

# Médecine:

## Bienvenue dans la 3<sup>ème</sup> dimension.

Philippe A. COUCKE  
[pcoucke@chu.ulg.ac.be](mailto:pcoucke@chu.ulg.ac.be)

“3D printing has the potential to revolutionize the way we make almost everything [...] The next industrial revolution in manufacturing will happen in America. We can get that done.”

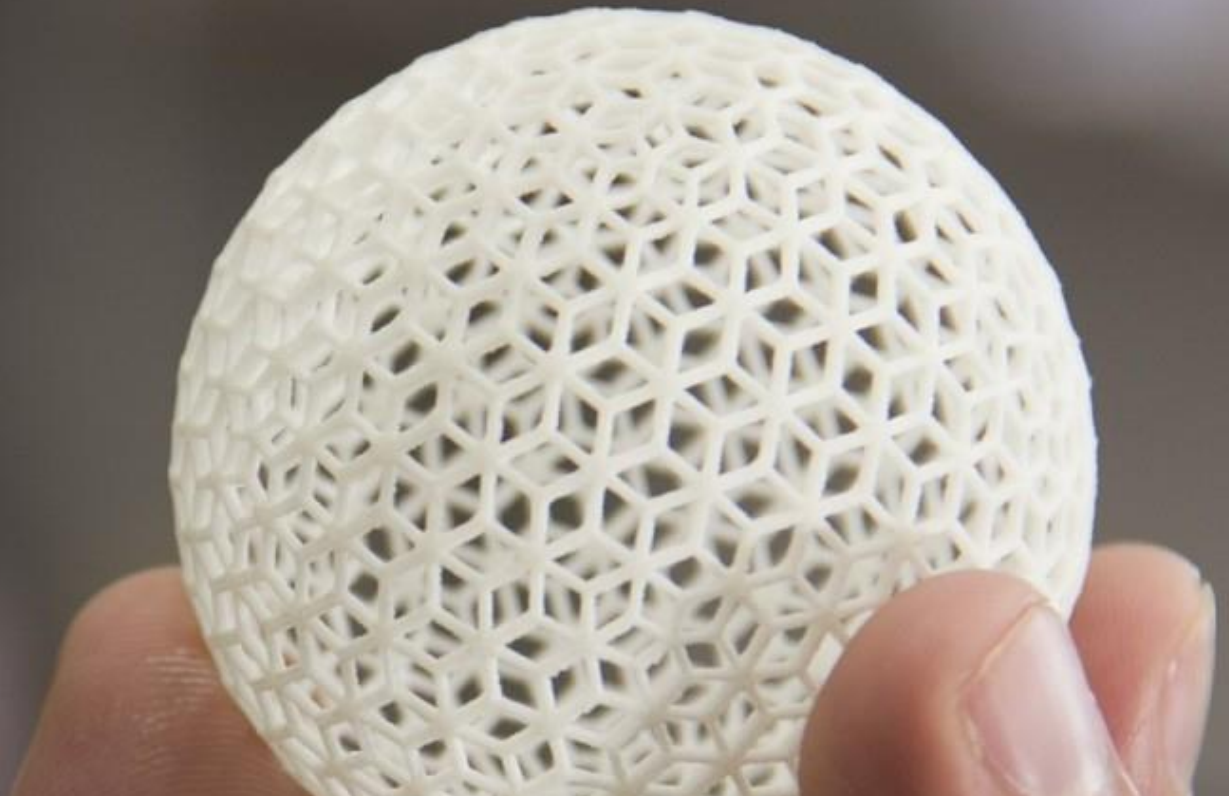
President Barack Obama,  
State of the Union 2013



## Marketers: Why 3D Printing is More Important Than You Think

BY [MEGAN DENNIS](#) MON, APRIL 11, 2016

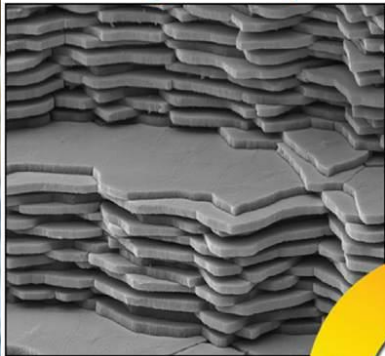
According to Steve Heller [the figures show](#) the stakes are high. Mainstream 3D printing growth in the industry is expected to grow by **31%** each year into a \$21 billion market by 2020.



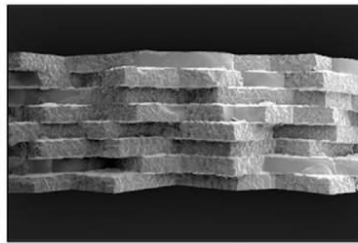
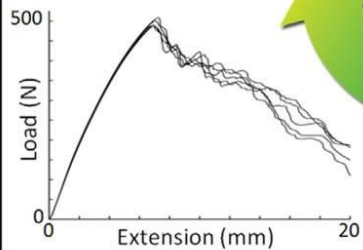
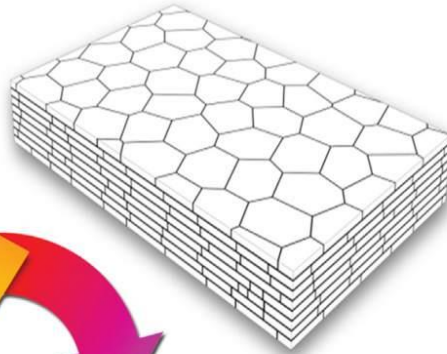
# Stronger 3D printing revealed by biomimetic design for additive manufacturing

March 8<sup>th</sup> 2017 [www.3DPrintingIndustry.com](http://www.3DPrintingIndustry.com)

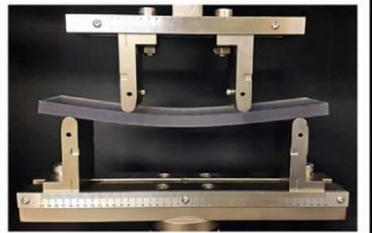
## A. Design Principles



## B. Parametric Modeling



## D. Mechanical Testing



## C. 3D Printing

*...the resulting tangible models were either direct mimics, or highly simplified structural analogs of the biological structures under study. The strength of the parametric workflow presented here is that it allows for the flexible and high-throughput creation of true 3D models and can be applied to any system with features amenable to modeling and 3D printing.*

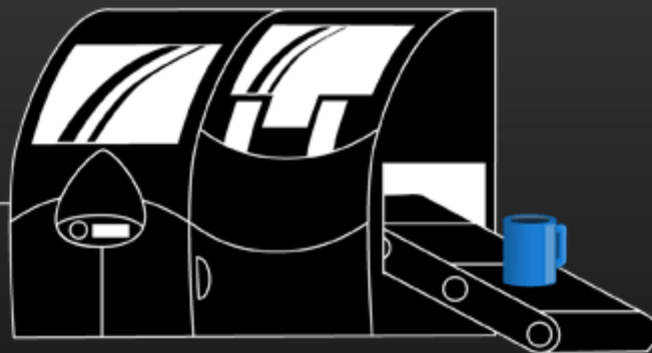


# sculpteo

**You upload  
your file**



**We make the  
3D printing for you**



**We ship it  
back to you**

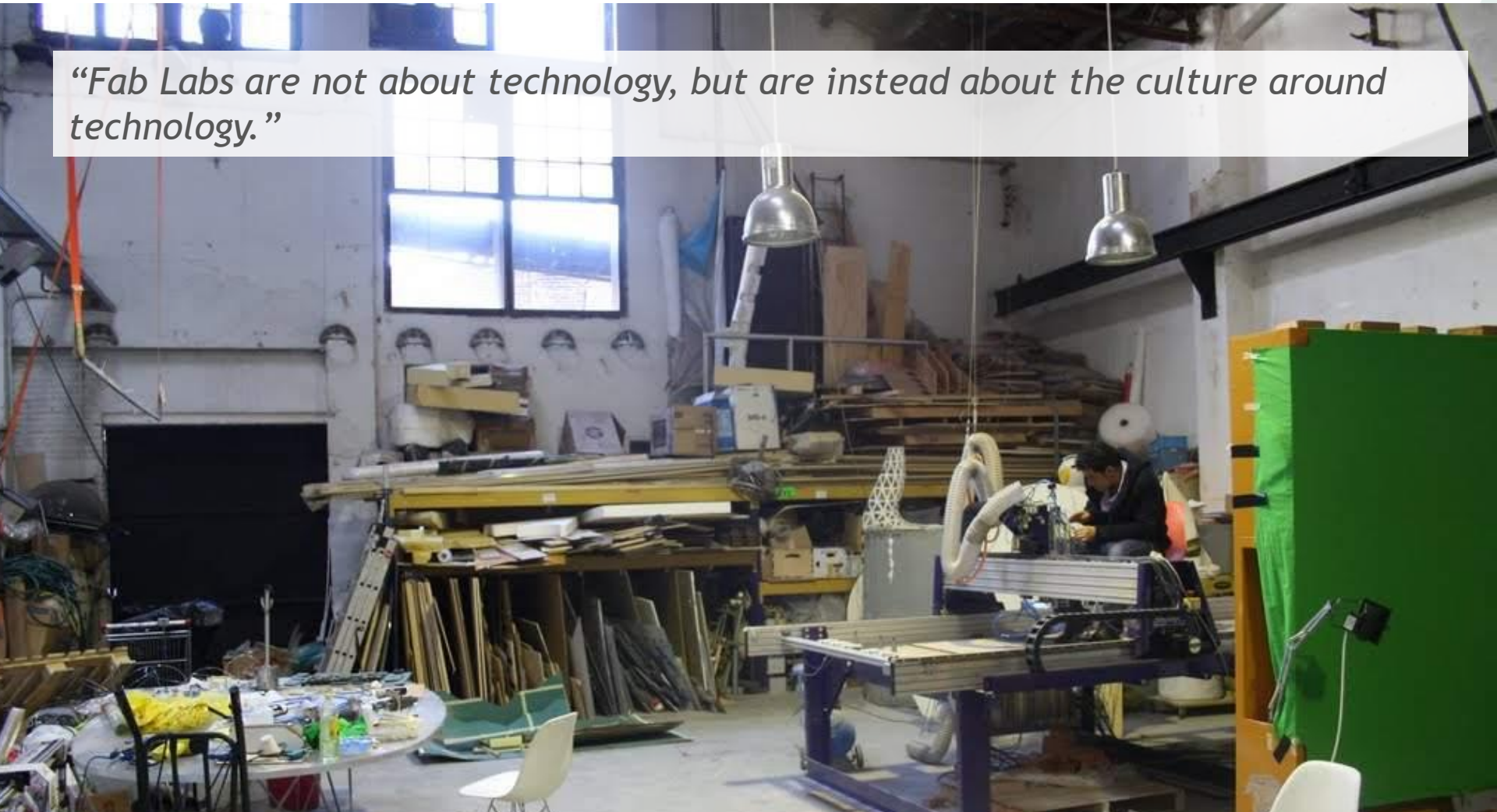


**3Discovered**'s platform connects 3D printable design owners with 3D printing service bureaus, and customers in a secure, commercial-grade exchange for 3D printed production parts and products.



**The Fab City Makers: putting manufacturing back in the hands of communities**  
[www.3DPrintingIndustry.com](http://www.3DPrintingIndustry.com) February 14<sup>th</sup> 2017

*“Fab Labs are not about technology, but are instead about the culture around technology.”*



## CES 2017: The 3D printed car is here !

January 9<sup>th</sup> 2017 [www.3DPrintingIndustry.com](http://www.3DPrintingIndustry.com)

Much has been made of the world's first 3D printed supercar in the past year, and it was on display in two different forms. The car was present as a fully functioning prototype and also displayed was its 3D printed frame. Also appearing at the event was the 3D printed motorcycle, the Dagger, which was unveiled for the first time last November.

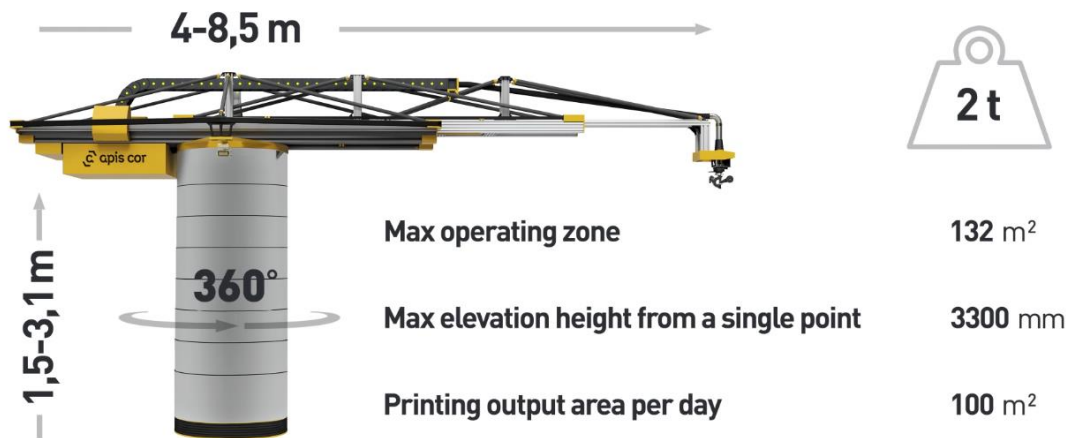




# Apis Cor 3D prints a house in one day

March 1<sup>st</sup> 2017 [www.3DPrintingIndustry.com](http://www.3DPrintingIndustry.com)

Russian company Apis Cor has successfully 3D printed a full-scale house in just 24 hours. The structure was created at Apis Cor's base in the Russian town of Stupino, outside Moscow. According to the company, the total printing time amounted to a full day.



## Computer “Studies” Rembrandt’s Style and Produces 3D Printed Painting

April 14<sup>th</sup> 2016 [WWW.FUTURISM.COM](http://WWW.FUTURISM.COM)



A computer has produced a 3D-printed painting in the style of Dutch master Rembrandt. The portrait was created after existing works by the artist were analyzed by a computer.

# McKinsey on 3D printing

Many leading companies seem surprisingly **unaware** of 3D's printing potential and **poorly organized** to reap the benefits

# 3D Printed Organs and the Super-Fast Hyperloop: Dubai is Accelerating the Future

September 20<sup>th</sup> 2016 FUTURISM.COM

H.E. Mohammad bin Abdullah Al Gergawi, Minister of the UAE Cabinet Affairs and the Future, and Vice Chairman of [Dubai Future Foundation](#), notes the significance of this project, stating, “These accelerators will now adhere to the government’s agenda and strategies, and serve as a catalyst to research and development within the most strategic sectors, such as education, health, infrastructure, transportation, and energy. They will provide a global platform to develop new and innovative solutions to the most pressing challenges facing society.”

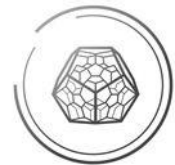
## THE BENEFITS



Round-trip airfare to Dubai



Dedicated creative workspace



Access to our prototyping lab



World-class mentors



Game-changing partnerships



Zero equity in your business



مؤسسة دبي للمستقبل  
Dubai Future Foundation

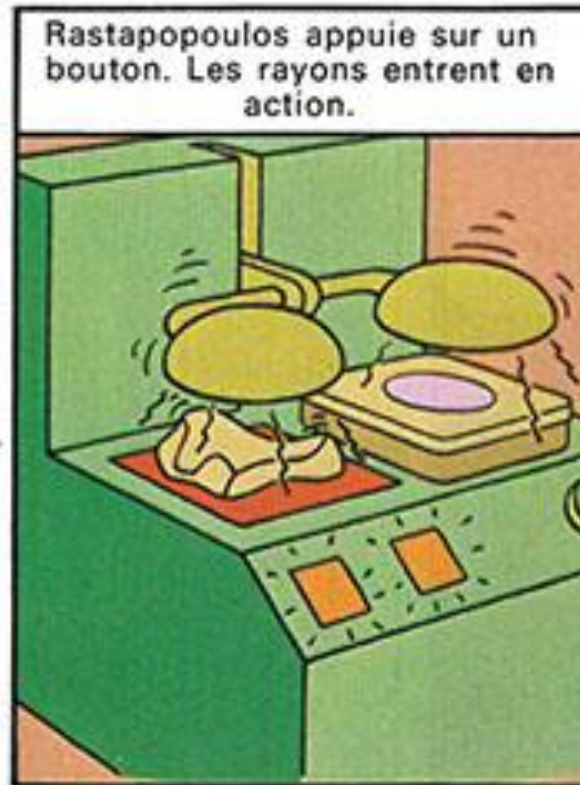
## Futurist Ray Kurzweil makes 3D printing predictions

3DPI December 7<sup>th</sup> 2016

*As the variety of materials available to print in 3D become more extensive and less expensive, both **free open-source** and proprietary clothing designs will be widely available **online** in as little as 10 years.*



**Et dans le secteur médical ?**



**Bioengineer:**

**The heart is one of the easiest organs to bioprint, we'll do it in a decade**

[www.wired.co.uk](http://www.wired.co.uk) November 21<sup>st</sup> 2013

## **Organovo** triples annual revenue validating the market for 3D bioprinting

3DPrintingIndustry.com February 9<sup>th</sup> 2017



Organovo (NASDAQ:ONVO) the 3D bioprinting company with headquarters in San Diego, CA has reported annual revenue of \$1.5 million for fiscal 2016. Total product and service revenue is more than double the amount reported at end of fiscal 2015.



# Technique impression d'organes

quelques explications basiques



Step 1  
Imaging



X-ray

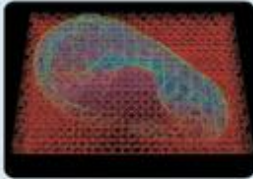


CT

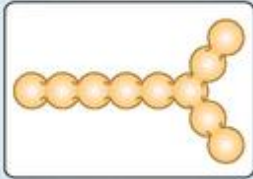


MRI

Step 2  
Design approach



Biomimicry



Self-assembly

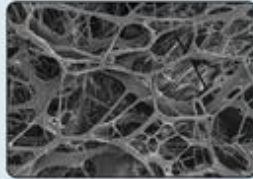


Mini-tissues

Step 3  
Material selection



Synthetic polymers



Natural polymers

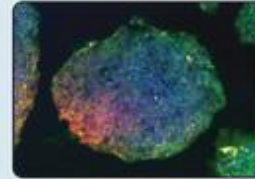


ECM

Step 4  
Cell selection



Differentiated cells

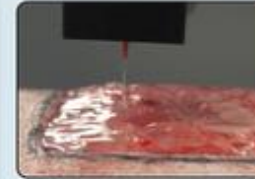


Pluripotent stem cells

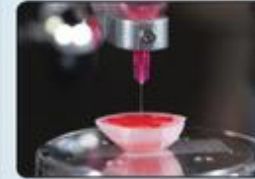


Multipotent stem cells

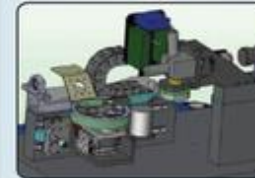
Step 5  
Bioprinting



Inkjet

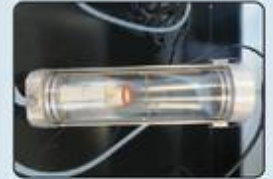


Microextrusion



Laser-assisted

Step 6  
Application



Maturation



Implantation



*In vitro* testing

Two-dimensional tissue



Skin

Cartilage

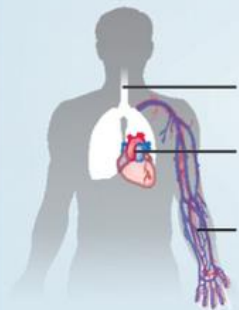


Skin



Cartilage

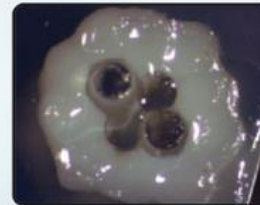
Hollow tubes



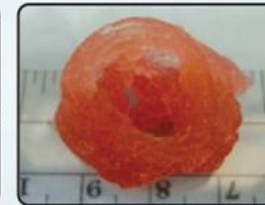
Trachea

Heart valve

Vasculature



Vasculature

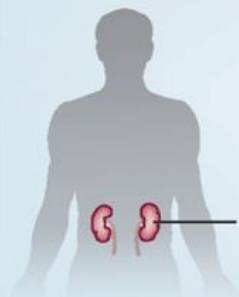


Aortic valve

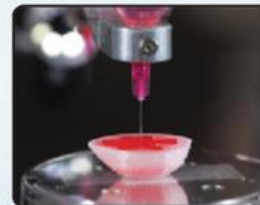


Tracheal splint

Solid organs

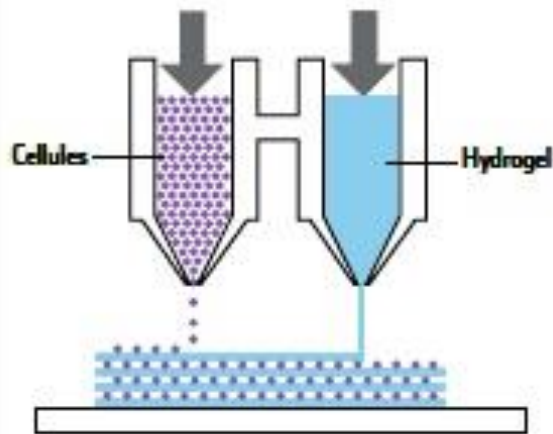


Kidney



Kidney

## TROIS TECHNOLOGIES EN LICE



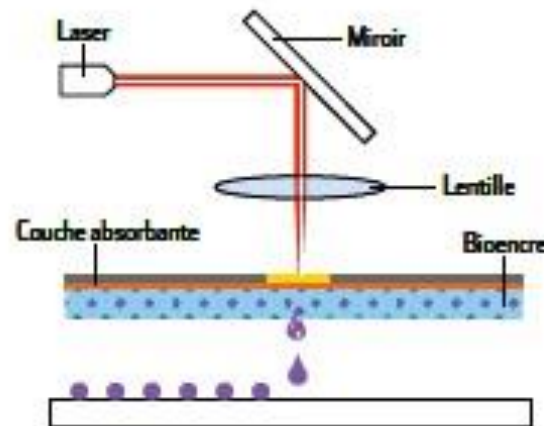
### MICRO-EXTRUSION

Les cellules sont poussées mécaniquement à travers une microseringue.

**Avantage** Première technique de bioprinting mise sur le marché. Les imprimantes sont commercialisées par Organovo.

**Inconvénients** Coût élevé de l'instrument et faible résolution compensée par l'impression d'agrégats de cellules.

SOURCES: TEAL; L'USINE NOUVELLE

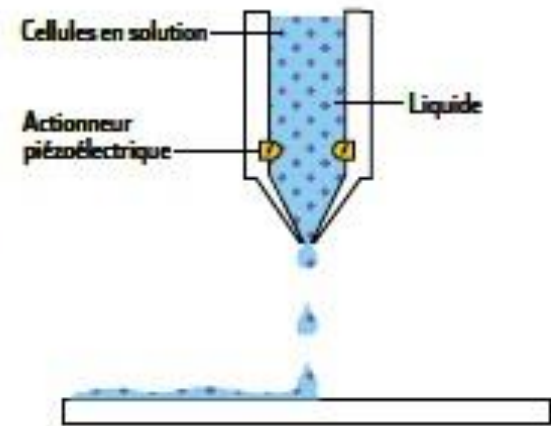


### TRANSFERT ASSISTÉ PAR LASER

Chaque impulsion du laser éjecte une microgouttelette vers le substrat. Le dispositif de balayage et de focalisation permet de créer des motifs complexes.

**Avantages** Haute résolution, pas de risque de bouchage.

**Inconvénient** La fabrication des cartouches d'encre doit être fiabilisée.



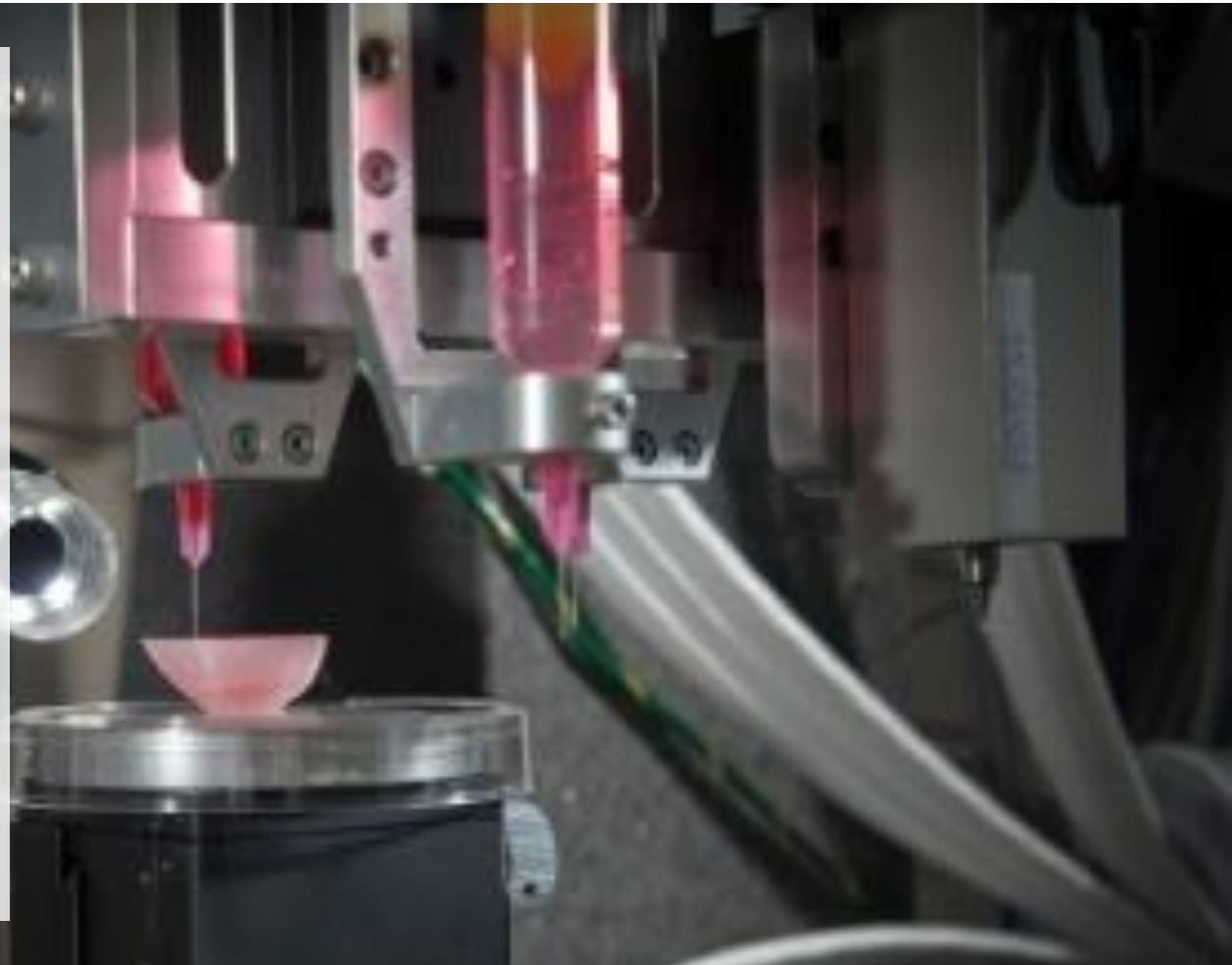
### JET D'ENCRE

La tête d'impression, pilotée par ordinateur, projette des microgouttelettes d'un liquide contenant des cellules. L'éjection de la goutte est provoquée par un procédé thermique ou piézoélectrique.

**Avantages** Haute résolution, faible coût.

**Inconvénient** La tête d'impression risque de se boucher.

*“Engineered **bladders, vaginas and urine tubes** that we engineered by hand have been successfully implanted. 3D printers,” Dr Yoo clarified, “offer the opportunity **to scale up this process**; they can very precisely combine cells and materials into the desired shape. The replacement tissue or organ can be designed on a computer using a **patient’s medical scans**.”*



**Bioprinted Tissues to Be Implanted Within 10 Years, Says Wake Forest’s Dr. Yoo**

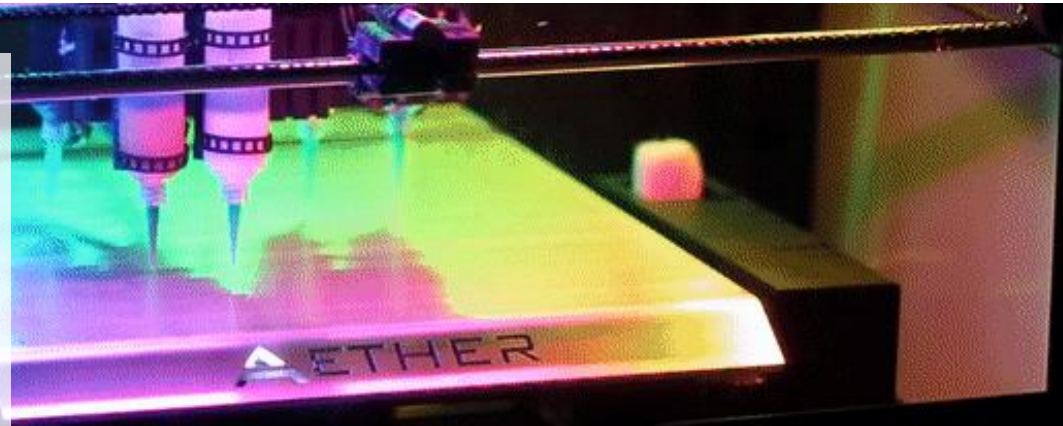
September 2<sup>nd</sup> , 2015 [3DPRINTINGINDUSTRY.COM](http://3DPRINTINGINDUSTRY.COM)

## Aether Makes Bold Claims with 12-in-1 Bioprinter

BY [MICHAEL MOLITCH-HOU](#) TUE, MARCH 22 2016 - [3DPRINTINGINDUSTRY.COM](#)

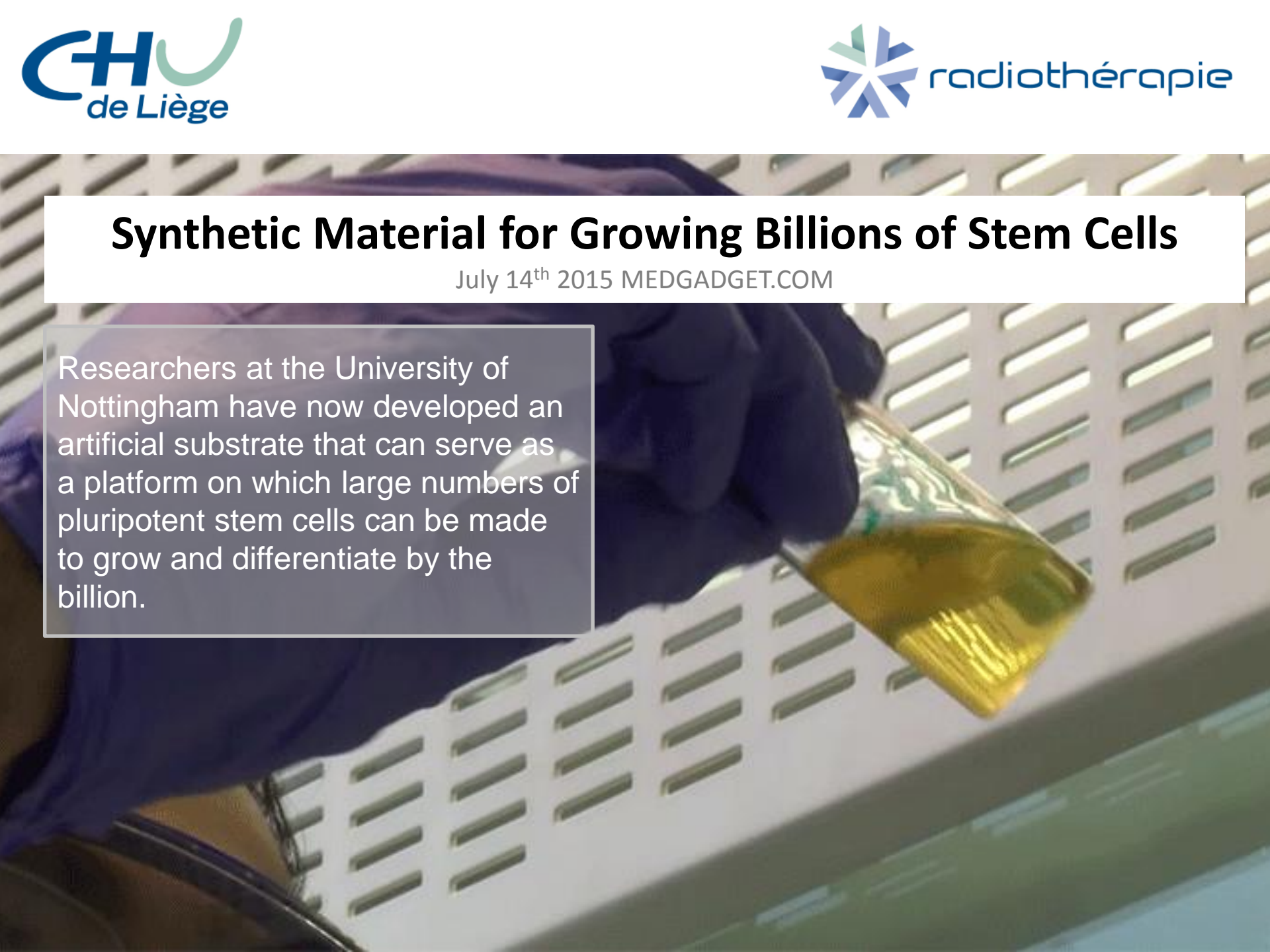
A San Francisco startup called Aether claims to be a pioneer in this space, [announcing](#) the development of “the most advanced and affordable 3D bioprinter ever created”, [the Aether 1](#).

Aether 1 is over 10 years ahead of what other companies are developing, but we’re selling it at an extremely low price to get it into the hands of as many innovators as possible. The company believes that it will be sold for less than \$9,000.



## Synthetic Material for Growing Billions of Stem Cells

July 14<sup>th</sup> 2015 MEDGADGET.COM

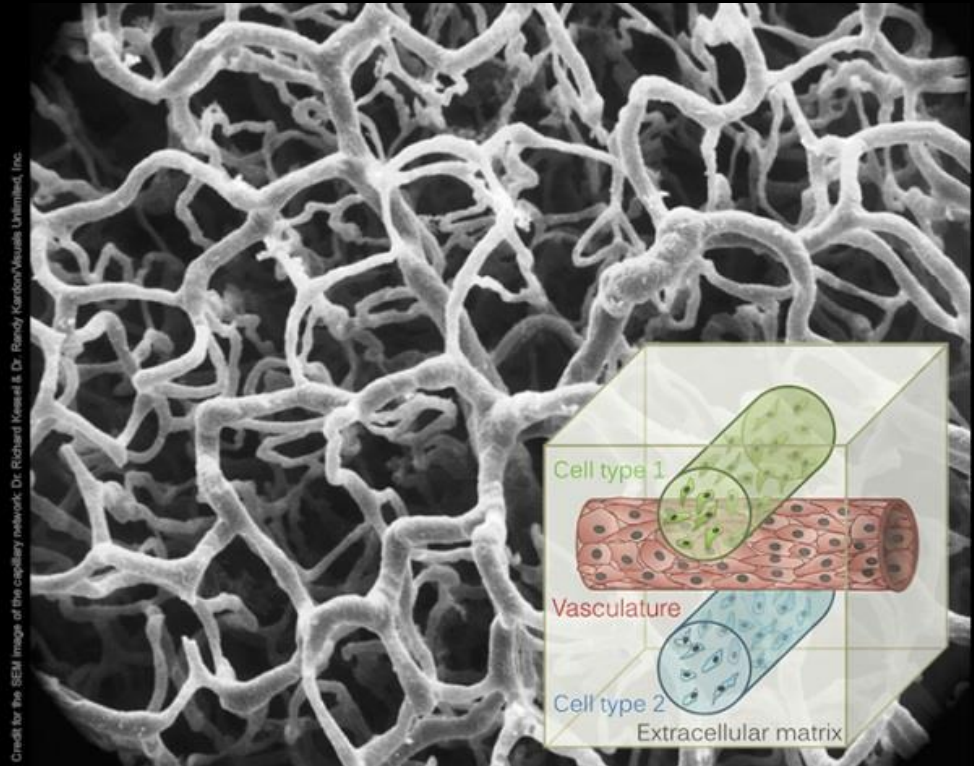


Researchers at the University of Nottingham have now developed an artificial substrate that can serve as a platform on which large numbers of pluripotent stem cells can be made to grow and differentiate by the billion.

## Harvard Scientists Just Figured Out How to 3D Print Complex Living Human Tissue

March 17<sup>th</sup> 2016 FUTURISM.COM

Harvard researchers have developed a method for bioprinting stronger structures in the form of thick tissue. The method also **embeds vascular systems** within the tissue to allow it to survive longer and integrate within the body.





## Harvard's 4D Printed Flowers to Pave Way for 4D Printed Human Tissues

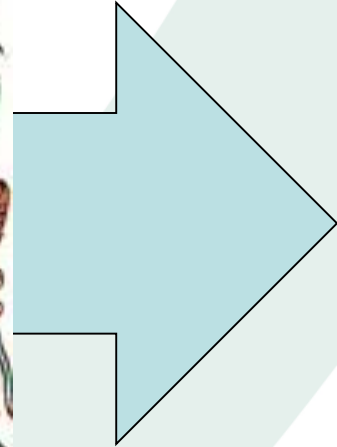
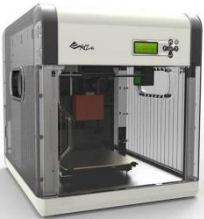
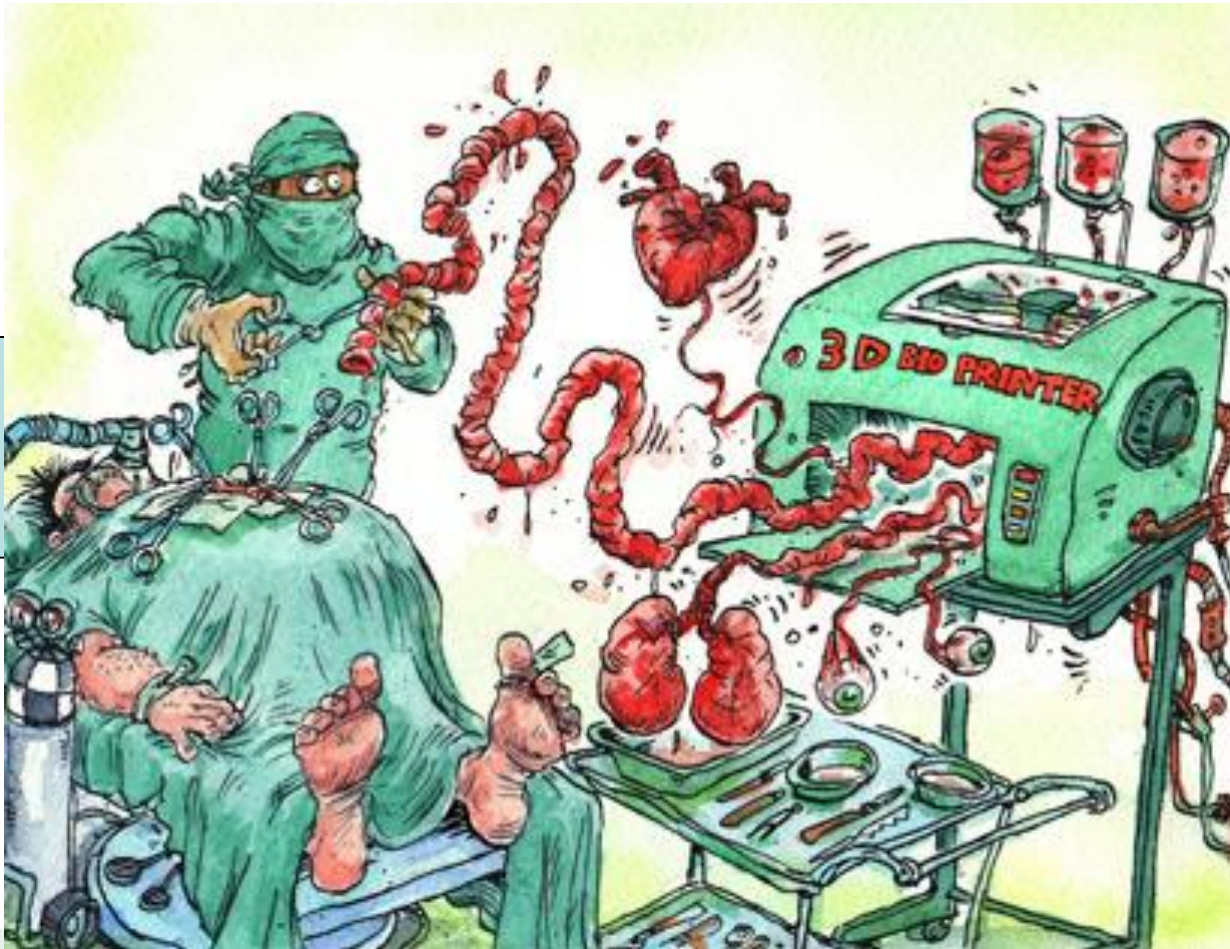
By [Michael Molitch-Hou](#) On Mon, January 25, 2016 3DPRINTINGINDUSTRY.COM

Team at Harvard's Wyss Institute for Biologically Inspired Engineering and the [Harvard John A. Paulson School of Engineering and Applied Sciences](#) has continued to make progress, [publishing a paper in \*Nature Materials\*](#) outlining an experiment in "Biomimetic 4D printing".

*Combined with a proprietary mathematical model developed by the team that predicts how a 4D object must be printed to achieve prescribed transformable shapes, the method opens up potential applications for 4D printing including smart textiles, soft electronics, biomedical devices, and tissue engineering."*



# Bioengineered / printed human organs



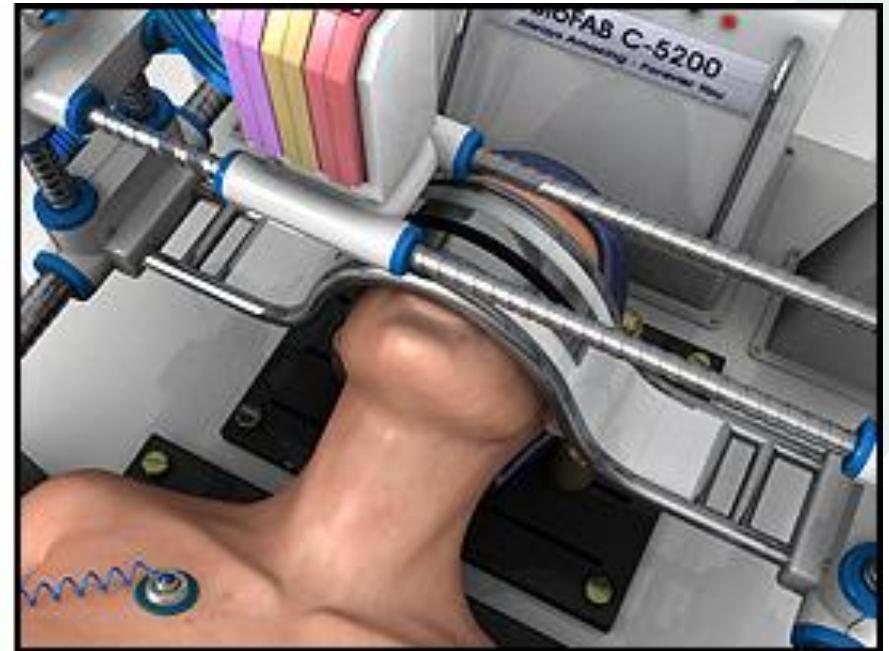
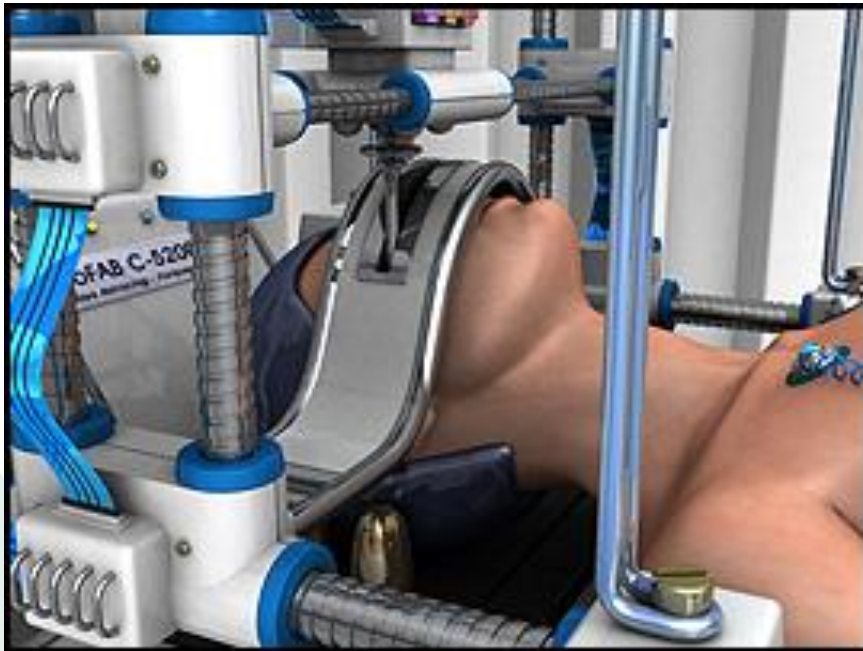
May 20<sup>th</sup> , 2015 [www.forbes.com](http://www.forbes.com)

# L'Oreal Seeks Quantum Leap With 3D Printed Skin

In a move at the limits of commercial technology, beauty business L'Oreal USA is pushing to 3D print skin.

## L'Oreal USA Announces Research Partnership with [Organovo](#) to Develop 3-D Bioprinted Skin Tissue

05/05/2015 [www.prnewswire.com](http://www.prnewswire.com)



# **Quelques exemples d'applications en médecine ....**

## **vétérinaire**

## **Injured Costa Rican Toucan Saved with 3D Printed Prosthetic Beak**

By [Tyler Koslow](#) On Wed, January 13, 2016 [3DPRINTINGINDUSTRY.COM](#)

For about a year now, Grecia (Spanish for 'Greece') the toucan has been struggling with a completely maimed upper beak, which was broken in an awful assault by a group of thoughtless teenagers. Causing an uproar in the local Costa Rican community, an Indiegogo project was soon launched to help repair Grecia's upper beak, which was quickly funded well past the set goal (closing out with over \$10,000).



## Meet Masha, the Elephant who Received a Prosthetic Leg after a Landmine Explosion

June 21<sup>st</sup> 2016 FUTURISM.COM

Masha, the Asian elephant, received the first prosthetic limb made especially for her species.



# **Quelques exemples d'applications en médecine humaine**

## **Du simple au compliqué**

**Facile et déjà dispo ...**



## Medical 3D Printing & Why You Might Move to Taiwan

December 22<sup>nd</sup> 2015 3DPRINTINGINDUSTRY.COM



**DICOM data** captured via CT or MRI scans from all over the world may be sent to DETEKT, where their expert engineers work with customers, using software from Materialise, to craft custom solutions for medical purposes. Combining the medical expertise of their customers with the design and engineering knowledge of their staff, the firm is able to create 3D printable surgical guides, implants, and models that can then be sent for production in their clean room.

## 3D printing makes digital dentistry happen

[www.accutechortho.com](http://www.accutechortho.com)

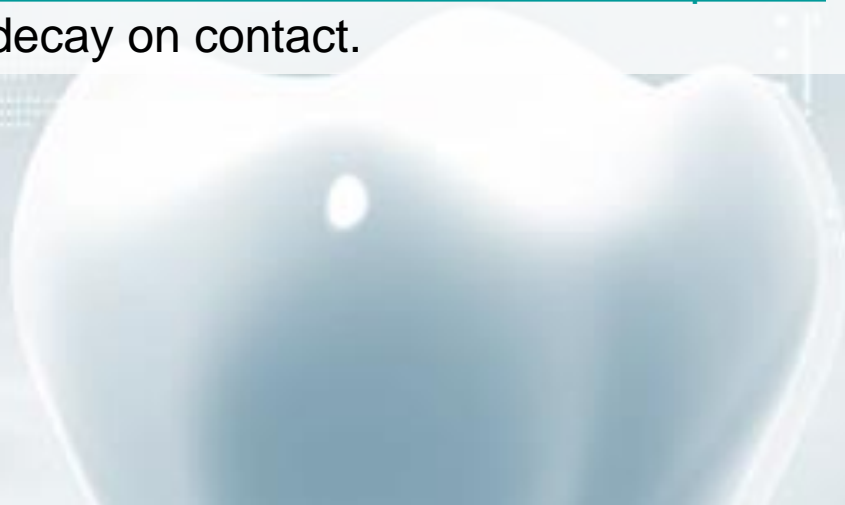
For a growing number of dental lab owners, digital dentistry is already here. With 3D printing as part of their business strategy, dental and orthodontic labs can speed production while improving quality and precision.

## The latest advance in 3D printing: replacement teeth

October 31th 2015 [theguardian.com](http://theguardian.com)

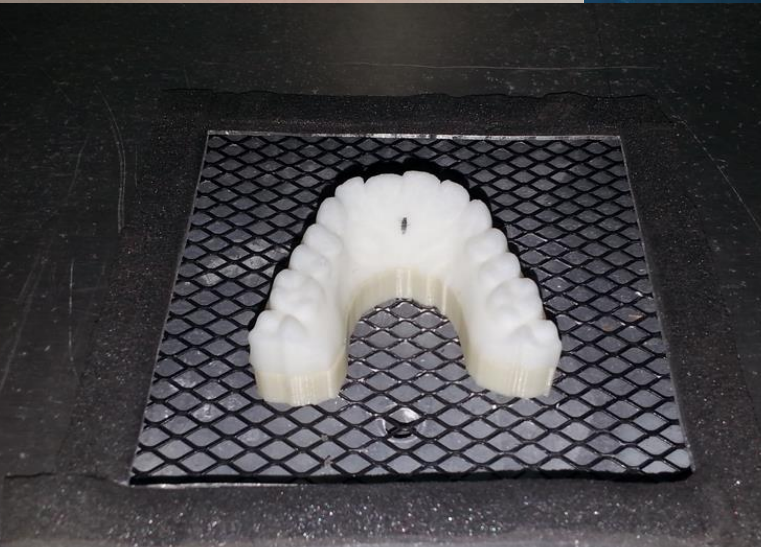
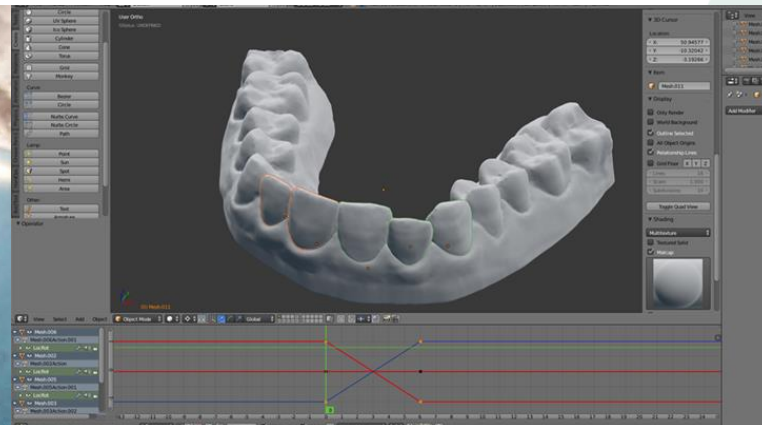
Bacteria-fighting plastic could be the future of dentistry

Dutch researchers at the University of Groningen are working on the creation of a [3D-printed tooth made of an antimicrobial plastic](#) that kills the bacteria responsible for tooth decay on contact.



# Sick of Expensive Orthodontic Care? A Student Prints His Own for Cheap!

July 22<sup>nd</sup> 2016 3DPRINTINGINDUSTRY.COM



## **OSSDSIGN Cranial Patient-Specific Implants Cleared by FDA**

JANUARY 20<sup>TH</sup>, 2017 [www.medgadget.com](http://www.medgadget.com)

OssDsign, a Swedish firm, received FDA clearance to introduce its OSSDSIGN Cranial patient-specific implants for cranioplasty procedures. The implants are made based off of individual patient CT scans and are manufactured using 3D printing. They consist of calcium phosphate composite tiles with titanium in the interior to provide reinforcement.



## Behind the scenes of how 3D printing speeded recovery of McDonald twins

December 21<sup>st</sup> 2016 [www.3DPrintingindustry.com](http://www.3DPrintingindustry.com)



© Christine Pogliano Grasso/ Facebook

The model proved vital to the success of the operation as at one point the lead surgeon was uncertain about proceeding. Specifically, the entanglement of the blood vessels was such that continuing with the operation required reference to the highly detailed model created by 3D Systems. Furthermore, a surgical guide was produced that could be used to show the surgical team where incisions were required.

## Surgeons replace a 12-year-old's cancerous vertebra with a 3D-printed implant

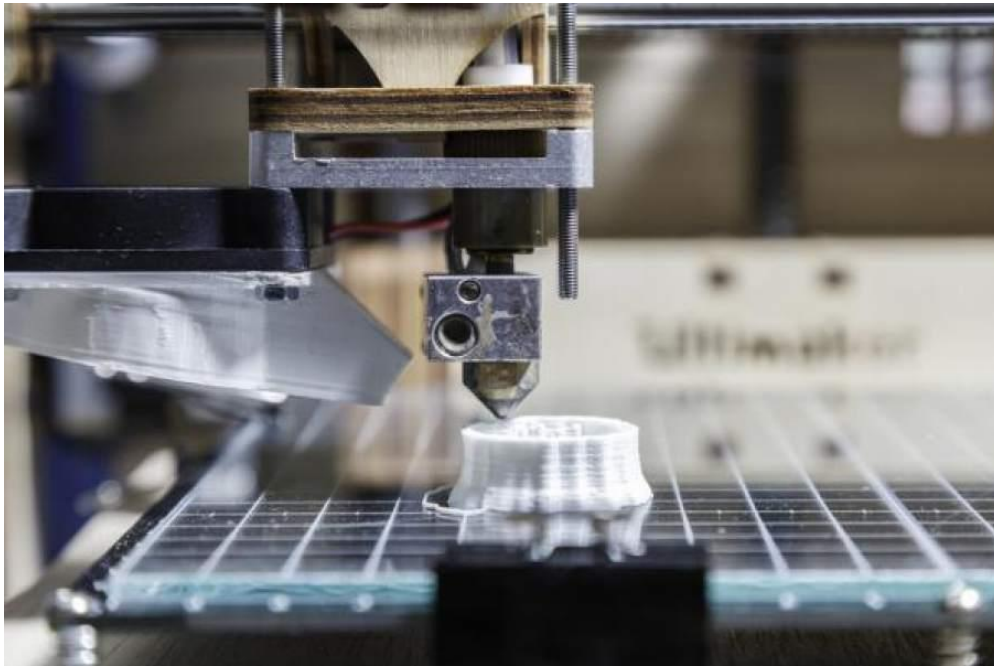
*August 25, 2014 newatlas.com*



According to market-based research firm [IDTechEx](#), the medical and dental market for 3D-printers is set to grow from US\$141 million to \$868 million by the year 2025. And when you consider the recent spate of groundbreaking medical procedures, it is pretty easy to see why.

## Bristol University close to printing bone and cartilage

June 24<sup>th</sup> 2016 [3DPRINTINGINDUSTRY.COM](http://3DPRINTINGINDUSTRY.COM)

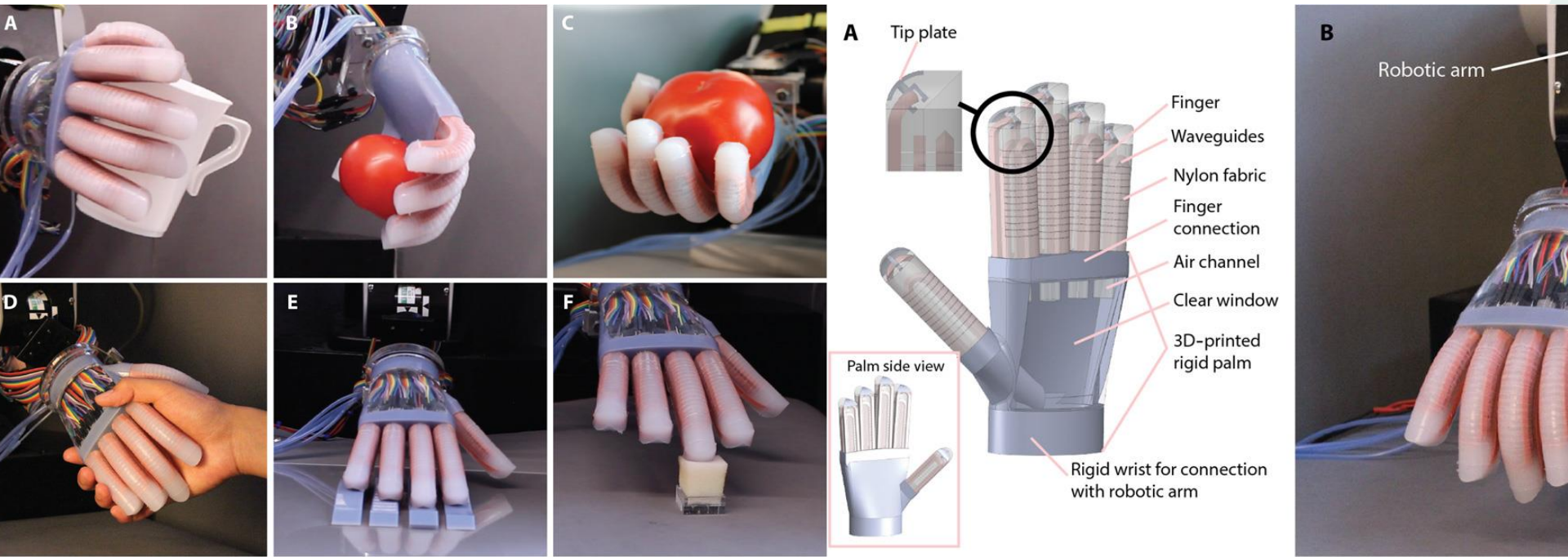


Bristol University has produced a bio-ink that prints stem cells that develop into complex tissues like bone and cartilage.

So true bioprinting is one step closer now.

# Gentle Bot: 3D printing a robot with feelings

January 6<sup>th</sup> 2017, 3DPI.com



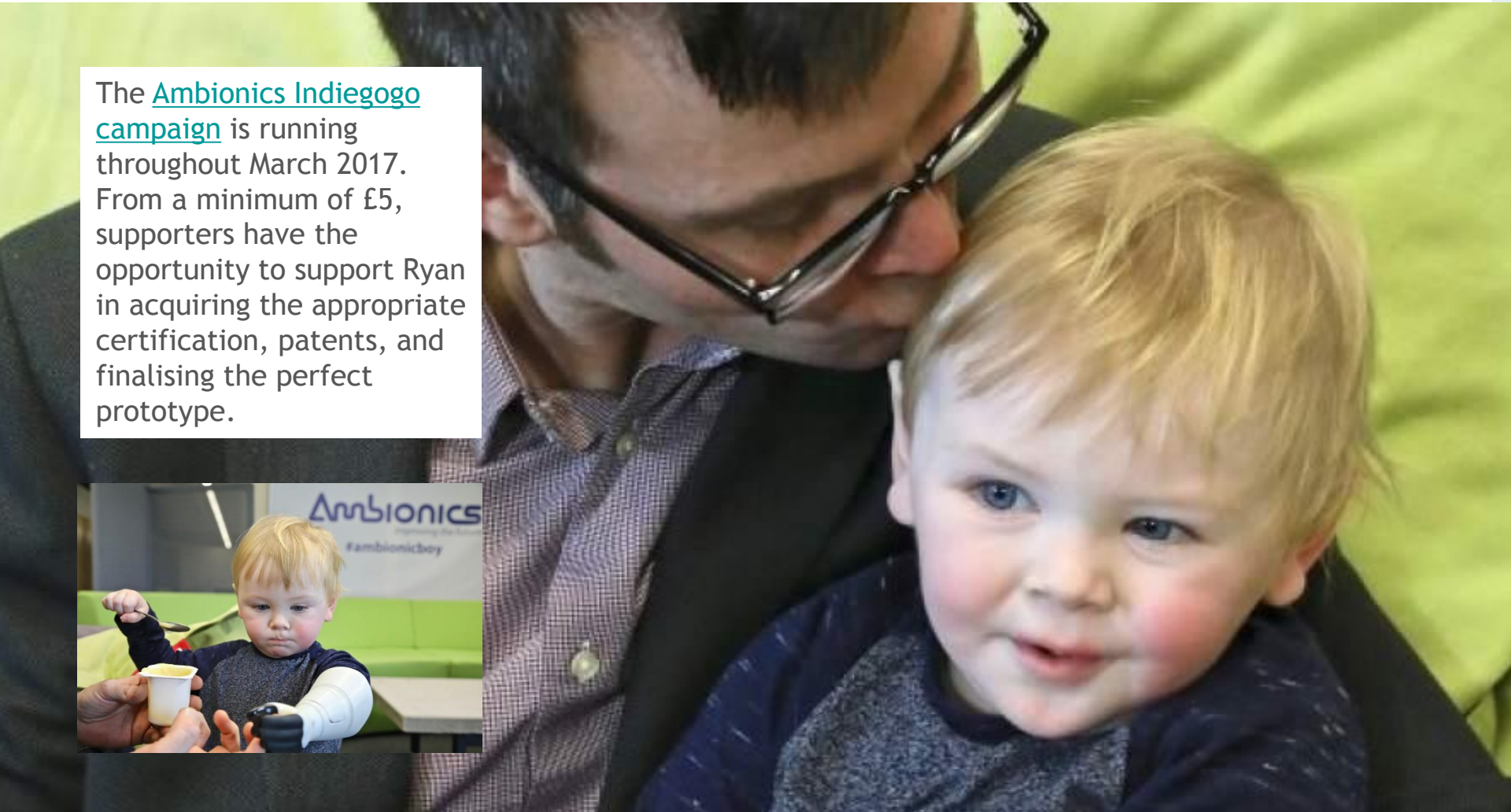
*Most robots today have sensors on the outside of the body that detect things from the surface. Our sensors are integrated within the body, so they can actually detect forces being transmitted through the thickness of the robot, a lot like we and all organisms do when we feel pain, for example.*



## Father develops 3D printed prosthetic arm to help crucial stage in children's lives

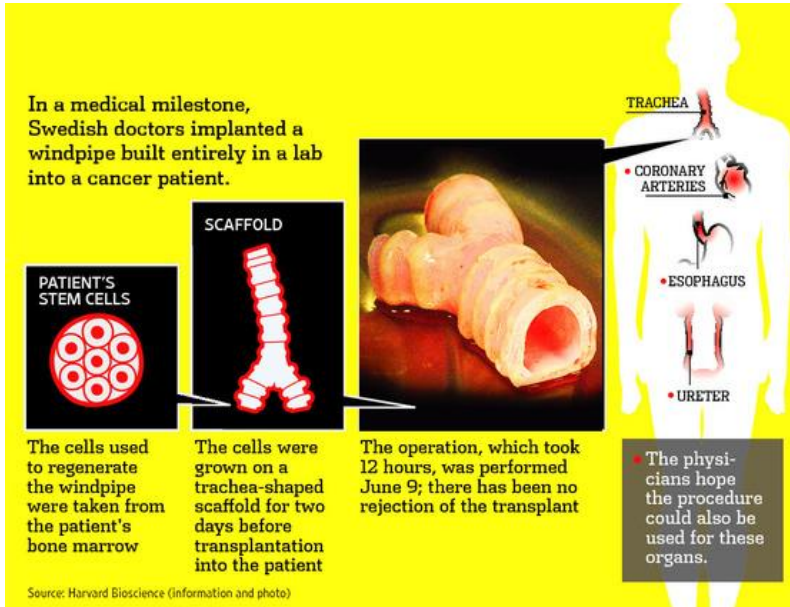
March 1<sup>st</sup> 2017 [www.3DPrintingIndustry.com](http://www.3DPrintingIndustry.com)

The [Ambionics Indiegogo campaign](#) is running throughout March 2017. From a minimum of £5, supporters have the opportunity to support Ryan in acquiring the appropriate certification, patents, and finalising the perfect prototype.



**Un peu plus compliqué ...**

In a medical milestone, Swedish doctors implanted a windpipe built entirely in a lab into a cancer patient.



The cells used to regenerate the windpipe were taken from the patient's bone marrow

The cells were grown on a trachea-shaped scaffold for two days before transplantation into the patient

The operation, which took 12 hours, was performed June 9; there has been no rejection of the transplant

The physicians hope the procedure could also be used for these organs.

TRACHEA  
CORONARY ARTERIES  
ESOPHAGUS  
URETER

PATIENT'S STEM CELLS  
SCAFFOLD

Source: Harvard Bioscience (information and photo)

## Man receives world's first synthetic windpipe

18:00 08 July 2011 by [Andy Coghlan](#)  
www.newscientist.com

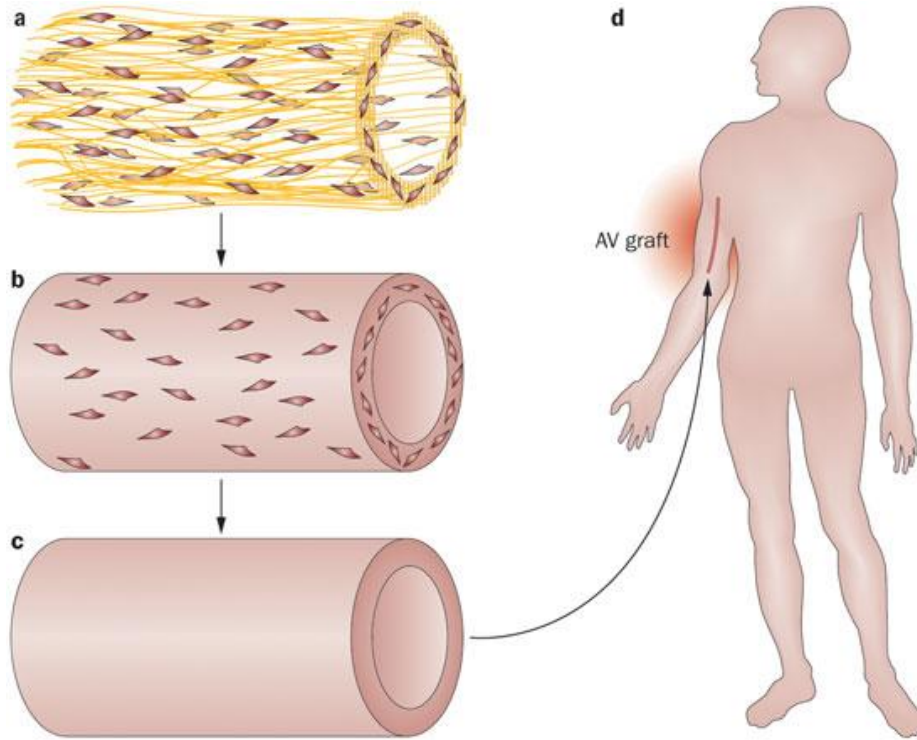
"The big conceptual breakthrough is that we can move from transplanting organs to manufacturing them for patients," says David Green, the president of [Harvard Bioscience](#) in Holliston, Massachusetts.



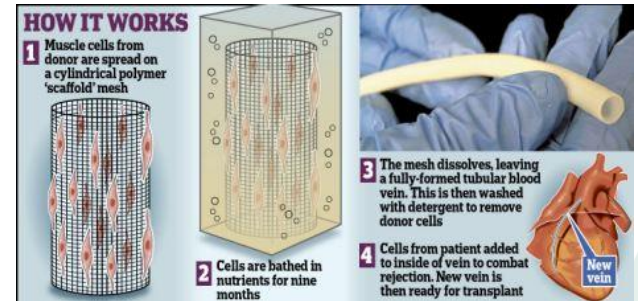
To build up the new artificial trachea, scientists harvested the **stem cells** from the patient's own bone marrow and planted them on **synthetic scaffolds**, made up from polymers with spongy and flexible texture.

# Surgeons implant bioengineered vein: Kidney dialysis patient first in U.S. to receive lab-grown blood vessel

June 6<sup>th</sup> 2013 sciencedaily.com



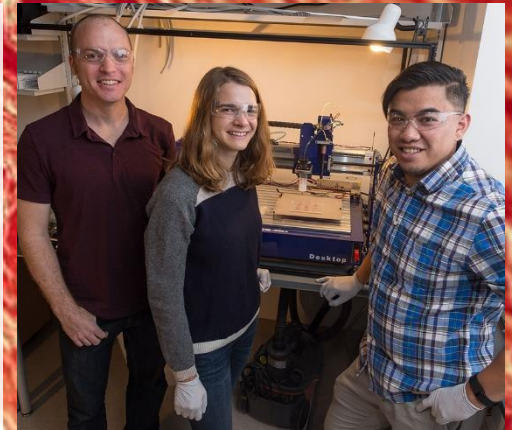
**HUMACYTE**



## Researchers Successfully Implant Artificial Blood Vessels Made with 3D Printing

On Mon, November 2<sup>nd</sup>, 2015 3DPRINTINGINDUSTRY.COM

In an article published in the journal [Tissue Engineering Part C: Methods](#), the team, led by assistant professor of bioengineering at Rice Jordan Miller and assistant professor of surgery at Penn Pavan Atluri, were able to create a silicon construct with a complex network of blood vessels, in which blood was able to flow normally to surgically attached, native blood vessels.

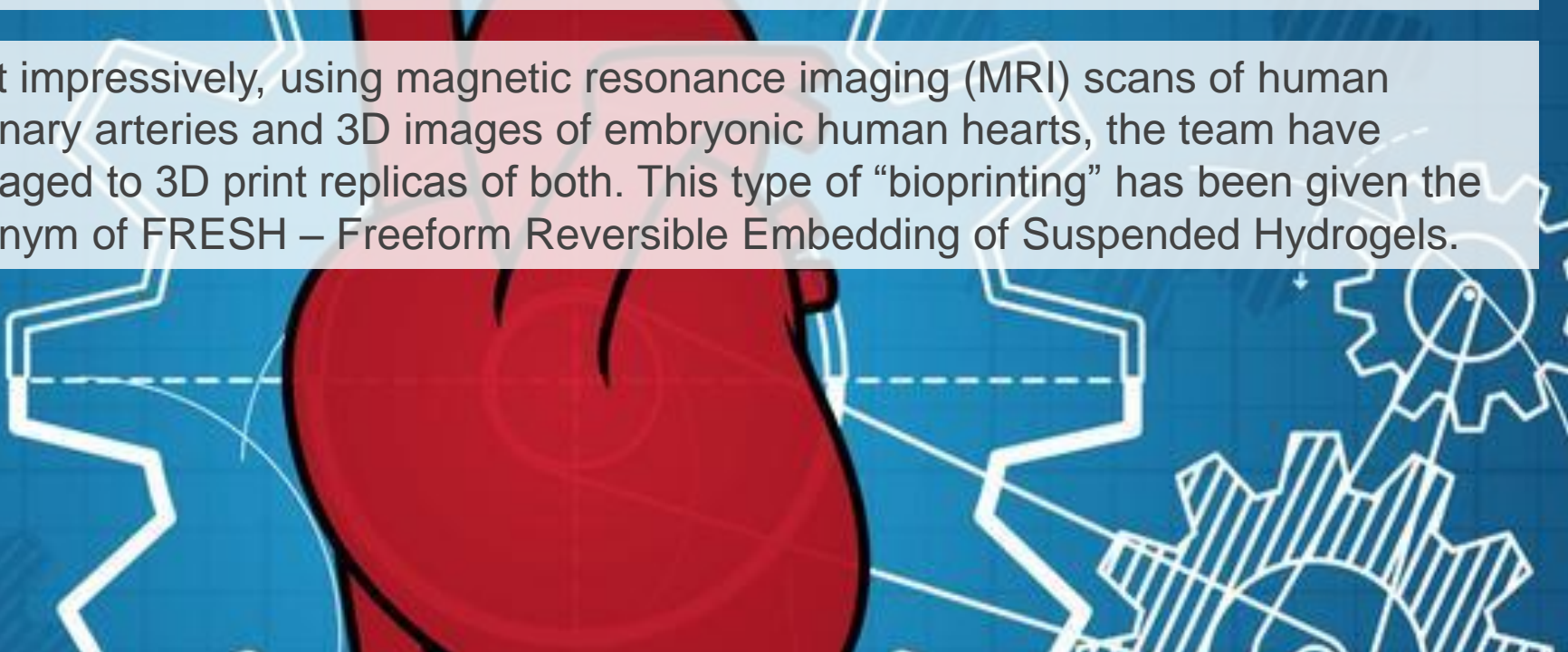


## Researchers Can Now 3D Print A Human Heart Using Biological Material

October 26th, 2015 | by Robin Andrews [www.iflscience.com](http://www.iflscience.com)

Printing a series of artery trees using this technique was perhaps the most substantial achievement by the team, who have produced complex biological structures with an [unprecedented degree of precision](#). The team's next step is to inject heart cells into these 3D printed biological tissue structures, essentially filling in the printed “scaffolding” with its biological “concrete”.

Most impressively, using magnetic resonance imaging (MRI) scans of human coronary arteries and 3D images of embryonic human hearts, the team have managed to 3D print replicas of both. This type of “bioprinting” has been given the acronym of FRESH – Freeform Reversible Embedding of Suspended Hydrogels.

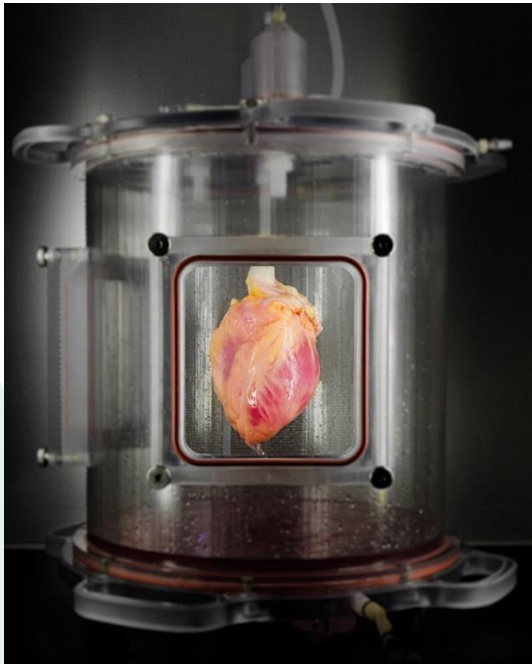


## MASS. GENERAL DECELLULARIZES, REBUILDS DONATED HEARTS WITH RECIPIENTS'S OWN CELLS

MARCH 11<sup>th</sup> , 2016 [WWW.MEDGADGET.COM](http://WWW.MEDGADGET.COM)

## SCIENTISTS GROW FULL-SIZED, BEATING HUMAN HEARTS FROM STEM CELLS

IT'S THE CLOSEST WE'VE COME TO GROWING TRANSPLANTABLE HEARTS IN THE LAB. By [Alexandra Ossola](#) Posted March 16, 2016 [www.popsci.com](http://www.popsci.com)



In this study 73 hearts, some from brain-dead donors, while others from those that died of cardiac causes, were essentially used to make **scaffolds** for new heart tissue.

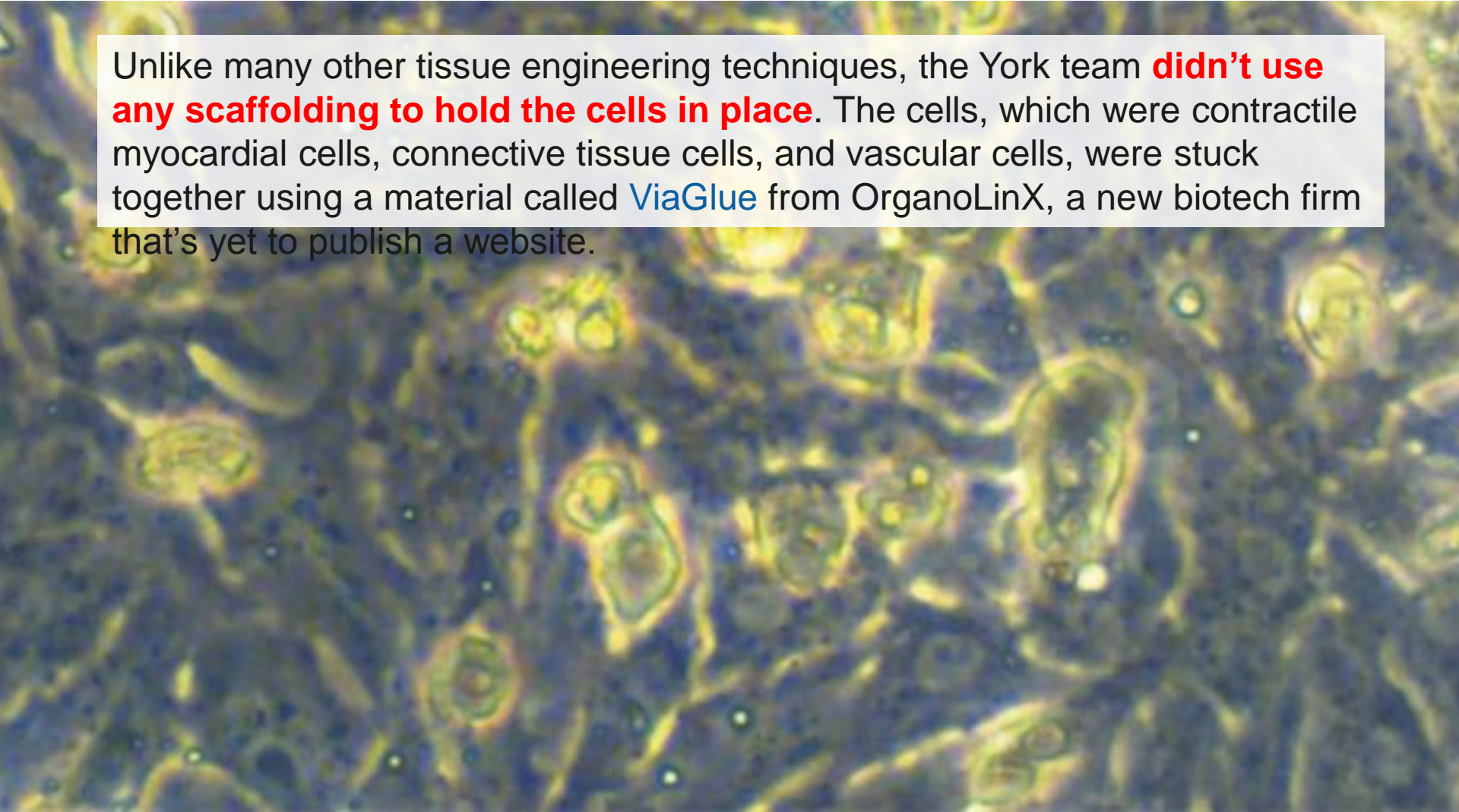
Both types of hearts did well under the decellularization process and when seeded with cells generated by reprogramming skin cells into pluripotent stem cells and then into cardiomyocytes, the resulting tissue within the organ began to spontaneously contract after a few days in the incubator.

After making sure the remaining matrix would provide a strong foundation for new cells, the researchers put the induced cells into them. For two weeks they infused the hearts with a nutrient solution and allowed them to grow under similar forces to those a heart would be subject to inside the human body. After those two weeks, the hearts contained well-structured tissue that looked similar to immature hearts; when the researchers gave the hearts a shock of electricity, they started beating.

## Synchronized 3D Beating Heart Tissue Made from Multiple Cell Types

FEBRUARY 17TH, 2017 [www.medgadget.com](http://www.medgadget.com)

Unlike many other tissue engineering techniques, the York team **didn't use any scaffolding to hold the cells in place**. The cells, which were contractile myocardial cells, connective tissue cells, and vascular cells, were stuck together using a material called **ViaGlue** from OrganoLinX, a new biotech firm that's yet to publish a website.





# 3D Printed Human Heart By **2023**, Says Top Scientist

by [Brian Krassenstein](#) | Mar 11, 2014 3DPRINT.COM

Williams, who is the Scientific Director of the Cardiovascular Innovation Institute at the University of Louisville, believes that within a decade, perhaps sooner, 3D printed human hearts will be available for transplant.

Williams also believes that one day nearly every hospital will house one or many 3D bioprinters, and that the next step from a 3D printed heart will be repairing only sections of hearts.

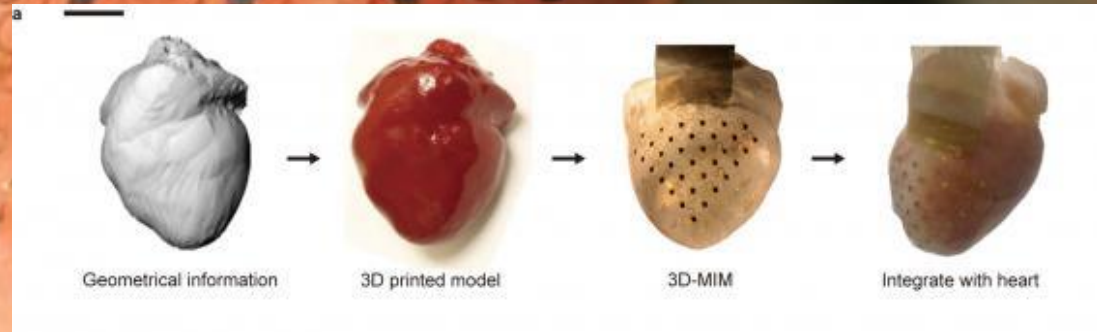


**Et en attendant cette prouesse...**

# 3D-printed 'electronic glove' could help keep your heart beating for ever

Monday 3 March 2014 [www.independent.co.uk](http://www.independent.co.uk)

Scientists have created a revolutionary new electronic membrane that could replace pacemakers, fitting over a heart to keep it beating regularly over an indefinite period of time.



# Revolutionary Bioprinting Tech Results in Beating Heart Cells

January 4th 2017 [www.futurism.com](http://www.futurism.com)

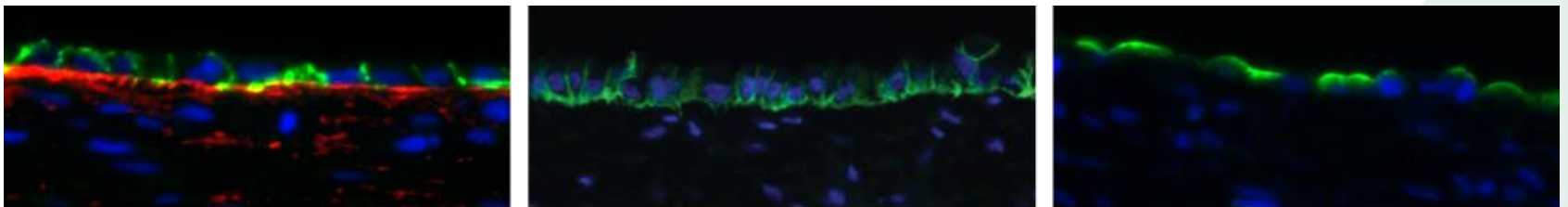
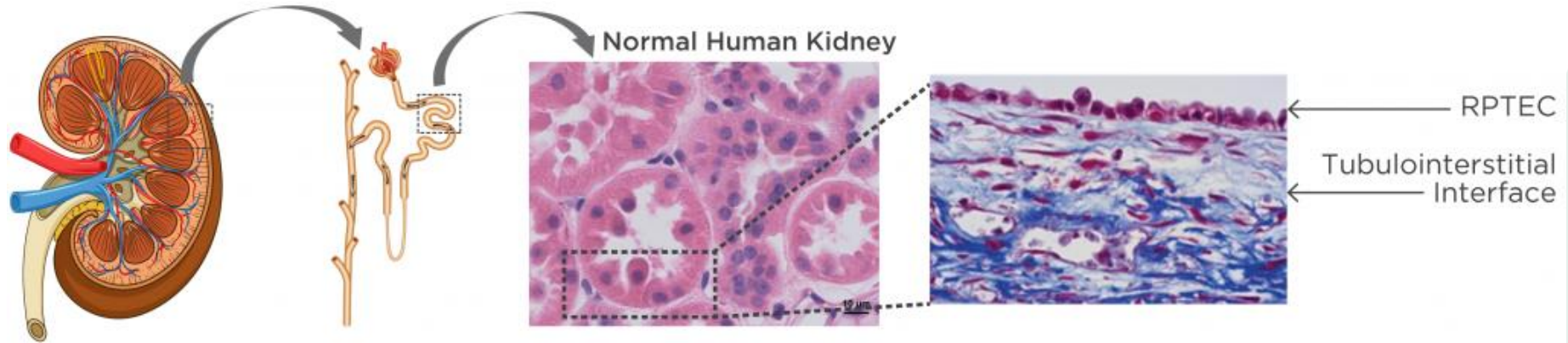
Someone in the US suffers a heart attack every 34 seconds, while someone dies from a heart-related disease every 60 seconds.

A new method from Australia uses bioprinting to create a patch of beating cardiac cells that can be stuck directly to a damaged organ following an attack.

# Autres organes vitaux

## Organovo 3D prints the base structure of a human kidney for drug-testing

February 22<sup>nd</sup> 2017 3DPrintingIndustry.com



By studying the 3D bioprinted kidney structures, Organovo can apply these findings to therapeutic treatment of kidney illness and disease. The ultimate goal is to produce tissue that can help to regenerate native tissues within the body.

## Organovo 3D bioprinted liver tissue could make it to the FDA by **2019**

December 23<sup>rd</sup> [www.3DPI.com](http://www.3DPI.com)

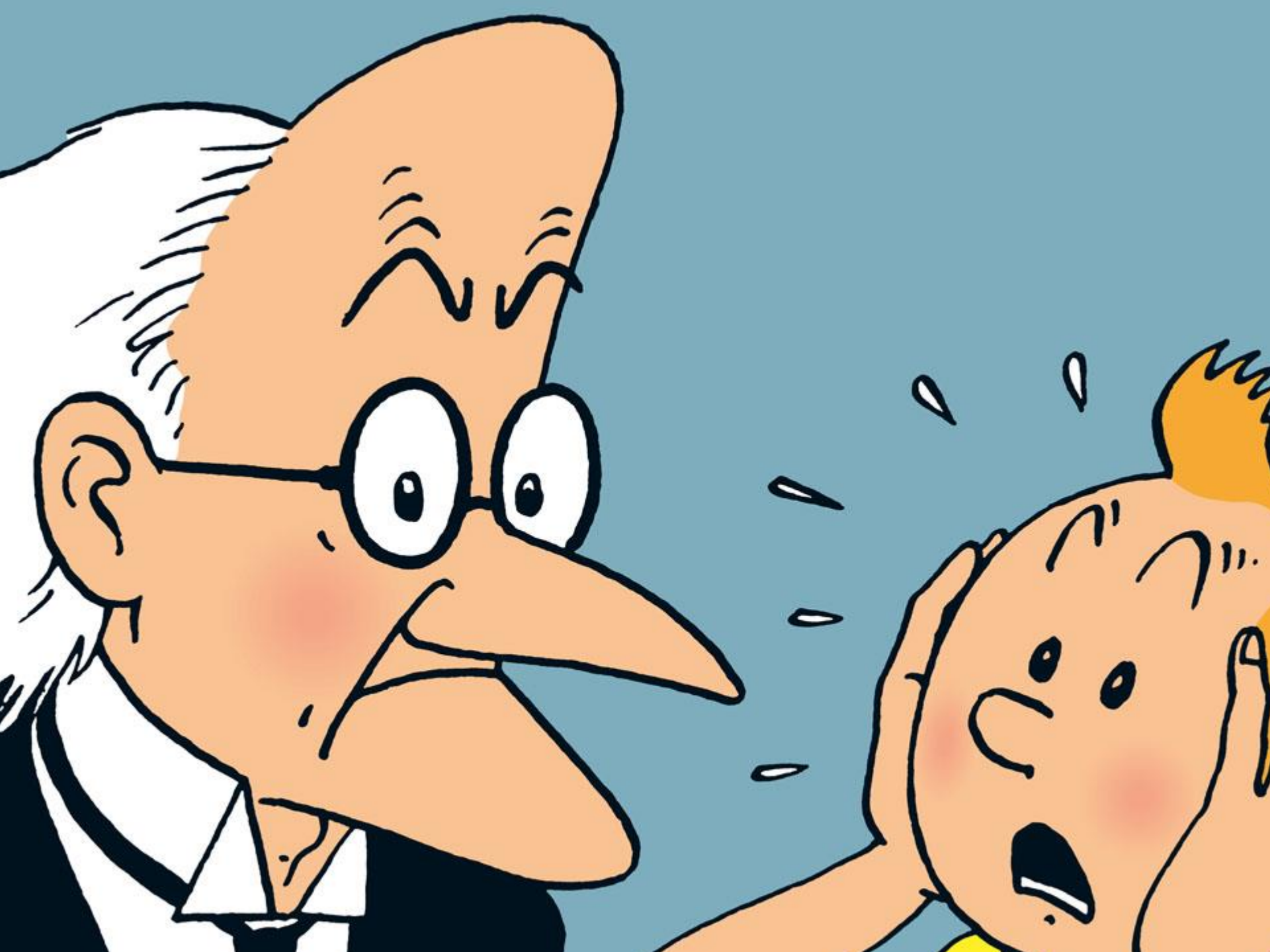
Though it will still be 3 – 5 years before the U.S. based Organovo apply for clearance of their liver tissue, that is still sooner than perhaps even the **FDA had in mind.**

Pre-clinical trial data shows that **3D bioprinted liver tissue** has been successfully planted into lab-bred mice. The human liver-cell tissue shows regular functionality and, at this stage, is being explored **as a suitable patch for the organ.**



**Et alors là...  
carrément plus compliqué!**





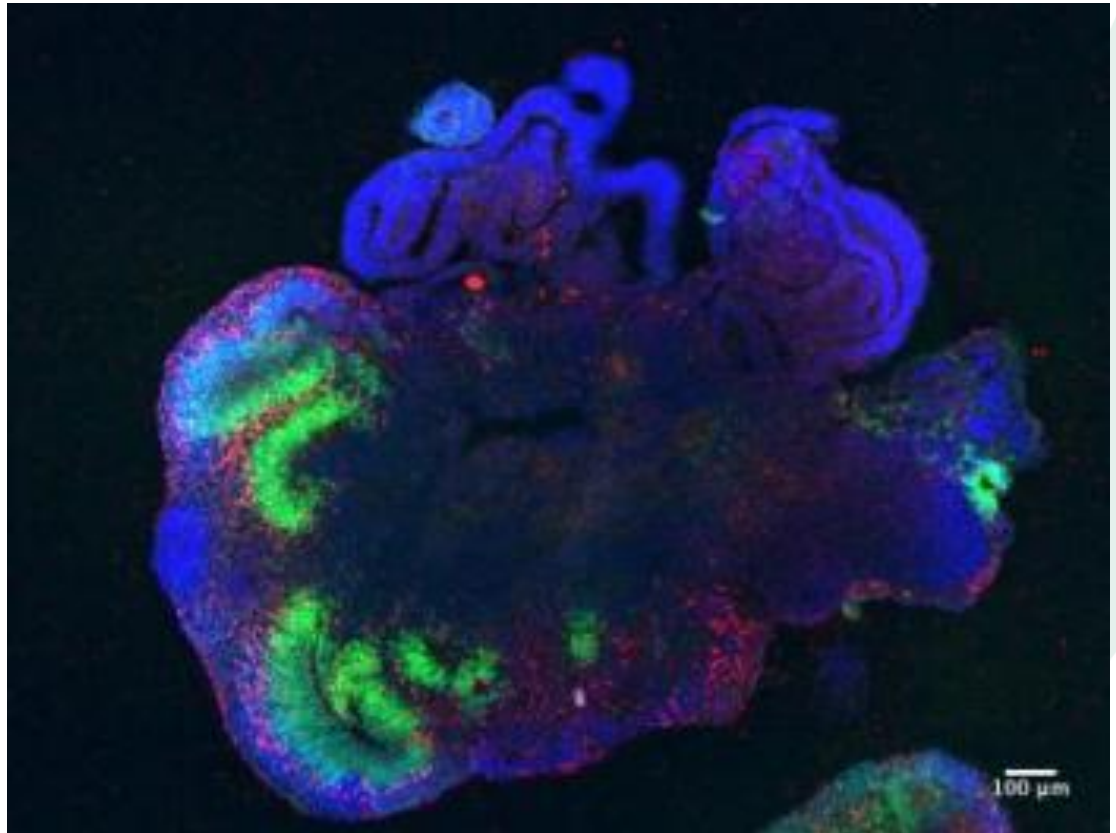
## Stem cell 'mini-brain' very similar to real brain, study finds

December 26<sup>th</sup> 2016 [www.medicalnewstoday.com](http://www.medicalnewstoday.com)

Latest developments in brain modeling, however, include creating functional 3-D **brain-like tissue and entire "mini-brains" from human stem cells.**

New research investigates such a 3-D mini-brain model and examines its advantages over a 2-D brain model.

The study was carried out by scientists at the Salk Institute, and the findings were **published in the journal *Cell Reports.***



## Lab Grown Mini-Brains Could End Animal Testing (on Brains)

February 16<sup>th</sup> 2015 [www.sciencealert.com](http://www.sciencealert.com)

Johns Hopkins Bloomberg School of Public Health: “animal testing may soon become a thing of the past, at least as far as the brain is concerned”.

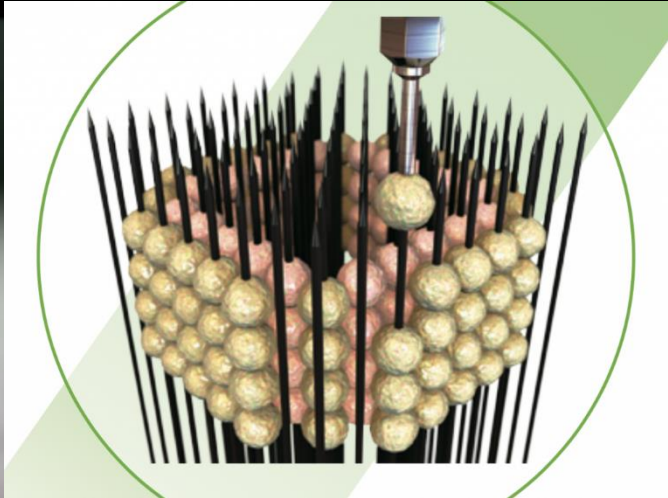
Conference for the [American Association for the Advancement of Science](#), “we have successfully developed “mini-brains” made up of neurons and cells of the human brain that are capable of replicating some of its functionality”.

The researchers hope that their tiny balls of brain cells will change the way new drugs are tested for effectiveness and safety, obviating the need for animal trials.



## Researchers in Kyoto pin-down 3D printed regenerative nerve tissue

[www.3DPrintingIndustry.com](http://www.3DPrintingIndustry.com) March 1<sup>st</sup> 2017



Researchers at [Kyoto University](#) in Japan have successfully implanted 3D printed cells into the thighs of lab rats. The 3D bioprinting used is the Kenzan method, where cells are placed onto an arrangement of neatly packed needles and left to culture.

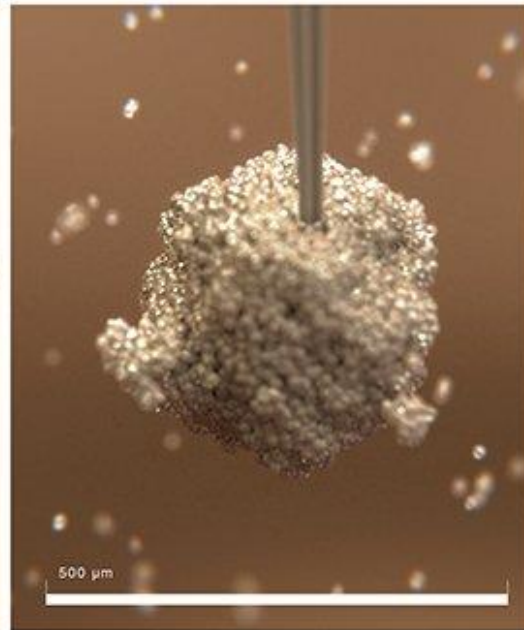
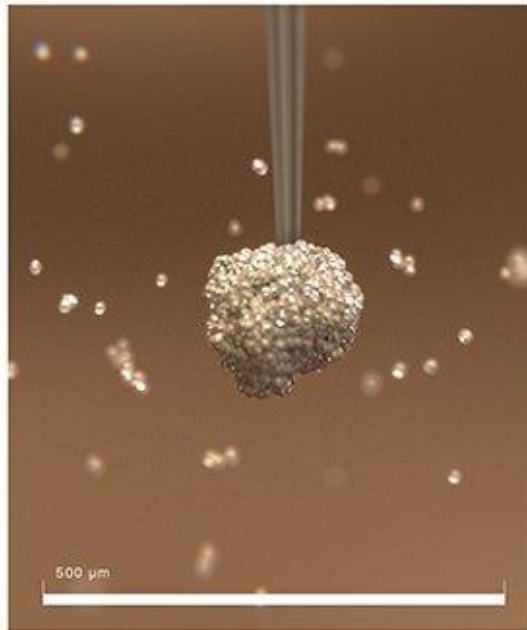


# Italian Researchers Expect 3D Printed Eyes by 2027, Providing Enhanced Vision & WiFi Connection

by [Bridget Butler Millsaps](#) · March 20, 2015 3DPRINT.COM



© EYE



© EYE

## Autres applications en médecine

- Impression de médicaments
- Impression de modèles pré-chirurgie

# First 3D-printed pill approved by US authorities

August 4<sup>th</sup> 2015 [www.bbc.com](http://www.bbc.com)



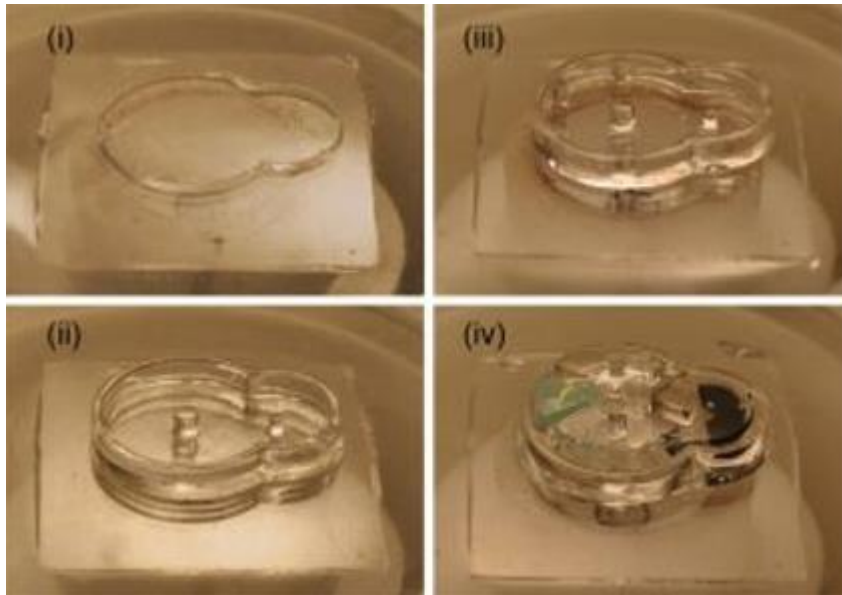
The new drug, dubbed Spritam, was developed by Aprelia Pharmaceuticals to control seizures brought on by epilepsy.

Printing the drugs allows layers of medication to be packaged more tightly in precise dosages.

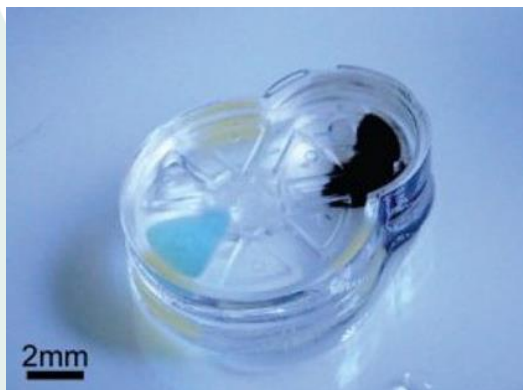
**FDA**  
**APPROVAL**

## Fast Method for Printing Biocompatible Implantable Microscopic Medical Devices

JANUARY 18TH, 2017 [www.medgadget.com](http://www.medgadget.com)



Tiny implantable medical devices with moving parts and drug chambers are a part of the future of medicine. Researchers at Columbia University have made a big step towards that by developing a new method for creating millimeter scale mechanisms out of hydrogels. Hydrogels are biocompatible, but they're difficult to work with. The Columbia team developed an additive manufacturing technique to layer hydrogels to result in tiny devices that are biocompatible and have powered mechanisms such as pumps and rotors.



The technology is dubbed **implantable microelectromechanical systems (iMEMS)**. One large achievement was the development of a “locking mechanism” that allows accurate control of the moving parts.

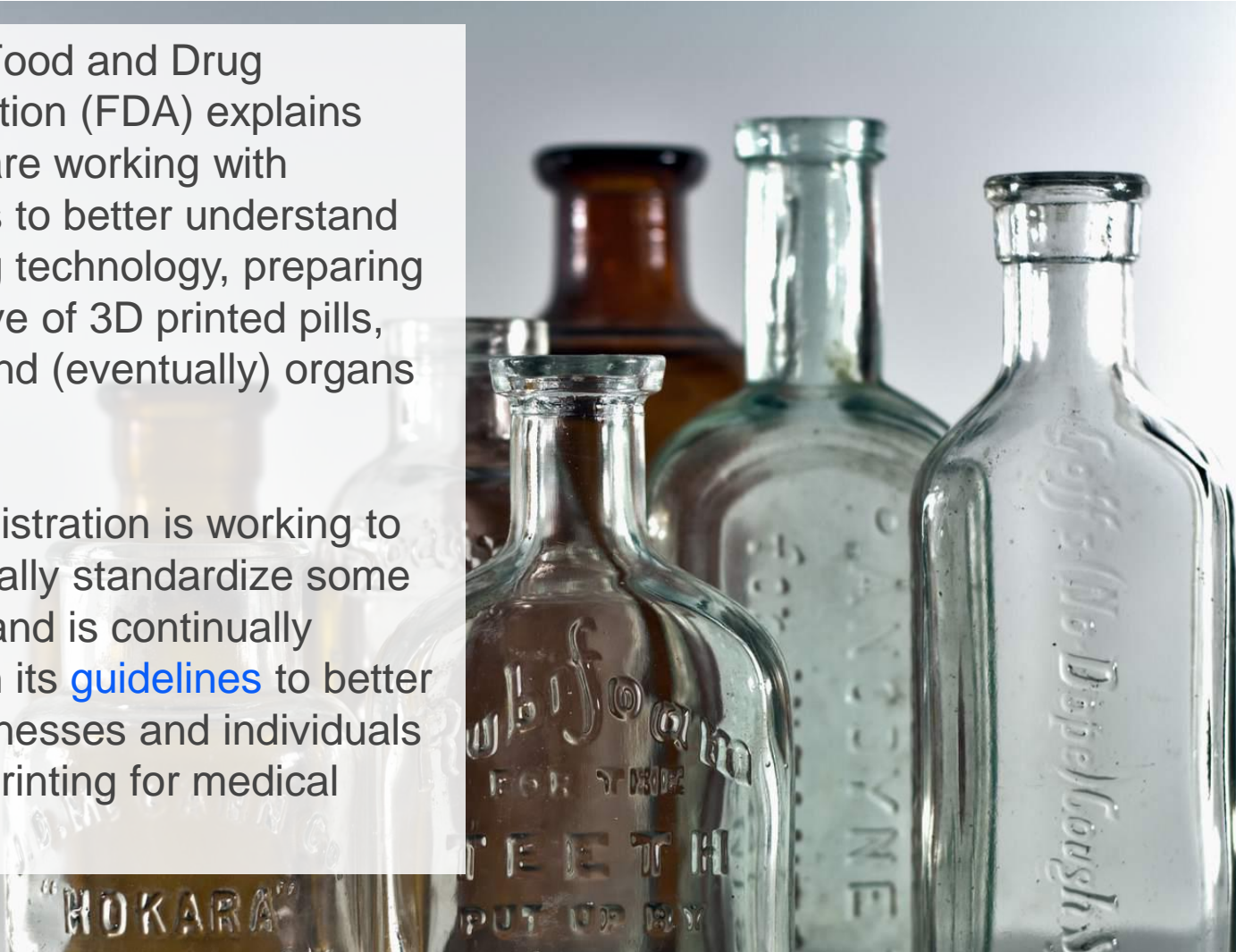


## Medicine gets personal: 3D printed pills and the FDA

December 22<sup>nd</sup> 2016

The U.S. Food and Drug Administration (FDA) explains how they are working with companies to better understand 3D printing technology, preparing for the wave of 3D printed pills, implants and (eventually) organs and tissue.

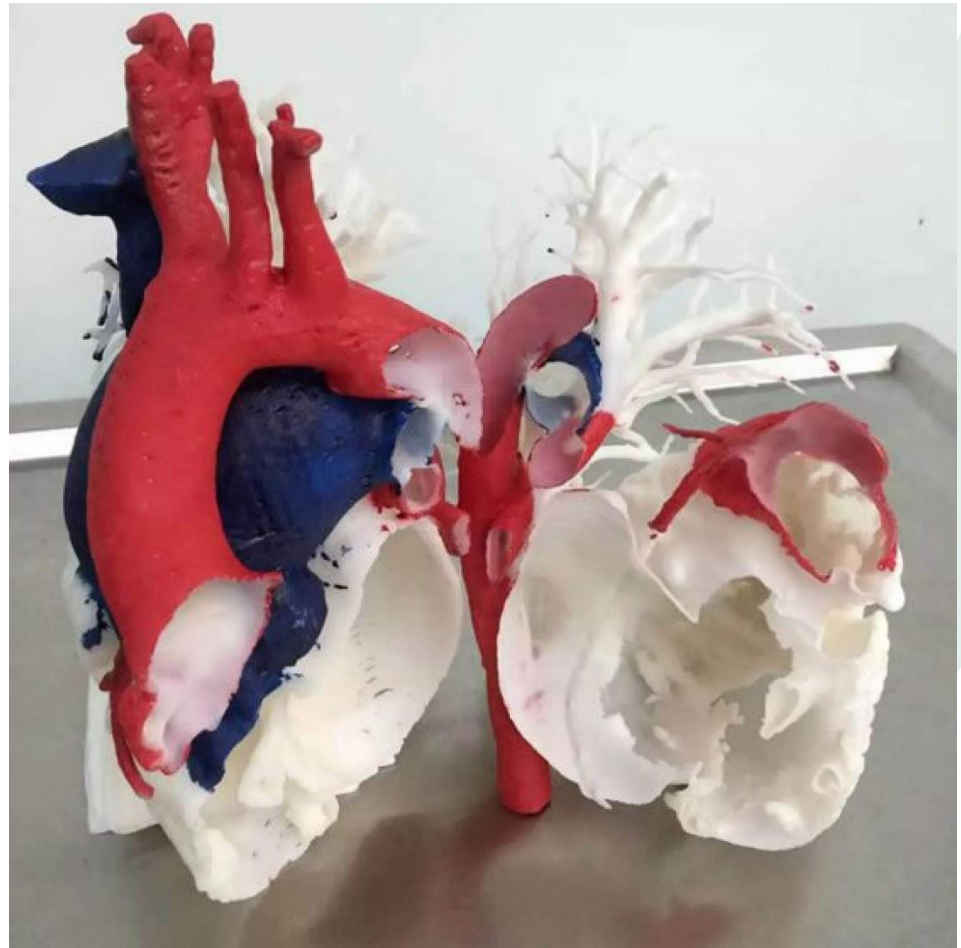
The Administration is working to internationally standardize some methods, and is continually working on its [guidelines](#) to better serve businesses and individuals using 3D printing for medical purposes.



## Chinese surgeons use 3D printing in two landmark paediatric heart surgeries

January 23<sup>rd</sup> 2017 [www.3Dprintingindustry.com](http://www.3Dprintingindustry.com)

Using 3D printing for surgical planning enables surgeons to physically manipulate a model of the affected areas and this is incredibly beneficial for preparing for procedures



## Students Launch Campaign to Provide African Hospitals with 3D Printing “Mini Factory”

BY [TYLER KOSLOW](#) TUE, MARCH 22<sup>nd</sup>, 2016. 3DPRINTINGINDUSTRY.COM



Together, the 15 students and their collaborators have launched the [Crowd4Africa](#) campaign on the Italian crowdfunding platform Eppela, and are planning to help these hospitals to 3D print orthopedic prosthetics and other spare parts.

## 3D printed stethoscopes cost as little as \$2.50 and are just as good

September 10<sup>th</sup> 2015 FUTURISM.COM



glia  
equal care

### Glia Free Medical hardware

Glia is a project with the **goal of releasing high quality free/open medical hardware** to increase availability to those who need it.

It's not just stethoscopes that the Gila project is working on. They hope to 3D print surgical tools and pulse oximeters, as well.

# A 3D Printer In Every Physician's Medical Bag?

September 25, 2015 MEDICALFUTURIST.COM

3D4MD has designed and tested a solar-powered, plug-and-play, ultra-portable 3D printing system to manufacture a range of hygienic, effective, and low-cost medical supplies at the point of use.



## EU Develops 3D-Printed Food for Elderly Patients Suffering from Dysphagia

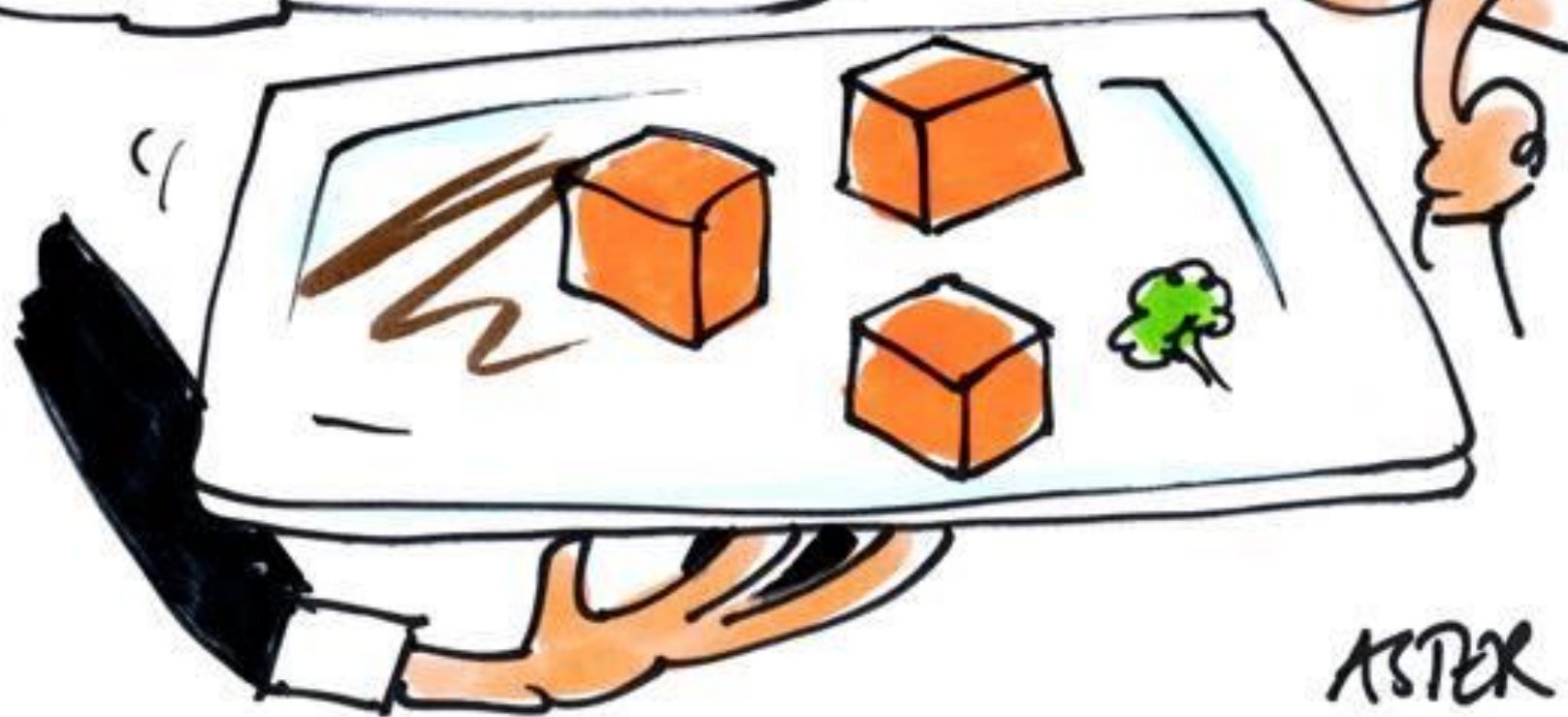
October 28<sup>th</sup> 2015 [WWW.FUTURISM.COM](http://WWW.FUTURISM.COM)

European experts are working on the **PERFORMANCE** (Personalized Food for the Nutrition of the Elderly Consumers) project, which uses 3D-printing technology to create easy-to-swallow and nutritious 3D-printed meals for the elderly. Studies show that 60% of nursing home patients suffer from dysphagia, or difficulty swallowing – which leads to these patients being served unappetizing pureed food.



VOS CAROTTES EN  
**3 DÉS**,  
MONSIEUR...

EUH, JE  
VOYAIS PAS  
ÇA COMME  
ÇA...



ASTER

# Conclusions



## Défis à relever

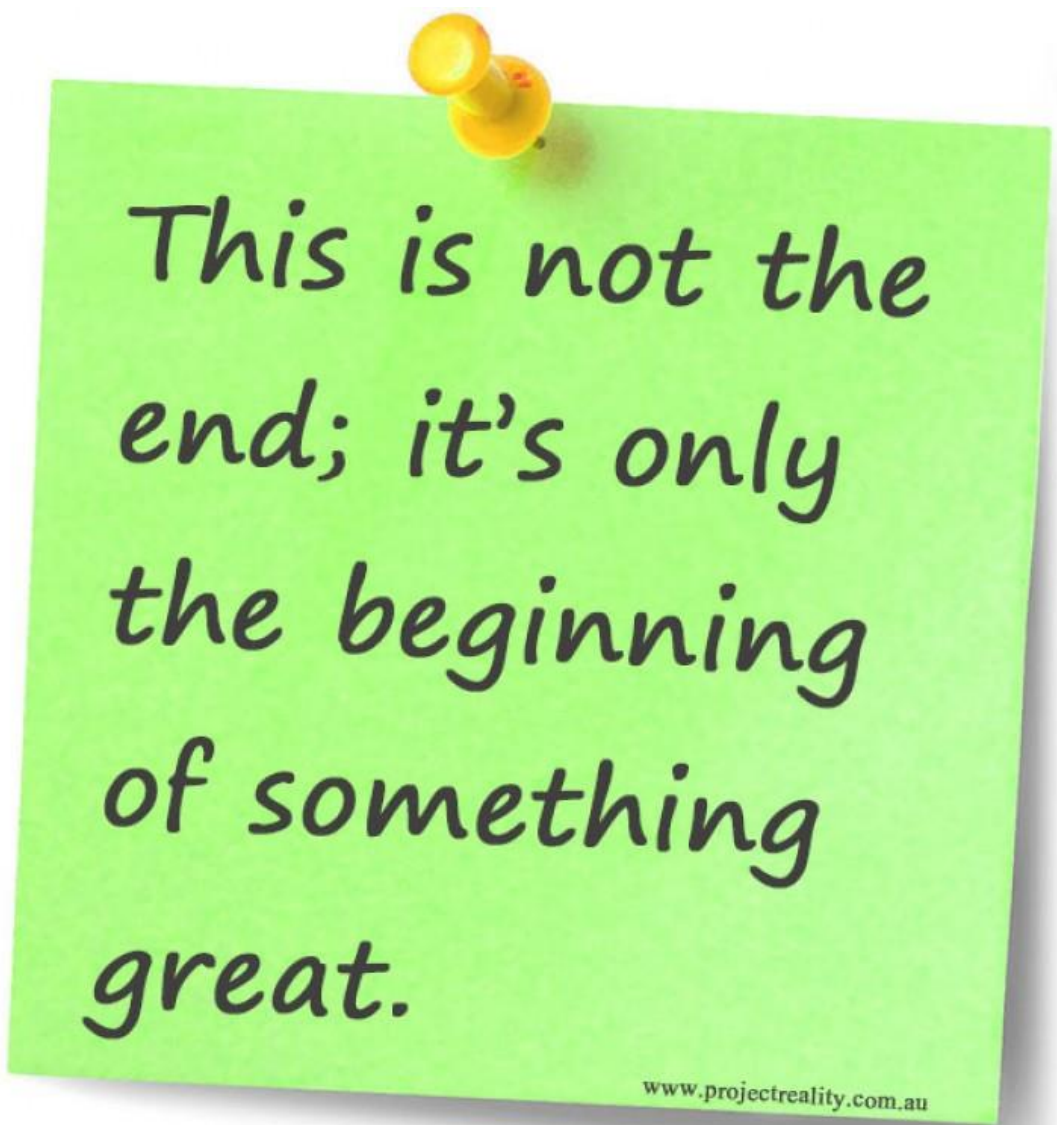
- Individualisation
- Géométries complexes
- Intégration fonctionnelle
- Réduction des couts de fabrication
- Disponibilité rapide

## Défis à relever

- Formation en STEAM (Science / Technology / Engineering / Arts & Math) devrait être poussé par les gouvernements!
- Passage de structures simples (une veine, une artère, une vertèbre) à des structures de plus en plus complexes et fonctionnelles (le rein, le coeur).

## Bénéfices attendus

- Amélioration de la qualité des soins
- Coûts/efficacité en matière de production
- Précision / individualisation
- Impact économique



*This is not the  
end; it's only  
the beginning  
of something  
great.*