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## And Tomorrow's Winners Will Be...

By CHRIS GAY

It's one thing to know what innovations are winning awards today, but what if you could know what will win in, say, five or 10 years?

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—low-cost, easy travel to space and potential bases on the moon and, in the longer term, Mars—will involve substantial innovation."



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We don't have a crystal ball, but we have the next best thing: the informed opinions of people who are either innovators themselves or who study innovation in various fields.

Here are some of their thoughts on which areas—and possible companies—will see the most innovation in the years ahead:

### *Space Travel and Habitation*

"Commercialized space travel will see a lot of innovation," says Jeffrey Baumgartner, founder of the JPB innovation consultancy.

"Much of it will be incremental in nature, but the result —low-cost, easy travel to space and potential bases on the moon and, in the longer term, Mars—will involve substantial innovation."

Some firms to watch, says Mr. Baumgartner, are Space Exploration Technologies Corp., known as SpaceX, Virgin Galactic LLC and Bigelow Aerospace LLC.

Human habitation in space so far has taken place in rigid vehicles like the International Space Station. Bigelow, based in North Las Vegas, Nev., is developing inflatable modules that should be easier and cheaper to launch. Bigelow already is orbiting two unmanned, expandable prototypes and says it is planning assembly of four new spacecraft by 2015.

"The key here," says Mr. Baumgartner, "is that aeronautics is leaving government control and being taken over by industry, where cost-cutting and profitability, rather than contractors

milking the state for as much as they can get, will lead to a lot of innovation, affordability and efficiency."

### *Heavy-Lift Launching*

A critical obstacle to any sort of space-based future is getting some rather sizable objects beyond the reach of the Earth's gravity.

But Langdon Morris, a partner with the InnovationLabs LLC consulting firm, notes that while state-invested companies in the U.S., Russia and Europe have developed "heavy lift" launch capabilities, one private firm is moving to surpass them all in terms of payload capacity—an innovation that could slash launch prices and make larger payloads commercially viable.

SpaceX, of Hawthorne, Calif., says it hopes for a 2013 launch of its Falcon 9 Heavy rocket, which is designed to carry payloads of up to 70,000 pounds into low Earth orbit, about one-third more than the Space Shuttle, which is the largest-capacity launch vehicle now in operation.

"Cost-effective heavy-lift launch will enable new space commerce industries," says Mr. Morris.

### *Space-Based Solar Power*

"Once heavy-lift launch is solved, space solar power will be close behind," says Mr. Morris. "Space solar power could transform the Earth's economy."

The idea is for satellites in geostationary orbit to collect the sun's energy and convert it into radio waves for transmission to surface stations, where it will be converted into electricity for local power grids.

Mr. Morris thinks there are several companies that could achieve this.

One is Manhattan Beach, Calif.-based Solaren Corp., which last year reached an agreement to sell 200 megawatts of electricity a year to California's largest utility, Pacific Gas & Electric Co., for 15 years, starting in 2016. Solaren says it plans to test key systems and deployments in space in 2014, and launch its Space Solar Power Plant into geostationary orbit in 2016.

A competitor, Switzerland-based Space Energy Group, says it hopes to launch a test satellite within three years, assuming it gets expected funding.

### *Nano-Scale Medical Devices*

With advances in nano-scale engineering, medicine is about to redefine "minimally invasive," says Francis Collins, former leader of the Human Genome Project and current director of the National Institutes of Health.

Dr. Collins notes that Johns Hopkins University researcher David Gracias and his colleagues are developing a new class of nano-scale tools for surgery and drug delivery.

"The drug-delivery devices are small enough to fit through a hypodermic needle, thereby facilitating minimally invasive implantation and guidance in hard-to-reach microspaces," says Dr. Collins.

### *New Treatment for Blindness*

Dr. Collins also sees possible breakthroughs in the work of Ehud Isacoff, John Flannery and their colleagues at the University of California, Berkeley, who are working on a novel therapy for blindness.

Their technique involves introducing light-sensing molecules, or "photoswitches," into retinas that have lost photoreceptor cells. The photoswitches can be used to control the activity of proteins in the eye that are essential to transmitting information from the outside world to the brain in normal vision.

One such protein, the glutamate receptor, has been put under the control of a photoswitch and introduced into the retinas of mice. The photoswitch turns the glutamate receptor on or off by changing its shape depending on the wavelength of light used—a technique that's been shown to induce light sensitivity in blind mice. Mr. Isacoff

says technologies of this type could one day treat blinding diseases in humans such as retinitis pigmentosa.

"The downstream retinal neurons that receive and process information from photoreceptor cells are preserved for years after the onset of blindness," says Dr. Collins, "giving hope that visual sensitivity might be restored by allowing the artificial input of information to these surviving cells."

Several retinal prosthetic devices have been under development, but their optical resolution has been poor and they present challenges in achieving long-term compatibility with host tissue, Mr. Isacoff says.

### *Breakthrough Fuel Technologies*

Two firms could provide significant breakthroughs during the next few years in the search for cleaner fuel technologies, says Andrew Shapiro, founder and president of GreenOrder, a unit of consulting firm LRN that promotes corporate environmental sustainability.

In the race toward off-the-grid, personalized power stations, Sun Catalytix Corp., of Cambridge, Mass., is challenging the dominant notion of batteries as a means of electrical energy storage.

The company is developing a system that would use power from solar panels to split water into hydrogen and oxygen, then store both in tanks for use in generating power when the sun goes down.

Meanwhile, Amyris Inc., of Emeryville, Calif., is developing genetic-engineering technologies that change the way microbes process sugar, turning them into "biorefineries" that could provide alternatives to products derived from petroleum.

The company has filed with the Securities and Exchange Commission to raise about \$120 million through an initial public offering of shares, and it recently received a corporate innovation award from the Aspen Institute.

### *Adaptive Learning*

Education, like most other services, could become more tailored to individual needs. That's difficult in the low-tech, labor-intensive context of the traditional classroom, but "adaptive learning" could change everything, says Michael Horn, co-founder and executive director of the Innosight Institute, a nonprofit think tank.

The technology—an amalgam of computer science, education and cognitive science—uses both desktop and Web-based programs that in some ways mimic the interactivity of human teachers.

"Start-up companies like Knewton and Grockit as well as stalwarts like Kaplan are starting to push in this area," says Mr. Horn, "and there promise to be breakthroughs in the next five years."

One breakthrough could be a platform that tracks and analyzes the progress of individual students, allowing teachers to customize lessons to the individual. There's no clear leader here, says Mr. Horn, but outfits like Agilix Labs Inc., Nixty, L Point Solutions Inc. and IQity & Co. are making early waves.

*Mr. Gay is a writer in New York. He can be reached at [reports@wsj.com](mailto:reports@wsj.com).*

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