White paper

Go additive and be disruptive

How to approach Additive Manufacturing from three sides

By Güngör Kara, EOS GmbH

Executive summary

Additive Manufacturing (AM) – or industrial 3D printing – is gaining momentum as it graduates to serial production. A few first-movers who have invested heavily in AM are already achieving notable technological results likely to ensure their competitive advantage in the next decade. An increasing number of companies are keen to benefit from AM's explosive growth potential. However, many struggle to identify how AM can benefit their business. They cite a lack of AM expertise in-house as the main barrier preventing them from embracing the disruptive technology. This white paper introduces a best-practice approach to acquiring the know-how players need to unlock the potential of AM and achieve a fluid transition.

This white paper is for you, if you

- → Want to secure a competitive advantage with Additive Manufacturing
- → Are seeking to understand how AM impacts and benefits your value chain and organization
- → Are looking for a best-practice approach to sustainably integrate Additive Manufacturing

Soon, there will only be two kinds of players – manufacturers who disrupt the market and those whose business is disrupted. Güngör Kara, Additive Minds

Table of contents

Disruptive potential

Additive Manufacturing (AM) – 3D printing (3DP) – has graduated from the niches of prototyping and rapid tooling to industrial production. It is fast gaining momentum in a global manufacturing landscape racing towards digitization.

Under mounting pressure to out-innovate and outperform their competitors, manufacturers are looking to AM technologies not only as "a viable alternative to conventional manufacturing processes in an increasing number of applications"[1]. They are aware of AM's unprecedented disruptive potential for innovation-driven growth in areas beyond the possibilities of subtractive mass manufacturing.

Yet, as keen as they are to leverage AM, companies are finding it unexpectedly hard to get to the point where they can start to cash in on the advantages and benefits of AM.

1 McKinsey Quarterly, January 2014, http://www.mckinsey.com/business-functions/operations/our-insights/3-d-printing-takes-shape

It's all about digital disruption

And the next disruption wave will
be in the field of production.
AM is a key driving force towards
developing digital and smart factories.

Top five publicly traded companies (by market capitalization)

Tech Other

2001	GE $406 B	Microsoft $365 B	EXXON $272 B	citi $261 B	Walmart $260 B
2006	EXXON $446 B	GE $383 B	TOTAL $327 B	Microsoft $293 B	citi $273 B
2011	GE $406 B	Apple $376B	PetroChina $277 B	Shell $237B	ICBC $228 B
2016	Apple $582 B	Alphabet $556 B	Microsoft $452 B	Amazon $364 B	Facebook $359 B

Source: http://www.visualcapitalist.com/chart-largest-companies-market-cap-15-years

A best-practice approach based on 150+ AM projects worldwide

The best-practice approach to AM transformation introduced in this white paper draws on the experience and data gained from 150+ successful AM implementation projects worldwide. These projects were supported, facilitated, or handled by Additive Minds, the AM consulting unit of EOS GmbH in Germany.

Additive Minds has built on the collective experience of EOS' experts – both in powder-based industrial 3D printing and AM consulting – to draw up an AM roadmap. Today, this roadmap lies at the core of a comprehensive AM program with training facilities in Krailling near Munich in Germany, in Pflugerville, Texas, and in Singapore. The program is structured in 4 phases and designed to keep the AM learning curve both short and cost-efficient.

In this white paper, Additive Minds looks at the key phases and barriers companies need to master in their journey towards AM transformation. The approach takes a holistic view of enabling processes, organization, and the most valuable resource a company has – the people that make it happen.

AM thinking is a radically new way of even 'imagining' solutions.

What makes adopting 3DP so challenging?

A 2016 Ernst and Young (EY) study[2] finds, companies are very clear on how 3DP can contribute to continued business success: Executives pooled named competitive advantages (25%), developing a new business model (14%), and a stronger value creation process (14%) as its main advantages.

Yet – while the first global movers are already establishing themselves in AM[3] – as many as 3 out of 4 companies had no experience of 3DP at the time of the survey[2]. Two of out 3 executives cited cost, 1 in 3 lack of expertise in-house as the "crucial barrier to 3DP application"[2].

In day-to-day business, these two factors are closely interlinked. AM expertise in making business cases – whether for printing spare parts or disruptive applications – is key to keeping investment risk low.

Lack of AM expertise
Three out of 4 companies in the EY study had no experience of 3DP at the time of the study.
EY global 3DP/AM study, April 2016

2 N=900 companies, EY global 3DP/AM study, April 2016; http://www.ey.com/de/de/services/advisory/performance-improvement/supply-chain/ey-global-3d-printing-report-2016
3 https://hbr.org/2015/05/the-3-d-printing-revolution

Resources in the job market to compensate for lack of AM experience in-house are few

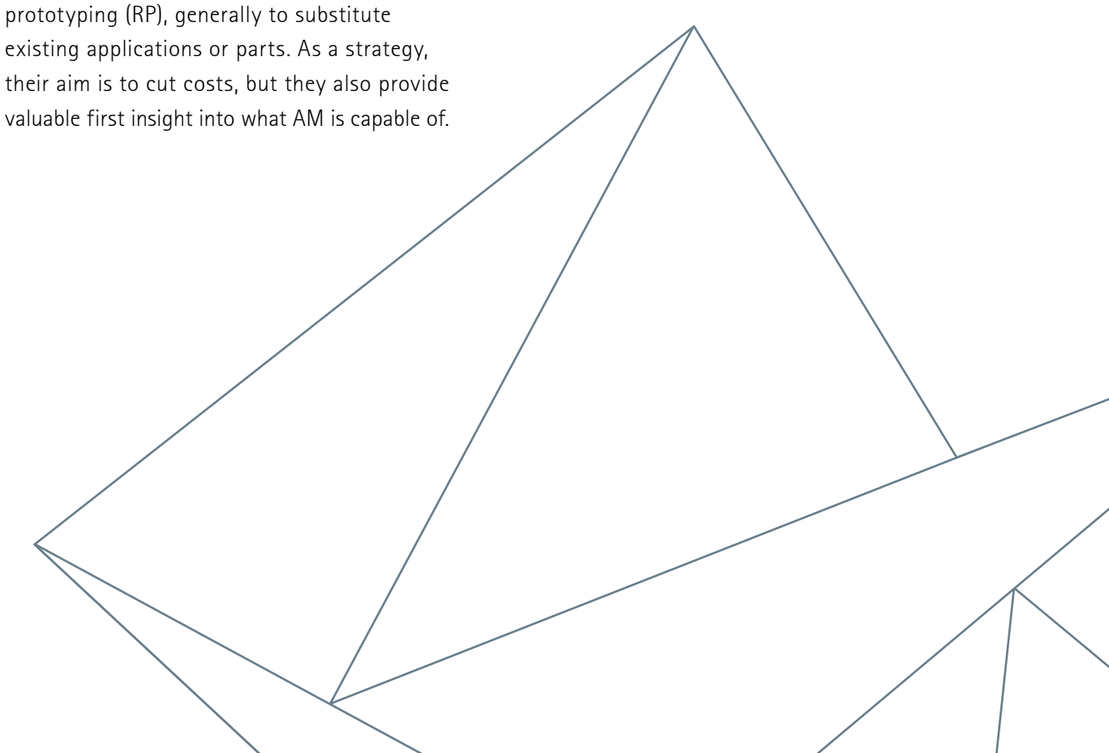
Closing the knowledge gap is a challenge. AM experience is a highly sought – and equally limited – resource in the job market. Graduate education, on the other hand, is only just embracing AM and 3DP. It will take years before graduates with the required engineering, design and business skills – as well as the crucial ability to collaborate – enter the job market in numbers sufficient to meet the surging demand.

Small projects are growing AM experience, but scalability of learning is limited

With few options to recruit, most organizations are on their own to learn as they go. 20% of the companies surveyed by EY stated experience of AM. Four out of 5 had gained this experience from smaller AM projects. These tend to focus on rapid prototyping (RP), generally to substitute existing applications or parts. As a strategy, their aim is to cut costs, but they also provide valuable first insight into what AM is capable of.

RP projects provide insight, but usually explore few of the limitless possibilities of AM design

However, solely relying on such RP experience to transition into large-scale AM is likely to fail. Not least, because most RP projects only explore very few of the almost limitless possibilities of AM design, from lattice structures to functional integration, from part integration to complex geometries and bionic structures.



Leveraging AM design principles in product innovation requires a mind shift – a radically new way of even imagining solutions.

The enthusiasm of a small group of engineers rarely carries over into the wider organization

Most engineers are enthusiastic over the sheer unlimited possibilities of turning ideas into data and data into things. However, without CXO-level support, their sentiment rarely fosters acceptance of AM in their wider organization. Especially siloed departments, such as supply chain, production, and quality, tend to doubt disruptive applications.

Experience gained from small RP projects rarely matches the requirements of industrial-scale AM

Many companies frame projects as RP pockets of innovation. In doing so, they limit possible outcomes to the perspective and immediate needs of their conventionally structured production and portfolio. Moreover, engineers in such project set-ups tend to overlook the business case for new ideas.

Small RP projects give first insights
Four out of 5 organizations with AM experience had gained it from smaller projects.

How will 3D printing make your company the strongest link in the value chain?
EY's Global 3D printing Report 2016

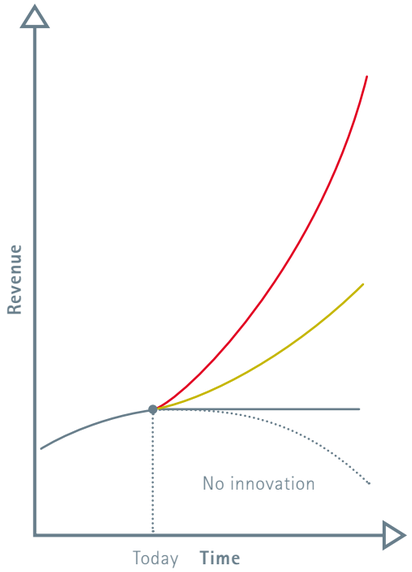
Experience gained from such insular RP projects is not easily scalable. It rarely matches the notably more stringent requirements of industrial-scale AM, for example, in understanding and managing the intricate interdependencies of a reliable high-quality product, supply chain, machine utilization, and delivery-to-order.

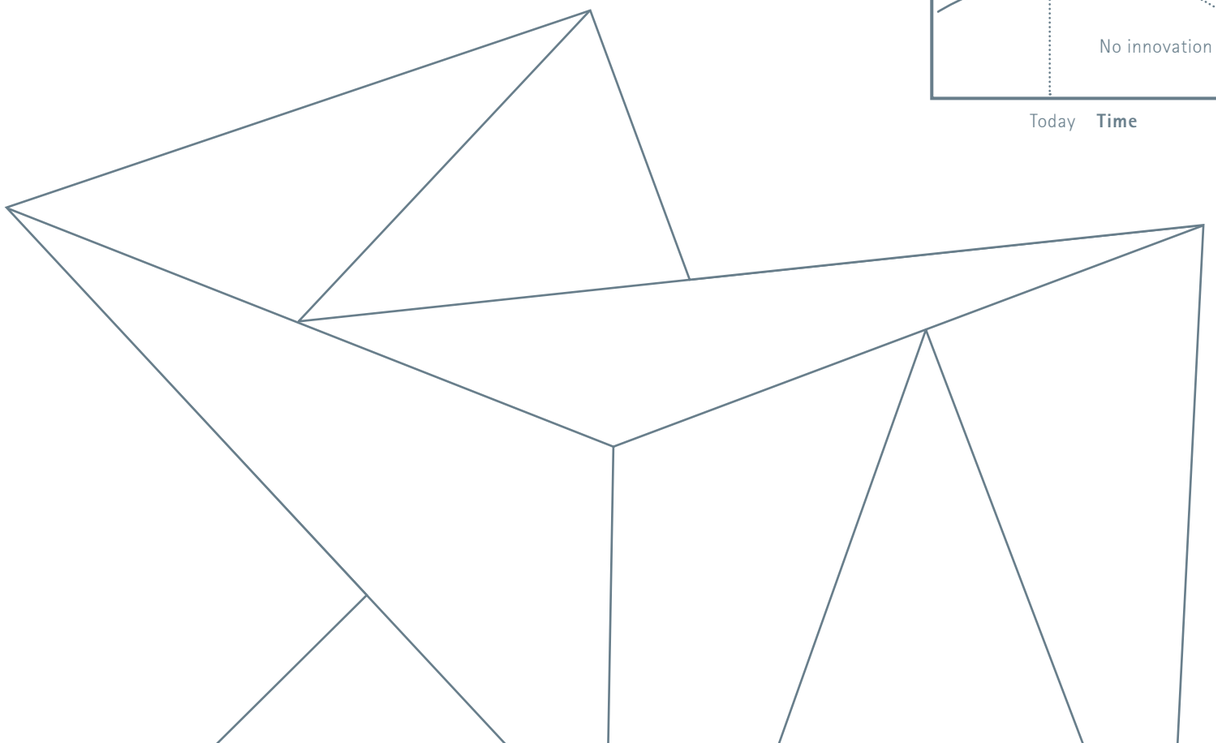
The requirements of serial production in Additive Manufacturing are extensive: 3DP adopters aiming to deliver AM innovations with significant added value to customers not only need to reinvent their value chain, but also transform their operations and organization to support the short incremental experimentation cycles of design-driven manufacturing.

Creating new business or protecting current business

A growing number of manufacturers is interested in utilizing 3DP for process optimization to protect current business. However, limiting 3DP to optimization as the strategic response in the face of rising pressure and shifting profit pools is also likely to make the smallest contribution to the bottom line – and to the company's footing in the market in the long term.

Incremental and radical AM innovation strategies, on the other hand, show the strongest potential to drive long-term growth both in revenue and in new business fields. These approaches leverage the total value of AM – and they also require the highest commitment to driving change within the company itself.





Three types of innovation and their impact on revenue

Radical innovation –
strong growth by fully leveraging AM for Siemens SGT-800 burner fronts

With functional integration in an all-in-one design, Siemens burners generate improvements in all business aspects:

→ 1 printed part instead of 13 assembled parts
→ Lead-time reduced from 26 to 3 weeks
→ Longer lifetime due to improved cooling and gas flow

Incremental innovation –
growth in new business fields
Robotic grippers from Wittmann Group/Kuhn-Stoff

Wittmann Group/Kuhn-Stoff delivers a perfect answer to the challenges of today's handling and robotics:

→ 86% weight reduction
→ 50% reduction in manufacturing costs
→ Production time reduced from 21 to 4 days

Improvements –
protect current business
Mercedes truck spare parts

New feature in after-sales spare parts from the 3D printer:

→ Economical and fast production with small quantities
→ Environmentally friendly without warehousing costs

Integration

Making manufacturing both additive and smarter

For most executives exploring AM-enabled business models, the decision to do so is part of defining a wider digitization strategy. The impetus to press ahead is strong. As a 2017 McKinsey study states, "As digitization penetrates more fully, it will dampen revenue and profit growth for some, [...] according to our research, while the top quartile captures disproportionate gains".

A similar polarity between first-movers and late-adopters is likely to emerge among companies looking to implement Additive Manufacturing. However, as responses during Additive Mind workshops suggest, many executives are not only struggling to define the most appropriate approach for their business, some do not have a clear idea of what fully leveraging AM could look like. Although 3DP adopters need to define their own individual goal, the target vision of an organization aiming to leverage the full potential of AM illustrates the scope and magnitude of the undertaking.

The U.S. hearing aid industry converted to 100% Additive Manufacturing in less than 500 days. According to one industry CEO, not one company that stuck to traditional manu-facturing methods survived.

The 3-D Printing Revolution, Richard D'Aveni in Harvard Business Review, May 2015

The target vision of serial production in AM

In a company capturing the full potential of AM, strategists focus on the total value of AM. They have reinvented their value chain to make delivering AM innovations with significant added value to customers the top priority. Supply chains are kept fast, time-to-market short, warehousing and costs low.

The entire organization – from one cross-functional team per application to AM know-how transfer programs – is highly collaborative and agile. It is aligned to support design-driven growth and disruptive business models.

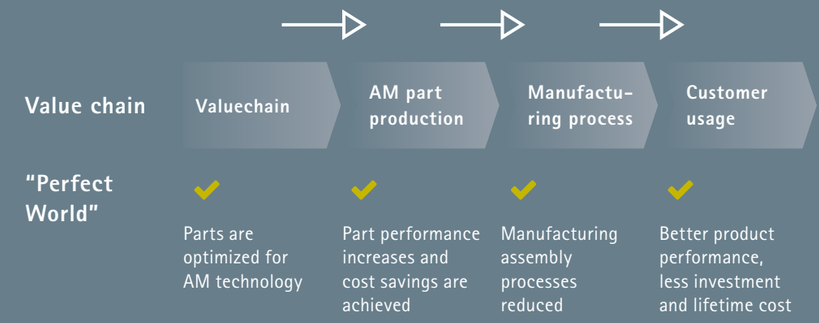
The AM production cell itself is embedded in a digital manufacturing environment. The AM process is managed end-to-end with a focus on pre-processing, quality procedures, and design for post-processing. Self-audits continuously probe and optimize the current set-up.

The case for digital reinvention, Jacques Bughin, Laura LaBerge, and Anette Mellbye in McKinsey Quarterly, McKinsey & Company, February 2017. www.mckinsey.com/business-functions/digital-mckinsey/our-insights/the-case-for-digital-reinvention

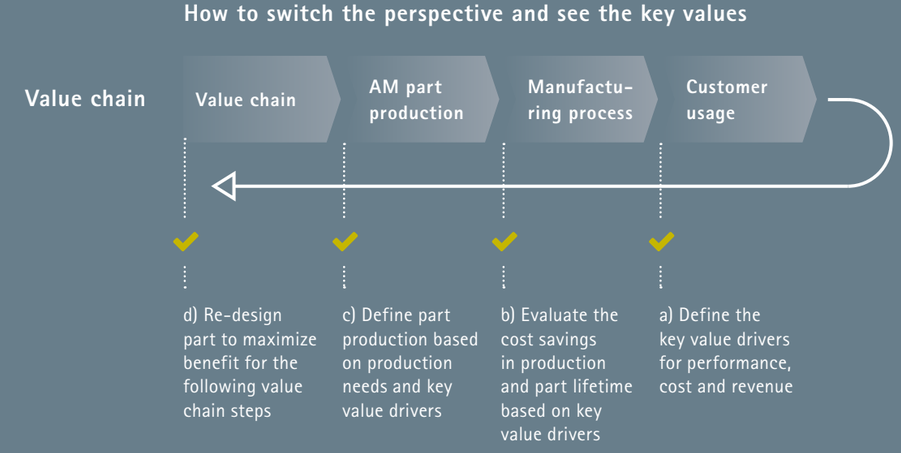
How to overcome the innovator's dilemma

Each link in the value chain has its own challenges

The challenges of the "innovator's dilemma" in our industry



How to switch the perspective and see the key values



Exploring the possibilities of AM

Defining an individual target vision requires an exploration phase. The focus of this exploration is on raising AM awareness. It is essential for decision-makers and stakeholders to have a clear view of what industrial 3DP technologies can – and cannot – achieve, both in general and for their business specifically.

Digital lean is green AM only adds necessary layers of material to a part or product. This keeps waste and material cost per component – and significantly cuts down the ecological footprint.

Understand what AM can do

The most compelling features of AM are those that do away with basic laws of subtractive manufacturing:

- → AM offers unlimited design freedom
- → Complexity has either no or only a minor impact on cost. Companies can design and produce directly for the intended purpose
- → The higher the complexity of a part or end product, the more cost-effective AM becomes
- → Cost per component remains the same, independent of lot size. This creates options for adding mass-customized products and customer co-creation to the portfolio
- → AM systems are comparatively compact and supply chains short. They can manufacture on the spot, whenever and wherever needed. This creates opportunities for companies to leverage their unique know-how in new verticals, in new regions, and for new products

Understand what AM cannot do

Although industrial 3DP systems are growing up fast, there are still restrictions and limitations to consider. 3DP is still more cost-efficient in production scenarios with smaller batches. Currently available systems limit component size to a maximum of approximately 1 meter in length.

Available raw materials include tool steel, stainless steel, titanium, aluminum, cobalt chrome, polyamide, and polyether ether ketone (PEEK). But not every metal and polymer used in conventional manufacturing can be processed using laser melting, i.e. the technology used in powder-based 3DP. Polymers and metals for AM need a closely defined melting point; rubber or compounds are unsuitable for 3D printing.

AM is evolving in leaps and bounds

With the growing potential and market size of AM, 3DP companies are investing in driving development. The range of materials is steadily expanding. Refractory metals and high-performance polymers are expected to become available within the next few years and to enable new applications.

R&D in multi-laser systems is working towards creating larger building spaces, which will allow for components of around 2-3 meters in length. Although these larger components are likely to – initially – be of lower quality than smaller components, multi-laser systems are expected to catch up fast.

Advantages of Additive Manufacturing

- → Mass customization
- → Co-creation with customers
- → Shorter time-to-market
- → Supply chain simplification
- → Lower cost of inventory
- → Lower capital investment for more complex products
- → Waste reduction
- → Weight reduction
- → Complex geometries
- → No tooling costs

Understand what AM can do for you

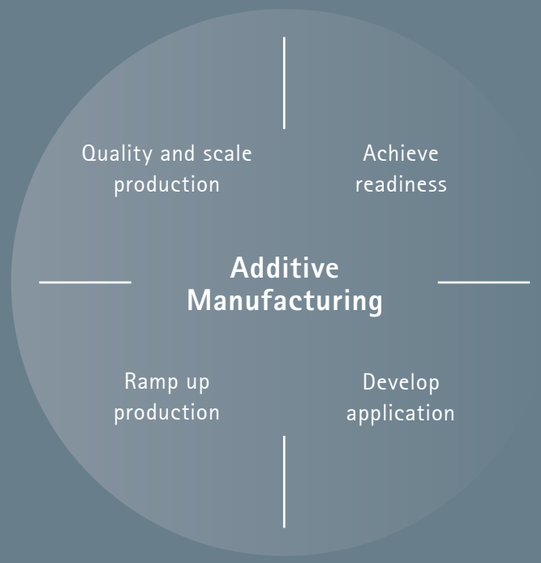
The AM journey starts with manufacturers revisiting their operations and supply chain. They need to explore which distinct advantages of industrial 3DP could best benefit their long-term capability to create business value.

Therefore they will

- → look at the key challenges their target industries are facing
- → explore which AM advantages are best suited to address these key challenges
- → re-evaluate their portfolio in the light of these new insights

During portfolio re-evaluation, it is essential to stay open-minded when envisioning future AM designs. The limitations of conventional manufacturing are deeply ingrained in our thinking – in many ways, they have virtually taken on the role of principle laws. However, AM transcends these "laws" and allows innovative designs that are impossible to produce with subtractive manufacturing. This could be, for example, re-designing an application, which would traditionally consist of multiple parts, as a single AM part following AM engineering guidelines. This new single-part application will be stiffer, lighter, and more robust – and come with a higher performance than the old multiple-part application.

The limitations of conventional manufacturing are so deeply ingrained in our thinking, they have virtually taken on the role of principle laws.



Understanding the principles of AM engineering

Embedding this phase of the exploration in a tightly integrated strategy is key, but there is no one-fits-all approach to starting this part of the AM journey. In general terms, many executives will opt to go from prototyping in R&D to pre-production with stand-alone AM systems and – in the last evolutionary stage – move to the integration in manufacturing cells for a serial production ramp-up.

Identifying the right approach

However, each organization needs to identify an exploration framework that best fits its unique needs and goals. Experience shows that adopters do best with a pragmatic, fast, and agile approach to understanding the principles of AM engineering. The exploration of engineering principles itself needs to be open to results – and unfold strong momentum from day one.

Depending on where they stand in their AM process, organizations need to decide how they want to frame their technological exploration. Here are examples of how other 3DP adopters frame their step into AM:

→ **AM pilot projects**
Some 3DP adopters set up pilot projects, which give their most innovative engineers ample space to explore AM to improve applications, free of performance pressure and return-on-investment demands.

→ **Innovation centers**
Other companies acquire AM systems through their central holding, then turn these over to selected teams of engineers. The systems come with one requirement only: to use these systems extensively over the following 12 months.

→ **Centers of Competence**
Especially global players tend to opt for Centers of Competence (CoC). They use CoCs to create momentum within their corporation, while enabling talents as well as interested influencers from their pool of engineers.

→ **Global innovation programs**
Key industries, such as the aerospace and medical industries, are more like to create global innovation programs, dedicated exclusively to AM.

→ **Seed teams**
Another option is to set up "seed teams" – a dedicated in-house group of high-potential employees, the "future champions" – and to let them work on the most challenging parts with the highest complexity.

Screening the portfolio to select parts for AM

At this point, best-in-class AM adopters look at their value chain not from their own perspective, but from that of their customers, in order to understand which advantages of AM bring the strongest added value to the customer. They define the key value drivers for performance, cost, and revenue.

Customer focus during portfolio screening
When selecting parts for AM redesign, best-in-class AM adopters look at their value chain from the perspective of their customer.

The next step is to pinpoint the value chain link that will benefit most from AM producing the part. A selected part needs to meet the following requirements:

The technical fit

→ Does the application fit into current AM systems?

→ Are the necessary materials available for AM? If the materials of the original application design are not available, are there AM powders that would make a good replacement?

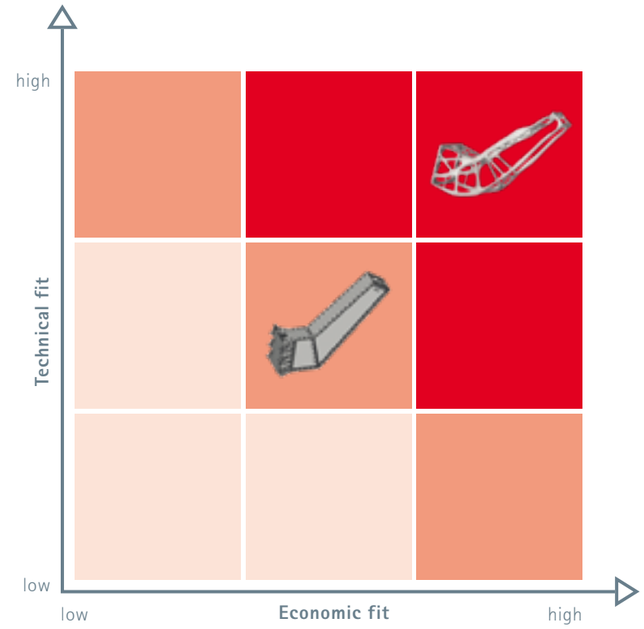
→ Does the part fulfill AM design rules, such as minimal wall thickness?

The economic fit

→ How high are production costs using AM compared to the cost of conventional machine tooling?

→ Do you save assembly steps? What are the savings in supply chain cost?

→ What is the added value of a redesigned part? Consider part lifetime based on key value drivers. Even higher manufacturing cost at this stage may ultimately generate significantly higher total value for customers.



1. Evaluate technical fit of application

→ Does it fit into current AM systems?
→ Are the materials available?
→ Does it fulfill AM design rules?

2. Evaluate economic fit of application

→ How high are the production costs?
→ What are the savings in the supply chain cost?
→ What value is added through AM?

3. Decide way forward

→ Is the application suitable for AM?
→ How can the value be increased?
→ Revise the design for AM

Considering the next step

→ How can you revise the design to increase the value of the selected application?

→ Is the application suitable for serial AM production?

Re-designing an application for AM or creating a new AM design

Optimizing selected parts for AM – or creating new designs – involves integrating advanced structures, such as lattice and complex geometries based on bionic designs. One option at this stage is to use topology optimization software.

Using topology optimization software

Optimized topologies are difficult, if not impossible to produce with the means of traditional manufacturing. With AM, on the other hand, design complexity incurs no additional cost. The advantages of optimized topologies include shorter time-to-market, reduced cost and complexity of assembly and part inventory, and increased product value.

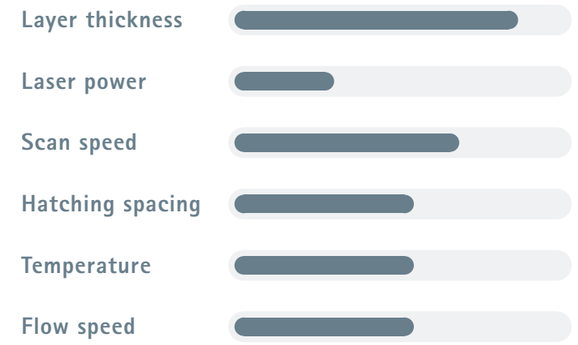
Optimizing process and material

It is important to ensure the part properties of the new application are of a high repeatable quality. In AM, part properties are defined by the AM process: the quality of the material, the machine used, and the process itself – the laser setting, laser power, and laser speed.

Fine-tuning part characteristics can offer competitive advantages

Tweaking the application's parameters improves both the performance of materials and part characteristics. Some AM systems come with a parameter editor. EOS systems give users access to over 200 variables to define how the laser will interact with the material. Fine-tuning variables changes part characteristics – essentially the very DNA of a part. This also provides a strong competitive advantage. The source of such improved characteristics cannot be detected from the outside, making it extremely difficult for competitors to create copies.

Process optimization



Business cases fall into two categories

The information collected during portfolio screening, part selection, and part development goes into building a business case. This involves considering strategic AM business options, from an overview of the current activities in the AM market to opportunities and threats.

1. Optimization approach

The typical cost improvement approach is to select parts designed for conventional manufacturing processes and re-design them for AM. As a result, there are reference figures for comparison. To cut costs, improvements should impact at least one of these total cost levers:

+ Part production cost
+ Material cost
+ Assembly cost
+ Shipment and logistics cost
+ Cost of additional tooling
+ Working capital cost
+ Supply chain cost

2. Innovative AM applications

The focus of the radical revenue growth approach is on innovative parts that offer higher part performance and/or notably lower total product life cycle cost for the customer's customer. An example of this type of application is the GE fuel nozzle – to date, it has saved airlines 3.0 million USD in kerosene costs.

Innovative applications open up new market potential because their optimized part performance radically improves their customer value. This customer-oriented approach has a significantly higher business impact than the optimization approach, but the business impact is harder to quantify.

Fast delivery on AM goals requires a strong network

Some companies will want to ultimately transform and keep all aspects of AM serial production in-house. Others may opt to focus their resources on part design and part properties, while outsourcing powder handling, post-processing and finishing outside the company itself.

Few organizations will have the agility or the operational and organizational AM maturity to deliver on their strategic business goals right from the start. At this point, the strategic value of business ecosystems cannot be overstated. As 3DP adopters start to transform their organizations, it is essential to flank their efforts by simultaneously putting together and nurturing a network of experienced service providers, developer communities, cooperators, suppliers, AM training facilities, and, of course, customers.

Takeaways

→ Educate decision-makers and stakeholders on the advantages and restrictions of AM.

→ Explore which AM advantages best benefit your long-term capability to create business value.

→ Gain an understanding of technological principles in AM.

→ Look at value chains from the perspective of the customer to identify which product gains the most added value through AM for the customer.

→ Build a business case for re-de-signed or newly created AM parts.

→ Put together a strong AM network to deliver on your strategic goals.

More to explore

→ www.additive-minds.com

Factories of the future

→ Audi: www.eos.info/presse/entwicklungspartnerschaft-zwischen-audi-und-eos

GE, https://gereports.ca/3d-printing-flight-journey-begins/#

Transformation

Getting organizations AM-ready

Much of the discussion around AM implementation centers on the integration of 3DP from the perspective of production and on its potential for reinventing business models. However, successful AM requires experimenting in short and iterative cycles – and a highly collaborative, agile organization with a rigorous customer focus capable of supporting this design-driven form of manufacturing.

A management theory says, "Culture eats strategy for breakfast".
Steve Jobs once said, "A small team of A+ players can run circles around a giant team of B and C players".

Transforming organizations into such agile, customer-oriented, high-performing, cross-disciplinary teams is the dream of many C-level managers. The reality check shows that conventionally structured organizations in subtractive manufacturing cling to silo thinking and fragmented views of customer needs. Breaking free of this deeply entrenched culture hinges on the full commitment of the CXO level.

How ready is an organization to embrace AM?
An assessment of change readiness lets decision-makers gauge the acceptance of AM in their organization. It gives them an understanding of the level of shared commitment across all ranks to implement AM as well as of the shared trust of their organization in its own capability to successfully transform.
Assessing change readiness allows the CXO level to pinpoint areas in need of more support.

Nurturing a collaborative culture around the AM vision

In an ideal scenario, visionaries at CXO level will nurture a new culture around the AM vision across their entire organization. They will se tup organizational units and/or dedicated project teams, encouraging product designers, R&D engineers, and project managers with fresh ideas to form open-minded, high-energy teams. They will enable them to experiment with AM technology and applications in a protected space, before challenging them with short ROI targets.

Their innovative applications will serve as the starting point of the roadmap for the transformation of the remaining organization.

Bottom-up or top-down: Visionaries at the top level and ambassadors at the project level drive the AM transformation.

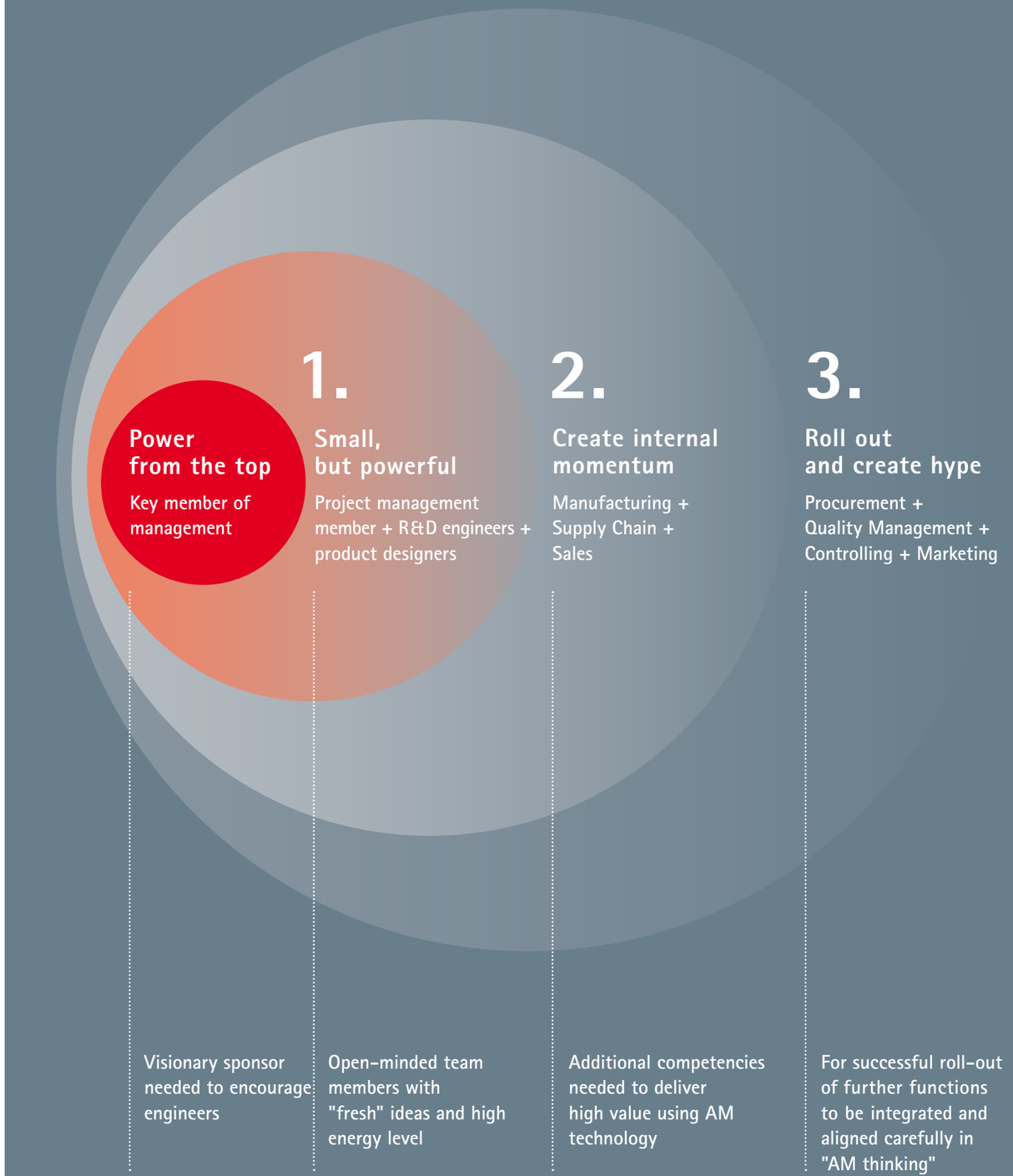
Enabling and supporting AM ambassadors

The enthusiasm of small innovation powerhouses in R&D has the potential to create a strong "hype" and – with backing from the top – can help to spread acceptance of AM across other departments, such as manufacturing, supply chain, and sales. The competencies of these departments are key to delivering high value from AM technology.

Supply chain evolution

The supply chain will be impacted in two dimensions: cost-optimized and value-added. The typical non-core parts, which are traditionally the majority of spare parts made of plastic, will be embedded in new, flexible supply chains and local 3D printing shops will make part production near end users in a few hours possible.

The "core parts" will increase the added value to customers and mainly consist of metal powder. These parts can be small, but have a strong impact on system performance. Their supply chains will be less open, enabling companies to control and ensure quality as well as reduce the risk of being copied. These two evolutional dimensions will change the way we set up supply chains, shorten lead times and minimize capital commitment in warehouses.

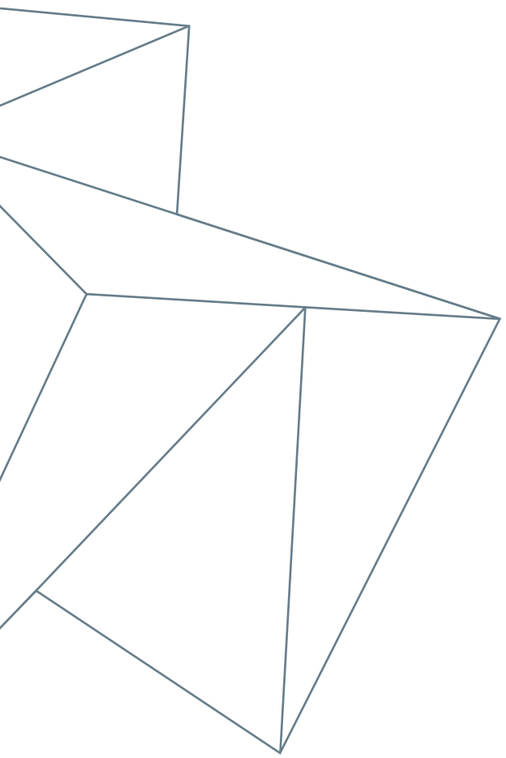


Organizations need to be involved in shaping their own transformation

AM transformations are most sustainable when top management invites operations, automation and information technology ranks to exchange ideas and contribute their unique insights. Driving transformation as a collective effort with openness to results helps people to perceive AM as a positive change. They will be more likely to commit, make more of an effort, and be more collaborative.

Support the AM transformation with training, education, and consulting

AM education programs and consulting as well as agile training courses throughout AM adoption need to be focused and goal-oriented, because the transformation itself is on a timescale, i.e. roll-out approaches, procurement, quality management, controlling, and marketing have to be carefully aligned to AM thinking.



Takeaways

→ Secure commitment at CXO level

→ Support AM ambassadors and stakeholders and nurture a culture around the AM vision

→ Tap into the unique insights of departments; include all ranks in the decisions regarding their transformation. Stay open to results

→ Leverage the insights of experts to pinpoint and support departments in need of training and transition support

More to explore

→ Additive Minds Academy: https://www.eos.info/additive-minds/academy

→ Industry 4.0 - How to navigate digitization of the manufacturing sector: https://www.mckinsey.de/files/mck_industry_40_report.pdf

AM transformation is all about people.

Empowering people

A successful AM transformation enables production, organization, and people. Especially employees need staunch support – and time – to transition to AM thinking. The dramatic changes to their culture force them to take a leap of faith – a leap away from familiar structures, roles, and mindsets. Transformation efforts need to build trust and give people a sense of empowerment as the organization around them restructures and transforms.

Actively addressing the skills gap

Manufacturing companies driving a sustainable AM transformation on a timescale not only need to help ranks become more educated about Additive Manufacturing and design thinking; some will need to acquire new skill sets. An AM education program should address the skills gap, not only for designers and knowledge workers, but for mid-management and operators as well.

Managers with a holistic understanding of AM drive the exchange of ideas

Transparent communication ensures mid-management sees the whole transformation picture. Managers with a holistic understanding of AM are more likely to support changes and be more efficient in restructuring and driving discussions about the transformation itself. To grow the ability to develop radical innovations, mid-management needs to engage all influencers of AM.

Nurturing talent in-house

Although numbers are growing there is still a notable shortage of product designers and AM operators with sufficient process knowledge and understanding of Additive Manufacturing. Without an appropriately developed infrastructure to support the AM industry, nurturing production-oriented design talent as well as machine operators in-house is a crucial step.

Designers and operators not only need know-how to find new applications for AM, they also need a clear understanding of the regulatory compliance issues that come with making commercial parts. Educating AM influencers on quality focus and nurturing their ability to perform in an agile organization are equally important.

Experienced designers must unlearn in order to learn

Especially experienced designers first need to "learn to unlearn" before they can embrace the unlimited design possibilities of AM. This keeps designers and engineers from incorporating production limitations of traditional manufacturing in their application designs. The most innovative minds not only master the design of parts, but optimize their designs for post-processing. They also optimize the melt pool by defining the ideal set of variables in the parameter editor for a specific or even new material.

Takeaways

→ Support employees in their transition to AM thinking

→ Establish an AM education program to address the skills gap

→ Keep communication transparent to ensure mid-management sees the whole transformation picture

→ Engage influencers of AM of all ranks and drive exchange

→ Nurture production-oriented talent with design thinking as well as machine operators

More to explore

→ Verein deutscher Ingenieure (VDI): Guideline for Additive Manufacturing VDI_3405-2_08-13.pdf in accordance with VDI standard 1000 and designed to complement the VDI standard 3404

Training programs in Germany

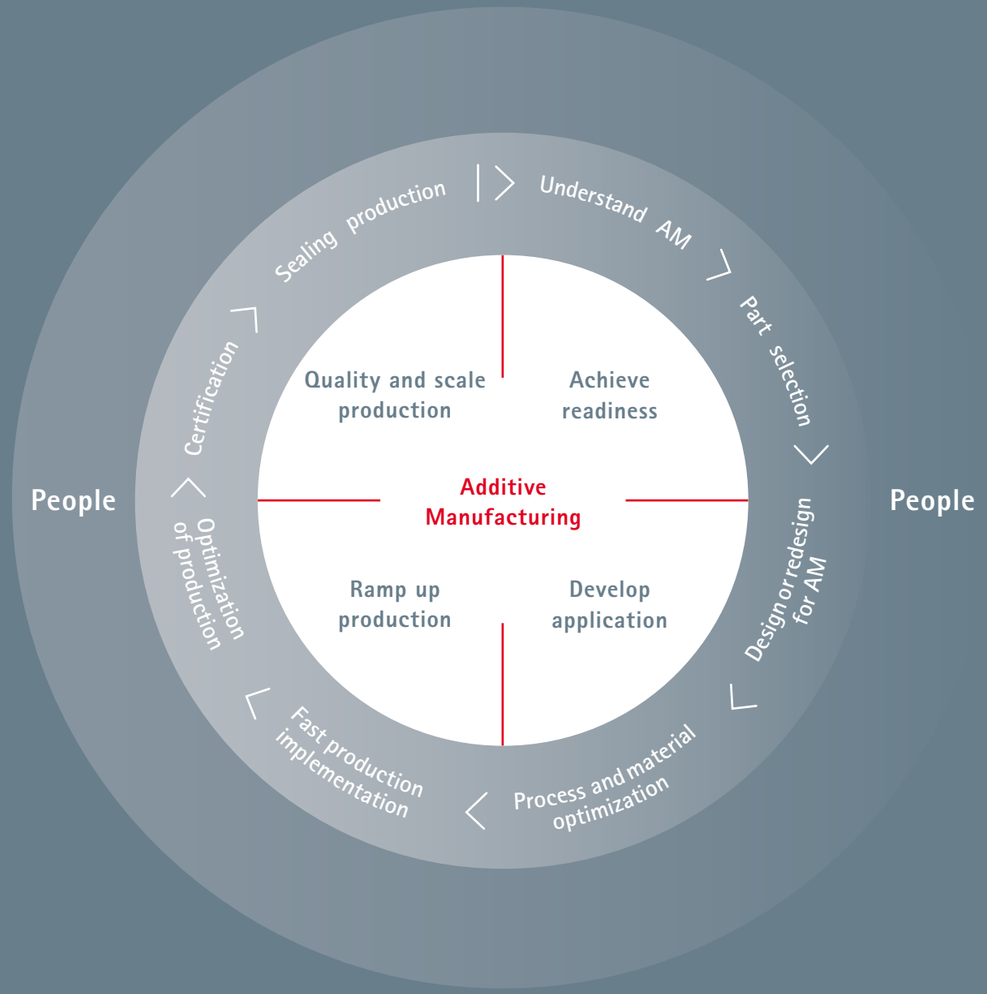
→ Fachkraft für additive Fertigungsverfahren (in compliance with DVS® 3602-1) http://www.lzh-laser-akademie.de/fachkraft-additive-fertigung.html

→ Anwendungstechniker (FH) für Additive Verfahren/Rapid-Technologien

→ VDI Wissensforum: Fachingenieur Additive Fertigung VDI

→ https://www.vdi-wissensforum.de

→ Universities in Duisburg, Darmstadt, Erlangen, Paderborn and other cities offer AM lectures and courses



Conclusion

The potential of industrial 3DP to disrupt traditional business models is enormous – from low-cost polymer parts to high-value metal parts; from customized small production batches to larger serial part production; from local print shops to global manufacturing networks. The potential impact of disruptive innovations is yet unexplored, but only the early-movers will be part of the disruptional wave to sweep across the next decade – and protect their business from being disrupted by others.

While some company leaders understand the magnitude and scope of the efforts needed to restructure their technical departments and break down organizational silos, many tend to underestimate the scale of change management necessary to overcome risk-averse mindsets, siloed thinking and a company culture prone to turf wars. At the same time, the majority of manufacturers are aware that their capability to harness the innovative power of Additive Manufacturing to increase customer benefit and capture revenue growth will directly impact their market position in the years to come.

The key to fast AM adoption is a bold, tightly aligned strategy that starts with closing the knowledge gap of its innovative in-house talent and enabling teams of product designers and engineers while kickstarting and driving the transformation of their organization. The success of industrial-scale 3DP hinges on this transformation encompassing all levels – operations, organization, and production.

Best-practice examples of successful early-adopters have 5 things in common:

→ Strategists start out with small cross-functional teams. They create protected environments for these teams to work on the "next big thing" while kicking off and driving the transformation of the wider organization.

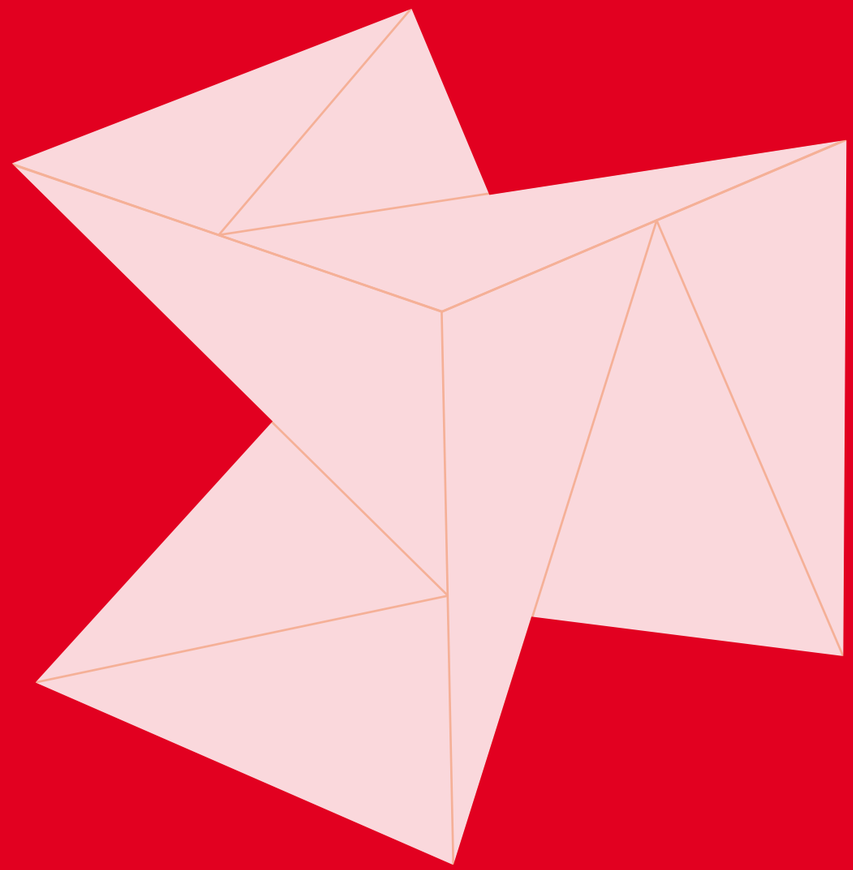
→ Leaders enable and train their people, especially talent in design and production, early on to transition to AM design thinking. They enlist experienced service providers, such as Additive Minds, to ensure learning curves at each transformation stage stay short, focused, and cost-efficient.

→ Executives actively promote a collaborative culture, which embraces cross-functional teams in agile environments with a rigorous customer focus. Empowering people, they address the skills gap with training and workshops.

→ The CXO level raises awareness and acceptance of AM across their entire organization, even before departments start to realign to support design-driven manufacturing. They assess and monitor organizational readiness and maintain transparent communication with mid-management. Across all transformation stages, strategists minimize risk by structuring processes to identify and address areas that struggle to realign.

→ To ensure the fast roll-out of their first (re-)designed AM parts, executives flank their efforts by joining forces with experienced service providers. While expanding their own capabilities, they foster a strong AM ecosystem of AM service providers, cooperators, suppliers, AM training facilities, and, of course, customers.

This decade will determine the industrial champions of the decades to come.



ADDITIVEMINDS
EXCELLENCE IN INDUSTRIAL 3D PRINTING

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Güngör Kara is a skilled expert in the fields of industrial 3D printing, innovation and operational excellence. In his role as Director of Global Application and Consulting, he heads the global activities of the application and consulting department at EOS, the worldwide technology and quality leader for powder-based, industrial 3D printing. Together with his team of experienced, technical consultants he has deep insights into current developments of Additive Manufacturing in multinational enterprises and innovative start-ups and supports them to the degree required. Before joining EOS he studied mechanical engineering in Berlin and has an MBA degree from the WHU – Otto Beisheim School of Management - in Vallendar and the Northwestern University in Chicago. Mr Kara also has more than 16 years of professional experience as an executive consultant – mostly at A.T. Kearney – in the fields of operational excellence, innovation, and business development.

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