Executive summary of the Wohlers Report 2016

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EXECUTIVE SUMMARY

Wohlers Report 2016
3D Printing and Additive Manufacturing State of the Industry
Annual Worldwide Progress Report

WOHLMER ASSOCIATES
Introduction

This executive summary compiles and condenses information published in *Wohlers Report 2016*, a 335-page study. The publication provides a global review and update of the technologies and applications of additive manufacturing (AM) and 3D printing—terms used interchangeably throughout the report. This is the 21st consecutive year of the report’s publication.

*Wohlers Report 2016* was written for product development and manufacturing professionals and organizations worldwide. Among the groups that have found it useful in the past are original equipment manufacturers, suppliers, service providers, researchers, educators, analysts, and investors.

The ISO/ASTM 52900 standard defines *additive manufacturing* as the process of joining materials to make parts from 3D model data, usually layer upon layer, as opposed to subtractive and formative manufacturing methodologies. AM is used to build physical models, prototypes, patterns, tooling components, and production parts in plastic, metal, ceramic, glass, and composite materials. AM encompasses seven distinctly different processes. Parts can be created in a layer-by-layer fashion by extruding, jetting, photo-curing, laminating, or fusing materials.

A key part of *Wohlers Report 2016* is its comprehensive coverage of the AM industry’s growth. It includes revenues and machine unit sales, complete with more than 100 tables and charts that illustrate relevant trends, history, and industrial segments. The foundation of this reporting is more than 20 years of data from system manufacturers, service providers, and industry insiders, collected through surveys, interviews, and other means. No other published analysis of the AM industry has two decades of hard data as its basis for computing growth, analyzing trends, and forecasting the future.

*Wohlers Report 2016* provides detailed descriptions of the many processes and material families available today. It also covers AM’s history, wide mix of applications, and industries adopting the technology. The report provides a synopsis of each of the manufacturers of industrial AM systems, along with important developments from the past 12–18 months. The report also covers the desktop 3D printer segment, companies that are producing materials for 3D printing, and manufacturers with new and emerging technologies.

The 2016 report provides current information on developments and trends in the production of parts for final products. The study provides updates on recent developments in countries and geographic regions, and documents government-sponsored research and development, collaborations and consortia, and the activities of 107 academic and 12 research institutes around the world. The report includes extensive appendices and links to a large, exclusive collection of supplemental online information.

The report concludes with a discussion of the expanding AM ecosystem, which includes the companies, technologies, markets, and business models that make up the emerging supply chain. It provides insights into the future to assist in strategic planning and investing. It also forecasts future opportunities and growth.
AM surpasses $5.1 billion

In 2015, the AM industry, consisting of all AM products and services worldwide, grew 25.9% (CAGR) to $5.165 billion. This compares to 35.2% growth in 2014, when the industry reached $4.103 billion. The CAGR for the past three years (2013–2015) is 31.5%. The CAGR over the past 27 years is an impressive 26.2%.

This $5.165 billion estimate of worldwide revenues includes both industrial systems and desktop 3D printers (those that sell for less than $5,000). This estimate does not include research and development initiatives at original equipment manufacturers (OEMs) and their suppliers. (They are among the principal customers of AM products and services.) Also, it does not include revenues from AM parts manufactured by OEMs.

Sales of AM systems for metal parts—a market segment that Wohlers Associates has been tracking for 15 years—are increasing. An estimated 808 metal AM machines were sold in 2015, growth of 46.9% over 2014 when 550 metal AM machines were sold.

In 2015, growth in unit sales of desktop 3D printers continued at a strong rate, increasing by 69.7% to an estimated 278,385 machines. Growth in 2014 was 88.0%, with unit sales of 163,999 machines. Average unit sales growth over the past four years (2012–2015) was 87.3%.

The following chart shows the $768.5 million AM materials market segmented by material type. As you can see, photopolymers is the largest segment, due in part to its historical and current use for prototyping and related applications. Laser-sintered polymers and filaments—both thermoplastics—are second and third in size. Metal AM has been available for roughly half of the industry’s 28-year history, yet it already represents 11.5% of the total and is growing fast. The "Other" segment includes materials for binder jetting, Solidscape machines, and sheet lamination.
Increasing number of system manufacturers

In 2015, 62 manufacturers from around the world produced and sold industrial-grade additive manufacturing systems (those that sell for $5,000 or more). This compares to 31 in 2011. As of March 2016, 28 companies in Europe, 10 in China, nine in the U.S., seven in Japan, four in South Korea, and one in Israel (Stratasys and Solidscape are counted as one company) were manufacturing and selling industrial AM systems. Most of the metal powder bed fusion systems are manufactured outside the U.S. Eight manufacturers of these systems are in Europe and six are in Asia. *Wohlers Report 2016* includes updated profiles of all these companies, and includes a useful chart that defines the AM processes and materials used by each.

Market opportunity and forecast

The global economy is said to be about $80 trillion, and manufacturing accounts for about 16%, which is $12.8 trillion. At about $5.2 billion in 2015, AM represents about 0.04% of all manufacturing—which is less than half of one percent. If AM grows to capture just 5% of this global market, it would become a $640 billion industry. Wohlers Associates believes that it could someday exceed 5% of the total.

By 2017, Wohlers Associates forecasts the sale of AM products and services to reach nearly $8.8 billion worldwide. This forecast assumes the manufacturing economy will not be affected by larger influences, such as a global economic recession or catastrophic natural disasters.

Never before have we had access to such powerful tools—and so many of them—for design, product development, and manufacturing. This has resulted in a wave of exciting creativity, and an expression of new product ideas at an all-time high. The breadth of new products, services, startup businesses, and entrepreneurship, with funding to support them, is incredibly exciting. And, we have only seen the “tip of the iceberg,” so stayed tuned.
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Tim Caffrey is a senior consultant at Wohlers Associates and a principal author of the *Wohlers Report*. His responsibilities include the execution of many consulting projects worldwide, as well as speaking and representing the company at national and international events. He has worked in association with Wohlers Associates since 2000.

Caffrey holds a bachelor's degree in mechanical engineering from the University of New Mexico. His career in additive manufacturing began in 1992 at Boeing's Propulsion Laboratory. He directed the company's first in-house AM facility, which grew from one system for wind tunnel models into a large operation that supported the entire corporation. Starting in 1996, Caffrey managed the AM operation at Plynetics Express, which had, at the time, the largest installed base of AM systems in the world.

His experience includes 24 years of professional writing and editing, which includes this annual publication, reports and roadmaps for consulting projects, and eight annual revisions of the textbook *Applying AutoCAD*. It
also includes maintenance procedures for Boeing aircraft, operational
tests for Boeing flight test engineering, engine case repair procedures at
Pratt & Whitney, advertising and marketing at Walmart's corporate
headquarters, and personal creative writing projects.

Caffrey's not-so-traditional career also includes stints as a cabinetmaker,
handyman, stagehand, audio technician, basketball coach, and actor. He
once won a national championship in ultimate frisbee, and has also
coached high school ultimate. He and his wife live in Fayetteville, Arkansas.
They have three adult children.

Industry consultant and analyst Terry Wohlers is president of Wohlers
Associates, Inc., an independent consulting firm he founded more than 29
years ago. Through this company, Wohlers and his team has provided
consulting assistance to more than 240 organizations in
24 countries. He has also provided insight to 150+
additional clients from the investment community.

Wohlers has been cited in countless domestic and
foreign publications including Bloomberg Businessweek,
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(NPR), Australia's Sky News, Canada's Business News Network (BNN), and
China's CCTV News.

In 2007, more than 1,000 industry professionals from around the world
selected Wohlers as the #1 most influential person in rapid product
development and additive manufacturing (AM) by the UK's TCT magazine
as part of its Top 25 Influential People survey.

Wohlers has authored more than 400 books, articles, and technical papers
on rapid product development and manufacturing. He has given 125
keynote presentations on five continents in cities ranging from New York
and Cape Town to Melbourne and São Paulo.

His appetite for adventure has motivated him to climb the Great Wall of
China, hike the rain forests of New Zealand, dive among sharks in Belize,
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Wohlers received an Honorary Doctoral Degree of Mechanical Engineering
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Associate consultant Ian Campbell is a reader (associate professor) in computer-aided product design at Loughborough University in the UK. He has led the Design Practice Research Group, served as director of the Research School of Design, and led the Digital Technologies Research Theme. Prior to 2000, Campbell was a lecturer at the University of Nottingham, working in the groundbreaking Rapid Prototyping Research Group led by Phill Dickens. Campbell began his career as an engineering designer at Ford Motor Company and the Rover Group.

Campbell has been working in the field of additive manufacturing since 1993. He has established international partnerships with colleagues in South Africa, Portugal, Slovenia, Egypt, and Romania. He is particularly interested in new design opportunities afforded by additive manufacturing and has advised industrial partners on how to best exploit them. He is an international honorary member of the Rapid Product Development Association of South Africa (RAPDASA) and has been editor of the Rapid Prototyping Journal since 1995.

How to order the report

Go to wohlersassociates.com to order the report online. The report, available as a color PDF, is US$495 worldwide. The printed and bound version is $595 worldwide. Credit card payment is preferred.