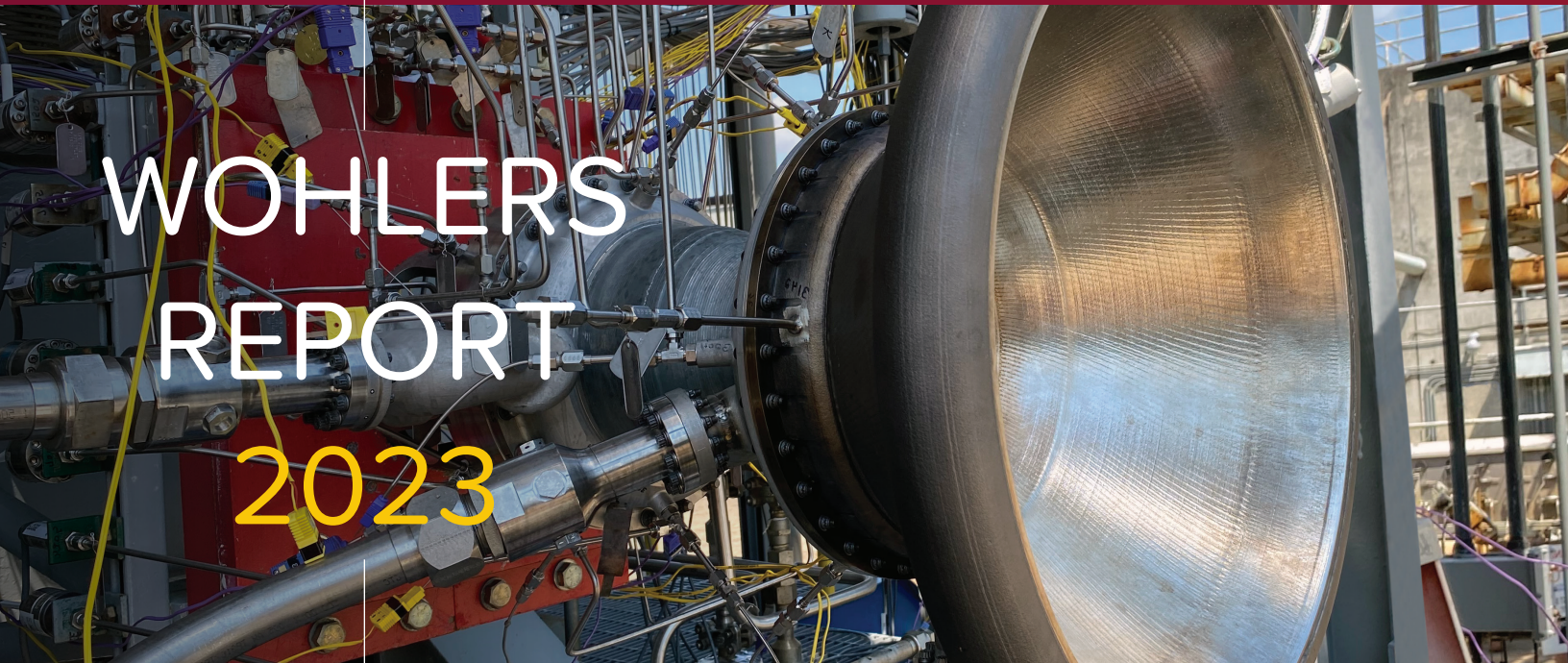


Executive summary



WOHLERS REPORT 2023

3D PRINTING AND ADDITIVE MANUFACTURING GLOBAL STATE OF THE INDUSTRY



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Introduction

This executive summary provides a sampling of information published in *Wohlers Report 2023*, a 404-page global study. The publication provides a thorough review and analysis of additive manufacturing (AM) and 3D printing—terms used interchangeably. This is the 28th consecutive year of the report’s publication.

Wohlers Report 2023 was written for any individual or organization seeking clear insight into the AM market. Groups that purchase this report include product development and manufacturing companies, service providers, startups, researchers, educators, and analysts. Others include investors, government agencies, and developers of industry standards and regulations.

An important part of this report is its comprehensive coverage of the AM industry’s growth. Part 3 of the report includes revenues and other growth information, complete with tables and charts illustrating relevant trends and industrial segments. At the foundation of this reporting is our nearly three decades of data and information from the industry. Organizations providing this data include service providers and other users/customers of AM, as well as the producers of AM systems, software, and materials. The information in this report has been produced with the help of surveys, interviews, and research, coupled with an international network of expert contributors and contacts.

The report serves as a “barometer” of the industry’s health and future. No other publication in the AM industry includes 28 years of hard data as its basis for calculating growth, analyzing trends, and forecasting the future.

Current technologies and trends related to end-use part production are discussed in detail. Also covered are mergers and acquisitions, the patent landscape, and legal issues in the industry.

The report provides updates on recent technical developments, advances in AM materials, and 3D scanning. *Wohlers Report 2023* documents government-sponsored research and development, collaborations, consortiums, and the activities of many academic and research institutes around the world.

The report concludes with a discussion of the emerging applications and trends in AM’s developing ecosystem. It provides insight into the future—what is driving the industry today and what to expect in the years ahead—to assist in strategic planning and investing. The report includes 55 charts and graphs, 101 tables, and 268 images and illustrations.

Wohlers Report 2023 is used as a tool for education and knowledge acceleration and can help give you a competitive edge. Readers new to AM gain a comprehensive understanding of the AM industry and how the technology is being put to work. AM veterans benefit from the up-to-date information on growth, trends, and the latest and most important developments worldwide.

End-use part production

One of the most interesting applications of AM is producing end-use parts. It represents 30.5% of all AM applications, based on research by Wohlers Associates. AM can be used for custom products and short-run production using polymers, composites, metals, ceramics, and biomaterials.

Consumer products include eyewear, footwear, and many other products. The following image shows a pair of eyeglass frames 3D printed in titanium. Today, most 3D-printed consumer products are more expensive than their conventionally manufactured counterparts, but added functionality, performance, and/or features can justify the price.

Fig. 1. 3D-printed titanium eyeglass frames, courtesy of Hoet



The production of parts for footwear is becoming a popular application. The following image shows custom insoles produced by Podoactiva of Spain. The company uses a clinical approach to capturing data from a customer, compared to some competitive companies, before production begins. The insoles are produced using HP Multi Jet Fusion, as well as conventional materials and methods of manufacturing.

Fig. 2. Custom insoles, courtesy of Podoactiva



The following part is a 3D-printed brake rotor for the Dodge Challenger Hellcat created by Ceramic Disc Technology. The company uses lattice structures to optimize performance. The rotor weight was reduced by 62%, coupled with a fivefold thermal conductivity improvement compared to a standard cast-iron brake rotor.

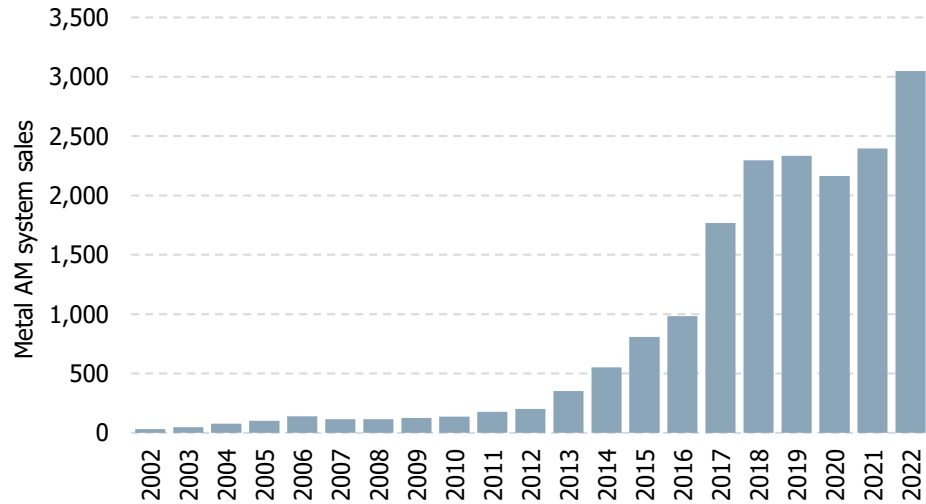
Fig. 3. Ceramic-aluminum brake rotor before finishing, courtesy of Ceramic Disc Technology



Fig. 4. Metal AM systems growth; source: Wohlers Associates

Metal AM systems

Sales of AM systems for metal parts increased by 27.2% in 2022. Wohlers Associates has been tracking this market segment for 20 years, as shown in the following graph. An estimated 3,049 metal AM machines were sold in 2022, compared to the 2,397 sold in 2021.

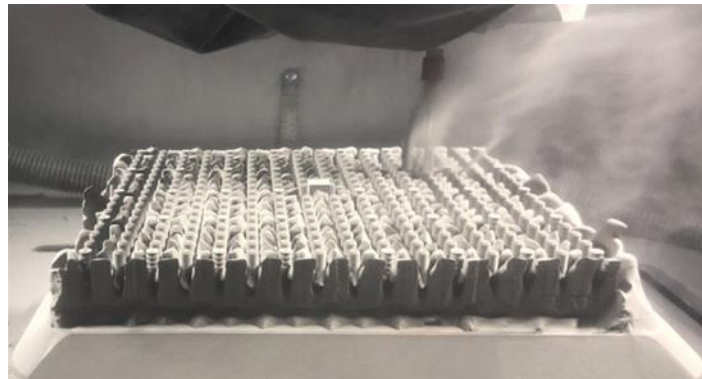


Post-processing

Post-processing typically requires more manual labor than any other part of the AM process chain. Companies offer automated equipment to help reduce the time and labor needed for post-processing.

Depending on the final application, each AM process requires one or more post-processing steps. Support material is removed, and parts are typically cleaned, cured, and/or depowdered. For parts made by material extrusion, automated systems help with soluble support structure removal. Parts made by powder bed fusion benefit from automated bead blasting systems and tumblers to remove unfused powder and improve the surface finish.

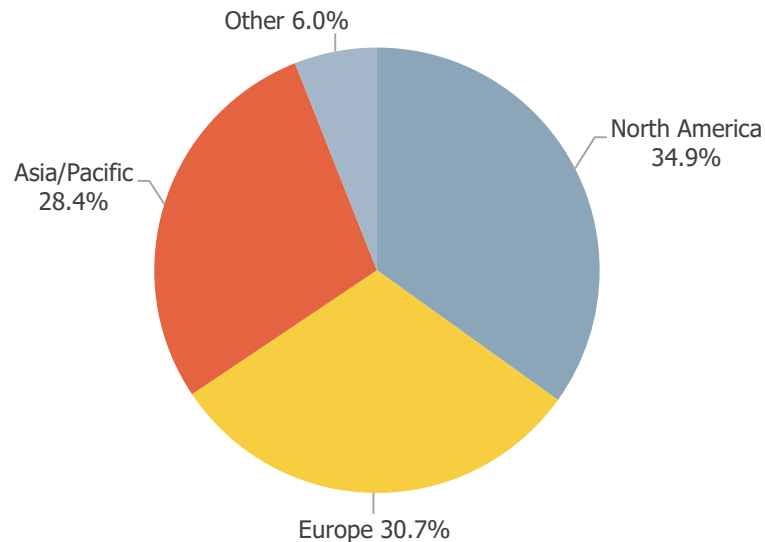
Fig. 5. DPS 1000 depowdering station, courtesy of Digital Metal



Installations worldwide

An estimated 34.9% of all industrial AM systems installed worldwide are in North America. Research by Wohlers Associates shows that 28.4% of all industrial systems are installed in the Asia/Pacific region. Meanwhile, 30.7% are in Europe, with the remaining 6.0% installed in Central America, South America, the Middle East, and Africa.

Fig. 6. AM system installation base by region; source: Wohlers Associates



The future of AM

Some of what is envisioned may not happen in our lifetime or at all. The building blocks, however, are in place for much of it to occur. It is largely a matter of ingenuity, funding, hard work, and determination.

AM has already changed our lives, whether we realize it or not. Consider that most consumer products, sporting goods, automobiles, and airplanes have benefited from AM at some point in their design and production lifecycle. For example, nearly 600 Boeing 737 MAX commercial jets were in service in mid-2022. The aircraft features the LEAP engine from GE Aerospace and Safran, which includes 3D-printed fuel nozzles, combustion liners, and heat exchangers. In the future, many more companies will bridge the gap between using AM for concept modeling and prototyping to custom and series production. This is when AM will become much bigger.

The team at Wohlers Associates has worked tirelessly over the past 28 years to deliver the most up-to-date and impactful insights. As your journey with AM unfolds, we would like to hear from you. We are always looking for good use cases and examples to consider for the next edition. We sincerely appreciate your support and contribution to the AM industry.

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Wohlers Associates is grateful for the generous input from 119 service providers, 128 manufacturers of additive manufacturing systems, and 27 producers of third-party materials.

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At the core of *Wohlers Report 2023* is a global team of five principal authors spanning four continents. These individuals collected, analyzed, and organized contributions and data from around the world. They also researched and authored many sections of the report. A vital part of the group is its editorial, analytics, and project management team. These professionals played a key role in the development of the report.

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About the Authors and Editors
Abbreviations, Acronyms, and
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Addiguru

AddUp

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- Eplus3D
- Farsoon
- Mimaki
- UnionTech
- XYZprinting
- ZRapid

Germany

- Arburg
- BigRep
- DMG Mori
- EOS
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- HP
- Markforged
- Optomec

APPENDICES

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Appendix D: 3D scanning system



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