



3D-Print your future: just think and produce

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

Athens, 13/06/2014





CREATE

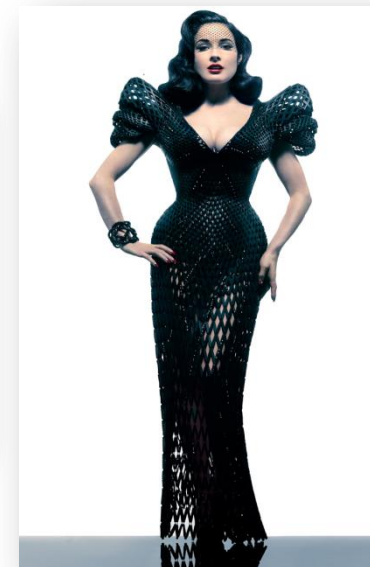
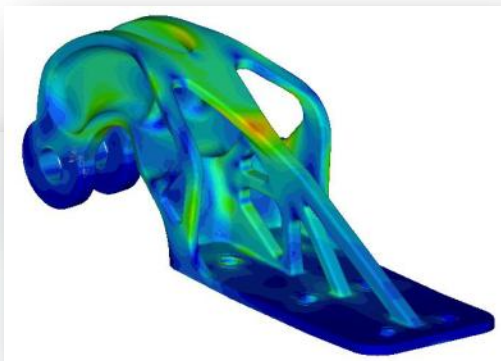




CREATE




CREATE





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

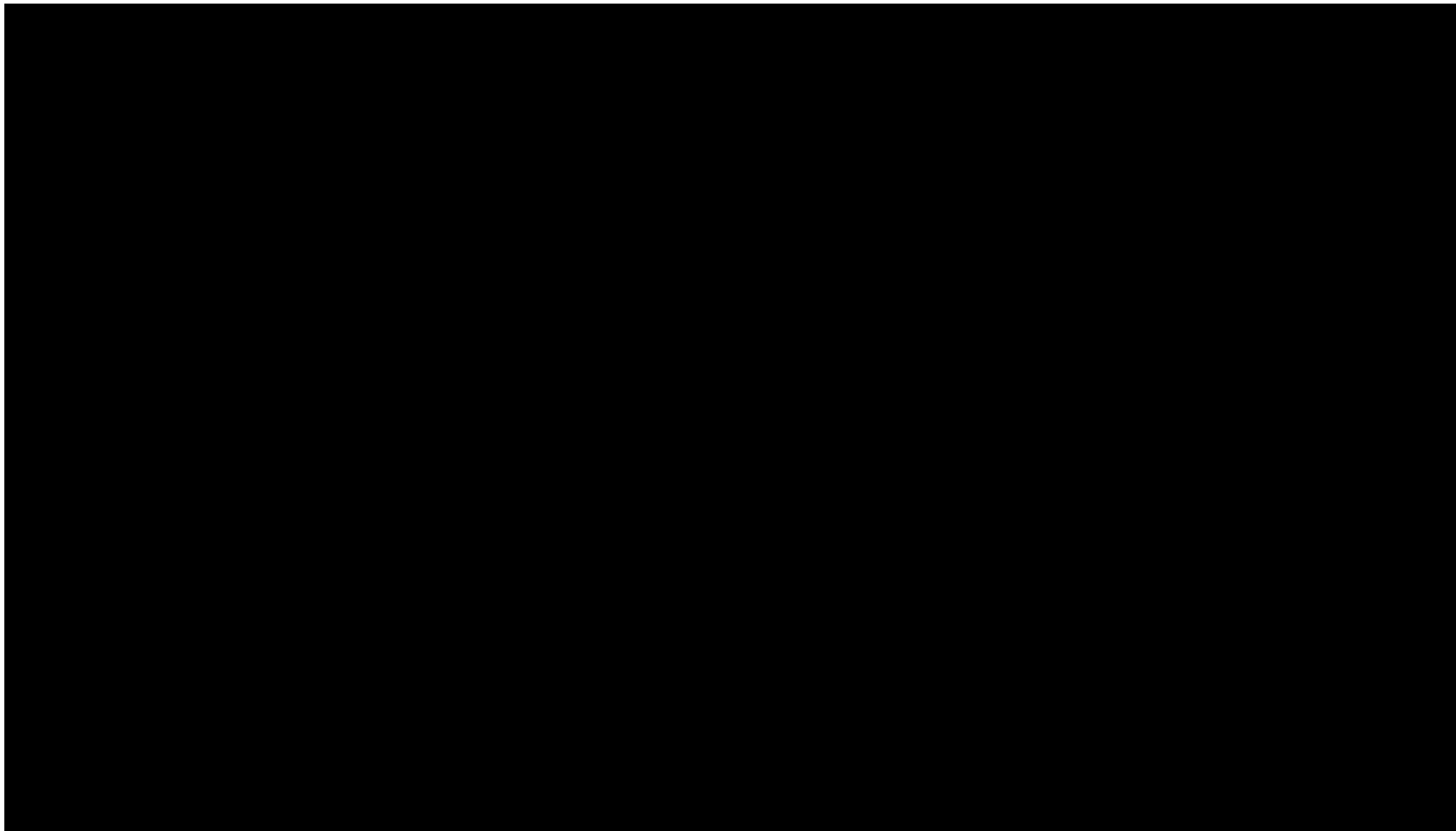




"Only he who attempts the absurd is capable of achieving the impossible."

Miguel de Unamuno





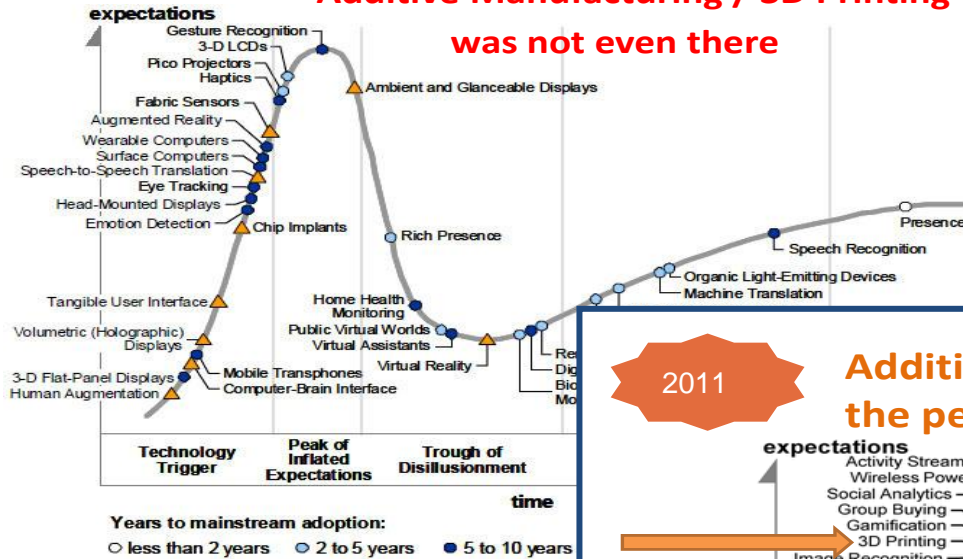
Courtesy of Disseny Hub



2009

3D-Printing... evolution, revolution or illusion?

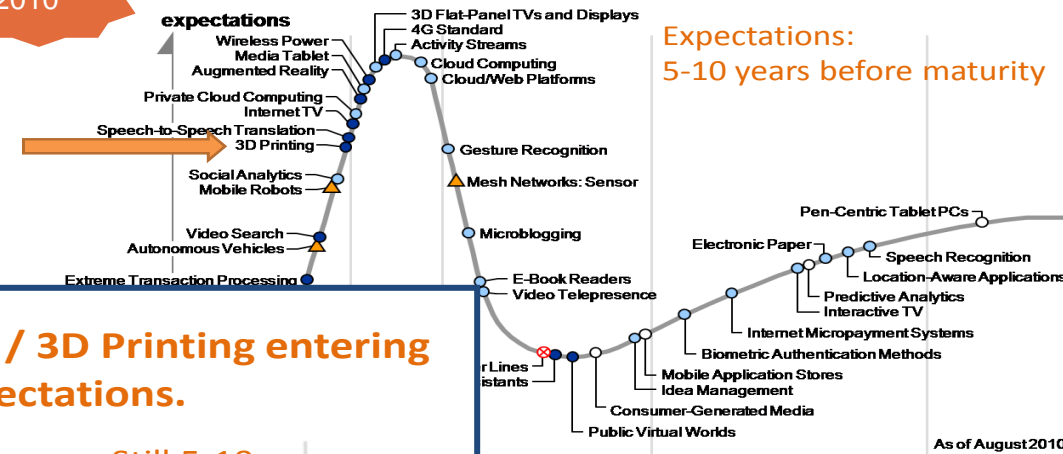
Additive Manufacturing / 3D Printing
was not even there



2010

Additive Manufacturing / 3D Printing appears.

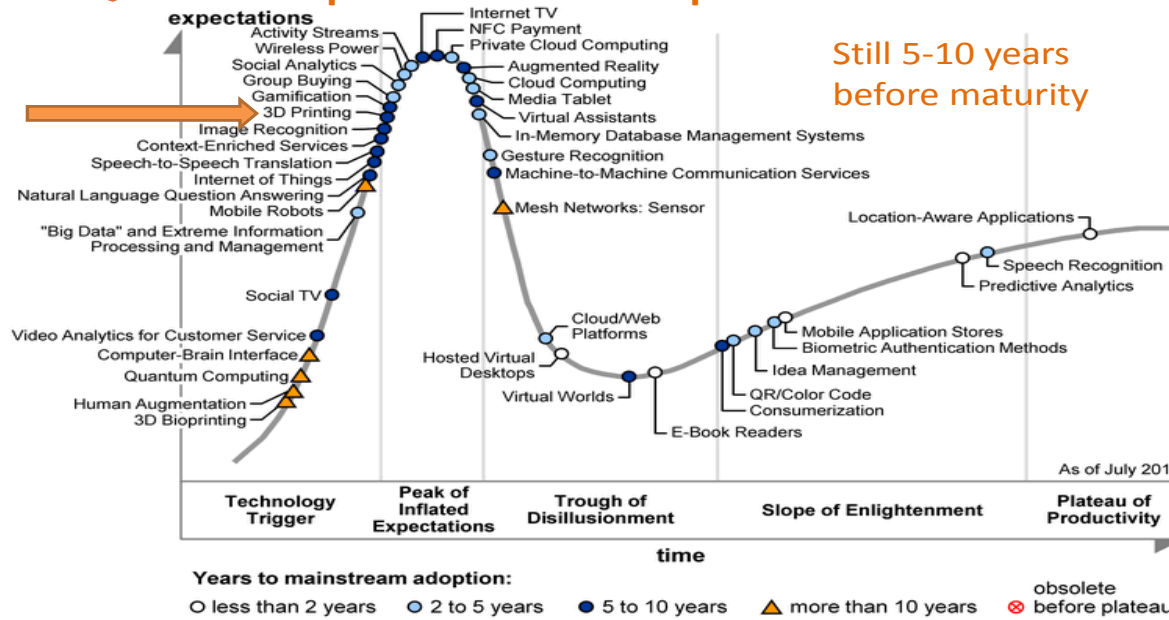
Expectations:
5-10 years before maturity



2011

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

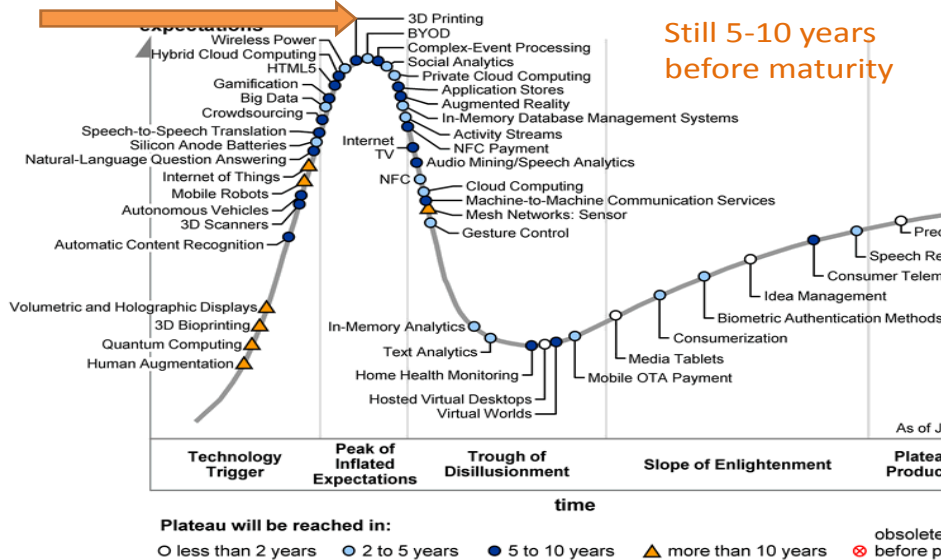
Still 5-10 years before maturity



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

2012

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

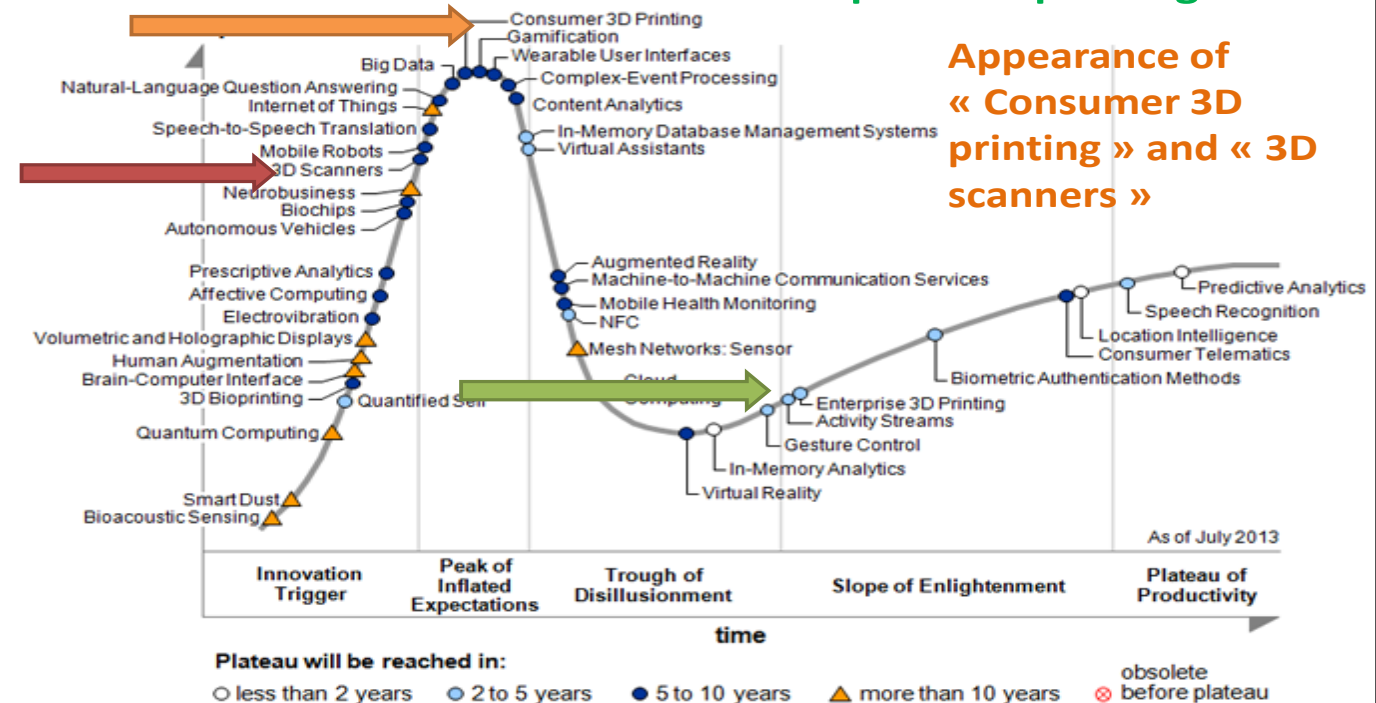


[Source: Gartner]

2013

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

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



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 Yi. 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 increasingly used in recent years. Manufacturers and designers have been able to make everyday items:

EL PAIS

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BBC

Cartuchos de células, impresoras de órganos

La bioprografía 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.

ANNE PRATS | Valencia | 12 NOV 2013 - 23:41 CET
Archivado en: Investigación médica, Células madre, Vida y Artes, Transparencia, Ciencia, Genética, Biotecnología, Tratamiento médico, Investigación científica, Biología, Ciencias naturales, Ciencia, Medicina, Sociedad, Salud



Un paciente se dispone a someterse a un trasplante de corazón. Mientras se le intuba, se le monitoriza y el anestesta se prepara para sedar al enfermo, en un rincón del quirófano, la bioimpresora 3D fabrica el órgano de reemplazo 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

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NEW YORK, TUESDAY, SEPTEMBER 14, 2010

THE NEW YORK TIMES, TUESDAY, SEPTEMBER 14, 2010

A Technology Sets Inventors Free to Dream

By ASHLEE VANCE
SAN FRANCISCO — Businessmen in the South Park district of San Francisco generally sell e-reader 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 limbs, clothing and architectural models. And while some wonder how such technology will make the transition from manufacturing appliances to producing consumer goods, its use is exploding.

A California start-up is even working on building houses. The printer, which would fit in a tractor trailer, would use materials delivered by computer, squirt out layers of special concrete and spray on a thin layer of plaster, then connect to form the bones of a house.

It is manufacturing with a laser-like precision of houses, suits and, well, workers. Advances in the technology say that by doing away with manual labor, 3-D printing could reverse the economies of manufacturing and revive American industry as a whole.

There is nothing to be gained by going outside 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 underengineered."

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 in the last decade and is now being used in a wide range of applications, from the more sophisticated offerings of companies including 3D Systems, which makes a printer to create a product as simple as a prosthetic limb, to the more complex designs of a company like Shapeways, which will print a part for a customer.

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

A Technology Sets Inventors Free to Dream

From Page A1

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



Scott Summitt, above, co-founder of Bespoke Innovations, with a prosthetic limb. Charles Overly, left, founder of LCM, 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.

Le Monde diplomatique

IMPRIMANTES 3D, DERNIERE SOLUTION MAGIQUE

Illusoire émancipation par la technologie

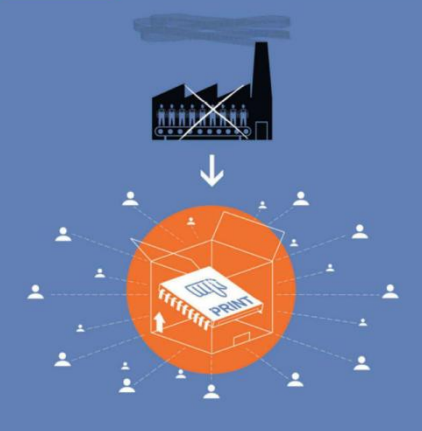
Depuis peu, des machines électroniques capables de produire des objets, fonctionnant à la manière d'imprimantes en trois dimensions, sont accessibles au grand public. Elles suscitent un engouement au sein d'une avant-garde qui y voit les ferments d'une nouvelle révolution industrielle. Mais les partisans 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 XXI^e 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 se réautourer).



A third industrial revolution

The third industrial revolution

A 14-PAGE SPECIAL REPORT



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:

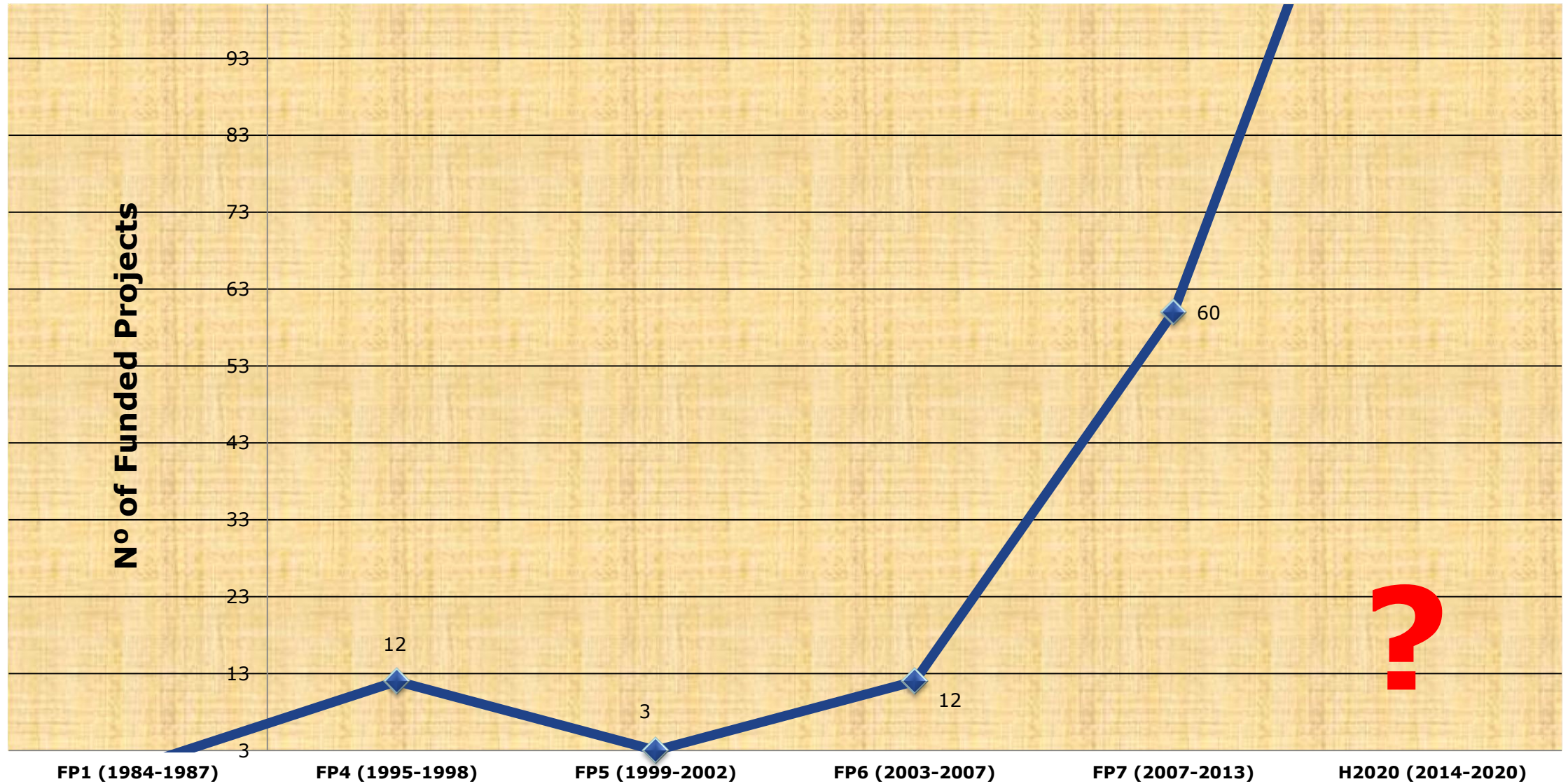
- European Commission (EC) was a pioneer:
Additive Manufacturing funded since the
First Framework Programme (FP1, 1984-1987).
- The following Framework Programmes (1988-2013) ensured continuous support from different EC services and different funding programmes.
- Only in FP7 (2007-2013), more than 60 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



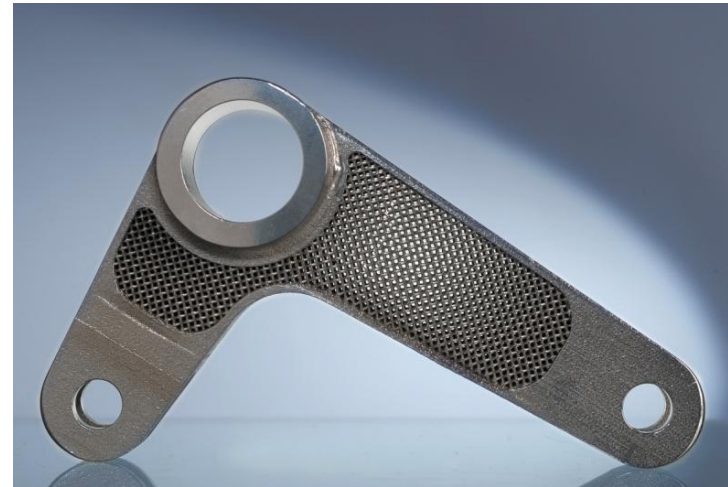
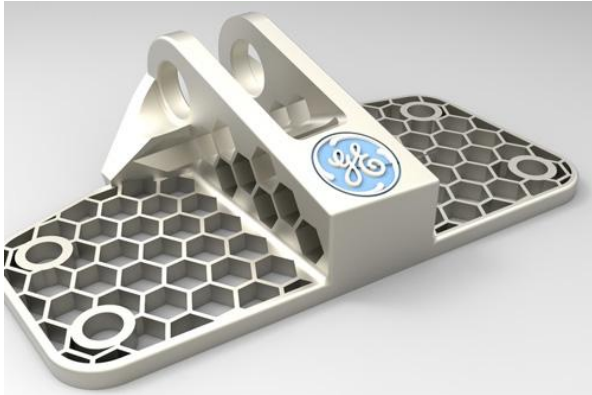
Additive Manufacturing Projects in European Commission



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



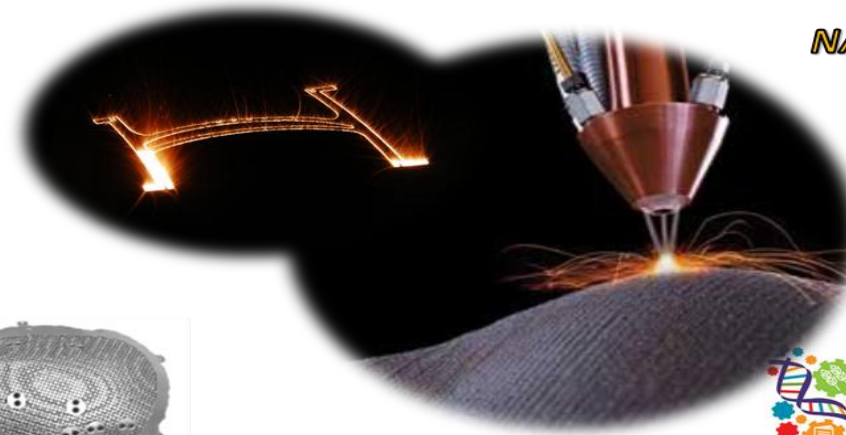
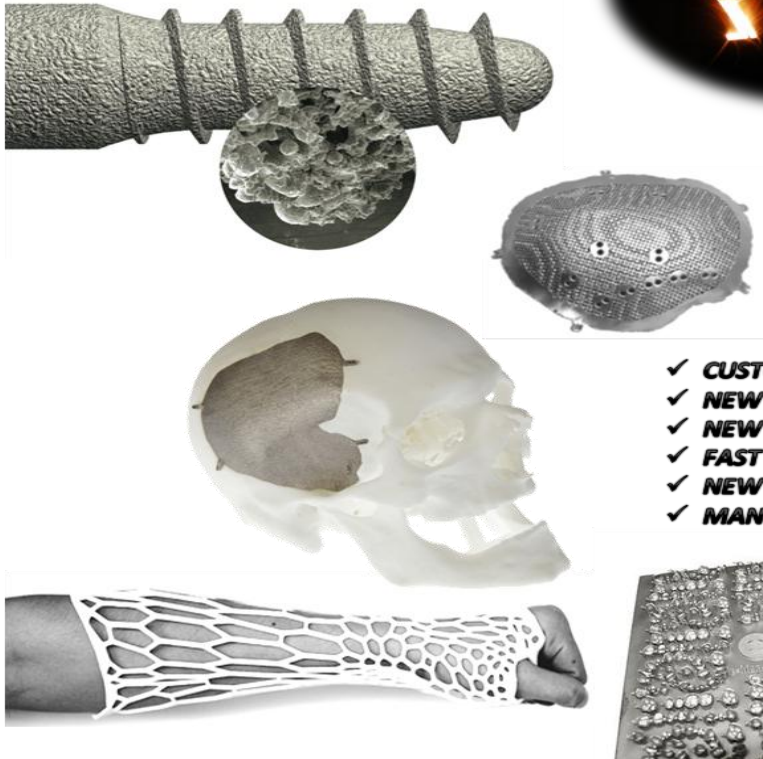
Courtesy of Sirris, UAS, GE



"ADDITIVE 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



**SOCIETAL
CHALLENGE**

TRANSPORT

"ADDITIVE MANUFACTURING"

Combining AM with
several KETs for
advanced products

ADVANCED MATERIALS

NANOTECHNOLOGIES

MICROELECTRONICS

PHOTONICS

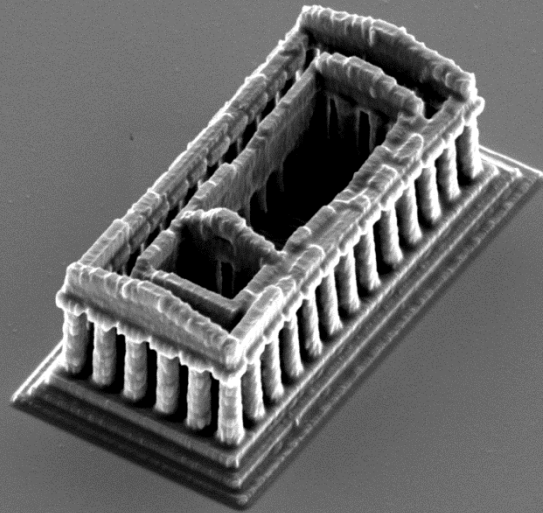


ADVANCED MANUFACTURING

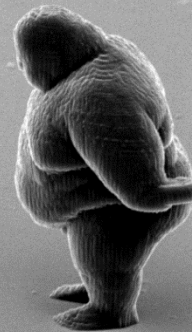


- ✓ CUSTOMIZATION FOR REAL END USER NEEDS
- ✓ NEW FUNCTIONAL DESIGNS FOR NEW VEHICLE CONCEPTS
- ✓ REDUCING COSTS INCREASING PERFORMANCE
- ✓ FAST RESPONSE TO HIGH DEMANDING SECTOR
- ✓ NEW TOOLS FOR NEW MINDED PROFESSIONALS
- ✓ NEW CONCEPT OPTIMISED INTRICATE STRUCTURES TO FIT FUTURE USABLE SHAPES
- ✓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

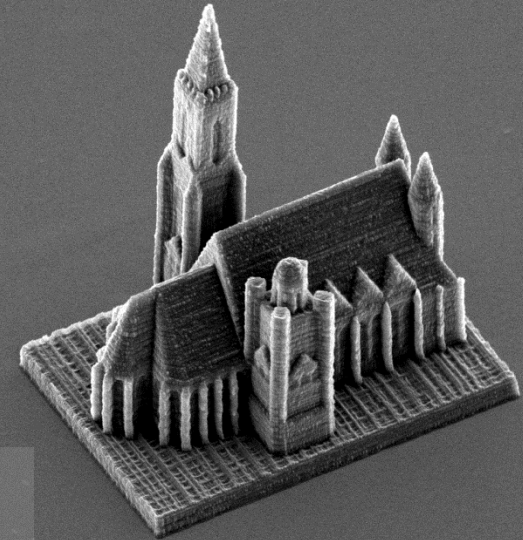
μ3D-Printing Cultural Heritage:



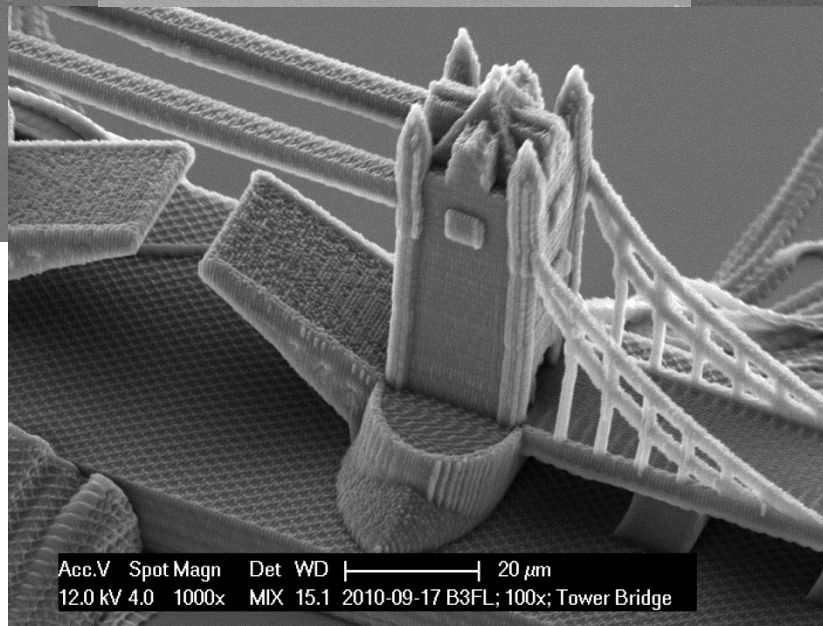
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12.0 kV 5.0 746x SE 23.3 2010-07-21 B3FL, 100x, Concordia



Acc.V Spot Magn Det WD Exp | 20 μm
12.0 kV 4.0 888x SE 33.5 1 2010-02-25 B3FL, 100x,



n Det WD | 50 μm
SE 20.1 2010-08-06 B3FL, 100x, Stephansdom



Acc.V Spot Magn Det WD | 20 μm
12.0 kV 4.0 1000x MIX 15.1 2010-09-17 B3FL; 100x; Tower Bridge

Courtesy of PHOCAM FP7 project

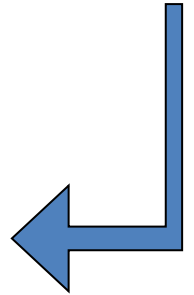
3D-Printing Cultural Heritage:



Semitic Museum, Nuzi lion fragments
screen grab from photomodeling, first pass 12/3/12
© 2012 Learning Sites, Inc.



Courtesy of PRODINTEC



3D-Printing Food:



TNO innovation for life



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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