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Additive Layer Manufacturing

Janvier 2016

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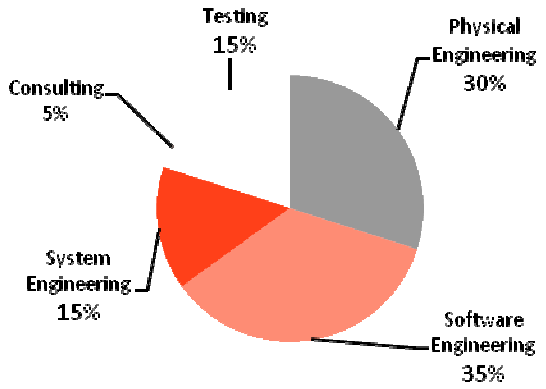
Inspiring TECHNOLOGY

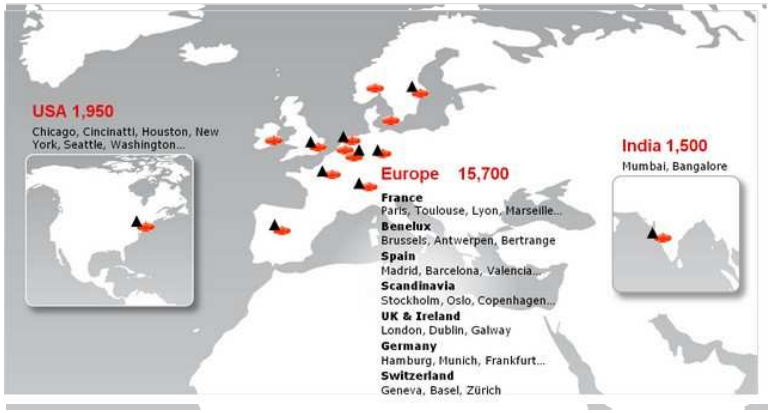
Sogeti High Tech focused on Engineering and R&D services

- **Sogeti High Tech - Engineering and Technology services**
  - 3,000 employees - 250 M€ turnover
  - 25 years of engineering services for industrial companies
  - A community dedicated to R&D: High Tech Labs
- **Within Sogeti : some key figures**
  - Local IT and engineering services
  - 20,000 employees over the world
  - 2013 Turnover: 1.7 billion Euros
- **Subsidiary company of Capgemini group**
  - 2013 Turnover: 10.092 billion Euros
  - Global workforce : 180,000 people
  - CAC 40 Paris stock exchange

Our 5 business lines



Sogeti located in 15 countries



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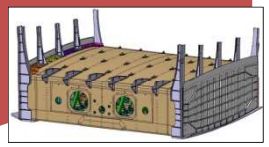
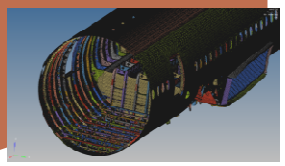
Main Credential on Engineering

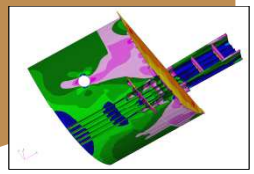
Design
- R&T / Aircraft architectures
- Composite & metallic
- Tools



FE Simulation
- Detailed modelling
- Linear & non linear
- Virtual Testing

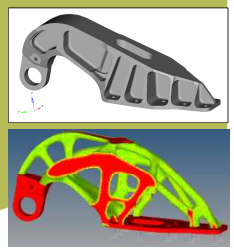


Static
- Composites & metallic materials
- Justification/Certification

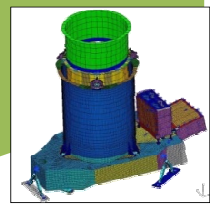


Fatigue
- Reparation/Modifications
- F&DT analyses

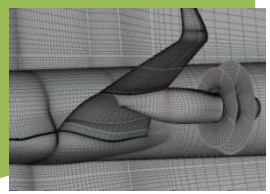
Optimisation
- Structural Optimisation
- MDO



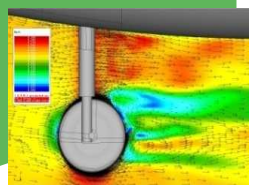
Space
- Telecom Satellite
- Earth observation
- Equipments



Aerodynamic
- Structured/Unstructured/Hybrid meshing
- CFD calculation
- Automation

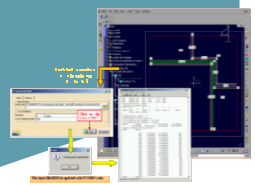


Acoustic
- Numerical simulation
- Wind tunnel & flight test analysis
- Noise propagation



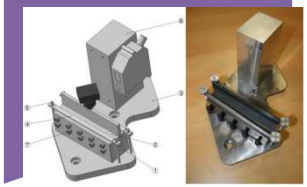
Project Performance
- Management support
- Technical expertise

Customer Services
- Tech Data
- Off-shore management



Manufacturing Engineering
- Additive Manufacturing
- Digital Manufacturing
- Design to cost

Innovation Work
- PhD: acoustic, composite
- Internal research



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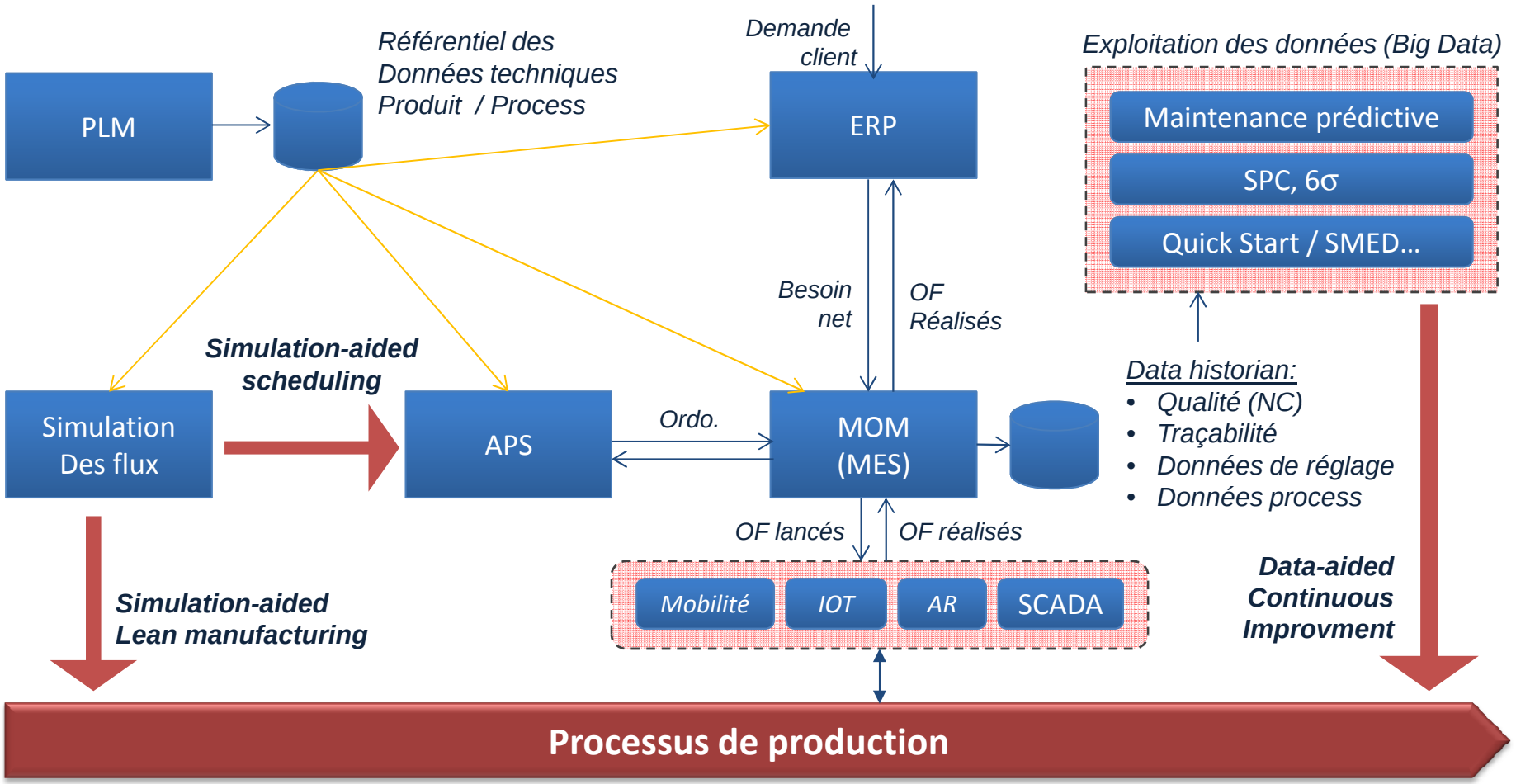
SOGETI High Tech : Digital Manufacturing solutions



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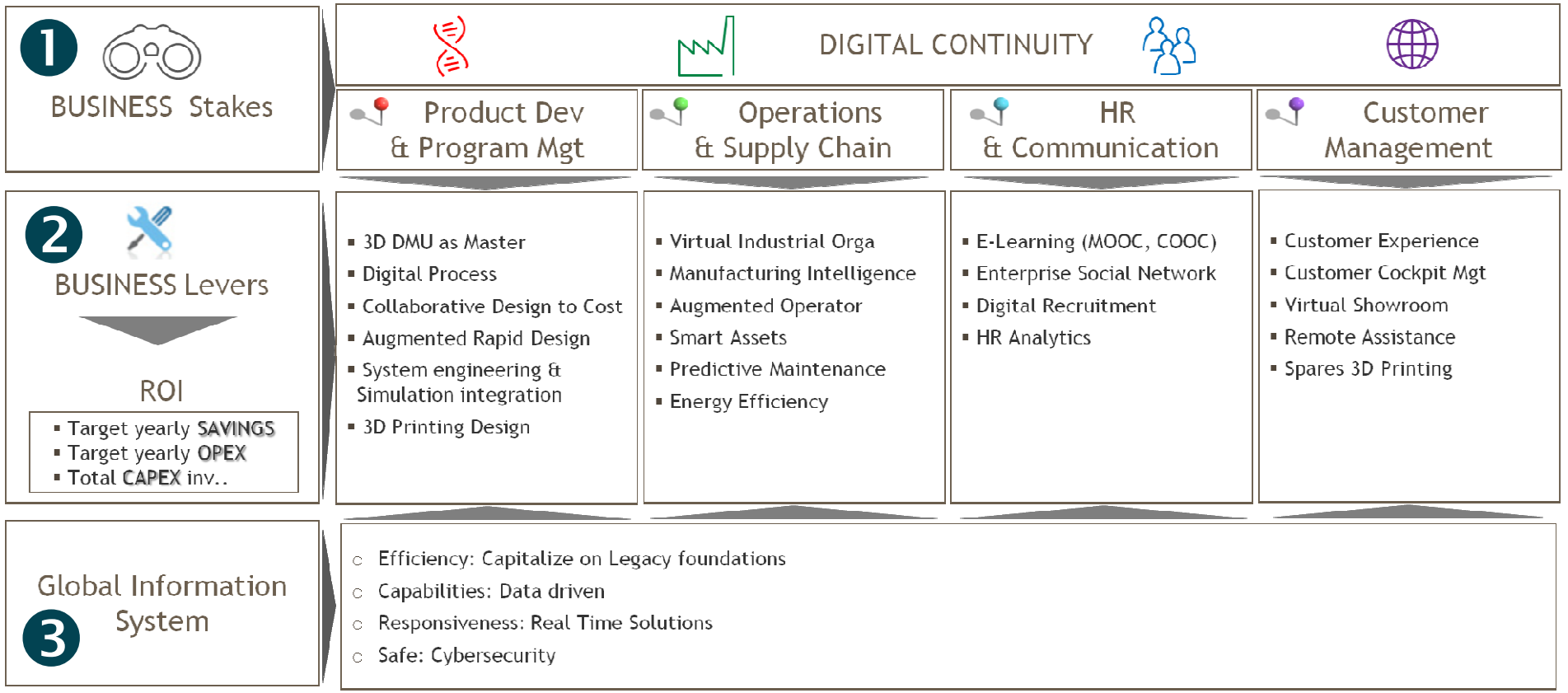
DIGITAL TRANSFORMATION

Digital Transformation Scope



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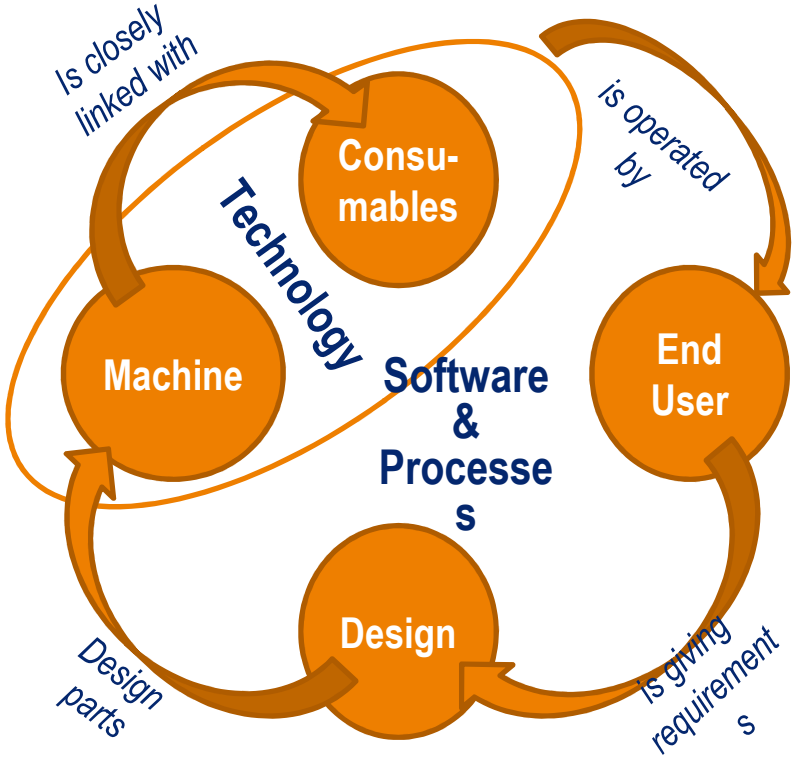
AM technology

- Additive Manufacturing mastering requires to align different assets and can be a radical game changer

3D Printing

A technology combining evolving competencies

Applying 3D printing in operation requires to align 4 evolving assets



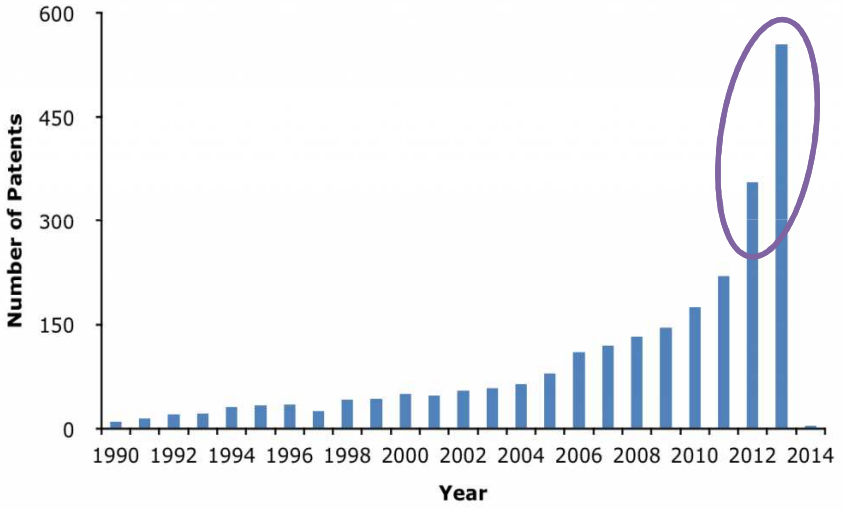
- Engineering knowledge to design optimized printable parts
- Printed part size: **from A3 to 1,50m**
- Production time: ~1h to 1 min
- Raw material evolution:
  From niche players to key players
- Material costs: 250€/Kg to ? (2€/kg)

Success in applying 3D Printing requires to build dedicated assets to align different competences and technologies together

3D Printing

A fast changing world

Entreprise 3D Printing moved from « **Peak of inflated expectations** » to « **Slope of enlightenment** » In one single year

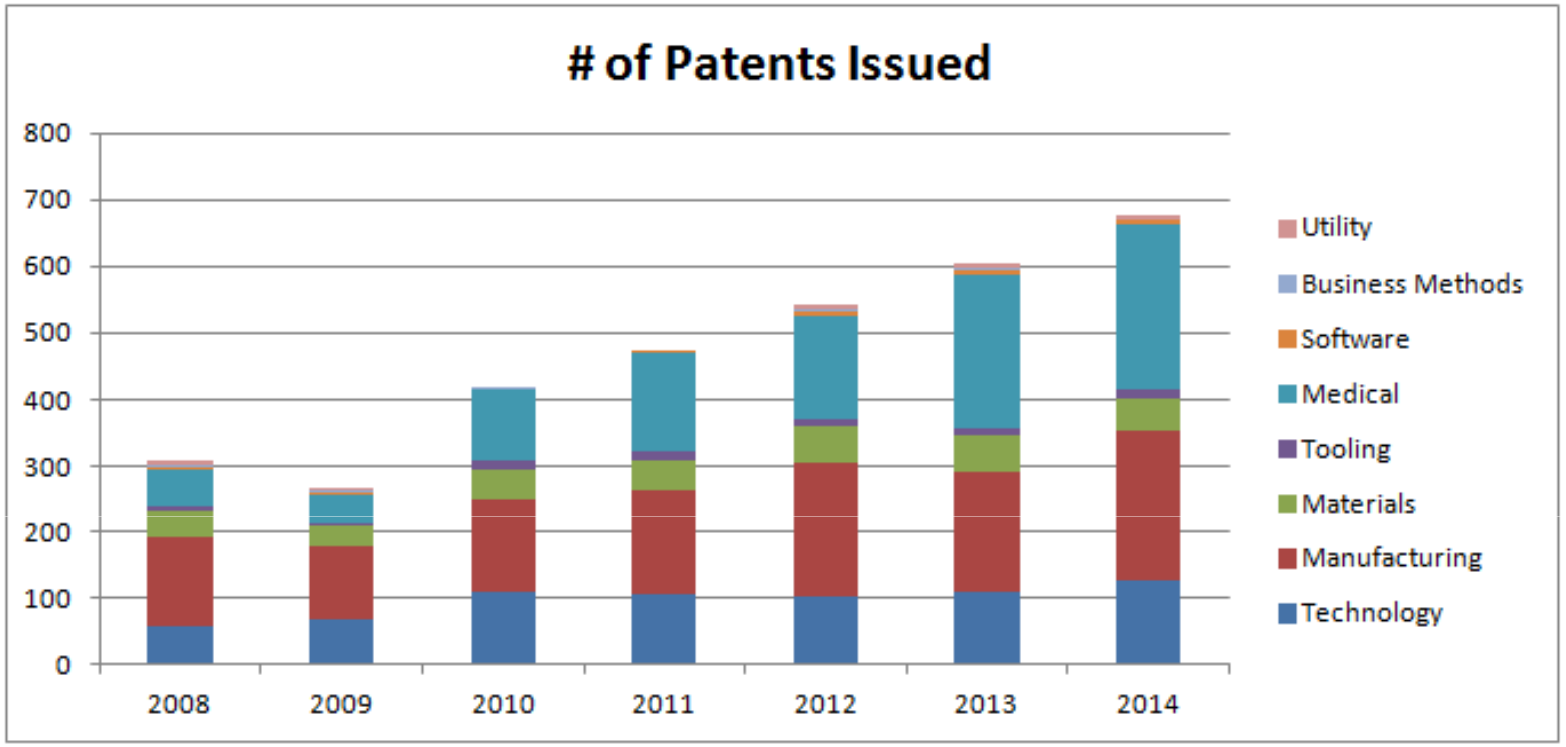


Source: IndustryARC Analysis

Number of patents explosed during the last years

Additive Manufacturing is confirmed has a new key technology to master for product manufacturers

Analysis of issued patents by topic – *3D Printing*

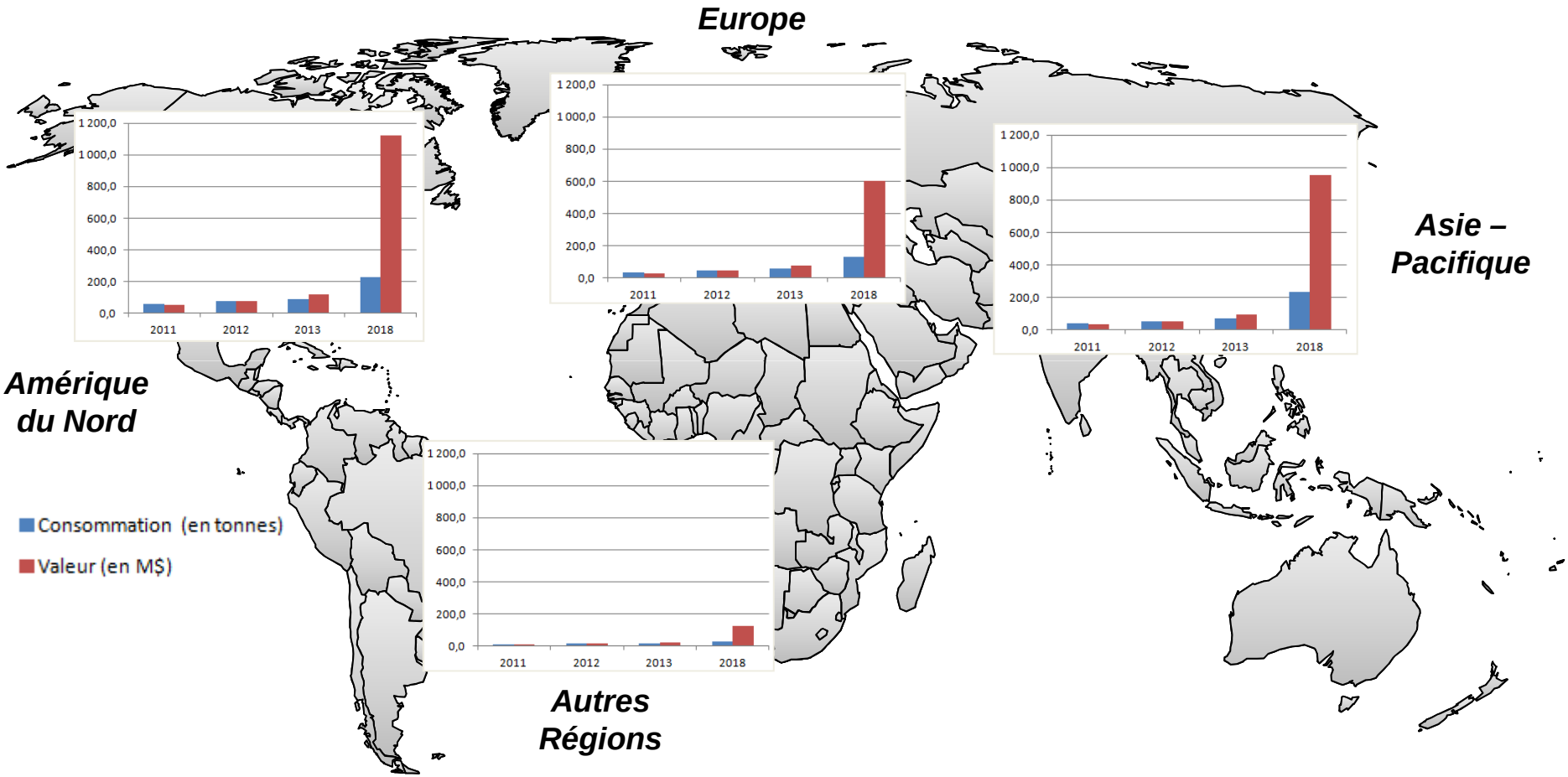


The main topics of issued patents are related to the medical industry, the manufacturing and the technology.

In the last 5 years, the number of issued patents has increased by more than 10% each year.

Many patents have expired, or will soon expire, meaning a lot of (potentially new) actors will enter the market with new technologies and products.

L’impression 3D métal, un marché en croissance dans une dynamique exponentielle



L’Amérique du Nord et l’Asie-Pacifique sont les deux régions qui portent l’impression 3D métal. L’Europe ne représente qu’un quart du marché global.

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Exemples d’applications par segment

Automobile

Education

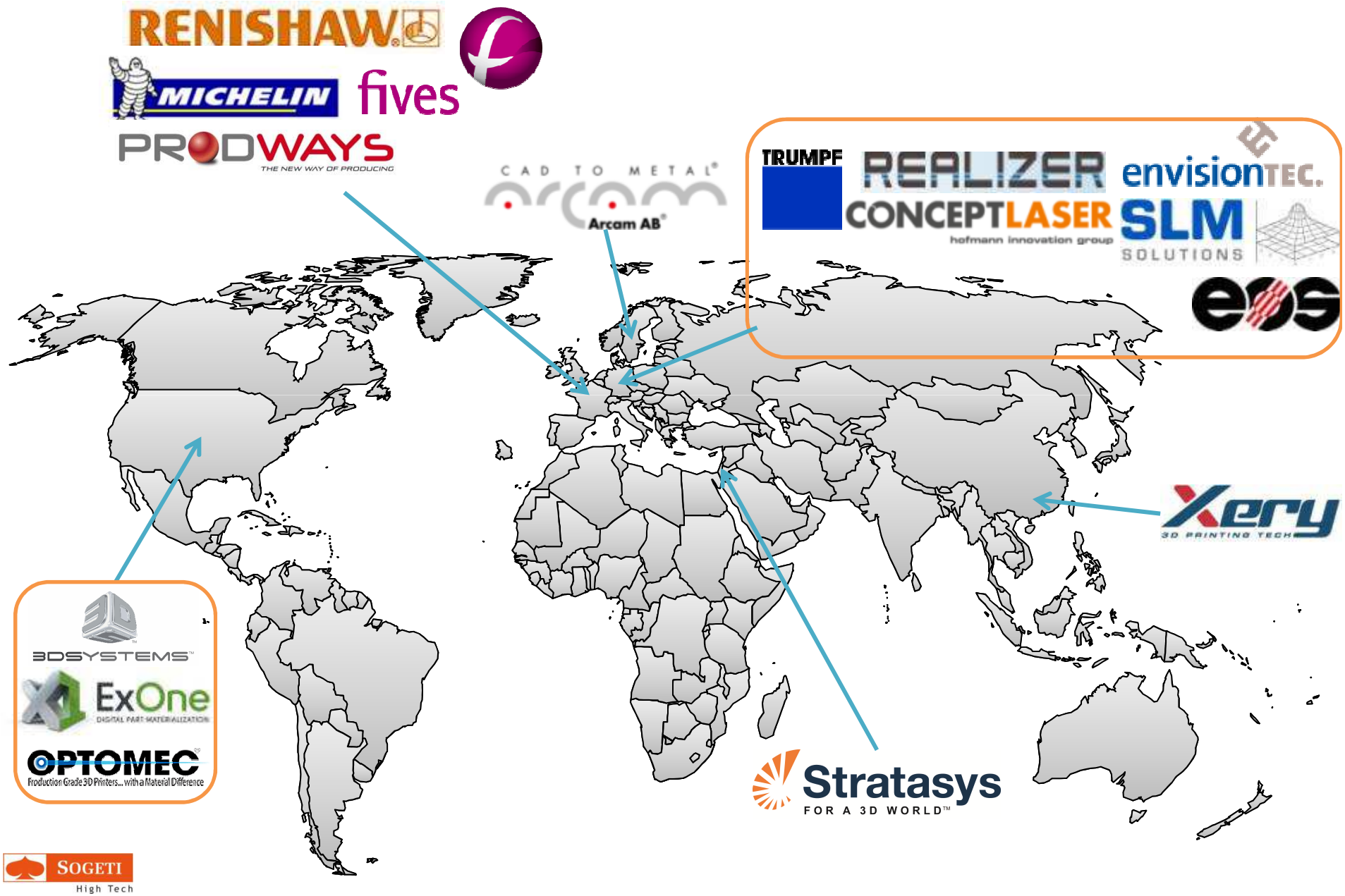
Autres Industries

Produits Grand Public

Aéronautique

Médical

Overview des Constructeurs de Machines

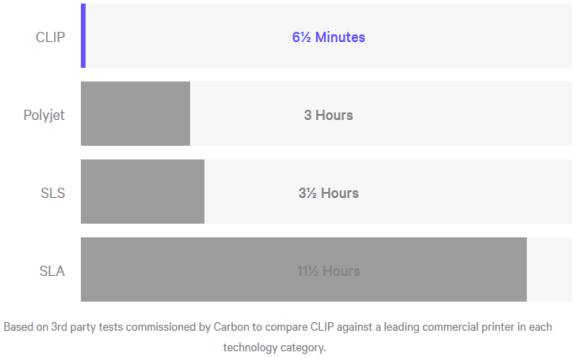


3D Printing

Upcoming breakthroughs - Blue chips enter the game

carbon3D

Google G/



***March 2015**: Carbon 3D a start-up presented the CLIP technology fastening the **printing time** with a factor 25 to 100*

***August 2015**: Google venture entered Carbon3D capital (100M$)*

***Q4 2014**: HP presents the* **HP Multi Jet FusionTM technology**
Combines: strength & texture by assembling two technologies for structure and coating
« HP Emerges! Witness the Birth of a 3D Printing Behemoth!"

***January 2015**: Announce: 10x faster, lower cost*

*Expected release: **2017***

*"In United States, the hearing aid industry has converted to 100% additive manufacturing **in less than 500 days** and not a company remained faithful to traditional manufacturing methods has survived"*
HBR France 2016

Technology breakthroughs can change the business game very fast

Divers domaines et technologies

Procédés

Fabrication par stratification
Dépôt de fil fondu
Frittage avec masque
Frittage laser
Fusion laser
Fusion par faisceau d'électrons
Fabrication par rechargement laser
Photo-polymérisation (stéréolithographie)

Matériaux

Plastiques
- Thermo-plastiques
- Thermo-durcissables
- …

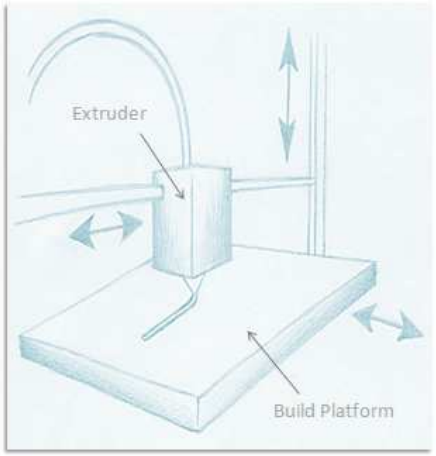
Métaux et alliages
- Ti, Ni, Cu
- Al, Co
- Acier
- Mg
- alliages…

Céramique
…

Usages

Prototypage
Production
Outillage (moules, …)
Réparation
…

FDM (Fuse Deposition Modelling)



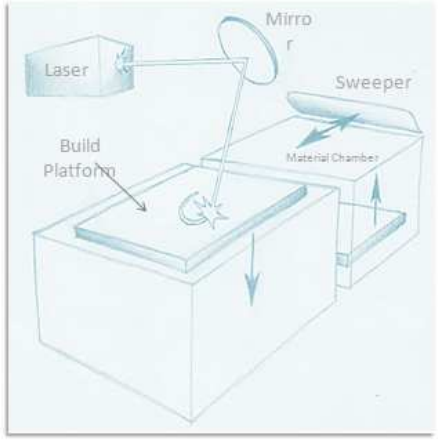
Process

- Nozzle heats and deposits plastic on build platform layer by layer

Challenges

- Material strength
- Controlled environment

SLS (Selective Laser Sintering)



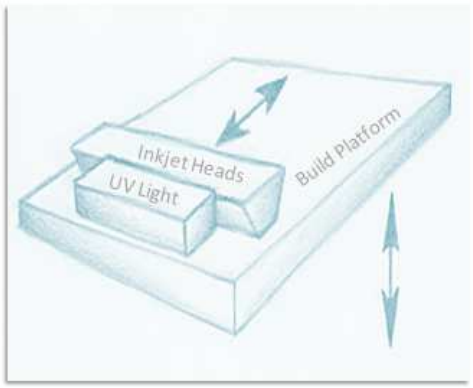
Process

- Laser sinters beads of material together

Challenges

- Material strength
- Post processing

Inkjet/Polyjet



Process

- Uses inkjet head to distribute liquid UV-sensitive photopolymer onto build platform
- UV light shines and cures each layer

Challenges

- Post processing
- UV light exposure

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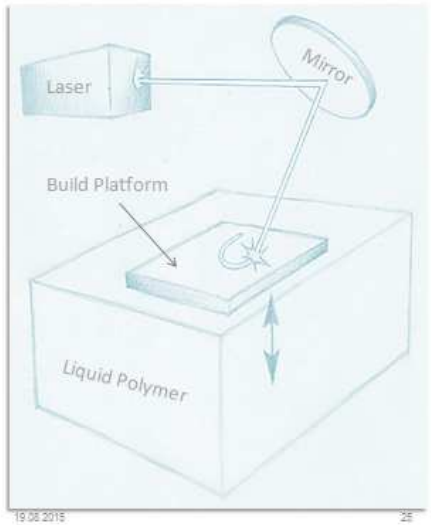
SLA (Stereolithography)



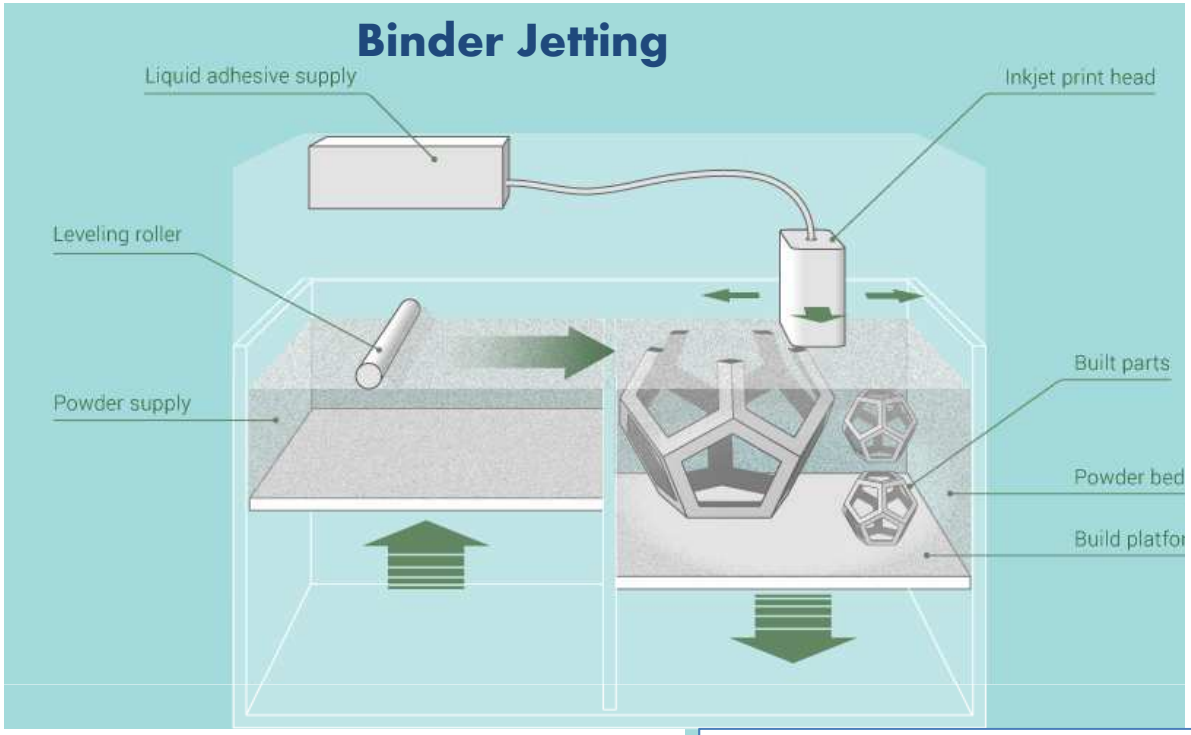
Process

- Laser shines into vat of UV-sensitive photopolymer
- Build platform lowers so each layer of part and support material can be cured layer by layer

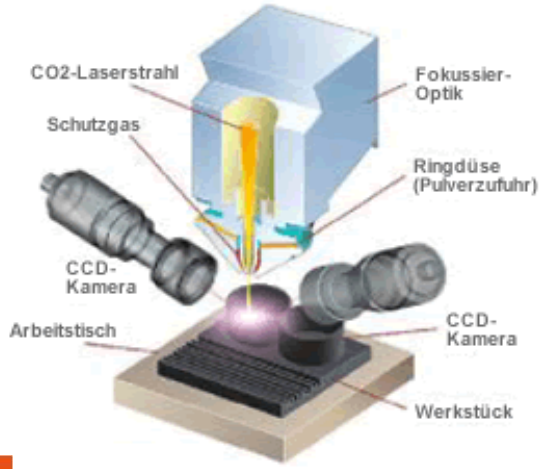
Challenges

- Brittle parts
- UV light exposure

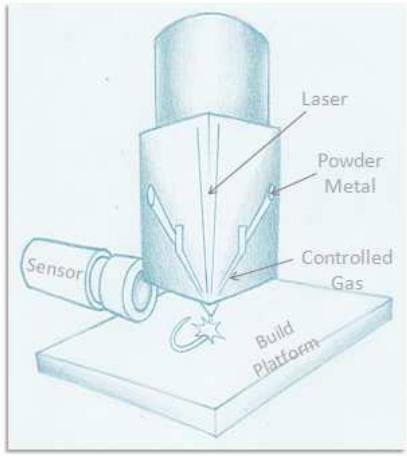
Binder Jetting



DMD: Technologie



DMLS (Direct Metal Laser Sintering)



Process

- Laser fuses granules of metal together

Challenges

- Expensive
- Post processing

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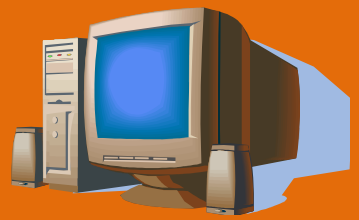
Aspirational goals for additive manufacturing – Massive use of Additive Manufacturing depends on 6 technological breakthroughs

Printing Speed
From hours to minutes

Materials
From high value low volume to dedicated high volume

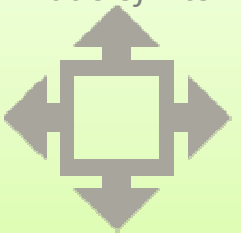
Numerical developpements



Printing Accuracy
From tenth to µm

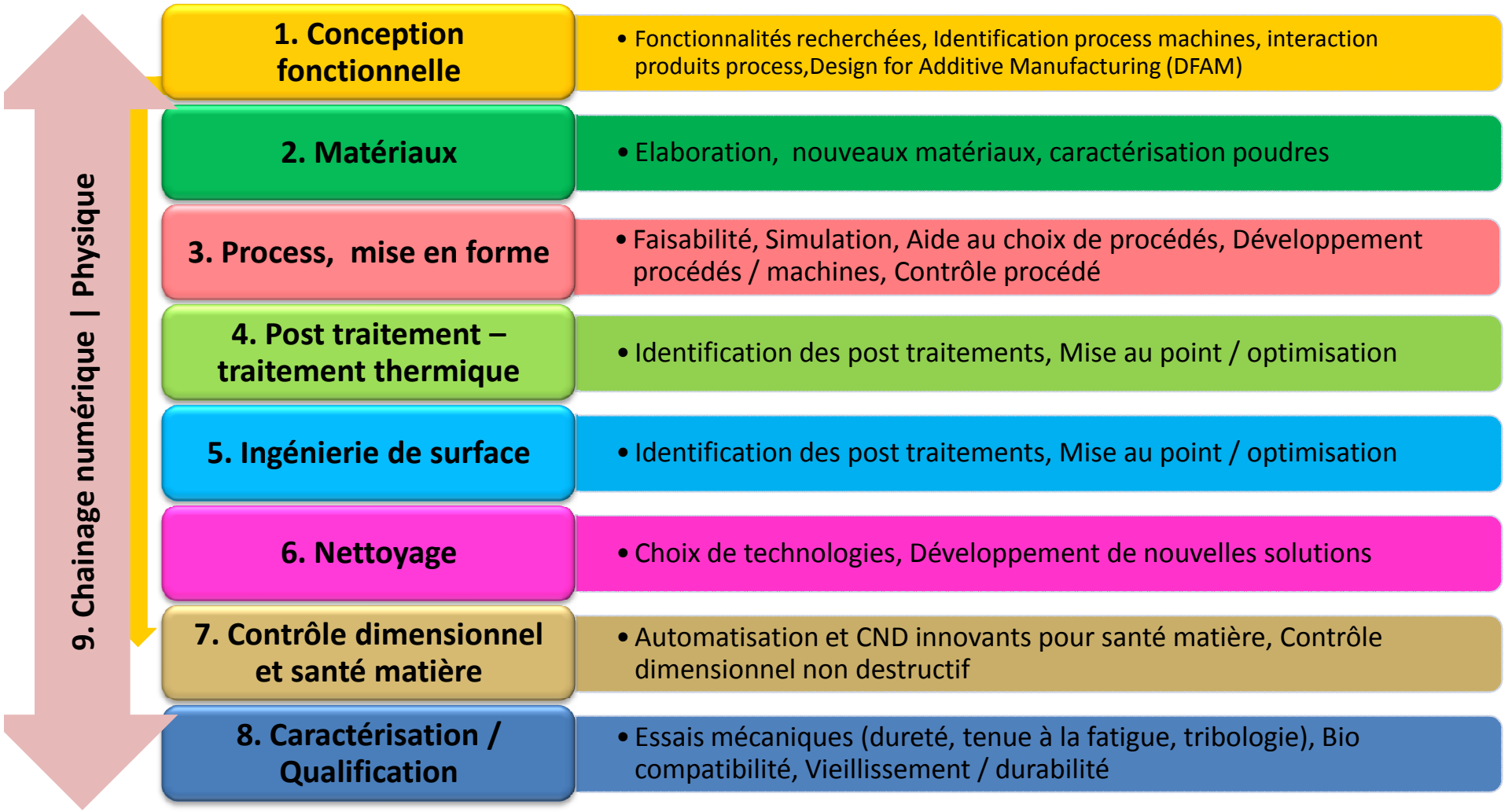
Quality/Certification

Printing Size
Ratio of 1 to 2

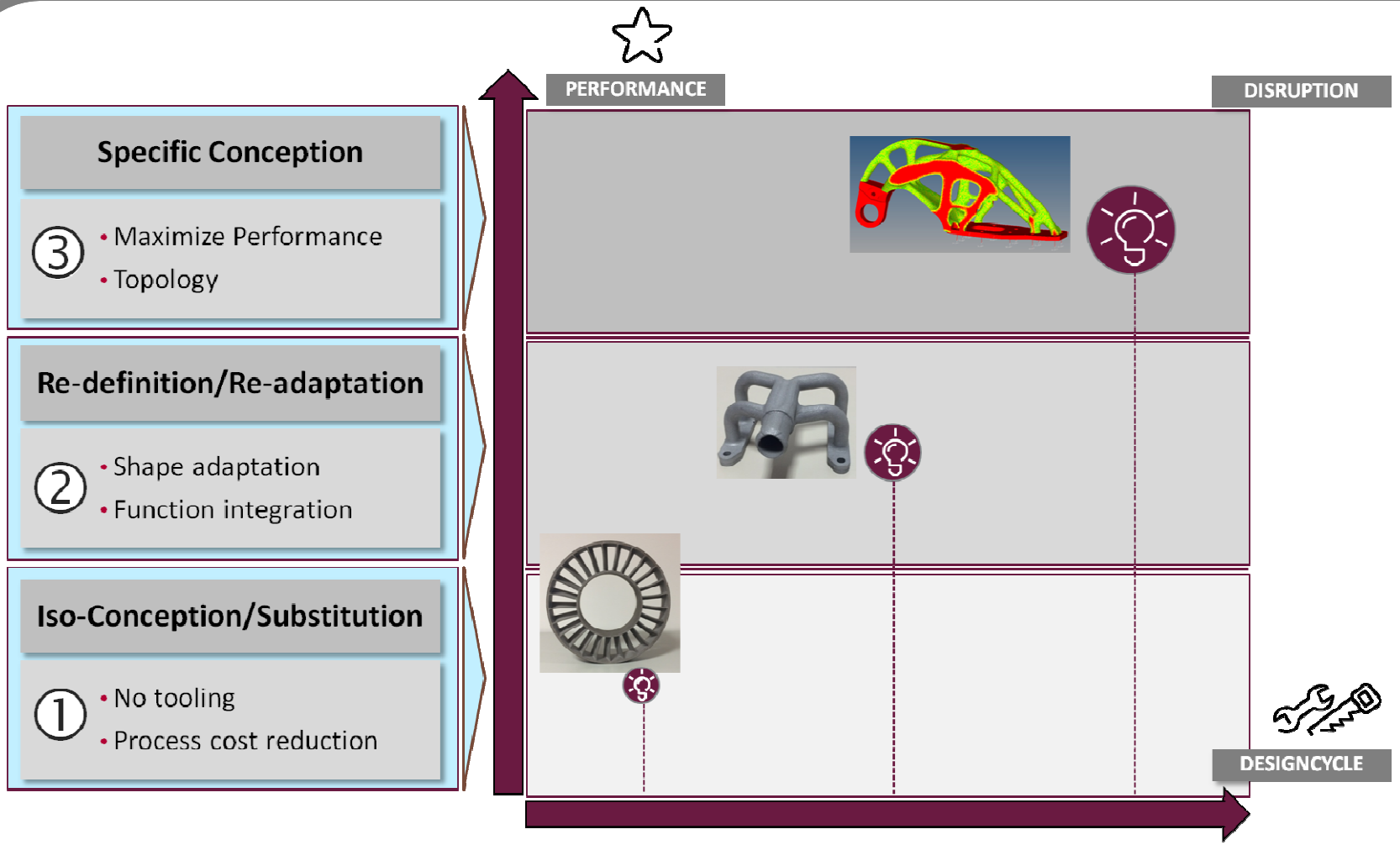


Expected maturity year

3D Printing :Design Disruption as Performance Driver

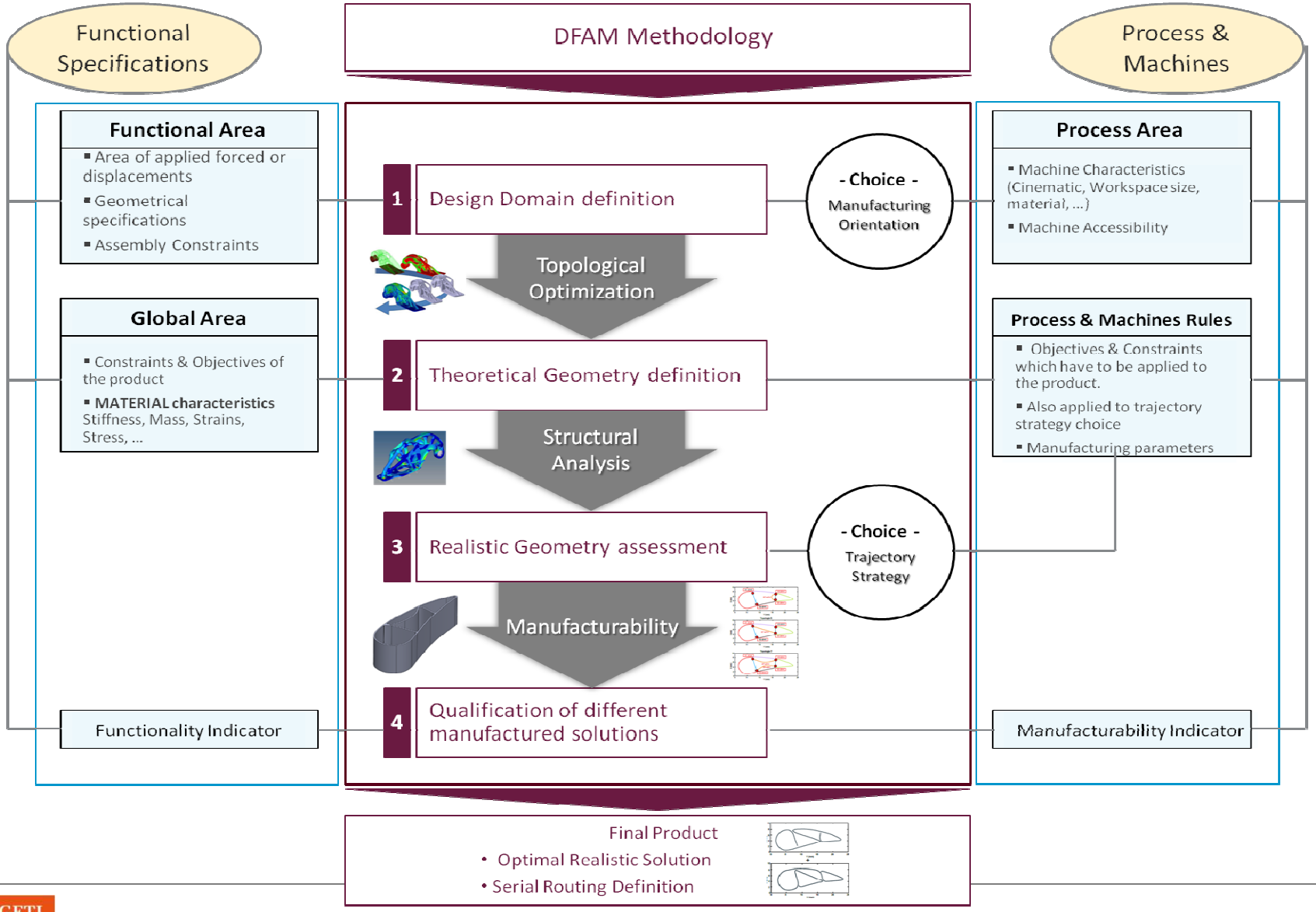


3D Printing :Design Disruption as Performance Driver



The major outcomes are linked with a dedicated conception process

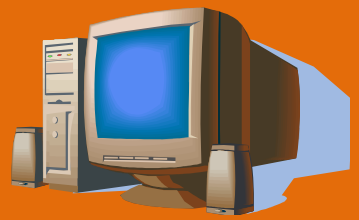
3D Printing :outils et platforme de design



Aspirational goals for additive manufacturing – Massive use of Additive Manufacturing depends on 6 technological breakthroughs

Materials
From high value low volume to dedicated high volume

Numerical developpements



Printing Size
Ratio of 1 to 2

Printing Accuracy
From tenth to µm

Quality/Certification

Printing Speed
From hours to minutes

Expected maturity year

weeks to days

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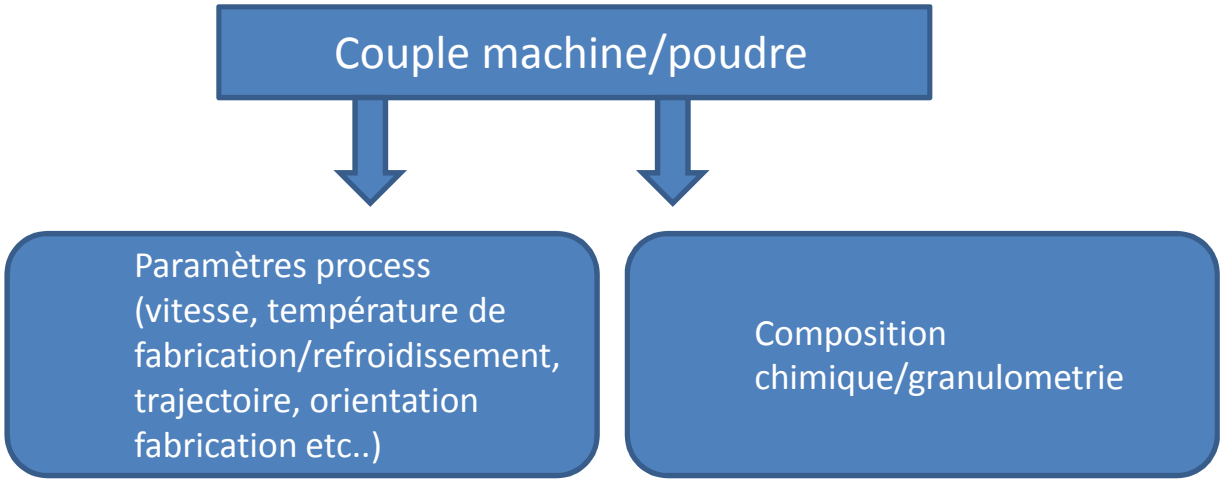
Un défis majeur

- **La qualité finale de la pièce fabriqué par AM (et donc la certification) dépend :**

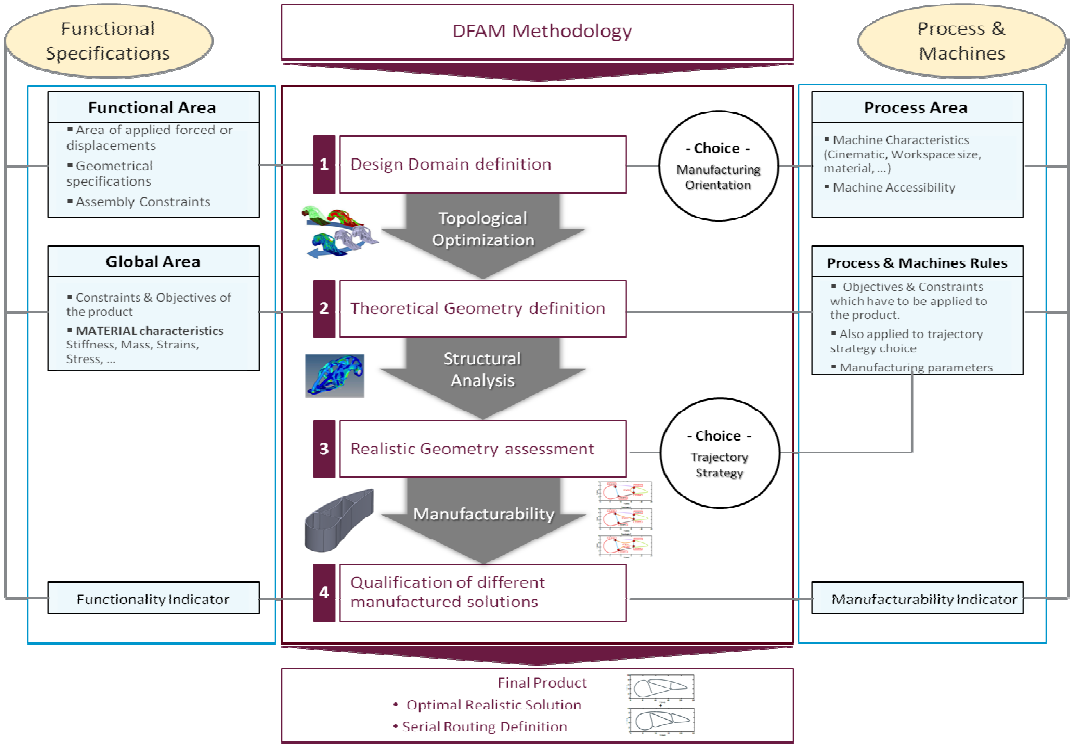


Pas de recette magique!! La meilleur composition de poudre pour L'imprimante X, n'est pas la meilleur formulation pour Y et les meilleurs parametres process changent aussi de machine a machine Et de poudre a poudre.

Bcp de tests pour valider couple parametres/poudres pour un design donnée

La solution est numerique

Solution numérique: librairie matériaux



protocol de test à mettre en place pour chaque couple Machine/poudre

➡ librarie numerique materiax

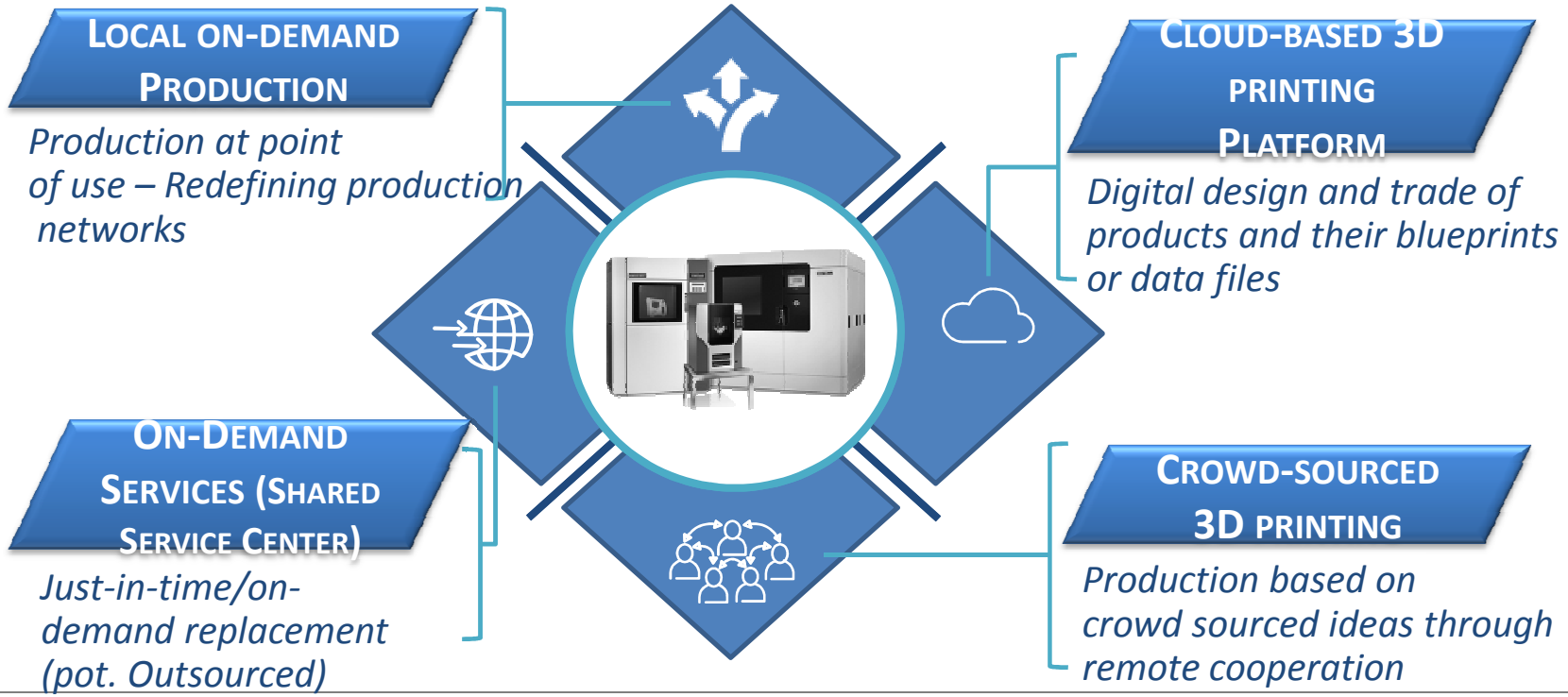
Un logiciel , permet d'injecter les bon paramètres physique dans la boucle de design.

➡ design adapté a la qualité matériaux envisageable

Un deuxième logiciel permet d'optmiser les paramètres process (orientation, trajectoires, vitesse etc) Pour obtenir la qualité recherché.

Autres défis du numérique

- **Optimisation type topologique pour optimiser pièces avec une spécificité thermique, fluidique, acoustique, etc**
- **Optimisation Support (mécanique et thermique)**
- **Intégration chaine design/pilotage machine**
- **Adaptation vis-à-vis du model choisi:**



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