

SYSTEM ALERT!

Tomorrow is almost here.



Researchers in Spain have developed a metal exoskeleton that will bring mobility to many children with neuromuscular disorders. Designing an exoskeleton small enough for children brings many engineering challenges. Photo Credit: Joan Costa - CSIC

Metal exoskeleton brings motion, hope to victims of childhood disease

We live in an incredible time when engineering can help a child born with a debilitating disorder walk.

Spinal muscular atrophy is a disease that affects the nerves in a child's spine. This weakens the muscles and makes walking impossible. Other complications follow. Unused muscles can grow stiff in a condition called sclerosis. Respiratory infections become life threatening.

A recently developed motorized exoskeleton is bringing hope to many affected by spinal muscular atrophy. The exoskeleton is designed to support a child's body. Rods called

orthoses fit around the legs and torso. Motors at the joints undertake the work of the muscles, allowing a range of motion. A controller directs the motion. With this motorized assistance, many children who have never walked may take their first steps.

The current system is designed for children ages three to 14. As of right now, technical issues make it difficult to design an exoskeleton for children below age three. Each leg requires five motors, and each motor needs space to operate. The exoskeleton must be big enough to accommodate them all. The bodies of children

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Image Credit: CSIC

Could wood make better windows than glass?

There are several interesting facts about transparent wood. For example, when sunlight shines through a glass window and into your living room, the spot of sunlight on the floor moves as the Sun's position changes in the sky. When the Sun shines through a window made of transparent wood, however, the spot of sunlight on the floor never moves, whether it is morning or late afternoon. The channels in the wood direct the light to fall at the same spot.

You might be wondering to yourself, "What? Transparent wood?" That brings us to the most interesting fact of all about this technology – its very existence.

It was recently developed in the laboratory using a relatively simple process. First, the piece of wood is soaked in lye, sodium sulfite, and water. The lye makes this a dangerous concoction for humans, but it does leach the wood of its lignin. Lignin is a

material in the cell walls of wood that gives it its rigidity and its color.

After the lignin has been removed, the wood still won't make a suitable window. The light enters the wood, but the wood's internal structure bounces the light around randomly within it. The final step is to soak the wood in an epoxy and to orient the small channels in the wood in one direction. The epoxy fills in the channels and dries hard, adding rigidity back in.

Now, the wood lets 90 percent of light pass through it. Transparent wood is almost as clear as glass!

And though it isn't ready for commercial sale yet, it offers several advantages over glass. It is a better insulator than glass, deflecting more heat. It is sturdier than glass, so it is less breakable. It eliminates glare. And it is also waterproof! ⚠️



Credit: Liangbing Hu



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'You can't see the forest ...'

Transparent wood does not occur naturally. If it did, we wouldn't say "You can't see the forest for the trees." Instead, the saying would be, "You can't see the forest or the trees." ⚠️

Emerging technology: 3-D printing with metal

Making a metal object by pouring liquid metal into a cast can be a time-consuming process. Casts must be specially built, and this is not a simple process. Another method for making metal objects, milling, works by cutting away excess metal from a metal block, leaving only the desired part. This can be quicker but wastes metal. Methods for 3-D printing metal objects are being developed, however. This can save time, materials, and possibly money.

First, a 3-D model of the planned object is made in a computer drafting program. The digital model is fed to the printer. For most methods of printing, the metal begins as a powder – fine granules of the preferred metal (aluminum, bronze, titanium, and so on). The powder is laid down a layer at a time.

Some machines use a laser to melt the granules of powder together with high precision. This binds them into a single solid, dense object.

Other printing machines work by putting down a layer of binding agent between each layer of powder. This essentially glues the metal powder particles together. In this method, when all layers have been placed, the object is baked in a kiln (a type of oven) to harden the binding agent. The resulting object is porous, meaning it contains a lot of air. A common additional step is to infuse the pores with liquid metal. This makes the object much stronger. ⚠️

3-D printing – plastics and more

3-D printers are becoming commonplace in schools, homes, and businesses. Users can make hard plastic objects such as prototypes, knickknacks, or toys. But 3-D printing isn't restrained to plastic. Adventurous engineers are pioneering new ways to print using nontraditional materials. ⚠️

3-D printing is often referred to as **additive manufacturing** because it creates a new object by adding layer upon layer of material. ⚠️

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Lunch by layer

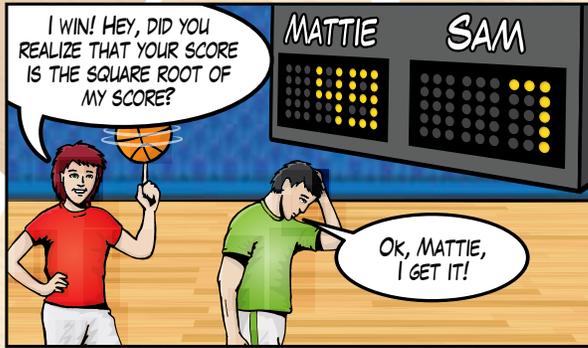
Printed food might not sound appetizing, but it is here and, according to many who have sampled it, it is quite delicious. Whether you are licking your lips in anticipation of a printed pizza pie right now, the technology doesn't show any signs of going away.

Multiple food printers are already on the market, specializing in dishes such as ravioli, pancakes, and pizza. NASA views the technology as a promising way to bring some variety to the meals of astronauts on long missions, and the space agency has funded research into the technology.

The technology suffers from some limitations. For starters, to be printed, the food must be able to be stored and extruded (forced out through a nozzle). That is why soft, sticky ingredients such as dough, cheese, and chocolate have proven good candidates. ⚠️

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Storyline: Cody White | Artwork: Jason Redd | ©2016 Pitsco Education

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younger than age three are too small to use the system as it has been designed. However, alternative designs with fewer motors might be possible for some children.

Of course, the human body naturally changes a great deal between age three and 14. The symptoms of spinal muscular atrophy change over time as well. For these reasons, the exoskeleton must be able to adapt. This adaptability is achieved in part with sensors that adjust the rigidity of the system.

The exoskeleton is the result of a project by the Spanish National Research Council and Marsi Bionics. It is currently being tested and is not yet widely available. Other motorized systems exist for adults with neuromuscular disorders, but this is the first for children with spinal muscular atrophy. The existence of this device and other motorized systems suggests a future in which the quality of life for those suffering from such diseases might be greatly improved. ⚠️



Exoskeleton vs endoskeleton

Humans have endoskeletons. That is to say their skeletons are inside their bodies. By contrast, an exoskeleton is a rigid support structure that is on the outside of the body. Many creatures such as grasshoppers and lobsters have exoskeletons. A few creatures have both.

The name for an engineered exoskeleton built with motors to allow movement is

a powered exoskeleton. The technology is still young, but a few powered exoskeletons have been built. In the future they might be used in medicine, military, and even firefighting applications. ⚠️

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Student name: _____

Class/Hour: _____

***SySTEM Alert!* Quiz (Volume 5, Number 2)**

This quiz covers the information in *SySTEM Alert!* Volume 5, Number 2. Circle the letter of the correct answer or write the letter by the question number.

1. What is another name for 3-D printing?
 - A. combinative assembly
 - B. tiered construction
 - C. object printing
 - D. additive manufacturing
2. Which of the following is a medical condition in which unused muscles grow stiff?
 - A. sclerosis
 - B. chorditis
 - C. hypothyroidism
 - D. hemophilia
3. What is a limitation of 3-D printed food?
 - A. It must contain no sugars.
 - B. It must contain no moisture.
 - C. It must harden quickly.
 - D. It must be able to be extruded.
4. Transparent wood lets _____ percent of light pass through it.
 - A. 100
 - B. 90
 - C. 80
 - D. 70
5. A creature with an endoskeleton has _____.
 - A. a skeleton on the outside of its body
 - B. a skeleton on the inside of its body
 - C. an especially flexible skeletal structure
 - D. an especially rigid skeletal structure

6. _____ is a material that gives wood its rigid structure and its color.
- A. lye
 - B. lignin
 - C. epoxy
 - D. granules
7. What hazardous material is used in the production of transparent wood?
- A. lye
 - B. lignin
 - C. epoxy
 - D. granules
8. What is the main challenge in creating an exoskeleton to help children under three who have muscular disorders?
- A. designing appropriate batteries
 - B. creating the fasteners
 - C. fitting the motors onto the exoskeleton
 - D. creating strong enough gears
9. What is the square root of 49?
- A. 3
 - B. 6
 - C. 7
 - D. 13
10. A creature with an exoskeleton has _____.
- A. a skeleton on the outside of its body
 - B. a skeleton on the inside of its body
 - C. an especially flexible skeletal structure
 - D. an especially rigid skeletal structure

Bonus:

Wearable technologies such as the exoskeletons discussed in this issue have great potential to improve lives. There are also many more everyday examples of wearable technology – some of them so common we barely think of them as technology. (Consider eyeglasses, used to enhance poor vision.) Try to think of other examples of helpful technology worn on the body. List as many examples as you can.