

DANIEL BURRUS'

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THE BIG IDEAS THAT ARE
CHANGING EVERYTHING

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3D Printing - Turning the Impossible Into the Possible

By Daniel Burrus, CEO of Burrus Research

What if you could deliver your product to your customer the moment it was manufactured? What if your customers could manufacture a replacement part whenever they need one? What if doctors could manufacture a body part, personalized for the individual patient, in the hospital at a moment's notice?

The answer to all of these seemingly impossible questions is: It's already happening thanks to 3D Printing.

3D Printing is the popular name for additive manufacturing, and it represents a true revolution in global manufacturing that will create both major disruptions as well as amazing new opportunities.

I have been covering 3D Printing for over 20 years in my *Technotrends Newsletter*, and at first the technology was used for rapid prototyping. Over the past few years, however, rapid advances in processing power, storage, and bandwidth have catapulted this technology into a tool for manufacturing finished products that include jewelry, shoes, dresses, car dashboards, parts for jet engines, jawbones for humans, replacement parts for synthesizers, and much more.

What Is 3D Printing?

When people first hear that you can manufacture something by printing it, they have a hard time visualizing it. Think of it this way: 3D printers build things by depositing material, typically plastic or metal, layer by layer, until the prototype or final product is finished. When the design is downloaded into the printer, a laser creates a layer of

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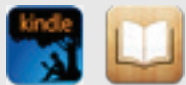
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TECHNOLOGY NEWS HIGHLIGHTS

Carbon Fiber Wheel

A newly designed carbon fiber wheel that could replace your cars steel rims was recently unveiled, which offers improved ride, handling, braking and acceleration, yet is up to 50 percent lighter than aluminum counterparts.



Carbon fibers are strands of pure carbon, thinner than a human hair, which can be bundled together (2,000 to 50,000 at a time) and infused with resin to form a carbon fiber reinforced plastic (CFRP). Depending on the number of layers and orientation of fibers, varying combinations of strength, weight and stiffness – up to three times that of steel, aluminum or titanium – can be achieved, making them highly versatile materials. Because they have an almost infinite “fatigue life,” parts no longer need to be overdesigned to compensate for repeated stresses, and since CFRPs are highly corrosion-resistant, they also won’t degrade over the course of time.

For information: Carbon Revolution, 1300 Highland Avenue, Suite 215, Manhattan Beach, CA 90266; phone: 310-546-6000; fax: 310-546-6007; email: info@carbonrev.com; Web site: www.carbonrev.com

Smart Headlights

Researchers have devised a system that could make it much safer to drive in the rain at night by reducing the glare of headlights on falling drops of water.

When viewed with a high speed camera, rain appears as discreet droplets of water whose motion can be tracked using a predictive computer algorithm. The headlights consist of arrays of LEDs, which are selectively deactivated to avoid illuminating drops in their path. The net result is a flickering effect that is actually undetectable by the human eye, but cuts down substantially



on the distracting glare that can lead to accidents. At low speeds, the system was shown to eliminate 70 to 80 percent of visible rain while sacrificing only 5 to 6 percent of the projected light.

For information: Srinivasa Narasimhan, Carnegie Mellon University, Robotics Institute, 5000 Forbes Avenue, Pittsburgh, PA 15213; phone: 412-268-1199; email: srinivas@cs.cmu.edu; Web site: www.cmu.edu

Walkie Talkie Apps

Several companies recently introduced another way to communicate using your smartphone without paying for a plan or minutes used – turn it into a walkie talkie. And “why” you ask would you want to revert back to such a seemingly outdated form of communication?

For one thing, it’s easier, faster and more accurate than texting. All you do is press “Talk” and one second after you start talking your voice is audible to whomever you selected from your contact list. Another big advantage is that messages are transmitted via the Internet, so you can communicate over WiFi even when you’re out of cellular range or out of the country. In addition, walkie talkie time is not charged to your cellular minutes. But perhaps most importantly, it fosters a different type of communication. Instead of long conversations, users generally connect sporadically several times during



the course of a day. It’s like having an intercom that reaches around the globe.

For information: Zello Walkie Talkie; Web site: www.zello.com or Heytell; Web site: www.heytell.com or Voxer Walkie-Talkie; Web site: www.voxer.com

Reducing CO₂ from Coal

A group of physicists recently reported that refrigerating the emissions from coal-fired power plants could reduce the amount of carbon dioxide (CO₂) being pumped into the atmosphere by up to 90 percent. The system being proposed would capture CO₂ as a solid, then heat it to form a gas that could be transported by pipelines to remote storage facilities. The process would also be capable of removing other chemicals, such as sulfur dioxide, nitrogen oxides and mercury from exhaust gases.

Although there is a cost associated with the method (about a 25 percent reduction in efficiency) it is more than offset by the healthcare savings that would be realized through reducing emissions. Currently, in the U.S. alone, there are approximately 600 power plants using coal to generate electricity. The economic impact in terms of increased healthcare costs is as high as \$380 billion annually including an estimated 46,000 premature deaths, 540,000 asthma attacks, 1,300 visits to the emergency room and two million lost days at work and/or school.



For information: Russell J. Donnelly, University of Oregon, Department of Physics, 120 Willamette Hall, 1371 East 13th Avenue, Eugene, OR 97403; phone: 541-346-4226; fax: 541-346-5861; email: rjd@uoregon.edu; Web site: www.uoregon.edu or www.physics.uoregon.edu

Deep Diving Robots

For years, autonomous underwater robots have been used to search the ocean floor for rare-earth metals and other resources because they can go where humans never could. Now, the same company that has developed some of the most sophisticated marine robots in the world – including the first to reach the deepest recesses of the Mariana Trench – is developing a new technology to allow deployment of multiple robots at the same time.

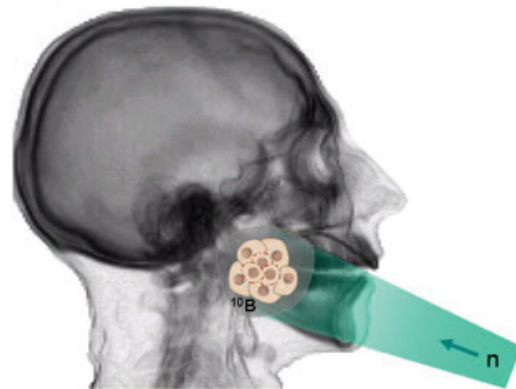


Using the new collision-avoidance system, for example, a five square kilometer area could be surveyed in a single day, making undersea exploration more productive and cost effective.

For information: Mitsui Engineering and Shipbuilding Co., Ltd., 6-4, Tsukiji 5-chome; Chuo-ku 104-8439, Japan; phone: +81-3-3544-3147; fax: +81-3-3544-3036; Web site: www.mes.co.jp/english/

Tumor-Specific Radiation

A new radiation therapy technology has been developed that is able to destroy tumor cells without damaging the surrounding tissue. Known as boron neutron capture therapy, it uses a particle accelerator to create neutrons rather than a nuclear reactor. Patients are injected with a boron-tagged chemical compound, which selectively concentrates in tumor cells. When irradiated, the boron reacts strongly with the neutrons to destroy only the cancer cells.

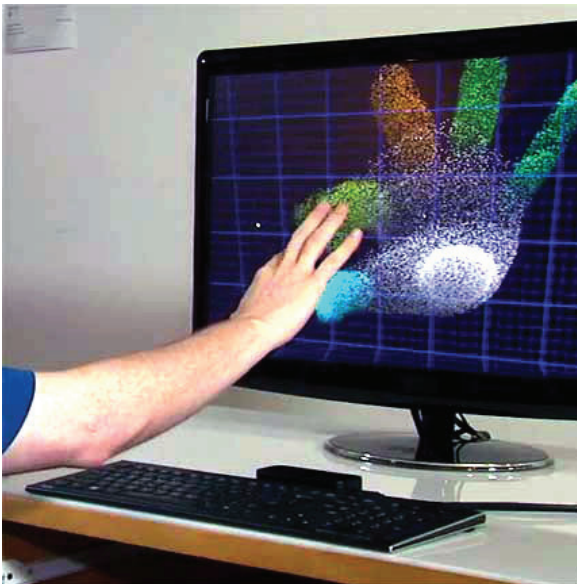


Using this technique, it will be possible to deliver two to three times the radiation typically administered over six weeks in a single hour of radiation therapy. Initial tests on brain tumors have resulted in tumor shrinkage of up to 70 percent. Clinical trials on patients suffering a relapse of glioblastoma are scheduled to begin in the near future.

For information: Osaka Medical College, 2-7 Daigaku-machi, Takatsuki City, Osaka 569-8686, Japan; phone: +81-72-683-1221; Web site: www.osaka-med.ac.jp/Global/

Controlling Computers with Hand Movements

While computing power has grown exponentially for decades, the way we interact with our computers has essentially stayed in one flat dimension by using a mouse, keyboard and recently touch. The next new thing in interactive computing devices is an iPod-sized USB peripheral called Leap, which creates an 8-cubic foot, 3-dimensional space that allows users to control their devices using hand movements. The system uses a 1.3 megapixel camera and infrared LEDs to detect movements as small as one-hundredth of a millimeter. It links to a variety of operating systems and even allows you to customize gestures. Multiple units can also be networked to expand the interactive area.



In addition to basic on-screen navigation, Leap could eventually be used for gaming, graphic design, virtual sculpting, and translating sign language into text. Its small form factor will also make it easy to integrate into

laptops and tablets. It's currently available at a retail price of \$69.99.

For information: Leap Motion, Inc., 333 Bryant Street, Suite LL150, San Francisco, CA 94107; email: info@leapmotion.com; Web site: www.leapmotion.com

Smart Carpet Detects Falls

Researchers recently demonstrated a new concept for carpeting that could not only identify when a person has fallen, but also identify subtle changes in the way they walk to predict potential future problems.



Optical fibers, which bend under pressure, are embedded into the carpet underlayment. The signals are relayed to a computer where a reconstruction software algorithm known as tomographic imaging is used to map walking patterns in real time. The technology could also be used to detect chemical spills or fires, and easily be retrofitted to living spaces or hospital wards. It has been estimated that more than half of hospital admissions in patients over 65 are due to falls, and that 30 to 40 percent of older adults living in assistive communities fall each year.

For information: Patricia Scully, Manchester University, Photon Science Institute, Alan Turing Building-3.322, Manchester, UK M13 9PL; email: patricia.scully@manchester.ac.uk; Web site: www.manchester.ac.uk

3D Printing

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material and fuses it...and then another and another... until the object is completed.

3D printers can range from the size of a microwave oven to the size of a car. A printer that can print a house by depositing cement, layer upon layer using a printer the size of a tractor-trailer, is already in development. Prices range from hobbyist kits for under \$1,000 to over \$100,000 for industrial versions.

Examples From Around the World

A Belgian company, LayerWise, used 3D printing to create a jawbone that was recently implanted into an 83-year-old woman. The jawbone was made of titanium and included all of the articulated joints and grooves needed for nerves, veins, and other internal workings of the jaw. The company is also printing spines for humans and bones for injured racehorses.



An Australian company, Inventech, has created what they call their 3D BioPrinters to print tissue structures using human tissue. For example, they can print 5 centimeters of artery for transplant in about 5 hours.

Bespoke Innovations is using 3D printing to create

prosthetic limb castings. They say that they will soon be printing the entire limb at a fraction of the cost it takes to manufacture limbs today.

Dutch fashion designer Iris van Herpen has printed dresses for Lady Gaga, and Dutch furniture designer Dirk van der Kooij has used 3D printing techniques coupled with robotics to print one-of-a-kind chairs, tables, and lamps using layers of thread as the production medium.



On-Demand Replacement Parts

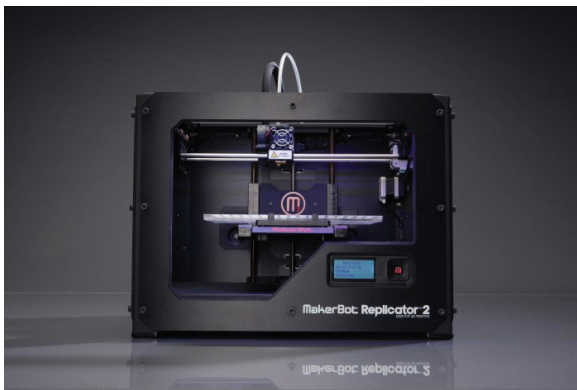
This amazing technology can also be used for on-demand printing of spare parts—something the U.S. military is already doing in the field. Knowing this, it is not hard to see that in the future, a manufacturer could sell a machine or system to a company, and as part of their maintenance and support contract they can put their 3D printer on-site with the licensed software to print replacement parts as needed.

On a smaller level, it is easy to see that service mechanics will have portable 3D printers in their vans or at their main office. Original equipment manufacturers (OEM) will most likely sell and license these printers to their dealer network.

It's also possible to scan an object or a part, convert it to a 3D printable CAD file, and then print a copy of the object in your location or in another location anywhere on the planet. Companies such as Replicator are already offering this as a service.

Social Manufacturing

Thanks to a number of companies such as MakerBot and Cube, which sell 3D printers for home hobbyists, open-source computer-aided design (CAD) software

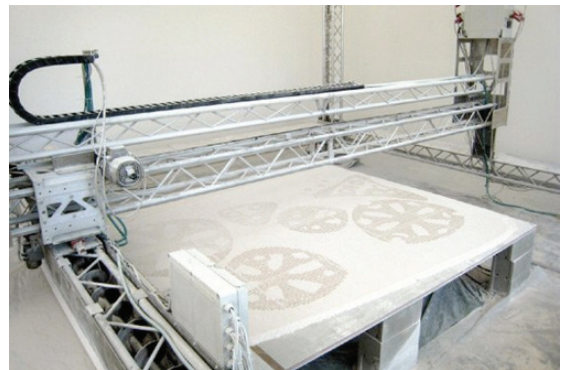


and websites where people can share their designs so that others can print them are now available. This is the beginning of social manufacturing.

In addition, there are already a number of companies including Shapeways and Quirky that will use their 3D printers to print the design you send them, and then they'll ship the final product to you. It's not hard to see that at some point Amazon will provide this service too.

Getting Ready for Tomorrow Today

3D printing is ideally suited for low-volume production, so it will not disrupt products that are best manufactured in mass. On the other hand, given the transformational nature of the technology, it's easy to see that rapid developments in distribution and just-in-time manufacturing will have an impact on the global supply chains as well as outsourced manufacturing. In order for the U.S. to stay competitive in this new field of manufacturing, the U.S. government, working with the private sector, has begun construction on the \$70 million National Additive Manufacturing Innovation Institute.



3D printing will definitely become more commonplace in the near future thanks to its many benefits, including the ability to print the complete part without assembly and the ability to print complex inner structures too difficult to be machined. Additionally, the entire process produces much less waste than traditional manufacturing where large amounts of material have to be trimmed away from the usable part.

Whether you call it 3D Printing or Additive Manufacturing, it is advancing quickly on a global level and offers something that up until recently was impossible: On-demand, anytime, anywhere, by anyone manufacturing.

