

3D Printing in Consumer Goods Manufacturing

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3D printing is reshaping the consumer goods industry with its ability to produce tailored and innovative products. This technology allows companies to manufacture a wide range of items, from custom furniture and bicycles to unique wearables and eyewear, with unprecedented precision and customization. The rise of industrial 3D printers marks a significant evolution in production, offering not just cost savings and rapid turnaround, but also the flexibility to create complex designs unachievable by traditional methods.

In this article, we explore the transformative role of 3D printing for consumer goods manufacturing, highlighting its capacity for intricate designs and durability. We will also delve into the suitable materials and printers for this production technique. The focus is on how 3D printing is revolutionizing the consumer products industry by enabling the creation of bespoke, high-quality items that meet evolving consumer demands.

Revolutionizing Manufacturing: The Dawn of 3D Printing in Consumer Goods

Industry 4.0 is transforming how companies manufacture, enhance, and distribute their products. Manufacturers incorporate technologies such as the Internet of Things (IoT), analytics, cloud computing, AI, and machine learning into their production facilities and operations. These digital technologies facilitate increased automation, self-optimization of process improvements, predictive maintenance, and heightened customer efficiency and responsiveness.

Industry 4.0 concepts and technologies are applicable across **various industrial sectors**, including the consumer goods industry. Traditionally, consumer products have been manufactured using conventional technologies. There is a shift towards more flexible and less wasteful methods, specifically industrial-scale 3D printing using Fused Filament Fabrication (FFF) technology. FFF 3D printing offers comprehensive tools for design freedom, customization, on-demand creation, and cost-effective prototyping. Demand-driven production reduces storage expenses.

Industrial 3D printing's advantages can be effectively utilized in the consumer products sector, where daily-use goods are increasingly produced using additive manufacturing. It allows for

complex applications and tailor-made solutions in low- and high-volume production, ensuring reliability, consistency, and repeatability.

Key Advantages of 3D Printing for Consumer Products

Now, let's explore some of the top benefits 3D printing offers in the consumer products industry.

Complexity Without Additional Cost

3D printing stands out in the consumer products realm for its ability to effortlessly integrate complex designs without extra costs. Traditional manufacturing methods usually require elaborate tooling, molds, or machining processes, each adding to the expense. In stark contrast, 3D printing adopts an additive approach, constructing products layer by layer. This method not only simplifies the production of detailed and intricate geometries but also significantly reduces the need for specialized tooling or molds, which are typically costly and time-consuming in conventional manufacturing.

Furthermore, the benefits of 3D printing in managing intricate designs are not confined to the manufacturing stage alone. Conventional methods often entail extensive post-processing to achieve the desired level of detail, thus inflating expenses. 3D printing, conversely, generally demands minimal post-processing. This attribute not only streamlines the production process but also contributes to substantial cost reductions. This technology represents a paradigm shift in manufacturing, offering a more efficient and cost-effective solution for creating complex consumer products.



Customization and Personalization

Everyone is talking about customization, from personalized headphones to tailor-made footwear. One of the significant advantages of 3D printing for consumer products is its ability to offer these kinds of customization. Unlike traditional manufacturing, which requires costly tooling changes for individual specifications, 3D printing introduces new customizable possibilities. The design data is directly transferred to a 3D printer, bypassing the need for any tools.

Additionally, customization through 3D printing reduces waste and increases efficiency, as products are made-to-order, eliminating overproduction. These personalized products not only cater to specific consumer desires but also foster a deeper emotional connection with the brand, enhancing customer loyalty and satisfaction.

Rapid Prototyping

Rapid prototyping via 3D printing is a game-changer in product development, significantly accelerating the design-to-production process. This technology allows for the quick creation of detailed, tangible prototypes, enabling designers and engineers to test, refine, and perfect products in real time. It dramatically reduces the time and cost associated with traditional prototyping methods, fostering innovation and creativity.

Moreover, rapid prototyping enables immediate feedback and iteration, ensuring the final product meets market needs and consumer expectations more accurately. This agility in development not

only speeds up the time-to-market but also enhances product quality and functionality, offering a competitive edge in the fast-paced consumer goods industry.

Cost-Effective Small-Scale Production

Despite the significant initial investment in 3D printing equipment, the long-term benefits and return on investment (ROI) make it worthwhile. 3D printing in consumer goods manufacturing transforms cost management in the following ways:

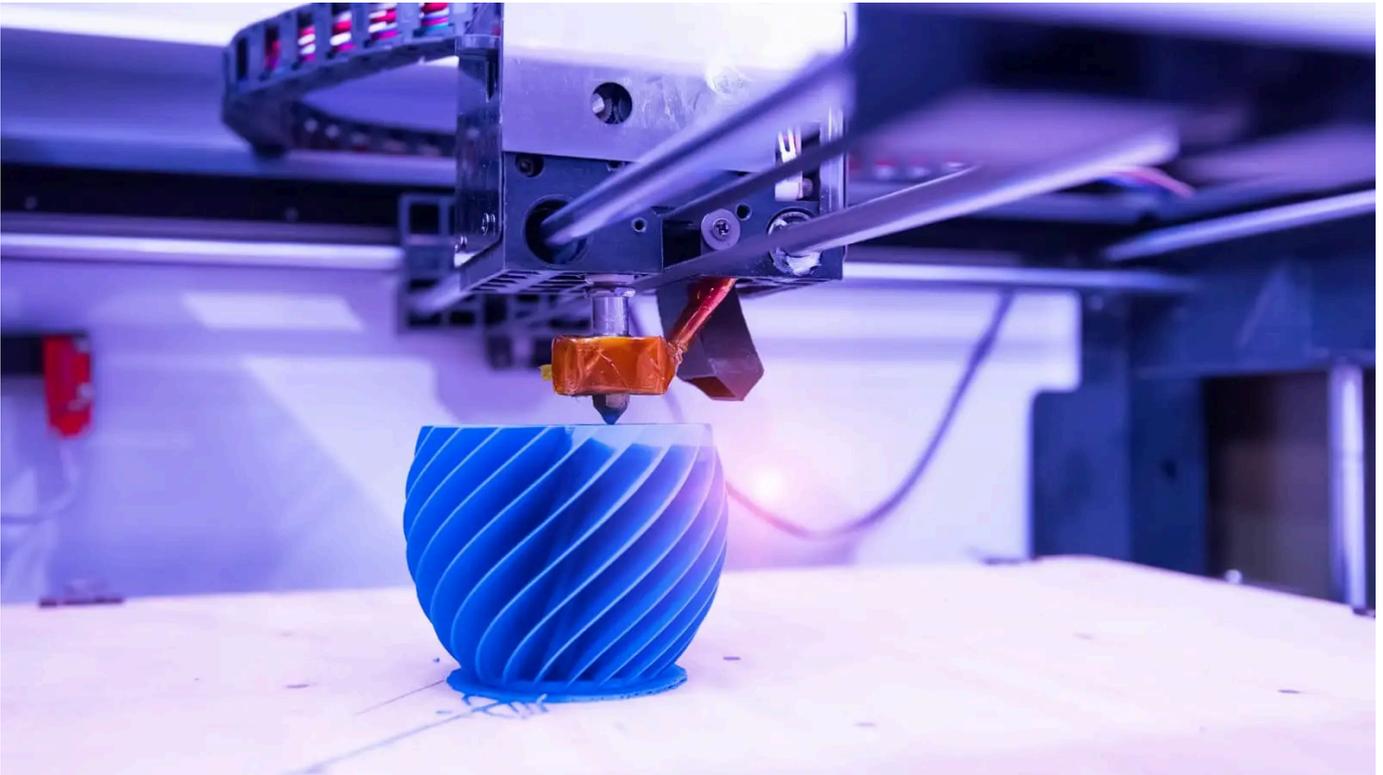
- **Savings on Material Costs:** 3D printing strategically adds material only where necessary. This results in a notable reduction in material costs.
- **Labor and Operational Efficiency:** In traditional manufacturing, various skilled tasks require a dedicated workforce. In contrast, a single operator can often manage multiple 3D printers, decreasing labor costs.
- **Reduced Inventory and Warehousing Costs:** 3D printing allows businesses to print on demand, reducing the need for vast warehouses. This capability cuts inventory costs and lowers transport expenses, as goods can be produced closer to the point of sale.

Sustainability

3D printing stands out for its sustainable approach, primarily by reducing material waste in manufacturing. This process not only supports sustainability but also promotes a cleaner working environment. In 3D printing, most materials can be reused and recycled, thereby minimizing waste. The technology is designed to use materials efficiently, consuming only what is essential for the print job and its support structures.

Furthermore, 3D printing's eco-friendly nature is enhanced through the use of sustainable materials like Polylactic Acid (PLA), which is derived from renewable sources such as corn starch or sugarcane. PLA's biodegradability marks a significant departure from traditional manufacturing methods that often rely on non-degradable plastics. This choice of material in 3D printing offers greater design freedom while simultaneously addressing environmental concerns.

Material Diversity



3D printing in consumer product manufacturing offers an extensive array of material options. This range includes diverse plastics, metals, composites, and more, providing a high degree of flexibility in material choice. Such versatility allows for the integration of varied properties into consumer goods, tailoring them to specific needs and functions.

This adaptability is key in producing consumer goods with exact material characteristics necessary for their intended performance. It enables manufacturers to explore innovative material combinations and formulations, extending beyond the confines of traditional manufacturing approaches. This aspect is particularly advantageous in creating unique, customized consumer products that meet the changing preferences and demands of the market.

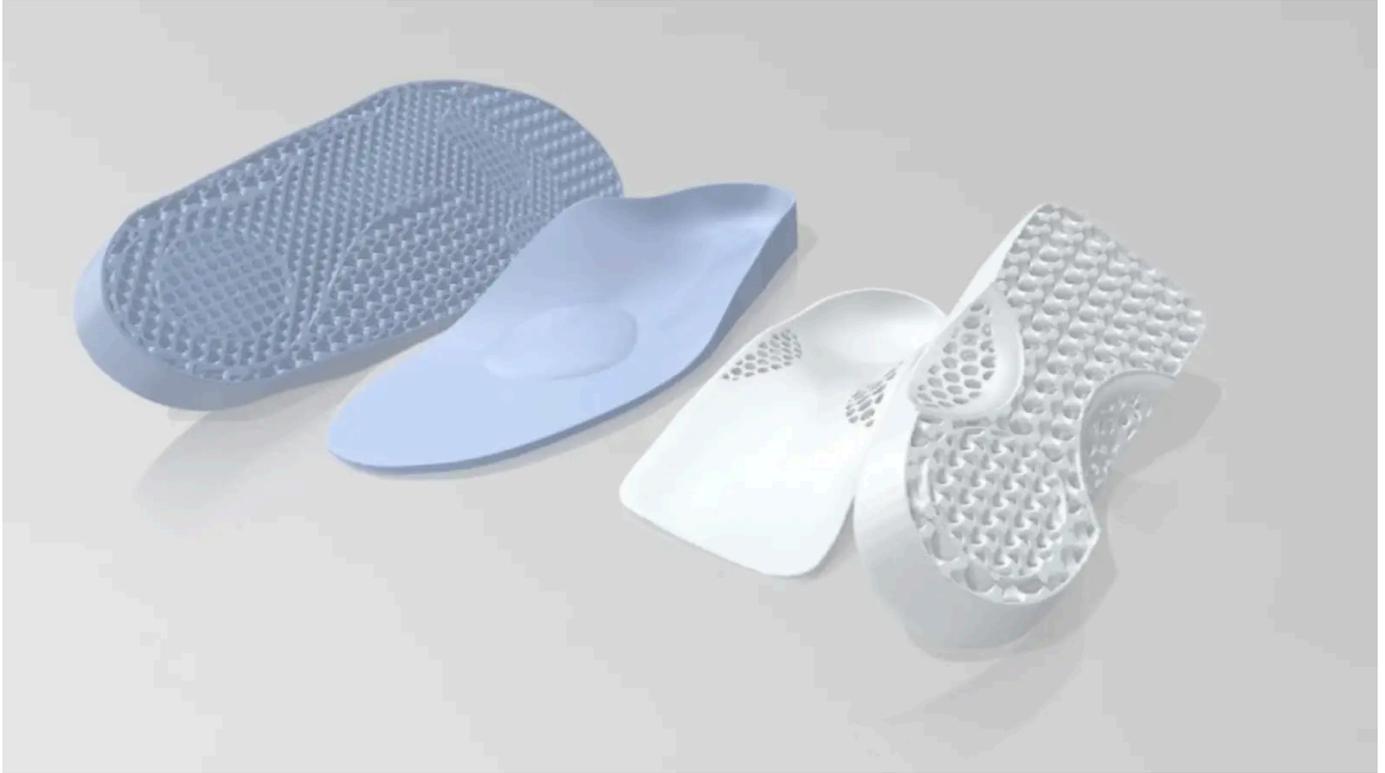
Innovation in Action: Real-World Applications of 3D Printing Across Consumer Industries

This section will examine industry examples like footwear, eyewear, cosmetics, sports, etc. While not exhaustive, this list reveals numerous applications in the market.

3D Printed Insoles

Dr. Scholl's, a prominent footwear brand, contributes to mass customization through 3D printing by creating custom 3D-printed inserts. Using Wiiiv Fit Technology, Dr. Scholl's offers a customization app that generates an accurate scan of a customer's feet. Customers must take a few photos of their feet from different angles to ensure a successful scan. The app's scanning

technology creates custom insoles based on 400 mapping points from each foot. This process, taking less than five minutes, ensures a custom fit for each customer.



Following the generation of the 3D design, personalized insoles are 3D-printed and delivered to the customer's doorstep within a few days. The app also allows consumers to add designs to the 3D-printed insole according to their preferences. This exemplifies the significant progress of 3D printing in the footwear industry, particularly in enabling cost-effective customization. Major footwear giants like Adidas, Nike, and New Balance also utilize the technology for **3D prototyping** and direct manufacturing.

3D Printed Custom Jewelry

With the notable growth of 3D printing, jewelry designers are embracing this technology to expedite the design and manufacturing of consumer goods while maintaining quality.

Watchmakers select specific additive manufacturing methods depending on the desired customization level. For instance, Swiss company SevenFriday utilized Multi Jet Fusion to craft FREE-D. This is an original watch with a distinctive design. By employing PA11, SevenFriday produces lightweight, organic, and durable parts while upholding high quality. The Italian brand Aion Watch is also pioneering the development of the lightest automatic watches in the world. Weighing 26 grams, the 3D-printed watches incorporate internal honeycomb feature to maintain rigidity and reduce weight by over 200%.

3D Printed Carbon Fiber Bike

Additive manufacturing has repeatedly demonstrated its utility for athletes, allowing customization of equipment for various sports to meet individual needs and enhance comfort. Furthermore, 3D printing contributes to the reduction of equipment weight. It is advantageous in sports to prioritize speed, ultimately improving overall performance.



A good example is Superstrata, a Californian bicycle manufacturer which introduced a carbon fiber frame back in 2021. The frame is exceptionally light and durable, claimed to be a lot stronger than steel. Manufactured using DED technology in a single process, the frame allows for up to 500,000 configurations. It offers a range of options through the company's online store.

3D Printed Mascara Brush

3D printing is making strides in mass production in the beauty industry, as demonstrated by the French fashion brand Chanel. They introduced the first ever 3D-printed mascara brush in 2018. Created using Selective Laser Sintering (SLS), this 3D printing technology fuses layers of polyamide powders with a laser beam to craft the mascara brush. Chanel claims the ability to create up to 50,000 brushes every day using this technology.

Chanel leveraged 3D printing to iterate the brush design through more than 100 prototypes, a process challenging traditional molding techniques. The brush incorporates microcavities that absorb more of the mascara. It eliminates the need for users to re-dip brushes for additional coats. Moreover, the granular texture of individual brush strands enhances the surface area and ensures improved mascara distribution on eyelashes.

3D Printed Helmet Liners

In 2017, Carbon partnered with Adidas to create 3D-printed midsoles for the Futurecraft 4D shoes. The unicorn startup is now collaborating with Riddell to create custom helmet liners. Utilizing Carbon's newly revealed L1 3D printer, the companies crafted personalized, 3D-printed helmet liners for Riddell's SpeedFlex Diamond helmet model. These liners were customized through Riddell's custom head scanning and helmet fitting process.



Employing simulation and optimization techniques, the liners were made from over 140,000 struts using impact-resistant elastomer. The outcome is a lattice liner that reduces impact forces while delivering excellent fit and comfort.

3D Printed Eyewear

3D-printed eyewear is experiencing rapid growth, surprising many with its expanding applications. Specsby, a Canadian company, exemplifies how eyewear companies can leverage 3D printing for unique eyewear. Specsby offers eyecare professionals a retail-ready app utilizing 3D scanning technologies and augmented reality.

Their cloud-based system empowers opticians to design unique frames. They use facial 3D scans to allow patients design frames using a live image of their face. Once confirmed, Specsby manufactures frames using in-house multi-color 3D printers. The process takes approximately 8 hours. Subsequently, frames undergo three days of assembly and inspection.

3D Printed Dental Aligners

SmileDirectClub is a US startup aiming to offer a cost-effective alternative for clear aligners and transparent orthodontic devices to adjust teeth. The target is 3D printing and BPA-free plastic to manufacture custom invisible aligners. The process starts with customers taking moldings of their teeth with a home impression kit. They then mail the moldings back with digitally uploaded photos. These are sent to dental professionals who creates a retainer plan. After confirmation, the company prints and dispatches the customer's set of dental aligners.



This approach results in notably more affordable aligners. The company collaborates with a network of over 200 licensed dentists and orthodontists to guide the process. SmileDirectClub has succeeded significantly, benefiting more than 300,000 persons seeking an affordable dental solution.

3D Printed Shaving Razors

Gillette recently introduced its Razor Maker™ platform. This platform aims to provide customers with razors tailored to look, color, budget, and style. It allows customers to choose from the 48 design options for custom shaver handles. These handles are produced with Stereolithography (SLA).

3D printing offers several advantages for the mass customization of Gillette's shaving razor handles. Notably, there is no upfront investment for the tooling because this technology only requires a 3D printer and digital 3D file to create a batch of the handles. This cost-effective

approach facilitates the low-volume production of complex designs. Simultaneously, the design freedom allows consumers to enjoy entirely personalized handles.

Exploring Materials for 3D Printed Consumer Goods

Material choice is vital in 3D printing because it determines end-product functionality, quality, and appearance. Here are some of the most common materials for 3D printing in consumer goods industry:

Plastics



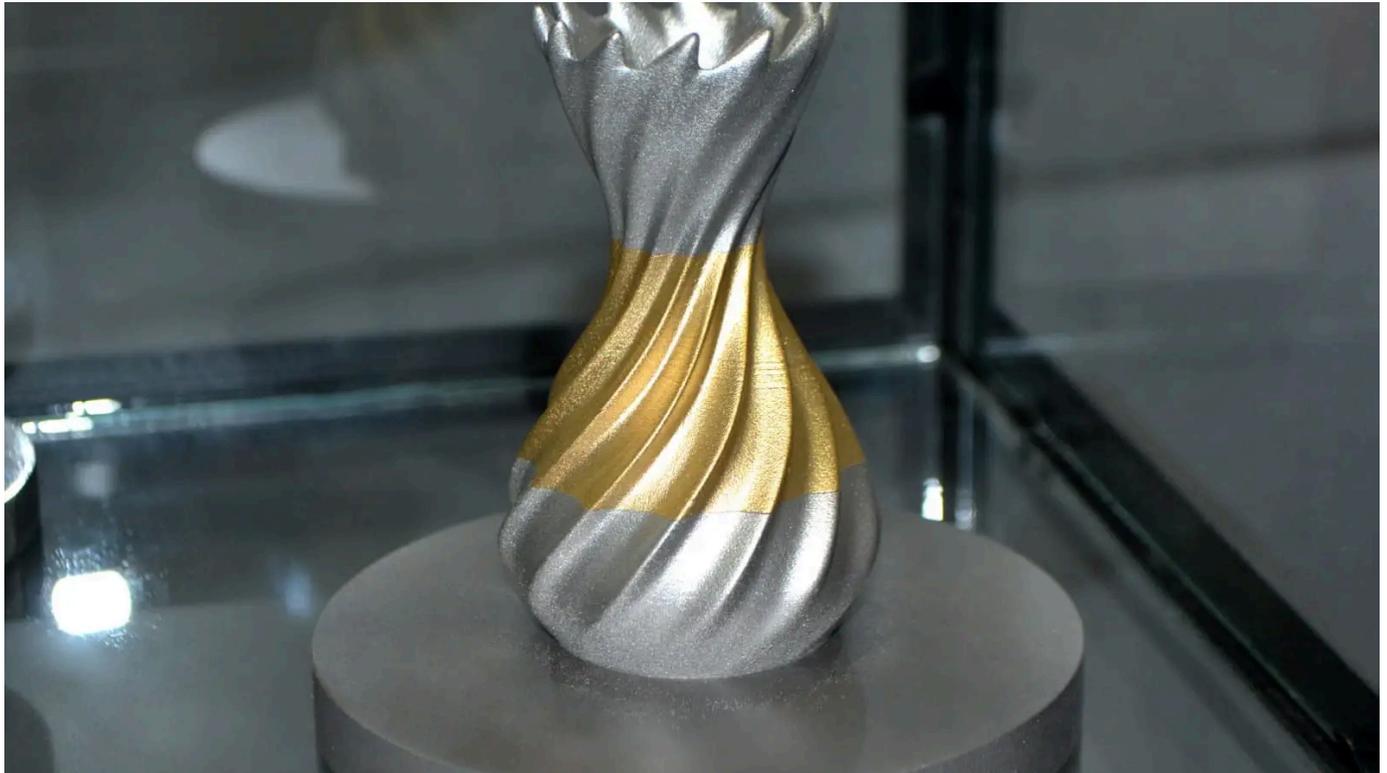
Plastic is the leading material in 3D printing for its versatility, enabling the creation of items ranging from toys to household accessories. This includes vases, desk items, and figurines, available in both vibrant and transparent colors, with matte or glossy finishes. Its popularity is due to its blend of flexibility, durability, and a wide array of colors, alongside affordability. Primarily used with FDM printers, plastic transforms from thermoplastic filaments into various shapes through a melting and molding process.

Some of the plastics used in 3D printed consumer products include the following:

- Polylactic acid (PLA)
- Acrylonitrile Butadiene Styrene (ABS)

- Polyvinyl alcohol plastic (PVA)
- Polycarbonate (PC)
- Polyethylene Terephthalate Glycol (PETG)
- Thermoplastic Polyurethane (TPU)

Metals



Metal ranks as the second most utilized material in 3D printing, primarily through direct metal laser sintering (DMLS). This method is embraced by manufacturers to streamline production, offering stronger and more varied consumer products. DMLS allows for faster production and higher volumes than traditional assembly methods.

- Stainless steel: Ideal for components in contact with water.
- Bronze: Suited for crafting vases and fixtures.
- Nickel: Used for printing coins.
- Aluminum: Ideal for thin metal objects.
- Titanium: The preferred choice for robust, solid fixtures.

Resins



Resins, while offering limited flexibility and strength, are less commonly used in 3D printing due to these constraints. However, they find their niche in processes like stereolithography (SLA) or digital light processing (DLP), which utilize UV light to cure liquid photopolymer resins. These materials are well-suited for producing high-detail consumer goods. Resin-based 3D printing is particularly effective for items needing precise mechanical properties, like snap-fit connectors or functional prototypes.

Composites

3D printers often apply carbon fiber composites atop plastic to bolster the material's durability, offering a swift and efficient metal substitute. This synergy harnesses carbon fiber's robustness with the adaptability of 3D printing, yielding products that are both light and strong. Such composites are ideal for crafting durable consumer goods like sporting gear, drones, and automotive parts, thanks to their lightweight yet sturdy nature.

Conclusion

Manufacturers actively seek cost-effective ways to provide customer-centric services and products in the consumer goods industry. 3D printing plays a crucial role in realizing this opportunity. The technology enables the development of innovative consumer products that might be impractical using traditional manufacturing approaches and business models. Companies can expedite innovation, explore unique designs, and meet customer demands for personalization.