

European R&I activities in Additive Manufacturing in FP7 and H2020

Andrea GENTILI

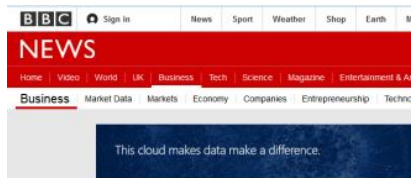
*EC, DG RTD, Dir. Transport
Deputy Head of the Unit "Aviation"*

Cologne, 28-29 September, 2016





AM in the press



3D printing: From racing cars to dresses to human tissue

By Fiona Graham
Technology of business reporter, BBC News

Q 9 September 2014 | Business



Wann fliegen wieder Menschen zum Mond? Und wie können sie die zweite Frage haben europäische Welt könnten sich Behausungen selbst mit 3-D-Druckern her-

EL PAIS
SOCIEDAD

Cartuchos de células, impresoras de órganos

La bioprintografía en 3D se presenta como una opción de futuro de la medicina y algunas experiencias a pequeña escala aunque falta salvar obstáculos, como la

La stampante 3D che produce bistecca
Uno dei fondatori di PayPal finanzia un progetto che ha come obiettivo la creazione di tessuti

Del nostro inviato: MICHELE FARINA

NEW YORK. Come la vuole la bibbia? Ben stampata, grazie. Peter Thiel, cofondatore di PayPal (sistema di pagamento online), avrebbe finanziato con 500 mila dollari (80mila euro) una start-up chiamata Modera Meats. Obiettivo? Realizzare bistecche di maiale (la carne bianca è più facile da stampare di quella va colata).

Le stampanti 3D sono da anni una realtà produttiva (l'Economist qualche mese fa ha parlato di «terza rivoluzione industriale» alla porta). Che giorno sarà bastano segnare da noi si potrà fare il proprio telefonino (o un violino) in casa. Le bio-printer sono in fase sperimentazione, per esempio nel settore della medicina rigenerativa. Gli scienziati hanno stampato da un computer porzioni di pelle, di muscolo, di vasi sanguigni. Non è escluso che si fatano a possedere ottomere organi complessi.

Fantascienza da brivido? Fa meno impressione parlare di cibo: già i ricercatori della Cornell University sono riusciti a «stampare» dei dolcetti molto simpatici (cupcakes). Realizzare carne dovrebbe essere più semplice che creare un organo.



170%

News Capital Hubbert Leadership Innovation Digital Skills Front New VA Reporter



Han fick en ny hand - med 3D-skrivare
Språke Holden Morsen skakade en hand - men det löstes både snabbt och billigt med en 3D-skrivare.



NEW YORK, TUESDAY, SEPTEMBER 14, 2010

A Technology Sets Inventors Free to Dream

By David Huxford
Special to The New York Times

It is a technology that is still in its infancy, but it is one that is already making a difference in the lives of many people. It is a technology that is still in its infancy, but it is one that is already making a difference in the lives of many people.



Η ΚΑΘΗΜΕΡΙΝΗ



laMonde diplomatique

Illusoire émancipation par la technologie

Depuis peu, des machines électroniques capables de produire des objets, fonctionnent 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 prémices d'une nouvelle révolution industrielle. Mais les partisans de ces outils de trilogie technologique oublient souvent l'histoire qui les a vu 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. Ces outils ont en commun une même principe technologique: guider les mouvements d'un outil mécanique à l'aide d'un logiciel. Les plus célèbres d'entre eux fonctionnent comme des imprimantes, mais en trois dimensions: (passage après passage, une base se déplace sur une surface et dépose des couches de matière. De plus en plus, on voit des modèles synthétiques) en utilisant un modèle numérique, jusqu'à obtenir du volume désiré. De la poignée de porte en bois, les objets ainsi produits ne multiplient.

Même si cette technologie suscite un élan d'enthousiasme de petites entreprises créatives, son développement est essentiellement l'œuvre d'amateurs, qui se diffusent comme des mouches. Enrichies dans le monde du logiciel libre, les applications se valent et progressent aux mécanismes de fabrication. Pour les plus radicaux d'entre eux, la réimpression populaire des outils constitue 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 de travail et rendre ainsi possible le mouvement de délocalisation de la production industrielle vers les pays du tiers-monde (2). Ce point de vue, plus proche des rêves d'affaires, est notamment exprimé par le magazine spécialisé Make («Fabrique»), qui, entre autres articles, organise chaque année une Maker Faire («Fête de la fabrication») dans plusieurs grandes villes des États-Unis.

Il suffit toutefois de se pencher dans les allées de ce salon pour constater une certaine distance au sein de la révolution amateur. Parmi les nombreuses attractions proposées lors de son édition de 2013, à New York, on pouvait ainsi visiter le Print Village («Village de l'impression»): une réimpression de stands consacrés à l'imprimante 3D RepRap et à une nombreuse dizaine (combinaison de mouvement, le RepRap est capable de reproduire la plupart des éléments qui la composent, et ainsi de s'auto-réprouver).

What is Additive Manufacturing ?

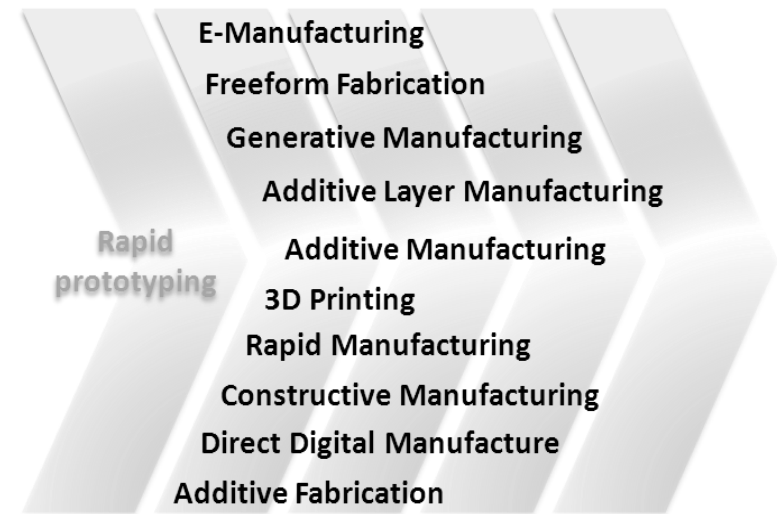
ISO/ASTM definition:

"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."

Different materials:

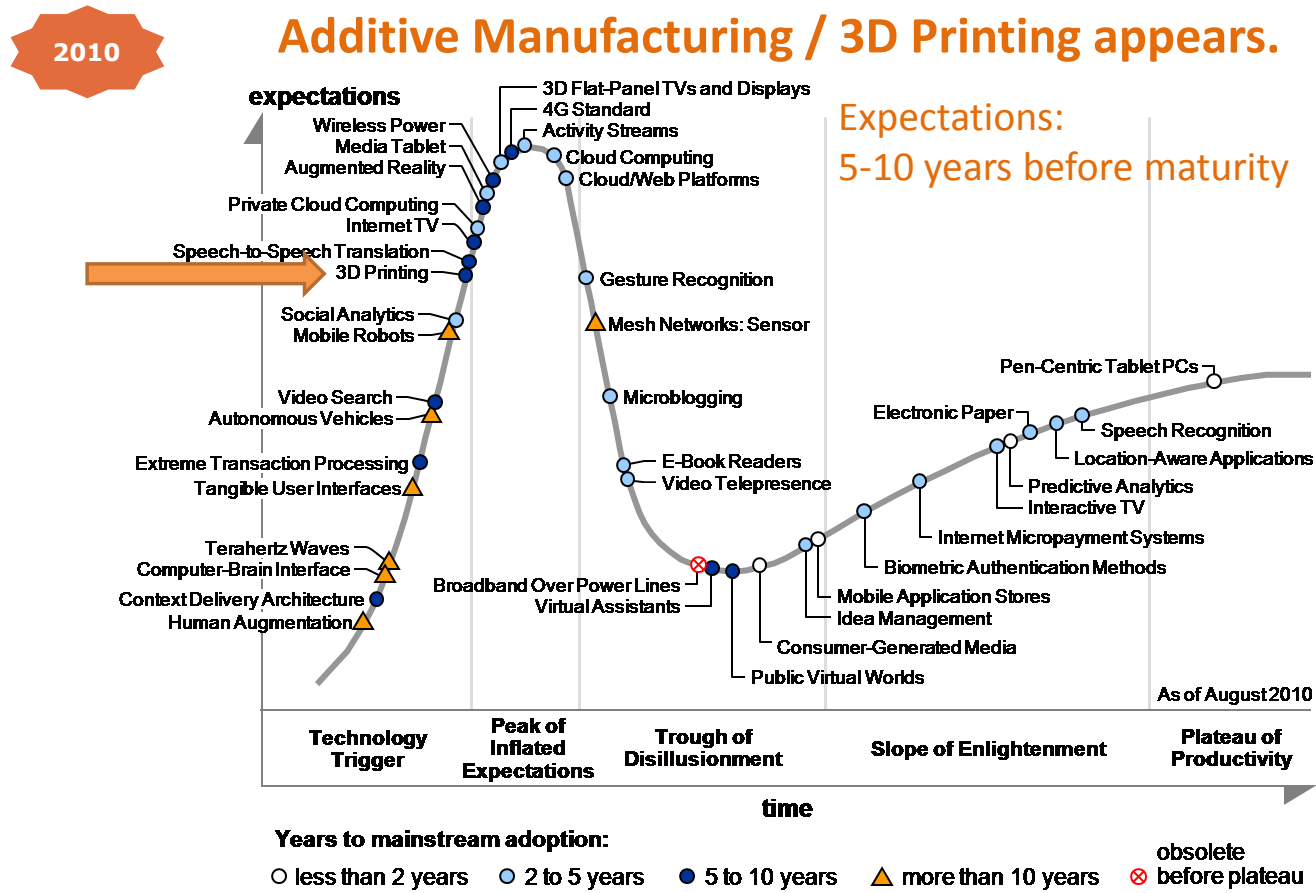
Polymers / Metals / Ceramics

Different terms used since AM started:



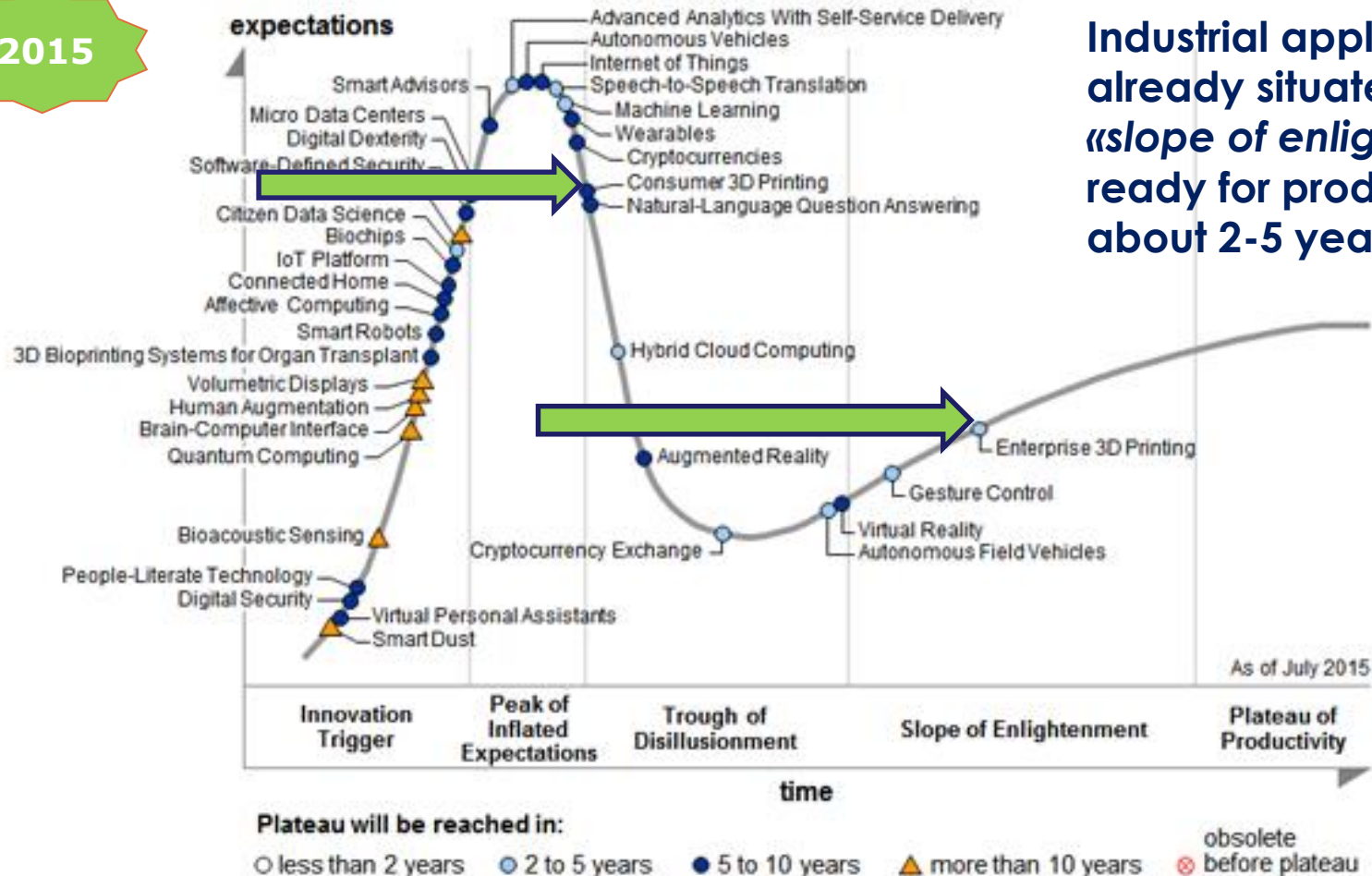
Different technologies: SLA / SLS / 3D-Printers
/ FDM / DLP / DMLS / EBM / LMD / LC / ...

Attention on Additive Manufacturing is recent



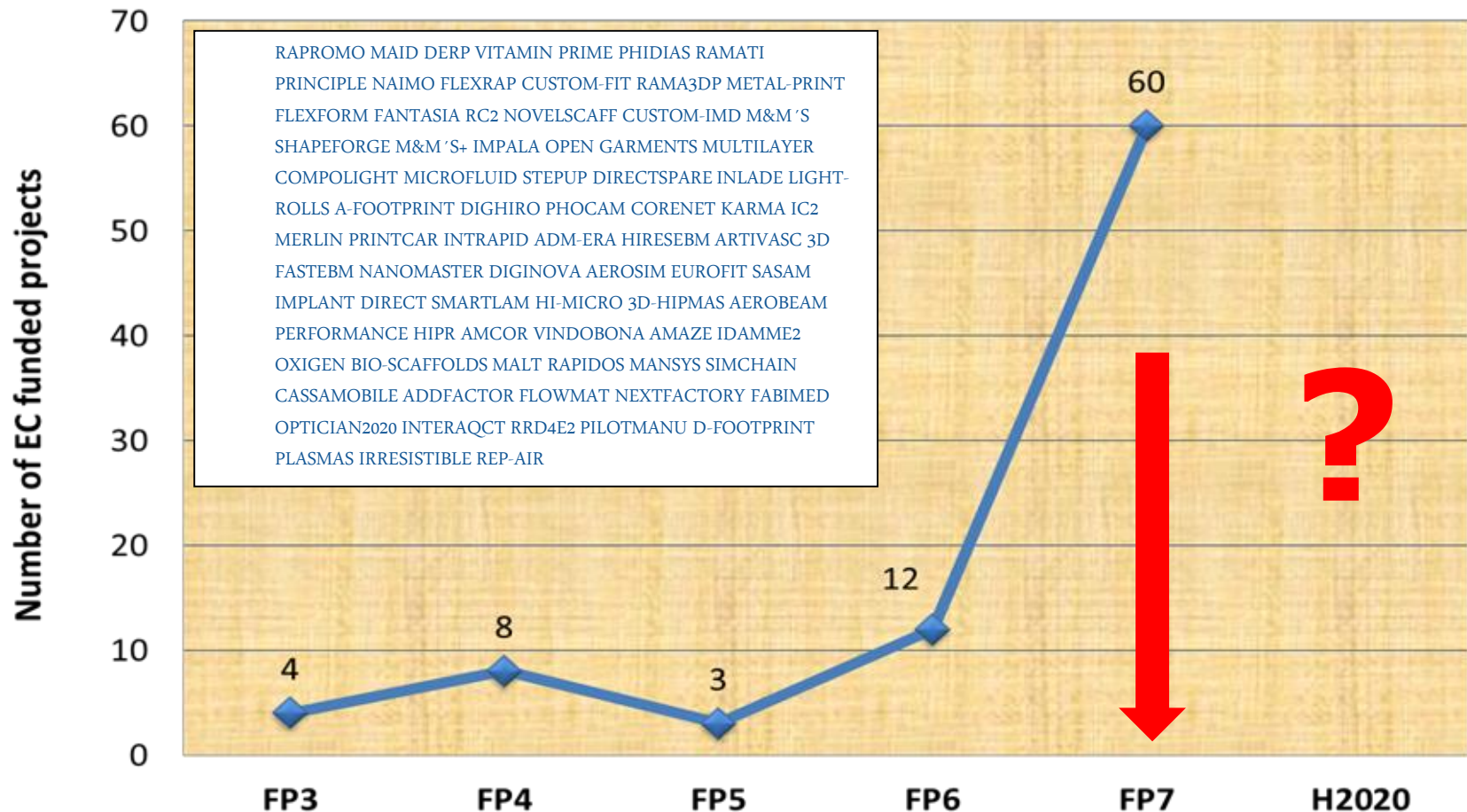
In 2010, the Gartner Hype Cycle estimated 5-10 years to adoption

2015



Industrial applications are already situated in the «slope of enlightenment», ready for production in about 2-5 years

AM projects in EU RTD Framework Programmes (1991-2013)



AM in EU Research and Innovation FP

- The EC provided funds since the First Framework Programme (**FP1, 1984-1987**), e.g. rapid prototyping with laser scanning of polymers
- The following Framework Programmes (**1988-2013**) ensured continuous support from different EC services and programmes
- In **FP7 (2007-2013)**, **60 AM projects** were funded (over **€160 million** in **EU funding** and total budget of around **€225 million**)
- In **Horizon 2020**, **17 AM projects** were funded **2014-2016**, with more than **€78 million** in EC funding and a budget of **€86 million** only in the **NMPB** Programme

AM in Horizon 2020

- The **Factories of the Future (FoF)** contractual Public-Private Partnership (**cPPP**) will play a major role in supporting Additive Manufacturing
- Under FoF, activities will be primarily developed through relevant **Industrial Roadmaps** in collaboration with the relevant stakeholders, e.g. **Additive Manufacturing Platform , ManuFuture ETP, AM FoF Clusters**
- **Industry** will play a **leading role** in defining **Research and Innovation** priorities, closing the gap between technology and manufacturing.
- Funded projects will be **outcome oriented**, going closer to the **market** and with high **SMEs** participation to maximise the expected **impact**
- Additive Manufacturing will also have a role in the **Societal Challenges**



**SOCIETAL
CHALLENGE**

TRANSPORT

Combining several KETs for advanced AM 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



The European Additive Manufacturing Technological Platform

- Started in 02/2004 as a **subplatform of ManuFuture ETP**
- The objective of the AM-platform is to contribute to a coherent strategy, understanding, development, dissemination and exploitation of AM.
- Closely collaborates with FoF cPPP to help to establish priorities for the Working Programmes and strategies about AM and 3DP
- The last AM Platform meetings (Sept 2015 & May 2016) gathered in Brussels more than 200 AM stakeholders from 14 EU countries, 4 Associated countries and 8 non EU countries (e.g. US, SA, Mexico, Taiwan, Japan, Saudi Arabia and Canada)

AM Roadmaps

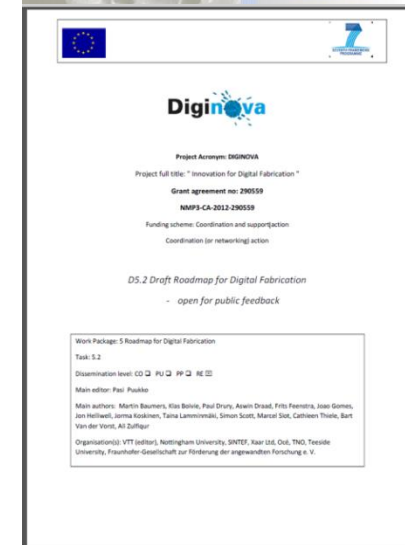
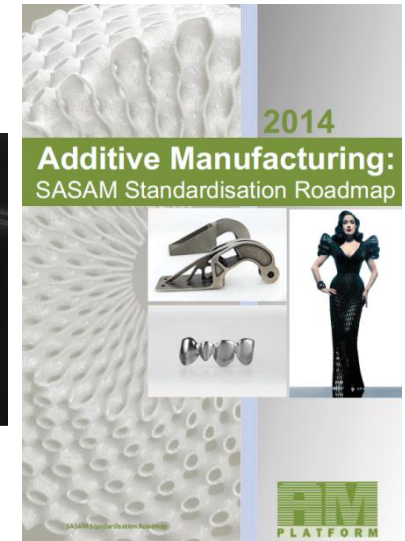
- The **Factories of the Future** Roadmap highlighted Additive Manufacturing within **Advanced manufacturing processes**
- The **European Additive Manufacturing Platform** published the **Strategic Research Agenda (SRA)** on Additive Manufacturing **2014-2020**
- The **FP7 CSA SASAM** produced a **Roadmap for Standardisation** in AM in collaboration with **CEN-CENELEC, ISO** and **ASTM**
- The **FP7 CSA DIGINOVA** developed a **Roadmap for Digital Fabrication**



FACTORIES OF THE FUTURE
Multi-annual roadmap
for the contractual PPP
under Horizon 2020

Prepared by

Policy research



FoF AM Cluster

AMAZE



BOREALIS



FoFAM



Stellar

A Success Story on AM in EU funded projects (FP7)

AMAZE

€10 M EU funding - €18 M budget

High-Tech Metal Products:
Large-scale AM parts



- Fast production of large defect-free AM metallic components up to 2 metres in size and close to zero waste
- Aeronautics, space, nuclear fusion, automotive and tooling
- **Largest AM EU funded project in FP7**

A Success Story on AM in EU funded projects (H2020)

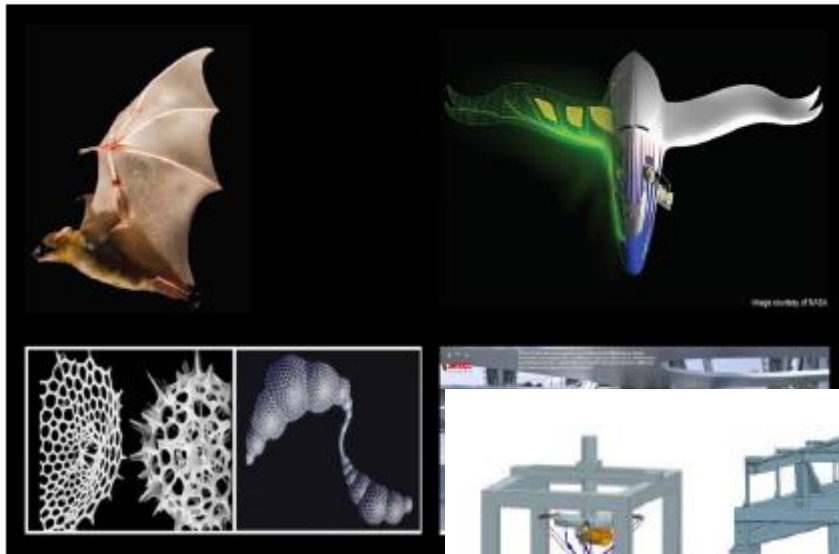
BOREALIS

Enlightening Next Generation of
Material

€6 M EU funding - €8 M budget

High-Tech Metal Products:
Hybrid Machines

- Flexible machine for Additive Manufacturing and Subtractive Manufacturing
- Borealis project focuses on the medtech, aerospace and automotive sectors



Lab scale demo
2015



Full size Prototype
2016



Industrial solution realization
2017-18



Market Catalogue Machine
2019

INEA's portfolio on Additive Manufacturing focused on Aviation

4 RIA projects granted over the period 2014-2016:

Bionic Aircraft (4.2 M€)

MMTech (5.7 M€)

AMOS* (1.4 M€) – INCO with Canada

EMUSIC* (1.8 M€) – INCO with China

Total EU funding: €13.2 million

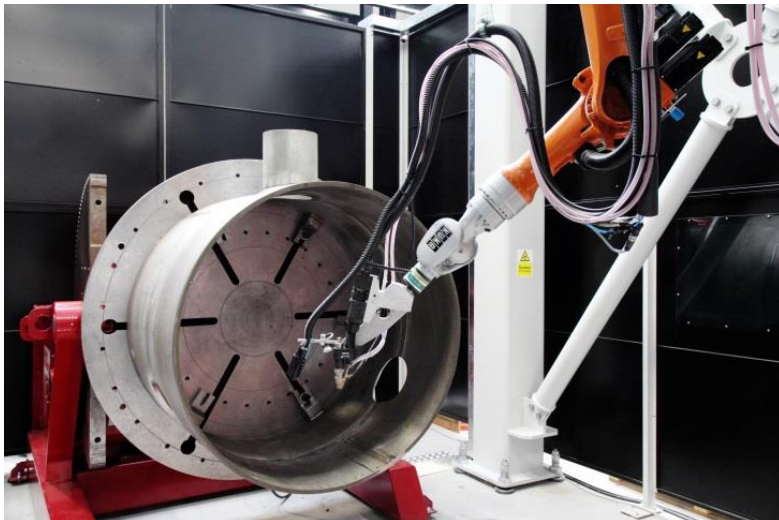
Main Partners:

Airbus; CIMNE; Fraunhofer; Advanced Manufacturing Limited
University of Sheffield; Calcom; LZN LASER ZENTRUM NORD
GMBH; Tecnalia; TEKNA; Hexagon; GKN Aerospace Sweden ab

AMOS

Additive Manufacturing Optimization and Simulation Platform for repairing and re-manufacturing of aerospace components

Coordinated by Univ. Sheffield & Univ. Mc Gill - Montreal



9 Beneficiaries (4 EU; 5 Canada)

Start Date: 1/2/2016

Duration: 48 M, EC funding: 1,4 M€

OBJECTIVE:

- investigating the potential of additive manufacturing (AM) processes **to repair and remanufacture aerospace components** such as turbine blades and landing gear.



EMUSIC

Efficient Manufacturing for Aerospace Components USing Additive Manufacturing, Net Shape HIP and Investment Casting

Coordinated by Univ. Birmingham (UoB) & Beijing Inst. of Aeron. Materials (BIAM)



20 Beneficiaries (11 EU; 7 Chinese)

Start Date: 1/4/2016

Duration: 36 M, EC funding: 1,8 M€

OBJECTIVES:

- To compare properties and costs of components manufactured using Additive Manufacturing, Near Net Shape and Investment Casting
- to identify and optimise the most suitable Net Shape Technology for each component
- to develop full scale, optimized state-of-the-art processing technologies and transfer of technologies to end-users

AM in the WP 2016-2017

Code	Topic title	Type
FoF-1-2016	Novel hybrid approaches for Additive and Subtractive manufacturing machines	RIA
FoF-5-2016	Support for the further development of Additive Manufacturing technologies in Europe	CSA
FoF-13-2016	Photonics Laser based production. From "Design to piece" – Excellence in Laser based additive industrial manufacturing	RIA
FoF-12-2017	ICT Innovation for Manufacturing SMEs (I4MS). iv. Digital Design for Additive Manufacturing	IA
PILOTS-04-2017	Pilot lines for 3D printed and/or injection moulded polymeric or ceramic microfluidics MEMS	IA
NMPB-22-2017	Business models and industrial strategies supporting novel supply chains for innovative product services	RIA
EUB-02-2017	IoT Pilots – Smart manufacturing: customisation – continuous Additive Manufacturing / Robot systems for Additive Manufacturing	RIA

AM in EU policy (I)

- The **EC Communication on Industrial Policy** in **2012** and **EC Digital Single Market Communications** in **2016** mention 3D-Printing and Additive Manufacturing as key elements to achieve their objectives
- The “**Industrial Landscape Vision 2025**” (**2013**, EC), showed AM as a case study on how Standards will facilitate new production systems, enhancing EU competitiveness
- The **2013** report of the EC Task Force for “**Advanced Manufacturing Technologies for Clean Production**” presented AM / 3D-Printing as a key Advanced Manufacturing Technology
- In **May 2015**, the **EESC** adopted an **own-initiative opinion** on 3D-Printing & in **September 2015**, the **EP** published and discussed a study for the **ITRE** Committee about 3D-Printing

AM in EU policy (II)

- **EC Additive Manufacturing Workshop (June 2014).**
First AM dedicated Workshop in the EC. AM needs and how to remove the barriers for development
- **Work Programmes 2014-2015** increased topics related to AM. Strategic CSA, **FoFAM**, focused in Regional aspects of AM and Clustering of projects
- **Work Programmes 2016-2017** have almost tripled (**3x**) opportunities in H2020 respect to 2014-2015
- Strategic CSA in **FoF-5-2016**, **AM-motion** to develop an overall EU strategy for the next decade. Results to be published in **2017**



Potential benefits of Additive Manufacturing

- Disruption of the manufacturing value chain, allowing a shift from mass production to **full customisation**.
- Makes **light weight structures** which retain structural strength
- **Less material**, less **waste**, less **energy**, less **CO₂** emissions
- Reduced time to market and **freedom in design**, which can create **new business models** and **market opportunities**
- Enables **production** on a **local basis**, closer to their point of consumption, strengthening **regional economies**



**Many thanks for your
attention!**

BACK-UP SLIDES

Additive Manufacturing from FP3 to FP7 (1991-2013)

EC Programme	Number projects
FP3	4
FP4	8
FP5	3
FP6	12
FP7 IDEAS ERC	3
FP7 NMP	34
FP7 ICT	2
FP7 PEOPLE	8
FP7 SME	5
FP7 TRANSPORT	1
FP7 INCO	1
FP7 JTI	5
FP7 KBBE	1
FP7 SIS	1
TOTAL	88

	<i>Metals</i>	11,3%
	<i>Polymers</i>	7,0%
Materials	<i>Biomaterials</i>	5,6%
29,6%	<i>Ceramics</i>	2,8%
	<i>Other materials</i>	2,8%
	<i>Process technologies</i>	23,2%
Technologies	<i>Informatics</i>	10,6%
34,5%	<i>Standardisation</i>	0,7%
	<i>Industrial processes</i>	7,7%
	<i>Health</i>	4,9%
	<i>Bioprinting</i>	4,9%
	<i>Aerospace</i>	3,5%
Applications	<i>Moulds and tools</i>	3,5%
35,9%	<i>Micro 3D-Printing</i>	2,8%
	<i>Foot and textile</i>	2,1%
	<i>Consumer goods</i>	1,4%
	<i>Electronics</i>	1,4%
	<i>Skills and education</i>	1,4%
	<i>Microfluidics</i>	0,7%
	<i>Design</i>	0,7%
	<i>Food</i>	0,7%

NMP-FP7 projects (2007-2013)

NANOMASTER	Graphene based thermoplastic masterbatches for conventional and additive manufacturing processes	DIRECTSPARE	Strengthening the industries' competitive position by the development of a logistical and technological system for "spare parts" that is based on on-demand production.
DIGINOVA	Innovation for Digital Fabrication	OPEN GARMENTS	Consumer Open Innovation and Open Manufacturing Interaction for Individual Garments
OXIGEN	Oxide Dispersion Strengthened Materials for the Additive Manufacture of High Temperature Components in Power Generation	COMPOLIGHT	CompoLight: Rapid Manufacturing of lightweight metal components.
AMAZE	Additive Manufacturing Aiming Towards Zero Waste & Efficient Production of High-Tech Metal Products	STEPUP	STEP UP IN POLYMER BASED RM PROCESSES
HI-MICRO	High Precision Micro Production Technologies	MULTILAYER	Rolled multi material layered 3D shaping technology
3D-HIPMAS	Pilot Factory for 3D High Precision MID Assemblies	IMPALA	Intelligent Manufacture from Powder by Advanced Laser Assimilation
AMCOR	Additive Manufacturing for Wear and Corrosion Applications	LIGHT-ROLLS	High-throughput production platform for the manufacture of light emitting components
HIPR	High-Precision micro-forming of complex 3D parts	A-FOOTPRINT	Ankle and Foot Orthotic Personalisation via Rapid Manufacturing
SMARTLAM	Smart production of Microsystems based on laminated polymer films	IC2	Intelligent and Customized Tooling
PRIME	Plug and PReduce Intelligent Multi Agent Environment based on Standard Technology	PHOCAM	Photopolymer based customized additive manufacturing technologies
SASAM	Support Action for Standardisation in Additive Manufacturing	CORENET	Customer-oriented and eco-friendly networks for healthy fashionable goods
BIO-SCAFFOLDS	Natural inorganic polymers and smart functionalized micro-units applied in customized rapid prototyping of bioactive scaffolds	ARTIVASC 3D	Artificial vascularised scaffolds for 3D-tissue-regeneration
PILOTMANU	Pilot manufacturing line for production of highly innovative materials		

AM in Horizon 2020: Calls in WP 2014-2015

Code	Topic title	Type
FoF 2 -2014	Manufacturing process for complex structures and geometries with efficient use of material	RIA
FoF 8 -2015	ICT-enabling modelling, simulation, analytics and forecasting technologies	RIA& CSA
FoF 10 -2015	Manufacturing of custom made parts for personalised products	RIA
NMP 7 - 2015	Additive Manufacturing for table-top nanofactories	RIA
COMPET-3-2015	Bottom-up space technologies at low TRL	RIA

RIA: Research and Innovation Actions

CSA: Coordination and Support Actions

NMBP-Horizon 2020 projects (2014-2015)

BASMATI	Bringing innovAtion by Scaling up nanoMATerials and Inks for printing
BOREALIS	Borealis – the 3A energy class Flexible Machine for the new Additive and Subtractive Manufacturing on next generation of complex 3D metal parts.
CerAMfacturing	Development of ceramic and multi material components by additive manufacturing methods for personalized medical products
DIMAP	Novel nanoparticle enhanced Digital Materials for 3D Printing and their application shown for the robotic and electronic industry
FAST	Functionally graded Additive Manufacturing scaffolds by hybrid manufacturing
FoFAM	Industrial and regional valorization of FoF Additive Manufacturing Projects
iBUS	iBUS – an integrated business model for customer driven custom product supply chains
M-ERA.NET 2	ERA-NET for materials research and innovation
NANOTUN3D	Development of the complete workflow for producing and using a novel nanomodified Ti-based alloy for additive manufacturing in special applications.
PRINTCR3DIT	Process Intensification through Adaptable Catalytic Reactors made by 3D Printing
ToMax	Toolless Manufacturing of Complex Structures
WRAP	Waste-Based Rapid Adhesive-free Production of Sports goods

BIONIC AIRCRAFT

Increasing resource efficiency of aviation through implementation of ALM technology and bionic design in all stages of an aircraft life cycle

Coordinated by LZN Laser Zentrum Nord GmbH

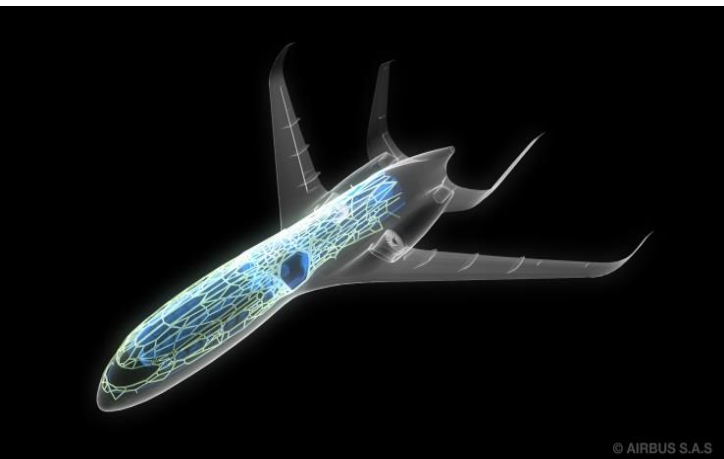
10 Beneficiaries

Start Date: 1/9/2016

Duration: 36 M, EC funding: 4,2 M€

OBJECTIVES

- The project will develop new technologies, methodologies and concepts for Additive Manufacturing (AM). Part of the project will be new design concepts and materials, to increase the weight saving potential of AM, as well as new concepts for quality control, repair, recycling and spare parts logistics.



EC AM and 3DP Exhibition and Conference

- Held on 02/02/16 at EC premises
- *Deputy General Director DG RTD supported the event*

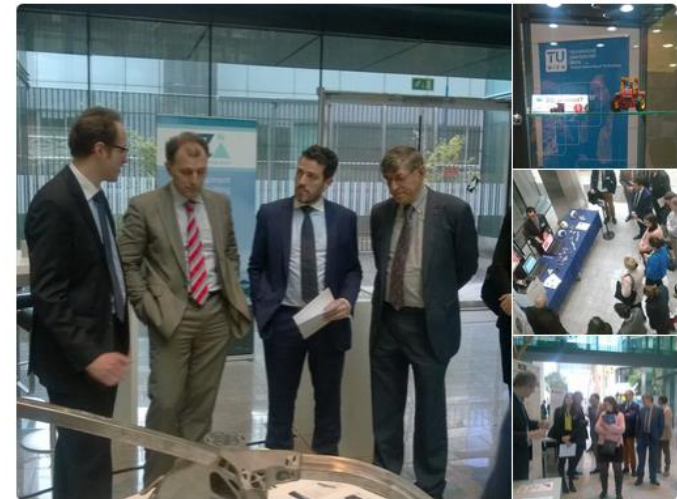


German ESTEBAN MUNIZ @G_EstebanEC - Feb 8
Deputy General Director DG RTD highlighted potential of #3dprinting & #additivemanufacturing in #H2020 projects!!!



German ESTEBAN MUNIZ @G_EstebanEC - Feb 8

Exhibition on [#additivemanufacturing](#) with [@AM_EUplatform](#) [@CECIMO_Info](#) and many other [#H2020](#) projects was a success!



← ↻ 3 ♥ ...



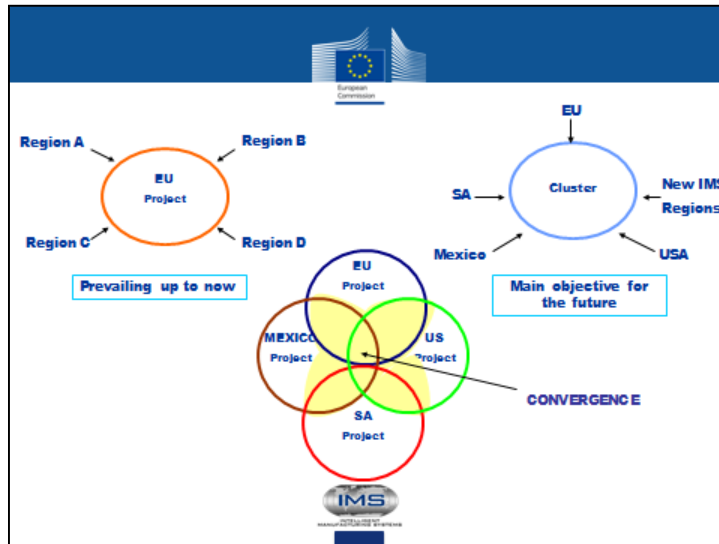
German ESTEBAN MUNIZ @G_EstebanEC - Feb 8

Deputy General Director DG RTD highlighted potential of [#3dprinting](#) & [#additivemanufacturing](#) in [#H2020](#) projects!!!



International Cluster on Additive Manufacturing and 3D-Printing

International Cluster on Additive Manufacturing and 3D-Printing Projects (US, SA, MX, EU), organised by EC and IMS.
Barcelona, 02/05/2016. WMF 2016



Project ID	Mutual Interest
M2-US-EXOVA	589
M13-EU-AATID	582
M9-EU-AMAZE	448
M14-EU-NANOTUN3D	397
M6-SA-MEDAERO	396
M1-US-QUESTEK	358
M3-US-NIU	340
GT10-EU-CAXMAN	285
M11-EU-RepAIR	263
M7-MX-FRISA	252
M10-EU-REProMag	250
GT11-EU-FOFAM	229
GT4-SA-DESIGN	222
PB3-EU-RAPIDOS	209
GT2-SA-EDUCATE	183
M12-EU-BOREALIS	182
GT7-MX-CIATEQ	164
M4-SA-DEDEF	162
GT12-EU-MANSYS	157
GT6-SA-HYGIENE	111
GT5-SA-SAND	108
M5-SA-FORMING	87
PB2-SA-POLYAM	81
GT13-EU-CASSAMOBILE	81
PB5-EU-BIOSCAFFOLDS	74
PB4-EU-ToMAX	69
M8-MX-SISAMEX	65
GT3-SA-NDTLBM	45
GT15-EU-NEXTFACTORY	42
PB1-SA-FDMFINISH	38
M15-EU-OXIGEN	36
GT8-MX-UASLP	31
M16-MX-METALSA	0
PB6-EU-HYDROZONES	0
PB7-EU-IBUS	0
PB8-MX-UNAM-MADIT	0
GT1-US-LOCKHEED	0
GT9-MX-VITRO	0
GT14-MX-UANL	0