



Additive Manufacturing Project
Canvas: 17 quadranti per il mio
progetto pilota

THANKS TO



AzzurroDigitale
STRATEGY&VENTURES



SIMONE RAVAGLIA

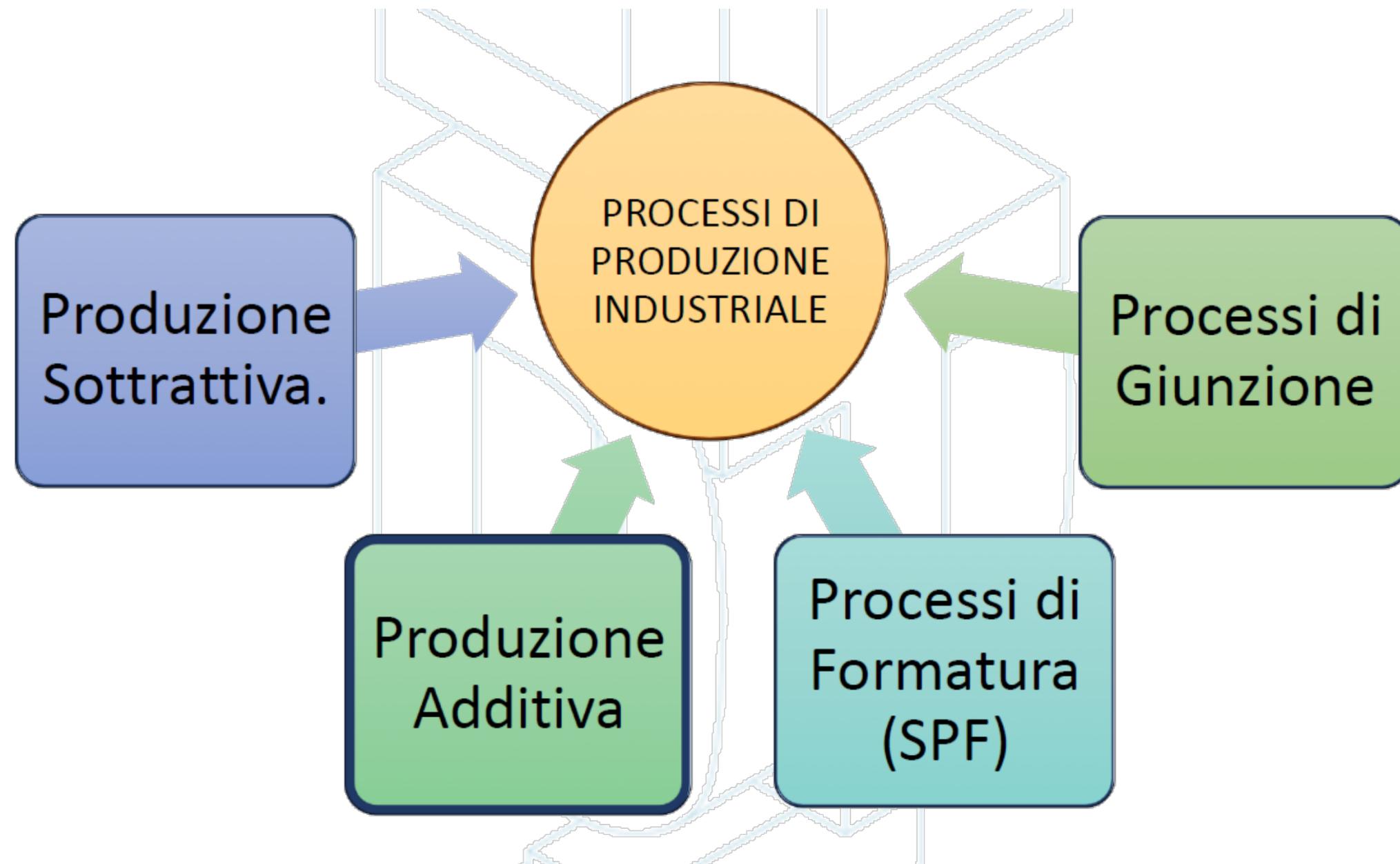
Technology Innovation Advisor



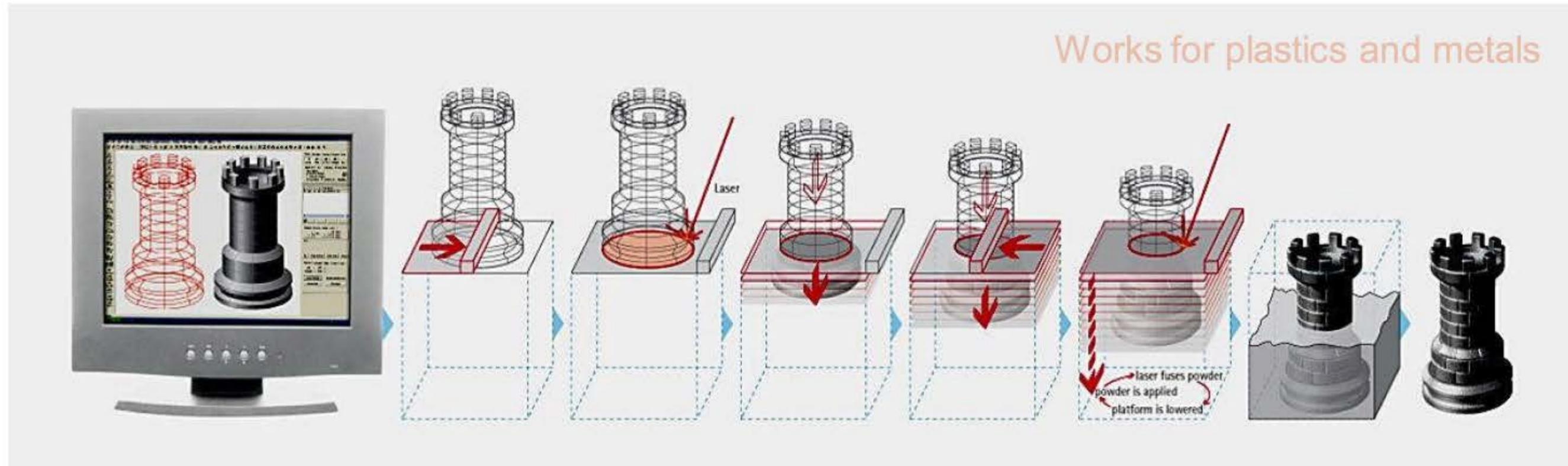
simoneravaglia.it

- 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 Academy e decido definitivamente di passare all'azione!
- 2020** ◇ Inizio una attività *freelance entusiasta* come Formatore e Advisor in Innovazione Tecnologica

Che cos'è l'additive manufacturing/stampa 3D?



Come funziona la stampa 3D?



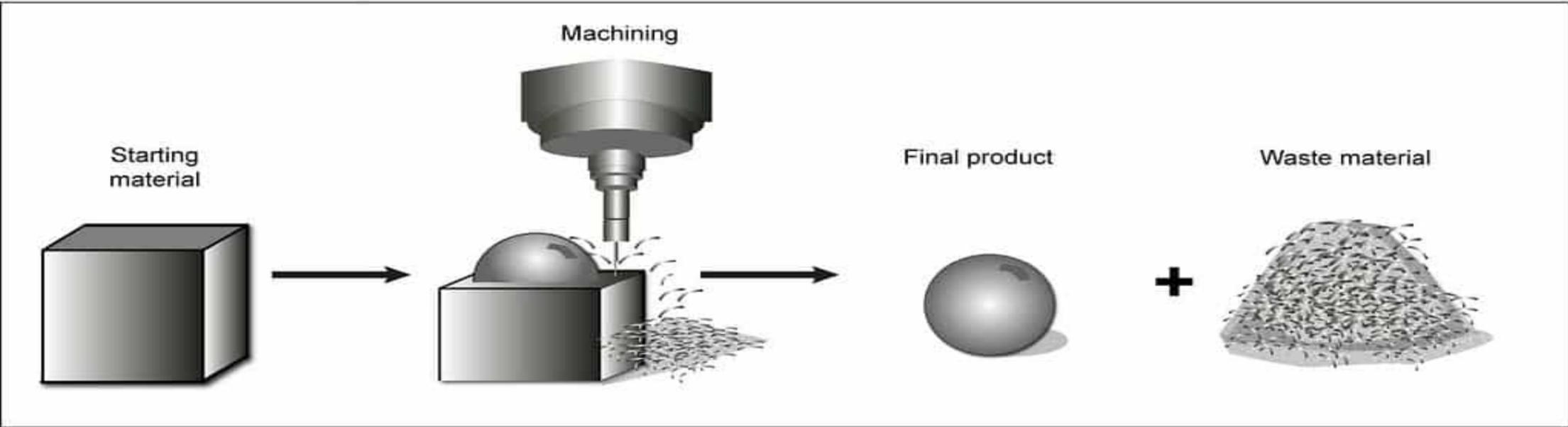
From a 3D CAD model...

- Application of powder
- Exposure by Laser
- Lowering of platform
- Re-application of powder
- Exposure by Laser

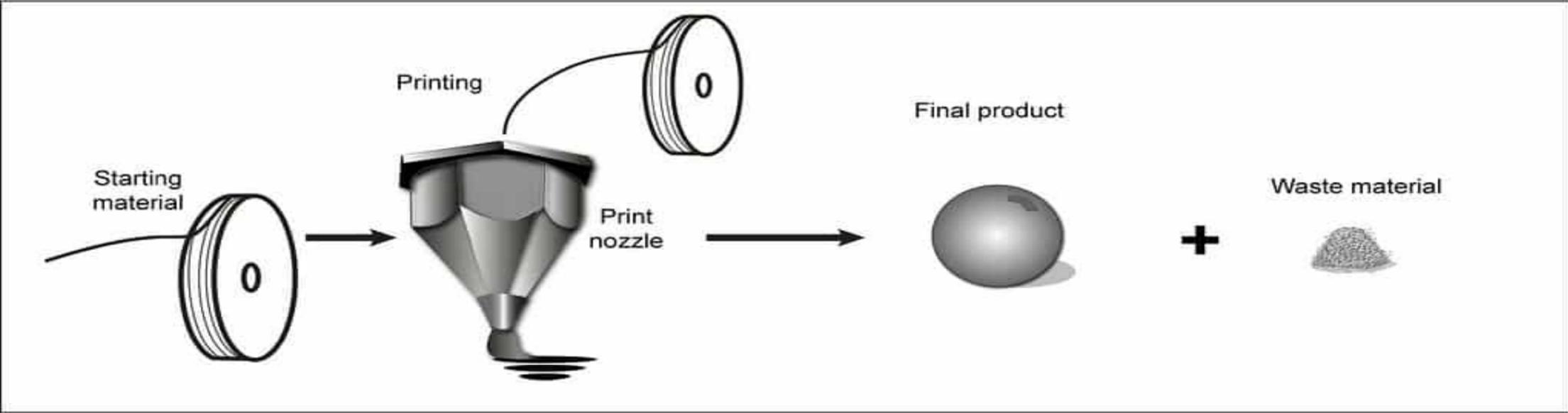
... to complete parts

Produzione sottrattiva – Produzione additiva

Subtractive manufacturing



Additive manufacturing

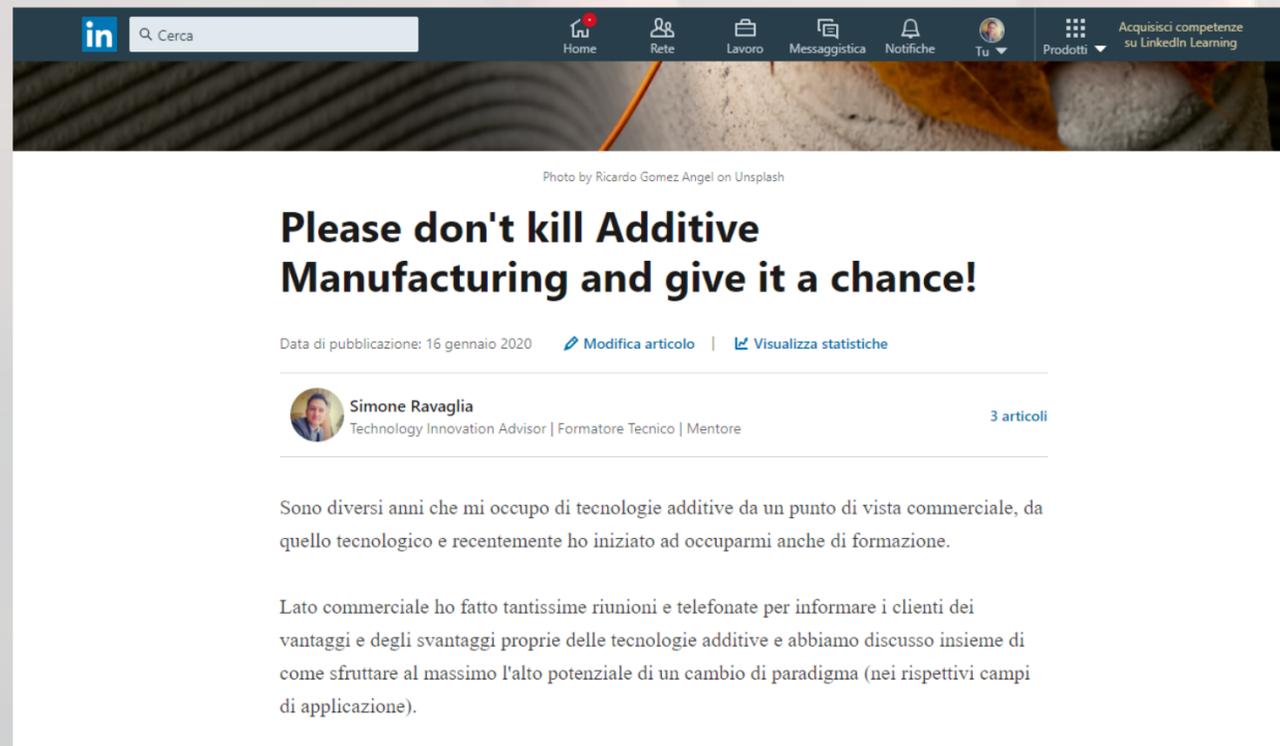


Sources: GAO (analysis); Art Explosion (images). | GAO-16-56

Perché un altro Canvas?

Per fare ordine!

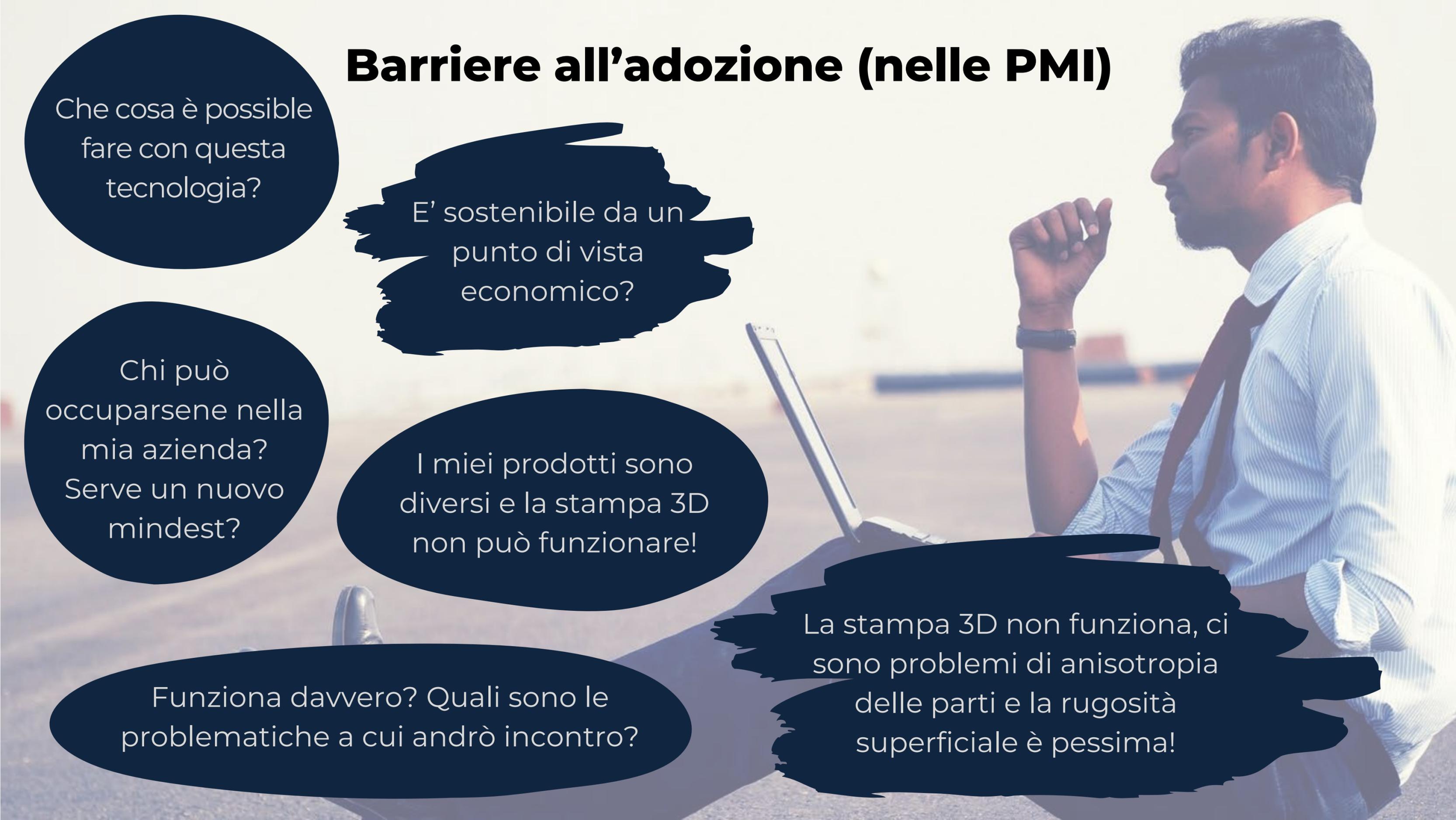
L'ordine allontana il dubbio e facilita l'apprendimento delle tecniche.
Ci permette di fare strategia e avere visione.



The screenshot shows a LinkedIn article interface. At the top, there is a navigation bar with the LinkedIn logo, a search bar, and icons for Home, Rete, Lavoro, Messaggistica, Notifiche, Tu, and Prodotti. Below the navigation bar is a header image with the text 'Photo by Ricardo Gomez Angel on Unsplash'. The article title is 'Please don't kill Additive Manufacturing and give it a chance!'. Below the title, it shows the publication date '16 gennaio 2020' and links for 'Modifica articolo' and 'Visualizza statistiche'. The author's profile is visible, showing a profile picture, the name 'Simone Ravaglia', and his roles: 'Technology Innovation Advisor | Formatore Tecnico | Mentore'. There is also a link to '3 articoli'. The main text of the article begins with 'Sono diversi anni che mi occupo di tecnologie additive da un punto di vista commerciale, da quello tecnologico e recentemente ho iniziato ad occuparmi anche di formazione.' and continues with 'Lato commerciale ho fatto tantissime riunioni e telefonate per informare i clienti dei vantaggi e degli svantaggi proprie delle tecnologie additive e abbiamo discusso insieme di come sfruttare al massimo l'alto potenziale di un cambio di paradigma (nei rispettivi campi di applicazione).'

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

Barriere all'adozione (nelle PMI)



Che cosa è possibile fare con questa tecnologia?

E' sostenibile da un punto di vista economico?

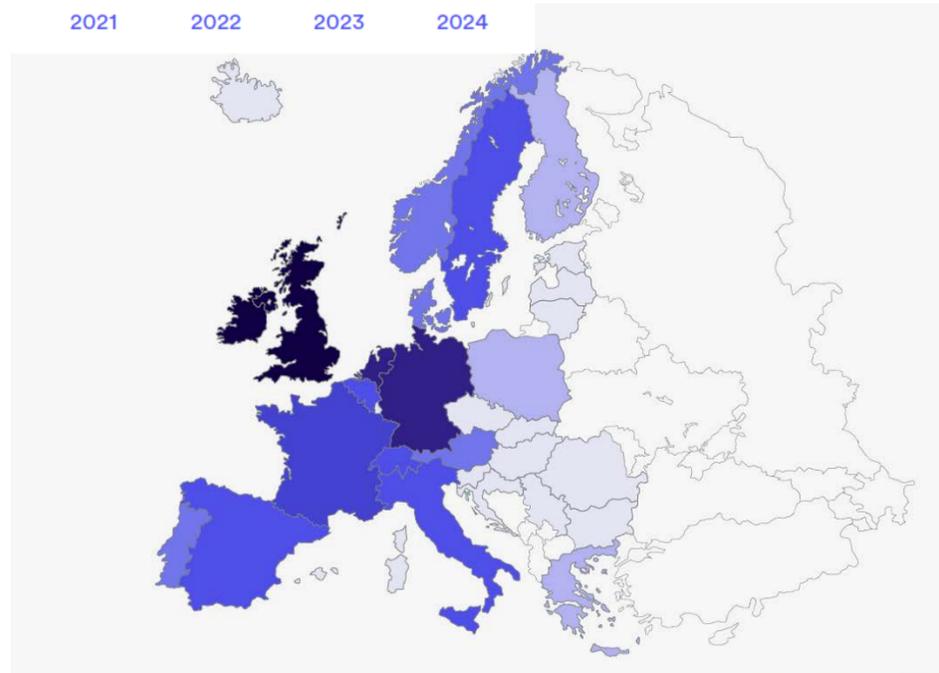
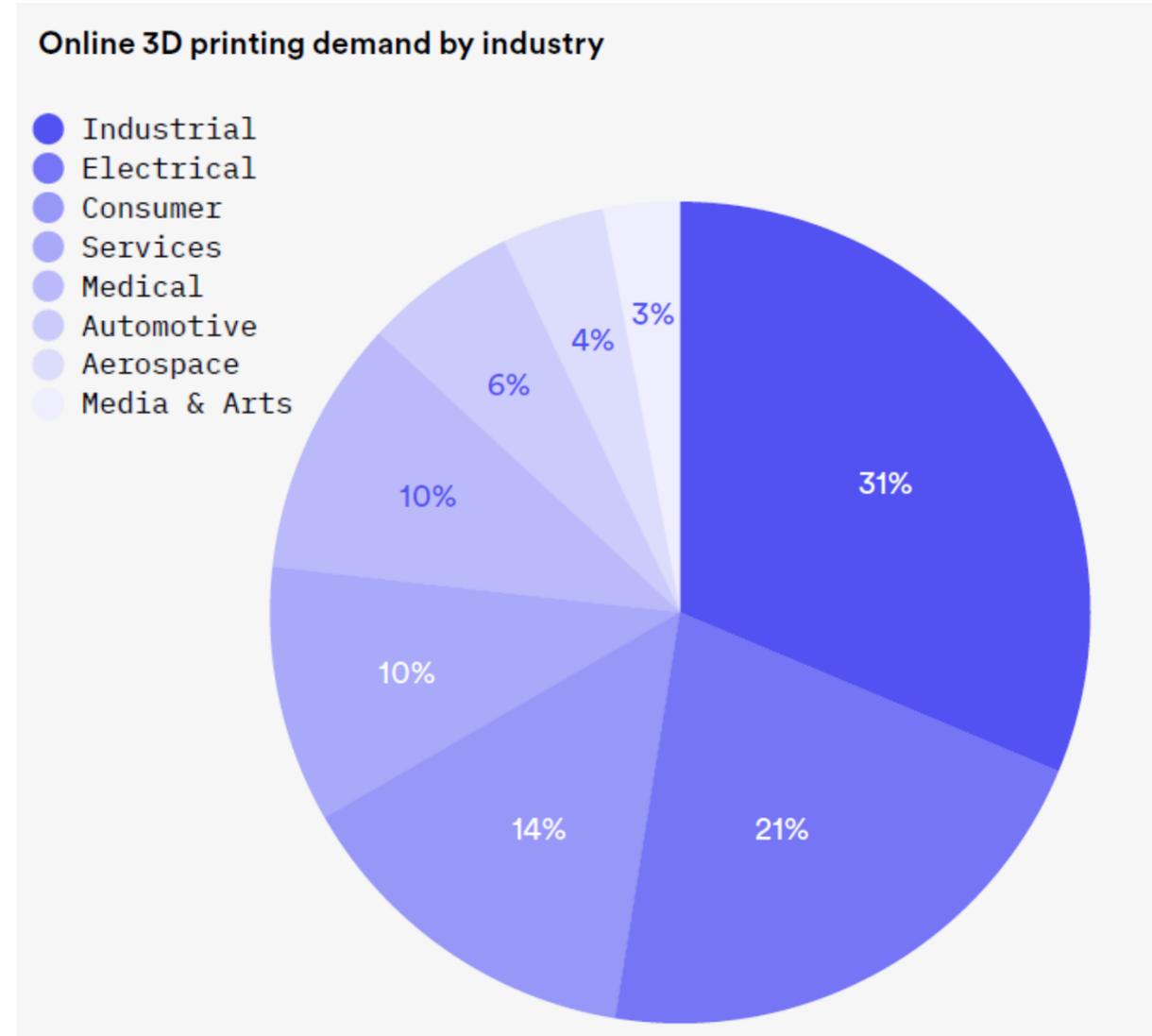
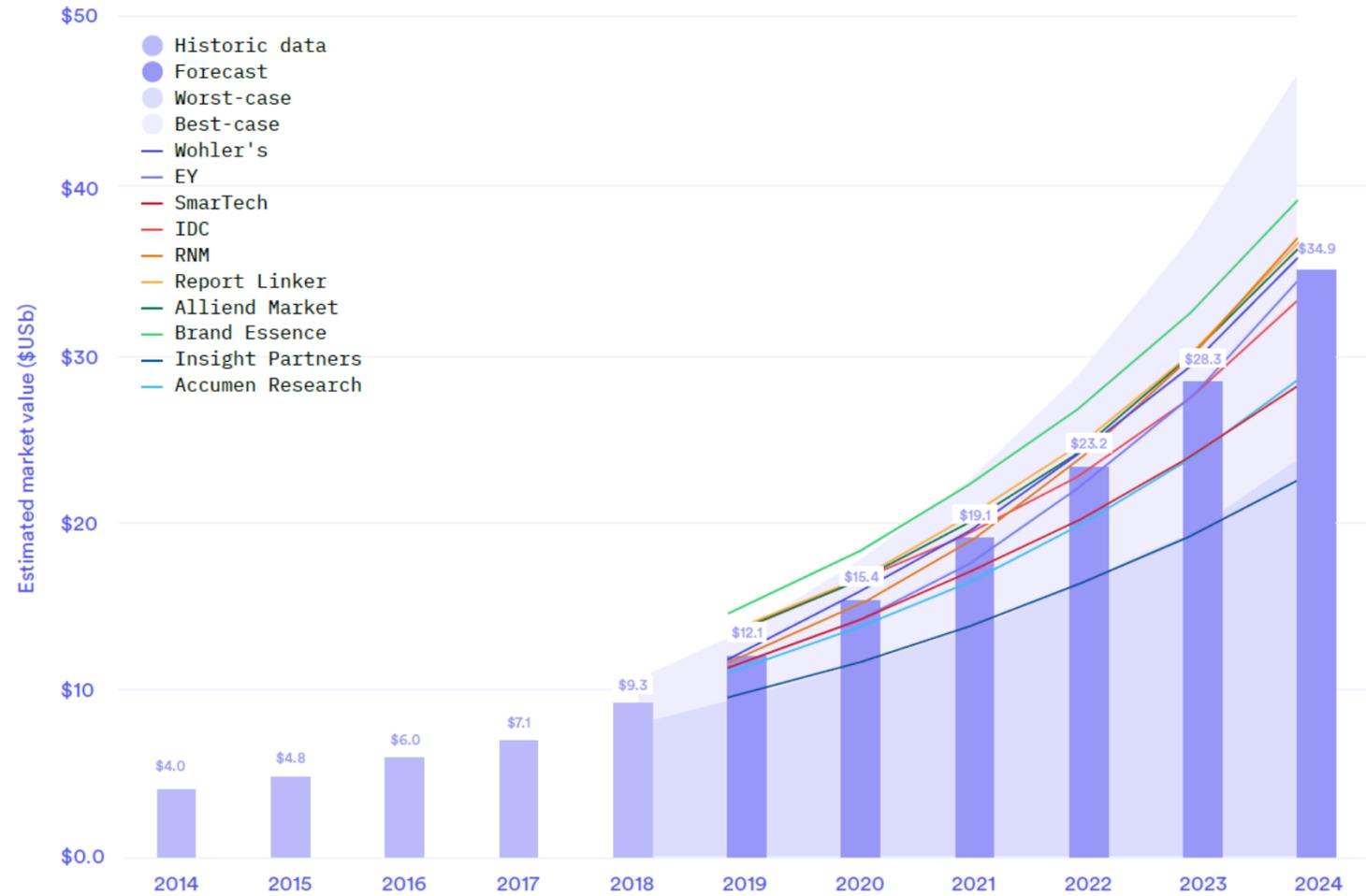
Chi può occuparsene nella mia azienda? Serve un nuovo mindset?

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

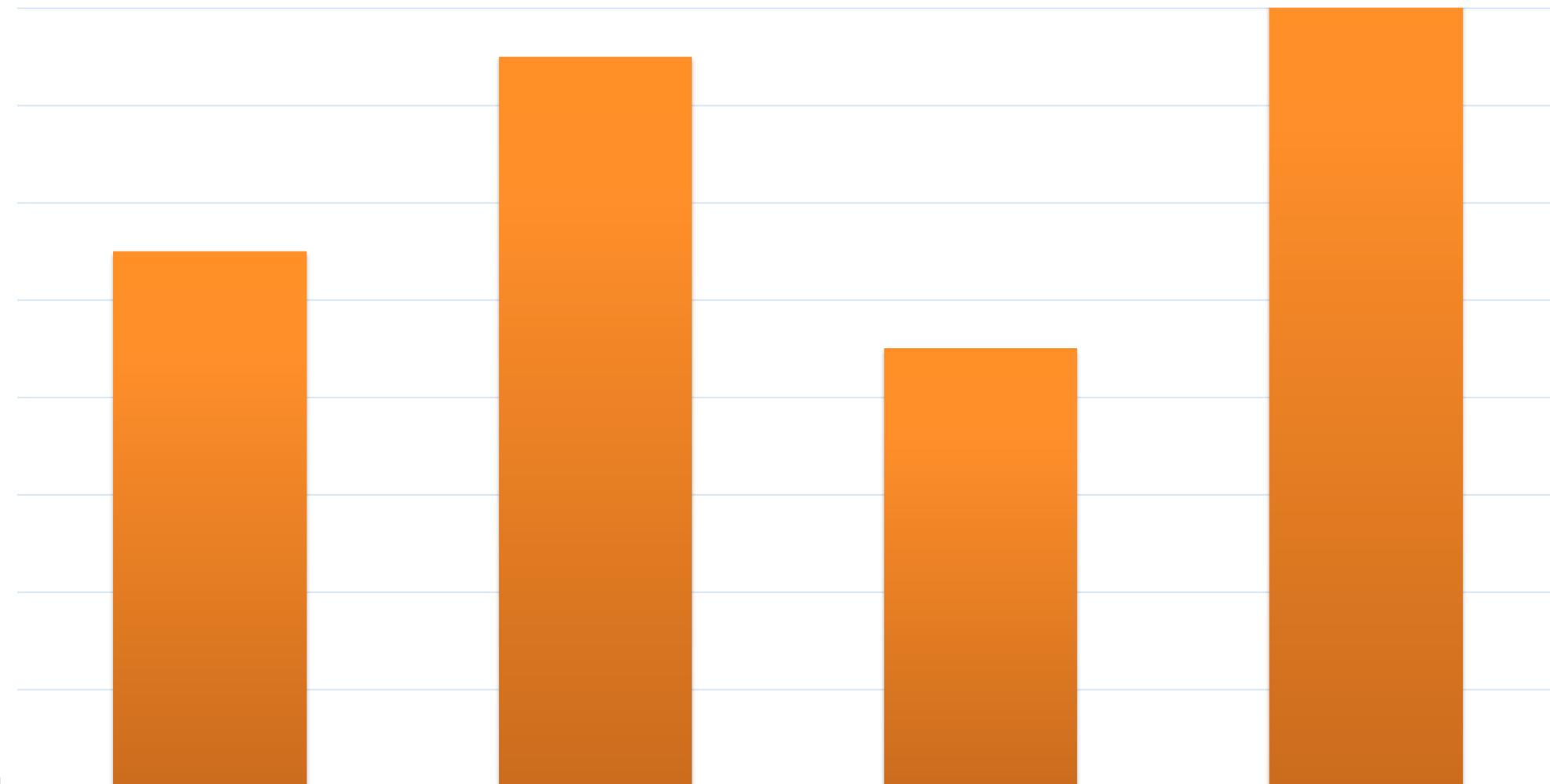
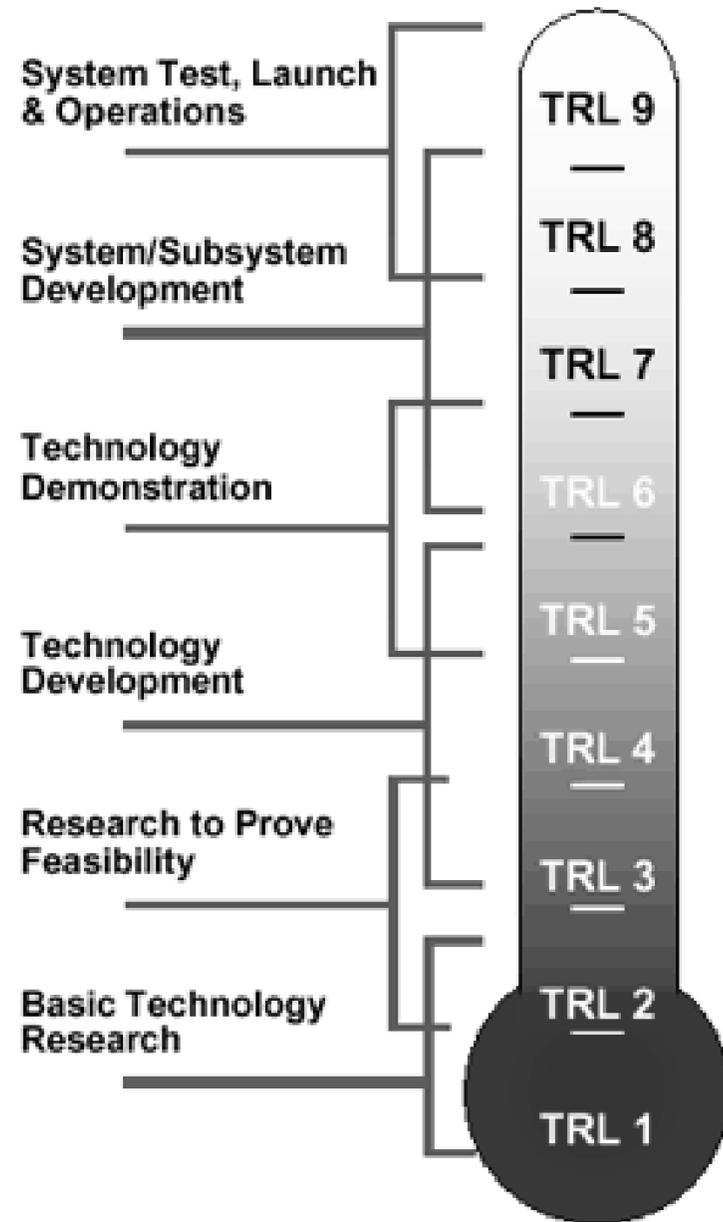
Funziona davvero? Quali sono le problematiche a cui andrò incontro?

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

Additive Manufacturing: mercato



Manufacturing readiness level



AEROSPACE

TOOLING

AUTOMOTIVE

MEDICAL

Iniettori

Inseriti per stampi

Condotti aria

Impianti dentali

Elementi strutturali

Componenti F1

Protesi

Palette turbine

Strumenti



WHEN

NOW

DESIDERIO (Io voglio)

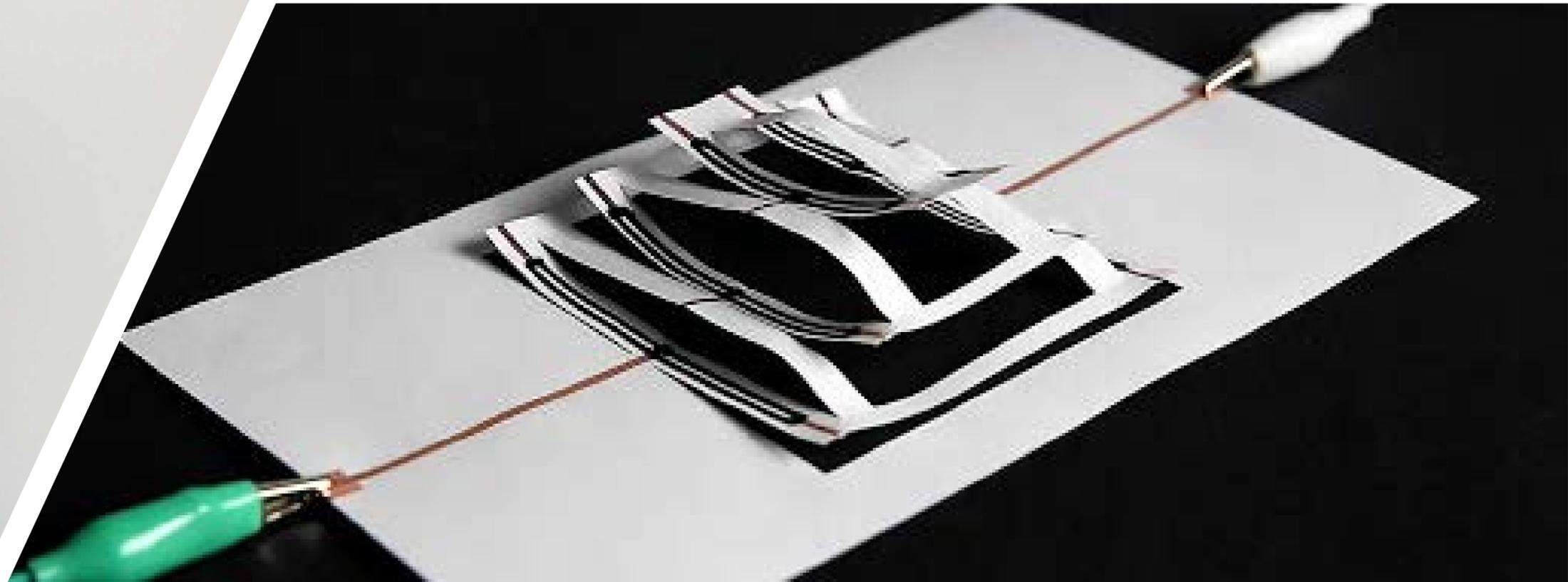
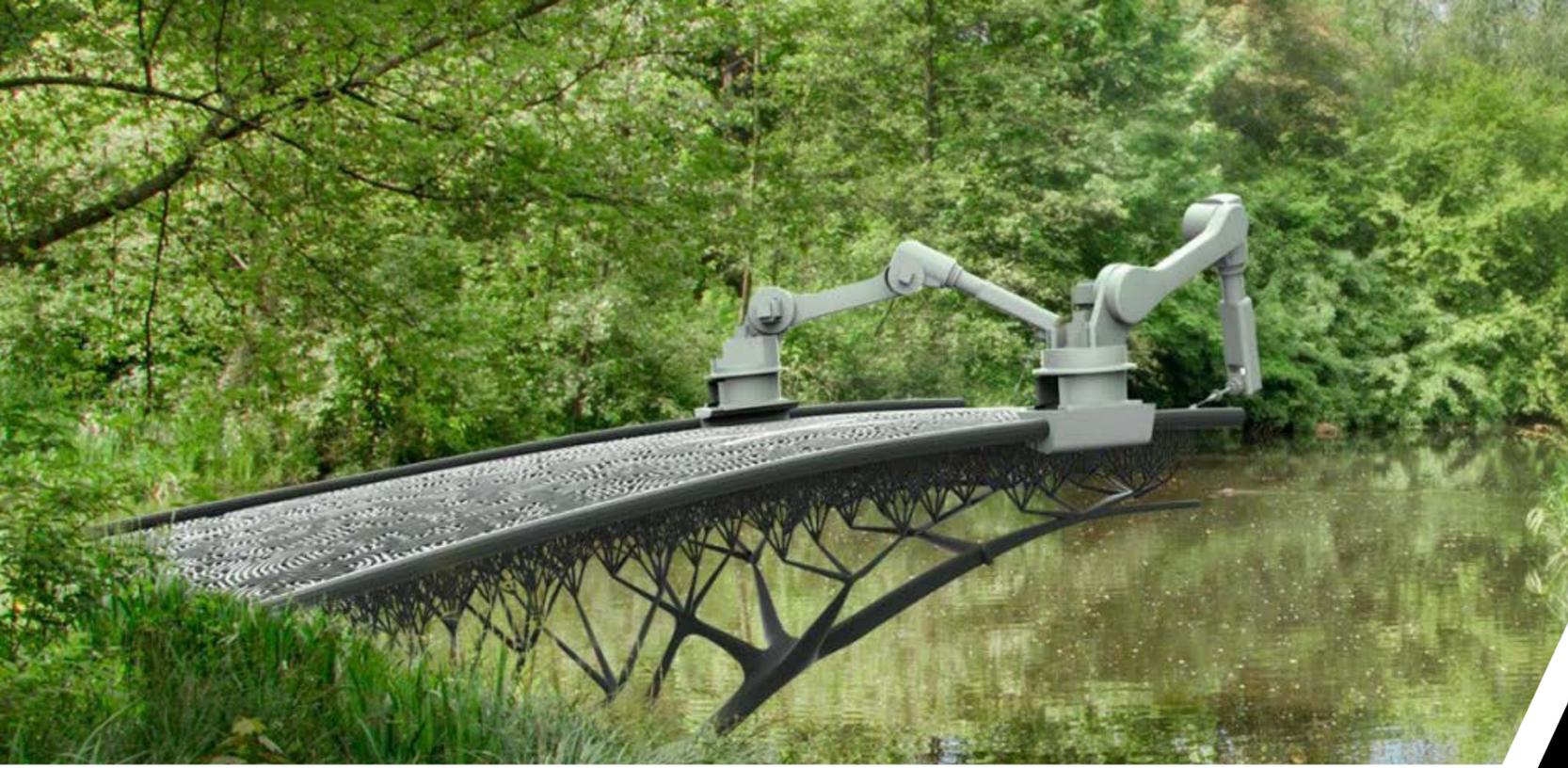
Le regole del quadrante ZERO:

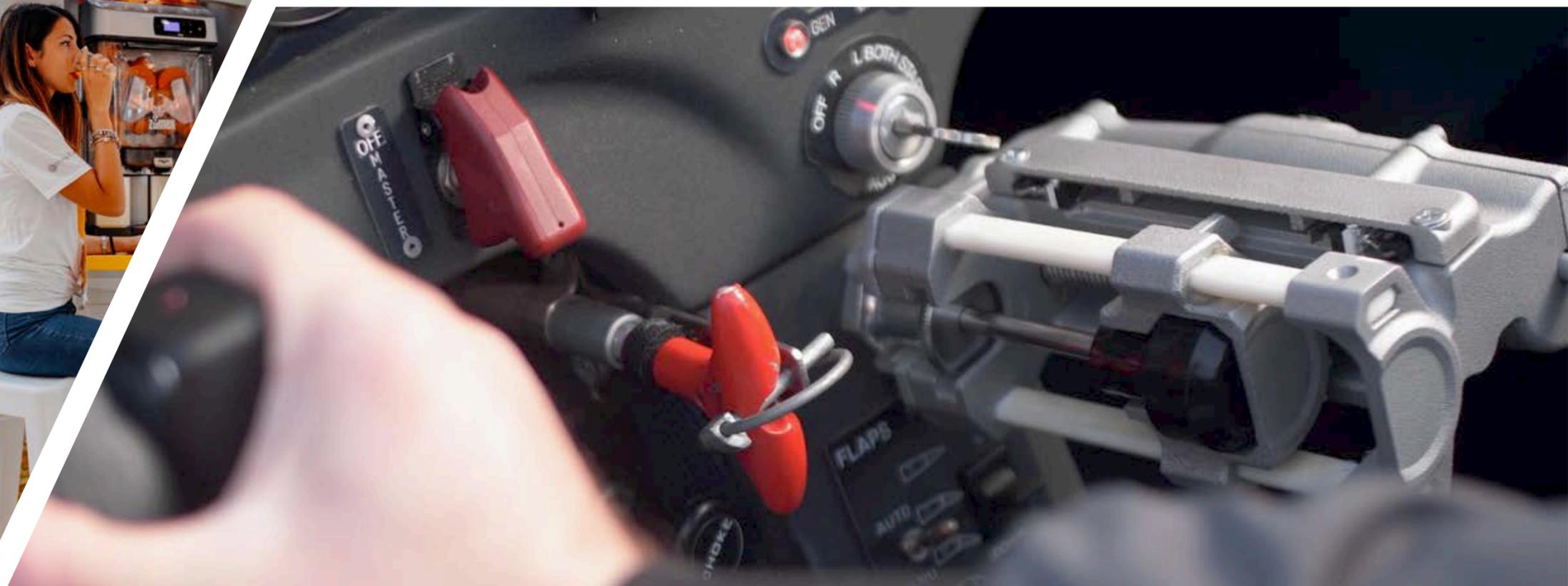
- 1) Non porti dei limiti
- 2) Trova ispirazione da progetti anche di altri settori (fatti contaminare!)
- 3) Prendi in esame parti o assiemi di parti
- 4) Descrivi il tuo progetto partendo da “Io voglio”
- 5) Fai uno schizzo a mano che rappresenti graficamente la tua idea

DESIDERIO

Io voglio...

inizio





DRIVER DI PROGETTAZIONE

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

01

Riduzione del numero di parti

02

Riduzione peso

03

Riduzione Lead Time

04

Migliore resistenza meccanica

05

Migliore fluidodinamica

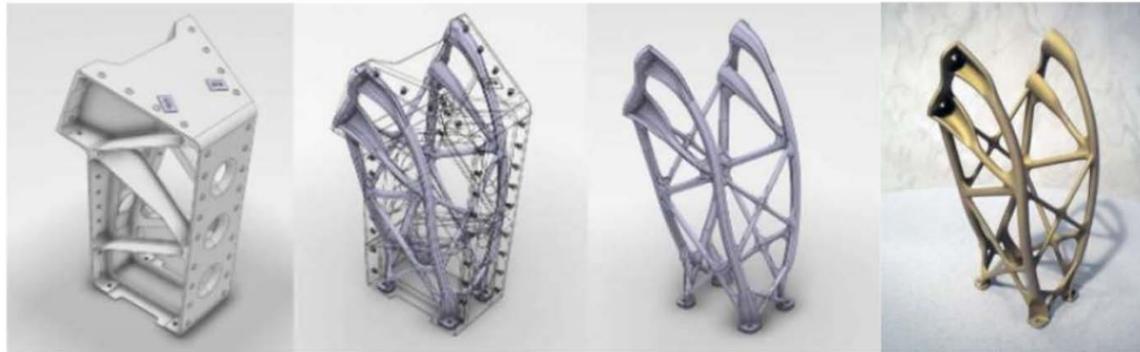
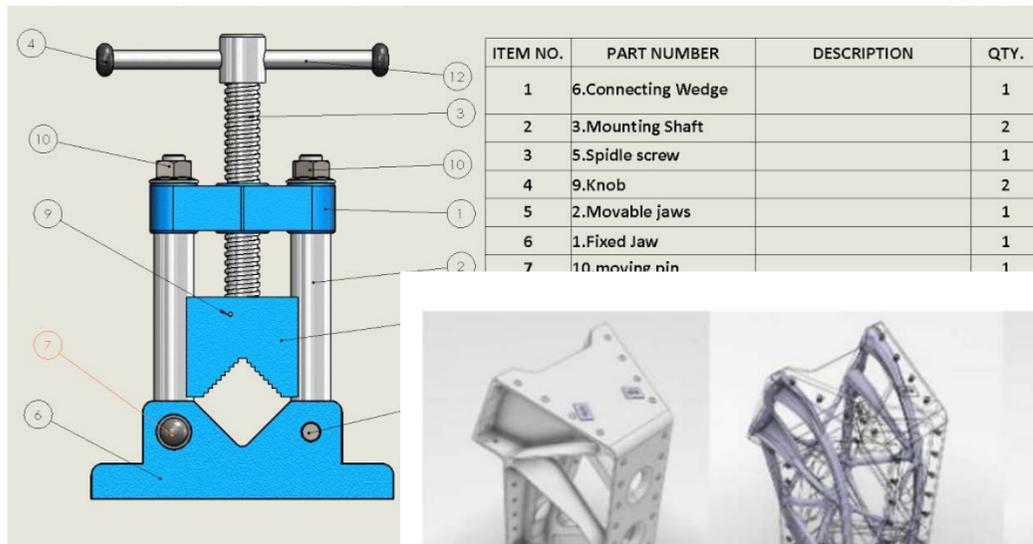
06

Migliore performance termica

07

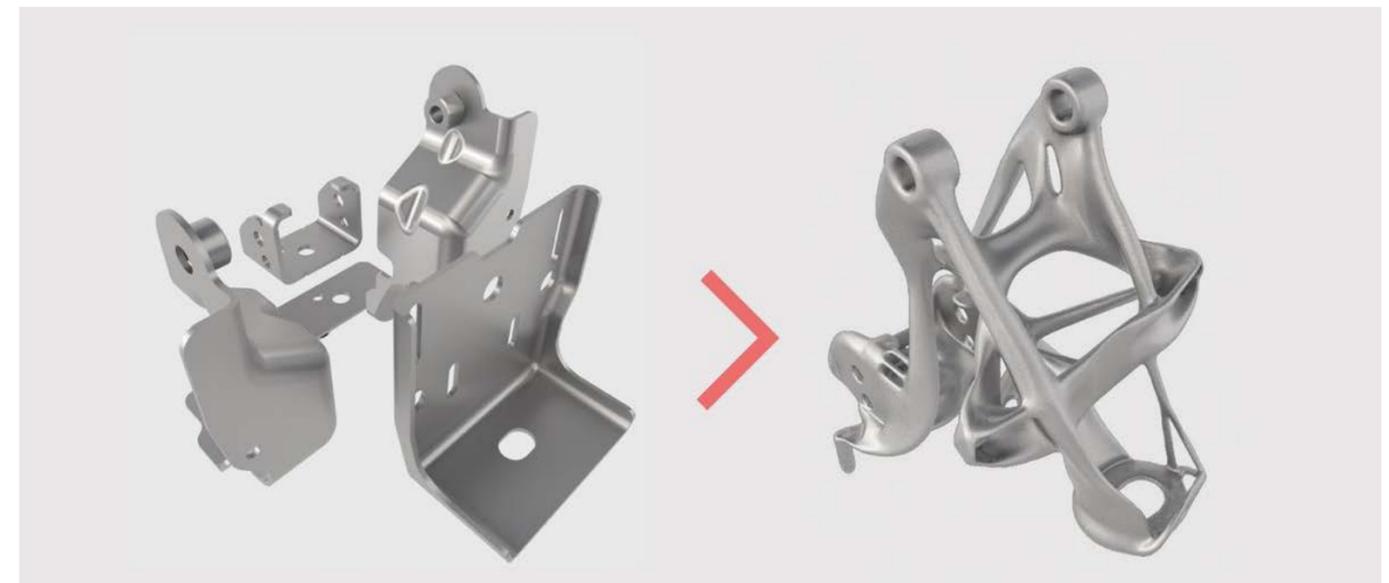
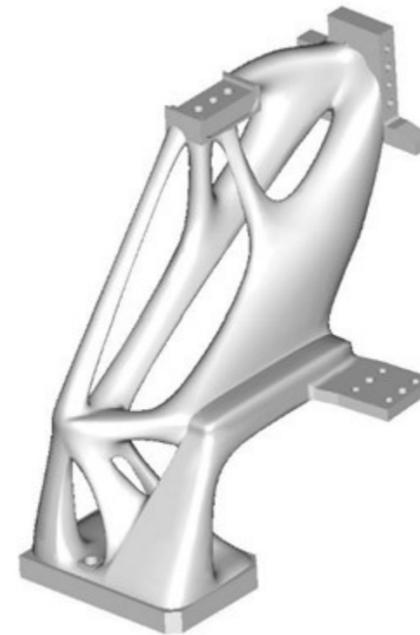
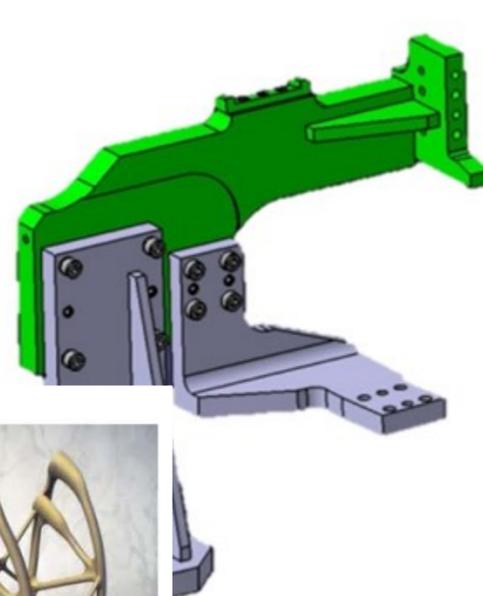
Design personalizzato

- 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

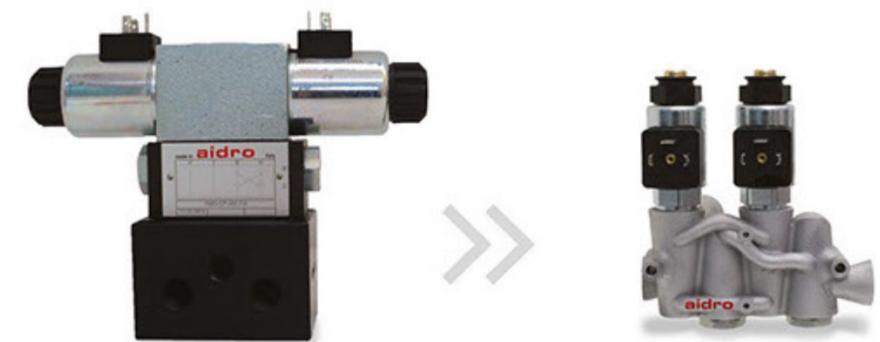
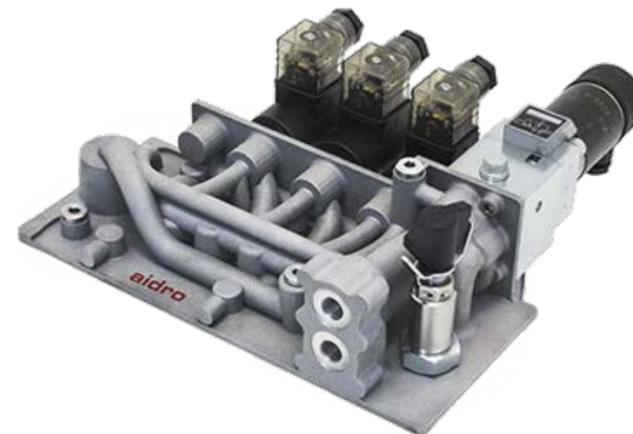
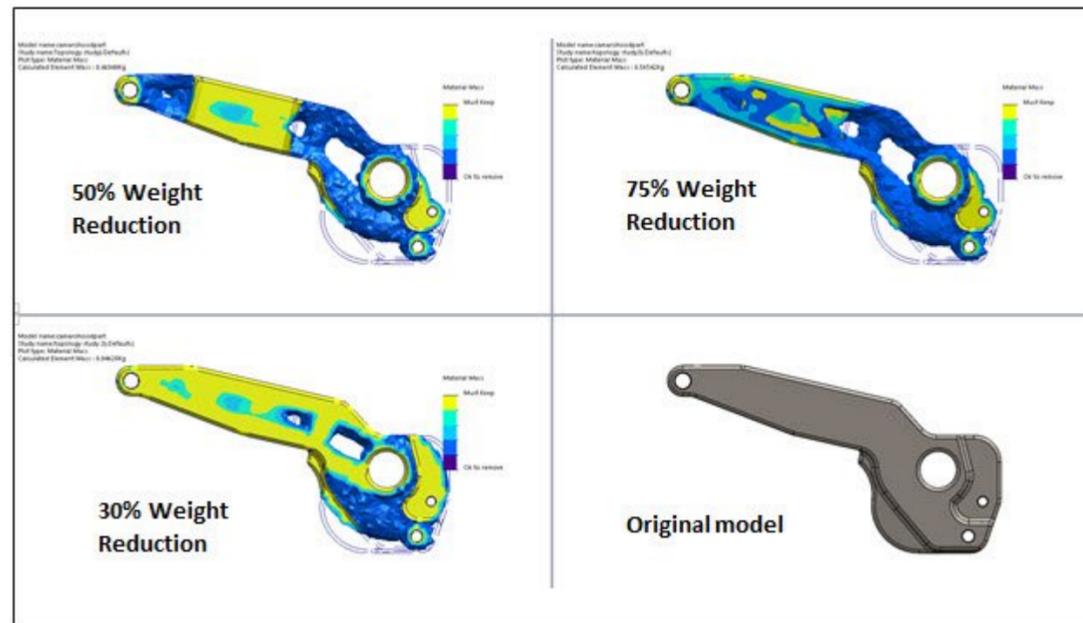


Airbus Defense and Space 3D printed a space-qualified satellite bracket. The team was able to transform a bracket made up of four main parts and 44 rivets into a single, laser-melted piece that is 40% stiffer and 35% lighter than its predecessor.

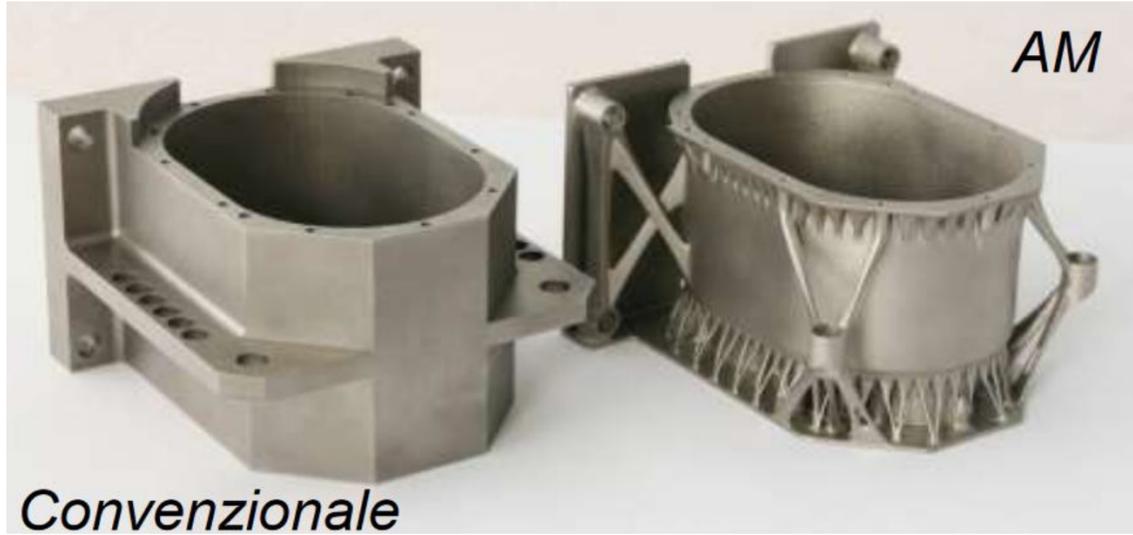
Se un oggetto non ha altre funzioni che quelle di collegare/assicurare altre parti, allora è sempre teoricamente possibile eliminarlo.



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



- Componenti di ricambio con lunghi tempi di produzione



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Digitalize your inventory using 3D printing.

Spare Parts 3D supports the digitalization of inventories and enables on-demand production using digital manufacturing.

Leveraging 3D printing to digitalize your inventory.
Increase your top-line & Improve your bottom-line.

<p>STOP WAREHOUSING On-demand manufacturing reduces your storage costs</p>	<p>AVOID INVESTMENT Leverage our production with our digital</p>	<p>REDUCE TRANSPORT Spares are produced locally, reducing</p>	<p>INCREASE CUSTOMER SATISFACTION Widen your catalog of</p>
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- 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.



Traditional process
cost advantage



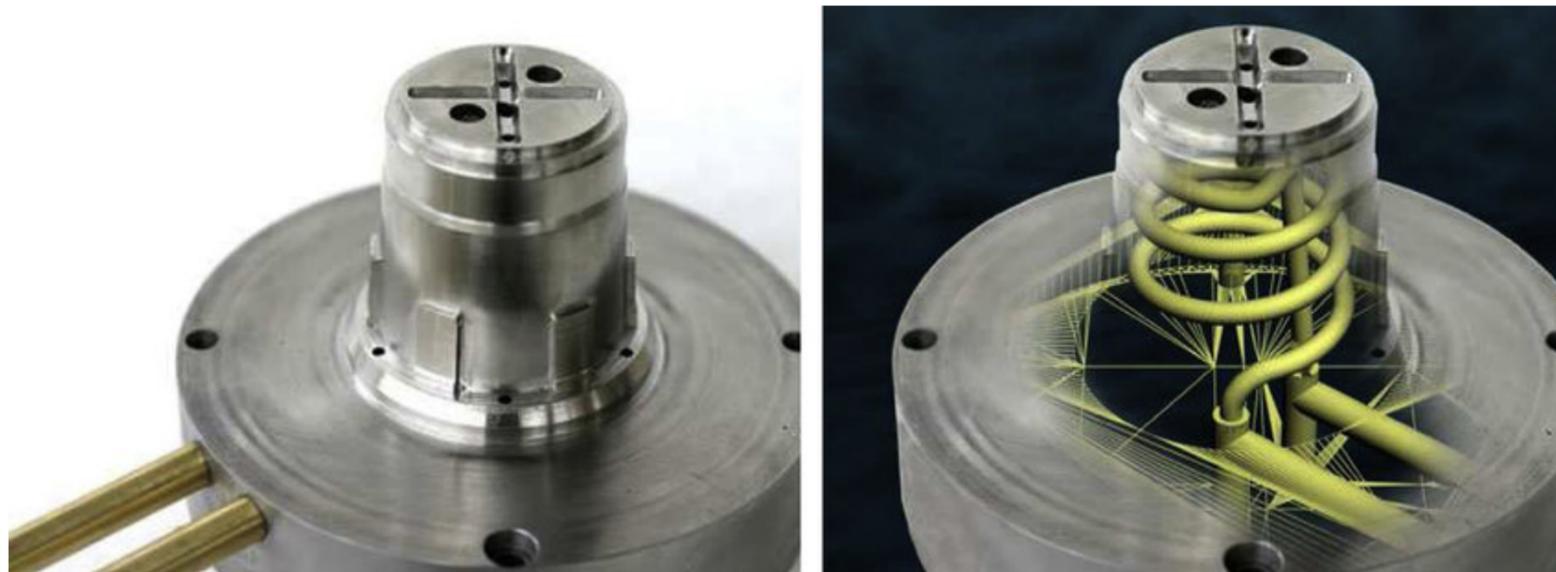
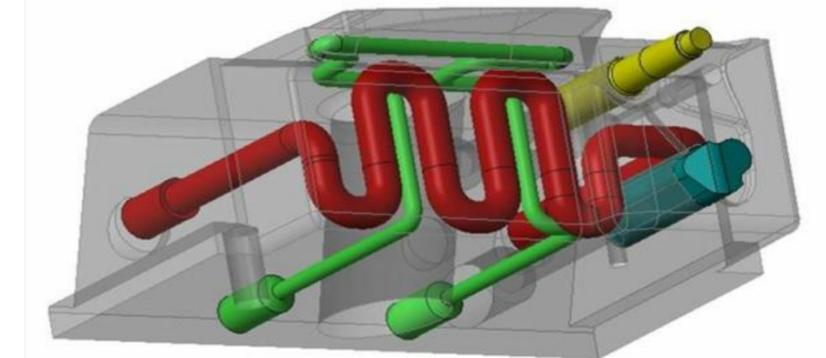
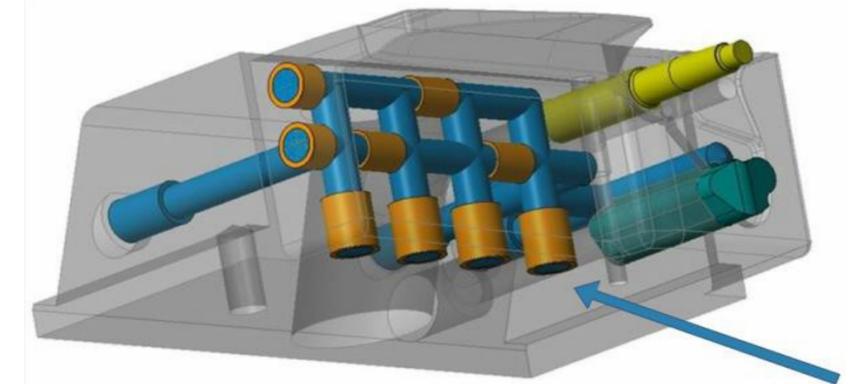
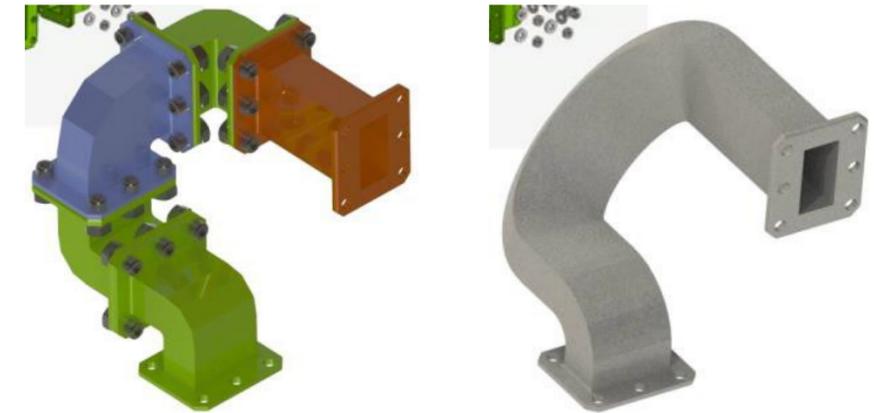
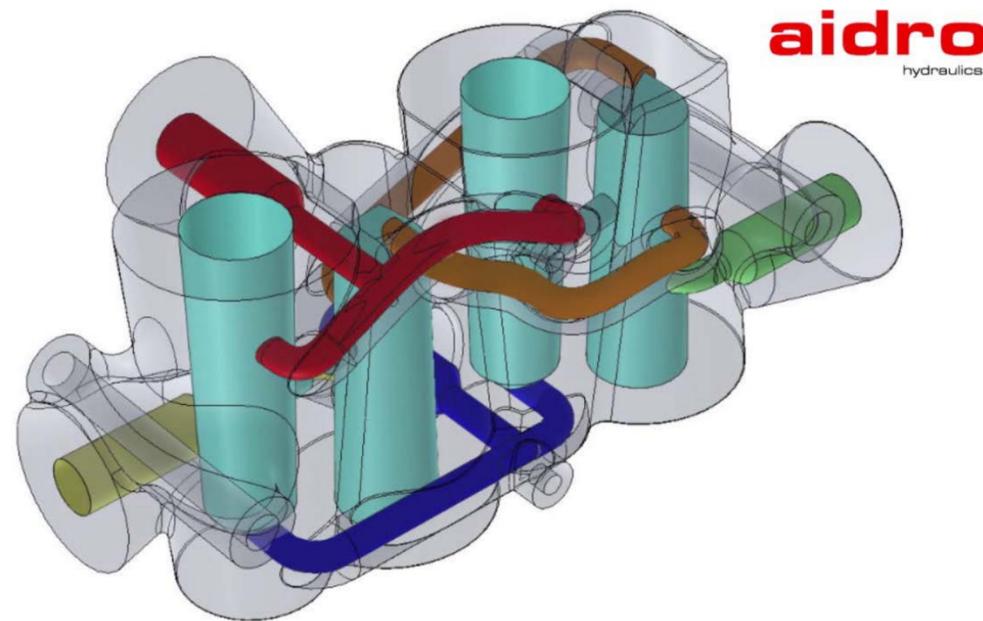
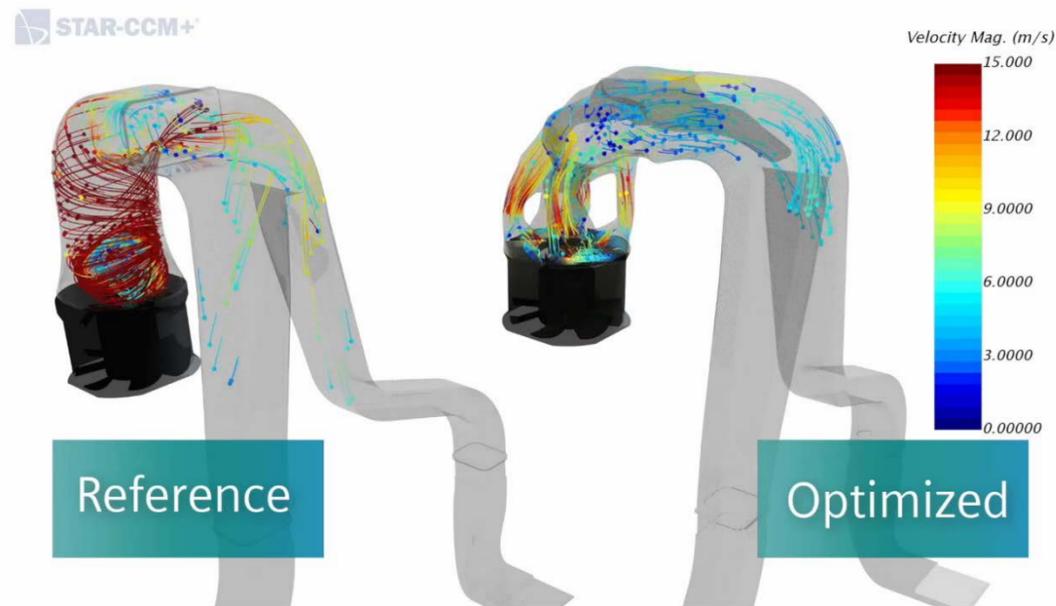
AM cost advantage



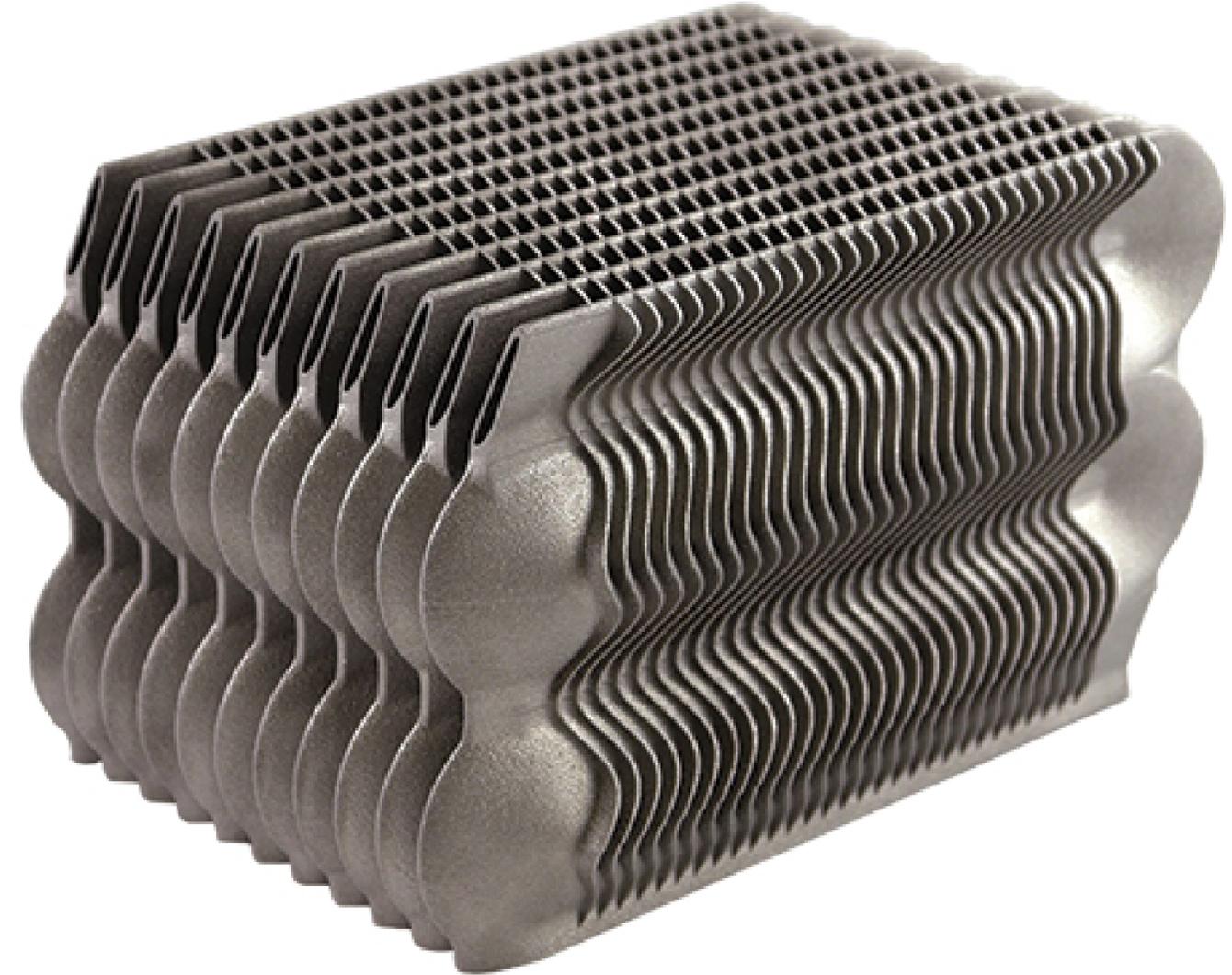
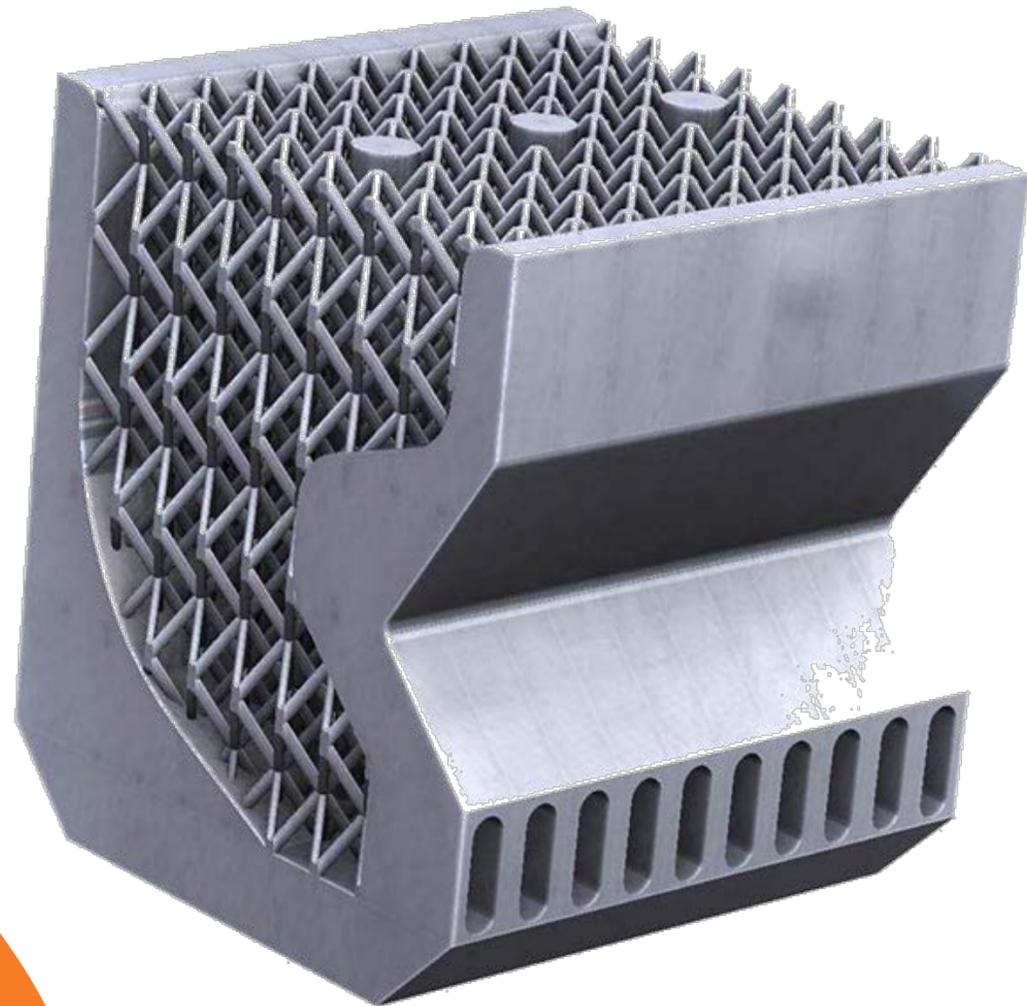
AM design advantage

- Lightweight
- Less material
- Improved mechanical properties
- More durable

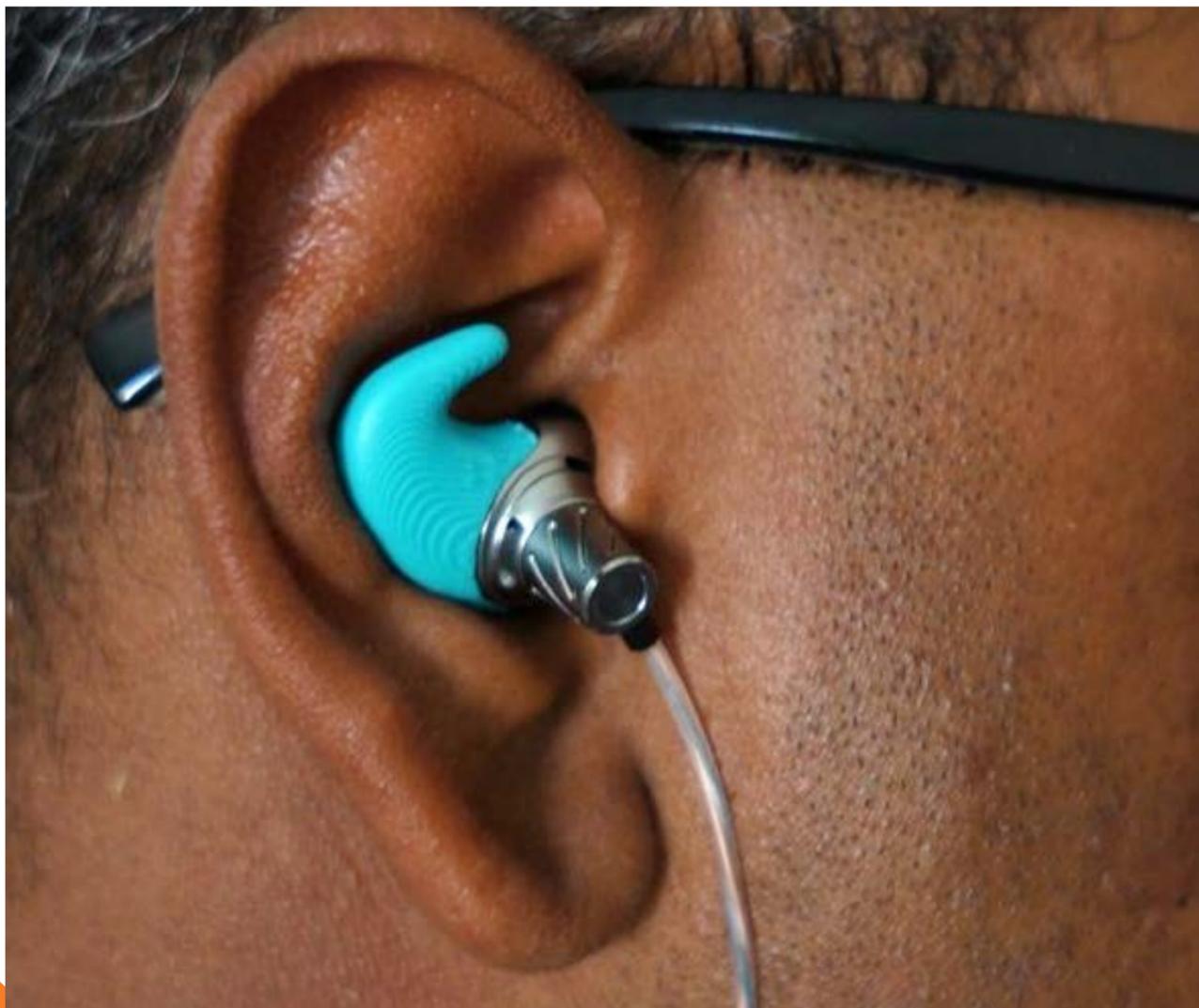
- Posso creare geometrie per migliorare il percorso e la circolazione dei flussi



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



- Posso personalizzare ogni singolo prodotto



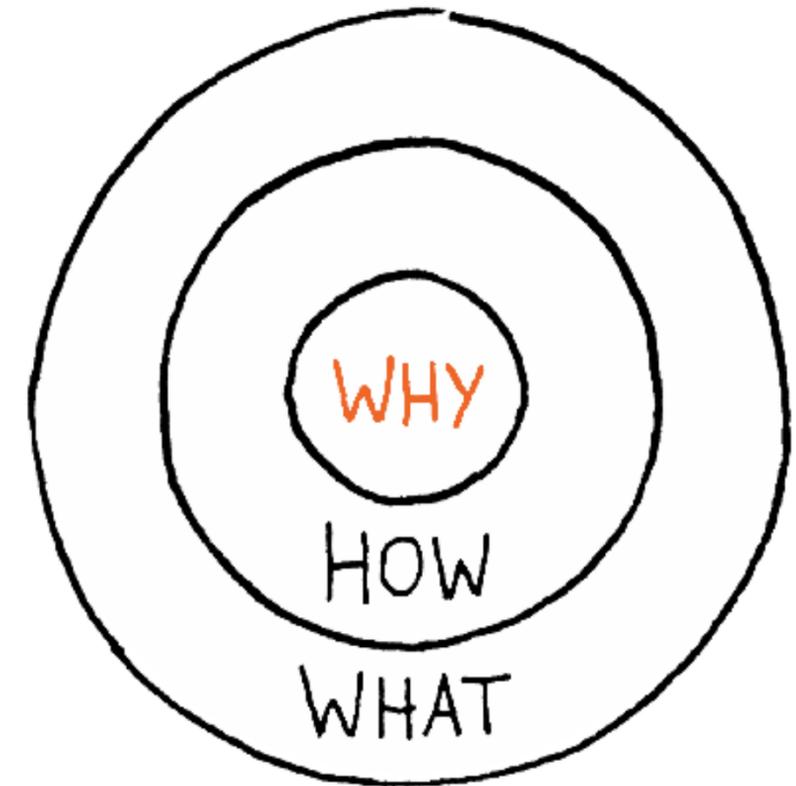
IL DRIVER È IL TUO PERCHÈ!

01

Scegli uno o più vantaggi

02

Assegna un indicatore che utilizzerai a fine progetto



MATERIALE

01

POLIMERI

02

METALLI

03

COMPOSITI

MATERIALE

2

MATERIALE: SCELTA, VINCOLI E LIBERTA'



Economicità



Proprietà

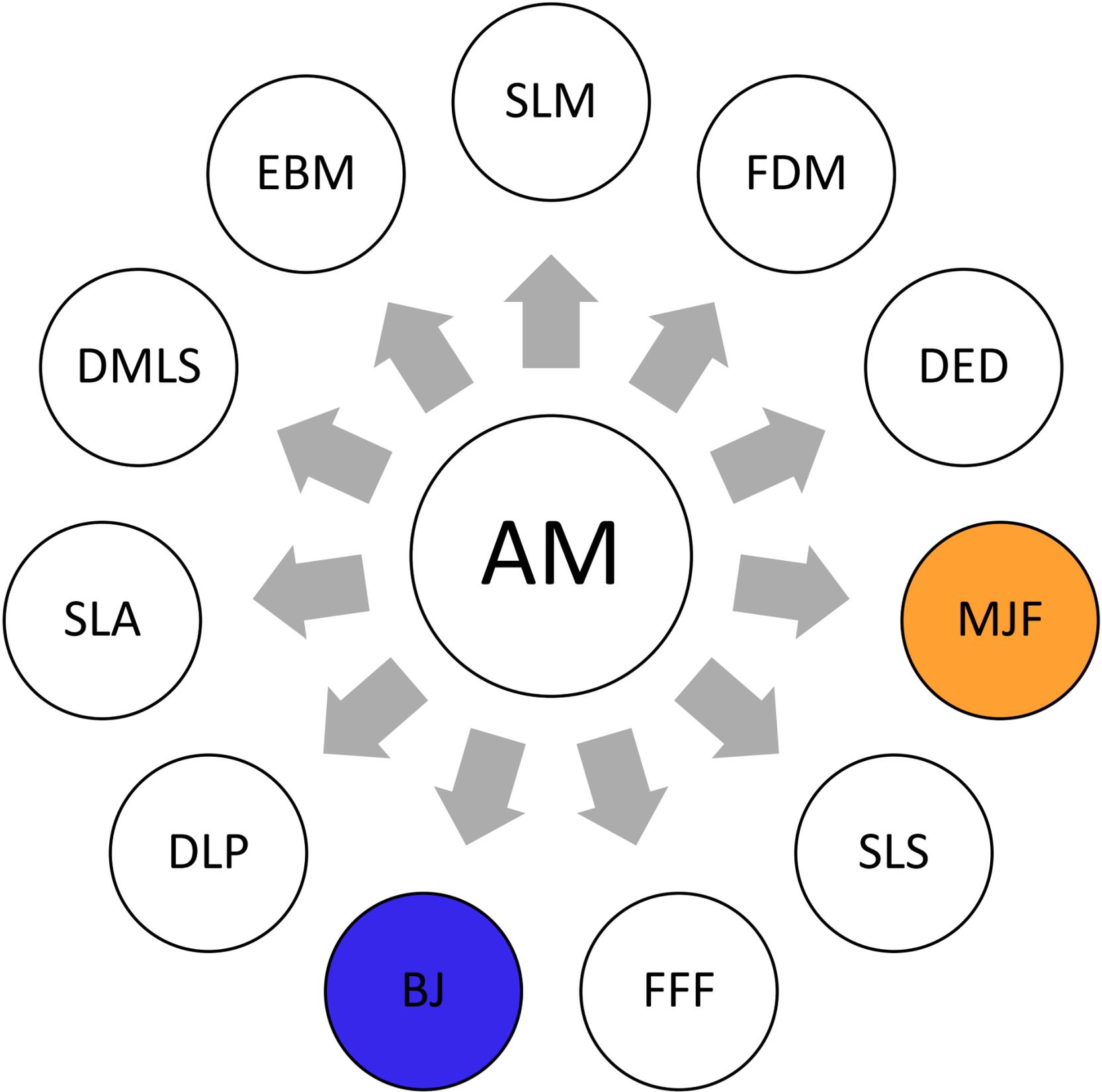


Disponibilità

TECNOLOGIE

TECNOLOGIE

3



ADDITIVE MANUFACTURING TECHNOLOGIES



SERVICE DI STAMPA 3D

shapeways*



i.materialise
more than online 3D printing services

Weerg.



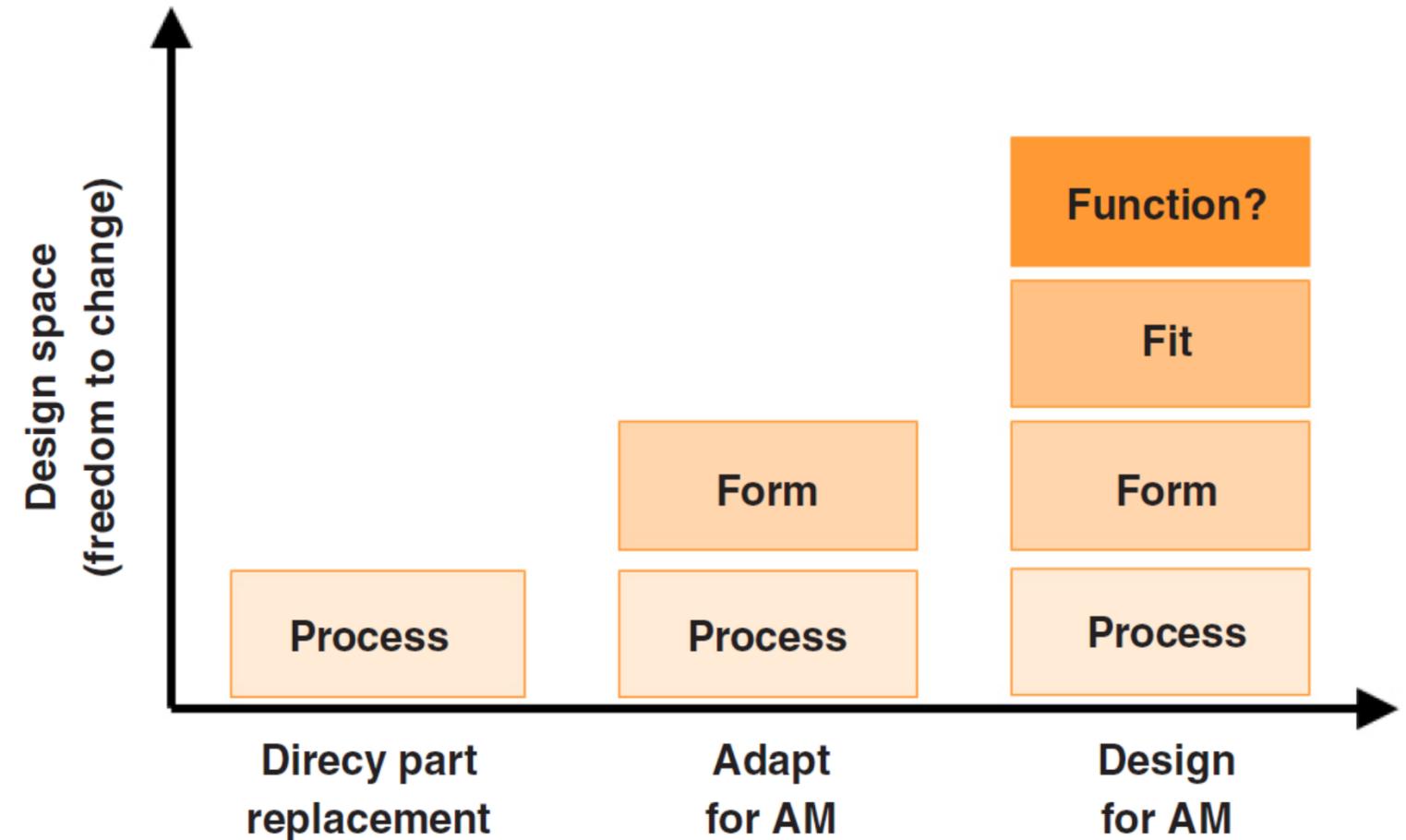
PROGETTAZIONE



DFAM o AfAM?

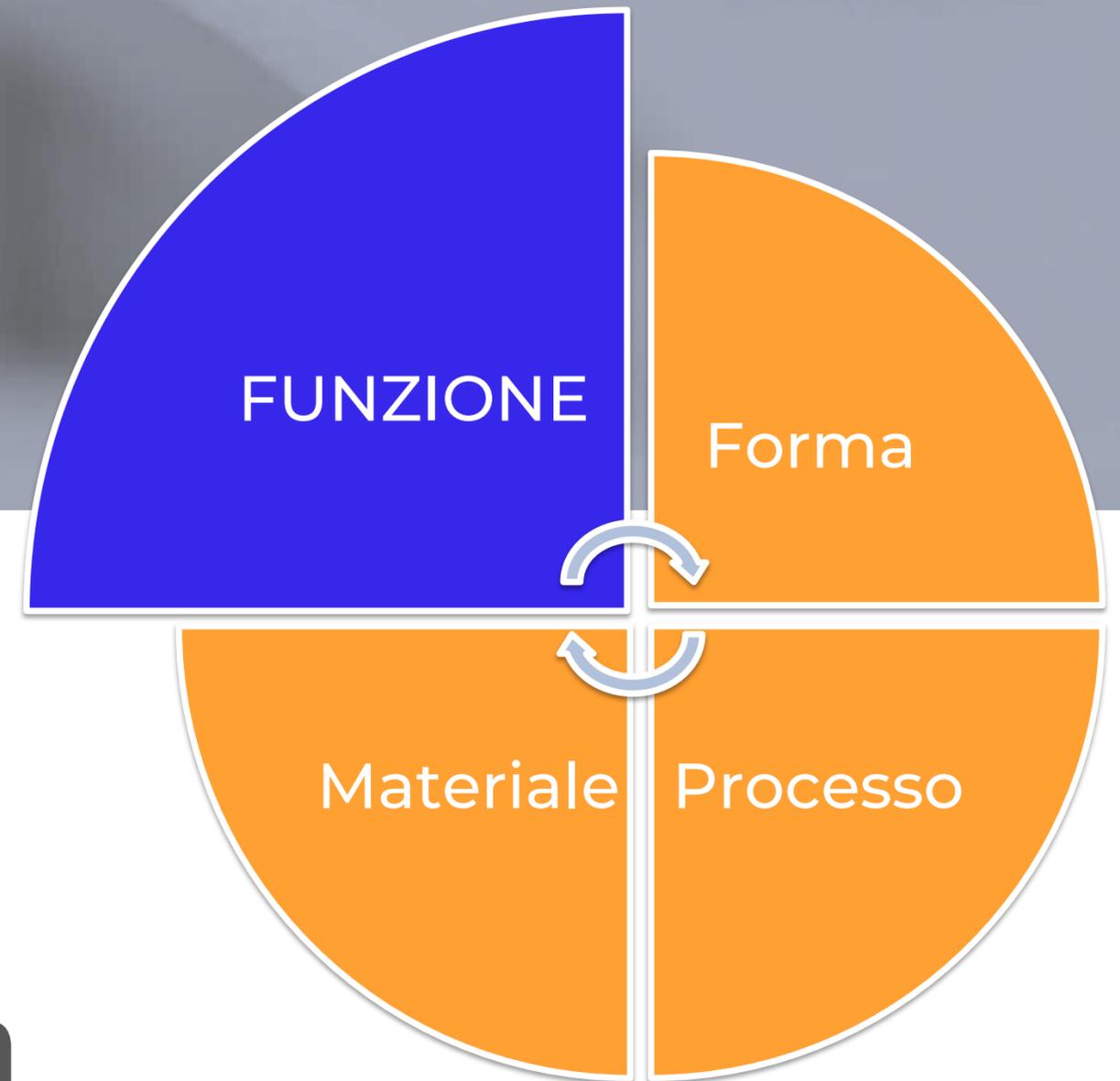
(Design for AM o Adapt for AM?)

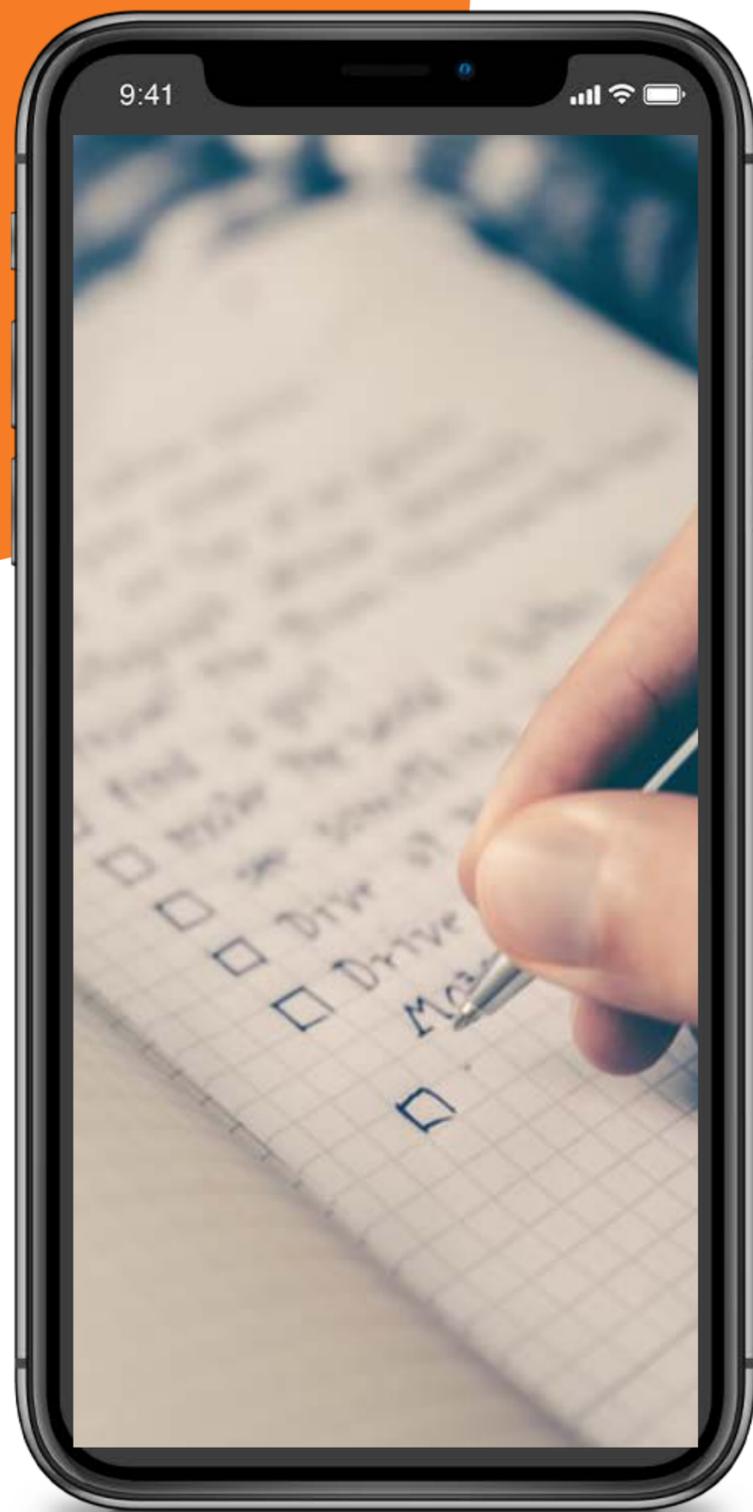
Quanta libertà ho per approcciare ad un cambio di paradigma?



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

DESIGN RULES FOR 3D PRINTING

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	Mark One	Functionality	Mark One	Material Removal	Mark One	Unsupported Features	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 support		
○	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 1mm		
○	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 oriented overhanging		
○	Thin features will almost always break	○	Interior corners must transition gradually	○	Hole or length dimensions are nominal	○	The part has or has a form to be exact		
○	Some walls are less than 1/16" (1.5mm) thick	○	Interior corners have no chamfer, fillet, or rib	○	Hole or length tolerances are adjusted for shrinkage or fit	○	The part has surfaces, or it should be exact		
○	Walls are between 1/16" (1.5mm) and 1/8" (3mm) thick	○	Interior corners have chamfers, fillets, and/or ribs	○	Hole and length tolerances are considered or are not important	○	The part has surfaces, or it should be exact		
○	Walls are more than 1/8" (3mm) thick	○	Interior corners have generous chamfers, fillets, and/or ribs	○	Starred Ratings	○	Total Score		



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

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

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

Tolerances
 +/- 0.3mm is standard.

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 $\geq 0.8mm$.

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

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.

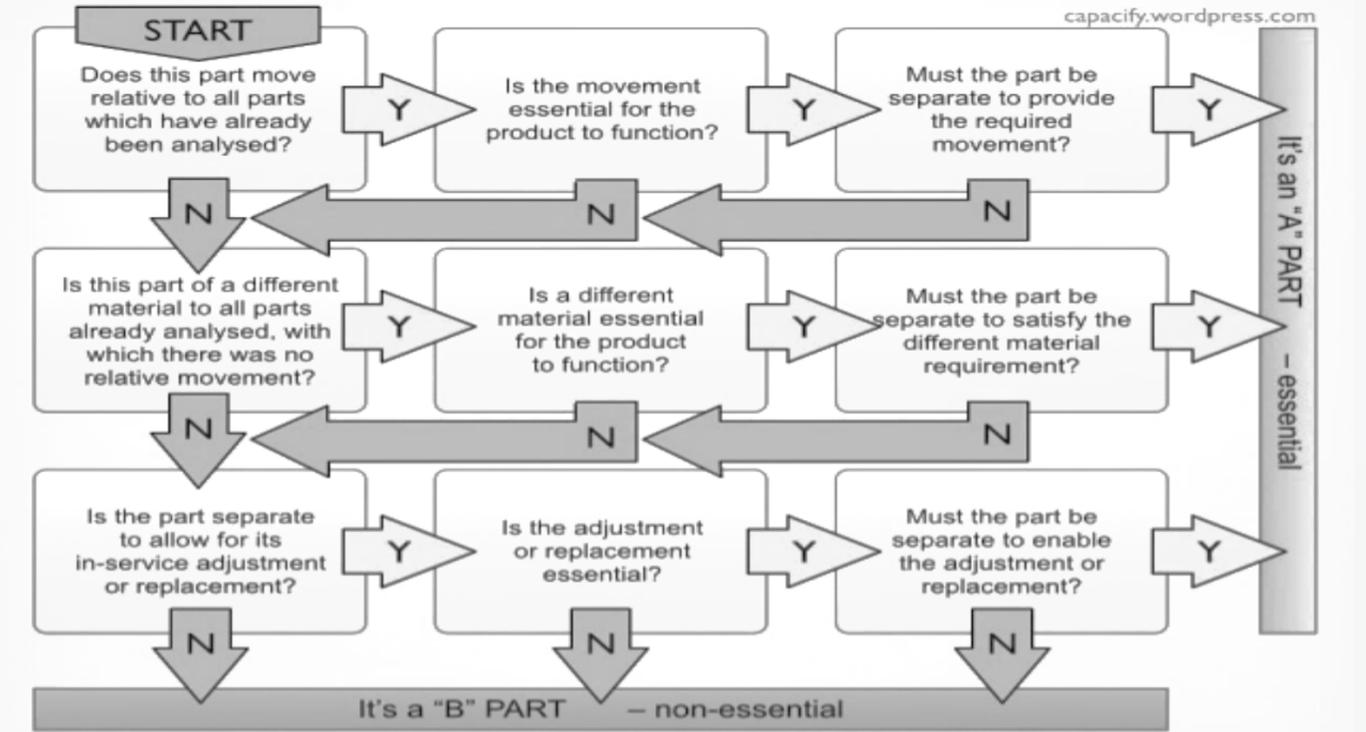
Mating (axels, gears)
 $> 0.5mm$ and $< 1mm$ gaps prevent fusion.

Min Clearance
 $> 0.5mm$

Max Clearance
 $< 1.0mm$

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

	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)
Stereolithography	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



MODELLAZIONE
(CAD)

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

OTTIMIZZAZIONE

- AUTODESK
FUSION360
- ALTAIR
HYPERWORKS
- WITHIN MEDICAL

SIMULAZIONE
(FEM, CFD)

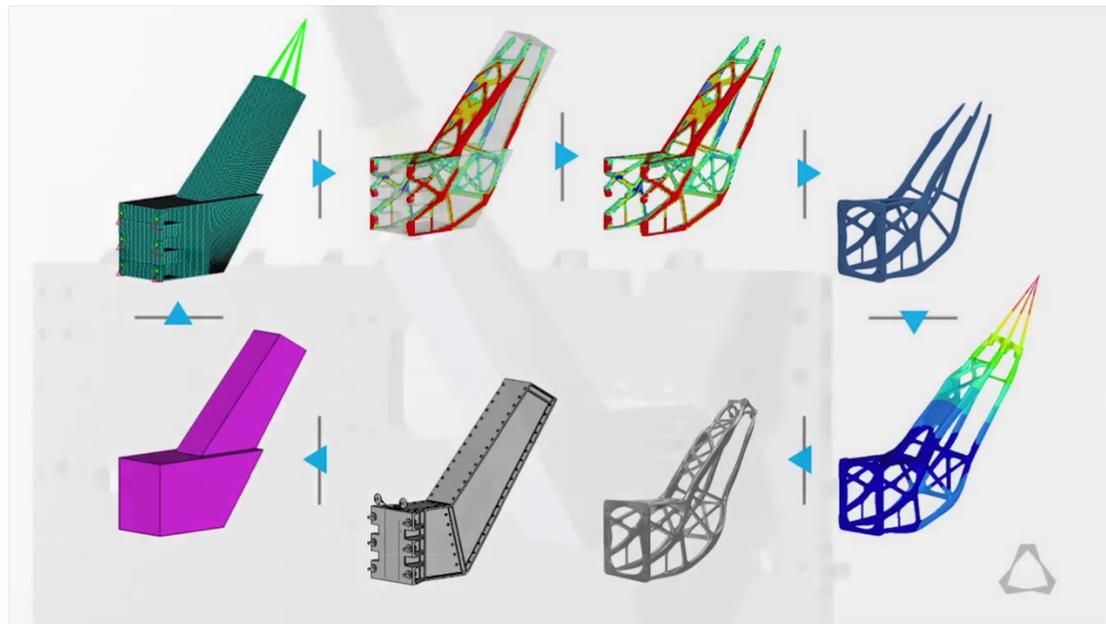
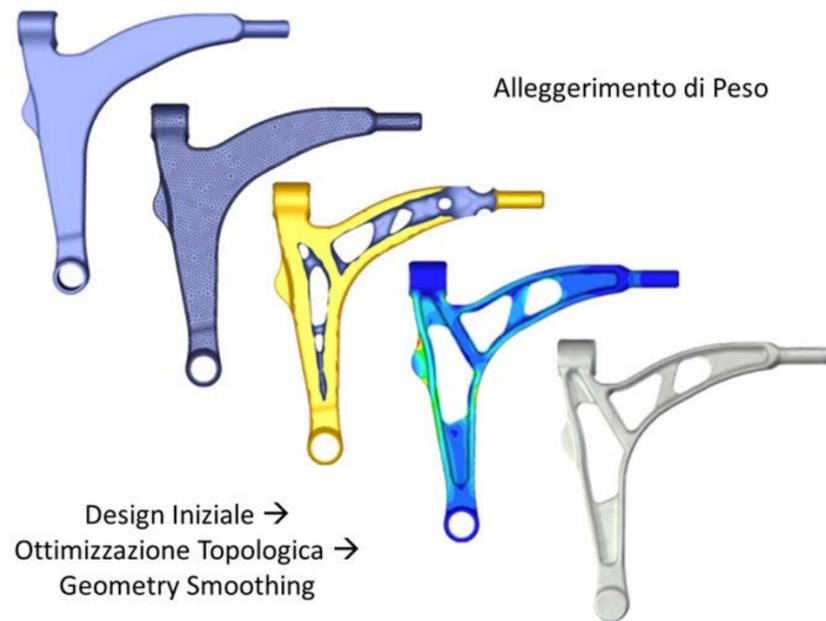
- ANSYS
- COMSOL
- SOLIDWORKS
- SOLIDWORKS
- AUTODESK
NETFABB
- WITHIN MEDICAL
- ESI VIRTUAL
- SIEMENS

PREPARAZIONE
(CAM, SLICING)

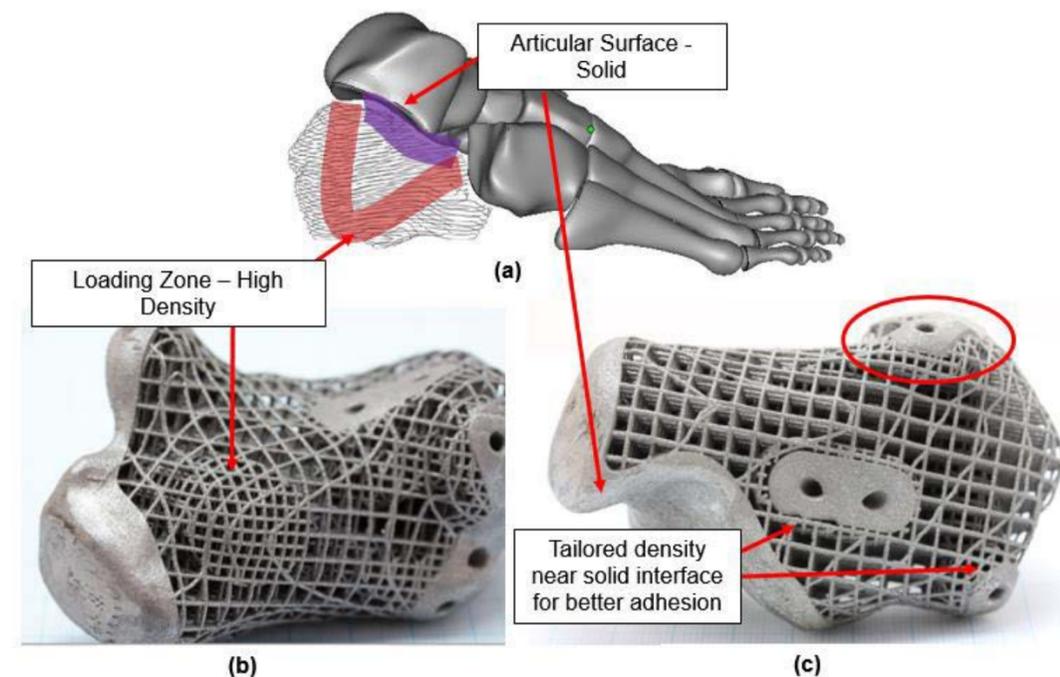
- AUTODESK
MESHMIXER
- CURA
- SIMPLIFY3D
- MAKERBOT PRINT
- MATERIALIZE
MAGICS
- AUTODESK
NETFABB

DIGITALI

OTTIMIZZAZIONE TOPOLOGICA



STRUTTURE TRABECOLARI



FINITURA

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

FINITURA

5





Perchè la finitura è importante?

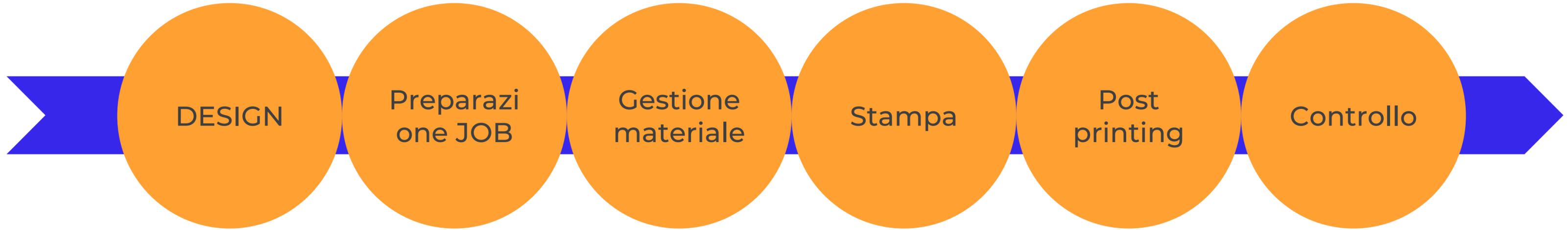
La maggiorparte delle parti prodotte con tecnologie additive necessitano di finitura per diventare applicazioni reali

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

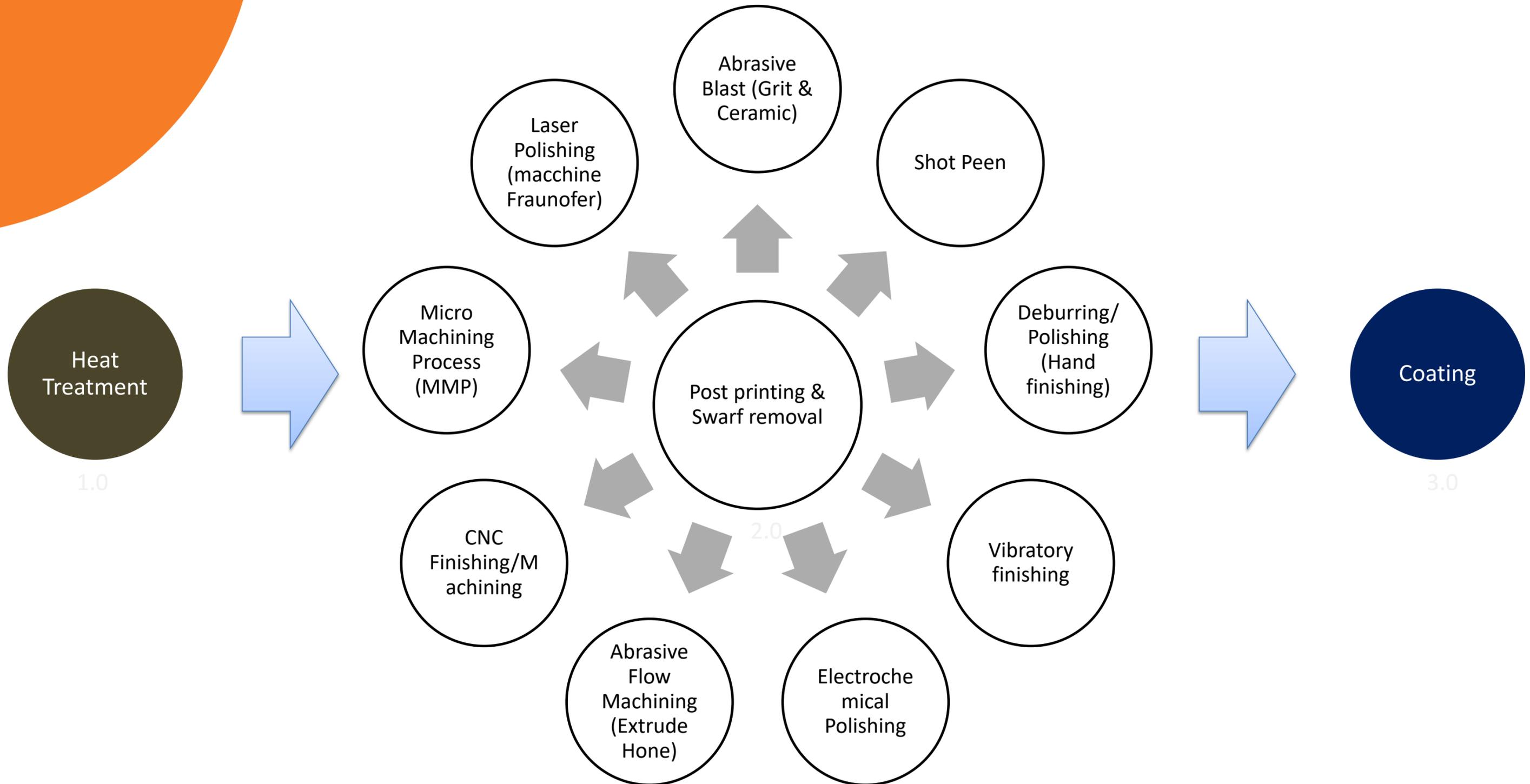
Le operazioni manuali sono davvero troppo difficili su materiali duri come titanio e inconel

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)

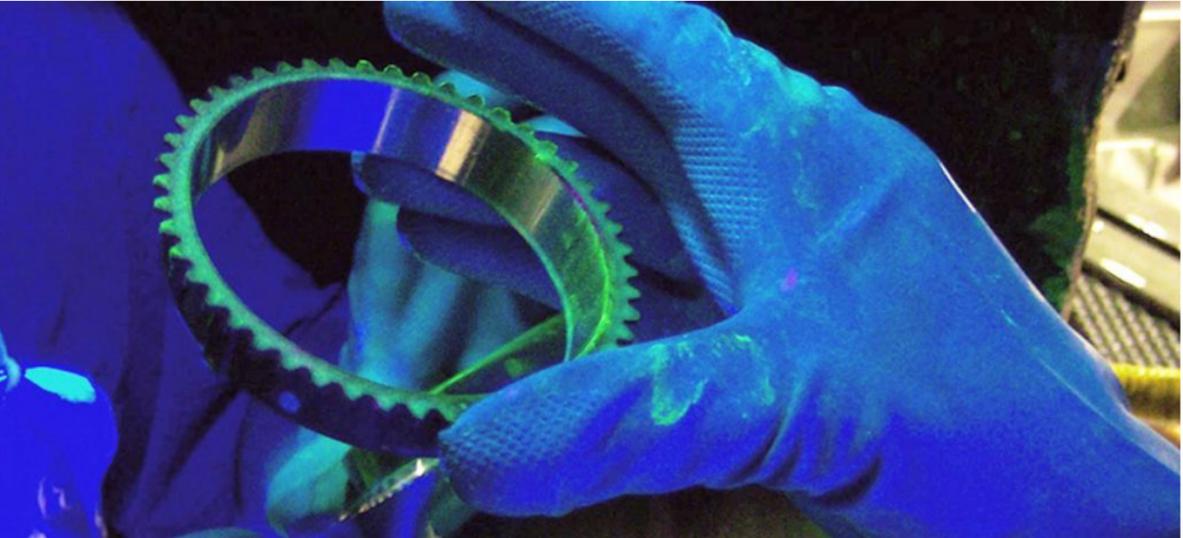
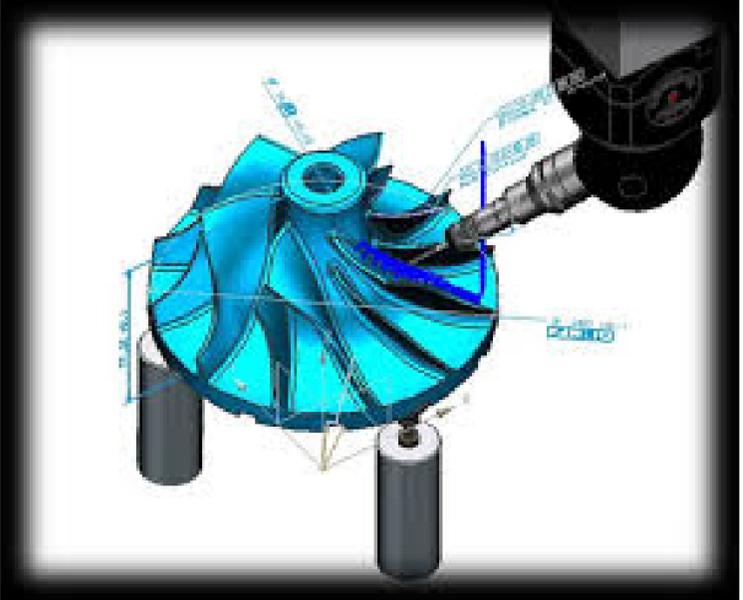
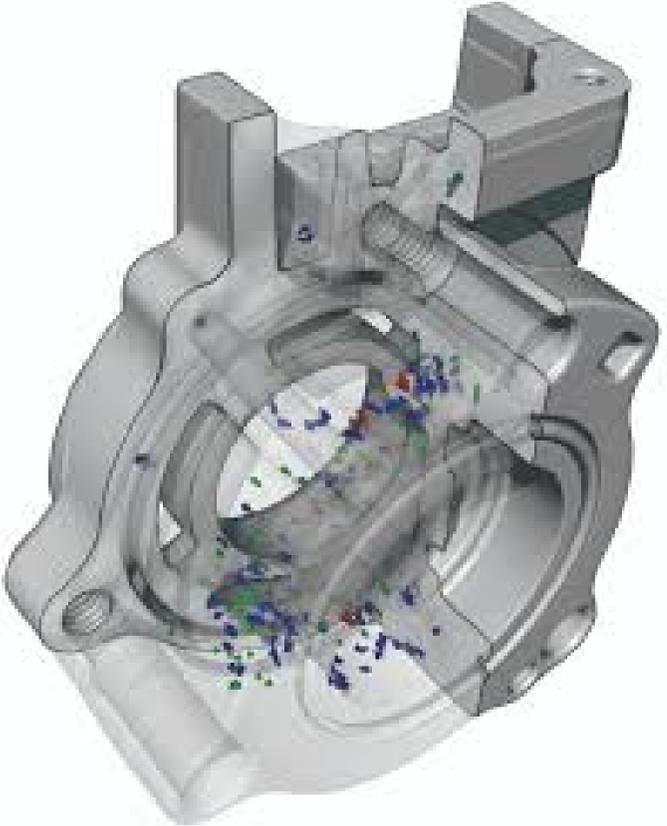
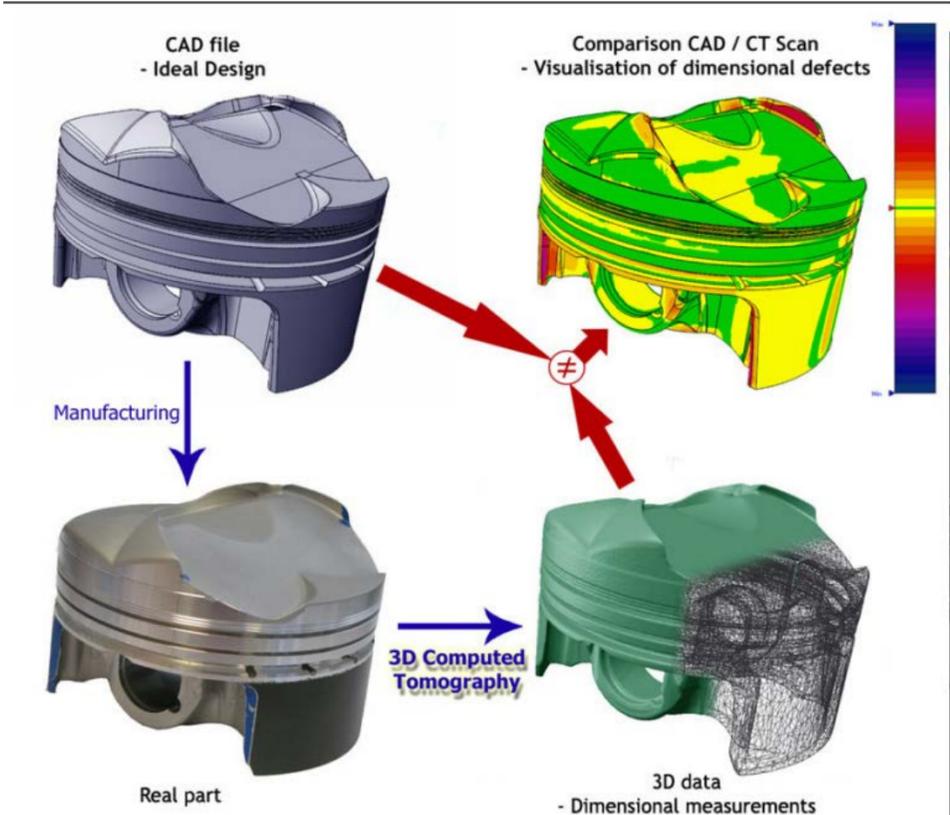
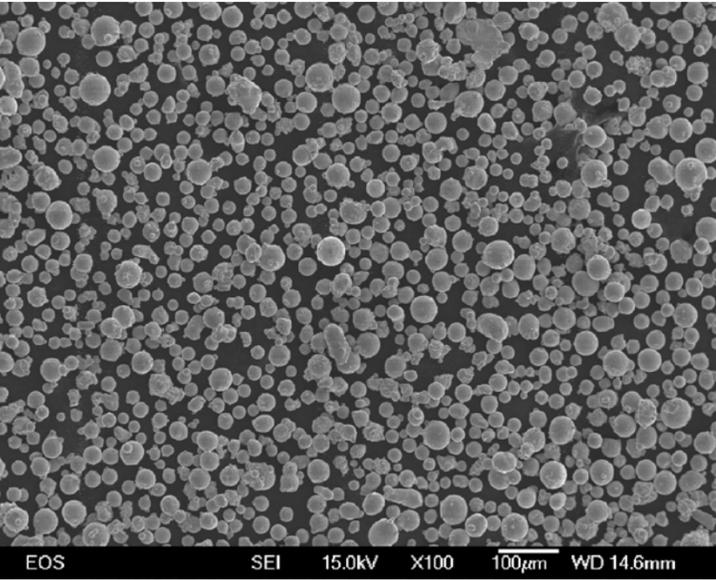
02

Controllo di processo

03

Controllo di prodotto

Controlli qualità nell'additive manufacturing



ECONOMIA

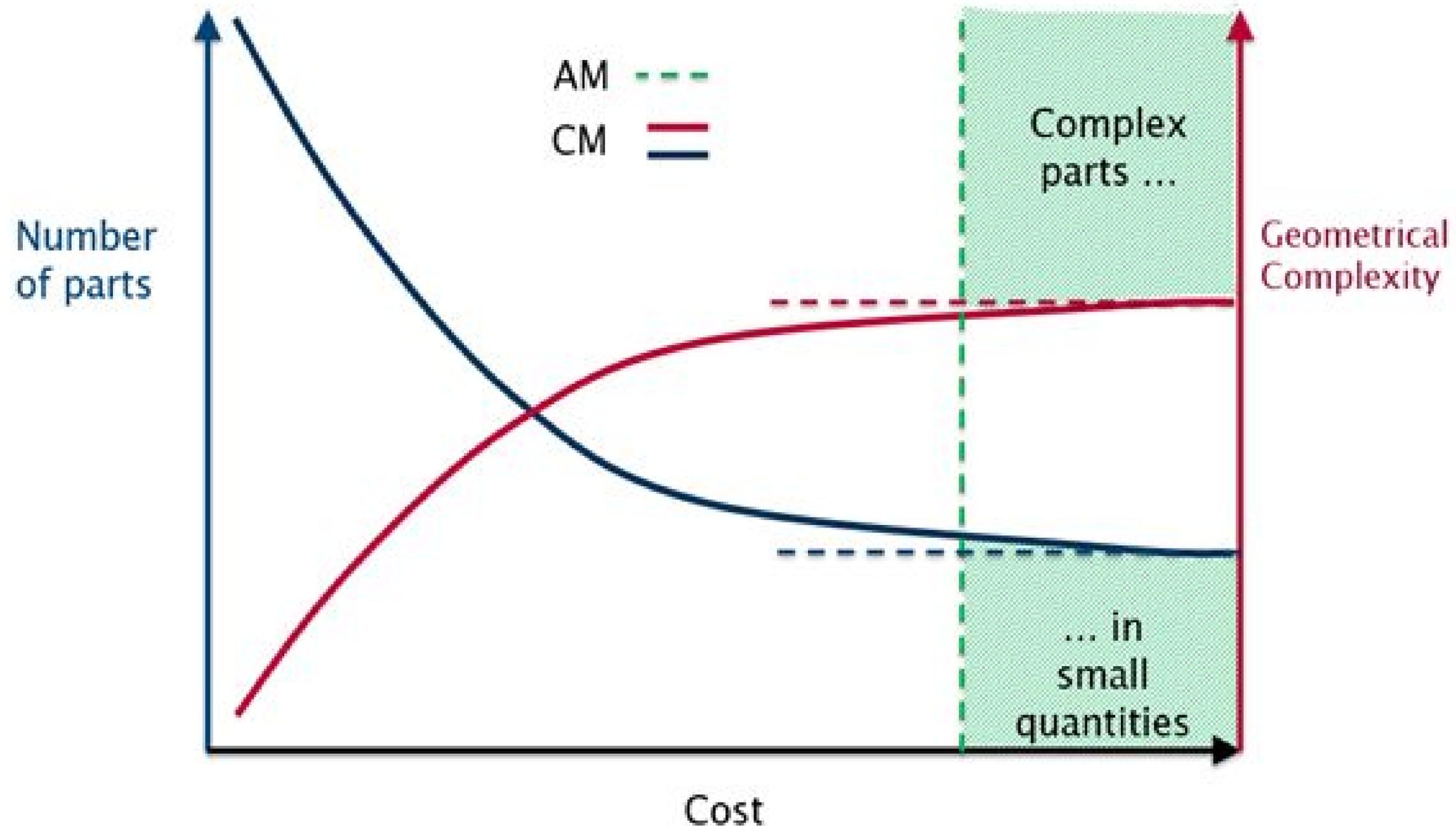
- 01 Stampa (Macchine)
- 02 Materiale
- 03 Personale che si occupa di stampa
- 04 Finitura (Macchine)
- 05 Personale che si occupa di finitura

ECONOMIA

7

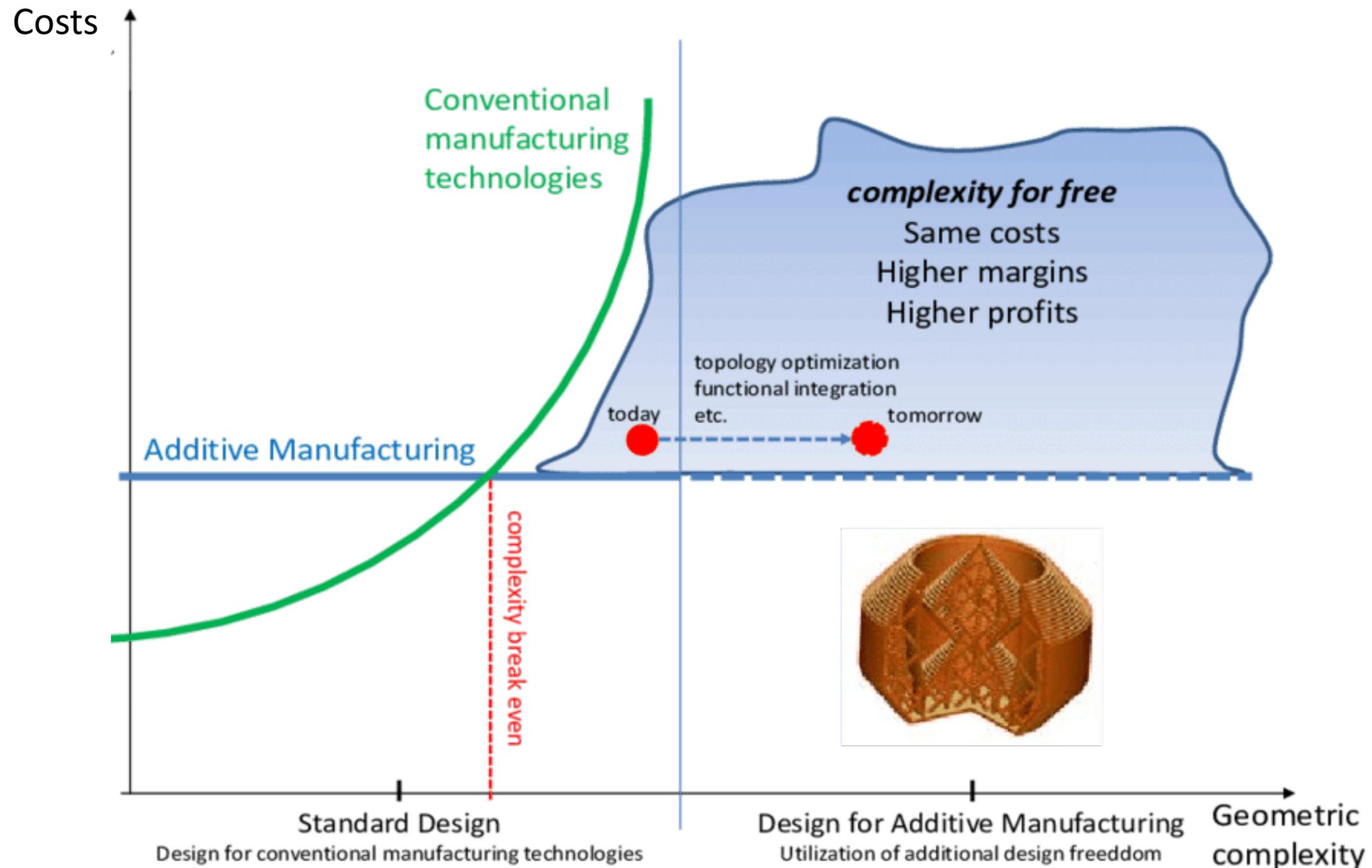
AM: Il fattore convenienza

ADDITIVE MANUFACTURING VS CONVENTIONAL MANUFACTURING



AM: Il fattore convenienza

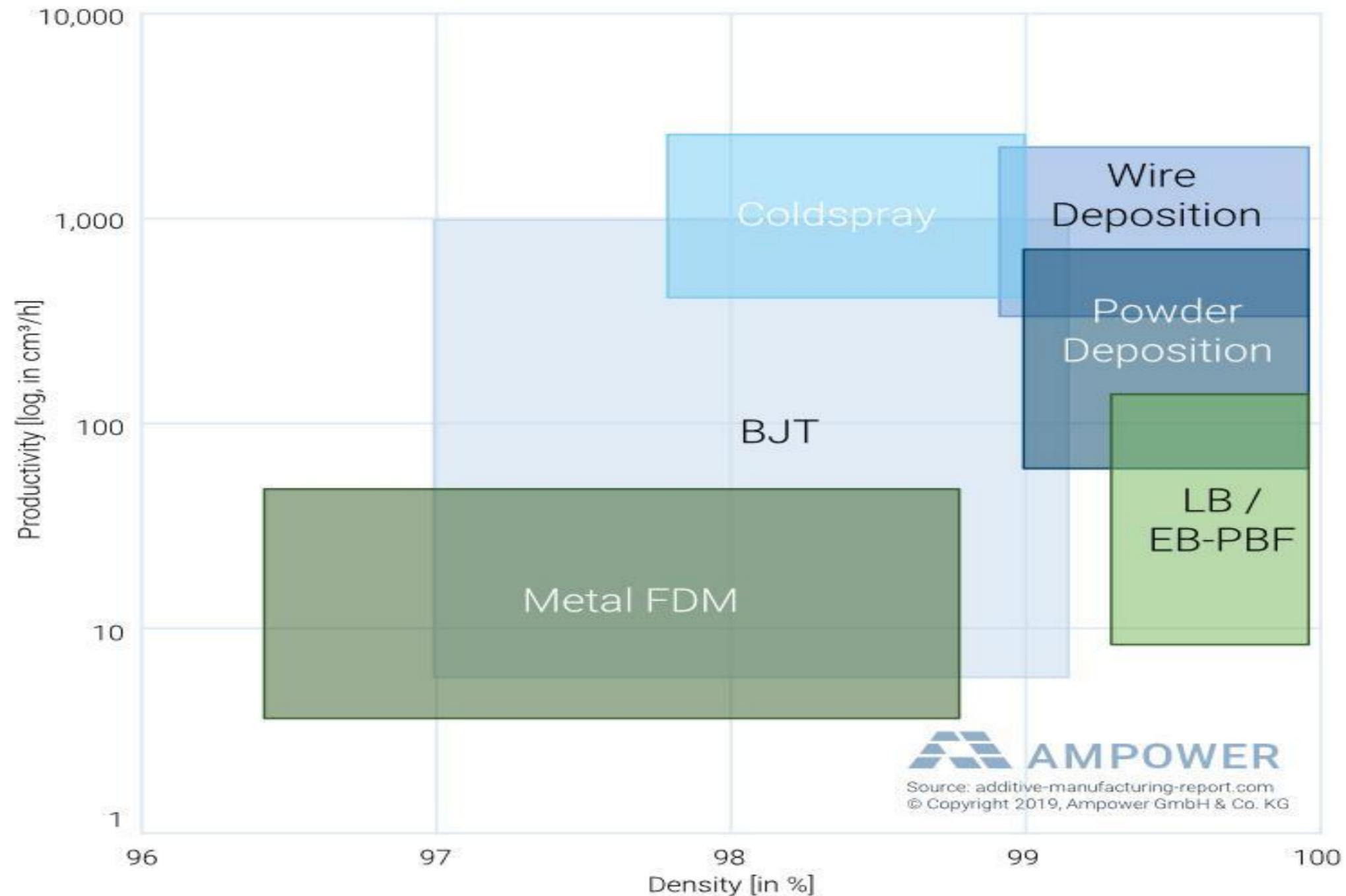
ADDITIVE MANUFACTURING VS CONVENTIONAL MANUFACTURING



AM: Il fattore convenienza

Material performance vs. productivity

Exemplary performance in terms of density

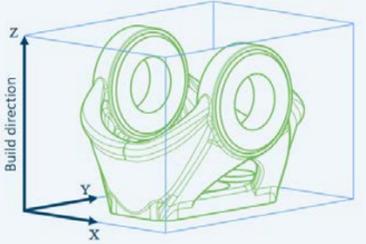


COST CALCULATOR

ADDITIVE MANUFACTURING COST TOOL

Estimate your Additive Manufacturing cost per part

In an early stage of business case contemplation an accurate calculation of manufacturing cost becomes complicated since multiple uncertain parameters have to be taken into consideration. However, in the phase of a principle part identification and screening, a fast estimation model is required to determine the potential for any given part. The AMPOWER part cost calculator provides an estimation of the minimal and maximal cost for 7 different metal Additive Manufacturing technologies with 4 different alloys. Read more about the considerations and explanations of the cost tool [here](#).



To the cost calculation

Preventivi Online

0523 609778 maepc@maeprototipi.com Riservatezza FAQ



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PROTOLABS

Selezionare il metodo di fabbricazione

<p>STAMPA 3D</p>  <p>Da 1 a oltre 50 pezzi spediti entro 1-7 giorni</p>	<p>LAVORAZIONE CNC</p>  <p>Da 1 a 200 pezzi lavorati entro 1 a 3 giorni</p>
<p>STAMPAGGIO A INIEZIONE</p>  <p>Da 25 a 10.000 pezzi stampati entro 1 a 15 giorni</p>	<p>SOVRASTAMPAGGIO E STAMPAGGIO CON INSERTI</p>  <p>Da 25 a 10.000+ pezzi consegnati entro 15 giorni</p>

Please en **Freelabster**

Servizi Risorse Diventa Freelabster Connessione / Iscrizione Stampare in 3D

Ordina la tua stampa 3D ora

Approfitta della professionalità dei Freelabster per realizzare i tuoi progetti

Per saperne di più

Ho un file 3D NON ho un file 3D

CARICA IL TUO FILE STL O ZIP (CONTENENTE STL)

Stiglia

o trascina-deposita il tuo file

Plastica

Economica

Scopri il prezzo

Click here to upload or drag and drop your model to the canvas.

La misura file: mm inch

Stats:

preventivo-on-line

ATTENZIONE: importo minimo € 20,00 (IVA e spese di trasporto esclusi), l'importo deve essere raggiunto con lo stesso tipo di materiale.

Materiale: Nylon 12 Nero spedizione a 8/10 gg lav.

Hp Jet Fusion

SLS

COD: N/A

Categoria: Prototipi

Weerg.

Preventivo Online Gratuito

falli un demo

materiali finiture gallery faq contat



NEW QUOTE

1. Carica qui il tuo file 3D
2. Ricevi i pezzi sul tuo tavolo da 3 giorni

> ATTENZIONE: condizioni sottocosto sulla stampa 3D di plastica biocompatibile solo per le aziende sanitarie ATECO 86 > info



Il Top della stampa 3D

> Carica qui tuo file 3D
I pezzi sul tuo tavolo da 3 giorni



Il meglio del CNC 5 assi

> Carica qui tuo file 3D
I pezzi sul tuo tavolo da 4 giorni

1 Select a technology

3D printing
FDM, SLA, SLS, MJF, DMLS, Polyjet

CNC machining
Milling (3-axis, 5-axis), Turning

Sheet metal
Laser cutting, Bending

Injection molding
Single cavity molds, Family molds

2 Upload files and configure parts to get an instant quote

+ Select CAD files

Instant pricing available for STL, OBJ, STEP, IGES, SLDPRN, 3DM, IPT, SAT and X_T files.

Please note: weapons and files requiring an export license (including dual-use) are prohibited.

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Workshapes

preventivo istantaneo

PREVENTIVO Istantaneo

Scegliere la lingua preferita e caricare il modello 3d

1 Cerco 2 Prezzo 3 Carrello 4 Consegna 5 Riepilogo

SUPPORT DISCOUNT Details

UNITÀ DEL MODELLO

Millimetri Pollici Centimetri

CARICA MODELLO 3D

O semplicemente trascinare e rilasciare modelli 3D singoli o multipli (fino a 10 contemporaneamente) in questa area

Attualmente supportiamo file: stl, obj, step, igs, slt, igs, igs, 3mf, 3mf e zip (con modelli e texture) fino a 100 mb

OUTCOME

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

- 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.

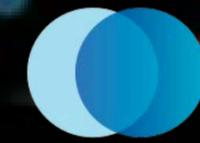


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Technology Innovation Advisor



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STRATEGY & VENTURES

THANK YOU