

3D Printing in Footwear

Mass Customization and Other Trends Turning Footwear AM Into a \$5.9B Revenue Opportunity



Table of Contents

- 1 Introduction
- 2 What is Footwear?
- 3 Today's Landscape
- 4 Major Applications of 3D Printing in Footwear
- 5 Mass Customization of Footwear
- 6 Hardware & Materials
- 7 Adoption of AM in Footwear: Pros & Cons
- 8 The Future of Footwear 3D Printing
- 9 Learn More

Introduction

For some time now, 3D printing has been used for footwear prototyping, a process that allows footwear professionals to craft test shoes before making their final products. In recent years, however, additive manufacturing technologies have become productive and cost-effective enough for the mass production of accessible end-use footwear products.

In fact, 3D printed midsoles — pieces of material sandwiched between the outer and inner sole of a shoe — are the very first consumer products to be mass produced using additive manufacturing. Insoles are virtually the first products to be mass customized.

These two main trends, production and customization, along with the explosive adoption of additive manufacturing (AM) in prototyping and mold production, will be the key factors driving 3D printed footwear for the foreseeable future.

This white paper discusses themes and findings explained fully in the SmarTech report "Markets for 3D Printed Footwear 2019 – AM Production in the Footwear Industry: A Ten-Year Forecast and Opportunity Analysis." This is the first comprehensive and in-depth report on 3D printing in the \$400-billion global footwear market.

What is Footwear?

The term “footwear” is generally used to describe garments worn on the feet. These garments serve to protect against the environment — both ground textures and temperature — and make it easier to walk or run while preventing foot injury.

Over time, however, the term has come to comprise a broader range of products. Throughout this white paper and the SmarTech report from which it borrows, “footwear” will be used to connote a broader spectrum of footwear-related products, all of which have been (or can be) 3D printed.

These include (1) specific types of shoe, (2) shoe parts, grouped into three major product families and (3) parts used for traditional or indirect manufacturing processes.



Footwear will be one of the first families of consumer products to transition to ***mass customization***

Today's Landscape



In 2018, the global footwear industry generated revenues of about \$260 billion. The segment is mature and growing steadily as hundreds of millions of people around the world, especially in emerging economies, are now able to afford quality footwear.

SmarTech expects that footwear 3D printing revenues currently represent roughly 0.3% of global footwear market revenues, but that figure is set to rise.

The footwear industry's movement toward widespread adoption of additive manufacturing is tied to the macrotrend of increased personalization of all consumer products, which can already be seen in everything from automobiles to jewelry. Although personalization is still in a very early phase — most consumers still consider brands more valuable than custom-made products — younger generations are beginning to place more value on custom-made products, especially as they become readily available.

At the same time, AM is also pushing toward increased *automation* in the footwear market by further digitalizing the labor-intensive shoemaking process.

As customization and digital automation come together, the trend of *mass customization* will begin to emerge. Footwear is expected to be one of the first families of consumer products where this transition will take place.

Major Applications of 3D Printing in Footwear

Mass Customized Orthopedic Insoles and Sandals

The first footwear products to be produced by additive manufacturing were orthopedic insoles. These provide increased comfort by adapting to the foot's geometry and the user's gait. 3D-printed orthotics provide even more accurate and effective support.

Mass Produced Midsoles

Midsoles have become one of the most significant examples of mass production via additive manufacturing. After a number of attempts and R&D experiments, adidas and Carbon have developed a workflow for cost-effectively 3D printing hundreds of thousands of footwear midsoles.

Limited Editions

Short batch production for limited editions takes place either through direct additive manufacturing of shoe parts or by adding AM for faster and more cost-effective prototyping and mold-making.

Designer and Luxury Products

3D printing has already been used for a number of highly experimental and artistic designer footwear products, ranging from entire shoes to custom sculpted heels.

Mass Produced Uppers

A few major firms are working to implement 3D printing technologies in the production of footwear uppers. This labor-intensive process is generally achieved through the extrusion of polyurethane materials along with an automated knitting or textile cutting process.

Fast Prototyping and Molding

AM is already used as a key technology to obtain faster and more cost-effective prototypes and tools to be used in traditional footwear manufacturing processes.



Mass Customization of Footwear

Mass customization will play a major part in the future of footwear 3D printing, and will be driven by technologies that can rapidly and accurately acquire an individual's unique geometric and biometric data.

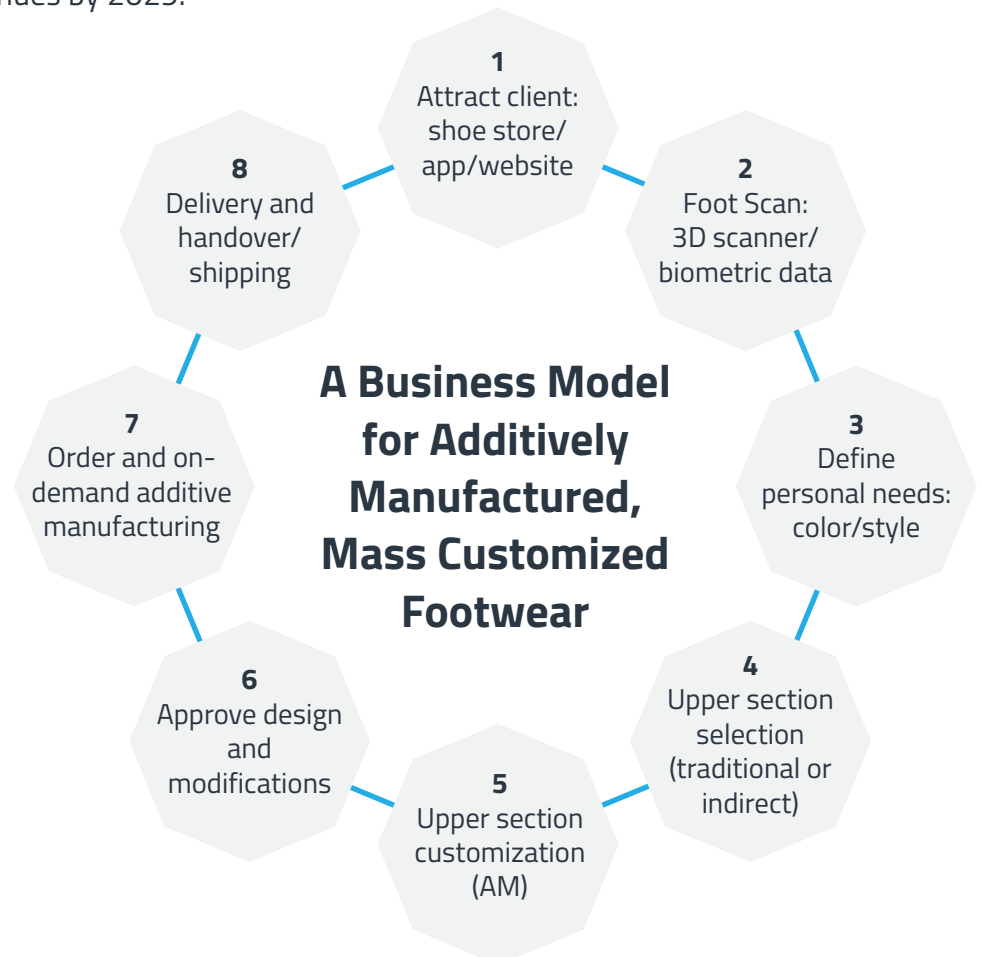
These technologies usually consist of footwear-specific evolutions of 3D scanning equipment, as well as online software that can leverage widely available 3D capturing technologies such as those now integrated into mobile devices.

SmarTech expects the segment of footwear-specific 3D scanning hardware to be the most significant out of all digital customization products, going on to generate over \$130 million in yearly revenues by 2029.

Once 3D capture tools have been used to acquire a consumer's geometric data, 3D printers are used to create the customized product. While customized 3D printed footwear today is most commonly outsourced to providers of prototyping and production services, SmarTech expects that, over time, the majority of AM usage in the footwear industry will take place in-house.

Powder bed fusion (PBF) is one of the most common AM technologies in footwear production today and is used especially for mass customization applications such as insoles, producing as much as 80% to 85% of all final parts in this area.

The most common material across all footwear 3D printing technologies is **polyurethane.**



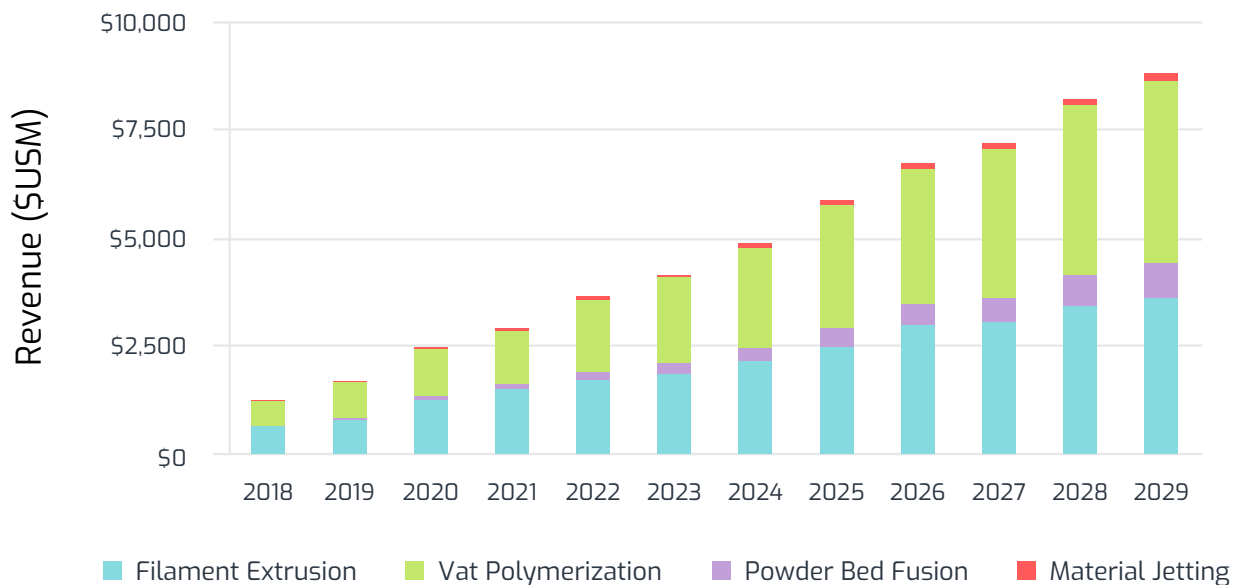
Hardware and Materials

The most relevant family of AM hardware technologies in footwear production is photopolymerization, which includes traditional processes such as Stereolithography (SLA) and Digital Light Processing (DLP), as well as “layerless” processes such as Carbon’s Digital Light Synthesis (DLS). These technologies are used primarily for mold-making and production of end-use parts.

Material jetting photopolymerization technologies are used for prototyping, while powder bed fusion technologies — including both Selective Laser Sintering (SLS) and thermal Powder Bed Fusion (PBF) technologies (such as HP’s Multi Jet Fusion) — are also relevant.

Filament extrusion technology is less common in the footwear industry but has been implemented for some final part production and in-house prototyping.

AM Hardware Units Demand in Footwear 2018-2019



Across all technologies used for part production in footwear 3D printing, the most common material is polyurethane, an elastomer that is available in different forms.

Polyurethanes are unique in combining the strength of rigid plastics with the flexibility and elasticity of rubber. Hoses, automotive bushings, seat foam, skateboard wheels, and Spandex are all common applications of the material.

Layerless photopolymerization technologies such as Carbon’s DLS use a blend of thermoset polyurethane and enough photopolymer material to enable a photopolymerization reaction. Thermal technologies such as powder bed fusion and thermoplastic material extrusion often use TPU (thermoplastic polyurethane), which is available in both powder and filament form.

Adoption of AM in Footwear: Pros and Cons

Drivers for Adoption	Obstacles to Adoption
Faster time to market via rapid prototyping	Setup costs
Increased production automation	Material costs
Increased design possibilities	Cost of custom lasts
Increased comfort through customization	Hard to break established value chain
Increased access to the market via on-demand manufacturing	Advantages not drastic enough to justify risk

Footwear 3D printing will become a **\$5.9 billion revenue** opportunity by 2029, making footwear the **most relevant consumer vertical for 3D printing**



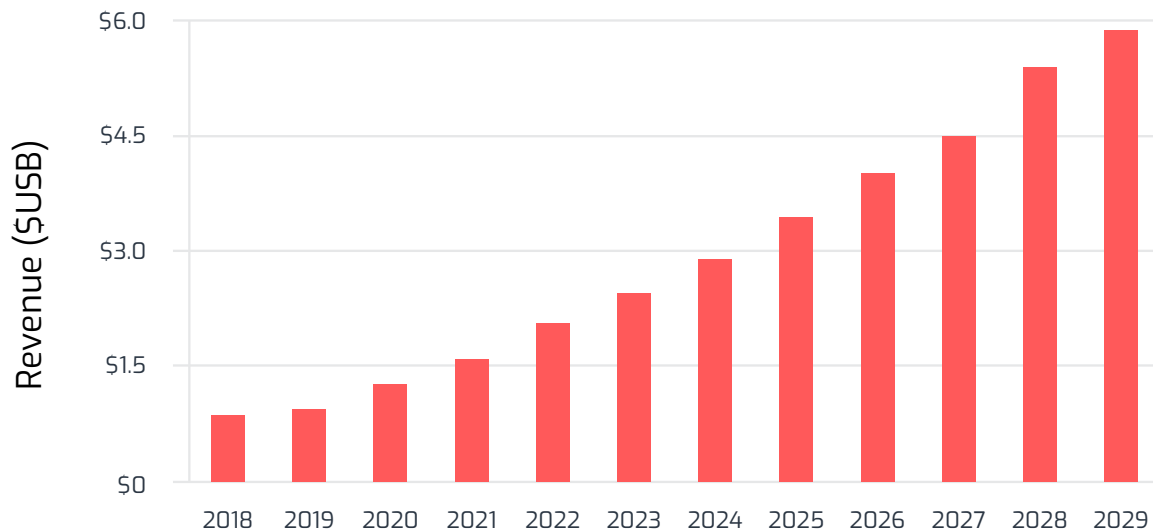
The Future of Footwear 3D Printing

The global footwear industry generated revenues of about \$260 billion in 2018 and is expected to grow at around 4% CAGR over the next decade, totaling around \$400 billion by 2029.

SmarTech expects that footwear 3D printing revenues currently represent roughly 0.3% of global footwear market revenues. This figure — which includes revenues from AM hardware, AM software, prototyping and tooling, as well as end-use products — is expected to grow to about 1.5% of overall global footwear revenues by 2029.

As small as this percentage may sound, it amounts to a \$5.9 billion revenue opportunity, making footwear arguably the single most relevant consumer vertical for 3D printing.

Revenues in the Footwear 3D Printing Market



Learn More

The SmarTech report “Markets for 3D Printed Footwear 2019 – AM Production in the Footwear Industry: A Ten-Year Forecast and Opportunity Analysis” focuses on several recurring areas of analytical focus that reflect the rapidly evolving landscape of footwear 3D printing.

The report forecasts trends over the next 10 years, broken down into specific analyses regarding technologies, materials, market segments and applications. Its findings are based on a deep understanding of commercially available additive manufacturing technologies and their respective capabilities, operating parameters and historical development trends.

This deep knowledge is complemented by a primary understanding of the competitive forces at play in the footwear industry, including how mass customization technologies (including both AM and 3D capturing hardware) are developed, sold and supported, as well as how they are utilized by different end users.

For more information on the report, please visit:

<https://www.smartechanalysis.com/reports/additive-manufacturing-footwear-industry/>

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