Additive Adoption A - Z:

The Scalable Manufacturing Playbook

The guide to scaling production with 3D printing.

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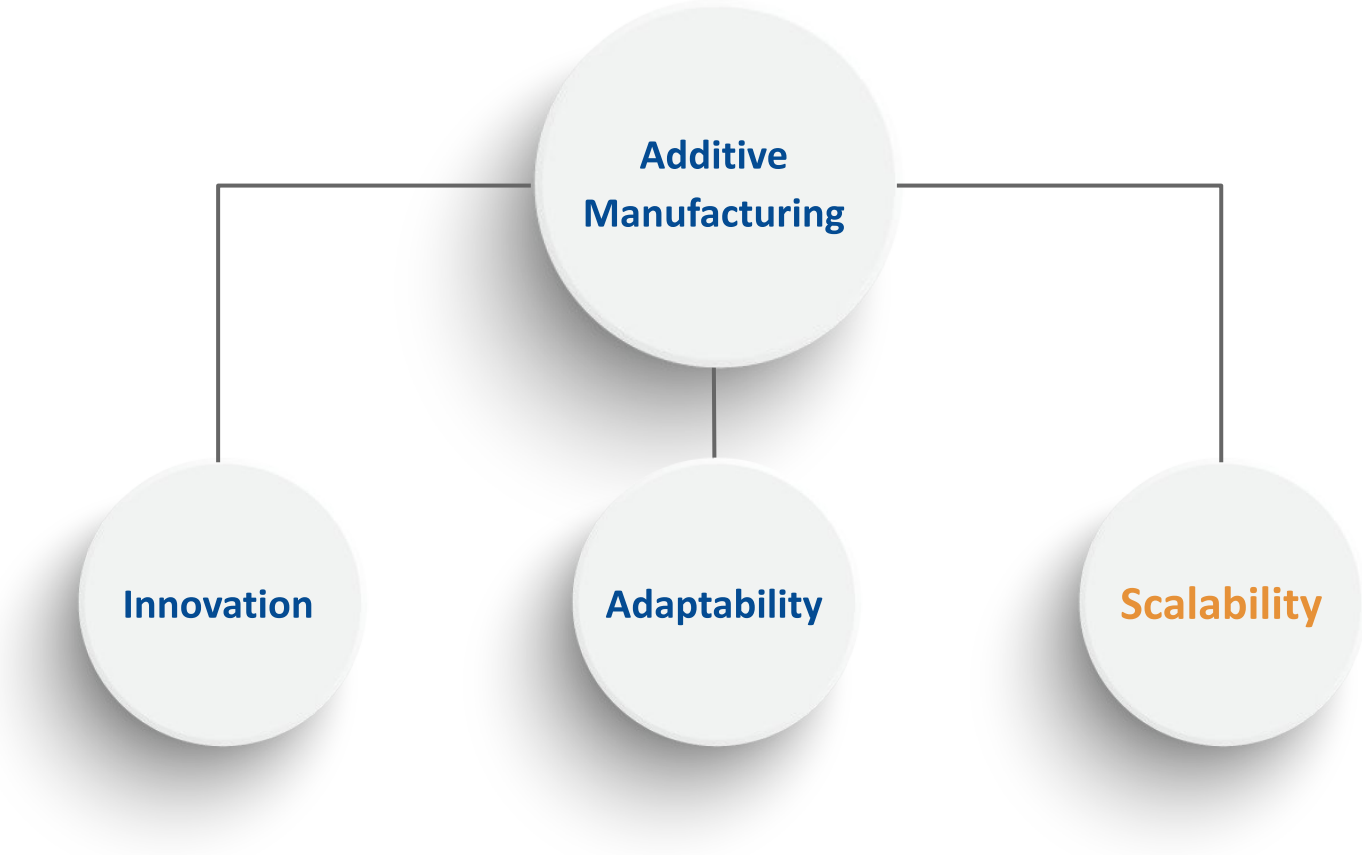
Contents



01. Introduction

Innovation, adaptability and scaled manufacturing are the axes of improvement offered by additive manufacturing, which also participate in adding more flexibility to your business. They will allow you to grow your business, push your boundaries, face brand new challenges, and bring your manufacturing process to the next level!

Meeting the needs of an ever-changing market is a complex challenge. By implementing innovation, adaptability, and scalability through the use of additive manufacturing, you will develop and maintain your competitive advantage. Keeping ahead of the competition is essential for your business, and given the uncertainty of market demand and supply chains, having the flexibility to scale production when and where it's needed is quickly becoming a real business advantage.

In this playbook, we are going to **focus on how 3D printing (also known as Additive Manufacturing) is supporting businesses to scale,** the benefits and possibilities created by scalability, and concretely how to implement 3D printing for a better scalability in your business.

Discover the different aspects of scalability and how they can impact your business!

02. Scalable Manufacturing

Scalability is the ability to cope and perform under an increasing or changing workload and market demands. **A business able to adapt performance and efficiency while facing variable demands has a great advantage**. Scalability has become increasingly relevant in recent years as technology has made it easier to acquire more customers and expand markets globally. Seasonality and visibility regarding medium or long-term demands can also present a particular challenge from a demand forecasting perspective.

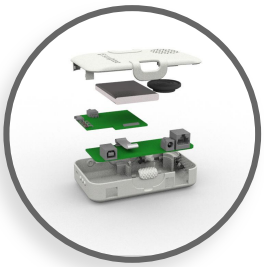
Manufacturing comes with its challenges and scalability is one of them. **Scalability is about reactivity, flexibility and optimization through your manufacturing process.** This is accessible to all industries and companies, but it requires the use of innovative manufacturing methods.

Do you want to improve your reactivity to market demands, implement more flexibility in your process, and optimize your costs? Scalable manufacturing can help you with these crucial aspects. Additive manufacturing is particularly adapted to the development of scalability in your business and we'll see with you how additive manufacturing can become your best ally.

Scalability		
Reactivity	**Flexibility**	**Cost Optimization**
Time to Market	Seasonality	Design Optimization
Lead-Time	MOQ	Short-term v. long-term projects
J.I.T. Manufacturing	Design Freedom	Overhead costs

03. Reactivity to Market Demand

Using additive manufacturing for production offers you the possibility to be more reactive, and at the same time, more competitive. Meet changing market demands and Go-To-Market with unbeatable lead-times thanks to an optimized and scalable manufacturing process. Benefit from new business opportunities offered by Just-In-Time manufacturing and get the parts you need when you need them.



3.1 Optimizing Time-To-Market

Time-to-market is the length of time it takes from a product being conceived until its being available for sale. There is no doubt that, improving your time-to-market will boost your business. While using a manufacturing technique such as injection molding, you need to get molds manufactured first, which leaves no room for changes in your projects.

Moreover, the manufacturing process is pretty time consuming with injection molding. It takes 8-10 weeks on average to create a mold, depending on its complexity and cavitations. Whereas, with additive manufacturing, you will speed up your manufacturing process, instead of developing molds during entire weeks before launching the manufacturing process, with 3D printing projects take days instead of months.

Indeed, interesting lead times is one of the main benefits of additive manufacturing, as it is speeding your whole process, from proof of concept, to prototyping, and production. Creating a 3D file is significantly faster than having to create a mold.

Top benefits of digital transformation according to executives

Source: PTC and CorporateLeaders Study (2018)

According to Sculpteo's State of 3D Printing 2020, 73% of the respondents to the survey say Lead time is one of the most important measures of success for 3D printing activity.

3.2 Reducing lead time

Lead times are largely influenced by the choice of local production or offshore production. This last option might be more cost-effective for large volumes where time is less critical, but it implies less flexibility and significant lead times. If you use injection molding and offshore production, your lead times might be unnecessarily long and cause Cost of Delay. Using a local supplier based can automatically reduce your lead time by weeks and even months.

Lengthy lead times don't allow you to react to market demand. For example, if a product that is taking a month to arrive suddenly stops to generate the customer's interest in the second week of lead time, then you will have a stock of obsolete products ending up in your warehouse.

3.3 Enabling Just In Time (J.I.T.) manufacturing

To face emergencies or uncertain demand forecasting, Just In Time manufacturing gives the opportunity to receive parts exactly when you need them. This is adding flexibility to your business to face unpredictable demands or events. This is a way for you to focus your resources on only fulfilling what you are going to be paid for, rather than wasting energy, time, and money on building stock. Thanks to additive manufacturing, Just In Time manufacturing is accessible to everyone. Once your 3D file is ready, you can manufacture it right away. Give your business the reactivity to compete.

04. Production Flexibility

Being able to adapt your process and your product is an important strength. Flexibility is important at every level of your company if you want a durable business. Learn how to adapt your process to demand with the right manufacturing tools. Let's see on which key aspects you can improve your flexibility thanks to additive manufacturing.

4.1 Adjusting to variability in demand

Being flexible enough in your manufacturing process allows you to adapt to the variability of demand. You have to keep in mind that this uncertainty regarding the demand or the seasonality of your product can lead to inventory issues. Busy warehouses can become a real problem, if you don't sell enough, you'll lose money, and if an unpredictable catastrophe physically hits your inventory, you will lose money as well.

Using additive manufacturing for your production can lead to interesting opportunities for your supply-chain, a perfect occasion to give a try to the digital inventory, with a dematerialization of your supply chain. This way, you will produce parts exactly when you need them instead of stocking them, and exposing them the risks of being unsold, or lost.

This kind of flexibility is useful when you notice a clear seasonality with some of your products. Also, when launching a new product, the demand can be quite unsure, and you have no long-term visibility on it. Using additive manufacturing and adapting your production to demand will be the wisest choice to make.

15 - 25% of inventory is wasted each year because of unsold products

Source: Slant3d

4.2 Minimum Order Quantity (MOQ)

While looking for the perfect parts for your project, not only do you need to find a manufacturer that sells the right supplies at the right price but also one that allows you to order an optimal amount of units. Have you ever struggled to order low-volume products? Indeed, the price can often be a blocking point when trying to manufacture small or medium series. While ordering smaller quantities, the costs can be inhibitively high.

With additive manufacturing you avoid this minimum order quantity, which can be particularly useful to produce limited editions or if you just need a few spare parts, for example. Using an online service bureau such as Sculpteo, there is no minimum order quantity, **from a single object to 10 000+ parts, you can 3D print the exact amount of parts you need**. This is why additive manufacturing is particularly adapted to the creation of limited editions.

4.3 Design Freedom

3D printing gives access to a design flexibility injection molding can't offer you. Indeed, using additive manufacturing will help your business save precious time while facing unpredicted events or decisions leading to changes in your products. With a mold, you won't be able to change its design to make modification on your final parts. If you need to modify your project, then you will need to start from the beginning and re-do the whole process. Your mold will become obsolete and you would have lost money and time. With additive manufacturing, it's different: you only have to modify your 3D file, it won't interrupt your manufacturing process at all. More reactivity in your process means you can adapt to your immediate needs without losing time and money. Using 3D files with 3D printing, you don't have to worry about the lifetime of the design you made, you will have the opportunity to implement all the changes you will need, when you need them.

05. Optimizing Production Costs

Cost optimization is linked to several phases of your project. We know that optimizing your costs by rethinking your supply-chain is an efficient solution, but you will have to go a little bit deeper and ask yourself the right questions. How can my design be optimized to reduce costs? What manufacturing technique is the most adapted to my project? Managing cash flow is of the highest importance, especially for startups, optimizing production costs to “Pay as you Grow” will be a crucial aspect of scaling your business.

5.1 Design optimization

Working on the product’s design for additive manufacturing allows you to optimize your 3D printed part and reduce its cost. Do you know that an efficient design can help you save money? Indeed, while creating your model, you can elaborate a design that could be really optimized by using lattices or honeycomb designs and use the minimum quantity of material needed. Moreover, if you have a well-designed 3D printed part, it will clearly minimize post-production steps that add cost and time to the development of your product.

Working on the design of your product by thinking additive is also the opportunity to improve your product with functional integration and a clear reduction of the assembly process. In 2017, **GE Aviation revealed that it had used Design for Additive Manufacturing to create a helicopter engine with 16 parts instead of 900**, with great potential impact on reducing the complexity of supply chains. Instead of using the services of 10 or 15 suppliers, they only used additive manufacturing!

Some other aspects such as nesting optimization can help you shorten your costs. Nesting involves translating 3D objects in space, rotating them either freely or constrained around specific axes and finally minimizing empty space while avoiding ‘no-build-zones’. By optimizing the nesting of elements in one batch, you can also optimize your batch and its price.

5.2 Short-term v. long-term projects

Even with all these advantages, additive manufacturing is not necessarily the perfect answer for all projects. In some cases, injection molding could be more adapted. Investing in a manufacturing technique such as injection molding can be interesting, for example, if you need to produce a part that cannot be improved by additive manufacturing, with a simple design, in huge volumes that have to be delivered regularly without any changes in the demand, then injection molding can be a good option to consider.

Your needs can also evolve: additive manufacturing can be a short-term solution for emergencies and to face shortages. This freedom of quantity is also an opportunity for your business to test the market with a short series run before launching a product and starting mass production. **Rather than heavily investing in new production lines, you'll let the market dictate your investments based on the performance of these short series runs.**

5.3 Optimizing overhead costs

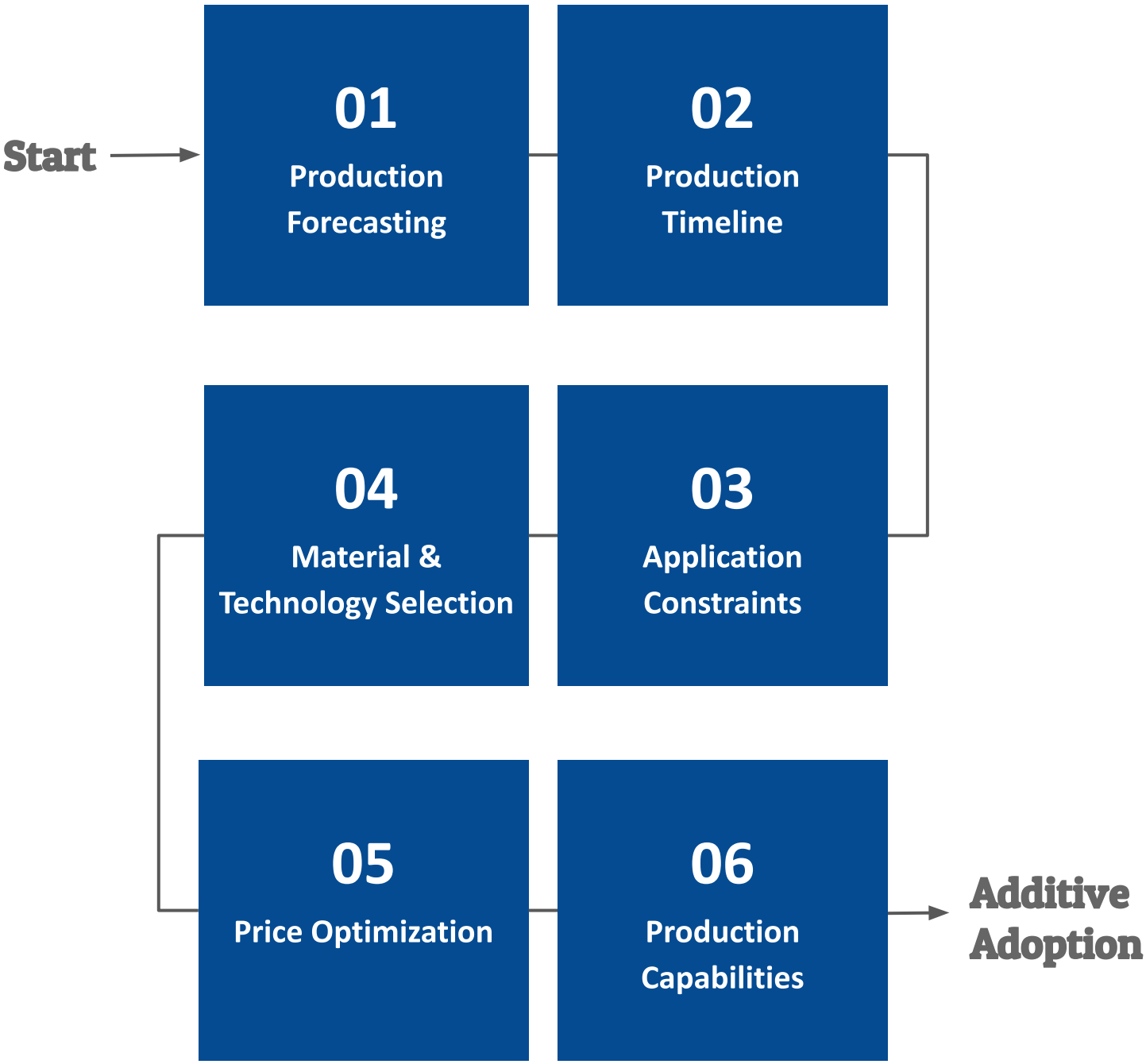
Manufacturing can become really expensive, but good news, these costs can be optimized! Thanks to additive manufacturing, you could reduce the costs of inventory, including all the costs linked to a warehouse, such as rent and insurance. All these costs can be cut with a dematerialization of the supply-chain. Using a digital warehouse, your inventory is made of 3D files which take zero physical space. Thanks to on-demand manufacturing, you can also reduce the initial upfront costs while ordering huge quantities of products. You **spend money only for the parts needed**, there is no need building a massive inventory. Additive manufacturing is also a solution to optimize your tooling process investments. Volkswagen Autoeuropa, the car manufacturer, is using 3D printing to manufacture some of its tools. The company estimates that thanks to 3D printing they saved 250,000€ in 2017.

5 - 15% are added to the costs of a product because of the warehousing costs of inventory

Source: Slant3d

06. The Scalable Manufacturing Playbook

Let's get practical! It is your turn to **evaluate where you can take advantage of scalability in your business by implementing additive manufacturing**. Going through these exercises and checklists with your design engineers, product managers, quality engineers, supply chain managers, and additive experts (either internal or external) will help you determine your additive opportunity and put it into action.



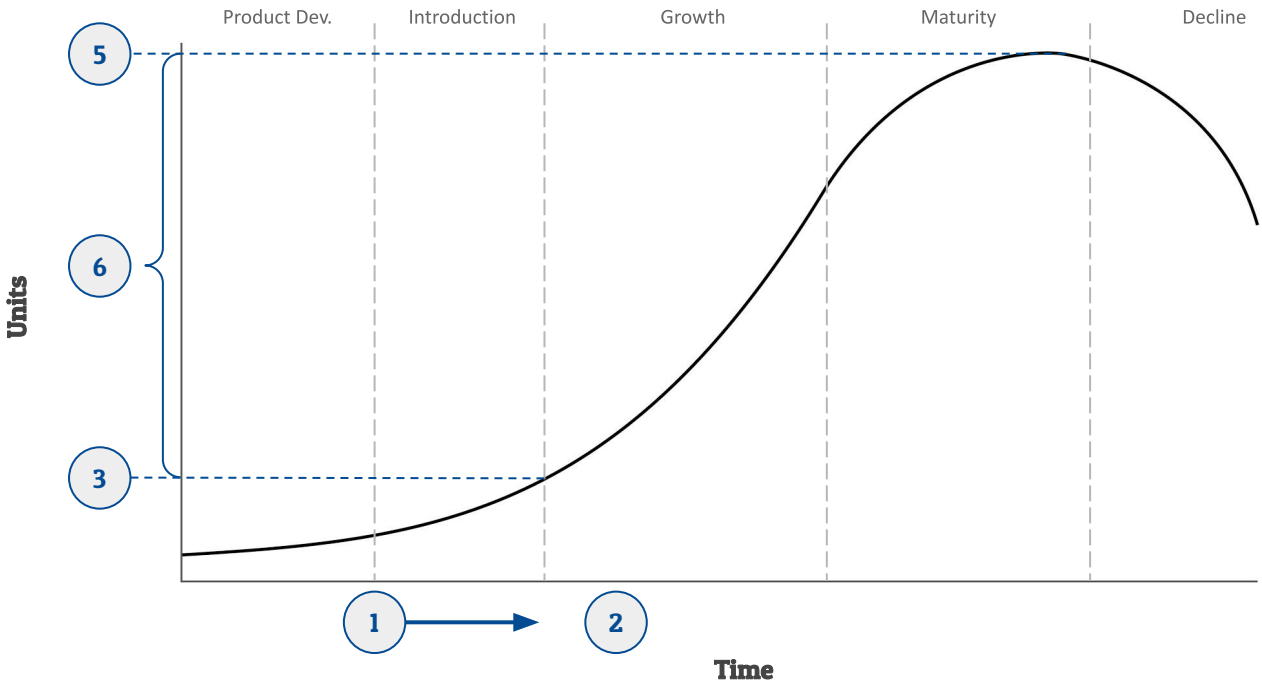
6.1 Demand Forecasting

Use the framework below to identify the manufacturing method best adapted to your production forecasting needs.

Criteria	Which Manufacturing Method is more adapted? Additive Manufacturing ← → Traditional Manufacturing
Demand To what extent can you predict market demand?	Very Unpredictable ← → Highly Predictable
Visibility How far in advance and you predict demand?	<2 Months ← → >6 Months
Lifetime How long do you expect this design/component to last?	Unsure ← → >1 Year
Seasonality Is there a predictable fluctuation in demand?	Irregular & Unpredictable ← → Regular & Predictable
Inventory How much stock can you afford to carry? How much reserve should you keep?	<1 Month ← → >6 Months
Minimum Order Quantity (MOQ) Does your order surpass MOQ for traditional manufacturing methods?	< ½ MOQ ← → >2 times MOQ
Lead-Time How quickly will you need the parts between ordering and delivery?	<2 weeks ← → >2 months
Quantity What is the total size of your production run?	<100 ← → >10k

6.2 Production Timeline

Use the guide to plan the quantity and production order deadlines for your product launch using Additive Manufacturing.



1 **Set dates for Launch or crowdfunding campaign:**

2 **Set fulfillment goal date for crowdfunding campaign:**

3 **Estimate number of units for first production run:**

4 **Determine production order deadline:**
Work back from (2) using Table 1 and estimate from (3)

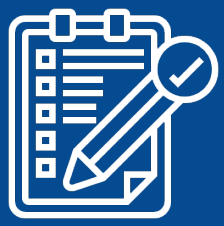
5 **Estimate peak monthly sales:**
Is AM still viable?

6 **Estimate monthly sales & production order deadline:**

7 **Review & adjust:**
Monitor sales and adjust periodic orders as needed

Table 1: Production Delay Estimates for AM

Order Quantity	Typical Production Delay (depending on part size)
1 - 100	1 - 3 days
100 - 1k	1 week
1k - 5k	1 - 2 weeks
>5k	3+ weeks



6.3 Application Constraints

Use the checklist to identify the properties required for the intended application.

Production

- [ ] Part Size _____
- [ ] Quantity _____
- [ ] Accuracy _____

Environmental Constraints

- [ ] Biocompatible / Skin contact
- [ ] Flame Retardant
- [ ] Chemical Resistance
- [ ] UV Resistance
- [ ] Temperature _____
- [ ] Pressure _____
- [ ] Water tightness
- [ ] Sterilizable
- [ ] Electrostatic Discharge (ESD)
- [ ] Corrosion Resistance

Mechanical Constraints

- [ ] Vibration _____
- [ ] Traction / Pressure / Flexure _____
- [ ] Shock Absorption _____

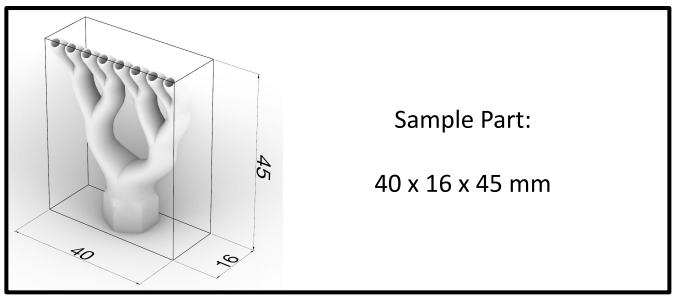
Aesthetics

- [ ] Color _____
- [ ] Surface finish _____

Other

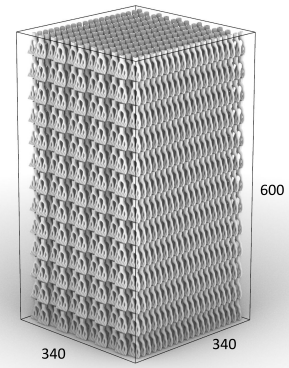
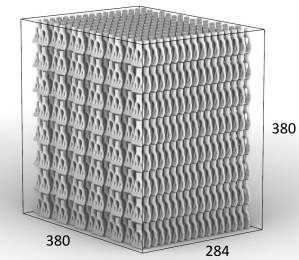
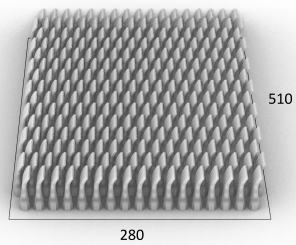
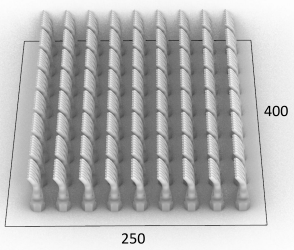
6.4 Material & Technology Selection

Use this comparison to narrow down the material / technology options before consulting with a specialist



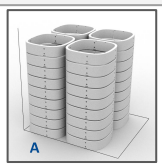
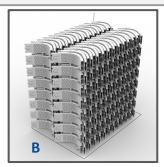
Sample Part:

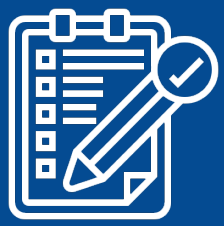
40 x 16 x 45 mm

	Polymer Powder-Bed Fusion		Photopolymer	Metal
	SLS ☐	**Multi-Jet Fusion** ☐	**Photocentric** ☐	**Binder Jetting** ☐
Build Volume				
Parts & Delay	**2800 parts/build** 2-3 days production delay	**1632 parts/build** 1-2 days production delay	**262 parts/build** 1 day production delay	**70 parts/build** 7-10 days production delay
Post-Processing	De-powder Sandblasting --- **(Optional)** Polish Dye Chemical smoothing		UV Curing process Support removal --- **(Optional)** Sanding support bumps	Sandblasting --- **(Optional)** Polishing plating
Materials	• PA12: Versatile all-purpose Nylon • PA11: Bio-sourced versatile Nylon • PP: Chemically resistant • TPU: Flexible and elastomeric polymer • PA6 (SLS Only): Rigid and heat resistant polymer		• EPD 1006: Affordable prototyping material	• Steel/Bronze 420SS/BR • Stainless Steel 316L

6.5 Price Optimization

While there are a number of factors which contribute to the cost of a 3D printed part (material, technology, volume, density, etc) the design can also play a great role in reducing the cost. Identify how the price of a part can be optimized with the following design considerations.

Direct (printing cost)	**Build Preparation:** Optimize how parts are packed in the build space	
	Shape: Does the part easily "pack" together? (think of tetris pieces)  	☐
	Orientation: Does the part need to be produced in a specific orientation for strength or aesthetic reasons?	☐
	Design: Can the part be redesigned to make it more "packable"? (Figure A vs Figure B above)	☐
	Size: Can the size be adjusted to fit more parts in the build? (even a few mm can help)	☐
	Position: Can parts be "nested" inside each other to reduce the footprint of the part? (think of Russian nesting dolls)	☐
	Production: Optimize printing time	
	Weight/Density: Can the design be modified to remove excess material? (hollowing or lattices)	☐
	Post-Production: Optimize finishing process	
	Supports: Can the part be redesigned to eliminate the need for support structures? (FFF, resins, metals)	☐
	Powder removal: Can the part be redesigned to make depowdering easier?	☐
Indirect (overall cost)	**Functional Integration:** Optimize the design and function of the part itself	
	Parts: Can the part integrate features to simplify the supply chain of the completed part? (hardware, fasteners, brackets, etc)	☐
	Assembly: Can the part be redesigned to make final assembly simpler? (channels, grids, holders, guides)	☐
	Function: Can the part be redesigned to add value otherwise impossible for other manufacturing methods? (lighter, more efficient, more durable)	☐



6.6 Production Capabilities

Use the criteria below to evaluate your internal capabilities for using 3D printing and potential production partners

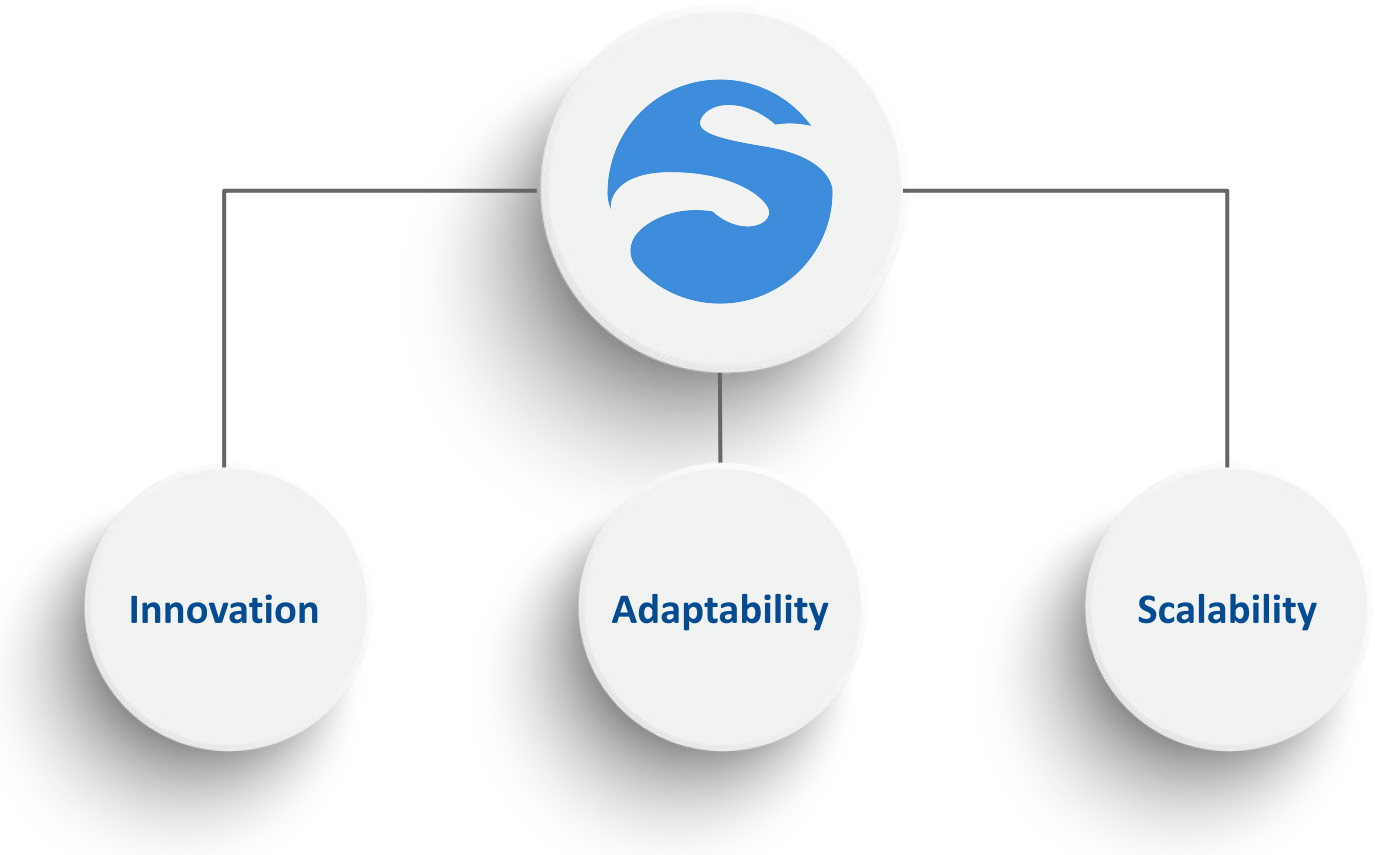
Criteria	Internal Capability	Potential Partner 1:	Potential Partner 2:
Production location Where will the production center be located?			
Dedication capacity Will the production center be able to reserve dedicated capacity for your volume of production?			
Quality control What systems of quality control does the production center have in place?			
Ordering process How will you place orders? Through a sales team, directly online, integrated with your ERP?			
Production delay What is the expected production delay for the technology/material?			
Certifications Does the production center have the necessary certifications for your industry? (ISO 9001, ISO 14001, ISO 13485, etc)			
Post-processing What types of post-processing do they offer to get the desired finished quality?			
Repeatability What systems are in place to ensure consistency?			

07. Putting It All Together

Now that you understand all the benefits of digital manufacturing for the scalability of your business and have considered how to put these plans into action, you might realize you'll need expert guidance. Sculpteo's experienced engineers, industrial designers, and production specialists are here to support you in your project, at all stages of its development. Sculpteo has been a **leader in digital manufacturing since 2009, working with innovative companies and supporting them to integrate 3D printing in their manufacturing process**.

With the great **expertise of our digital manufacturing specialists from Sculpteo Studio**, offering consulting, training and design services, you will have the opportunity to identify your 3D printing opportunities and optimize your whole process. These experts will support you from the early stages of your process to the end of the production run!

With a professional 3D printing service you have access to industrial 3D printing technologies and materials to get the results you expect for technically demanding industries.



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We've compiled our best ebooks, playbooks, guides, and customers' stories, made for professionals who want new additive manufacturing opportunities

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