Additive Manufacturing Project Canvas: I 7 quadranti per il mio progetto pilota

THANKS TO

AzzurroDigitale
STRATEGY&VENTURES

SIMONE RAVAGLIA

Technology Innovation Advisor

simoneravaglia.it

2000

Decido di abbandonare l'azienda di famiglia per iniziare la mia carriera come disegnatore meccanico

2007

Inizio un'attività indipendente come progettista meccanico freelance e lavoro con importanti aziende italiane in mercati automotive, consumer e industriale

2011

Faccio una importante esperienza all'estero in India di oltre tre mesi profondamente formativa

2012

Rientro in azienda come Responsabile Area Tecnica di una nota azienda manifatturiera emiliana

2016

Intensifico la mia attività in progetti di Innovazione e divento il Responsabile Innovazione e R&D

2018

Frequento il master in Technology Innovation Management presso la Bologna Business School

2019

Frequento il master Karmic Business Accademy e decido definitivamente di passare all'azione!

2020

Inizio una attività *freelance entusiasta* come Formatore e Advisor in Innovazione Tecnologica

Additive Manufacturing Projects Canvas BETA

Additive Manufacturing Projects Canvas BETA

Progetto _____ Data _____

MATERIALE

2

TECNOLOGIE

3

PROGETTAZIONE

4

DESIDERIO

Io voglio...

inizio

PERCHÈ (IL DRIVER DI PROGETTO)

Che cosa vuoi ottenere dall'utilizzo delle tecnologie additive? Quale specifico vantaggio vuoi ottenere? (leggerezza, maggiore resistenza, personalizzazione, riduzione costi, branding appeal, ecc...)

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Descrivi il risultato finale, fai una sintesi di progetto e declina almeno un indicatore da tenere sotto controllo (%riduzione peso, % incremento performance meccanica, % riduzione costo, ecc...).
In questa fase sei pronto per decidere se andare avanti e realizzare il primo prototipo o esplorare altri progetti.

fine

FINITURA

5

QUALITA'

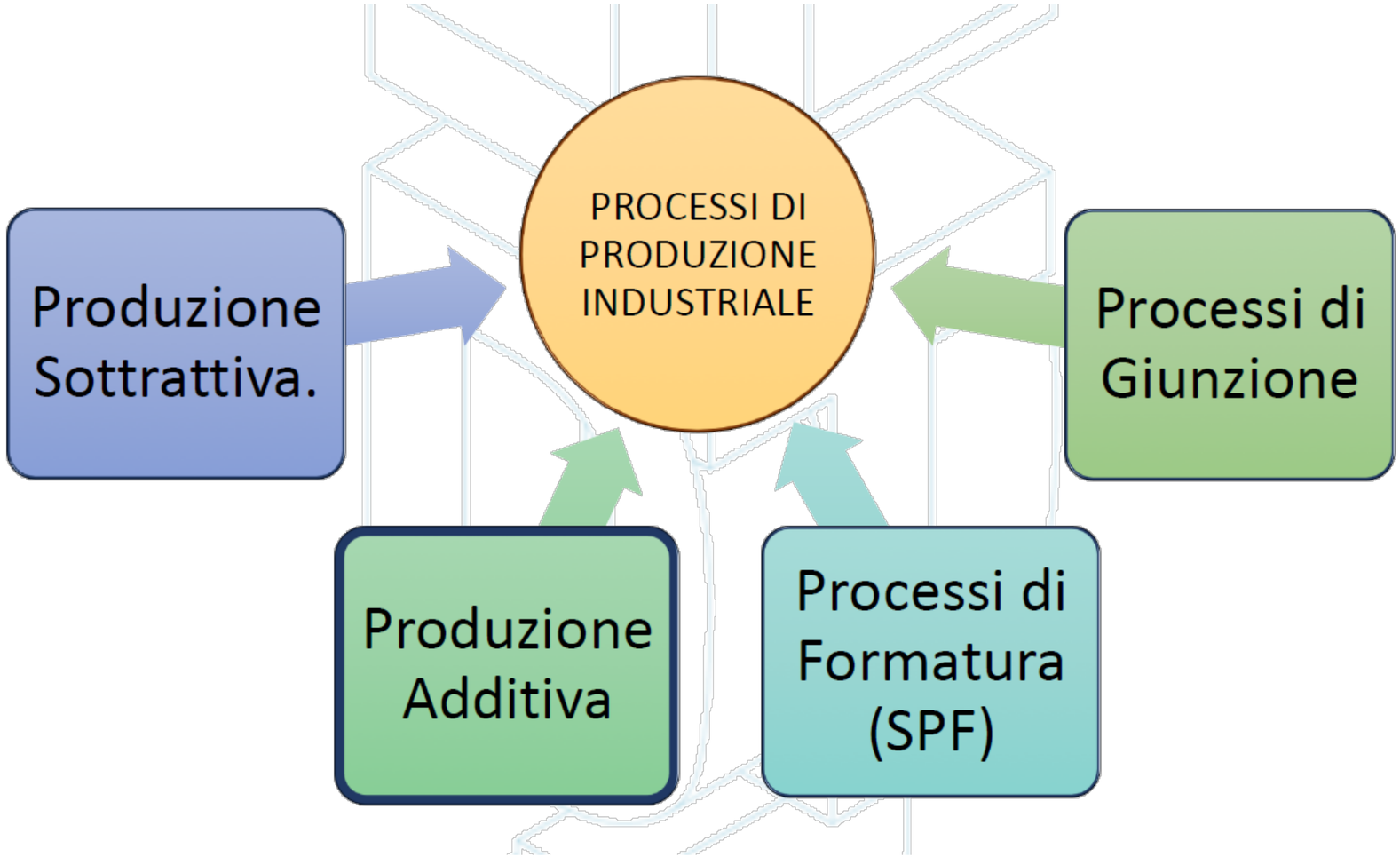
6

ECONOMIA

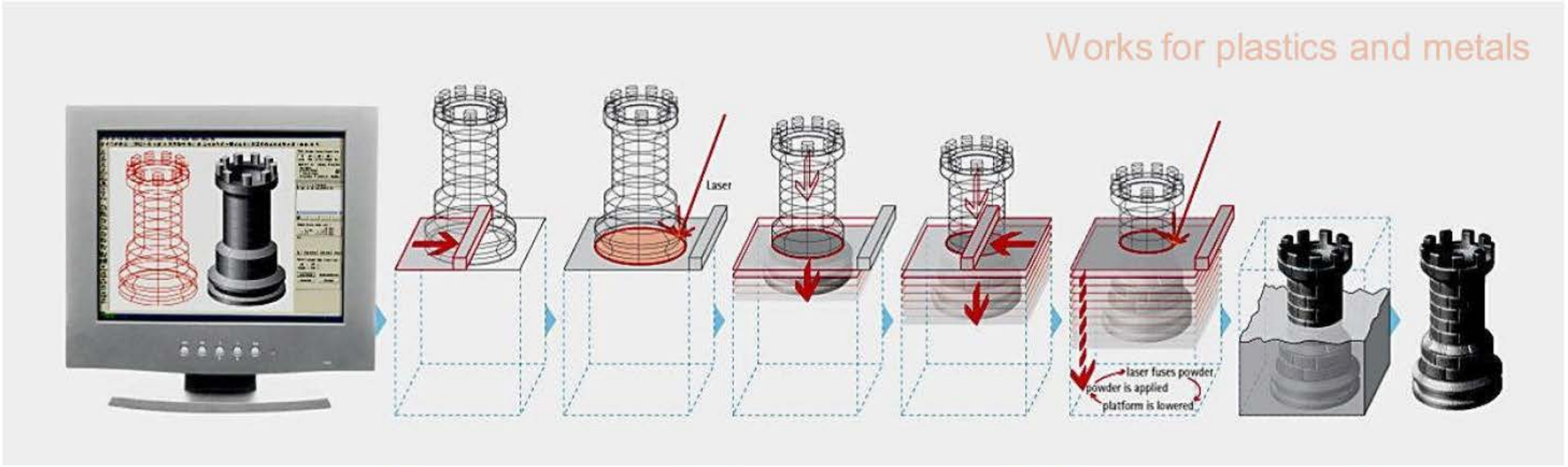
7

Designed by Simone Ravaglia
AMPC issue 0/2020

Che cosè l’additive manufacturing/stampa 3D?



Come funziona la stampa 3D?



From a 3D CAD model…

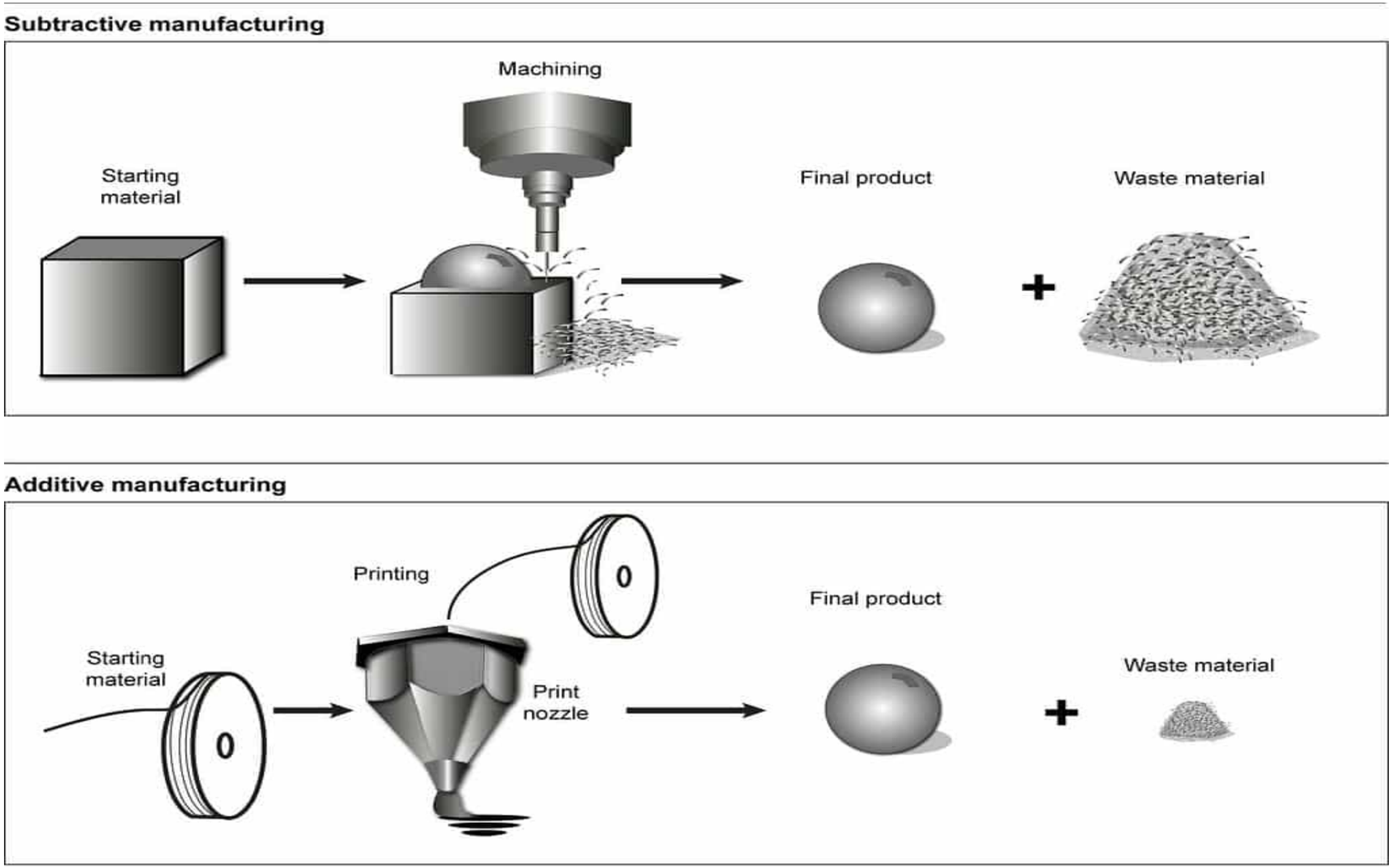
- Application of powder
- Exposure by Laser

- Lowering of platform
- Re-application of powder

- Exposure by Laser

… to complete parts

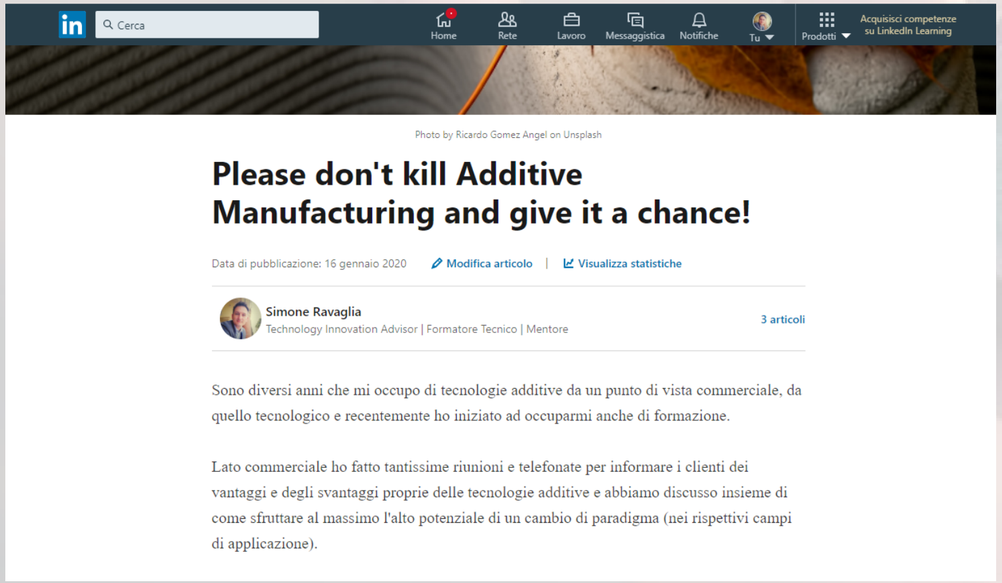
Produzione sottrattiva – Produzione additiva



Perché un altro Canvas?

Per fare ordine!

L’ordine allontana il dubbio e facilita l’apprendimento delle tecniche.
Ci permette di fare strategia e avere visione.



“La sfida della stampa 3D è il cambiamento culturale delle PMI italiane.”
Massimo Temporelli

Barriere all’adozione (nelle PMI)

Che cosa è possible fare con questa tecnologia?

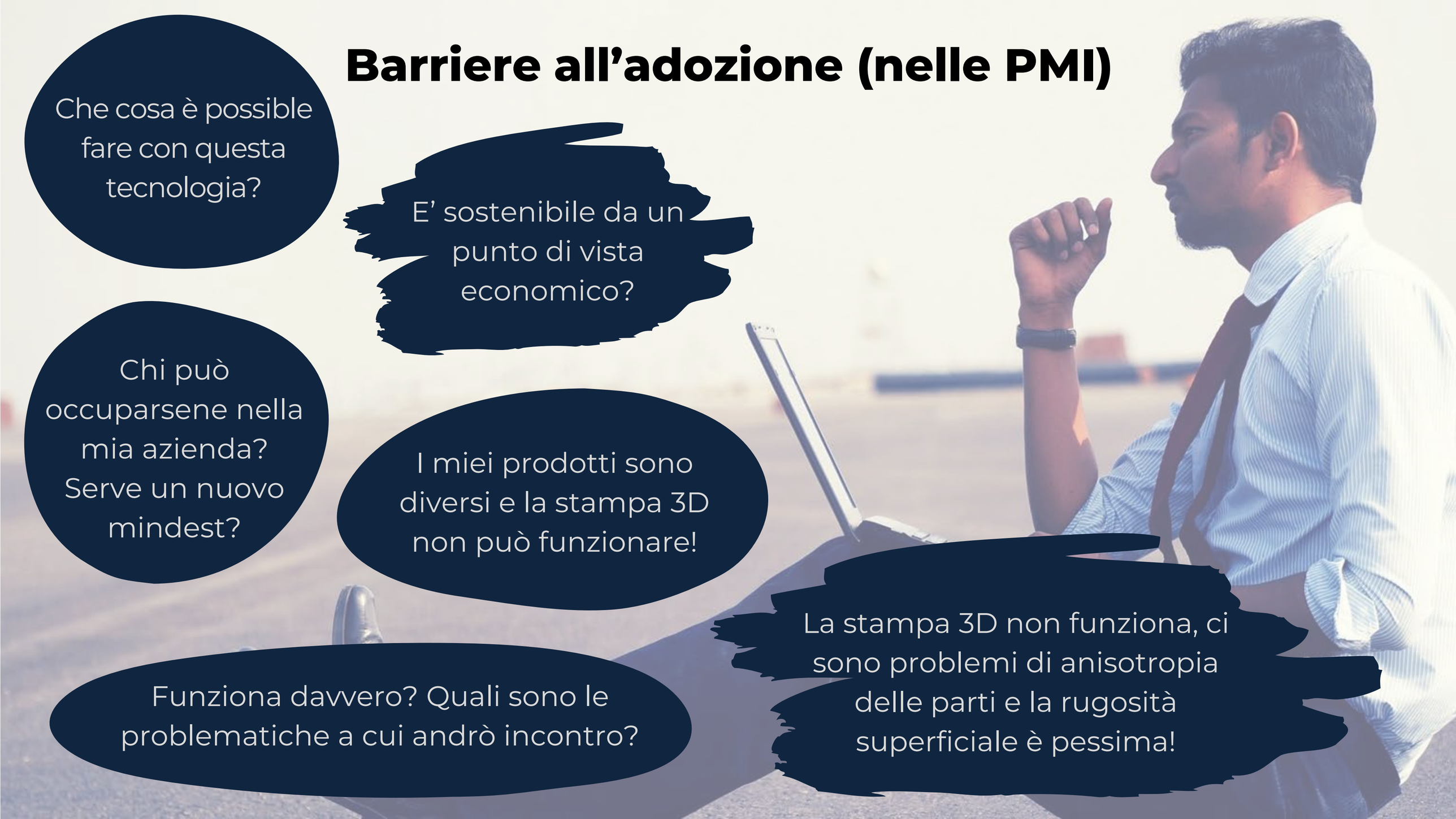
E’ sostenibile da un punto di vista economico?

Chi può occuparsene nella mia azienda? Serve un nuovo mindest?

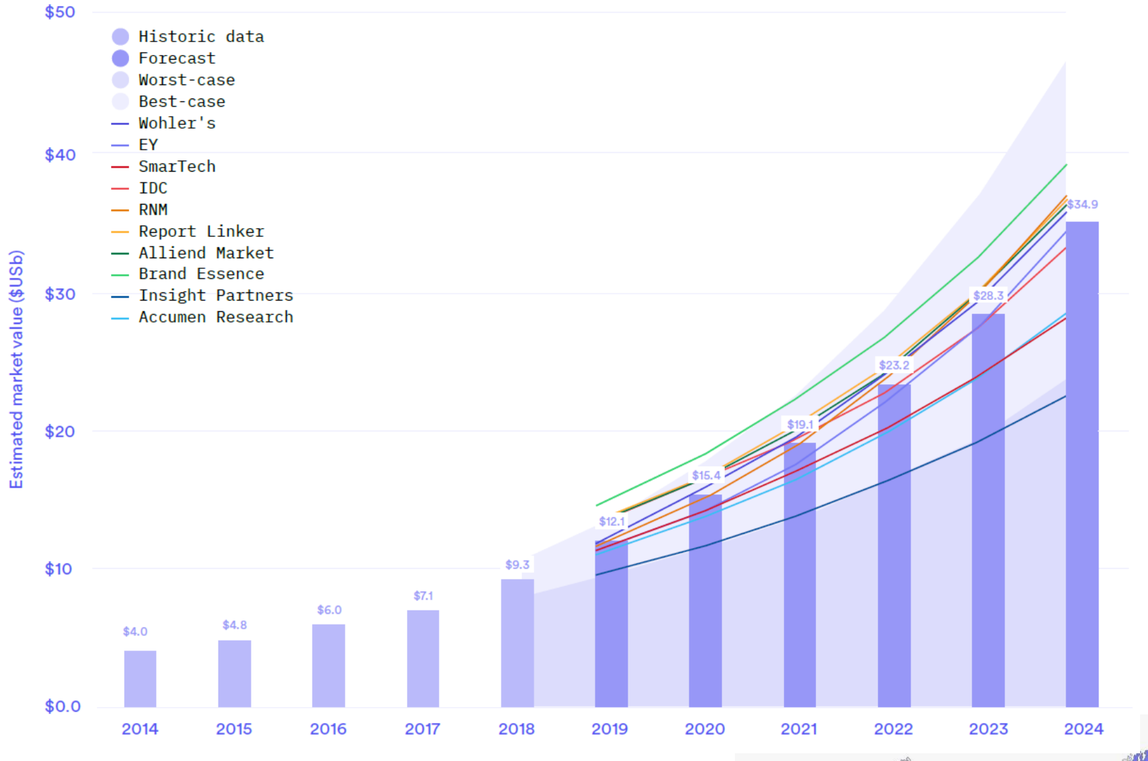
I miei prodotti sono diversi e la stampa 3D non può funzionare!

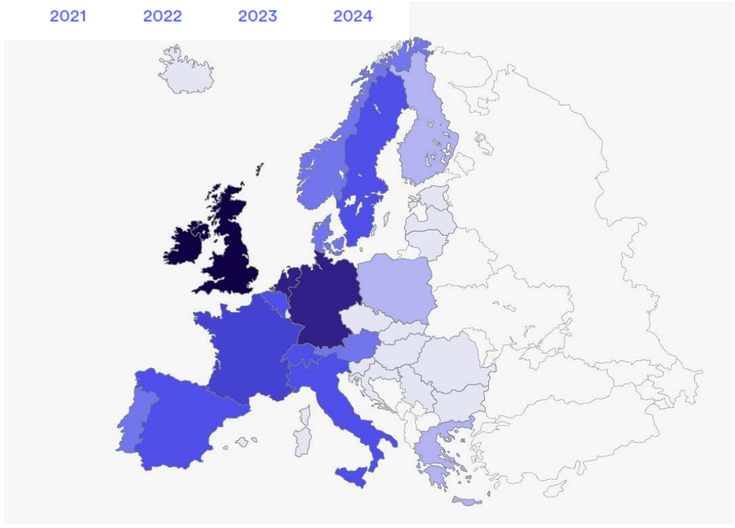
La stampa 3D non funziona, ci sono problemi di anisotropia delle parti e la rugosità superficiale è pessima!

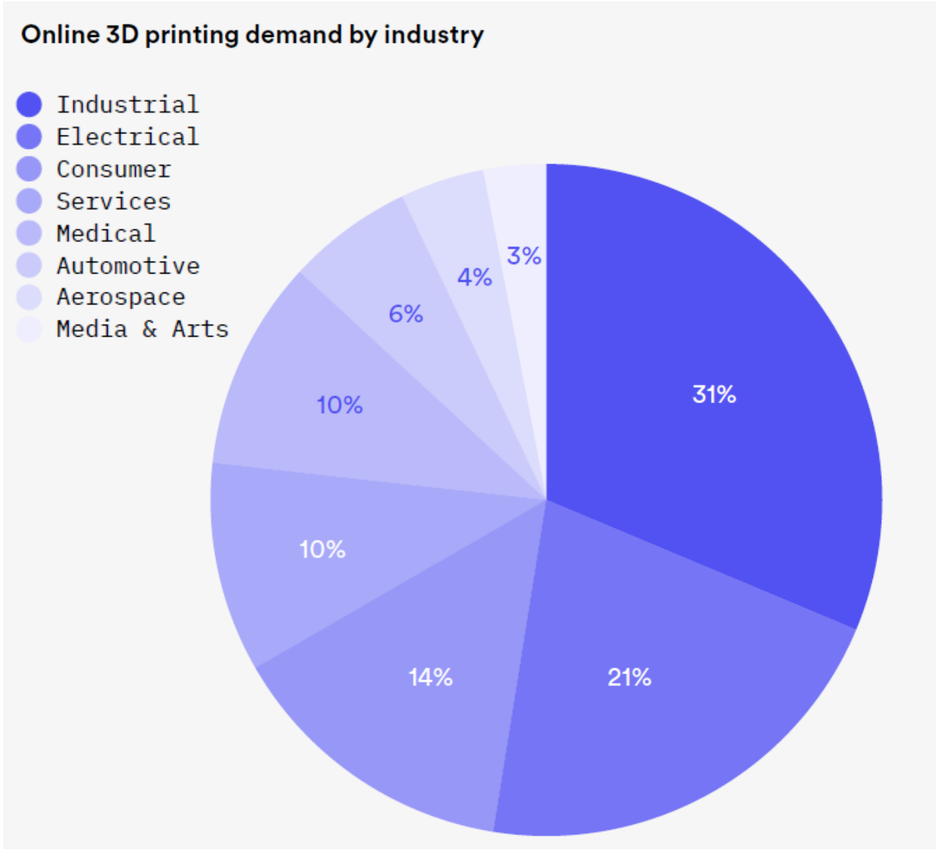
Funziona davvero? Quali sono le problematiche a cui andrò incontro?



Additive Manufacturing: mercato

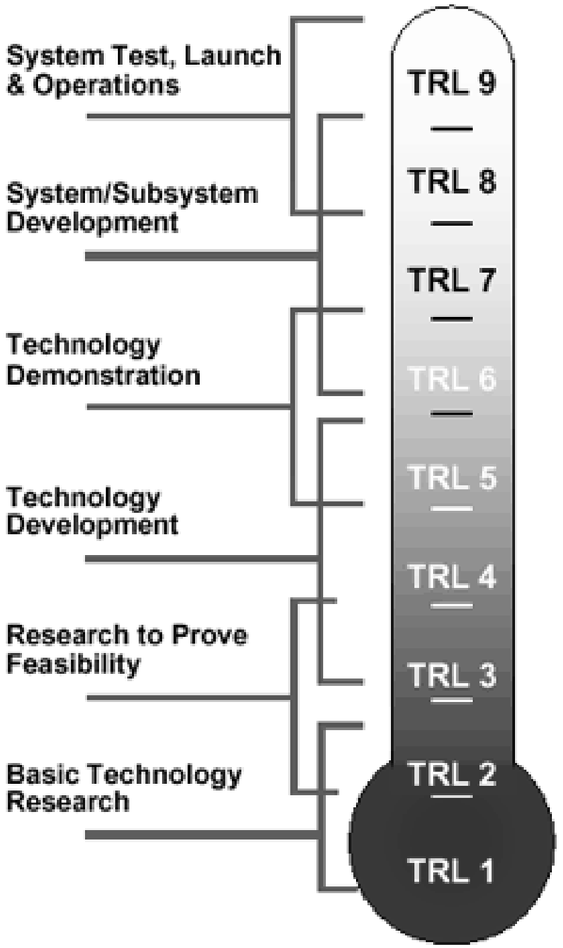


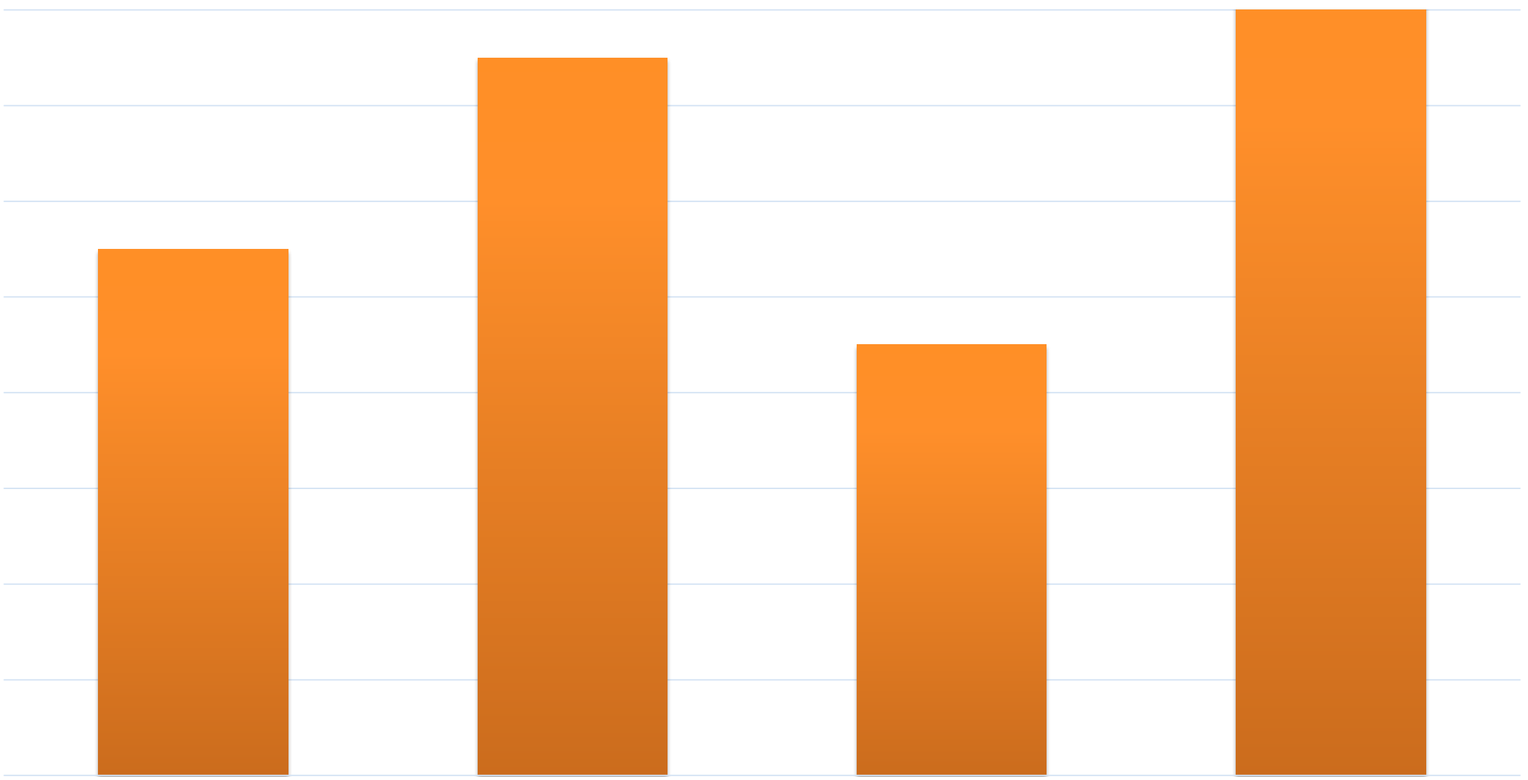




Fonte: 3DHubs 2020

Manufacturing readiness level





AEROSPACE	TOOLING	AUTOMOTIVE	MEDICAL
Iniettori	Inserti per stampi	Condotti aria	Impianti dentali
Elementi strutturali		Componenti F1	Protesi
Palette turbine			Strumenti

Fonte: Roland Berger


THEN
NOW

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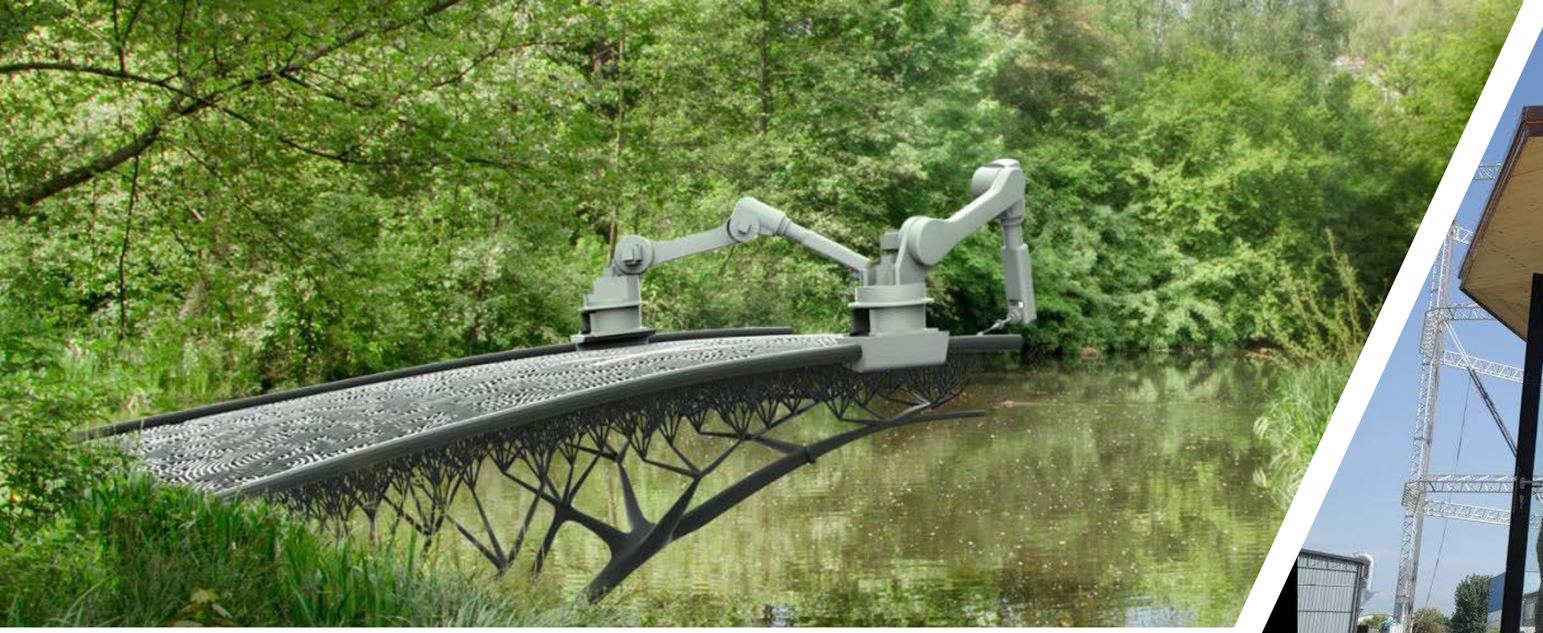
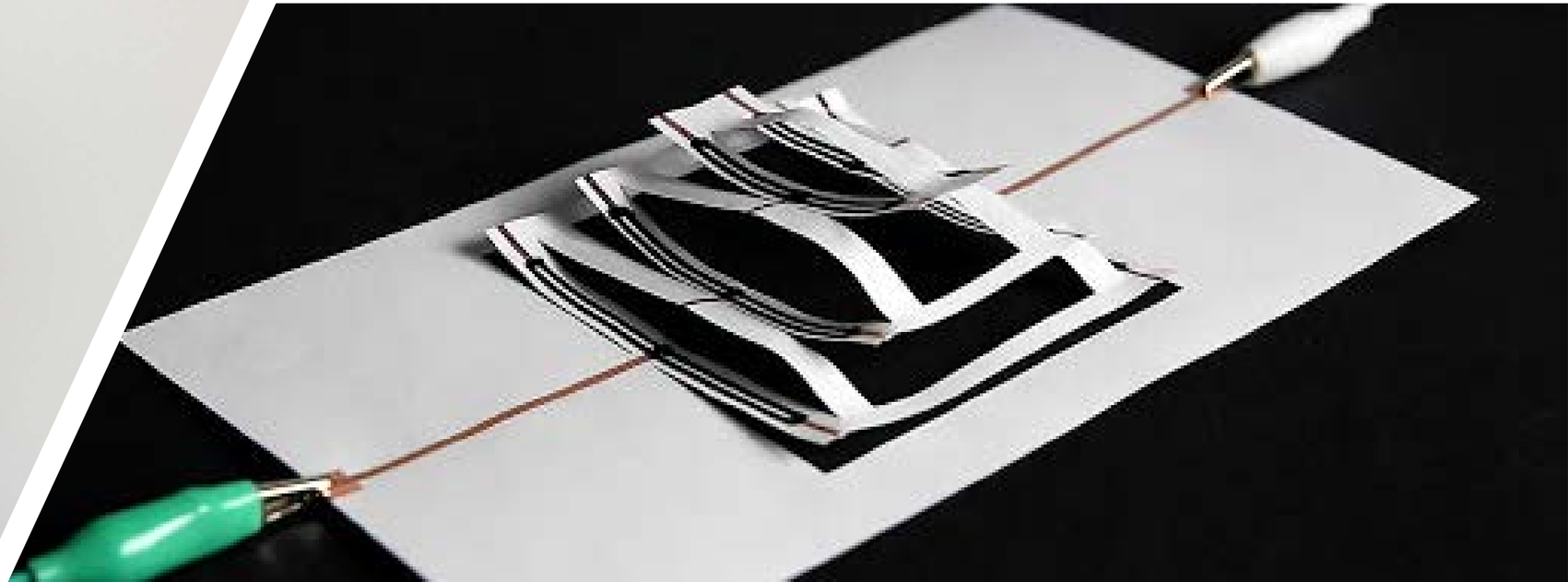
AMPC issue 0/2020

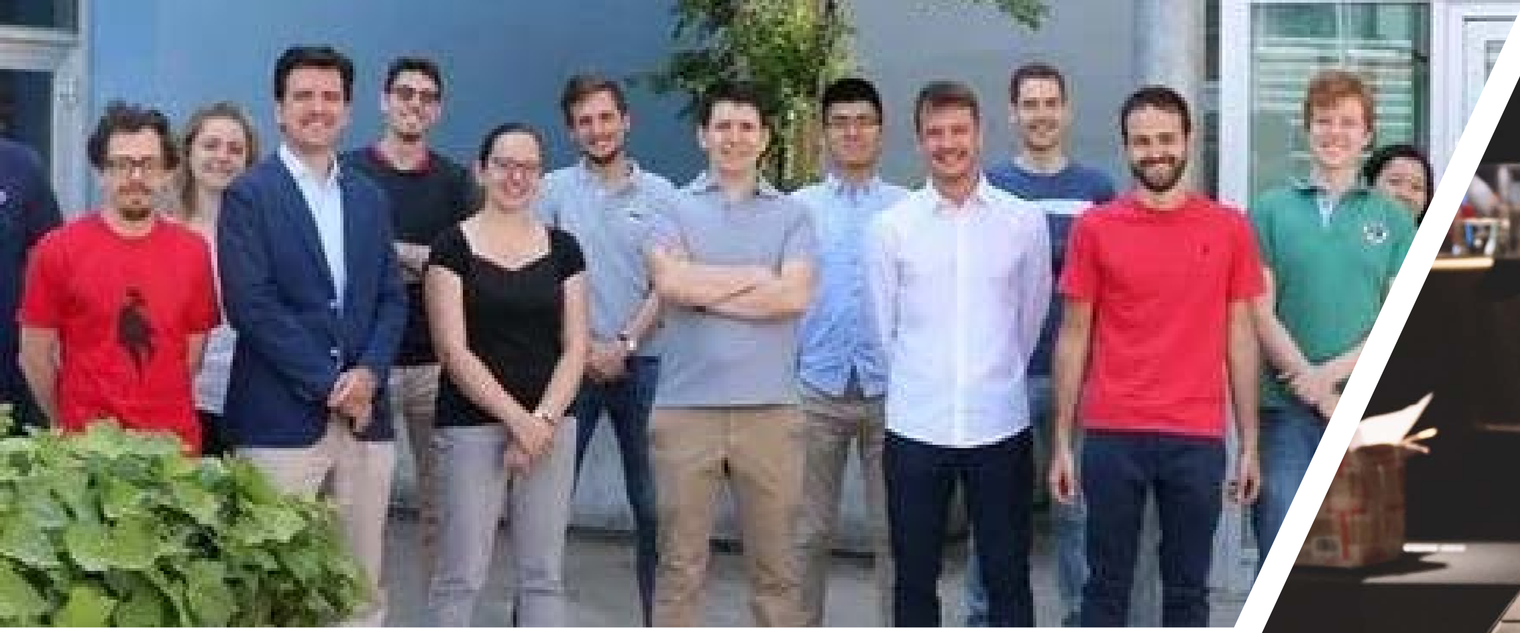
DESIDERIO (Io voglio)

<u>Le regole del quadrante ZERO:</u>

1) Non porti dei limiti
2) Trova ispirazione da progetti anche di altri settori (fatti contaminare!)
3) Prendi in esame parti o assiemi di parti
4) Descrivi il tuo progetto partendo da “Io voglio”
5) Fai uno schizzo a mano che rappresenti graficamente la tua idea



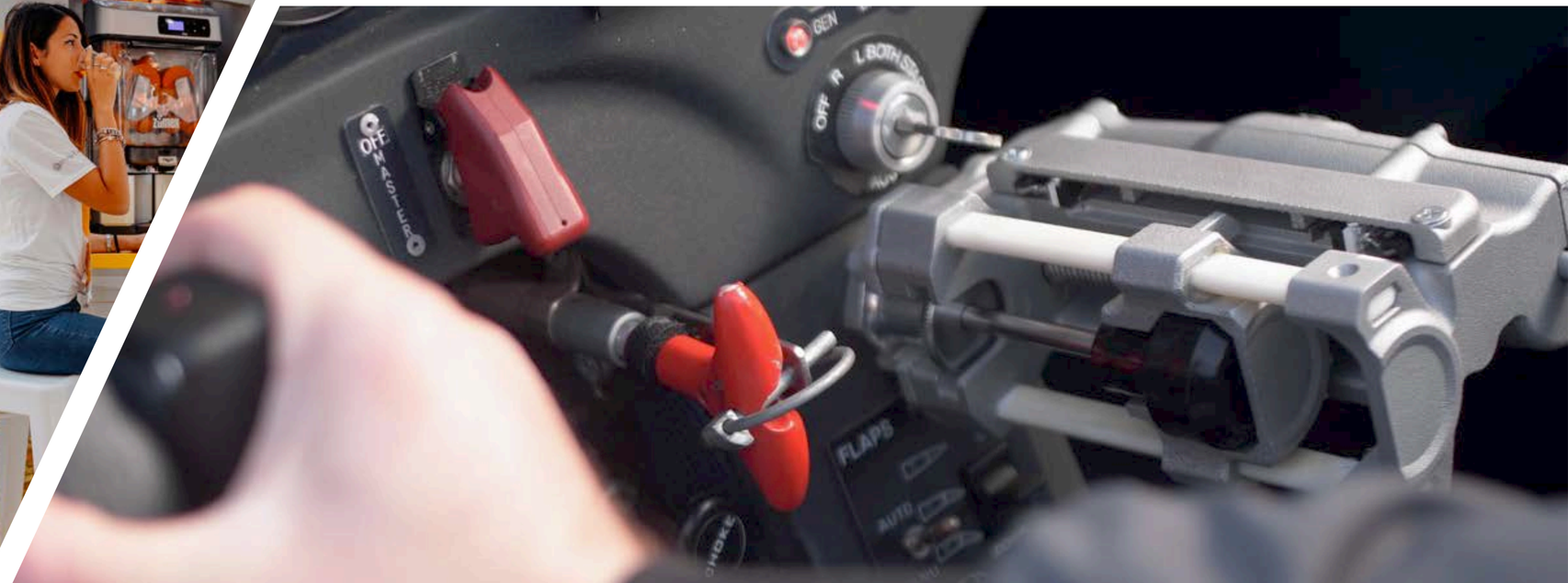





Barilla


NACQUE
IL TUO NOME


CircularEni


FLAPS

DRIVER DI PROGETTAZIONE

01 Riduzione del numero di parti

02 Riduzione peso

03 Riduzione Lead Time

04 Migliore resistenza meccanica

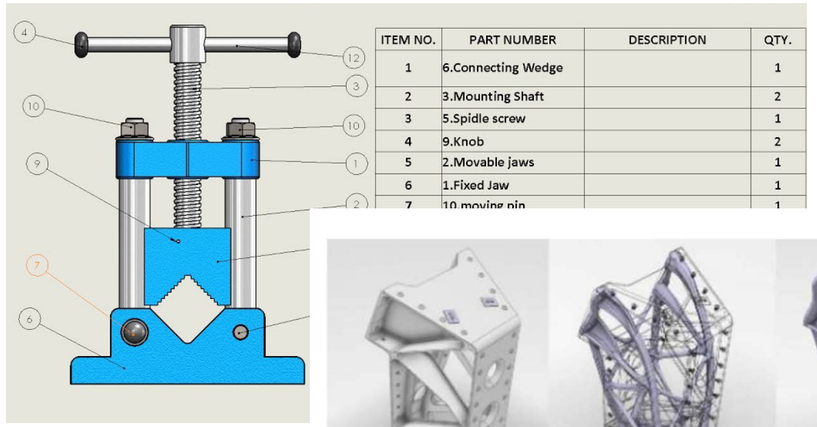
05 Migliore fluidodiamica

06 Migliore performance termica

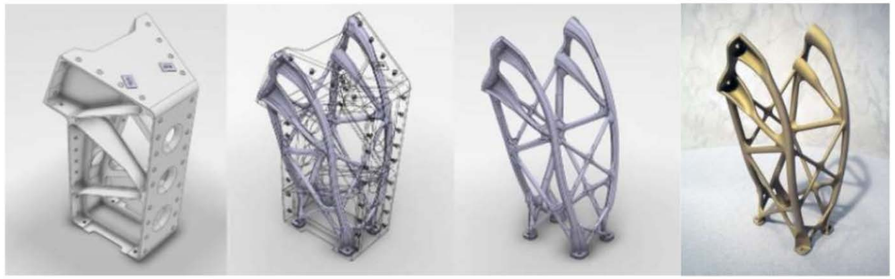
07 Design personalizzato

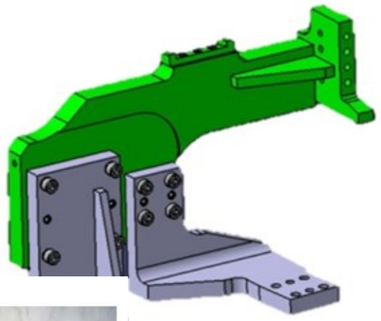
01 Riduzione del numero di parti

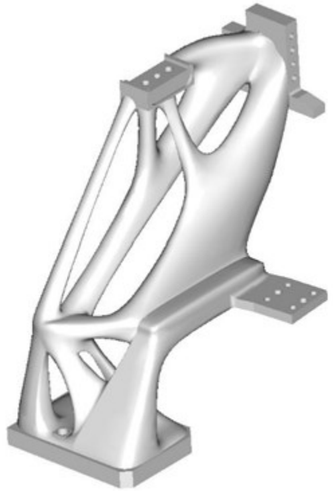
- Punto di partenza: Distinta Base o Lista dei componenti (Bill of Material)
- Isolare i componenti principali da quelli secondari (Tecniche di Design for Assembly)
- Integrare i componenti



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	6.Connecting Wedge		1
2	3.Mounting Shaft		2
3	5.Spidle screw		1
4	9.Knob		2
5	2.Movable jaws		1
6	1.Fixed Jaw		1
7	10.moving pin		1

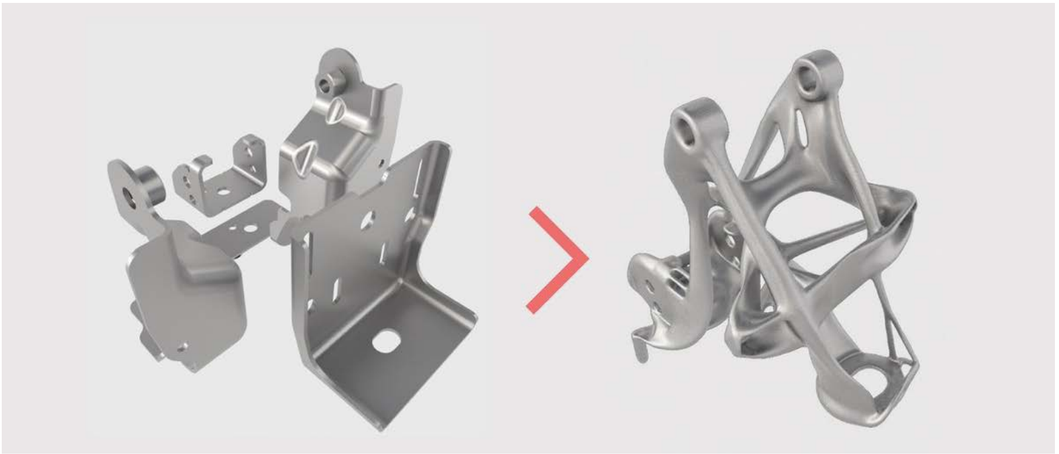






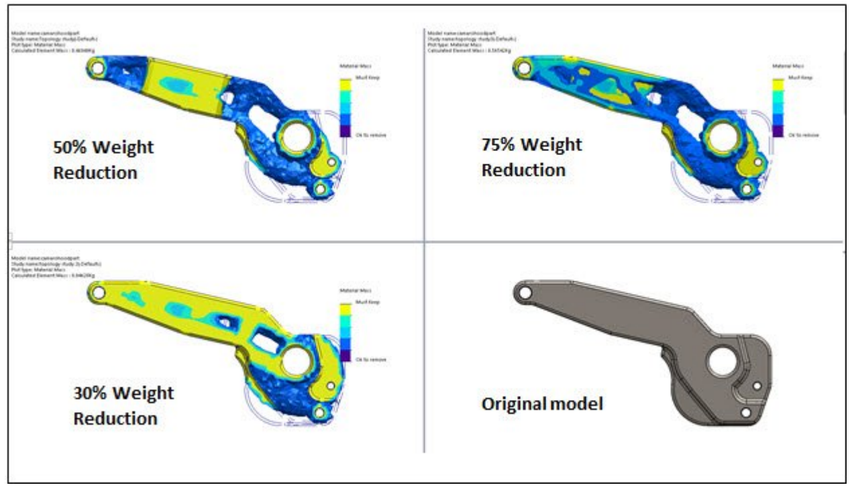
Airbus Defense and Space 3D printed a space-qualified satellite bracket. The team was able to transform a bracket made up of four main parts and 44 rivets into a single, laser-melted piece that is 40% stiffer and 35% lighter than its predecessor.

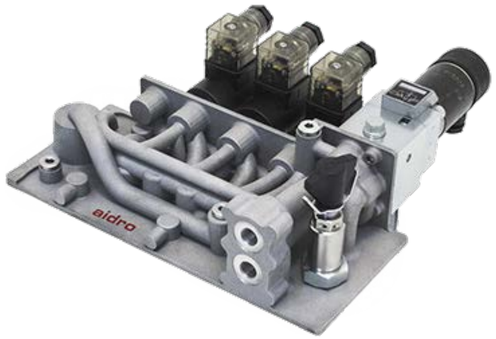
<u>Se un oggetto non ha altre funzioni che quelle di collegare/assicurare altre parti, allora è sempre teoricamente possibile eliminarlo.</u>



02 Riduzione peso

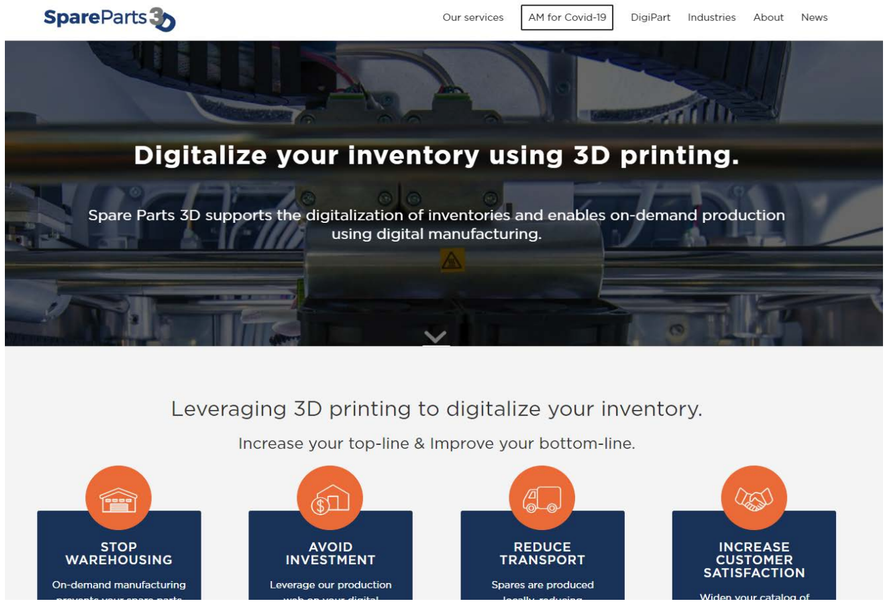
- Togliere il materiale non necessario
- Utilizzare materiali diversi (in alcuni casi materiali con prestazioni elevate hanno costi simili a quelli «poveri»)





03 Riduzione lead time

- Componenti di ricambio con lunghi tempi di produzione



04 Migliore resistenza meccanica

- Utilizzare materiali diversi (in alcuni casi materiali con prestazioni elevate hanno costi simili a quelli «poveri»)
- In alcuni casi lo stesso materiale ha proprietà meccaniche migliori
- Aggiungere features per migliorare la resistenza meccanica

Mechanical Properties

The following table shows mechanical properties of grade 5 Ti-6Al-4V alloy.

Properties	Metric	Imperial
Tensile strength	≥ 895 MPa	≥ 130000 psi
Yield strength	≥ 828 MPa	≥ 120000 psi
Poisson's ratio	0.31	0.31
Elastic modulus	105-120 GPa	15200-17400 ksi
Shear modulus	41-45 GPa	5950-6530 ksi
Elongation at break	≥ 10 %	≥ 10 %

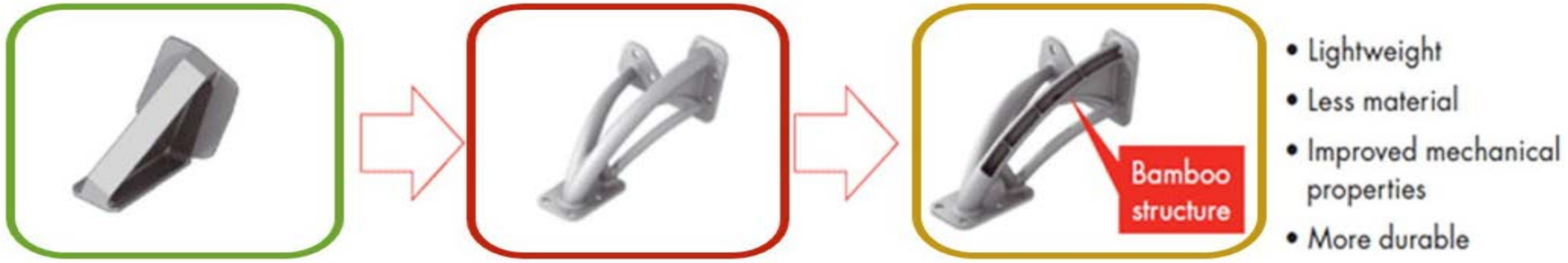
TITANIUM Gr.5

+ 15%

Tensile data at room temperature [7,9]

	Heat treated [8]	
	Horizontal	Vertical
Ultimate tensile strength, Rm	1070 MPa	1080 MPa
Yield strength, Rp0.2	955 MPa	990 MPa
Elongation at break, A [10]	13 %	15 %

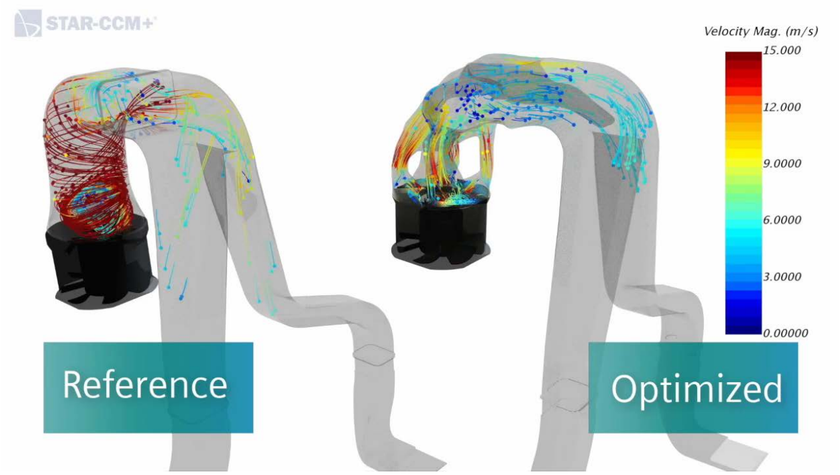
[7] Tensile testing according to ISO 6892-1 A14, proportional test pieces, diameter of the neck area 5 mm, original gauge length 20 mm.
[8] Heat treatment procedure: Specimens were heat treated at 800 °C for 2 hours in argon inert atmosphere.
[9] The numbers are average values determined from samples with horizontal and vertical orientation respectively
[10] Values are averaged and subject to variations depending on process conditions.

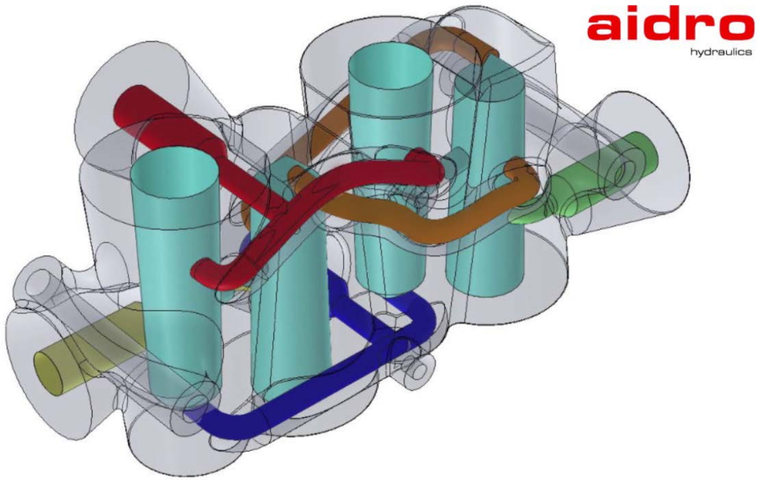


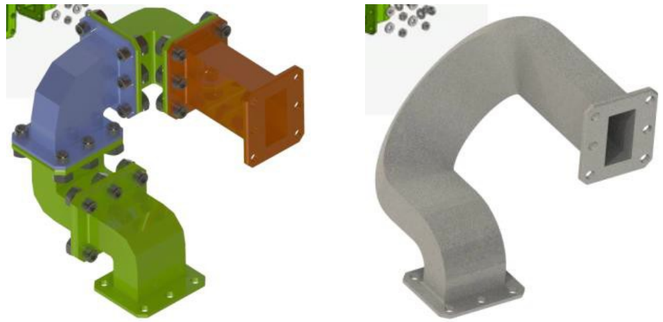
05

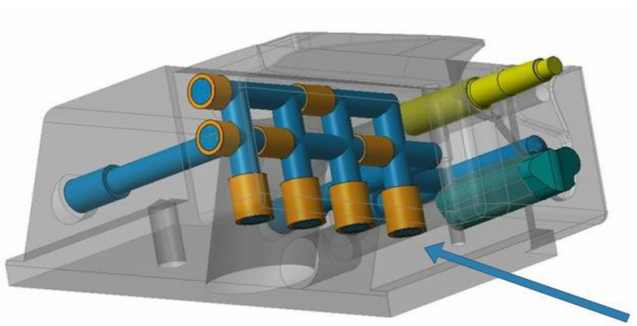
Migliore fluidodinamica

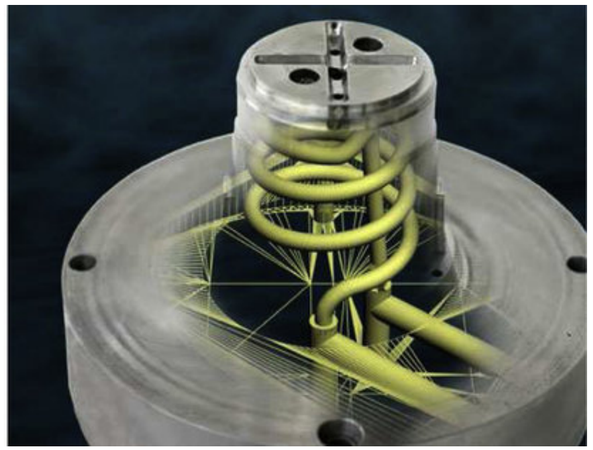
- Posso creare geometrie per migliorare il percorso e la circolazione dei flussi

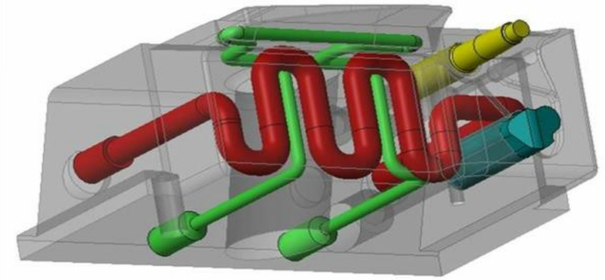






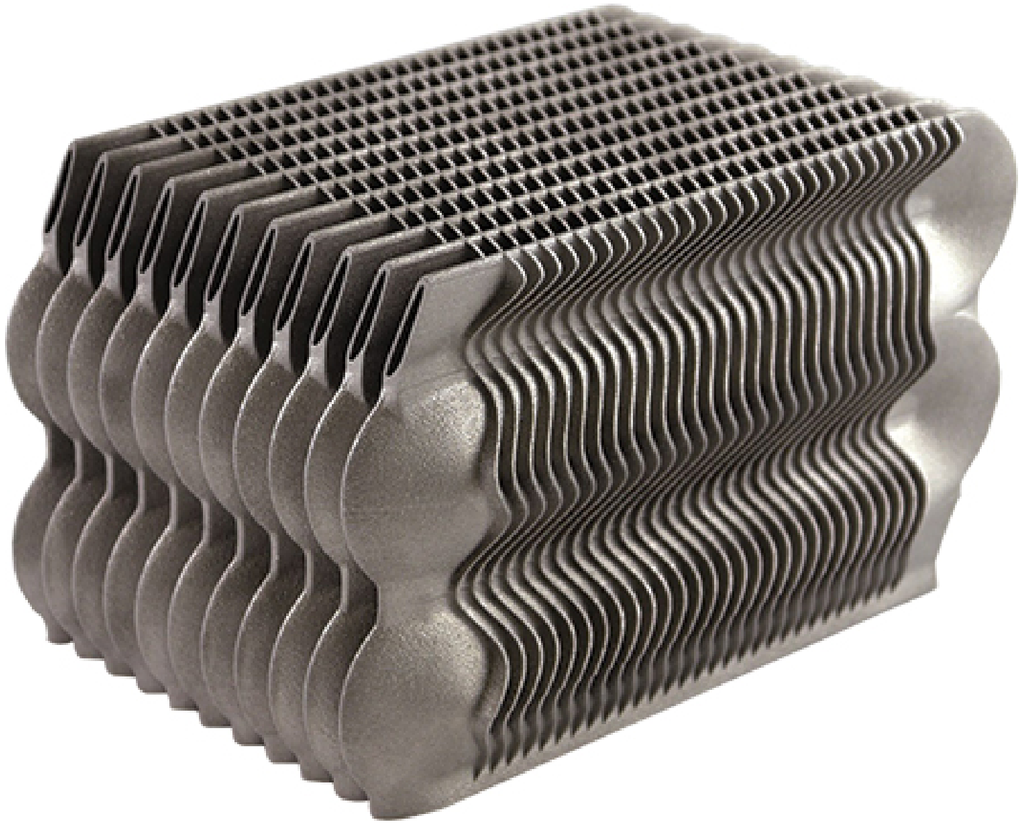






06 Migliore performance termica

- La finitura superficiale può facilitare lo scambio termico
- Posso creare features per migliorare lo scambio termico



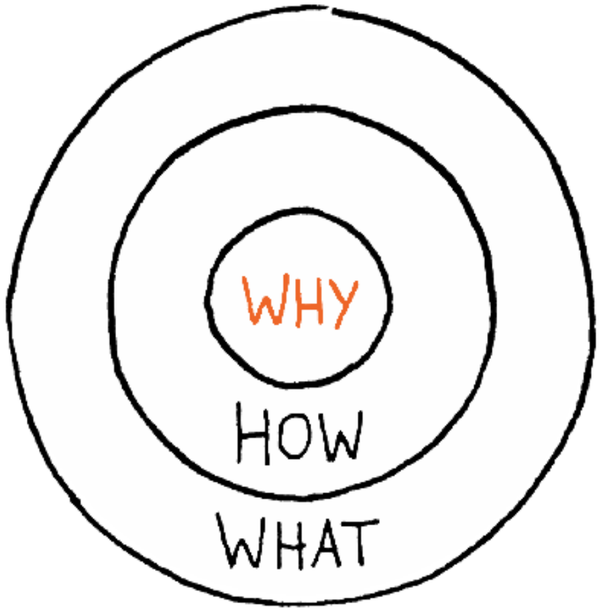
07 Design personalizzato

- Posso personalizzare ogni singolo prodotto

IL DRIVER È IL TUO PERCHÈ!

01 Scegli uno o più vantaggi

02 Assegna un indicatore che utilizzerai a fine progetto



MATERIALE

01 POLIMERI

02 METALLI

03 COMPOSITI

MATERIALE: SCELTA, VINCOLI E LIBERTA’

Economicità

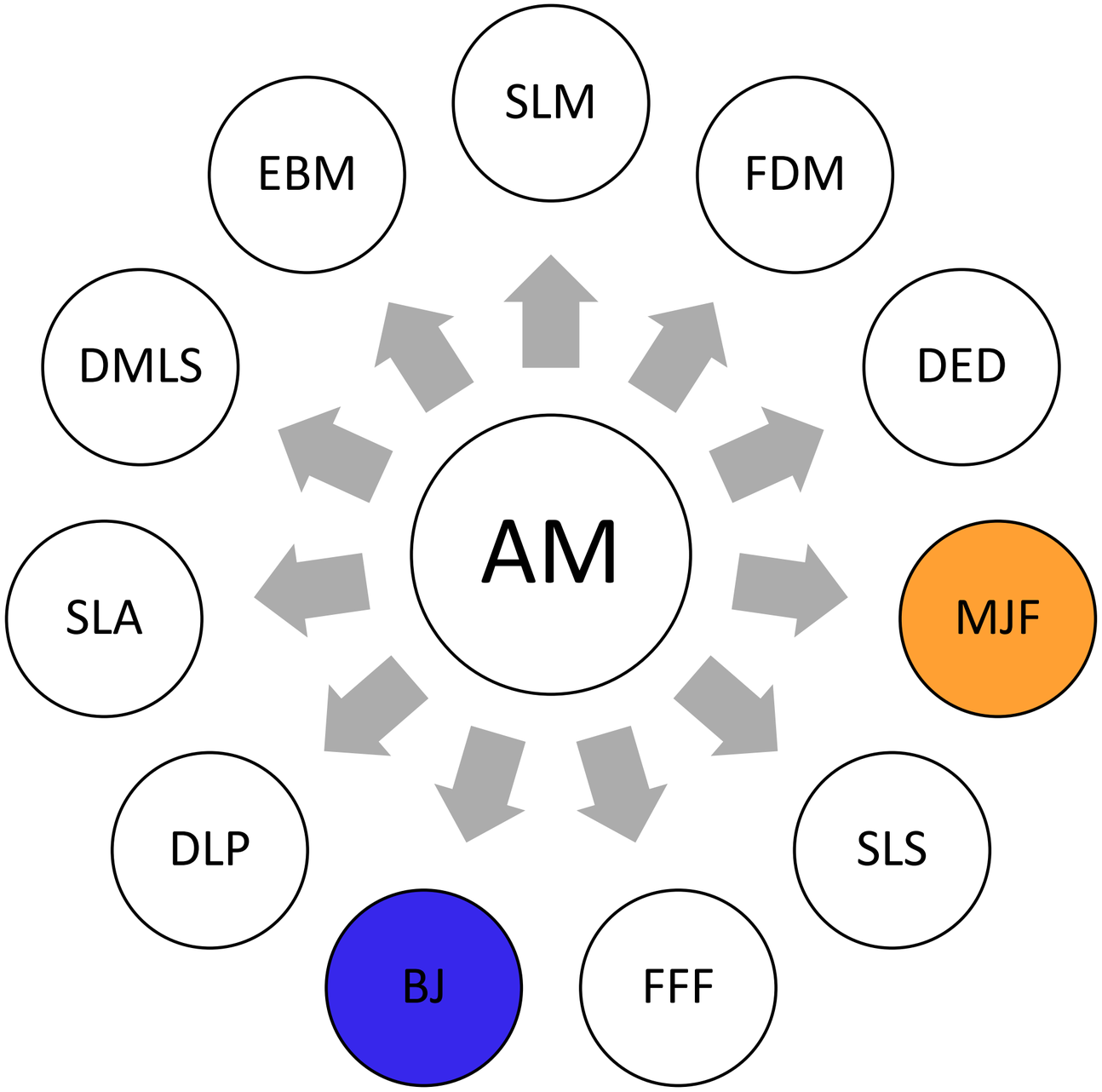
Proprietà

Disponibilità

TECNOLOGIE

TECNOLOGIE

3



ADDITIVE MANUFACTURING TECHNOLOGIES

Find out more at **www.3dhubs.com/what-is-3d-printing**

3D HUBS

SERVICE DI STAMPA 3D

shapeways

BEAMIT
metal additive manufacturing

i.materialise
more than online 3D printing services

Weerg.

ZARE

PRINTELIZE
ONLINE 3D PRINTING

3DVOXEL

3D HUBS

ADDITIVA
DESIGN ENGINEERING MANUFACTURING

PROGETTAZIONE

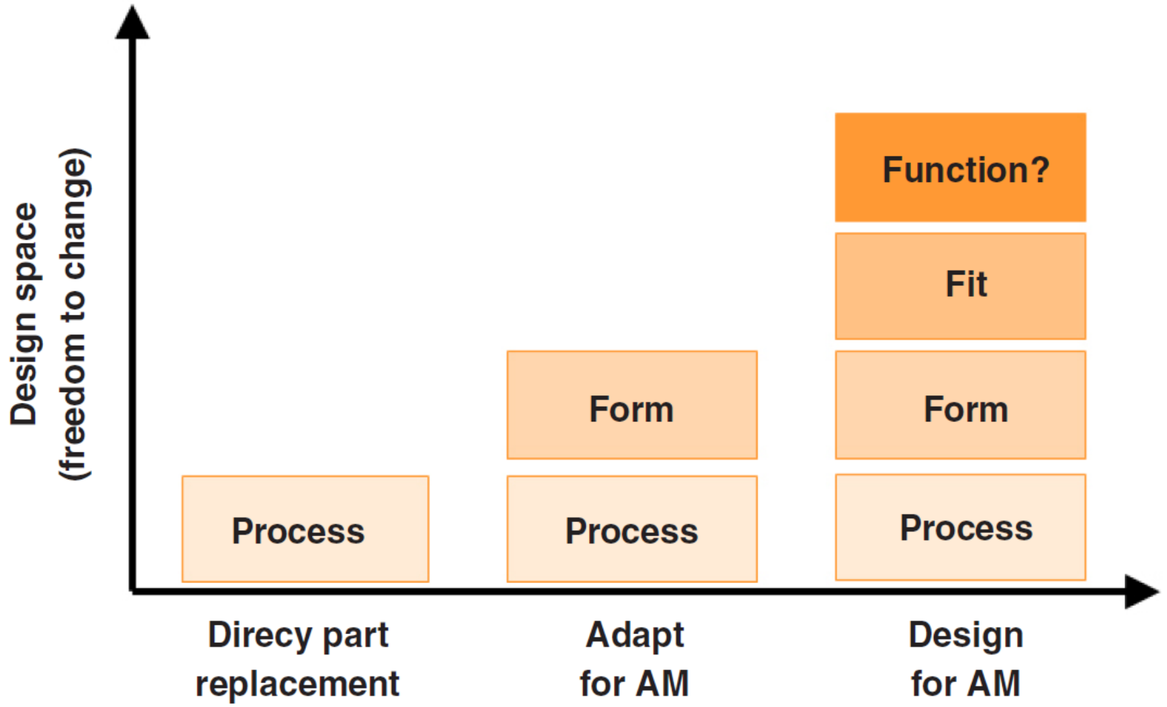
PROGETTAZIONE

4

DFAM o AfAM?

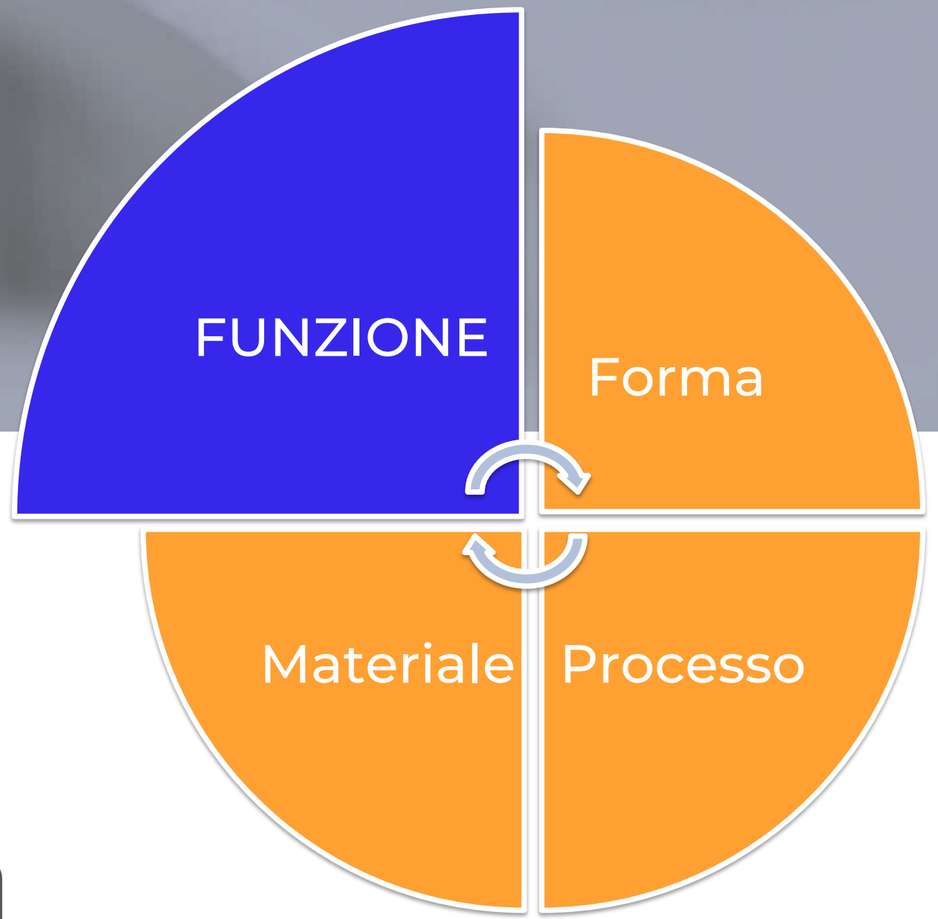
(Design for AM o Adapt for AM?)

Quanta libertà ho per approcciare ad un cambio di paradigma?



Source: Renishaw

DfAM
Design for Function



Data set (requisiti per iniziare)

- Dati relativi ai materiali (proprietà fisiche e meccaniche)
- Requisiti di progettazione (Funzionalità, Tolleranze, rugosità superficiale,...)
- Vincoli di progettazione (Design space & Superfici o Aree Funzionali)
- Informazioni sulla funzionalità della parte o dell’assieme
- Carichi e vincoli

DfAM TOOLS

01 ANALOGICI

02 DIGITALI

01 ANALOGICI

Design for Additive Manufacturing

A quick method for reducing the number of printing and prototyping failures, by Joran Booth
Instructions: Mark one for each category for the part you plan to print. Check daggers and stars first, then scores

Mark One	Complexity (Simple parts are inefficient for AM)	Mark One	Functionality (AM parts are light and medium duty)	Mark One	Material Removal (Support structures ruin surface finish)	Mark One	Unsupported Features (Unsupported features will droop)	Sum Across Rows	Totals
†○	The part is the same shape as common stock materials, or is completely 2D	*○	Mating surfaces are bearing surfaces, or are expected to endure for 1000+ of cycles	○	The part is smaller than or the same size as the required support structure	○	There are long, unsupported features	x5 =	
*○	The part is mostly 2D and can be made in a mill or lathe without repositioning it in the clamp	*○	Mating surfaces move significantly, experience large forces, or must endure 100-1000 cycles.	○	There are small gaps that will require support structures	○	There are short, unsupported features	x4 =	
○	The part can be made in a mill or lathe, but only after repositioning it in the clamp at least once	○	Mating surfaces move somewhat, experience moderate forces, or are expected to last 10-100 cycles	○	Internal cavities, channels, or holes do not have openings for removing materials	○	Overhang features have a sloped supp		
○	The part curvature is complex (splines or arcs) for a machining operation such as a mill or lathe	○	Mating surfaces will move minimally, experience low forces, or are intended to endure 2-10 cycles	○	Material can be easily removed from internal cavities, channels, or holes	○	Overhanging minimum of		
○	There are interior features or surface curvature is too complex to be machined	○	Surfaces are purely non-functional or experience virtually no cycles	○	There are no internal cavities, channels, or holes	○	Part is orient overhanging		

Mark One	Thin Features (Thin features will almost always break)	Mark One	Stress Concentration (Interior corners must transition gradually)	Mark One	Tolerances (Mating parts should not be the same size)	Mark One	Geometri (Large, flat areas
○	Some walls are less than 1/16" (1.5mm) thick	○	Interior corners have no chamfer, fillet, or rib	○	Hole or length dimensions are nominal	○	The part has or has a form be exact
○	Walls are between 1/16" (1.5mm) and 1/8" (3mm) thick	○	Interior corners have chamfers, fillets, and/or ribs	○	Hole or length tolerances are adjusted for shrinkage or fit	○	The part has surfaces, or t should be clo
○	Walls are more than 1/8" (3mm) thick	○	Interior corners have generous chamfers, fillets, and/or ribs	○	Hole and length tolerances are considered or are not important	○	The part has surfaces, or t be exact

Starred Ratings
* Consider a different manufacturing process
† Strongly consider a different manufacturing process

Total Score
33-40 Needs redes
24-32 Consider red
16-23 Moderate lik
8-15 Higher likelih

REID C DESIGN LAB

Build Volume: *350x350x420mm*

Advantages
Self-supporting, no support required
High strength parts
Chemical resistance
Biocompatible
Accurate to CAD
Fast build times - No tooling costs
Complex geometries possible

Drawbacks
Rough surface finish
Limited material choice
Low resolution so loss of fine details
Warping

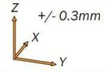
Pins *- standard tolerance is +/- 0.3mm so any features with dimensions below this are unlikely to be printed without issue. So pins should be designed ≥ 0.8mm.*

Tips & Tricks *- hollow parts out with escape holes for trapped materials. Anneal living hinges by dipping in boiling water and work back and forth.*

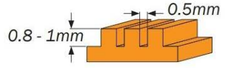
Surface Finishes
Sand blasting
Polishing
Painting
Dying

Materials
PA 12
PA 12 + GF
PA 11
PA 6

Tolerances
+/- 0.3mm is standard.

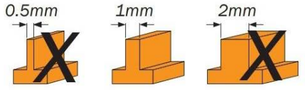


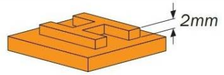
Slots *- effected by depth or thickness of the wall, ≥ 0.5mm is minimum but will fail to print if the depth or wall thickness is over 2mm.*



0.8mm – 1mm is preferred.

Walls *- thicker walls are at risk of warpage. Thin walls can also be a problem area. 0.7mm minimum, but 1mm is preferred.*





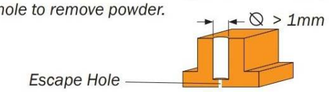
Text *- sans serif such as Arial with a minimum font height of 2mm. Embossed text: > 1mm high. Engraved features: > 1mm deep.*

Mating (axels, gears)
> 0.5mm and < 1mm gaps prevent fusion.

Min Clearance
> 0.5mm

Max Clearance
< 1.0mm

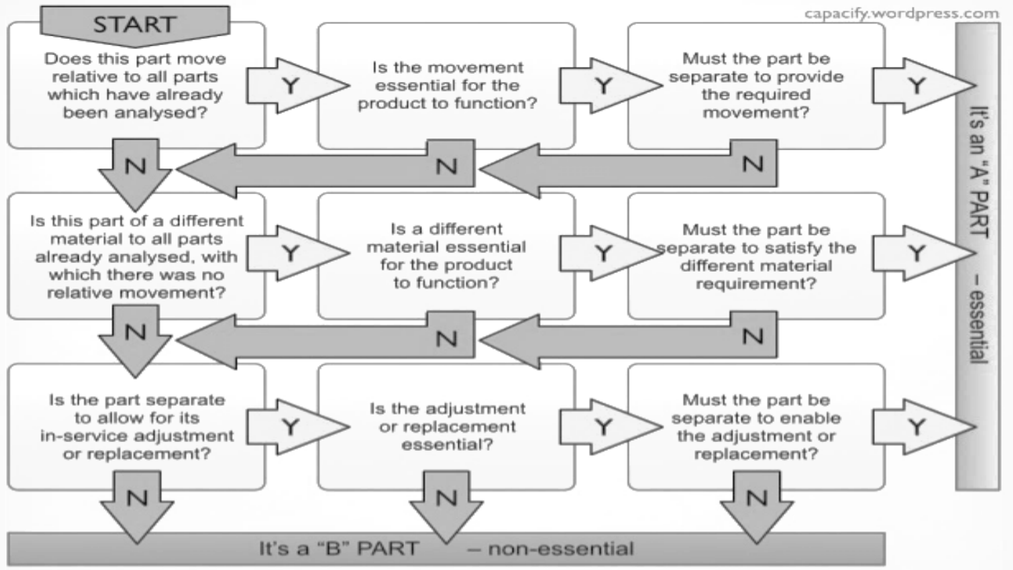
Holes *- the deeper the hole the larger the diameter needed. All holes should be ≥ 1mm. Blind holes should be designed with an escape hole to remove powder.*



DESIGN RULES FOR 3D PRINTING

3D HUBS

	Supported Walls	Unsupported Walls	Support & Overhangs	Embossed & Engraved Details	Horizontal Bridges	Holes	Connecting /Moving Parts	Escape Holes	Minimum Features	Pin Diameter	Tolerance
	Walls that are connected to the rest of the print on at least two sides.	Unsupported walls are connected to the rest of the print on less than two sides.	The maximum angle a wall can be printed at without requiring support.	Features on the model that are raised or recessed below the model surface.	The span a technology can print without the need for support.	The minimum diameter a technology can successfully print a hole.	The recommended clearance between two moving or connecting parts.	The minimum diameter of escape holes to allow for the removal of build material.	The recommended minimum size of a feature to ensure it will not fail to print.	The minimum diameter a pin can be printed at.	The expected tolerance (dimensional accuracy) of a specific technology.
Fused Deposition Modeling	0.8 mm	0.8 mm	45°	0.6 mm wide & 2 mm high	10 mm	Ø2 mm	0.5 mm		2 mm	3 mm	±0.5% (lower limit ±0.5 mm)
Stereo-lithography	0.5 mm	1 mm	support always required	0.4 mm wide & high		Ø0.5 mm	0.5 mm	4 mm	0.2 mm	0.5 mm	±0.5% (lower limit ±0.15 mm)
	0.7 mm			1 mm wide & high		Ø1.5 mm	0.3 mm for moving parts & 0.1 mm for connections	5 mm	0.8 mm	0.8 mm	±0.3% (lower limit ±0.3 mm)
	1 mm	1 mm	support always required	0.5 mm wide & high		Ø0.5 mm	0.2 mm		0.5 mm	0.5 mm	±0.1 mm
	2 mm	3 mm		0.5 mm wide & high		Ø1.5 mm		5 mm	2 mm	2 mm	±0.2 mm for metal & ±0.3 mm for sand
	0.4										



02 DIGITALI

MODELLAZIONE (CAD)

- SOLIDWORKS
- CATIA
- CREO
- NX
- SOLIDEDGE
- INVENTOR
- AUTODESK FUSION360

OTTIMIZZAZIONE

- AUTODESK FUSION360
- ALTAIR HYPERWORKS
- WITHIN MEDICAL

SIMULAZIONE (FEM, CFD)

- ANSYS
- COMSOL
- SOLIDWORKS
- SOLIDWORKS
- AUTODESK NETFABB
- WITHIN MEDICAL
- ESI VIRTUAL
- SIEMENS

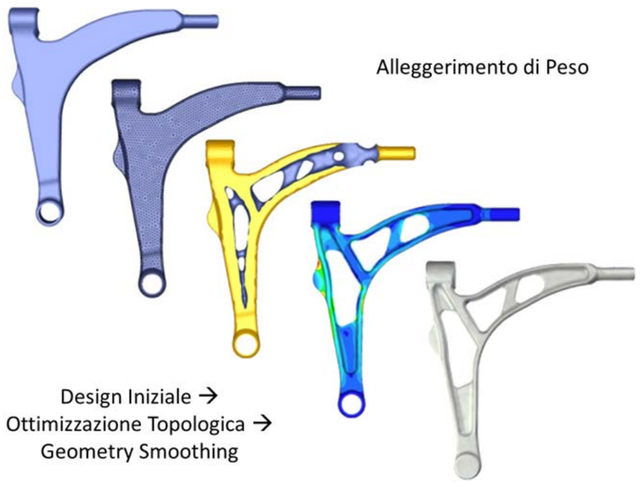
PREPARAZIONE (CAM, SLICING)

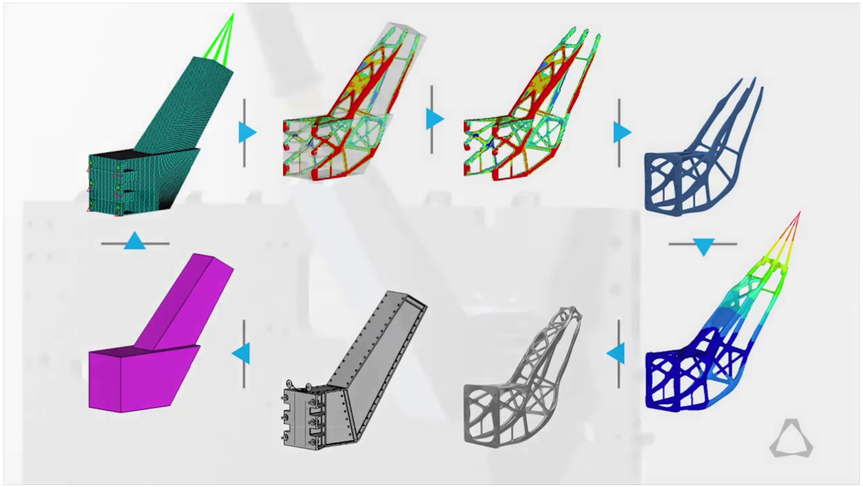
- AUTODESK MESHMIXER
- CURA
- SIMPLIFY3D
- MAKERBOT PRINT
- MATERIALIZE MAGICS
- AUTODESK NETFABB

02

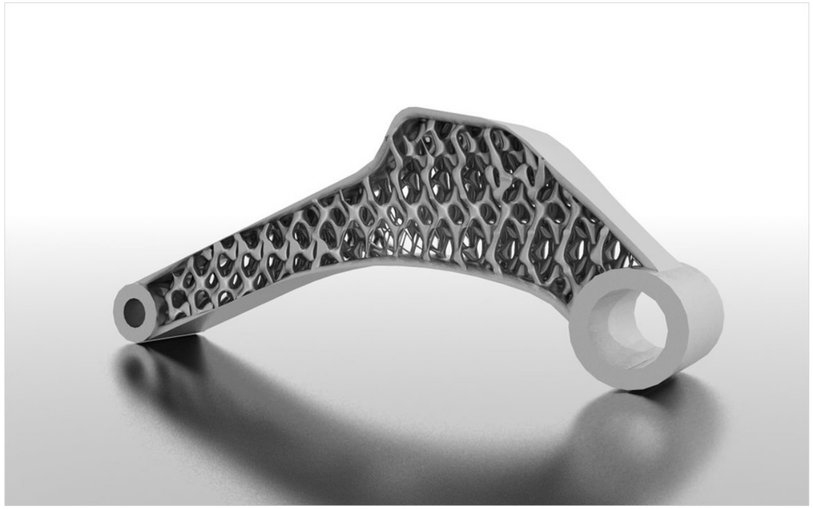
DIGITALI

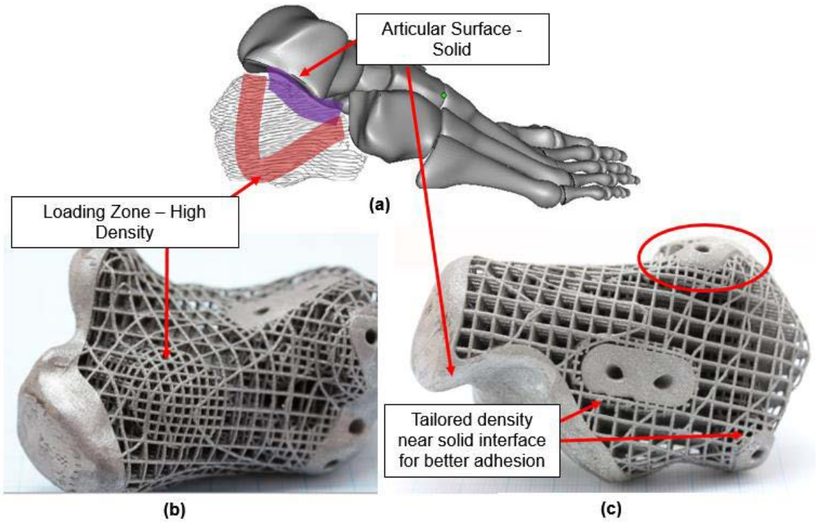
OTTIMIZZAZIONE TOPOLOGICA





STRUTTURE TRABECOLARI





FINITURA

FINITURA

5

Ok you can build it, but can you finish it?
Marc Saunders

Perchè la finitura è importante?

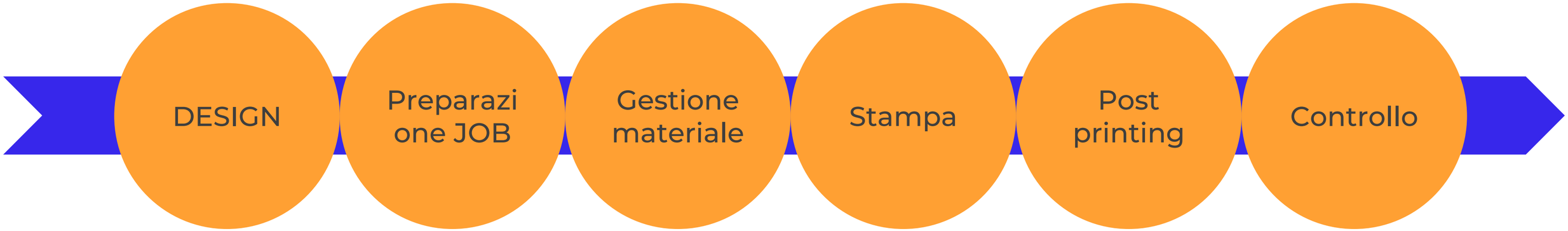
La maggiorparte delle parti prodotto con tecnologie additive necessitano di finitura per diventare applicazioni reali

Le tradizionali lavorazioni a CNC sono attualmente troppo costose per finire piccoli lotti di produzione

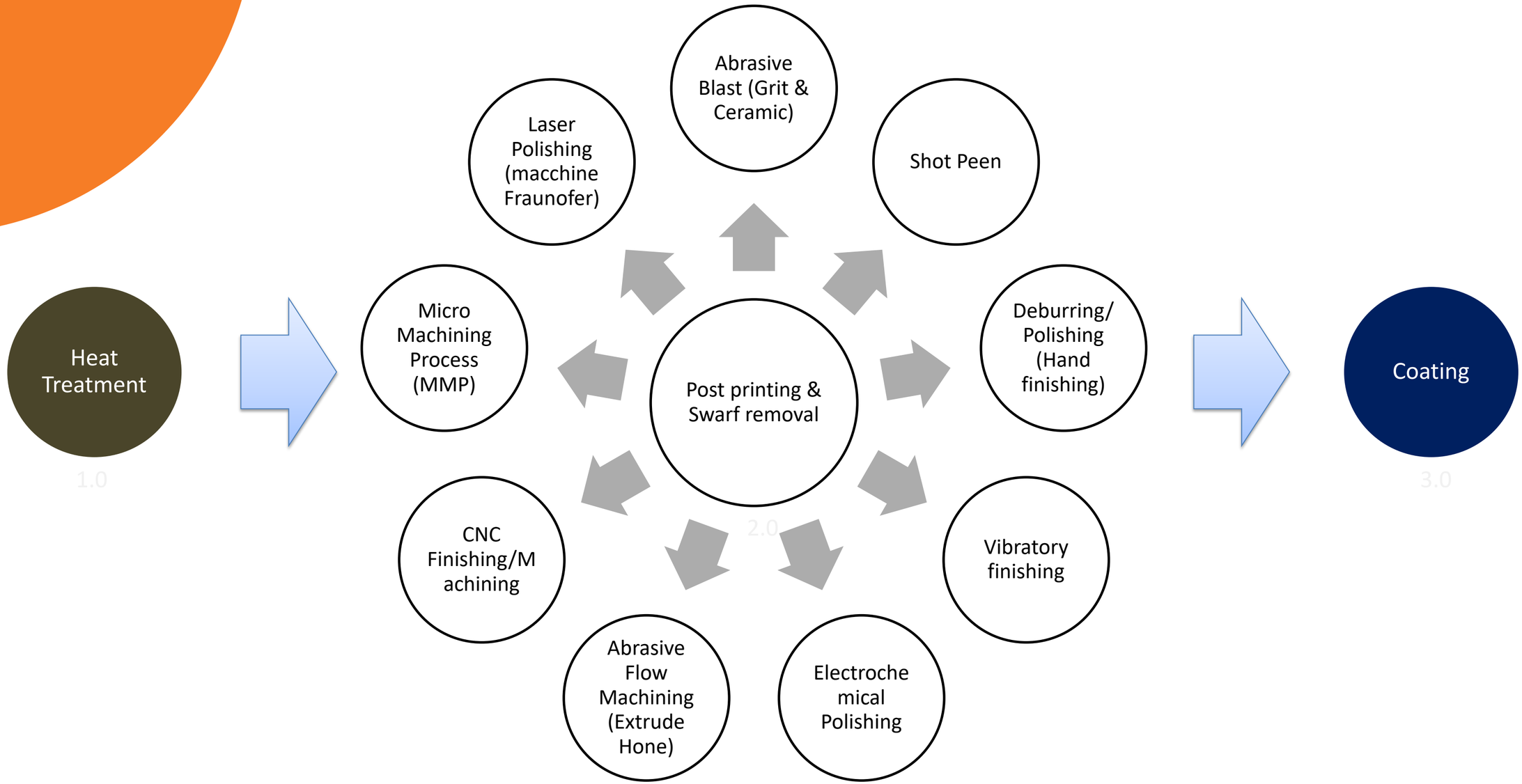
Le operazioni manuali sono davvero troppo difficili su materiali duri come titanio e inconel

Occorrono processi automatizzati per far diventare la finitura più economicamente sostenibile

PROCESSO: LO SFORZO MINIMO



TIPOLOGIE DI FINITURA



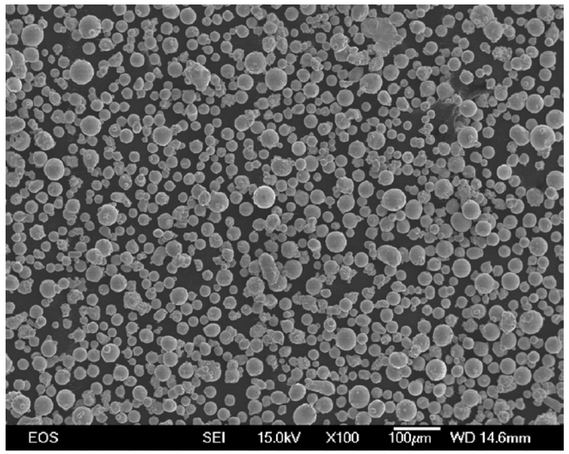
QUALITÀ

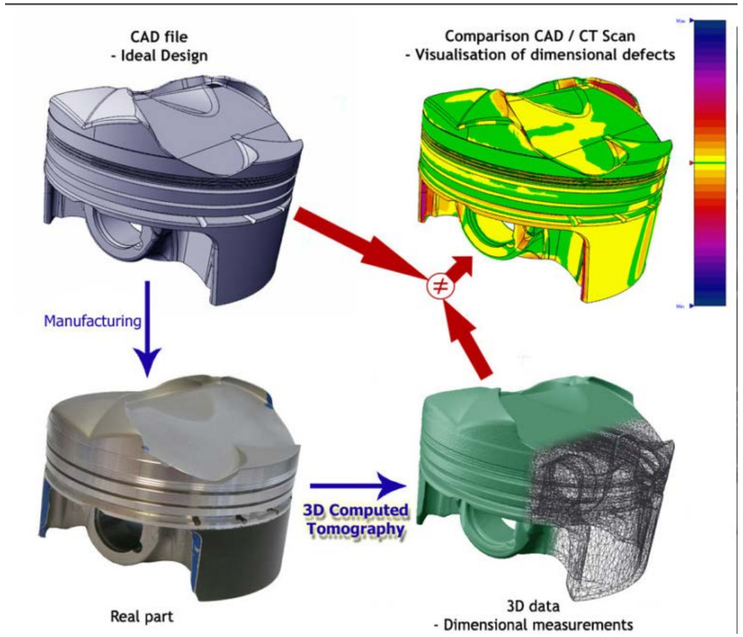
01 Controllo della materia prima (raw material)

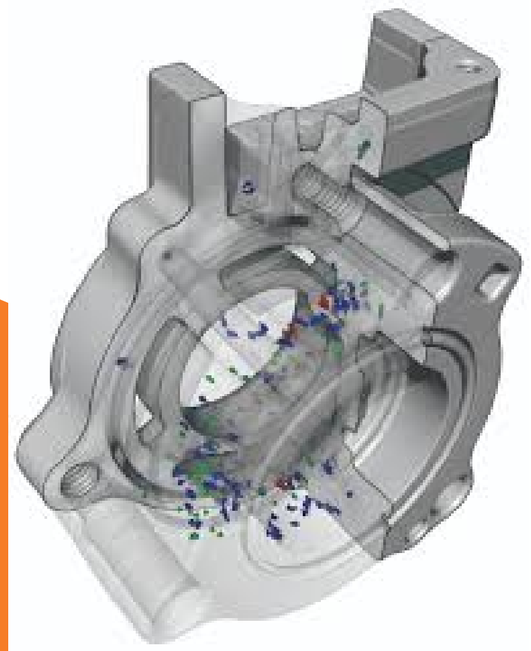
02 Controllo di processo

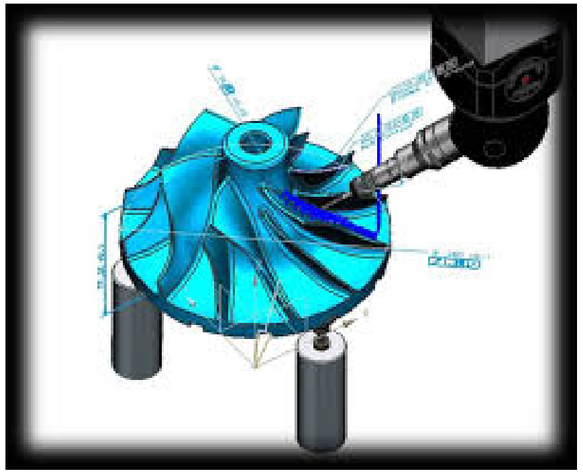
03 Controllo di prodotto

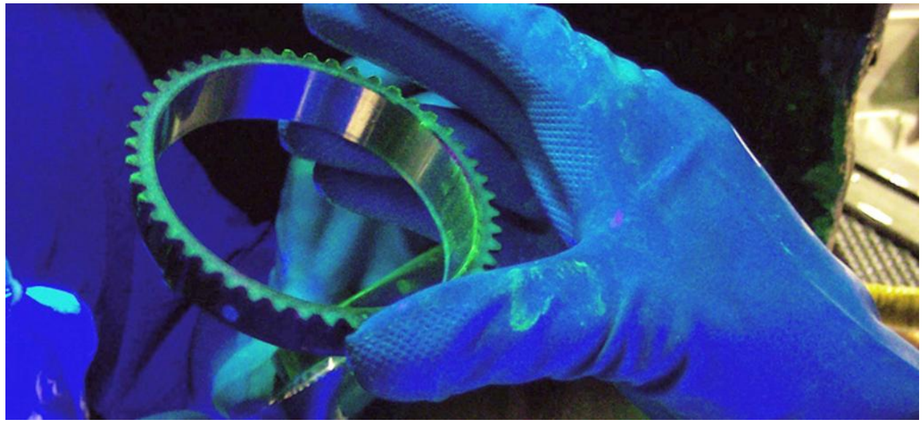
Controlli qualità nell’additive manufacturing











ECONOMIA

01 Stampa (Macchine)

02 Materiale

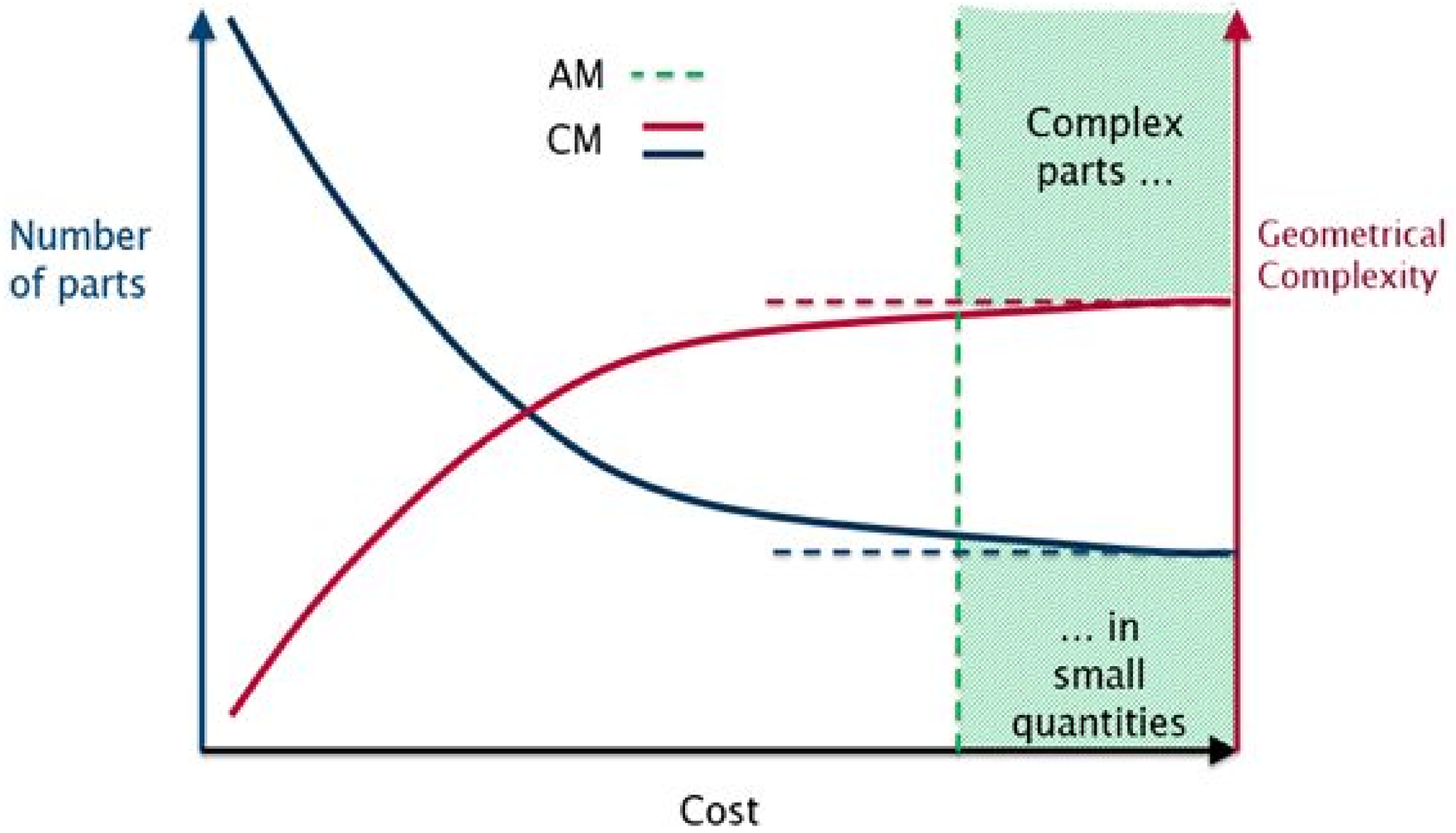
03 Personale che si occupa di stampa

04 Finitura (Macchine)

05 Personale che si occupa di finitura

AM: Il fattore convenienza

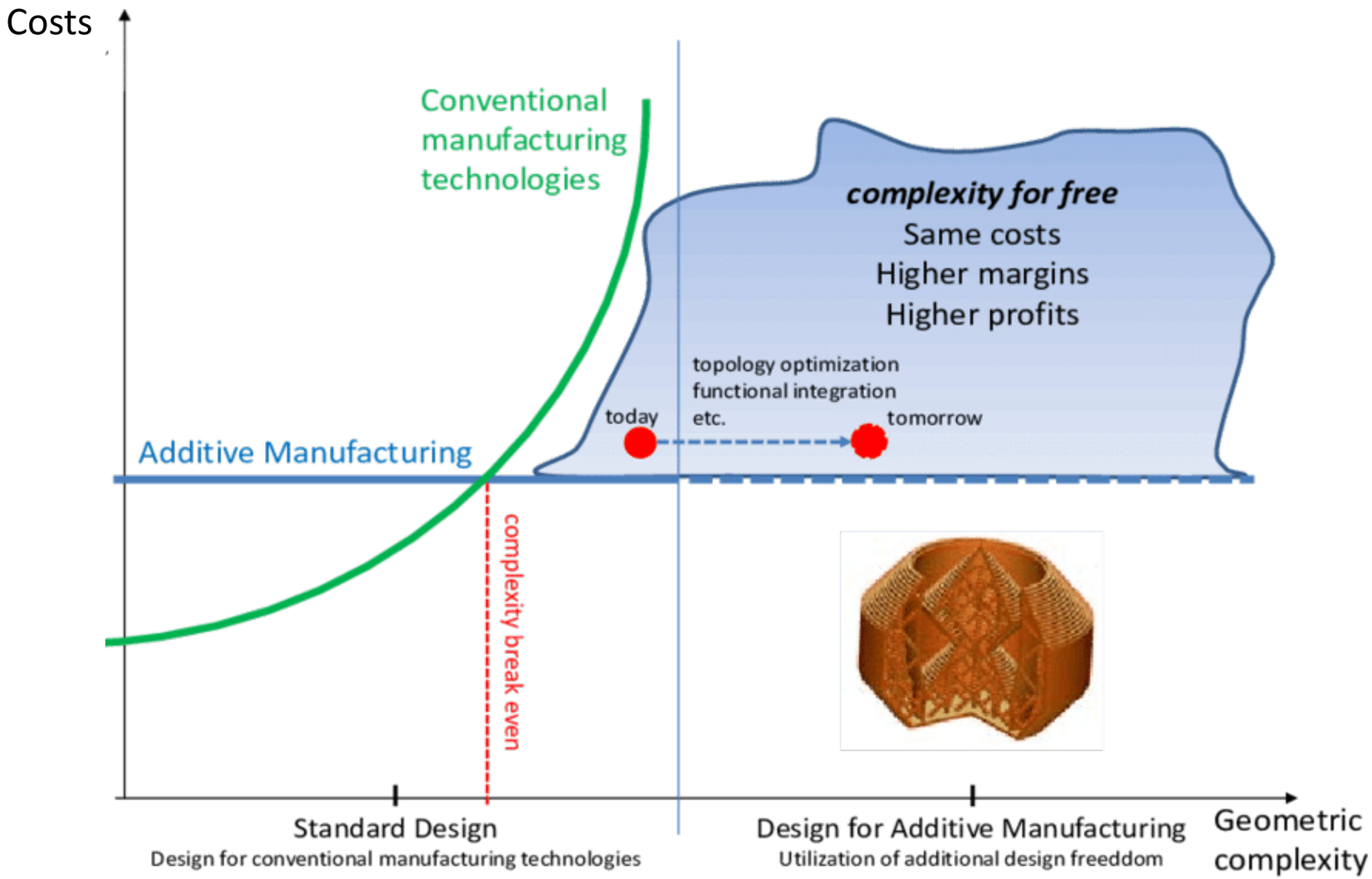
ADDITIVE MANUFACTURING VS CONVENTIONAL MANUFACTURING



Source: sirris

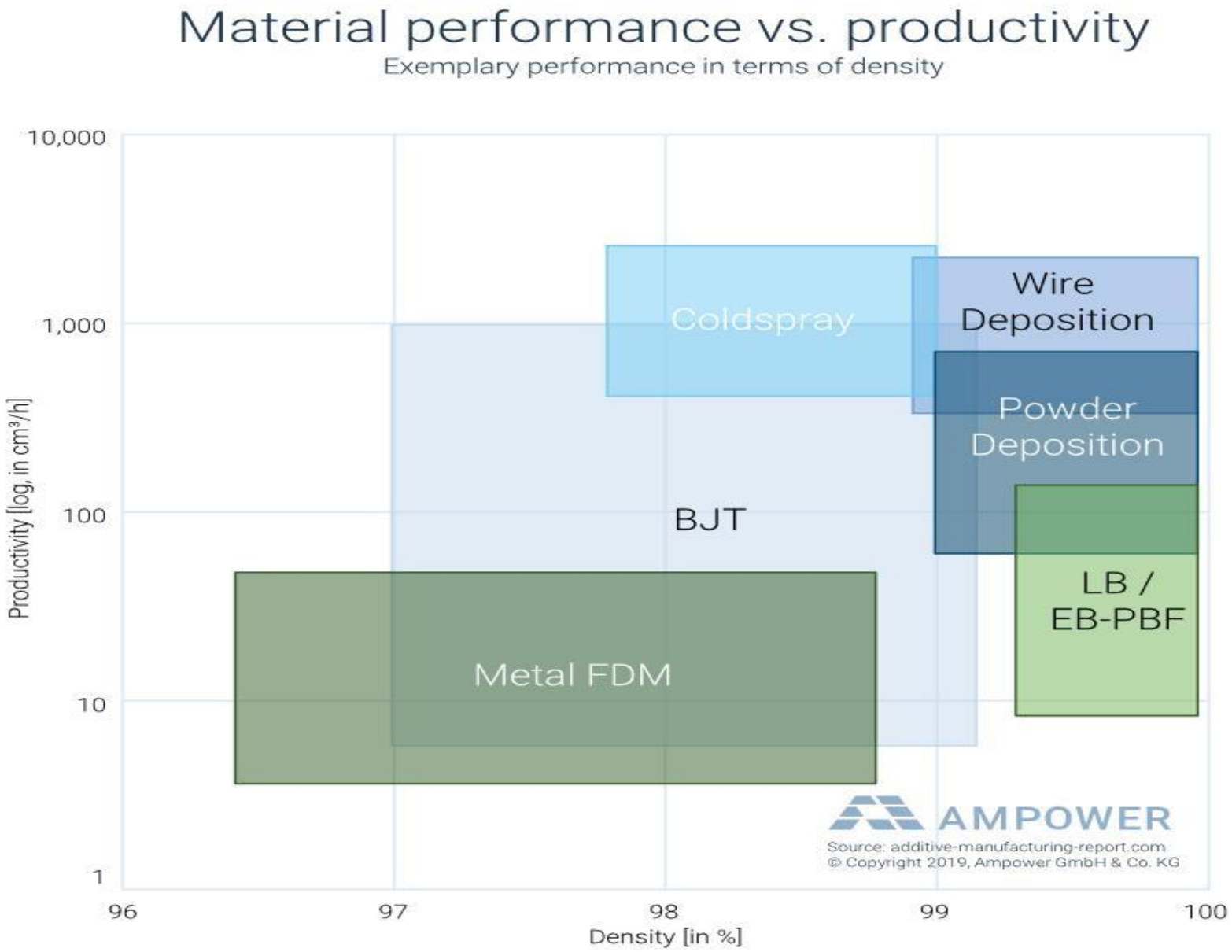
AM: Il fattore convenienza

ADDITIVE MANUFACTURING VS CONVENTIONAL MANUFACTURING



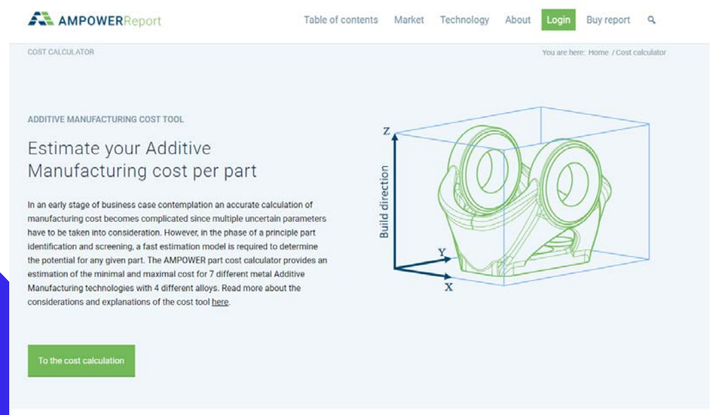
Source: researchgate

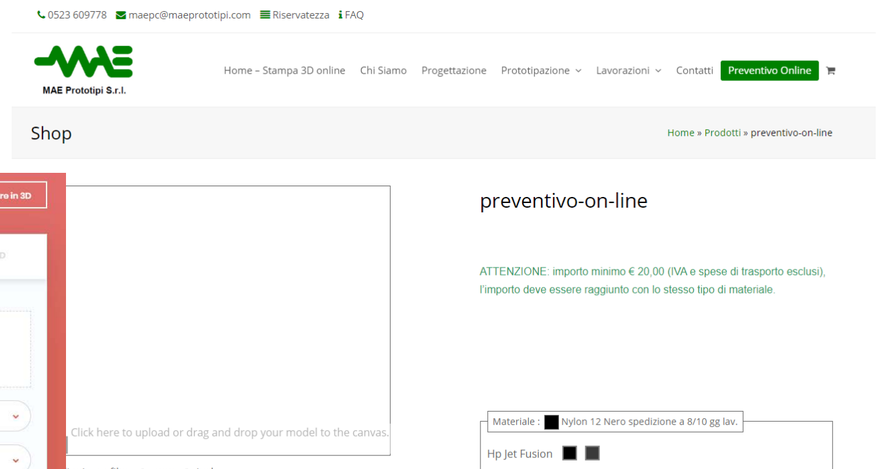
AM: Il fattore convenienza

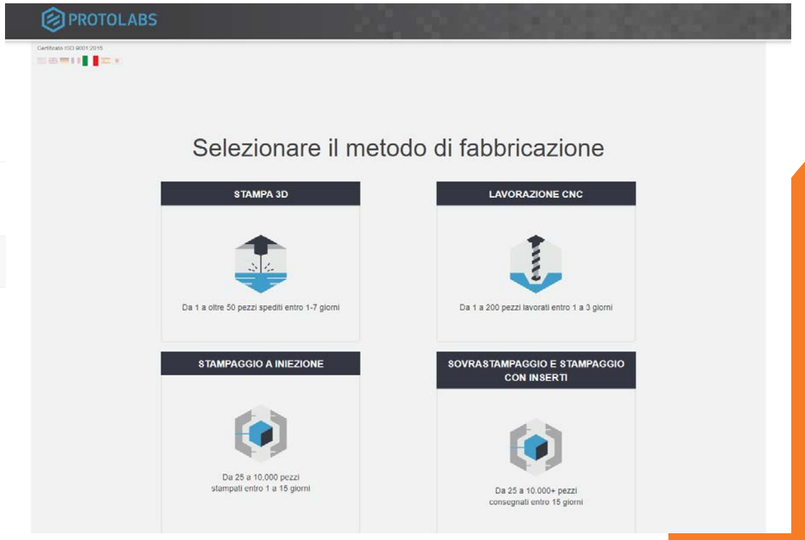


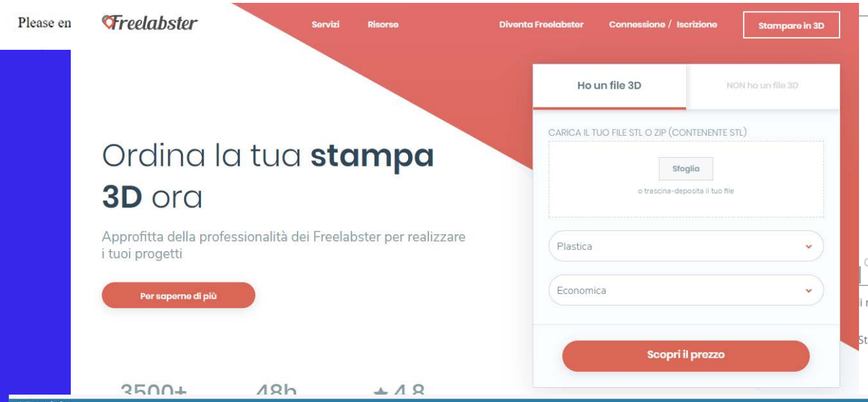
Source: ampower

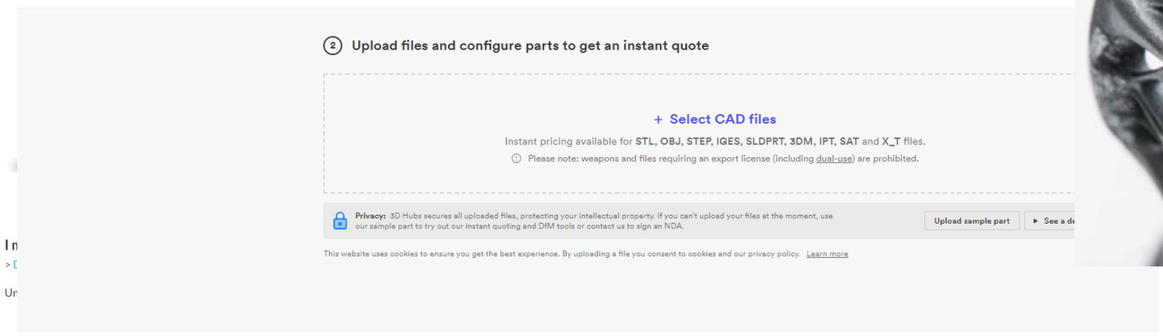
Preventivi Online

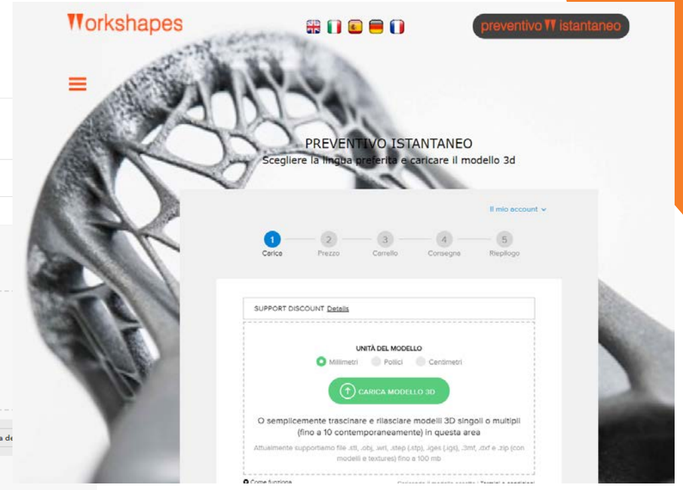












OUTCOME

- E’ la fine del processo Canvas e l’inizio del lancio in produzione!
- Il risultato finale che ti aspetti (e che magari non ti aspettavi)
- Adesso valuta l’indicatore che hai scelto nel quadrante 1 durante la scelta del Driver (% riduzione peso, % incremento performance meccanica, % riduzione costo, ecc...).
- In questa fase sei pronto per decidere se andare avanti e realizzare il primo prototipo o esplorare altri progetti.

Additive Manufacturing Project Canvas

Workshop

Additive Manufacturing Projects Canvas BETA

Progetto _____ Data _____

MATERIALE

2

TECNOLOGIE

3

PROGETTAZIONE

4

DESIDERIO

Io voglio...

inizio

PERCHÈ (IL DRIVER DI PROGETTO)

Che cosa vuoi ottenere dall'utilizzo delle tecnologie additive? Quale specifico vantaggio vuoi ottenere? (leggerezza, maggiore resistenza, personalizzazione, riduzione costi, branding appeal, ecc...)

1

OUTCOME

Descrivi il risultato finale, fai una sintesi di progetto e declina almeno un indicatore da tenere sotto controllo (%riduzione peso, % incremento performance meccanica, % riduzione costo, ecc...).
In questa fase sei pronto per decidere se andare avanti e realizzare il primo prototipo o esplorare altri progetti.

fine

FINITURA

5

QUALITA'

6

ECONOMIA

7

Designed by Simone Ravaglia
AMPC issue 0/2020

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Technology Innovation Advisor

simoneravaglia.it

AzzurroDigitale
STRATEGY&VENTURES

THANK YOU