Unleashing the potential of Additive Manufacturing (AM) in Belgian industry

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1 Foreword

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Having proven itself as an efficient means of making prototypes in a short timeframe and at less cost, 3D printing, one of the most promising recent technologies, has moved further. In the form of Additive Manufacturing (AM), it's already having a significant impact on manufacturing, from design to full-scale production. More and more companies across the world recognise the opportunities AM brings and are making significant investments in AM technologies. The global growth we're seeing confirms forecasts made by SmarTech and Wohlers Associates that predict that by 2025, the global AM market will have reached 33 billion US dollars. Looking at the development of AM over the last few years, it's very likely that it'll be used for low-volume, highly specialised and complex products over the next three to five years.

Given the level of activity, it's likely that the Belgian AM ecosystem will maintain its solid position as a pioneering nation and develop itself further when it comes to the industrialisation of AM on a larger scale. But all players within the value chain, from AM suppliers to end users, need to collaborate, inspire and share their expertise about the current and future opportunities of AM if the technology is to become more widely adopted within (manufacturing) companies in Belgium.

We've undertaken this research together with Agoria and Sirris to create greater awareness of the possibilities of AM for Belgian industry and to inspire the ecosystem to take action to help make sure that Belgium maintains its position as a place-to-be for AM expertise.

2 Executive summary

Additive Manufacturing – 3D printing on an industrial scale – will undoubtedly be a disruptive technology in the field of Industry 4.0 in the coming years. It's now more than 30 years since its birth and companies around the world are finally beginning to believe (and invest) in AM. In Healthcare, AM allows for real customisation of prostheses and hearing aids, for example. In the Aerospace industry, we're seeing improved design for weight reduction. Given its expected positive impact on a wide range of activities in different sectors - greater customisation ability, better fit for functionality by designing parts for specific uses, reduction of number of components and benefits to the supply chain with the introduction of a digital rather than physical inventory -, we recommend that all manufacturing companies prepare their business to grasp the opportunities of AM.

Belgium has been a leading pioneer with regards to the evolution of AM with a number of early players originating in the country. As a result, we can now boast expansive know-how and expertise. The Belgian AM ecosystem strongly believes in its potential, expecting both revenues and jobs linked to AM to grow substantially over the next three years. Still, efforts are required if we're to make the transition from 3D printing for (smaller) prototyping towards more industrial applications of AM for larger series of complex end products. AM will certainly become a fully-fledged manufacturing technique, complementary to others already in existence. Implementing it can add value to businesses in different ways; it offers the opportunity to create new products and markets, to be more flexible and responsive towards customers (feedback) and to improve (internal) production processes. The different opportunities are highlighted by the use cases further on in this study.

To boost the Belgian ecosystem, we must join forces and act now. It's up to AM experts and service providers to educate Belgium's manufacturing companies – that have less experience with and knowledge about the technology – about what they'll need to do to embrace the opportunities offered by AM. This is crucial as too many Belgian (manufacturing) companies today deem the technology to be still too immature and therefore perceive its adoption to be relatively high risk. They struggle to grasp the myriad of opportunities AM can bring, perhaps because it's difficult to calculate the business case or they simply don't see the need to change current means of production, which are still up to the job, and therefore don't consider it. With the right support from the ecosystem, trust and awareness around AM will automatically increase. Manufacturing companies themselves also have a responsibility to make their AM adoption successful. They can create know-how by experimenting with AM and work (preferably with external service providers) to accelerate their learning curve. The more companies in Belgium that understand and know about AM, its drivers and opportunities, the more AM applications and best practices will arise, which in turn will speed up the development of industrialised AM in Belgium, and ultimately result in its wider adoption.

3

About the study

The aim of this collaborative study is to gather insights on how AM technologies have already been adopted by Belgian companies and discover to what extent they'll continue to penetrate Belgian industry going forward. The study starts with an overview of the current global and local AM landscape and how it's expected to evolve in the next decades. We'll then elaborate on the drivers and opportunities AM can bring to all manufacturing companies in Belgium, including some typical applications and existing use cases from Belgian companies. The next section will clarify existing barriers and hurdles, as experienced by service providers and current (potential) users of AM. Finally, we'll share our newly gathered insights about the above and put forward some suggestions on the next steps required to bring AM to an industrial level across the country.

This study was made by collecting information about industrial AM in Belgium in different ways. In the first phase, we performed desk research. In the second phase, we collected the input of Belgian companies in three ways:

1. Interviews with the following AM experts

- Jo de Grootte, Sales Manager at ZiggZagg
- Bart Van der Schueren, CTO /EVP at Materialise
- Peter Mercelis, AM entrepreneur (co-founder Additive Lab, founder Layerwise and Board member of Aerosint and Antleron)
- Bertrand Herry, CEO at Any-Shape
- Herman Derache, Managing Director at Sirris

2. Gauging the broader landscape through an online questionnaire

A total of 95 companies from across the AM value chain[1] (service providers, (potential) users and research centres) participated in our online questionnaire to provide their views on the adoption of AM, different applications, hurdles and required next steps.

Of our respondents, 78% are headquartered in Belgium. With the scope of the study being industrial AM, almost all (97%) focus on the B2B market. Insights come from a range of different sized companies (see figure 1).

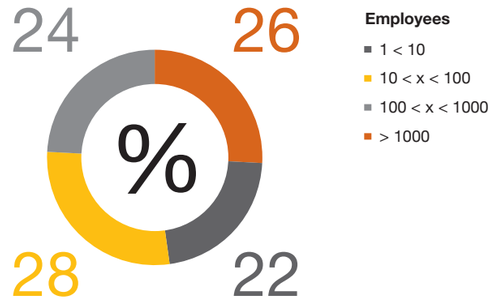


Figure 1. Overview of company sizes in the survey

Sixty percent of respondents to our survey state that AM isn't (yet) seen as their core business. We divided respondents into five types of profiles linked to their activities related to the AM value chain: current users, potential users, service providers, technology providers and knowledge creation and sharing organisations. We analysed the results for each profile separately to better understand their different positions.

1 The AM value chain will be explained more broadly in the next chapter

Five key takeaways from Bart van Der Schueren, Chief Technology Officer (CTO) at Materialise

1. To stimulate the adoption of AM, all AM protagonists should collaborate to promote a more open and flexible market model. This will lead to more control, more choice in materials and systems and ultimately lower cost.
2. For companies who can't rely on a specialised internal 3D printing service, Belgium offers sufficient qualified external service bureaus.
3. AM offers companies design optimisations that let them manufacture (pre-)series with a more customer-centric approach. This flexible production process enables a much shorter customer feedback loop and allows companies to better meet individual customer needs and demands.
4. 3D Printing offers a level of customisation that's generally well-understood for B2C products. Industrial companies however, respond more slowly to the possibility to cost-effectively manufacture entirely individualised products.
5. Continued innovation will fuel the adoption of AM. That's why companies need to invest in and experiment with technologies such as AM now, if they want to maintain a competitive advantage and position themselves for long-term growth.

As can be seen in Figure 2, current AM users account for 34% of all respondents. Adding in potential AM users brings this percentage to 52%. Sixty-seven percent of the big corporations (above 1,000 employees) in our study fall into this category of (potential) AM users. Service and technology providers together account for 40% of the participants. A big majority of the respondents (75%) had at least basic experience with AM.

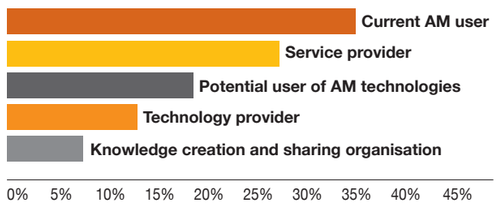


Figure 2. Overview of respondents' AM roles in the survey

3. Roundtables

To validate our findings and the advice of our experts, we organised interactive roundtables to dive deeper into the important topics related to industrial AM in Belgium. The roundtable took place in March 2019 and brought together a selected group of individuals working at different places along the value chain. The main topics discussed were the current ecosystem of AM in Belgium, the drivers and opportunities that'll take AM to an industrial level in Belgium and the most important barriers to be solved, both individually and collectively, within the complete ecosystem.

I. Additive manufacturing is moving beyond prototyping into a mature manufacturing technique

AM is gaining recognition as an alternative to conventional subtractive manufacturing techniques to deliver final products. Far from a standalone technology, AM involves many different types of machines (and therefore technologies) and software.

AM works in a completely different way to traditional manufacturing processes: the design of a part or product is first sent to the 3D printer in slices (pre-process), the printer then builds the product by adding material layer upon layer (printing process) and finally the support structure is removed and the end product cleaned and assembled (post-process). The three most common AM techniques are Stereolithography (SLA), Fused Deposition Modelling (FDM) and Selective Laser Sintering (SLS). Production velocity, resolution and other product properties vary depending on the chosen technique and material used.

Globally, it's commonly stated that AM will disrupt the manufacturing industry over the next decade. The AM industry, consisting of all AM hardware, software, materials and services worldwide, has continued to grow substantially over the last years. SmarTech Publishing, one of the leading industry analysis firms specialising in AM markets, estimated the total global AM market to be worth 9.3 billion US dollars in 2018, an increase of 18% on the previous year. Estimations in Wohlers Associate's report[2] are very much in line with these figures. Figure 3 shows a forecast of the total AM market up to 2027, as well as the size of its separate components (hardware, materials, software and services). According to these predictions, the global AM market is expected to be worth about 20 billion US dollars in 2022.

Photopolymers account for a large segment of the AM materials market, due in part to their historical and current use for prototyping and related applications. In the coming years though, the global AM market is expected to shift from prototyping to the mass production of parts for end-use products, which will be strongly enabled by the rise of metal as a reliable material to print. Metal AM has been available for roughly half of the industry's 30-year history, yet it already represents 16.2% of the total and is growing fast (SmarTech, 2018). The emergence of low-cost metal AM systems into the market led to a substantial increase in the sale of metal AM systems.

The main industries for AM applications on a global scale are Healthcare, Aerospace and Automotive. An example of using AM within the Healthcare sector is Luxexcel (see the use case on page 12) a company that 3D prints lenses for ophthalmic applications, mainly because of the ability to customise the product for individual patients.

The importance of the investments being made in AM by big global original equipment manufacturers (OEMs) like Airbus, Thales, Audi and Volkswagen should certainly not be underestimated. While companies supplying parts to these OEMs can test and create know-how about AM, they're not the final decision makers about turning AM-made pieces into end products. A number of companies in the Aerospace industry are experimenting with AM because the OEMs (Airbus and Boeing) made it clear that they need to be ready to use the technology within five to 10 years. Since the Belgian manufacturing economy is mainly downstream of these OEMs, the need and demand for AM will also cascade down towards Belgian industry.

The global AM market is expected to be 20 billion US dollars in 2022

(SmarTech, 2018)

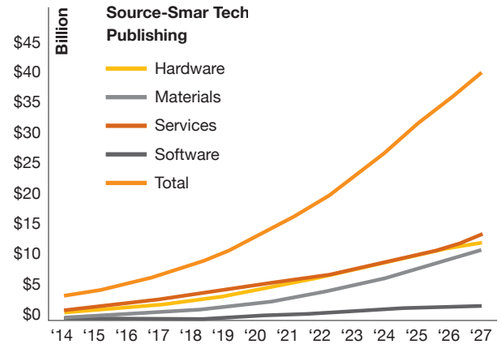


Figure 3. Overview of the global AM market (incl. forecast) - SmarTech, 2018

2 Based on Wohlers Report 2017, providing a worldwide review and analysis of additive manufacturing

Use Case

Luxexcel

3D printed lenses by Luxexcel

The company

Luxexcel is the only company in the world able to 3D print lenses. The company has 40 employees and is active in Eindhoven (NL), Turnhout (B) and Alpharetta (USA). Launched in 2009, it focuses on 3D-printed lenses for ophthalmic applications (eyeglasses).

The challenge

Ophthalmic lenses are one of the oldest customised products for health purposes. The traditional manufacturing process consists of at least 12 different steps, starting from an adapted lens blank from an ophthalmic lab's stock. Around 80% of the material is wasted during the cutting (grinding) process. Luxexcel's founders believed that there was room for the development of a new manufacturing process, based on the strengths of AM.

The solution

The company developed technologies to create one complete 3D printing solution, including hardware, materials and design software. Ophthalmic labs print customised lenses with a Luxexcel printer and then VisionEngine coats the lenses, after which the lab sends them to the optometrist or optician.

Luxexcel remains responsible for all technical aspects, with the ophthalmic lab forming the lenses using print heads to deposit multiple layers of a mid-index acrylic material (type of resin), called VisionClear™, onto a substrate sheet. The company has in-house knowledge of the entire printing process. The 3D-printed lenses are ISO compliant and compatible with all standard industry coatings and processes.

The Advantages

Luxexcel disrupted the traditional manufacturing process of lenses, creating added value for ophthalmologic labs. Its technology replaces several production steps like taping, polishing and grinding with one single step of 3D printing. It also avoids the need for a large inventory of blanks, as it enables on-demand production. Another advantage of using 3D printing for this application is that the lenses can be completely customised for users.

Using AM for ophthalmic lenses is quite technologically challenging because of the requirements for transparency, surface smoothness and accuracy of refraction. The know-how the company has gained over the years gives it a real competitive advantage which'll expand even further in the years to come. AM offers opportunities for future products that don't yet exist in the eyewear industry, such as the integration of a filter or sensor in the lens or sunglasses with optical power that switch electrically from light to dark.

II. Belgium has a strong footprint in all required elements of the industrial AM value chain

What does the AM value chain look like?

The production process of AM requires three types of resources: material, printer and software. With these technological resources brought together, AM production is segmented into three phases. These phases can be carried out either within the company, outsourced or via a combination of both.

The value chain is surrounded by different support elements. (Applied) research and training organisations create (new) knowledge and transmit it to all value chain stakeholders. Community building organisations facilitate knowledge transfer between companies via, for example, networking opportunities and by setting up collaborative projects.

What does the AM value chain look like in Belgium?

Belgium is a pioneering country in the field of AM thanks to top-notch research that took place in Katholieke Universiteit (KU) Leuven. Its research teams were able to valorise developed technologies, giving birth to two major players: Materialise and Layerwise (acquired by 3D Systems in 2014). This explains why Belgium's rather well represented in the hardware and software pillars of the AM value chain. Two other innovative start-ups, Aerosint and Twikit, also attract a lot of attention in this field. Most service providers adopt diverse approaches to meeting their clients' needs, combining different stages of production. These activities will consolidate in the years to come.

Strong know-how and infrastructure present in Belgium

KU Leuven remains a leading reference for metal printing technology development, although, other universities such as Ghent University and the University of Liège (ULg) have also developed cutting-edge expertise. Sirris has built up more than 25 years of expertise in applied AM research, playing an essential role in the transfer of AM knowledge to companies via collaborative applied research, research and development (R&D) consulting and training.

The amount of know-how present in Belgium today, thanks to historical players in the country, is huge and must seep through to the industry

(Interview Herman Derache, 2019)

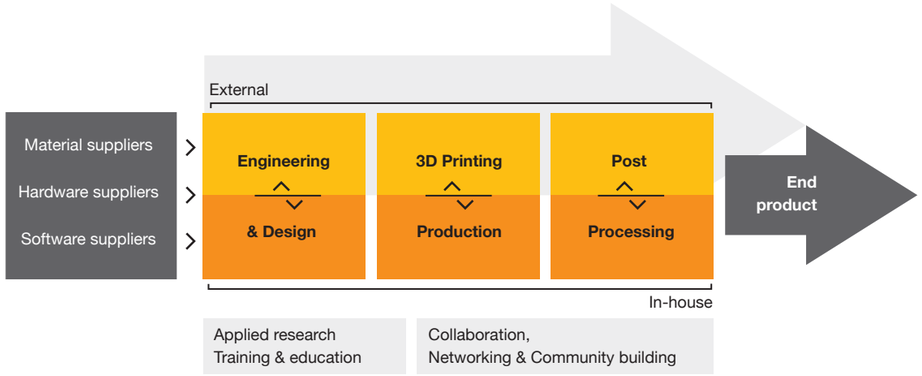


Figure 4. The AM value chain

Use Case

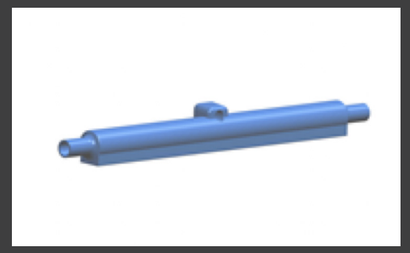
Bonduelle

The company

Bonduelle is the worldwide leader in vegetable products. In Kortemark, peas and beans are processed on a flexible line, where different sizes of cans are processed and labelled before hitting supermarket shelves. 3D Infinity is a Belgian SME specialised in 3D scanning and 3D printing.

The challenge

The labelling process takes place at the end of the line, which was designed to be very flexible to be able to label different sizes of cans. Glue is applied to the can using a glue tube composed of a plastic tube that's approximately 25cm long with a diameter of 15mm and housing two copper connectors. When the incumbent supplier of these glue tubes went out of business, it jeopardised the gluing process. One of Bonduelle's technicians approached 3D Infinity to check the feasibility of printing an exact replica of the plastic part of the tube.



Design of 3D printed glue tubes

The solution

3D Infinity made a 3D scan of the existing tubes to make digital models. Although Bonduelle's initial idea was to only print the plastic part of the tube and to look for another supplier to make the copper connections and then unite them, which would have involved different manual manipulations, 3D Infinity suggested re-engineering the tubes to integrate the connections in the print. Three design iterations later - to ensure optimal glue flow through the tube - and having tested two different materials, the final model was validated and implemented on the line.

The advantages

Not only have the glue lines been able to be kept as they were with no big investment needed. Bonduelle also no longer has to store stocks of glue tubes. It can simply order a new tube when necessary (about every six months).

In short

- Cost: 800 euros for reverse engineering; every tube printed costs 35 euros
- Timing: one month to validate the final model

"The contribution of Belgium industry to the global AM economy is estimated to be 3 to 3.5 %.

Sirris, 2017

An important number of small and medium-sized enterprises (SMEs) have invested in AM over the past years, leading to the development of a rich network of service providers, particularly in Flanders. Most are (very) small companies, focused on a sole printing technology. Thanks to their experience, the majority can provide design support. The biggest players integrate design, engineering and post-processing services (internally or through partnerships). Bonduelle collaborated with 3D Infinity for its design and engineering phase, as explained in the use case on page 14.

Big corporations, mainly in Aerospace and Defence, have also invested in AM, in collaboration with R&D organisations, by internalising expertise via the development of new materials/technologies for their own applications.

The Belgian AM community anticipates strong growth

Survey results show that 50% of Belgian companies active in AM expect a high growth rate in terms of revenues in the next three years, leading to an important increase in jobs linked directly to AM. In a first estimation, we see a potential job creation or transition between 1,000 and 1,500 for the next three to five years in manufacturing companies. In 2017, the amount of workers in AM companies - where AM is seen as their core business - was about 1,500. This represents 90% of the total AM employment in Belgium. Additionally, the average employment growth rate for the last eight years was 15%. We therefore expect the amount of jobs, directly linked to AM, to double within the next three to five years in manufacturing companies.

A supportive ecosystem

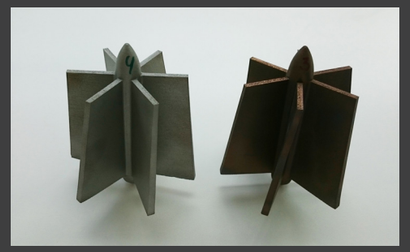
FlandersMake, the strategic research centre for the manufacturing industry, supports collaborative applied research in Flanders, focusing on Industry 4.0. In Wallonia, Mecatech funds innovative projects with a broader approach. Both also work thanks to European funding. By doing so, they enable companies to adopt AM.

Training is rather limited for the moment, although some universities and technical colleges have already integrated some AM aspects in their curricula. Sirris offers a masterclass on "Design for additive manufacturing" that's proven popular with the industry. In both Flanders and Wallonia, recent initiatives have been launched (by Technifutur, VDAB and Agoria) to expand training for the industry as well as job seekers.

Three players in the market are linked with cluster and networking activities: Through its technical workshops and activities over the last 25 years, Sirris has brought companies together. In Flanders, Strategic Initiative Materials (SIM) is very active in both raising awareness, through Flam3D, and bringing companies together for collaborative projects. Flam3D is a cluster grouping mainly service providers from Flanders and the Netherlands. Agoria launched a specific AM business group to develop the Belgian AM market by raising awareness and creating know-how sharing opportunities for the industry and to better address sector challenges in the political sphere.

Use Case

ENGIE Laborelec



3D printed “twister” by ENGIE Laborelec

The company

ENGIE Laborelec is a field centre of expertise and research that supports a large number of customers across the entire electricity value chain (from production to distribution). Founded in 1962, today, Laborelec is a cooperative company with ENGIE shareholders and various independent network managers present in more than 60 countries, and with offices in Belgium, the Netherlands, Germany, Chile and Abu Dhabi.

The challenge

For a number of strategic spare parts, ENGIE faces a series of technical challenges, including part obsolescence, long lead times, slow-moving spare parts in warehouses, as well as expensive and numerous production methods to deliver high-quality parts. In addition, the validation procedure for new designs was extremely long.

The first use case identified by ENGIE was a twister that forms part of an air extraction pump (about 18 x 10cm) that was no longer produced byt the original part manufacturer. ENGIE tackled the challenge of component obsolescence as a first use case in 2016.

The solution

Since 2014, ENGIE Laborelec has housed ENGIE’s metal additive manufacturing thematic laboratory equipped with AM systems, combined with a dedicated powder lab and a materials lab. The team has enough know-how with regards to materials and AM processes to propose new design strategies and facilitate stable and robust production. In some cases, complete rethink of the design of a product is achieved, improving process efficiency and enabling it to be produced in one piece (instead of multiple separate parts).

The advantages

Several advantages were realised over time. First, for niche and dedicated applications, the production costs for parts have been reduced and delivery times shortened, thanks to less complex production processes. This also allows parts to be manufactured on demand, avoiding storage costs. Parts can also still be replaced, even after obsolescence. Rethinking the design also called into question the maintenance process for these parts and, as a result, new specific tools have been developed to reduce the time needed for maintenance. Recently, this project also stimulated teams’ creativity for the identification of new cases.

In short

- For the ENGIE first use case, the twister was commissioned in October 2016 and retired after 2,000 hours of service. A non-destructive evaluation found no cracks or critical degradation.
- Other ENGIE initiatives have showed great potential for additive AM manufacturing, leading to a reduction in production costs of up to 50% and cutting delivery time to one third for some parts. Field testing of a series of AM components is currently under way.

III. AM unlocks new ways to enhance products, increase customer responsiveness and improve internal operations

The use of AM is especially interesting for low-volume pieces. However, given the speed at which the technology evolves, the number of pieces included in this “low volume” is constantly on the rise. In the next three years, AM will mostly be used for the production of series below 100 pieces. Prototyping is likely to remain popular, but it seems to be the only application not expected to grow in the future.

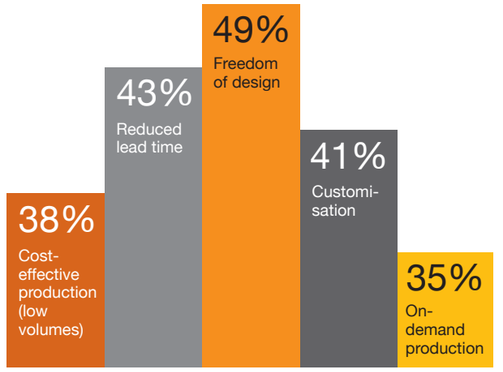


Figure 5. Top five AM drivers

For Belgian companies, five main technological advantages (see figure 5 above) will encourage AM implementation, which can be applied to different applications: improving products, customer responsiveness and internal processes.

I. Product improvement

AM’s freedom of design unlocks the ability to produce new geometries and designs that weren’t possible using conventional manufacturing techniques. This feeds the creation of new pieces and products. Printed parts can be lighter than their equivalent non-printed parts, which was the main differentiator for use cases in the Aerospace and Automotive industries, for instance. Design also enables features such as local strength and the integration of functions.

Mass customisation is well-understood by the Healthcare sector. AM adds value in Healthcare mainly because it enables very patient-specific customisation, not possible before (e.g. implants) or which was very labour-intensive (glasses, soles, etc.). As the Luxexcel case shows, mass customisation is one of the biggest opportunities driving AM implementation. While it’s well understood for the B2C market, it’s still under evaluated for B2B, where it could bring high added value for automated production lines for instance

II. Improving internal processes

AM is about much more than simply changing end products, different AM features can also help improve internal processes. Design freedom can improve production by the creation of tooling that enhances or speeds up a specific production step. It can also decrease the number of production steps required for particular pieces, thereby reducing lead time. This is the main reason that AM is frequently used for prototyping, where it speeds up the iteration of prototypes. It’s also interesting for pieces that are too expensive for stock, but where quick local availability or speed of transport is vital, such as critical spare parts.

Production cost per unit is typically higher with AM than with traditional manufacturing. However, when comparing the total cost of ownership (TCO), AM can be cheaper. TCO takes into account direct and indirect costs related to a product (e.g. mould investment, inventory, warehousing and transport). This makes AM typically cost-effective for the production of low volumes and explains why the production of small to medium plastic series reduces the difference in terms of cost-efficiency compared to more traditional methods. For some pieces, AM can simply lower production costs because of the smaller amounts of materials used and the reduction of labour-intensive production steps

Together, the different advantages of AM often add up. For instance, the production cost of printed spare parts is still higher than traditional (standard) parts. However, taking into account the costs of inventory, warehousing and transport, the gap between the TCO of traditional and printed spare parts diminishes. Taken together with other advantages, such as reduced lead time, AM becomes a preferable solution.

Use Case

JAC

JAC's bread slicer with AM printed parts

The company

Established in 1946, JAC's a family business with headquarters in Liège and production plants in Belgium, Germany and France. The firm specialises in bakery machines, like dough processing machines and bread slicers, an industry in which it's grown to be European market leader. With a large patent portfolio and the creation of various standards, innovation has always been JAC's main strategic growth axis. Any-Shape is a Belgian SME based in Flémalle that specialises in serial industrial 3D printing.

The challenge

When the trend for bread slicers that allow users to choose the thickness of bread slices, machines that are usually broader in size than standard slicers, arose, JAC sought to develop a machine with the standard 60 cm dimension so that stores wouldn't have to change their shelving systems. Part of the solution was found by slicing bread vertically rather than horizontally. It takes a long time to develop such a new product (+/- 3 years) and it's difficult to make its development cost-efficient, even after commercialisation, as machines continually go through modifications based on customer feedback.

The solution

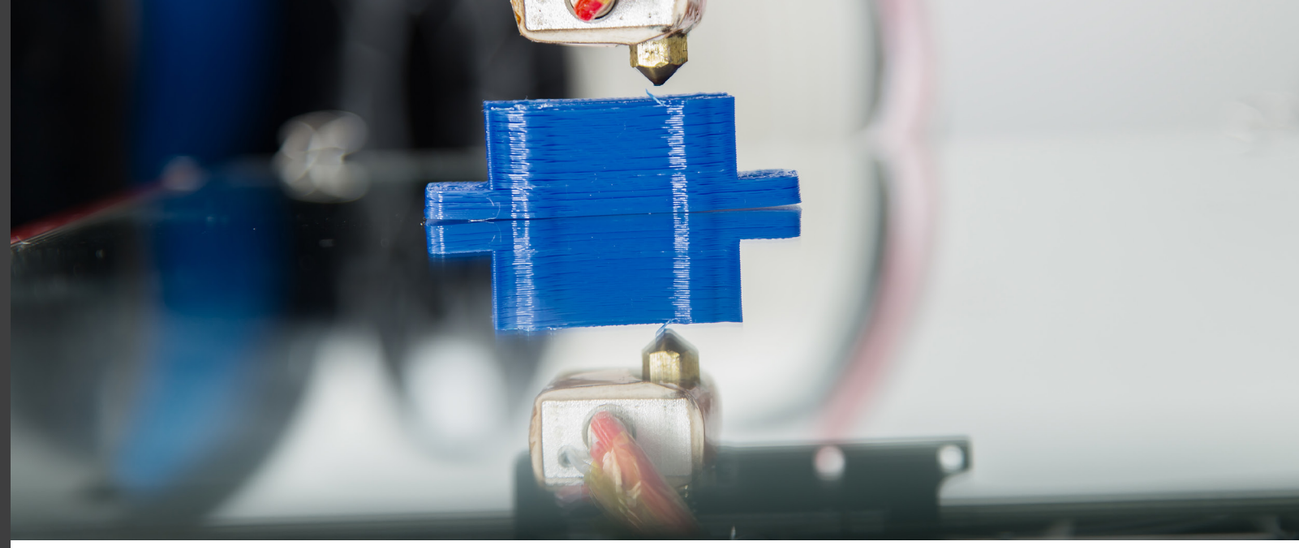
JAC was already using AM to prototype the plastic parts of its machines, such as accessory support. AM has the advantage that there was no need for an injection mould, making it quicker and cheaper for unique pieces or small series. Through discussions with Any-Shape, JAC's AM service supplier, JAC discovered that the price per produced part wasn't as high anymore compared to traditional methods (JAC produces about 1,000 machines per year). JAC decided to implement AM production for this piece.

The advantages

Although the parts are still a little bit more expensive than production by mould injection, the extra cost is compensated by the flexibility AM brings; the company no longer needs to commit to fixed volumes. As the accessory support is visible to the customer, AM also brings a high level of finishing and enables a nicer design.

In short

- JAC collaborated with Any-Shape
- The SLIM machine won the innovation price at iba in München, the world's leading trade fair for bakery and confectionery craft.
- Thanks to the use of AM, JAC gains one month for all modifications to machine design and saves between a 1,000 euros and 10,000 euros for each modification.



III. Improved responsiveness towards customers.

One main opportunity that AM brings is the ability to further evolve products/pieces quickly even after commercialisation. On-demand production can enhance client involvement, leading to faster product modification.

Figure 6 offers an overview of the five most valuable technical advantages of AM and how they add value to a business. As internal operations can be impacted by four of them, it's the easiest area to work on when implementing AM for positive impact.

IV. Conclusion

The different technological advantages can be translated into different added values for a business. Given the broad range of possibilities, any company can apply AM and create value.

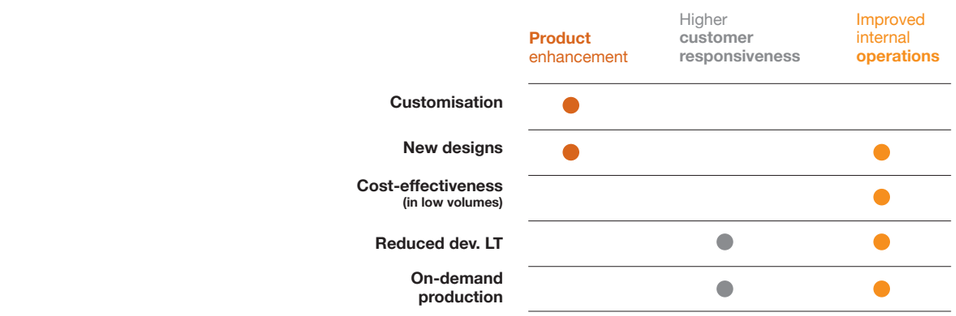


Figure 6. Overview of business value vs. technical advantages AM can bring

“Some companies in Belgium are already very far ahead when it comes to adopting AM for end production, but practically nobody knows about it.

Interview Jo De Groote, ZiggZagg, 2019

IV. To extract the full potential of AM, industrial companies need to overcome their fear

Figure 7. Main hurdles linked with AM today

Lack of AM awareness

AM can seem rather disruptive and far from your current business, making it difficult to identify where and how to start.

Companies not ‘familiar’ with AM still face questions like: What are the opportunities for my business? What does the business case for AM look like? What implications does it have for my current production processes? Etc.

Many decision makers in the Manufacturing industry still don’t yet fully understand the opportunities or added value of AM (e.g. customisation): when they’re confronted with a challenge, they don’t consider AM in the range of possible solutions because they don’t understand it. This is reinforced by the fact that most use cases can’t be openly shared as they’re covered by non-disclosure agreements (NDAs).

Finally, as with any relatively new technology, it’s not always easy to find engineering profiles with the right AM knowledge. The same is true when it comes to trust from the industry or companies potentially using the technology. This is not specifically linked to AM in particular, but can be seen with every ‘new’ technology. It can expect to be gradually resolved over time.

Trust

Adopting AM within a company is often perceived as a (unnecessary) risk. As the technology isn’t completely mature, companies prefer to wait, rather than invest in it early on, particularly those that are currently successfully manufacturing using traditional means. They prefer to take a rather passive approach, waiting for the technology to offer the same guarantees and trust as traditional manufacturing technologies before they take the leap.

It’s essential for companies to trust in AM technologies’ ability to deliver consistent and perfectly reliable high-quality products. This is especially important for industries subject to very specific requirements, such as Aerospace and Automotive, where minor failures could have drastic consequences.

To increase trust, the lack of AM certification and qualification of printed pieces needs to be addressed.

Once a company has identified and worked out or experimented with AM for specific use cases, trust in the technology will automatically grow. Gaining trust is an important part of the learning curve.

Cost

The cost of AM materials and printers remains relatively high (especially for metal printing) which is sometimes regarded as a threat for potential users, as it makes AM appear to involve or require substantial investment. The general perception is that it's hard to be cost efficient with AM. Companies also often find it difficult to estimate the potential return on investment (ROI) or assess the complete business case for AM adoption. Looking at cost per printed part, AM will rarely be the most interesting solution, as it involves higher production costs, due, for example, to:

- the cost of (re-)design: this cost will always exist because producing a piece with AM without redesigning it first means missing out on a big part of the benefits it could bring
- the cost of post-processing: an important and time-consuming step that shouldn't be underestimated
- the qualification cost: an opportunity cost that needs to be borne as you won't always be able to qualify - and therefore sell – certain printed pieces

If Belgium's manufacturing industry is unable to overcome these hurdles, we risk missing out on the immense benefits AM technologies have to offer and, importantly, are likely to be left out of the digital race, unable to catch up. Not only will we lose our current front runner position in AM, but our manufacturers will become less competitive against those employing AM.

V. To boost the Belgian ecosystem we need to join forces and act now

Recommendations for industrial companies

1. Launch a pilot using the 4E stepwise approach (see below)

The main challenge to improving processes or creating new products using AM is to identify the first pertinent use case. All companies experience the same virtuous circle: identifying the right AM opportunities raises your position in the learning curve and creates internal know-how. This internal know-how helps (partially) resolve the technology and cost challenges as it helps you identify the next right opportunities. The first step is to start somewhere.

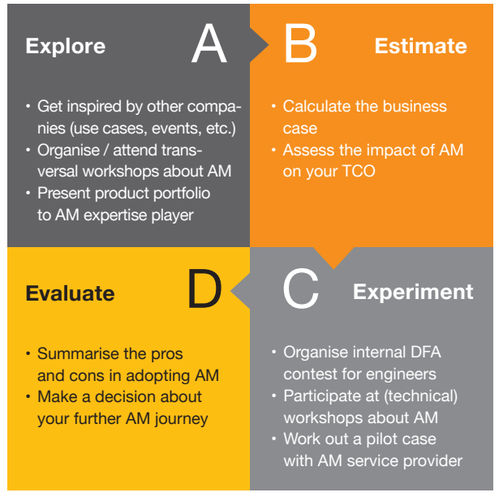


Figure 8. 4E-stepwise approach towards a successful AM journey

A. Explore

The main objective of explore is to identify interesting use cases. Start by identifying and narrowing down the AM opportunities that could be useful for your company. Look at the different challenges your company is facing and crosslink them with the different opportunities from figure 6. Focus on small challenges within your internal processes, it's easier to start your AM journey with non-critical parts, such as tooling.

There are some key recommendations for this phase. Try to create a bottom-up approach stimulating creativity and innovation. Look for inspiration from other companies through use cases, events or fairs. Encourage transversal teamwork because it's important that knowledge doesn't only build up in only one (R&D) department. The main aim is to detach AM know-how from the R&D team. You can also assess the potential of your product portfolio with people with AM experience.

B. Estimate

Identify interesting business cases for your company. Make first computations for identified use cases, taking a TCO approach. Try to identify all costs related to the pieces and compare them with the actual TCO. AM impact on TCO can be good or bad (see page 17) and has to be balanced with the other benefits AM can bring to the process on a case-by-case approach. Make a balance between advantages that AM would bring to the case and its cost. Choose one or more cases your teams can experiment with, perhaps in the form of a contest (see the Bonduelle use case on page 14).

C. Experiment

The main goal of the experiment phase is to acquire knowledge. Appoint at least one internal person to the project. This helps with project management (certainly for transversal projects) and puts one person in charge of internalising acquired knowledge. Encourage participation at (technical) workshops about AM design. Collaborate with a third party with AM expertise (a company from the same group or a service provider) to help with design and print projects. This will accelerate your knowledge uptake process.

D. Evaluate

Evaluate the developed use case. Did the final product meet all requirements? Was it implemented? More importantly, what did you learn? How accurate were your TCO estimations? How did the collaboration process work with partners? Were there hurdles with the design or with the choice of technology? Based on their newly created experience, did those involved identify new opportunities?

Create awareness about the project internally by asking project managers to disseminate their experience.

Questions to help you identify a good use case for AM

- Would your product benefit from shorter time to market?
- Would your product benefit from faster iterations based on client feedback?
- Is your product/service already customised to some extent?
- Would your customers value customisation (to some extent) of your product?
- Do you produce some pieces in medium series?
- Do some relatively small pieces of your product portfolio require different production steps because of their manufacturing process?
- Do you need some pieces in small amounts in different places around the world?

2. Transformation towards AM adoption

Once you've been through the 4Es, you should feel more comfortable deciding whether or not you should pursue the AM journey. If yes, there'll be questions about investment and technologies. Should you acquire printing systems yourself or rely on external service providers? Working with third-party service providers to limit investment is certainly an option if volumes are low or as long as your internal expertise isn't yet sufficient.

In both cases, a mind-set switch is required to get everyone on the same page about your (new) AM-oriented strategy. Create a dedicated AM team to lead the transformation. It's recommended that you internalise expertise by hiring experts. However, this is a challenge as they're not easy to find. One final thing that's important to mention: when applying AM to end products, you need to guarantee product quality. Even if specific standards aren't yet commonplace, some standards exist (even if very few) that you can rely on. Most firms work with their own quality standards, defined together with customers and suppliers. This helps increase trust and acceptance with customers who might still be sceptical about your AM-printed (end) products.

Recommendations for the ecosystem

Companies must assess for themselves whether AM can improve their business or not. The role of the ecosystem is to support firms by taking action on hurdles that can't be solved by individual companies. Special attention should be given to bringing together the rather scattered Belgian ecosystem. As the number of Belgian players is limited, finding partners with the right expertise should be a main priority.

Stakeholders in the ecosystem should join forces to create awareness about the opportunities of AM for all companies, in all industries and sectors. Specific opportunities for individual companies must be pointed out. Attention should be given to the broad diffusion of use cases (e.g. for all publicly funded projects about or involving AM) and development of (short) training opportunities to help participants open their minds to processes other than traditional manufacturing methods. (Such projects are already being thought about by competence centre Technifutur).

There's a funding gap for Belgian companies between technology creation and industrialisation. Specific publicly funded programmes focusing on industrial uptake and training should be launched (e.g. as done for AI in Flanders). These would help promote the industrialisation of AM.

Collective projects should tackle issues such as quality certification, reproducibility and fast-response, and create know-how sharing between companies, accelerating their learning curve.

Individual companies should be given funding to assess the pertinence of incorporating AM technologies into their production processes and products (with third parties). We recommend that the funding percentage for these projects be in line with the risk perception linked with the use of this still fast-evolving technology and the risk of disrupting production processes or business models. Specific focus must be given to SMEs and support companies that collectively invest in AM hardware.

1. Accelerating know-how uptake through collaboration:

The issue of not having enough internal know-how and expertise should be solved gradually in the years to come. Collaboration and know-how sharing between experienced companies and those just starting out on their AM journey should be fostered by all ecosystem stakeholders to accelerate their learning curve.

Once a certain level of knowledge dissemination has been reached, companies will more easily find the right profiles to complement their teams and gain greater internal AM expertise.

AM technologies need to be better integrated into education programmes. Not just for engineers (in universities), but also for profiles such as (product) designers and some ICT and business profiles. The first phase should focus on general courses, where a certain mind-set can be created, complementary to the traditional subtractive manufacturing thinking process. In a later phase, certain types of technologies should be taught more specifically.

Besides student education, there's also a need for vocational training for employees and job seekers, on all job levels. There are projects in the making with Vlaamse Dienst voor Arbeidsbemiddeling en Beroepsopleiding (VDAB) and Technifutur. Sirris also provides training on AM design. These initiatives must be broadened.

2. Promoting expertise

Raising awareness will open the Belgian market for Belgian technology and service providers, but it's also important to showcase and brand Belgian expertise at an international level (e.g. by being present at the global fair about Additive Manufacturing: Formnext) to show what we're doing in Belgium and promote our internal experts at an international level with trade agencies.

4
Conclusion

Marc Lambotte
CEO Agoria

AM will have a significant impact on the production world in the coming years. For many manufacturing companies, AM will become an important new production technology alongside existing ones. As outlined in this study, AM allows manufacturers to introduce completely new products to the market; products that were previously unthinkable and/or deemed impossible. AM also offers specific advantages that allow companies to improve their competitiveness through more efficient processes (e.g. digital stock management for special AM products) and greater customer responsiveness (agile 'design-produce-in use' product cycle).

In the Belgian manufacturing industry, around 1,500 people are currently employed in AM. Over 200 Agoria members are studying the technology, or are already actively working on it. Over the past three years, the number of AM jobs has grown by about 15% per year. This growth will accelerate in the coming years. We therefore expect the number of jobs within the Manufacturing industry to double in five years to at least 3,000. However, this will depend on the extent to which Belgian industry embraces the technology. The expectation is that for 20% of manufacturing companies AM is an opportunity, and even a necessity, to remain competitive on an international level. This opportunity is linked another 1000 jobs that will be created or transformed in the manufacturing industry.

Together with our members, Agoria does everything in our power to seize this opportunity. That's why Agoria set up a new business group in 2018 that brings together the various members of the AM value chain.

The AM business group has a threefold mission: first, to help identify companies' 'growing pains' to be able to formulate solutions. An example of this is the implementation of specialised teams within VDAB and Technifutur to train the technical AM experts of tomorrow quickly and effectively. Second, we aim to build bridges between companies that have already implemented AM. This way, they can rely on each other to absorb knowledge more quickly and to convert it into concrete business. Last but not least, we strive to spread the good word further to inspire all companies to take the AM step. Hopefully this study will help you on your way!

We'd also like to extend an appeal to the governments of this country. Belgium is a pioneer in the field of AM research, and the industrial adaptation of AM can translate into significant added value for our country. That's why it's essential that the authorities focus on the training of technicians/operators and on the transformation of engineering courses to take the latest production technologies into account. Governments can also help increase customer confidence in AM by supporting quality assurance and certification initiatives.

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3D Infinity	Service provider
Addiparts	Service provider
Aerosint	Hardware Provider
Altair	Software provider
Any-Shape	Service provider
Asco Industries	End user
Bonduelle	End user
CPP Belgique	Service Provider
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