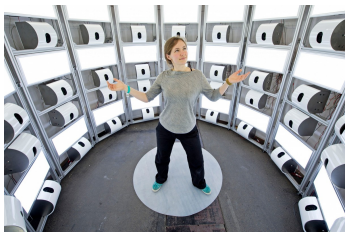
Bundles | 5 August 2021

3D printing's post-pandemic potential

The potential of 3D printing is back in the spotlight as we emerge from the pandemic. Its growth has slowed significantly but it's set for a rebound. We look at what's going on and what we can expect in terms of the technology's development in the coming years. As for its impact on world trade, that's still fairly limited and we examine the reasons why

In this bundle



Corporate Sector Coverage

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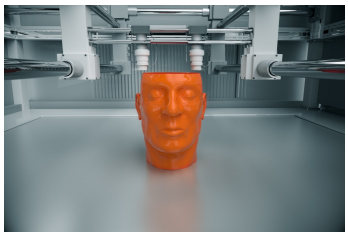

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3D printing set for post-pandemic rebound

The growth of 3D printing plunged in 2020 due to the Covid-19 recession, but the experienced vulnerability of supply chains and the economic recovery could be catalysts for a rebound. We expect growth to recover to 25-30%, slightly higher than in the years before Covid-19. We don't expect 3D printing to be applicable for mass production any time soon

A 3D print scanner scans a woman at a technology fair in Germany

3D printing back in the spotlight

3D printing caught quite some attention half a decade ago. In our 2017 report, we discussed the possibilities of the technology and its consequences for world trade. Now that 3D printing has come to the rescue in at least some markets where Covid- 19 has caused supply shortages, the technology is attracting attention once again.

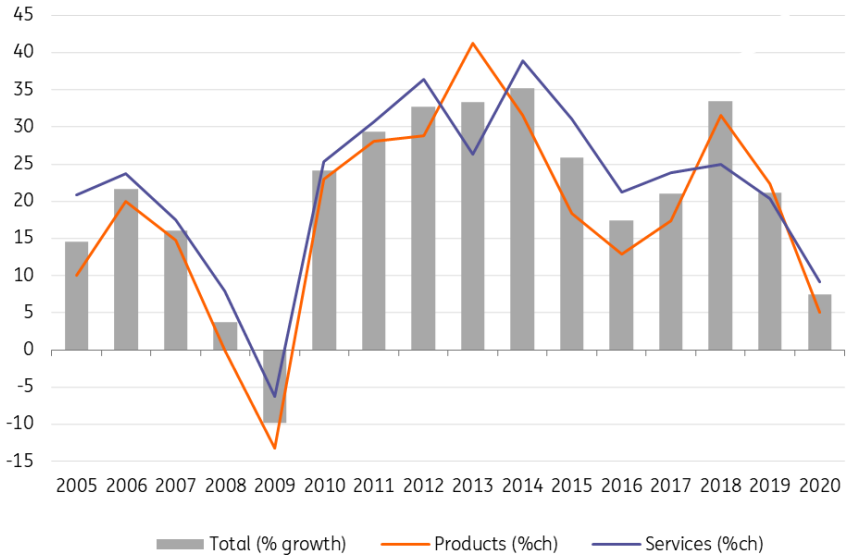
The three articles in this follow up to our 2017 study look at the development of 3D printing in recent years. As for its future, specific attention is given to the short and longer-term effects of the pandemic on the outlook for the 3D printing business.

Short run pain of Covid 19: a setback in demand

The Wohlers Report 2021 shows that the revenue growth of the 3D printing business dropped to 7.5% in 2020 and that this is substantially lower than the average growth rate of 25.2% in the previous three years. Quite a few 3D printing companies recorded significant losses. Nevertheless, a positive growth rate is relatively good given the worldwide recession last year. It also compares favourably to the financial crisis when, according to the Wohlers Report, 3D printing revenue dropped 3.7% and 9.8% in 2008 and 2009, respectively.

Click here for more information on the Wohlers report

Worldwide revenue growth 3D printing business, % change to previous year (2005-2020)



Source: Wohlers report 3D printing and additive manufacturing: Global State of the industry, 2021 Wohlers Associates

According to 3D printing consultants such as Wohlers Associates and Joris Peels, many manufacturing companies decided to postpone plans to invest in 3D printers last year due to their own financial problems caused by Covid-19 and because of the significant uncertainty about the near future.

Small desktop printers more in demand than larger industrial ones

The 7.5% revenue growth the industry nevertheless managed in 2020 originates in part from the large number of printed products sold by the service departments of 3D printer manufacturers and from specialised 3D printing service companies. Those who postponed buying a printer for 'in house production' turned to these companies to fulfil their needs for printed products. Together with maintenance and training activities, these activities make up 3D printing services. And those services grew by 9.2% in 2020, according to the Wohlers Report 2021.

Besides services growth, the 6.7% increase in sales of smaller 3D desktop printers to 753,000 units last year made an important contribution to the industry's overall 2020 revenue growth, the report says that due to the pandemic, revenue growth dropped to 7.5% but that compares favourably to the previous recession.

> *Dut to the pandemic, revenue growth dropped to 7.5% but that compares favourably to the previous recession*

The same report shows that a negative contribution in 2020 came from the larger industrial 3D systems (priced above $5,000). Sales dropped 8.4% in 2020 to 21,000 units. During the previous three years, the growth in unit sales of industrial systems had been 20.7% on average. The demand for large printers has, in part, been substituted by demand for 3D desktop printers which are continually declining in price.

The plunge in demand for those large, industrial printers has led to significant cost-cutting operations within 3D printing producers and, in some cases such as Voodoo Manufacturing, the end of the enterprise. The smaller production capacity that results from this means that supply constraints may curb the recovery in the near future.

In 2020, the revenue associated with materials that 3D printers' need increased by 9.9%, according to the Wohlers report. This indicates that the stagnation of investments in industrial 3D printers is not accompanied by a proportional decline in products made with 3D printers.

Long-run gain of Covid- 19: an impulse for adoption of 3D printing

The pandemic has shown how vulnerable international supply chains are to disruption. The unanticipated shortages in the supply of intermediate products have led to sudden unwanted cutbacks or the temporary standstill of production in various industries, not just in eye-catching markets such as automotive. According to a survey by Euler Hermes in the last quarter of 2020, sectors like Machinery & Equipment, IT, Tech, Telecoms, and Energy & Utility suffered even more severe disruption than the automotive sector. The US stands out here with most companies experiencing ‘severe’ disruption in 2020 (26%).

The pandemic has caused supply chain disruptions leading to shortages of various intermediate and final products. 3D printing has come to the rescue in some of these cases. The ease in which 3D printers can switch from producing one product to producing a totally different one makes it easy for them to resolve unserviced demand.

The interruption of supply has triggered discussions in boardrooms on how to increase the resilience of supply chains. Thoughts naturally turn to diversifying suppliers and increasing inventories, but that is easier said than done, as shown in this ING report for electronics, automotive and textiles industries.

> *Covid-19 could be the shock that many CEOs need to overcome*

their fear thresholds for new technologies

Covid-19 could be the shock that many CEOs need to overcome their fear thresholds for new technologies. People working in the 3D printing industry consider the fear threshold for new technologies one of the obstacles for the wider application of 3D printing, according to ING's 2017 study. Of course, it remains to be seen how strong this effect will be in future years.

In his 3D printing consultancy work, Joris Peels notes clearly that the role 3D printing has been playing in solving the supply shortages during the Covid-19 crisis has changed the attitude of companies towards 3D printing: "*Before the pandemic, most companies would order a printer for experimenting and it would usually take a long time before 3D printing would subsequently be incorporated in the regular production process, if at all. Now that 3D printing has become much better known and trusted due to its success during the crisis, we are seeing a vast increase of companies that seriously consider integrating 3D printers in their production process. And they ask us how they can do it as soon as possible.*"

Waning expectations

The share of 3D printing in worldwide manufacturing is still very small (0.1%) and since our 2017 report, the annual growth decreased from 29% to 21%. But the 7.5% turnover increase in 2020 in a shrinking global economy shows that 3D printing still has potential.

Supply disruptions due to Covid-19 have been an opportunity for the 3D printing business to show its value. 3D printers stepped in when traditional machines could not handle the exploding demand for face masks, nasal swabs and ventilator parts. The American 3D printing company Carbon, for example, produced a million nasal swabs per week in April 2020.

3D printing did not only step in to service extra demand for certain (pandemic-related) products. It also helped out in cases where supply chain disruption caused by the lockdowns led to more general shortages. For example, the Italian company Isinnova started to design and 3D print valves that were in short supply.

Expectations that 3D printers will become the dominant production method need to be tempered significantly

This experience is, according to consultants, contributing to a decrease in the 'threshold fear' in boardrooms for investing in 3D printing. The underlying growth of 3D printing is also being driven by rising demand for customised products; printing facilitates customisation because the marginal cost of making product variations is virtually zero. We expect the 3D printing business to grow 25-30% per annum until 2040.

But industry experts are less optimistic than a few years ago that production with printers will any time soon be fast enough to make the printing of standardised products, such as binbags and bottles, economically viable. This means that the expectation that 3D printers will become the dominant production method in manufacturing needs to be tempered significantly.

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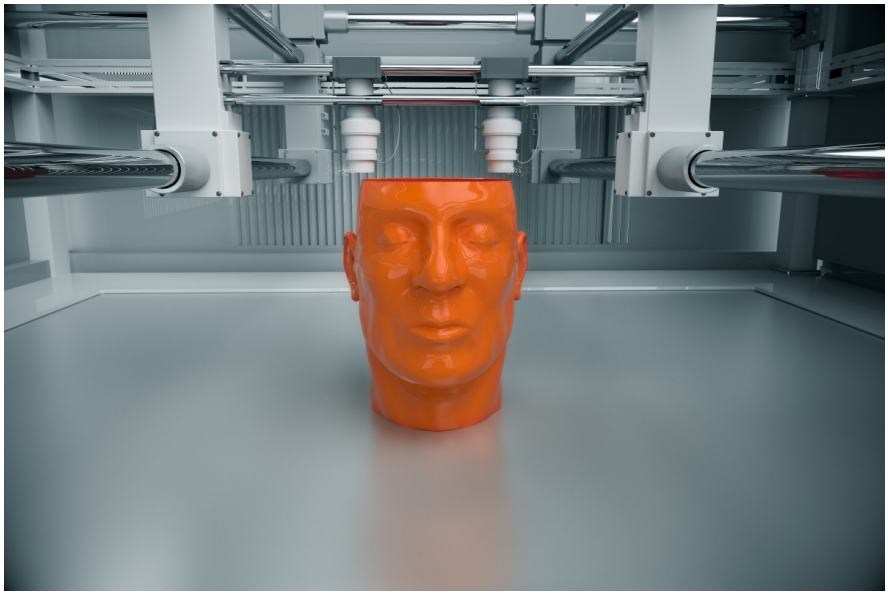
3D printing's potential

3D printing is the dominant production technique in some niche markets, but to become a widely used method in manufacturing, further technological breakthroughs are needed to drive down costs. There is no sign of that happening soon. But other drivers of growth make us believe that 3D printing could make up 5% of all manufactured products around 2040



A 3D printer makes a model of a human head

3D printing's weakness: Economics

The exact share of 3D printed goods in worldwide manufacturing isn't known. But for some niche markets, notably in dentistry, medical devices and hearing aids, we know that it amounts to 75 to 100% of total production. These markets are rather small, however.

According to Wohlers Associates' annual report on 3D printing, global revenue of the 3D printing business was $12.8 bn in 2020, which is 0.1% of the global value-added of manufacturing. If we assume that raw materials used by the 3D printing business make up around 15 cents on every dollar of revenue in the 3D industry, the share of value-added of the 3D printing industry in manufacturing value-added terms is even a bit smaller at 0.085%.

No chance that 3D printing will become the dominant means of production any time soon

So, notwithstanding the dominance in some niche markets, the quantitative importance of 3D printing for total manufacturing is still very small. The three industry experts that we spoke to in researching this report all rule out the possibility that 3D printing will be the dominant production method in overall manufacturing any time soon. 3D printing designer Janne Kyttanen says, "it is difficult to imagine 3D printing beating high-velocity manufacturing technologies like laser cutting and injection moulding".

Joris Peels, 3D printing consultant, explains: "3D printers have to make products, also intermediates, layer by layer. It is unlikely that this will one day be faster than a traditional mould that can stamp out intermediate products at a very high velocity".

Many mass-produced products are still unsuitable for 3D printing

Terry Wohlers of consultancy firm Wohlers Associates, which has been collecting and analysing data on 3D printing on an annual basis for the last 26 years, points to the current limitations regarding the sort of products that are economically viable for 3D Printing. "The use of 3D printing for series production is most suitable when manufacturing volumes are relatively low, and product value is relatively high".

This makes many mass-produced products for the near future unsuitable for 3D printing. Wohlers expects that the number of applications will expand as machine, material, and operational costs are driven down. Kyttanen, however, adds that "although 3D printing can in some cases replace the current production method of existing products, we must realise that other technologies also develop, getting more automated and digitised".

Benefiting from the popularity of customised products

The success of 3D printing in markets like hearing aids shows that this production technique has a comparative advantage in making products with a complex shape. It also shows that 3D printing is well equipped to produce custom-made products. Contrary to traditional production methods, the costs of adjusting the product are very low. Customised products are, for example, to be found in footwear, eyewear and jewellery. These are attractive markets for 3D printing companies that produce products for third parties.

A 3D printed training shoe

Profit margins and customisation

Profit margins are much higher in markets with customised products than in markets for standardised products produced en masse.

The United Nations Conference on Trade and Development, UNCTAD, concludes in its World Investment Report 2020 that given the current state of 3D printing technologies, "the main limit to the disruptive power of 3D printing is its technical and economic feasibility". Looking forward, UNCTAD concludes that "unlike digitalisation and automation, which are expected to affect all industries to some degree, 3D printing in 2030 is likely to be still confined to selected industries or niche segments".

For Kyttanen, the true gamechanger is that "3D printing enables the production of new products and services". It remains to be seen to what extent 3D printing can service notional demand for new products.

Untapped potential

Despite only a small chance that 3D printing will one day be the dominant production method in manufacturing, industry experts see a possibility that 3D printing will grow significantly in the years to come.

Terry Wohlers expects a yearly average growth rate of 27% until 2030, which would result in a market turnover of $115 bn in 2030. That is ninefold the size of the market today and would be close to 1% of global manufacturing. Wohlers expects that one day 3D printing will be able to make up at least 5% of manufacturing. With a continuation of the yearly growth rate of 27%, it will take around 20 years to reach that point (2040).

The growth forecast of 27% is somewhat higher than the average growth in the three years preceding the crisis (25%), but we consider 27% plausible for various reasons:

- Threshold fear diminishing

Threshold fear has traditionally been an impediment to growth in 3D printing. We expect this to diminish significantly since 3D printing has proved itself during the pandemic, coming to the rescue during supply shortages. As we noted earlier, consultants have been noticing that customers are now in a 'fast forward' mood when it comes to integrating 3D printers into their production process. We think that the upward influence on investment in 3D printing from this tendency could even be more than two percentage points.

- **Lack of suitable materials is being overcome**

The lack of sufficient materials has been a bottleneck in the past but according to industry experts, innovations in construction and polymers are solving this problem. A wider range of materials is on its way and will incentivise more companies to work with the new technology.

- **New adopters are entering the market**

Our expectation that the share of 3D printed products in worldwide manufactured products will continue to increase is also based on the fact that we see many new companies and sometimes new industries starting to work with 3D printers. For example, the US military has started to use 3D printers to make shelters for missile launchers. The power and energy industry has also adopted 3D printers in recent years.

There is no good reason to expect that this will suddenly stop. The total amount of suppliers of industrial 3D printers has reached 228 in 2020, according to the Wohlers Report 2021. This is seven times as many as in 2012.

The same report shows that only three years ago, the eight largest suppliers still had a combined market share of 14%, falling to 9% last year, and in line with this, 2020 also showed a decline in turnover of the big eight while smaller suppliers delivered an increase in revenue. We see the increase of suppliers as an indicator for increased competition which usually results in more downward price pressure. This is positive for demand and hence the growth of the 3D printing market.

- **It's all about adaptability**

The fact that 3D printing can produce customised products much cheaper than traditional machines means that 3D printing will benefit from the rising popularity of customised products. About one in six consumers has at least once acquired a customised product.

Taking all this into account, we think that Wohlers' expectation of a future share of 5% of 3D printed goods in total manufacturing is realistic. We think that it could be reached by around 2040.

In our 2017 study on 3D printing, we looked at the possibility of 3D printed products making up one quarter to one-half of all manufactured products. This scenario can only become a reality if mass production with 3D printing becomes economically competitive. For now, however, there's no indication that we are close to such a breakthrough.

Reshoring a stimulus for 3D printing, but don't expect huge effects

The disruption of supply chains is not only a hot topic in boardrooms but also in public policy debates. In developed countries, calls from politicians to bring production home (reshoring) or moving production to countries nearby (nearshoring), have been increasing over the last decade. Covid-19 has only made those calls louder.

The ability to secure supplies of medical products has been a problem since the outbreak of the virus. But calls for reshoring should also be seen in light of the decreasing popularity of globalisation, the reduced support for free trade, and the new global geopolitical order which is characterised more by economic rivalry than international cooperation. While China and the US are at the heart of this rivalry, it has also stimulated calls for strategic autonomy and the protection of technological know-how in other Western regions such as the EU.

Reshoring is about more than economics

In the public debate, the issue of whether to reshore production or not is no longer purely an economic one dominated by cost-benefit analyses for companies. Other movements, like criticism of the contribution of cross border supply chains to global warming, effects on local employment and violations of workers' rights and tax evasion also add to the calls for switching from complex global value chains to more 'local for local' production through reshoring.

What does this mean for 3D printing? Well, 3D printing facilitates reshoring because printers use less labour and therefore increase the economic viability of reshoring production to developed economies where labour costs are relatively high.

Bring it home?

How big will the influence of reshoring be on the use of 3D printers? First, it should be stressed that although reshoring has been a buzzword for more than a decade now, actual reshoring has been very limited. According to Dachs et al. (2019), only 4.3% of the 2,450 firms surveyed in eight European countries were engaged in bringing activities back home between 2007-2015.

> *The pandemic could lead to an increase in interest in reshoring and 3D printing*

Having said that, the pandemic could lead to a significant increase in interest in reshoring. Covid-19 has brought about widespread supply chain troubles. No fewer than 94% of the companies that Euler Hermes surveyed in six industries and five countries reported supply chain problems in 2020.

But it should be said that it is rather questionable whether reshoring is a solution for supply chain disruptions. After all, bringing production of intermediate products back home is, in itself, no guarantee that interruptions in the production process can be avoided. A pandemic or other natural disasters, such as earthquakes or floods, can happen back home, too.

So it comes as no surprise that, according to the Euler Hermes survey at the end of 2020, the

percentage of the interviewed companies that are considering bringing production back home in response to recent supply chain troubles is less than 15%. This is a relatively low percentage given that more than half of the surveyed companies are thinking about moving their production sites or are looking for new suppliers. This could mean that companies are rather looking to diversify suppliers rather than bringing production back home.

In an overview of recent empirical studies, the economics department of the European Commission also stresses the small importance of reshoring thus far and points out that, although increasing, reshoring from China and other Asian countries has been less frequent than reshoring within the EU.

Protectionism a potential push for 3D printing

Reshoring might become necessary for companies if it becomes increasingly popular among politicians, leading governments to change the playing field. Tariff increases or increases of other trade barriers could change the relative costs of producing in developed countries and thereby force companies to relocate production sites back home or to countries that have a free trade agreement with the home country.

In response to the higher tariffs that the US imposed on imports from China, we have seen various companies relocating. Some of them back to the US, some of them to countries like Vietnam and Thailand, according to the Financial Times.

For now, the conclusion is that most companies do not consider reshoring as the best answer to supply chain disruptions. But the more they become acquainted with labour-saving production methods like 3D printing, the more it could become an interesting option, especially if politicians step up protectionist policies.

Thus, the development of reshoring plans will be important to watch.

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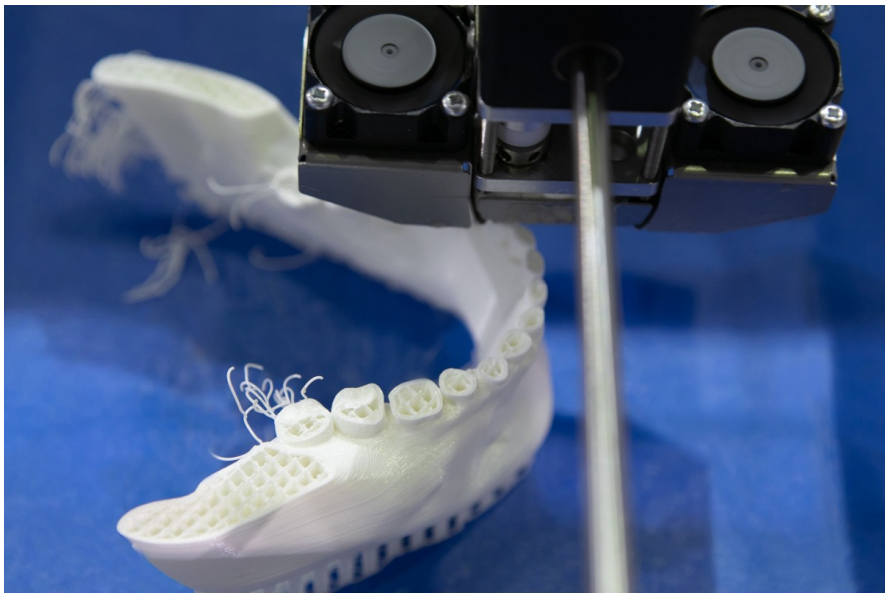
3D printing is a threat to world trade but its impact is still limited

The share of 3D printed goods in global manufacturing could rise to 5% over the next two decades. That is a significant increase from the current share of 0.1%, but much lower than in the two scenarios in our 2017 report. The effect on world trade is more subdued as well, at -4.5%. This implies, on average, 0.2 percentage points less trade growth per year



Dentistry is one area where 3D printing can thrive

The re-bundling of the production process

3D printing can hurt world trade in two ways. Firstly, 3D printing usually means the re-bundling of production phases, because 3D printers can make the (intermediate) product as a whole. So it shortens the supply chain leading to less trade in intermediates. And as far as 3D printing is part of a strategy to produce closer to the customer - given the rising popularity of local for local - it leads to less cross border trade as well.

> *The re-bundling of the production processes does not in all cases lead to proportionally less trade*

Economically, 3D printing is mainly used as a production method for customised or complex-shaped products. Experience shows that it is not a given that all customised 3D printed products are made close to the consumer. In an interesting Worldbank study, Freund et al (2018), showed that in the case of hearing devices and dental crowns, 3D printing has not led to localisation as production only takes place in a few countries.

According to this research, the lack of skilled labour in many countries is an important reason that the production of, for example, hearing devices isn't done in the countries where they're used. The thought that with the arrival of relatively cheap and small 3D desktop printers, dentists would all start printing crowns themselves, has not materialised. At least not yet. So the re-bundling of the production processes does not in all cases lead to proportionally less trade.

Customisation is a key part of 3D printed products

Secondly, hearing aids and dental crowns are customised products. Customisation usually gives the supplier of the product pricing power, meaning they can more easily pass on the costs of, for example, transport to the buyer.

A third reason why the cost of transport has apparently not been prohibitive for centralising production in a few countries is that the likes of hearing aids and dental crowns are light and small. That makes them relatively cheap to transport.

> *A product's size is more important than its weight when gauging the effect of 3D printed products on trade and transport*

Of course, not all 3D printed products are light and small. 3D printing is, for example, used a lot for making metal products. But since roughly three-quarters of all exported products are transported by container ships and the costs of that are foremost determined by the size of the product, weight is less important.

Knowing that many 3D printed goods are customised goods and those which are usually of the size between a marble and a football, transport costs are often not decisive when choices are made regarding the location of production of three printed goods. In other words, it seems plausible to assume that transport costs are less determinative for the profit margin of 3D printed products than for those produced en mass.

This means that the substitution of traditional production methods by 3D printers probably does not always translate into bringing production closer to the consumer. So it also doesn't translate into less trade and transport.

This 3D printed pedestrian bridge, recently opened in Amsterdam, shows that the technology is well-suited to making complex shapes

Earlier, we stated that, although we recognise that forecasting the speed of the technological improvements of 3D printing is very hard and perhaps not a task for economists. But we feel comfortable with a rise in the market share of 3D printing, in total manufacturing, to about 5% in the long run. Calculations show that, given a slight increase in the growth rate of the 3D printing business, this share can be reached by around 2040.

A manufacturing share of 5% for 3D printed products by 2040 would have a permanent downward effect on the size of world trade of around 4.5 percentage points of global trade. That is if all printed goods were to be made close to the consumer. But keeping the experiences of dental aids and hearing devices in mind, the effect of switching to 3D printing on world trade will be somewhat lower, around 3% to 4% for goods. Taking into account the part of traded services that are linked to the goods trade, the damage to trade adds up to 4.5%

Concluding remarks

Currently, 3D printing is economically not competitive for producing uniform products en mass such as rubbish bags, bottles, plugs and so on. As long as this is the case, 3D printing will not lead to large changes in the complex cross border value chains that currently characterise the way mass products are made. Of course, further technological developments in 3D printers can change that, but industry experts don't expect this to happen anytime soon.

3D printing is economically not competitive for mass production

This means that 3D printed goods will in the short run consist mostly of customised and complex-shaped products made as one-offs or in a series of relatively low quantities

This doesn't mean however that there is little room for growth of the 3D business. In line with some

industry experts, we expect that the number of applications will expand as machine, material, and operational costs are driven downward and customised products become more popular. We also think that the adoption of this technology will accelerate because the threshold fear is diminishing since 3D printing has proved its usefulness in a wide range of markets during the pandemic.

We expect that the share of 3D printing in global manufacturing could well rise to 5% over the next two decades. This will have a downward influence on the growth of cross border trade and transport. But the effect will be less than proportional because transport costs are financially less important for customised products than for standardised ones. This makes us believe that the downward effect on trade and transport will be less than 5%, around 3 to 4%.

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3D printing's post-pandemic potential; the complete report

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The potential of 3D printing was recently shown in Amsterdam with this 3D-printed bridge, opened by Queen Maxima in July 2021

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