Accelerating Products to Marketing with Additive Manufacturing

Digital Solution overview for Nanoinnovation 2017, Rome, Italy

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JABIL

Nano Innovation 2017 Rome, 26-29 September
Conference & Exhibition

How Jabil Empowers You Today

OUR MARKETS

OUR E2E OFFERINGS

innovate | design | plan | make | deliver | manage

OUR DIGITAL ENGINE SPEED, AGILITY FACTOR

The Digital Thread: Jabil's Intelligent Digital Platform™

The data and connectivity thread that makes Jabil fast and efficient across the entire product lifecycle

INNOVATION FUEL: ENGINEERING EXCELLENCE

- Acoustics
- Additive Manufacturing
- Adhesives
- Advanced Assembly
- Automation
- Dynamic Tuning
- Emerging Markets
- Experience Design
- Fluidics
- Human Machine Interface
- Intelligent Digital Supply Chain
- IoT
- IT Cyber Security
- Materials Technology
- Miniaturization
- Optical Communications & Networking
- Optics
- Power Engineering
- Precision Injection Mold Tooling
- Precision Mechanics
- Printed Electronics
- Sensors
- Smart Clothing
- Test Engineering
- Value Engineering
- Wireless Connectivity

OUR DIFFERENCE

Talent
Continual education & investment in people

Portfolio
Unmatched collection of technology & engineering capabilities across 14 sectors

Digital
Our digital platform, connectivity & data-based approach

Values
Award-winning social & environmental responsibility programs & great people

Business model
Unique SECURE WORK-CELL MODEL PROTECTS REPUTATION, BRAND & IP

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180k	102	27,000	26	1,600	330	18b/1.2b
EMPLOYEES	PLANTS GLOBALLY	SUPPLIERS	PLANTS IN USA	CAPABILITIES	TOP BRANDS	REVENUE/OCF

Jabil Italy

Location: South Italy - Marcianise Industrial Area

- Employees = 850
- Campus area: 90,000 smq
- Production area: 18,000 smq
- 30 Km from Naples Airport
- 33 Km from Naples Harbour
- Close to A1 main Italy highway

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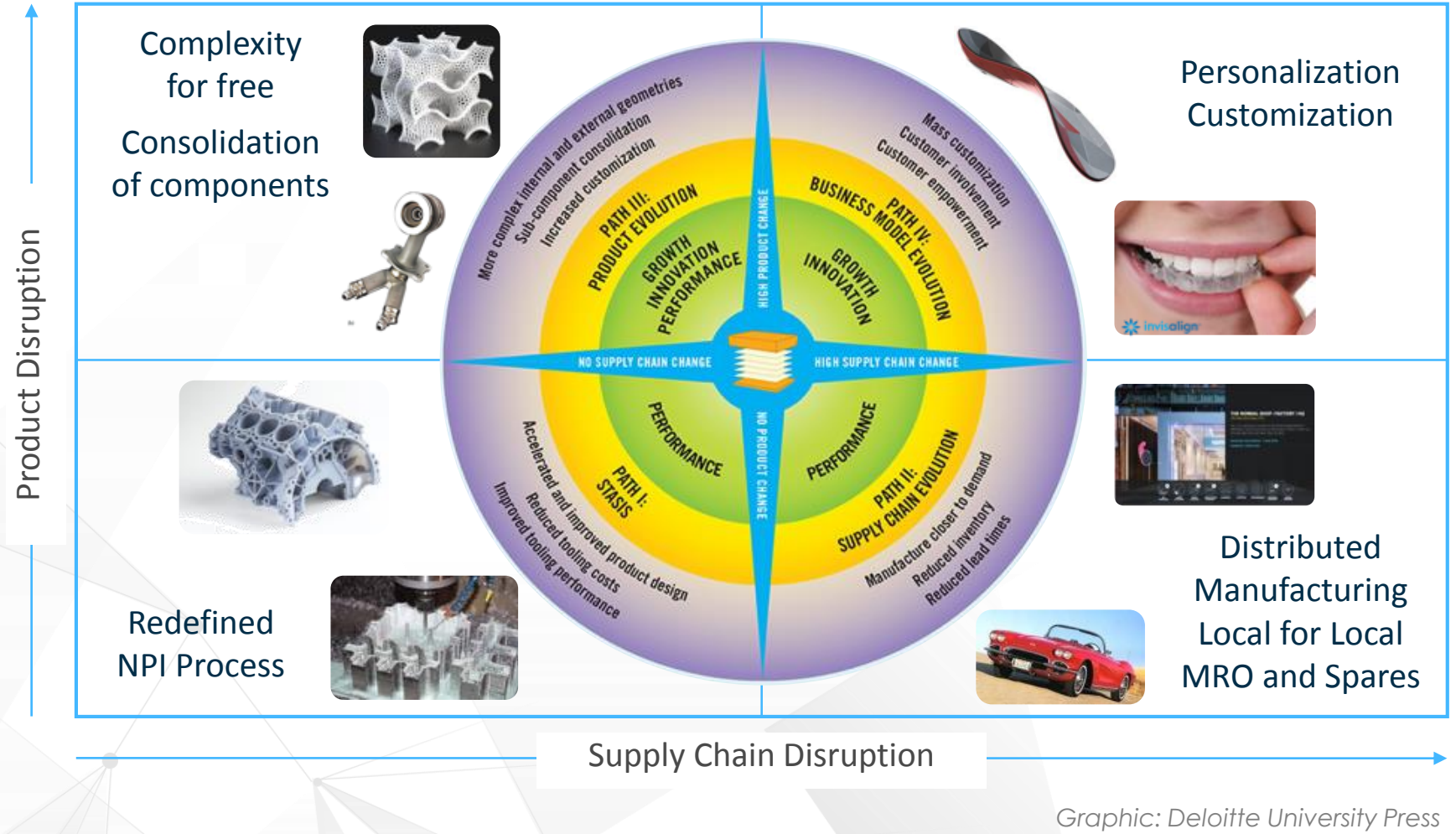
3D Printing Value Proposition

DESIGN FREEDOM AND ELIMINATION OF TOOLING ENABLES DIGITAL



Graphic: Deloitte University Press

3D printing is the process of producing parts through a layer-by-layer additive process without the need for part specific tooling, or the waste associated with traditional processes.

As a fully digital manufacturing process, 3D printing is a fixtureless production process that allows parts to be instantly moved from location to location as digital files, creating a more agile, responsive manufacturing operation.

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The $12 Trillion Opportunity

3D PRINTING TRANSITION FROM PROTOTYPING TO PRODUCTION

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Additive Manufacturing Market Gaps

MANUFACTURING IS MORE THAN PROTOTYPING AT SCALE

Materials

- More materials
- Digital materials
- Microstructure
- (clear processing
- parameters)
- Standards

Software

- Ease of use
- Printer drivers
- Compatibility with
- different machines
- (standards)
- Process control

Hardware

- Speed
- Cost
- Build volume
- Precision
- Surface quality
- Thermal contraction
- Repeatability
- Anisotropy
- Energy efficiency

Workflow

- Broken workflow
- Design reliability
- Manual preparation
- for printing
- Manual post processing
- Consistency
- between machines
- Energy efficiency

Legal

- Safety after user file
- changes
- Design piracy
- Copyright
- Safety of printers

Source: IDTechEx Identified

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Our Purpose

Change the way things are made

Our Business

We integrate 3D printing solutions into manufacturing:

Materials development and certification

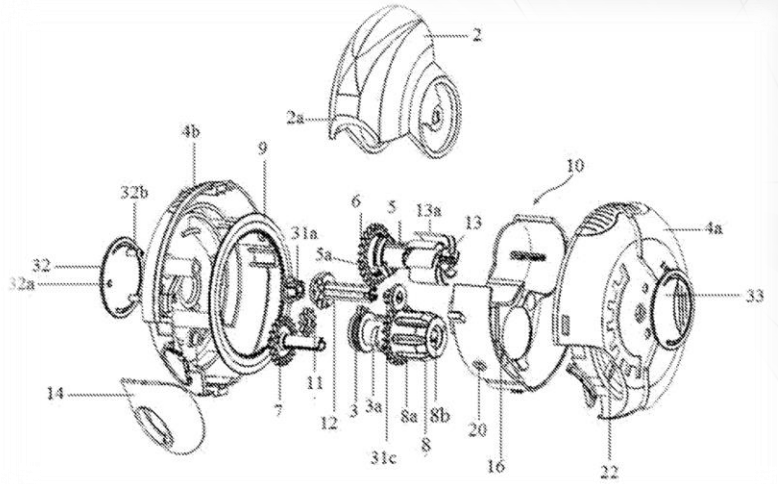
Process development

3D Supply chain integration

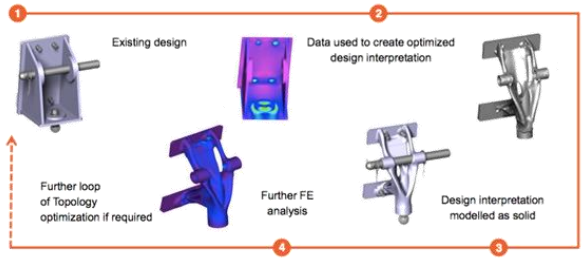
Provide hardware, software, materials and services

Accelerating Production Parts

Supply Chain and Use-Case Review
- Review Areas of impact
- Assess material and technology needs
- Define integration pathway



DFAM – Consultation & Workshops



Manufacturing Process Design
- Process development
- Material development
- Machine parameter development

Manufacturing Implementation
- System Integration
- Hardware & Software delivery
- Service support

Differentiated Production Parts
- Enhanced performance
- Complex part
- Cannot make traditionally

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Manufacturing Technology Platforms

HP Multi Jet Fusion

BUILD VOLUME

406 mm x 305 mm x 406 mm

16 x 12 x 16 in

Carbon CLIP

BUILD VOLUME

141 mm x 79 mm x 326 mm

5.6 x 3.1 x 12.8 in

Fuse Filament Fabrication

BUILD VOLUME

197 mm x 215 mm x 200 mm

7.8 x 8.5 x 7.9 in

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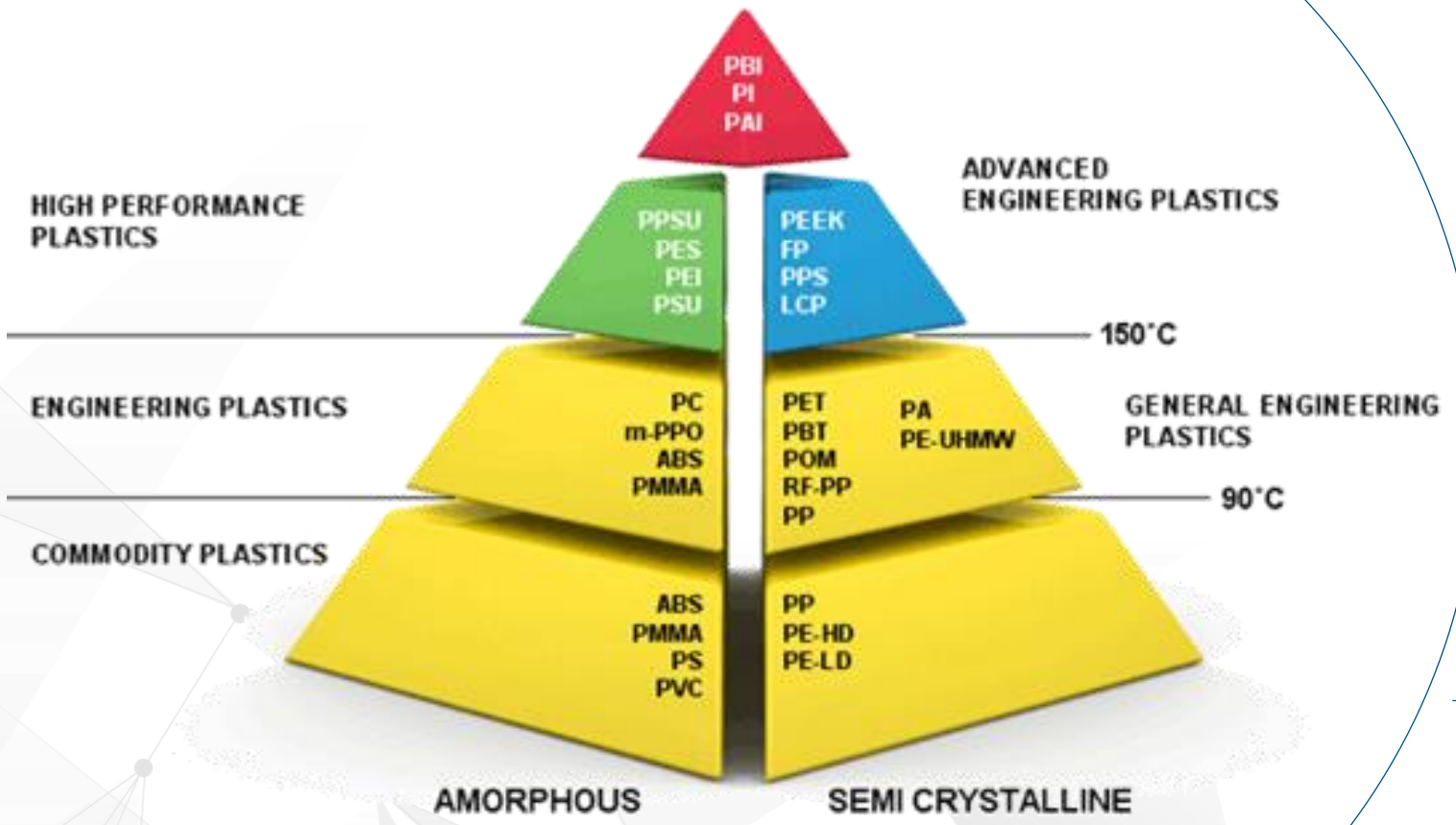
Materials are key to Additive Manufacturing

MATERIAL PROPERTIES AND COSTS OPEN UP APPLICATIONS



Applications

Powders

Filaments

Liquids

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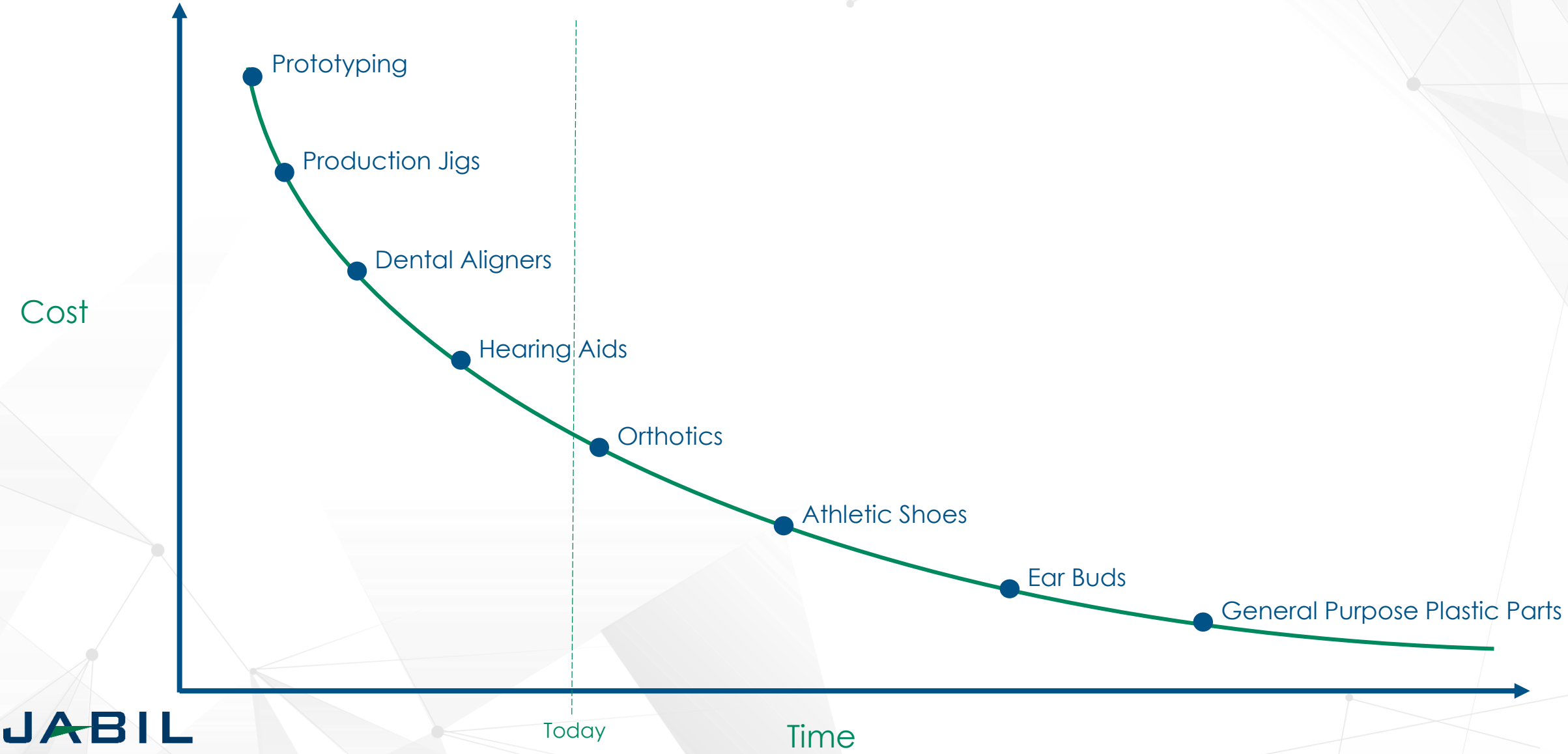
Cost Curve enables Applications



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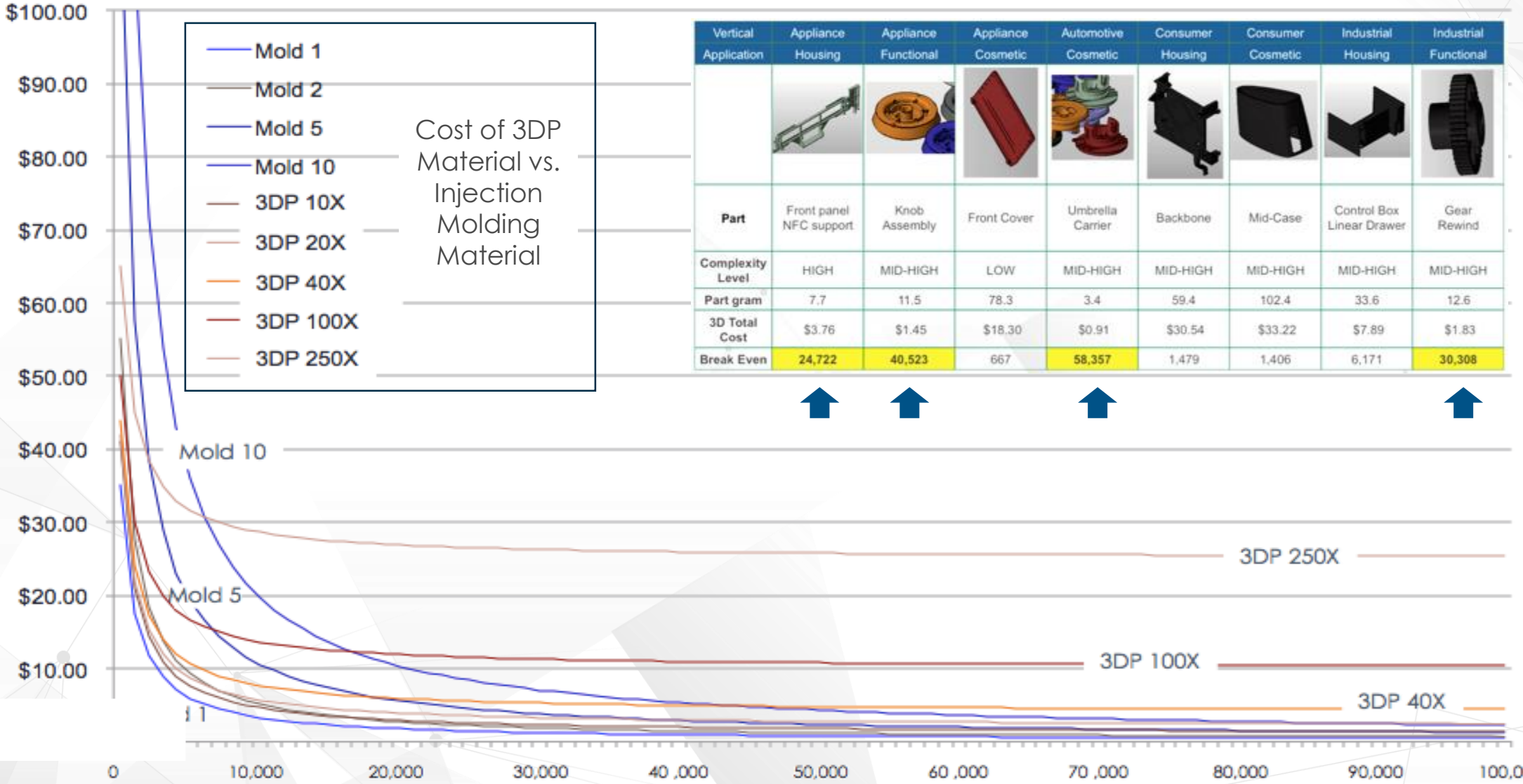
Cost Curves: 3D Printing vs. Injection Molding

SAMPLE FROM EXISTING JABIL SUPPLY CHAIN PURCHASES



Vertical	Appliance	Appliance	Appliance	Automotive	Consumer	Consumer	Industrial	Industrial
Application	Housing	Functional	Cosmetic	Cosmetic	Housing	Cosmetic	Housing	Functional
Part	Front panel NFC support	Knob Assembly	Front Cover	Umbrella Carrier	Backbone	Mid-Case	Control Box Linear Drawer	Gear Rewind
Complexity Level	HIGH	MID-HIGH	LOW	MID-HIGH	MID-HIGH	MID-HIGH	MID-HIGH	MID-HIGH
Part gram	7.7	11.5	78.3	3.4	59.4	102.4	33.6	12.6
3D Total Cost	$3.76	$1.45	$18.30	$0.91	$30.54	$33.22	$7.89	$1.83
Break Even	24,722	40,523	667	58,357	1,479	1,406	6,171	30,308

Functional Part Production

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MULTI JET FUSION – PRODUCTION (MJF VS SLS)

Mobile Camera Mount

Compression design fit

Dimensions: 25mm x 25mm x 28mm

Printed in PA12

Print time: 7 hours, 2000 parts per print

Part volume: 7,880 cm^3

Parts printed: 1300

Technology	MJF	SLS
Part material	Nylon	Nylon
Mold material	N/A	N/A
Part lead time	1 day	10 days
Mold cost	$0	$0
Part cost	**$3.75**	**$7.80**

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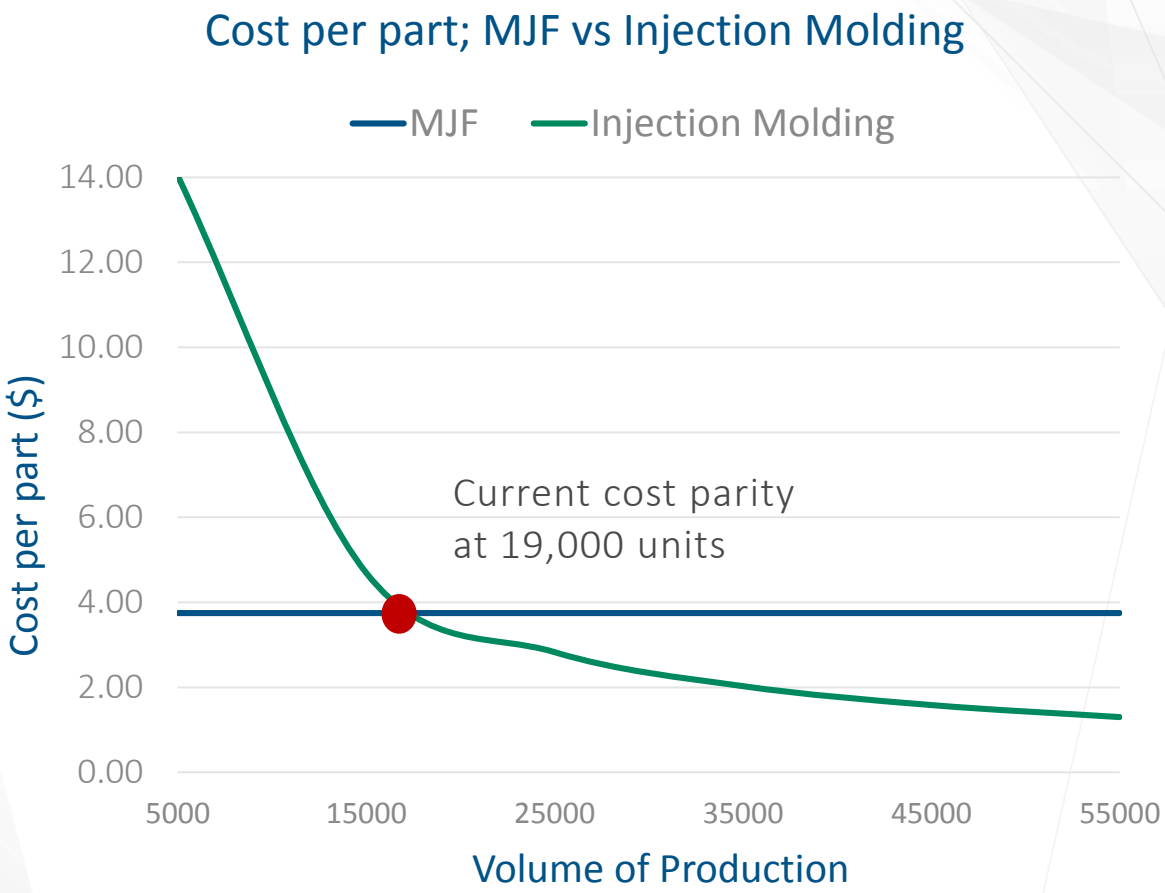
MULTI JET FUSION – PRODUCTION (MJF VS PRODUCTION MOLDING)

Technology	MJF	Production Injection mold
Part material	Nylon	Nylon
Tool material	N/A	Steel
Part lead time	1 day	16 weeks
Tool cost	$0	$70,000
Part cost	**$3.75**	**$0.18**



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MULTI JET FUSION – PRODUCTION (MJF VS PRODUCTION MOLDING)

Technology	MJF	Production IM	IM	Breakeven
Part material	PA12	Nylon		
Tool material	N/A	Steel		
Part lead time	1 day	16 weeks		
Battery Cover	$0.42	$10,000	$0.02	25,000
Sun Visor	$2.64	$20,000	$0.50	9,400
Housing	$43.03	$85,000	$3.00	2,125

Universal Controller – 5-Piece Assembly

Dimensions: 250mm x 200mm x 50mm

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CARBON – PRODUCTION (CLIP VS SUBTRACTIVE)

Machined from Aluminum

- Part mass: 302.7 g
- Machining time: 35 min

Order qty	Cost
20	$189
40	$154
60	$142

Printed in RPU 70

- Part mass: 77.4 g
- Print time: 3 hr
- Parts per print: 3
- Post processing: 3 min

Order qty	Cost
20	$50
40	$50
60	$50

Printed in RPU 70

Optimized in RPU 70 with SolidThinking Inspire for 3X safety factor with same mass as conventional design

Courtesy Carbon

Solutions

CARBON – PRODUCTION (CLIP VS PROTOTYPE MOLDING)

Secures floor mat down to carpet

Small hooks (similar to velcro)

Dimensions: 6mm x 70mm x 70mm

Printed in RPU 70

Print time: 80 min, 22 parts per print

Part volume: 10mL

Parts printed: 5

Technology	CLIP	Prototype injection mold
Part material	RPU 70	Nylon 6,6
Mold material	N/A	Aluminum
Part lead time	1 day	5 days
Mold cost	$0	$4,000
Part cost	**$4.50**	**$6.00**

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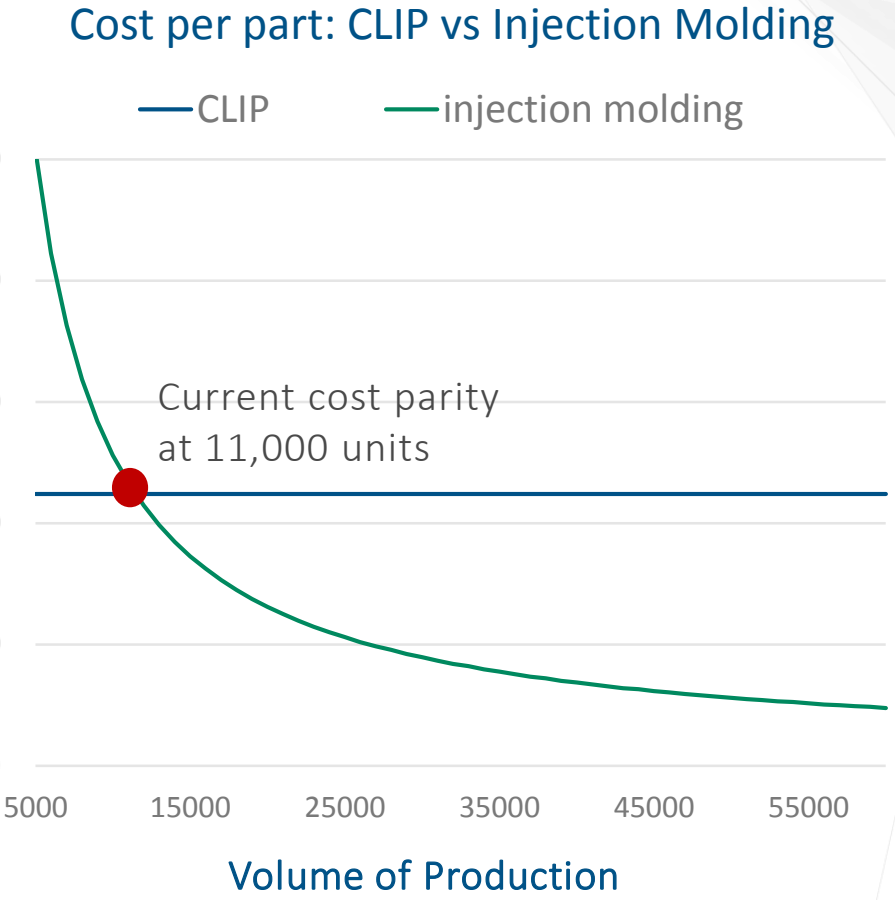
Courtesy Carbon

Solutions

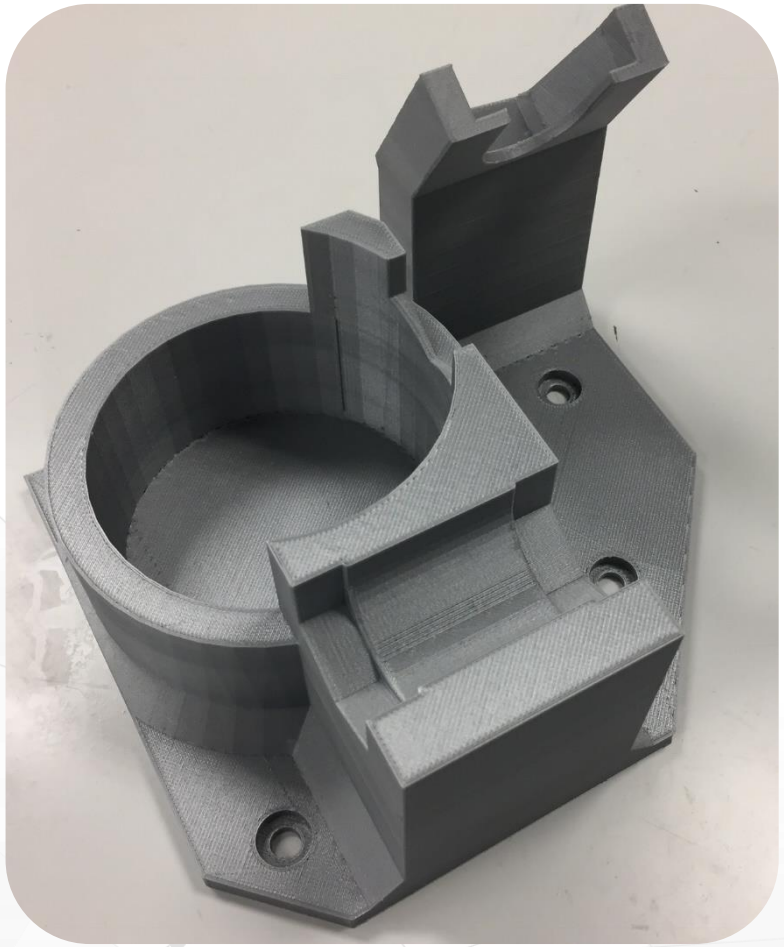
CARBON – PRODUCTION (CLIP VS PRODUCTION MOLDING)

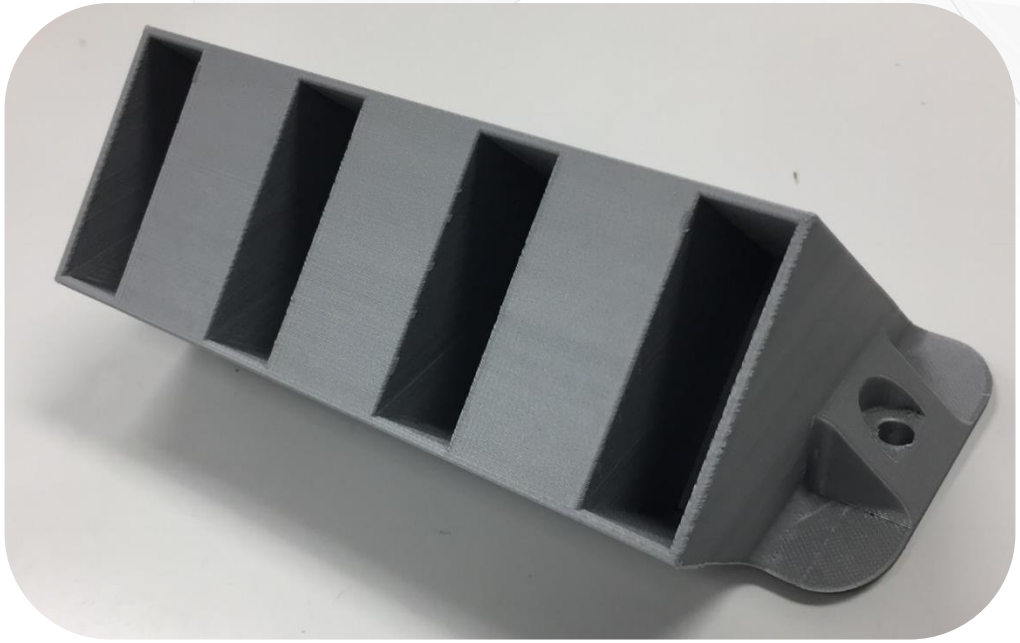
Technology	CLIP	Production Injection mold
Part material	RPU	Nylon 6.6
Tool material	N/A	Steel
Part lead time	1 day	12 weeks
Tool cost	$0	$50,000
Part cost	**$4.50**	**$0.12**

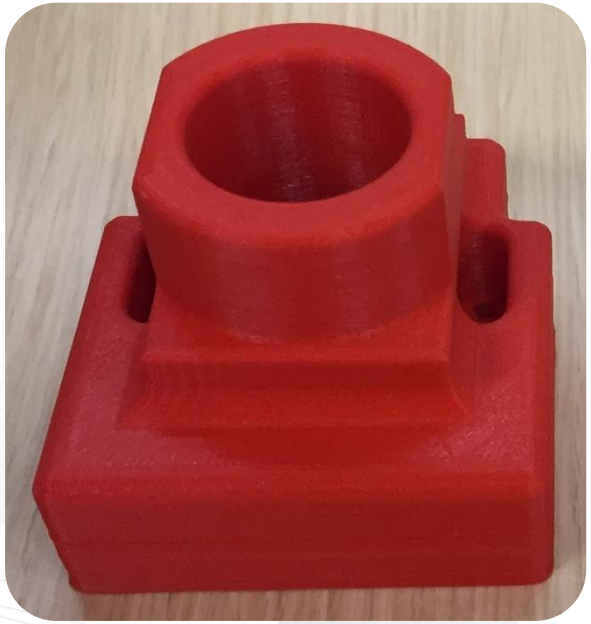


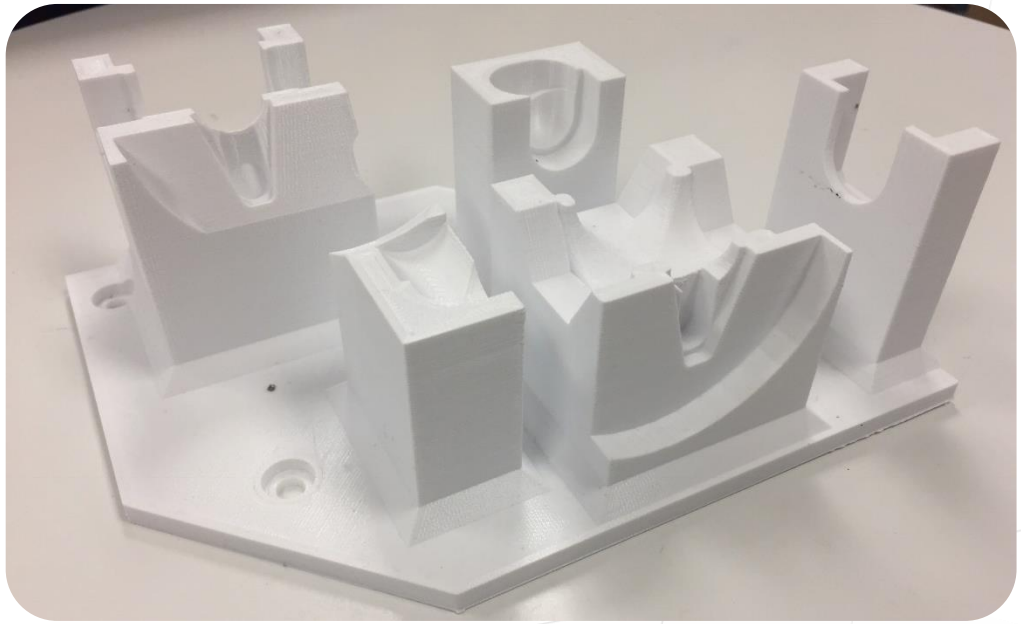
Courtesy Carbon

Fixtures and Tooling









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Industrial Print Racks

RELIABLE CAPACITY FOR FIXTURES AND TOOLING

1. Industrialized printers and drawers to improve uptime and speed
2. Individual, closed environmental printing chambers with ventilation
3. Compliance with industrial safety standards
4. Accessible and easy serviceability
5. Fully networked for remote visibility, access and administration
6. Integrated print server and collaboration software

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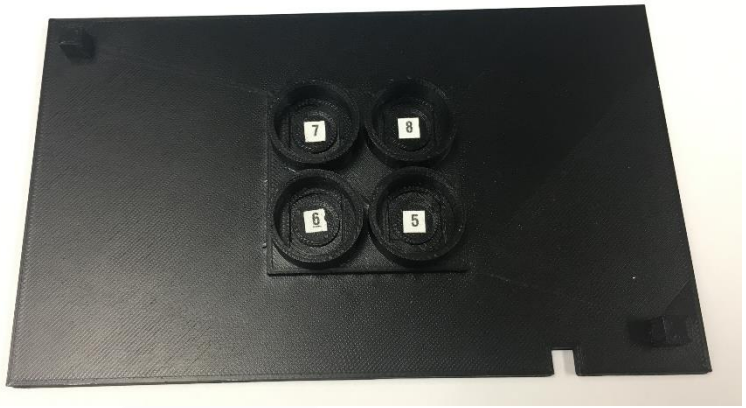
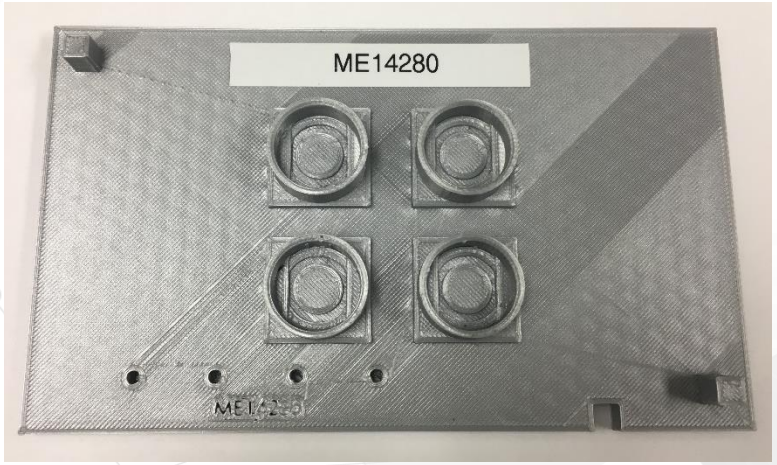
Tooling and Fixtures to Support Production - Qty 60st to Print vs Buy





Solution	FFF Print Racks	Machine Shop
Part material	ESD-PETG	Aluminum
Design Time	100 hours	100 hours
2D Print	0 hours	200 hours
Review & Approval	10 hours	10 hours
Part lead time	4 days	18 days
Part cost*	**$35**	**$1,000**
Total (qty 60)	**$2,100**	**$60,000**

*Part cost does not include design time

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Fixtures and Tooling Acceleration - Case Study Examples

Customer Projects	Cost and Lead Time	3rd Party CNC	3rd Party 3D Printing	In-House 3D Printing
	Cost	$4,000	$1,600	$400
	Lead Time	4-6 weeks	1-2 weeks	1-day
	Tooling for Phone Testing Automation Project			
	Cost	$27,000 est.	n/a	$1,215
	Lead Time	2-4 weeks	n/a	2.5 days
	Tooling for Footwear Production Automation			
	Cost	$10 (Qty 20)	n/a	$4.10
	Lead Time	1-week	n/a	70 minutes
	Wave Solder Component Covers			

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Summary

- Additive Manufacturing is moving into production applications
- The solutions require an end-to-end approach that focuses on the total cost, quality and repeatability
- Breakeven points in functional production parts have reached 10,000's of units without design optimization - substantially higher with design optimization
- Breakeven points, compared to subtractive processes, in tooling and fixtures are also compelling
- Addl benefits time-to-market & inv reduction

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