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

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Research and Innovation

European Commission

AM in the press

Research and Innovation

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 terms used since AM started:

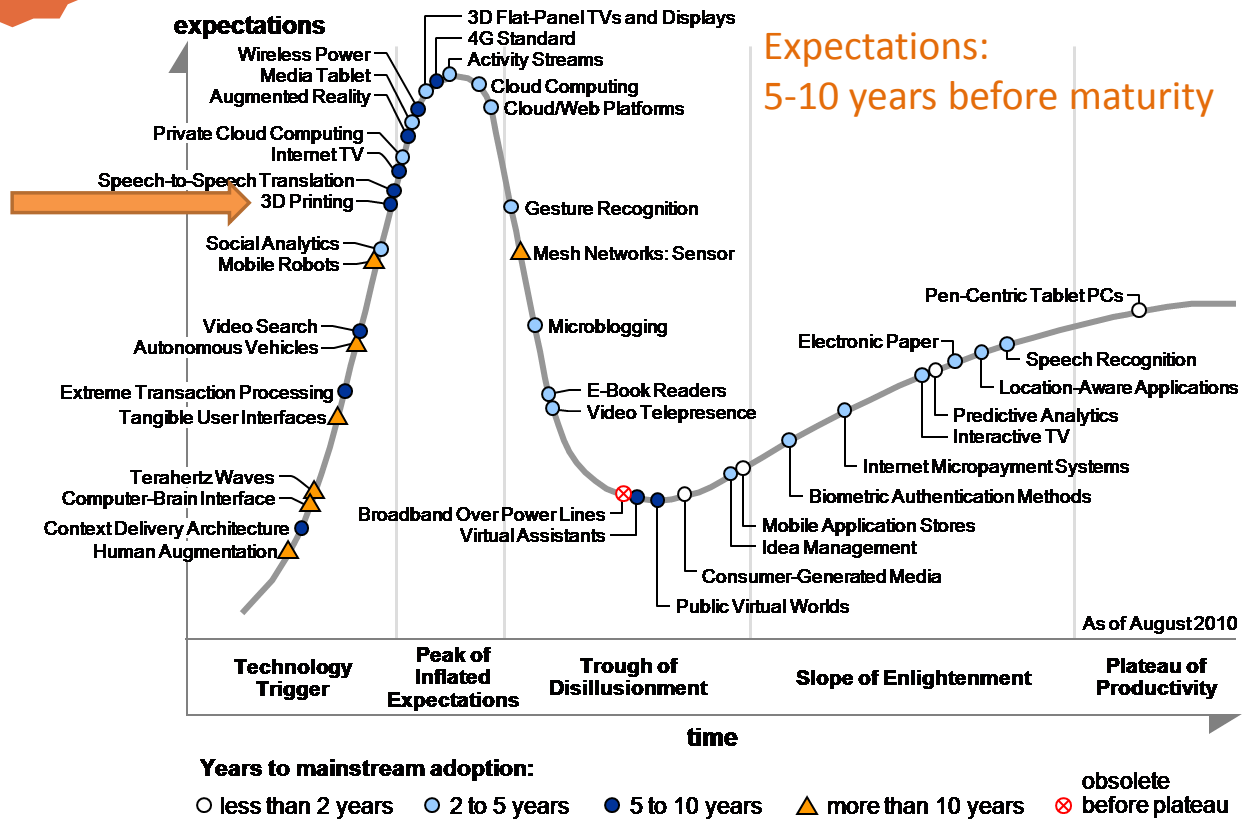
Different materials:
Polymers / Metals / Ceramics

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

Attention on Additive Manufacturing is recent

2010

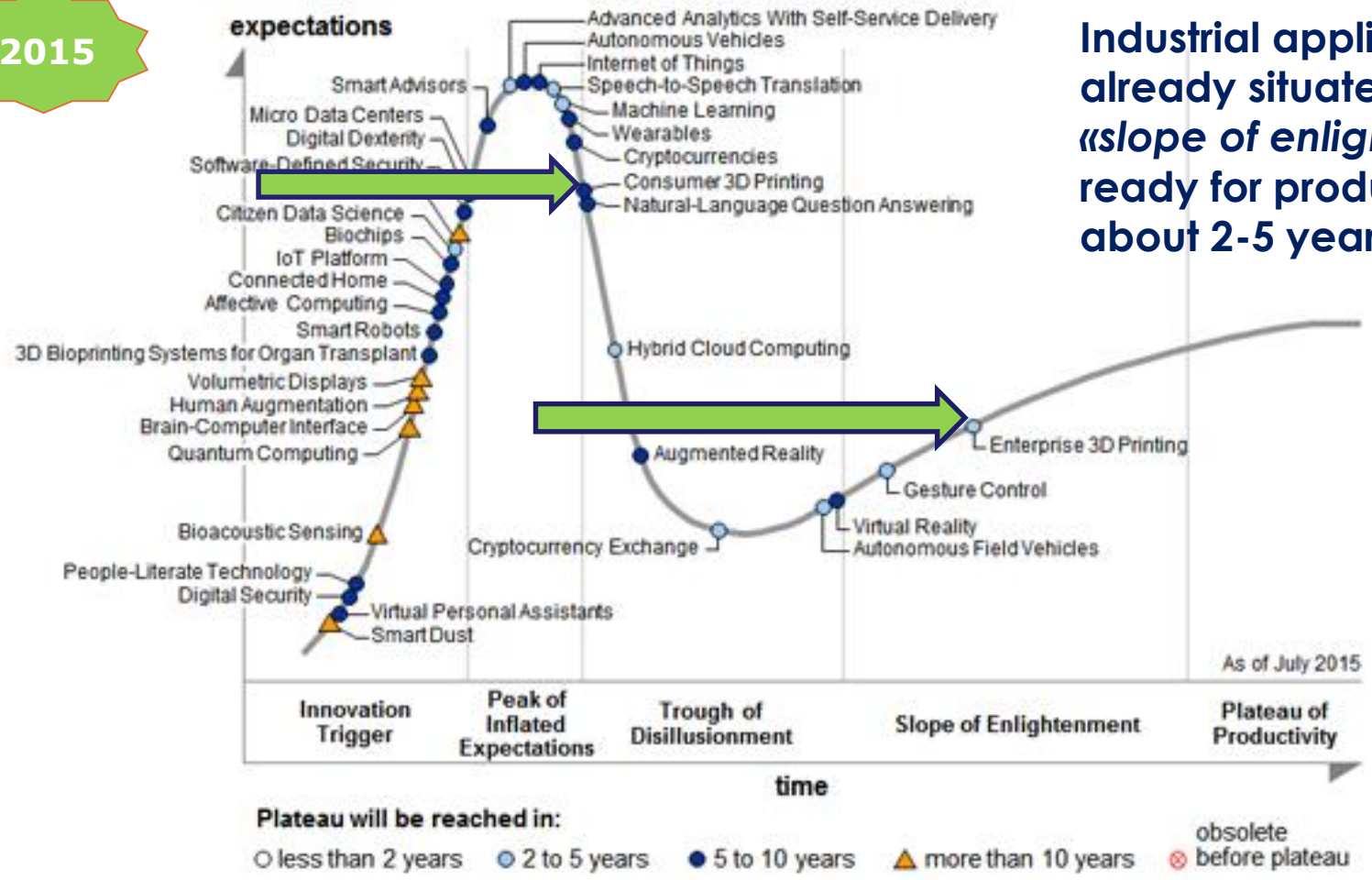
Additive Manufacturing / 3D Printing appears.



Expectations:
5-10 years before maturity

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

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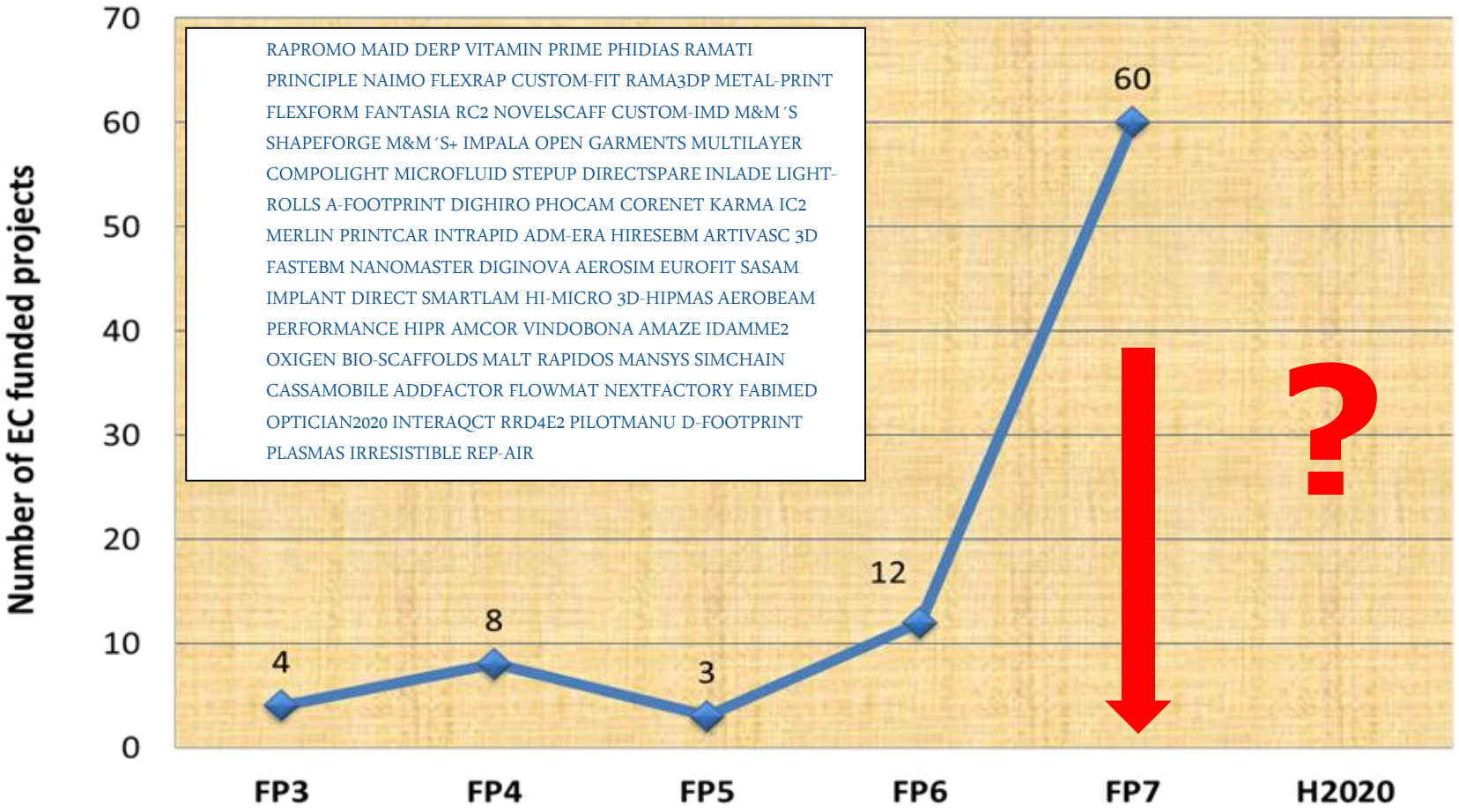
AM projects in EU RTD Framework Programmes (1991-2013)



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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**

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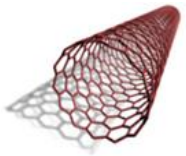
Combining several KETs for advanced AM products

SOCIETAL CHALLENGE

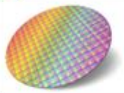
TRANSPORT



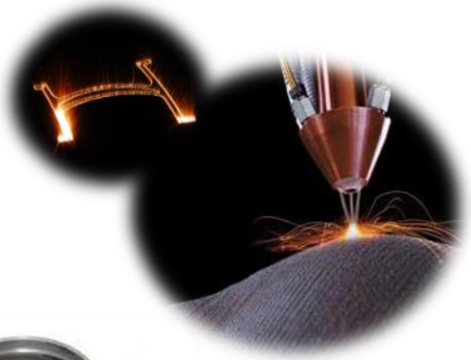
ADVANCED MATERIALS

NANOTECHNOLOGIES

MICROELECTRONICS



PHOTONICS



ADVANCED MANUFACTURING

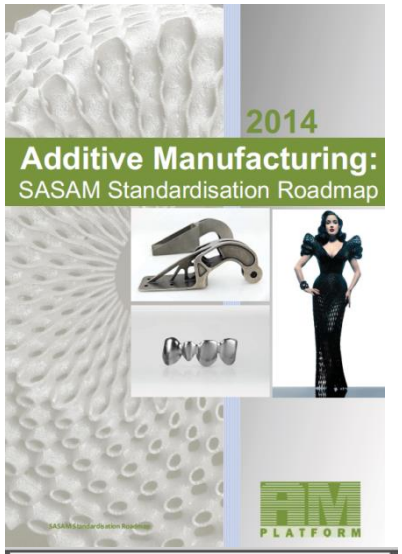
- ✓ CUSTOMIZATION FOR REAL END USER NEEDS
- ✓ NEW FUNCTIONAL DESIGNS FOR NEW VEHICLE CONCEPTS
- ✓ REDUCING COSTS INCREASING PERFORMANCE
- ✓ FAST RESPONSE TO HIGH DEMANDING SECTOR
- ✓ NEW TOOLS FOR NEW MINDED PROFESSIONALS
- ✓ NEW CONCEPT OPTIMISED INTRINCATED STRUCTURES TO FIT FUTURE USABLE SHAPES
-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

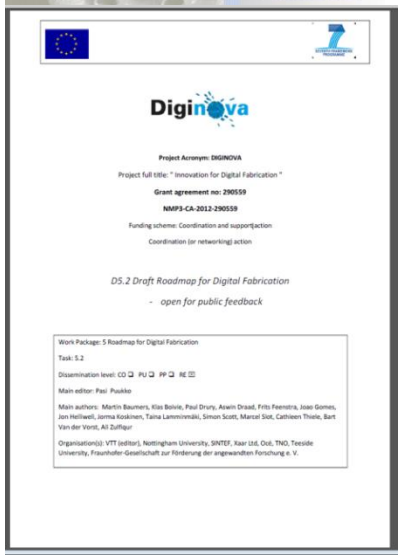
The European Additive Manufacturing Technological Platform

- 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 stablish 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**





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FoF AM Cluster

AMAZE

REProMag
Resource Efficient Production of Magnets

BOREALIS

Hi-Micro

FoFAM

TOMAX

Stellar

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

AMAZE

€10 M EU funding - €18 M budget

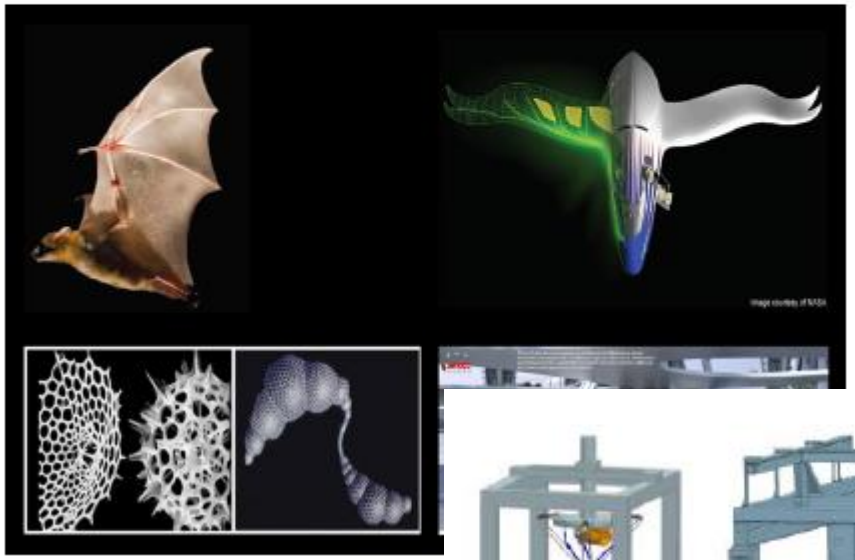
High-Tech Metal Products:
Large-scale AM parts

- 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

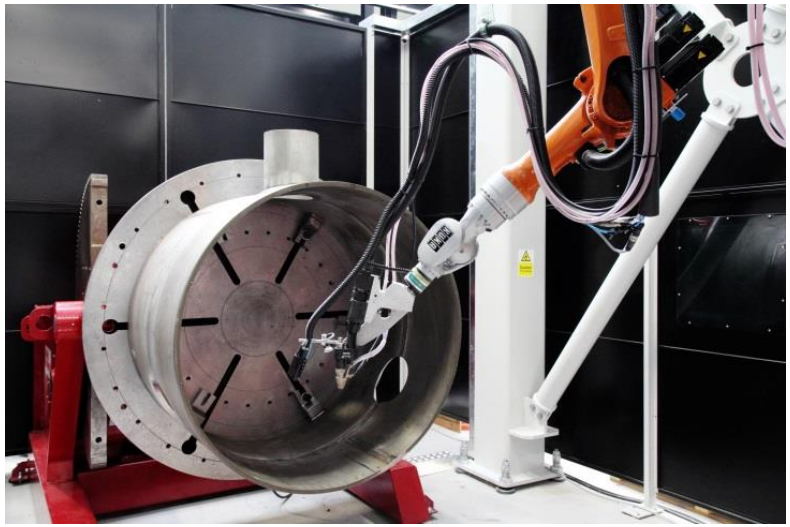
Main Partners:

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.

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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 microfuidics 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

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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 **CO_2** 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**

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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**

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

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NMP-FP7 projects (2007-2013)

NANOMASTER	Graphene based thermoplastic masterbatches for conventional and additive manufacturing processes
DIGINOVA	Innovation for Digital Fabrication
OXIGEN	Oxide Dispersion Strengthened Materials for the Additive Manufacture of High Temperature Components in Power Generation
AMAZE	Additive Manufacturing Aiming Towards Zero Waste & Efficient Production of High-Tech Metal Products
HI-MICRO	High Precision Micro Production Technologies
3D-HIPMAS	Pilot Factory for 3D High Precision MID Assemblies
AMCOR	Additive Manufacturing for Wear and Corrosion Applications
HIPR	High-Precision micro-forming of complex 3D parts
SMARTLAM	Smart production of Microsystems based on laminated polymer films
PRIME	Plug and PRoduce Intelligent Multi Agent Environment based on Standard Technology
SASAM	Support Action for Standardisation in Additive Manufactruring
BIO-SCAFFOLDS	Natural inorganic polymers and smart functionalized micro-units applied in customized rapid prototyping of bioactive scaffolds
PILOTMANU	Pilot manufacturing line for production of highly innovative materials

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.
OPEN GARMENTS	Consumer Open Innovation and Open Manufacturing Interaction for Individual Garments
COMPOLIGHT	CompoLight: Rapid Manufacturing of lightweight metal components.
STEPUP	STEP UP IN POLYMER BASED RM PROCESSES
MULTILAYER	Rolled multi material layered 3D shaping technology
IMPALA	Intelligent Manufacture from Powder by Advanced Laser Assimilation
LIGHT-ROLLS	High-throughput production platform for the manufacture of light emitting components
A-FOOTPRINT	Ankle and Foot Orthotic Personalisation via Rapid Manufacturing
IC2	Intelligent and Customized Tooling
PHOCAM	Photopolymer based customized additive manufacturing technologies
CORENET	Customer-oriented and eco-friendly networks for healthy fashionable goods
ARTIVASC 3D	Artificial vascularised scaffolds for 3D-tissue-regeneration

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

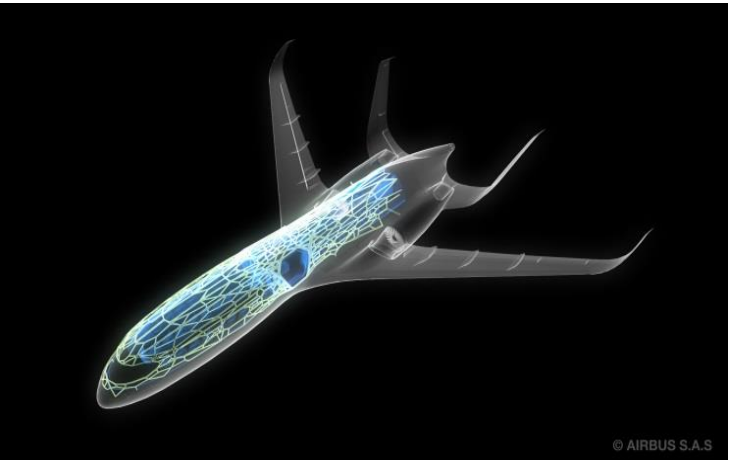
NMBP-Horizon 2020 projects (2014-2015)

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*

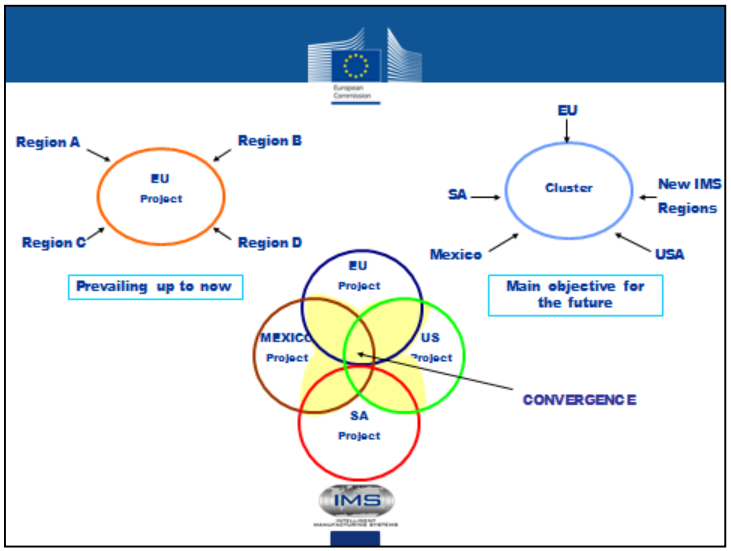
German ESTEBAN MUNIZ @G_EstebanEC · Feb 8
Deputy General Director DG RTD highlighted potential of #3dprinting & #additivemanufacturing in #H2020 projects!!!

German ESTEBAN MUNIZ @G_EstebanEC · Feb 8
Exhibition on #additivemanufacturing with @AM_EUplatform @CECIMO_Info and many other #H2020 projects was a success!

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-DEDREF	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