Around the World in 80 Days,* all these faraway places.

From these books I learned that the movement of the world was flowing. I could see it around me. When I was growing up, there were steamboat sidewheelers traveling the Danube. As I grew older, they were replaced by diesels. Right before I left, hydrofoils appeared. I saw for myself the evolution that was visible in the imagination of Jules Verne and the machines of Da Vinci.

I never had an urge to see my books' inventions in reality, perhaps because that urge was satisfied by progress as I was growing up. I saw sidewheelers become hydrofoils and the horse-drawn wagons on my street replaced by cars. Even though I did not have a car, I could ride in one and feel the wind blow in my face. The train was a thrill. I was in awe of airplanes. You could say that I was rooted in the 1800s.

What surprises me today are the Internet and the web. Now, human beings are part of a living system as big as the globe. The human and machine species are evolving every second, and I know it will get even better. It's all flowing, and really, really surprising. ■



Untethered Imagination: By reading books such as 20,000 Leagues Under the Sea (illustrated above) Bejan could travel far beyond his city's limits.
Inset image: Duke University