The Mini Page®
Betty Debnam, Founding Editor and Editor at Large

Science Fiction Turning Into Fact

Printing the Future in 3-D

In "Star Trek," if the crew wanted anything — blankets, a special meal, gemstones — the "replicator" could just pop it out. A few years ago, this sounded like far-out science fiction. But today this technology, 3-D printing, is just around the corner.

People are making houses, toys, jewelry, airplane parts and exact copies of dinosaur fossils with 3-D printers. NASA is running experiments on printing a moon base out of lunar soil, or any meal an astronaut wants. It is sending a 3-D printer to the space station to learn how astronauts can create replacement parts and tools.

But the most exciting possibilities for 3-D printing are in medicine. Scientists are testing hundreds of different ways 3-D printing could help heal people. It could create exact artificial copies of a damaged arm or leg. It could copy cancer tissue so doctors could figure out the best way to kill it. Someday, we may even be able to re-create whole organs for people needing a new liver or heart.

To learn more about this amazing new technology, The Mini Page talked with an expert on 3-D printing from the Medical University of South Carolina in Charleston.

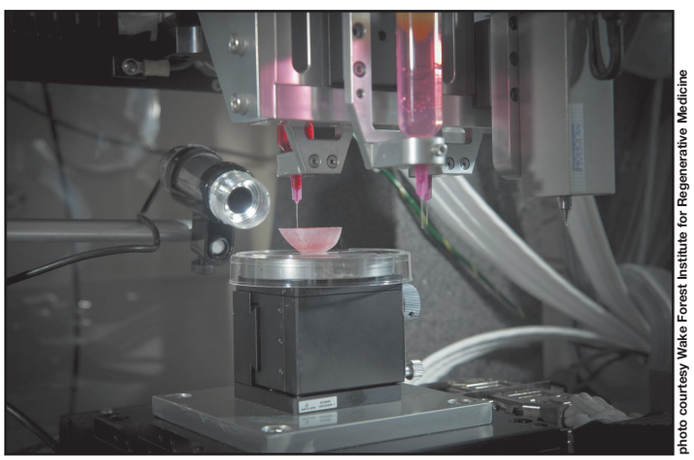

photo courtesy Wake Forest Institute for Regenerative Medicine

A 3-D printer at the Wake Forest Institute for Regenerative Medicine in Winston-Salem, North Carolina, prints an experimental kidney.

In 2000, a medical researcher, Thomas Boland, invented the first general bioprinter by remodeling a regular inkjet printer. He replaced the ink in the cartridges with living cells.

When 3-D printing uses living tissue, it is called *bioprinting*. The material used to print the living tissue is called *bioink*.

What's the difference?

In 2-D printing, the letters or pictures are printed on a flat sheet of paper. They are in two dimensions: length and width.

In 3-D printing, objects have a third dimension: depth. Objects printed in 3-D are more like sculptures.

A 2-D printer receives computer commands telling it where to place tiny bits of ink. One by one, these ink drops create letters or pictures.

A 3-D printer receives computer commands telling it where to place tiny bits of materials. The materials can be almost anything, from plastic, to living cells, to metal. The 3-D printer puts down the materials one layer at a time, building up the object.

Adding layers

Objects can be made in almost any shape. Because material is added in layers, this type of printing is also called **additive manufacturing**.

The first 3-D printers came out in the 1980s, but in the last few years, the equipment has become much better and much less expensive. New, inventive ways to use this technology are being discovered all over.

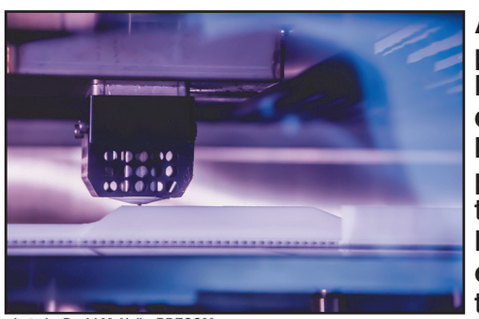

photo by David McNally, RDECOM

A 3-D printer head drops bits of plastic to build layers of a tool.

From Plastics to Living Tissue

Artificial body parts

With 3-D printing, making **prosthetics** (prahs-THEH-tiks), or artificial body parts, is much cheaper. For example, with traditional manufacturing, a prosthetic child's hand might cost $25,000 to $50,000. As the child grows, the hand would have to be replaced over and over. This could get very expensive.

With 3-D printing, a prosthetic hand might cost $5. Experts believe such inexpensive prosthetics will be easily available within 10 years.

A 3-D printed part can be made to fit each person's body exactly. This means the body part will work better and be more comfortable. A part could be built in a day.

Already, people are using 3-D-printed hands, arms, hips, teeth, skulls, knees and ears. These prosthetics are not living. Printing live limbs is many years away. But prosthetic 3-D body parts that move well could be available in a few years.

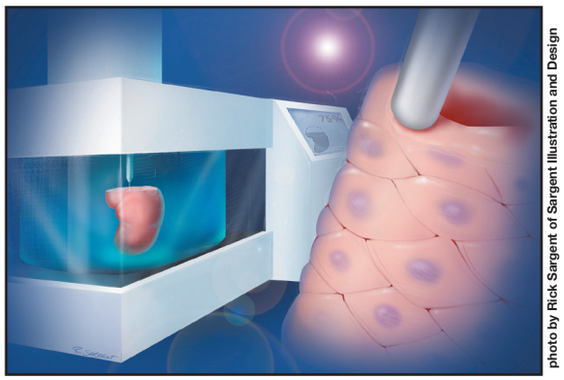

photo by Rick Sargent of Sargent Illustration and Design

This artist imagines a kidney being printed inside a special chamber on the left. To the right, a printer is putting down layers of cells to build a blood vessel at the Medical University of South Carolina.

Super models

Doctors are printing exact copies of body parts to help them learn. For example, they feed images of an injured heart into a computer. It creates a 3-D model from the images and sends the data to the printer.

Out comes an exact copy of the heart, letting the doctor practice on it without worrying about hurting the patient. This is especially valuable with unusual or tricky problems.

Printing with living ink

It is much harder to print with living cells than with other material. Living material needs to be nourished and kept moist. Body cells act together in ways we don't always understand.

Sometimes body parts are too complicated to print directly. For example, a blood vessel is hard to print. The printer makes a mold of the blood vessel first, then coats it with a special protein gel that needs to be kept alive. With this process, doctors saved a 2-year-old girl's life by bioprinting a windpipe for her.

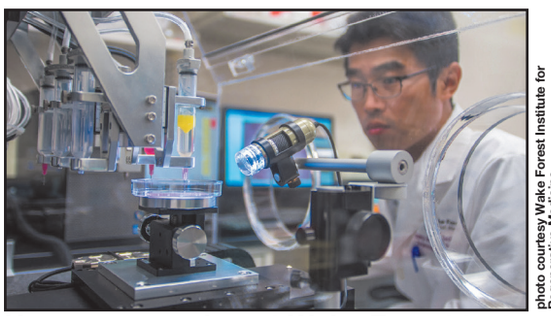

photo courtesy Wake Forest Institute for Regenerative Medicine

Here, a researcher at Wake Forest tests the printing of muscle tissue.

Ready Resources

The Mini Page provides ideas for websites, books or other resources that will help you learn more about this week's topics.

On the Web:

- cnn.it/1nMIJqy
- discovery.ca/dp/videos/?clipid=1064070

At the library:

- "Human Body" by Richard Walker
- "Scholastic Discover More: Technology" by Clive Gifford

Basset Brown's Try 'n' Find

3-D Printing

C	S	M	V	L	T	N	A	L	P	S	N	A	R	T
H	O	K	O	L	A	I	C	I	F	I	T	R	A	P
D	E	P	I	L	E	N	I	C	I	D	E	M	I	R
O	F	A	Y	N	D	S	E	U	S	S	I	T	N	I
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R	L	E	S	E	G	D	I	R	T	R	A	C	V	N
S	L	G	S	C	I	T	E	H	T	S	O	R	P	G

Words that remind us of 3-D printing are hidden in the block above. Some words are hidden backward or diagonally. See if you can find: ARTIFICIAL, CARTRIDGES, CELL, COPY, DIMENSIONS, DOCTORS, FAT, FIT, HEAT, INK, LEG, MATERIALS, MEDICINE, MOLD, PRINTING, PROSTHETICS, SKIN, TECHNOLOGY, TISSUES, TRANSPLANT.

Mini Spy

Mini Spy has created a 3-D print of her doll.

See if you can find:

- ❑ spoon
- ❑ cheese
- ❑ number 7
- ❑ letter A
- ❑ letter D
- ❑ knife
- ❑ flyswatter
- ❑ fork
- ❑ two fish
- ❑ pencil
- ❑ paperclip
- ❑ ladder
- ❑ letter E
- ❑ needle
- ❑ horse head
- ❑ seal

Rookie Cookie's Recipe
Creamy Corn Chowder

You'll need:

- 2 (14.75-ounce) cans creamed corn
- 2 (12-ounce) cans evaporated skim milk
- 1 red bell pepper, seeded and chopped
- 2 bay leaves
- 1 teaspoon dried minced onion
- Salt and freshly ground pepper

What to do:

1. In a medium saucepan, combine creamed corn, milk, bell pepper, bay leaves and dried onion. Cook over medium-high heat and bring to a simmer. Decrease the heat to medium and simmer for 10 minutes.
2. Season to taste with salt and pepper. Remove the bay leaves before serving. Serves 4.

You'll need an adult's help with this recipe.

Adapted from "The Robin Takes 5 Cookbook for Busy Families" with permission from Andrews McMeel Publishing (andrewsmcmeel.com).

Meet Cozi Zuehlsdorff

Cozi Zuehlsdorff stars as Hazel in the movie "Dolphin Tale 2." The movie is based on a true story about a rescued baby dolphin.

When she was 8 years old, Cozi got the part of Annie in the musical of the same name at her community theater. She discovered that she loved performing. She has appeared in several other community musicals.

She has also acted in TV commercials and shows and in the movie "Dolphin Tale." She is a voice actor with the chorus that sings in TV animated shows such as "Sofia the First" and "Jake and the Neverland Pirates."

Cozi lives in Orange County, California, with her parents and older sister. She loves to sing, act, play the piano and make movies with her friends. She is home-schooled.

Micha Hancock

Goldie Goodsport's Supersport

Height: 5-11
Birthdate: 11-10-1992
Hometown: Edmond, Oklahoma

Micha (MIKE-uh) Hancock is a setter for the Penn State Nittany Lions women's volleyball team. Her job is to make pinpoint passes — or assists — for her teammates to "kill" with smashing hits over the net. On defense, she is a "dig" specialist — keeping the opposing team's attacks in play. Micha's play is championship caliber, and she has the hardware to prove it.

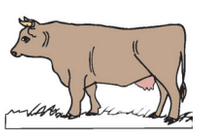
Last season, Micha set the table as her Nittany Lions devoured the competition, compiling a 34-2 match record and capturing a record-tying sixth NCAA championship in program history.

Micha's play in the postseason, including a championship game victory over conference rival Wisconsin, earned her the NCAA Tournament Most Outstanding Player honor. Now Micha and the Nittany Lions are poised to defend their national title as the 2014 season gets underway.

Mighty Funny's Mini Jokes

All the following jokes have something in common. Can you guess the common theme or category?

Mary: How do millionaires dance?
Manny: Check to check!



Moe: Why don't cows have money?
Millie: Because people milk them dry!

Maurice: What is the difference between an angry rabbit and counterfeit money?
Monty: One is a mad bunny and the other is bad money!

Printing to Heal

Copying a community

Doctors hope to be able to perform tests on 3-D prints of living tissue. For example, they could run tests on copies of a cancer tumor to target the exact medicine for killing the cancer.

For years, doctors have been able to grow many copies of the same cell. But every living tissue is made from many types of cells. Cells "talk" to each other. They influence one another's actions. Testing just one type of cell does not give a complete picture. With 3-D printing, researchers can duplicate the actual cell community.

Medicines are tested on animals before being given to humans. The ability to test drugs on exact tissue copies would lessen animal testing.

Beyond testing

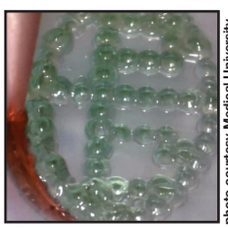


photo courtesy Medical University of South Carolina

Printing a test pattern of living cells.

We are probably more than 50 years away from being able to print whole organs. But we are nearly able to print pieces of organs. If we could implant those pieces into a patient, the body could often heal itself.

For example, if a patient had an injured kidney, doctors could take a sample of the part that was still healthy and print 3-D copies of it. They then would attach, or **graft,** the printed tissue onto the kidney. After that, the body would be able to do the rest of the repairs itself.

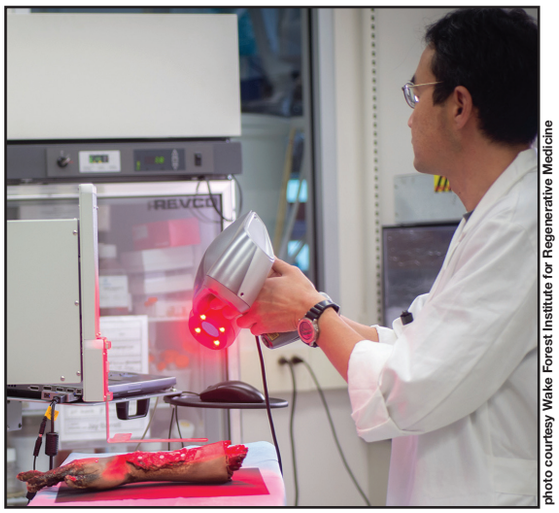


photo courtesy Wake Forest Institute for Regenerative Medicine

A researcher at Wake Forest works with an artificial hand to learn how to transplant 3-D skin onto a burn victim's body.

Making bioink

To make bioink, scientists would take cells from a person's own body. They wouldn't need a lot of original body cells. The printer could make as many copies as needed.

Our bodies have a great ability to regrow living tissue. In most cases, scientists wouldn't even need special cells such as stem cells. In fact, they would probably just use fat cells.

As with other body cells, fat cells could grow into other types of cells. Few people would be sad if they lost some fat cells!

The Mini Page thanks Dr. Mike Yost, science director of the biofabrication facility, Medical University of South Carolina, for help with this issue.

Look through your newspaper for stories about 3-D printing.

Next week, The Mini Page is about how to behave when going online.

Transplants

Transplanting copies of a person's own tissue is much safer than transplanting tissue from someone else. Your body wants to kill cells that aren't part of you. But it would see 3-D tissue copies as being identical to its own parts.

Doctors could transplant the new tissue with a **catheter** (KA-the-ter), or special tube.

Within a few years, doctors will probably be transplanting 3-D prints of simple tissues such as cartilage to repair joints such as knees.

Writing on the body

The U.S. military and Wake Forest Institute are working to treat burn patients with bioprinting. Now, doctors treat burns by removing healthy skin from a patient's body. They use that skin to cover the burn. This is painful, and when a patient is badly burned, it can be hard to find enough healthy cells to graft.

With 3-D printing, the patient would need to give up only a small amount of healthy skin, about half the size of a postage stamp.

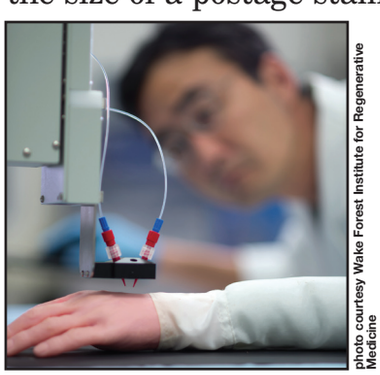


photo courtesy Wake Forest Institute for Regenerative Medicine

A Wake Forest researcher works with a fake hand to learn how to print over a burn.

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