3D-Print your future: just think and produce

Germán ESTEBAN MUÑIZ
Key Enabling Technologies
DG Research and Innovation
European Commission

Athens, 13/06/2014

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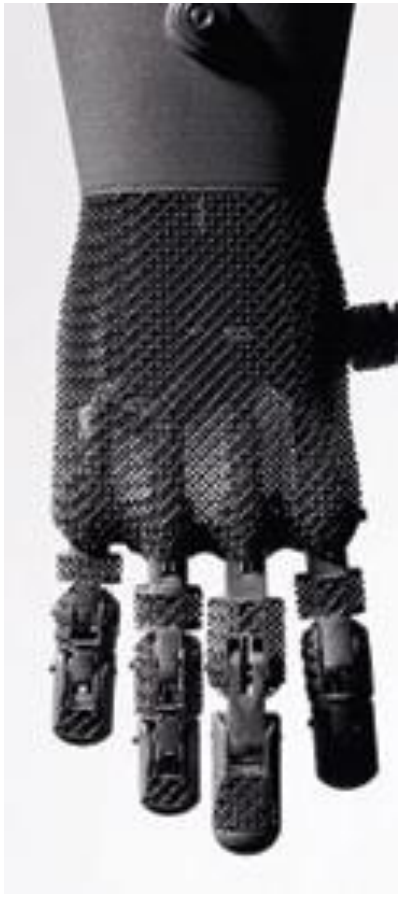

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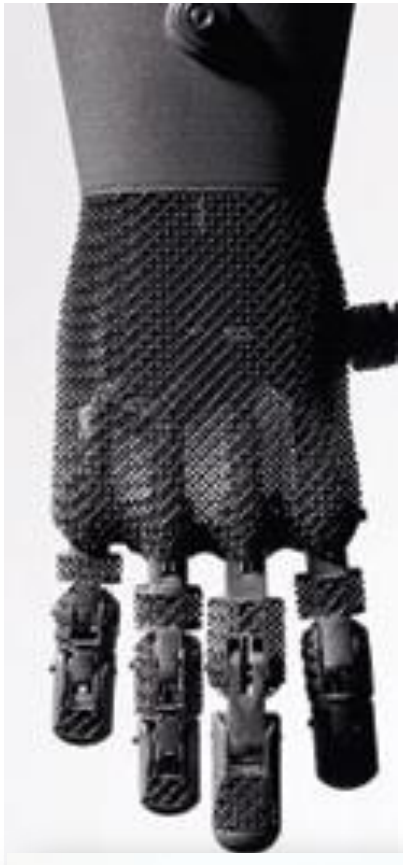

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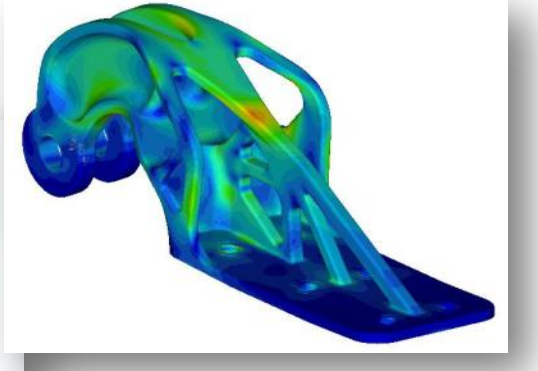

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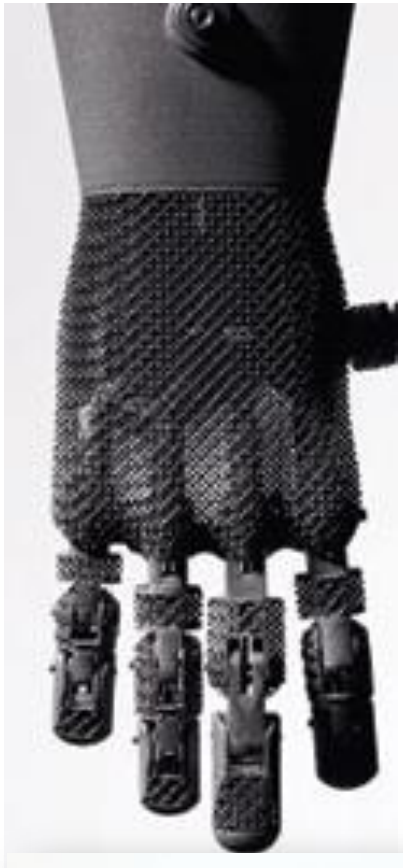

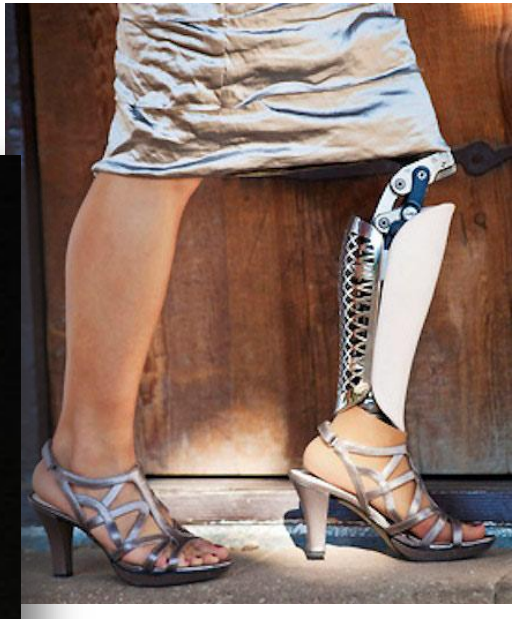

Courtesy of: Materialise / Francis Bitonti / Arcam / EADS / Sirris

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"Only he who attempts the absurd is capable of achieving the impossible."

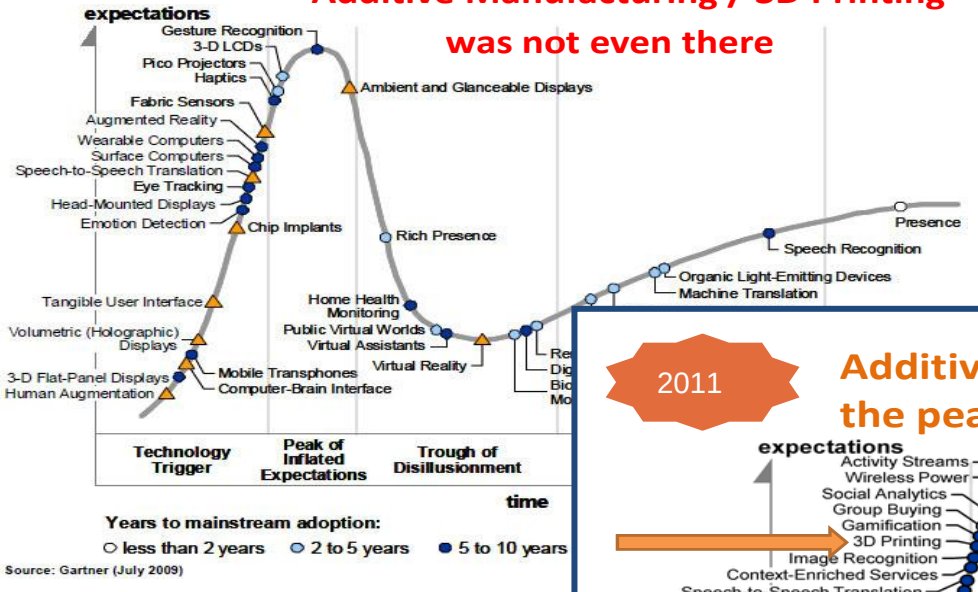
Miguel de Unamuno

Courtesy of Disseny Hub

3D-Printing… evolution, revolution or illusion?

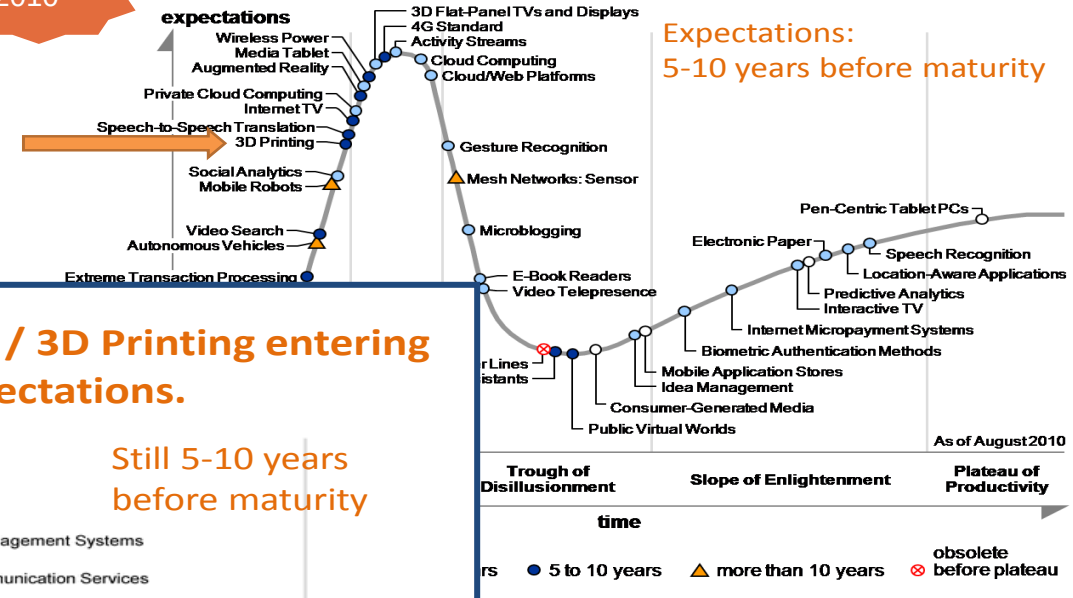
2009

Additive Manufacturing / 3D Printing was not even there



2010

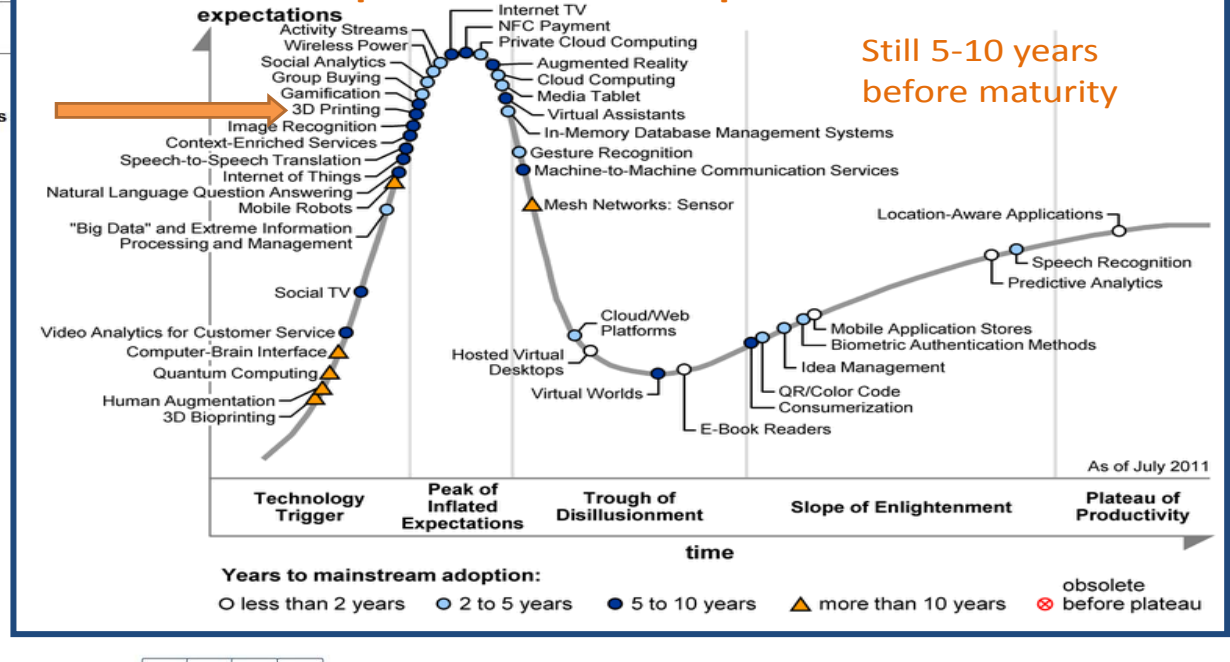
Additive Manufacturing / 3D Printing appears.



Expectations:
5-10 years before maturity

2011

Additive Manufacturing / 3D Printing entering the peak of inflated expectations.



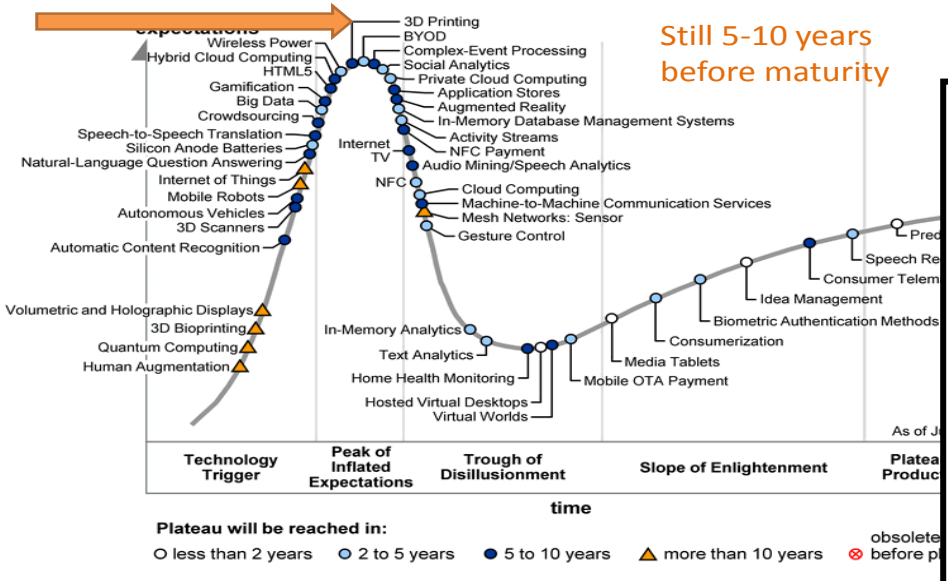
Still 5-10 years
before maturity

3D-Printing. Then… Is it already here?

2012

Additive Manufacturing / 3D Printing at top peak of inflated expectations

Still 5-10 years before maturity

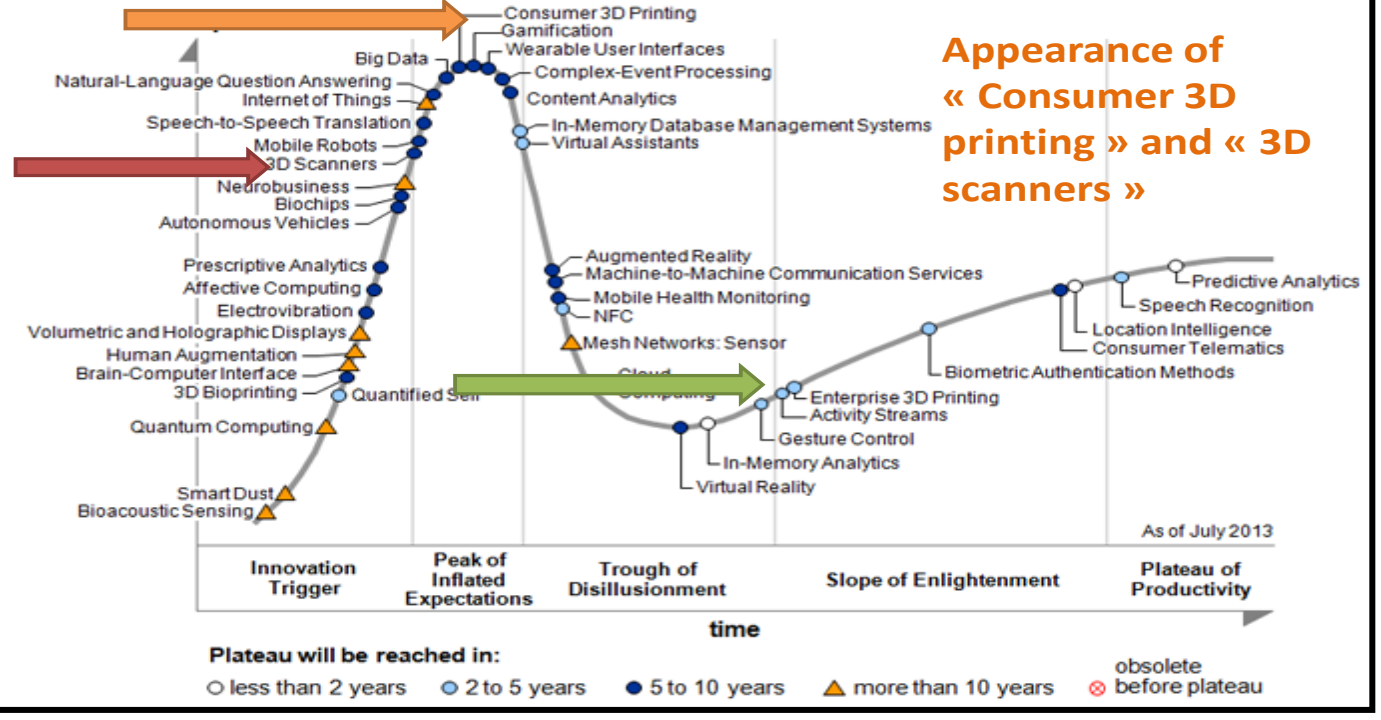


[Source: Gartner]

2013

Additive Manufacturing / 3D Printing suddenly on the «slope of enlightenment» and renamed «Enterprise 3D printing »

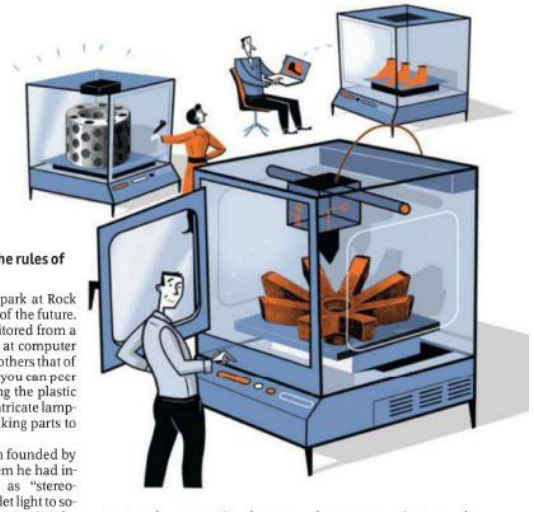
Appearance of « Consumer 3D printing » and « 3D scanners »



SPECIAL REPORT
MANUFACTURING AND INNOVATION

Additive manufacturing

Solid print

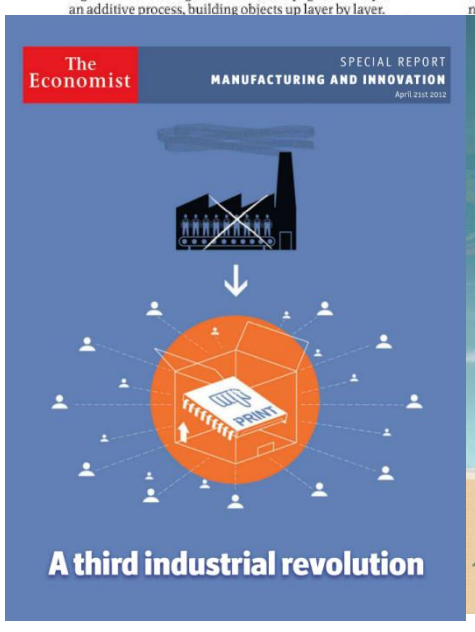


Making things with a 3D printer changes the rules of manufacturing

INSIDE A LOW-RISE building in a business park at Rock Hill, South Carolina, is a vision of the factory of the future. Several dozen machines are humming away, monitored from a glass-fronted control room by two people looking at computer screens. Some of the machines are the size of a car, others that of a microwave oven, but they all have windows that you can peer into. One is making jewellery, others are producing the plastic grip for an electric drill, the dashboard of a car, an intricate lampshade and a bespoke artificial leg. One is even making parts to build more machines like itself.

This is the headquarters of 3D Systems, a firm founded by Chuck Hull, who in a 1986 patent described a system he had invented for making three-dimensional objects as "stereolithography". It worked by using a beam of ultraviolet light to solidify a thin layer of liquid plastic, a bit like ink, and repeating the process by adding more liquid plastic. Other forms of 3D printing have since emerged (see box, next page), but they all work as an additive process, building objects up layer by layer.

structure by conventional means, whereas a 3D printer can do this easily. 3T RPD, a British firm that offers additive-manufacturing services, printed a gearbox for a racing car with smooth internal pathways for hydraulic oil instead of drilled-out right-angle



BBC NEWS

NEWS FROM ELSEWHERE

25 April 2014 Last updated at 11:27 GMT

China: Firm 3D prints 10 full-sized houses in a day

By News from Elsewhere...
...media reports from around the world, found by BBC Monitoring

A company in China has used giant 3D printers to make 10 full-sized, detached single-storey houses in a day, it appears.

A private firm, WinSun, used four 10m x 6.6m printers to spray a mixture of cement and construction waste to build the walls, layer by layer, official Xinhua news agency reported.

The cheap materials used during the printing process and the lack of manual labour means that each house can be printed for under $5,000, the 3dprinterplans website says.

"We can print buildings to any digital design our customers bring us. It's fast and cheap," says WinSun chief executive Ma Yihe. He also hopes his printers can be used to build skyscrapers in the future. At the moment, however, Chinese construction regulations do not allow multi-storey 3D-printed houses, Xinhua says.

The method of 3D printing has become more widely used in recent years. Manufacturers and designers have been able to make everyday items

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SOCIEDAD

VIDA Y ARTES »

Cartuchos de células, impresoras de órganos

La biorreprografía en 3D se presenta como una opción de futuro de la medicina regenerativa Existen algunas experiencias a pequeña escala aunque falta salvar obstáculos, como la vascularización del tejido

JAIME PRATS | Valencia | 12 NOV 2013 - 23:41 CET

Archivado en: Investigación médica Células madre Vida y Artes Trasplantes Cirugía Genética Biotecnología Tratamiento médico Investigación científica Biología Ciencias naturales Ciencia Medicina Sociedad Salud

Prótesis de nariz y oreja elaboradas con impresoras 3D en una muestra organizada en el Business Design Center de Londres / CHRIS RATCLIFFE (BLOOMBERG) TCUFFE

Un paciente se dispone a someterse a un trasplante de corazón. Mientras se le intuba, se le monitoriza y el anestesista se prepara para sedar al enfermo, en un rincón del quirófano, la bioimpresora 3D fabrica el órgano de remplazo que sustituirá al infartado. El zumbido de los cabezales del aparato en movimiento, cargado con cartuchos de cardiomiocitos y de otros tipos celulares, indica que el nuevo corazón aún no está listo. En unos minutos podrá comenzar la operación.

Esta imagen forma parte del género de la ciencia ficción. Y, si algún lejano día deja de serlo, los expertos creen que habrá que esperar no menos de tres décadas. "Yo lo situaría en la frontera de los próximos 30 años", afirma José Becerra, del Centro de Investigación Biomédica en Red en Bioingeniería, Biomateriales y Nanomedicina. Pero, aunque sea a largo plazo, hay motivos para imaginar que la escena del quirófano o una similar acabe siendo realidad por razones que van más allá de la simple fe en el desarrollo científico. "Lo mágico de todo esto es que se vislumbra [como una posibilidad de futuro] gracias al desarrollo que están teniendo las impresoras 3D y la informática, unido a la aparición de nuevos materiales y los avances en el conocimiento biológico", comenta este catedrático e investigador del Laboratorio de Bioingeniería y Regeneración Tisular de la Universidad de Málaga.

El previsible impacto de la impresión 3D en la medicina es uno de los principales factores que invita a pensar que será posible crear órganos y tejidos a medida, compatibles con el receptor a partir de células obtenidas del propio paciente. Una prueba de ello son los equipos capaces de fabricar tejido hepático vivo, que ya son una realidad, como muestra el catálogo de la empresa estadounidense Organovo, una de las líderes del sector. Pero esto sería empezar por el final en el campo de las aplicaciones médicas de las impresoras 3D.

The New York Times

 NEW YORK, TUESDAY, SEPTEMBER 14, 2010

A Technology Sets Inventors Free to Dream

By ASHLEE VANCE

SAN FRANCISCO — Businesses in the South Park district of San Francisco generally sell either Web technology or sandwiches and burritos. Bespoke Innovations plans to sell designer body parts.

The company is using advances in a technology known as 3-D printing to create prosthetic limb casings wrapped in embroidered leather, shimmering metal or whatever else someone might want.

Scott Summit, a co-founder of Bespoke, and his partner, an orthopedic surgeon, are set to open a studio this fall where they will sell the limb coverings and experiment with printing entire customized limbs that could cost a tenth of comparable artificial limbs made using traditional methods. And they will be dishwasher-safe, too.

"I wanted to create a leg that had a level of humanity," Mr. Summit said. "It's unfortunate that people have had a product that's such a major part of their lives that was so underdesigned."

A 3-D printer, which has nothing to do with paper printers, creates an object by stacking one layer of material — typically plastic or metal — on top of another, much the same way a pastry chef makes baklava with sheets of phyllo dough.

The technology has been radically transformed from its ori-

A Technology Sets Inventors Free to Dream

From Page A1

turers and designers to build prototypes.

These days it is giving rise to a string of never-before-possible businesses that are selling iPhone cases, lamps, doorknobs, jewelry, handbags, perfume bottles, clothing and architectural models. And while some wonder how successfully the technology will make the transition from manufacturing applications to producing consumer goods, its use is exploding.

A California start-up is even working on building houses. Its printer, which would fit on a tractor-trailer, would use patterns delivered by computer, squirt out layers of special concrete and build entire walls that could be connected to form the basis of a house.

It is manufacturing with a mouse click instead of hammers, nails and, well, workers. Advocates of the technology say that by doing away with manual labor, 3-D printing could revamp the economics of manufacturing and revive American industry as creativity and ingenuity replace labor costs as the main concern around a variety of goods.

"There is nothing to be gained by going overseas except for higher shipping charges," Mr. Summit said. "It's unfortunate that people have had a product that's such a major part of their lives that was so underdesigned."

A wealth of design software programs, from free applications to the more sophisticated offerings of companies including Alibre and Autodesk, allows a person to connect a product at home, then send the design to a company like Shapeways, which will print it and mail it back.

"We are enabling a class of ordinary people to take their ideas and turn those into physical, real products," said J. Paul Grayson, Alibre's chief executive. Mr. Grayson said his customers had

Scott Summit, above, co-founder of Bespoke Innovations, with a prosthetic limb. Charles Overy, left, founder of LGM, with a model of a resort in Vail, Colo. "We used to take two months to build $100,000 models," he said, adding that now they cost about $2,000.

merits of mass consumption. LGM. "Well, that type of work is

the world's biggest technology companies. Hewlett-Packard, the largest paper-printer maker, has started reselling 3-D printing machines made by Stratasys. And Google uses the CADspan software from LGM to help people using its SketchUp design soft-

Le Monde diplomatique

IMPRIMANTES 3D, DERNIÈRE SOLUTION MAGIQUE

Illusoire émancipation par la technologie

Depuis peu, des machines électroniques capables de produire des objets, fonctionnant à la manière d'imprimantes en trois dimensions, sont accessibles au grand public. Elles suscitent un engouement au sein d'une avant-garde qui y voit les ferments d'une nouvelle révolution industrielle. Mais les partisans de ces outils de bricolage technologique oublient souvent l'histoire qui les a vus naître.

par **Johan Söderberg**, janvier 2013

Ce serait la révolution industrielle du XXIe siècle : ce qui devait auparavant être acheté en magasin pourrait désormais être fabriqué chez soi grâce à des outils comme une découpeuse laser, une imprimante 3D, une fraiseuse à commande numérique, etc. (1). Ces machines suivent toutes un même principe technologique : guider les mouvements d'un outil mécanique à l'aide d'un logiciel. Les plus célèbres d'entre elles fonctionnent comme des imprimantes, mais en trois dimensions : passage après passage, une buse se déplace sur trois axes et superpose des couches de matière (le plus souvent une résine synthétique) en suivant un modèle numérisé, jusqu'à obtention du volume désiré. De la poignée de porte au vélo, les objets ainsi produits se multiplient.

Même si cette technologie suscite un foisonnement de petites entreprises créatives, son développement est essentiellement l'œuvre d'amateurs, qui se définissent comme des *makers*. Enracinés dans le monde du logiciel libre, ils appliquent ses valeurs et pratiques aux mécanismes de fabrication. Pour les plus radicaux d'entre eux, la réappropriation populaire des outils ouvrirait la voie à une « démocratisation » de la production industrielle, avec, en ligne de mire, l'abolition de la société de consommation. D'autres espèrent réduire les coûts du travail et rendre ainsi obsolète le mouvement de délocalisation de la production industrielle vers les pays du tiers-monde (2). Ce point de vue, plus proche des cercles d'affaires, est notamment exprimé par le magazine spécialisé *Make* (« Fabriquez »), qui, entre autres activités, organise chaque année une Maker Faire (« foire de la fabrication ») dans plusieurs grandes villes des Etats-Unis.

Il suffit toutefois de se promener dans les allées de ce Salon pour constater une certaine dissonance au sein de la révolution annoncée. Parmi les nombreuses attractions proposées lors de son édition de 2011, à New York, on pouvait ainsi visiter le Print Village (« village de l'impression ») : une vingtaine de stands consacrés à l'imprimante 3D RepRap et à ses nombreux dérivés (emblème de ce mouvement, la RepRap est capable de reproduire la plupart des éléments qui la composent, et ainsi de s'autorépliquer).

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3D-Printing? or Additive Manufacturing?

- Additive Manufacturing (AM) refers to a group of technologies that build physical objects directly from 3D Computer-Aided Design (CAD) data.
- ISO/ASTM has defined "Additive Manufacturing" as:

  "process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies, such as traditional machining."
- Today, both terms are used interchangeably, but Industry still prefers to use the "Additive Manufacturing" term, while Home Appliances and Consumer Goods widely use "3D-Printing".

Different terms used since AM started:

Courtesy of AM Platform

Different technologies, different materials:

SLA / SLS / 3D-Printers / FDM / DLP / DMLS / EBM / LMD / LC / …

Polymers – Metals – Ceramics - ?

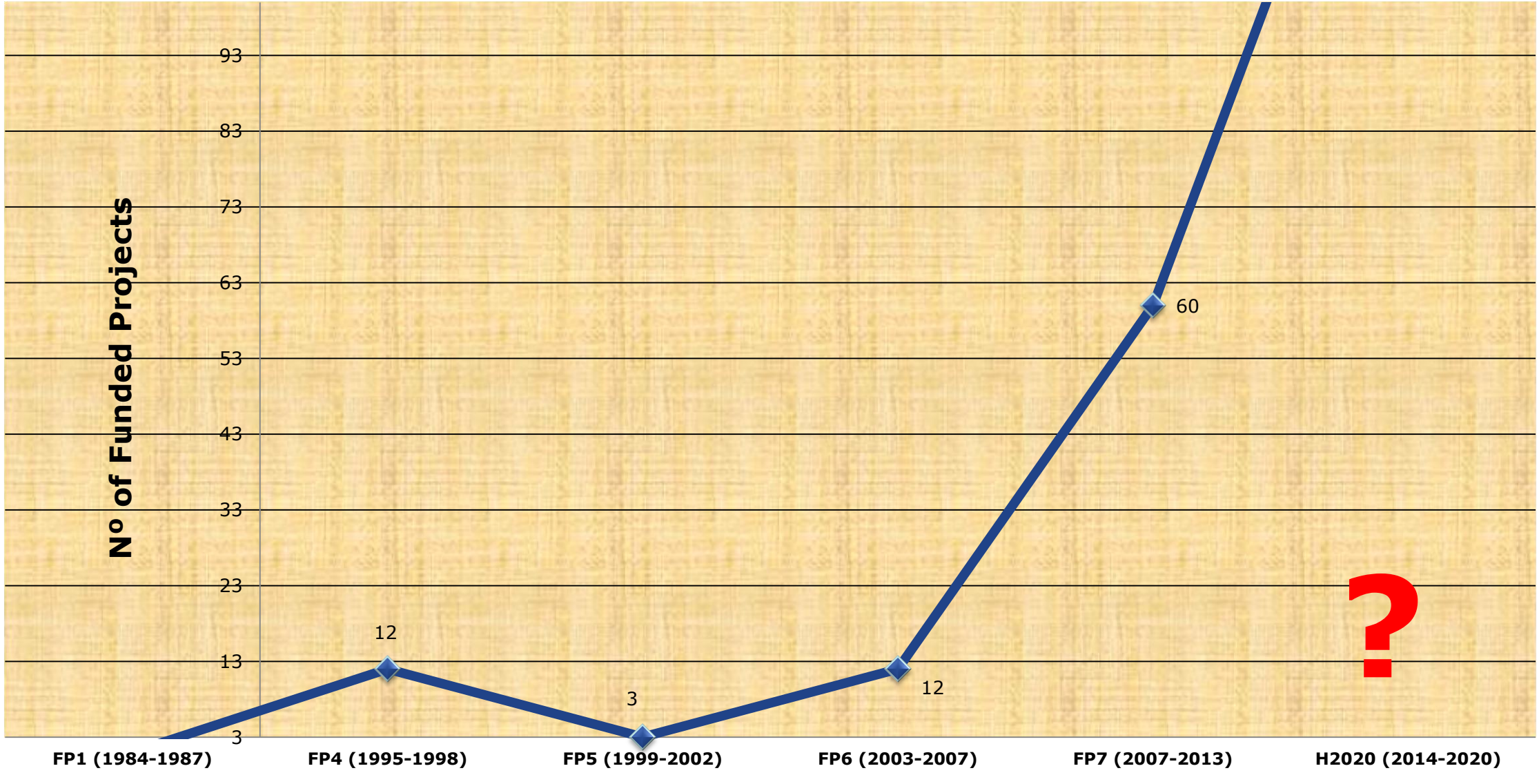
Additive Manufacturing in the EC:

- European Commission (EC) was a pioneer:
  Additive Manufacturing funded since the
  First Framework Programme (FP1, 1984-1987).
- The following Framework Programmes (1988-2013) ensured continuous support from different EC services and different funding programmes.
- Only in FP7 (2007-2013), more than 60 successful projects based on AM technologies were funded with a total amount over €160 million in EC funding and a total budget of around €225 million.
- EC explicitly mentioned 3D-Printing in the Industrial Policy Communication in 2012 as a key part for the new Industrial Revolution.
- The EC "Industrial Landscape Vision 2025", in 2013, showed AM as a case study on how Standards will facilitate new production systems, enhancing EU innovation and competitiveness.

AM
1988-2013

RAPROMO MAID DERP VITAMIN PRIME PHIDIAS RAMATI PRINCIPLE NAIMO FLEXRAP CUSTOM-FIT RAMA3DP METAL-PRINT FLEXFORM FANTASIA RC2 NOVELSCAFF CUSTOM-IMD M&M´S SHAPEFORGE M&M´S+ IMPALA OPEN GARMENTS MULTILAYER COMPOLIGHT MICROFLUID STEPUP DIRECTSPARE INLADE LIGHT-ROLLS A-FOOTPRINT DIGHIRO PHOCAM CORENET KARMA IC2 MERLIN PRINTCAR INTRAPID ADM-ERA HIRESEBM ARTIVASC 3D FASTEBM NANOMASTER DIGINOVA AEROSIM EUROFIT SASAM IMPLANT DIRECT SMARTLAM HI-MICRO 3D-HIPMAS AEROBEAM PERFORMANCE HIPR AMCOR VINDOBONA AMAZE IDAMME2 OXIGEN BIO-SCAFFOLDS MALT RAPIDOS SASAM IMPLANT DIRECT SMARTLAM HI-MICRO 3D-HIPMAS AEROBEAM PERFORMANCE HIPR AMCOR VINDOBONA AMAZE IDAMME2 OXIGEN BIO-SCAFFOLDS MALT RAPIDOS MANSYS SIMCHAIN CASSAMOBILE ADDFACTOR FLOWMAT NEXTFACTORY FABIMED OPTICIAN2020 INTERAQCT RRD4E2 PILOTMANU D-HYDROZONES FOOTPRINT PLASMAS IRRESISTIBLE REP-AIR

Additive Manufacturing Projects in European Commission



3D-Printing in H2020 and RIS3:

- Horizon 2020, has identified Additive Manufacturing (AM), including 3D-Printing, as part of one of the Key Enabling Technologies (KETs) and as an Advanced Manufacturing Technology.
- Up to date, more than 125 European Regions from 28 Member States have joined Regional Smart Specialization. More than 2/3 of these Regions have identified KETs as a priority for RIS3.
- AM responds to the Industrial Leadership, to several Societal Challenges, and requires a high degree of Innovation.
- AM gives the designers the ability to innovate, to quickly turn concepts into 3D models or 3D prototypes, opening up shapes that were impossible to produce before, allowing to make a mass customisation, a real shift from today´s mass production, and a relocalisation of manufacturing in Europe.

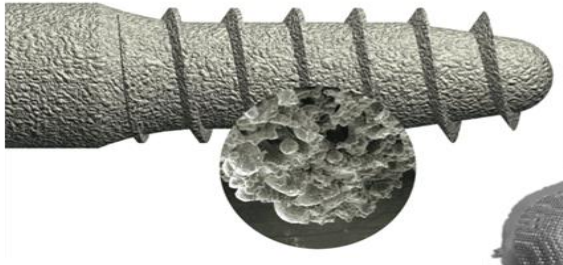
Additive Manufacturing in the Industrial Leadership

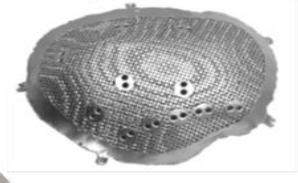
Courtesy of Sirris, UAS, GE

"ADDITTIVE MANUFACTURING"

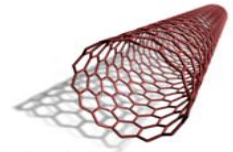
SOCIETAL CHALLENGE

HEALTH





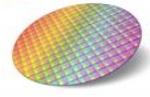
- ✓ CUSTOMIZATION FOR REAL USER NEEDS
- ✓ NEW FUNCTIONAL DESIGNS FOR CONVENTIONAL USES
- ✓ NEW CONCEPT SOLUTIONS FOR LOW COST SITUATIONS
- ✓ FAST RESPONSE TO CRITICAL DEMANDS
- ✓ NEW TOOLS FOR NEW MINDED PROFESSIONALS
- ✓ MANUFACTURING ON DEMAND



ADVANCED MATERIALS

NANOTECHNOLOGIES

MICROELECTRONICS



PHOTONICS

BIOTECHNOLOGIES

ADVANCED MANUFACTURING

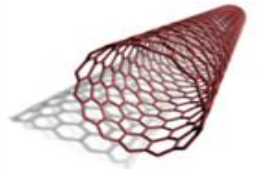
Combining AM with several KETs for advanced products

"ADDITTIVE MANUFACTURING"

SOCIETAL CHALLENGE

TRANSPORT

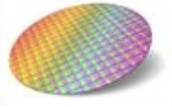
Combining AM with several KETs for advanced products



ADVANCED MATERIALS

NANOTECHNOLOGIES

MICROELECTRONICS



PHOTONICS

ADVANCED MANUFACTURING

- ✓ CUSTOMIZATION FOR REAL END USER NEEDS
- ✓ NEW FUNCTIONAL DESIGNS FOR NEW VEHICLE CONCEPTS
- ✓ REDUCING COSTS INCREASING PERFORMANCE
- ✓ FAST RESPONSE TO HIGH DEMANDING SECTOR
- ✓ NEW TOOLS FOR NEW MINDED PROFESSIONALS
- ✓ NEW CONCEPT OPTIMISED INTRINCATED STRUCTURES TO FIT FUTURE USABLE SHAPES
- ✓ MANUFACTURING ON DEMAND

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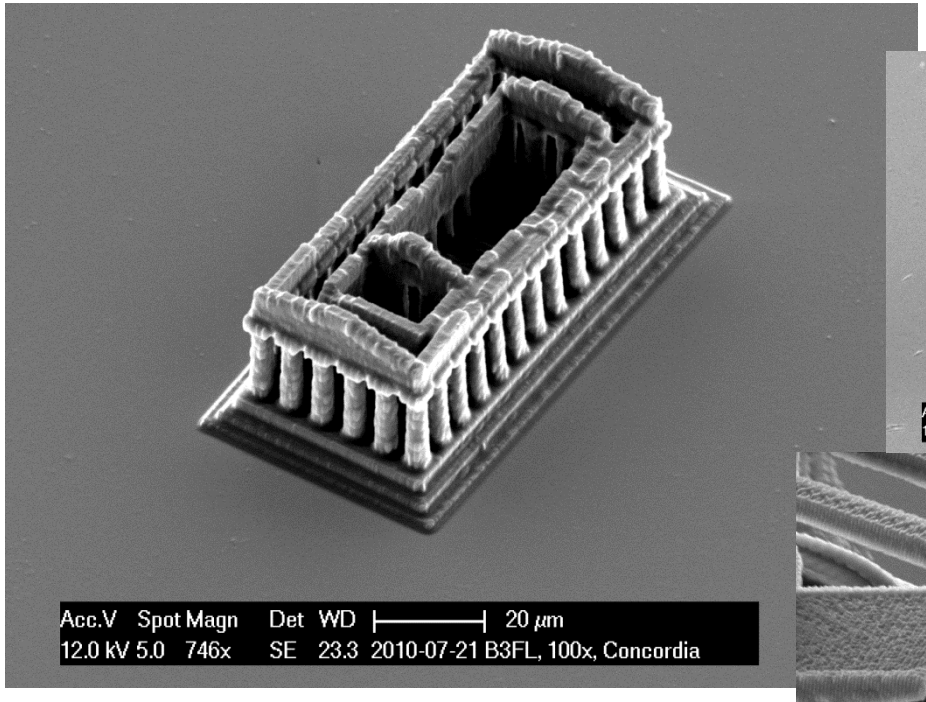
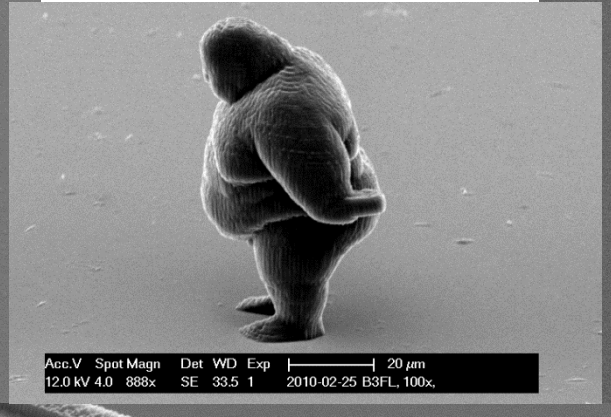
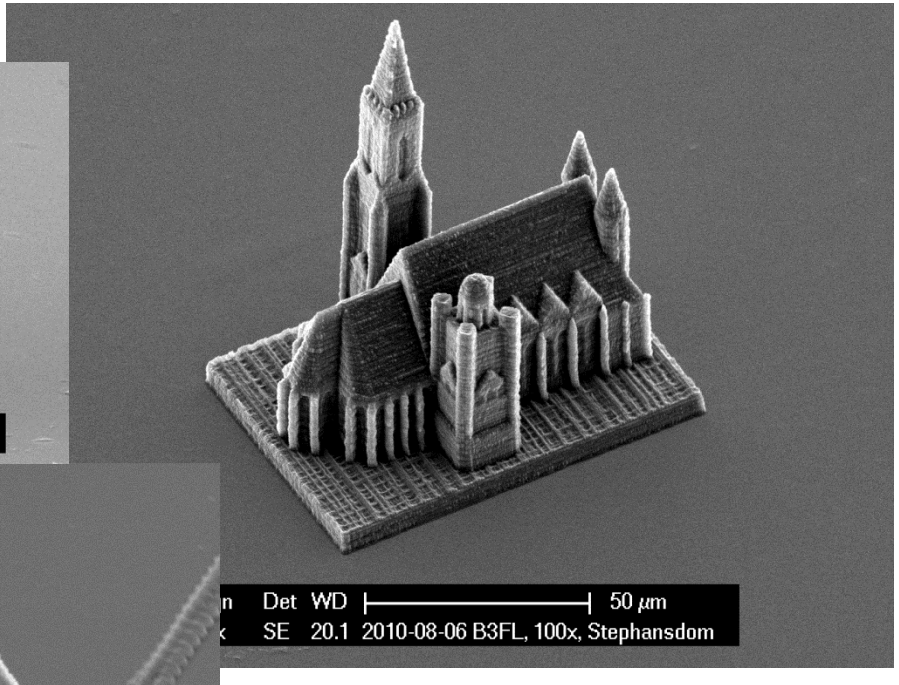
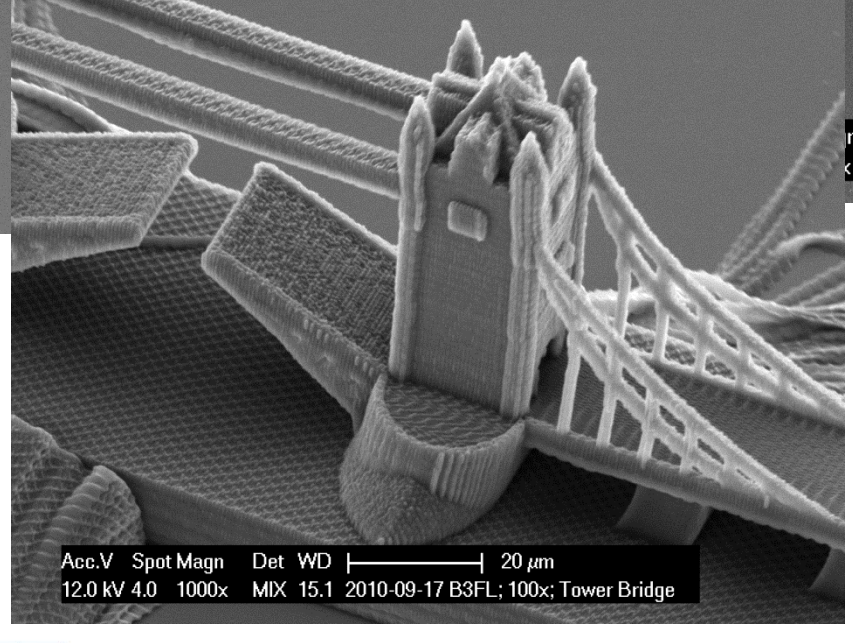
μ3D-Printing Cultural Heritage:







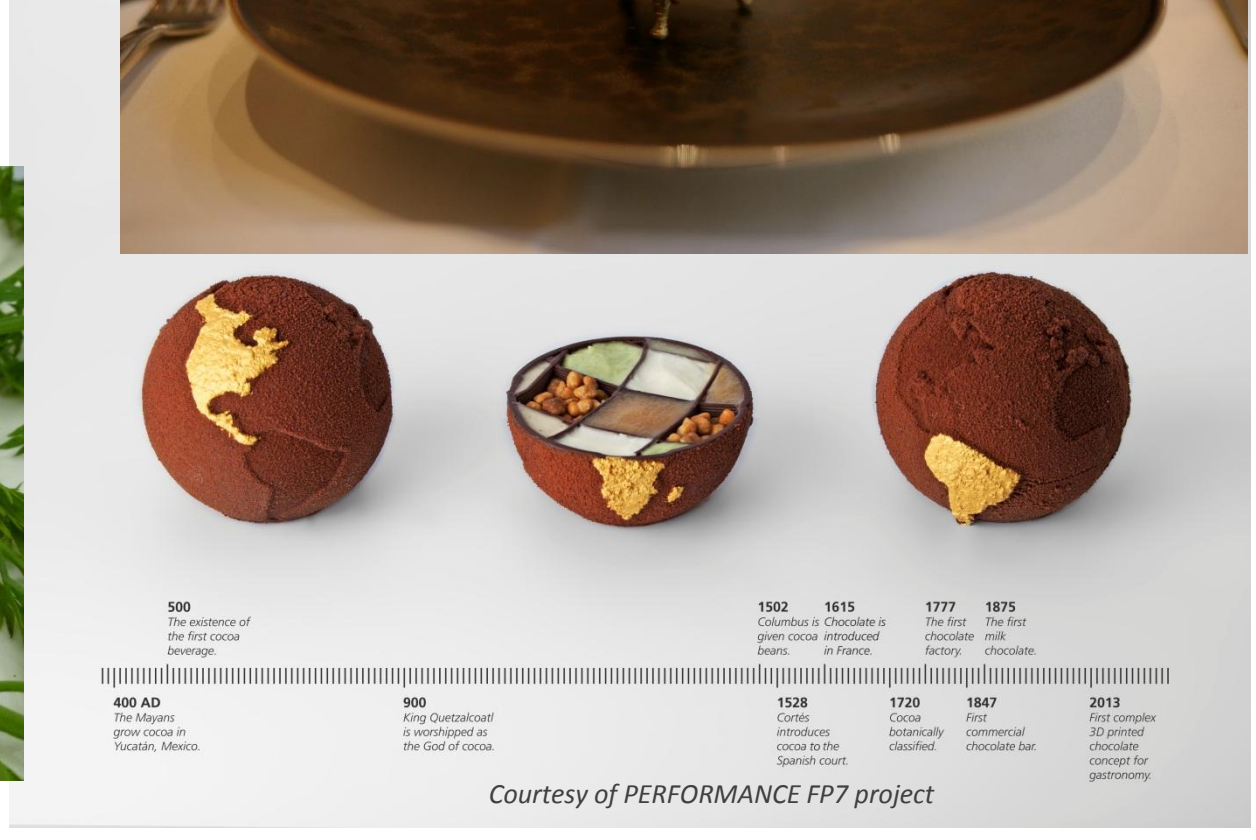


Courtesy of PHOCAM FP7 project

3D-Printing Cultural Heritage:

Courtesy of PRODINTEC

3D-Printing Food:



Courtesy of PERFORMANCE FP7 project

"Imagination is everything. It is the preview of life's coming attractions."

Albert Einstein

Thanks for your attention!

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