

EXECUTIVE SUMMARY

Wohlers Report 2002



Rapid Prototyping
& Tooling State
of the Industry

Annual Worldwide
Progress Report

TERRY WOHLERS



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Wohlers Report 2002

This eight-page document provides an overview of the information published in *Wohlers Report 2002*, a 250-page, softbound publication. The report includes 25 charts and graphs, 23 tables, and 87 photographs and illustrations. The focus of the report is on the many important facets of rapid prototyping and tooling, including the industries being served, applications, revenues, unit sales, and forecasts. It also provides current information on trends with regard to service providers, advanced approaches to tooling, system manufacturers worldwide, RP stocks, and new developments in the U.S., Europe, Asia, and other parts of the world. The report covers research and development activities, growth trends in CAD solid modeling, RP materials, medical modeling, and reverse engineering. *Wohlers Report 2002* concludes with a discussion of the future of rapid prototyping, where it is headed, and what to do.

Introduction

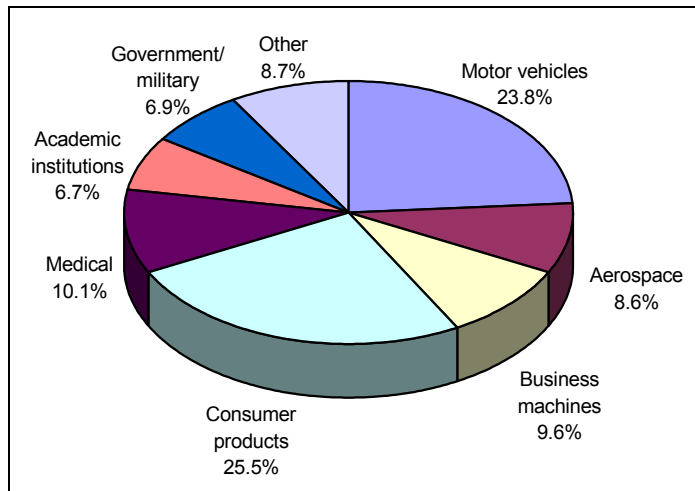
Rapid prototyping (RP) refers to the physical modeling of a design using a special class of machine technology. RP systems quickly produce models and prototype parts from 3D computer-aided design (CAD) model data, CT and MRI scan data, and data created from 3D digitizing systems. Using an additive approach to building shapes, RP systems join liquid, powder, or sheet materials to form physical objects. Layer by layer, RP machines fabricate plastic, wood, ceramic, metal, and composite parts using thin, horizontal cross sections of the computer model.

Methods, processes, and systems for *rapid tooling (RT)* are also developing, many of which are new and not well understood. As an emerging technology, the definition of RT is often debated and not clearly defined. Most would agree, however, that RT is driven from a freeform fabrication process—the key to making it rapid.

Rapid prototyping is having a profound impact on the way companies produce models, prototype parts, and tooling. This impact is also being realized in production, as some companies are now using it to produce final manufactured parts. This practice, termed *rapid manufacturing (RM)*, is developing into an intriguing market opportunity. RM may even become the most significant area of growth in this decade.

Industries being served

Companies that use rapid prototyping cut across most manufacturing industries. The following chart reflects the major industrial sectors that are taking advantage of the technology. Consumer products and motor vehicles continue to dominate the industries being served. Combined, they represent nearly half of the total.



Source: Wohlers Associates, Inc.

The “Other” category includes industries such as professional sporting goods, non-consumer and non-military marine products, and various other industries that do not fit into the named categories.

Industry growth

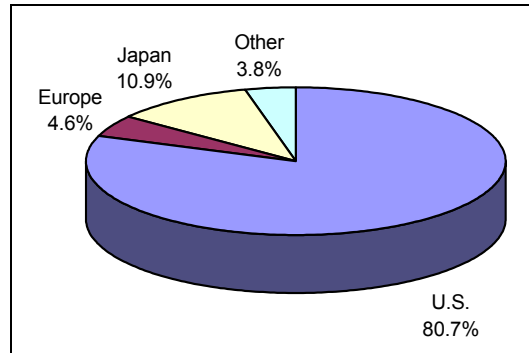
The RP industry continues to expand. More systems were installed, more material was consumed, and more applications for the technology were uncovered. Yet, the rate of growth proved to be a disappointment.

Accustomed to the stellar growth of years past, it is sobering to learn that 2001 was yet another year in which growth stagnated. Most sectors of the RP industry had either minor growth or some degree of decline. Revenues from products and services were down significantly. Machine unit sales were flat. Unexpectedly, even the low-cost 3D printer segment experienced a decline in unit sales.

The events and economic conditions of 2001 had an effect on the RP industry. Budgets were slashed, projects were put on hold, and layoffs were common. Each of these factors decreased the demand for prototypes and tooling and reduced capital equipment expenditures.

Seeking another measure of industry growth, Wohlers Associates is reporting revenues from RP materials sales. Last year, there was a worldwide expenditure of an estimated \$71 million for RP materials. This estimate includes resins, powders, filaments, sheet materials, and other material types used in RP machines. In future reports, Wohlers Associates intends to track and report the growth of this important market segment.

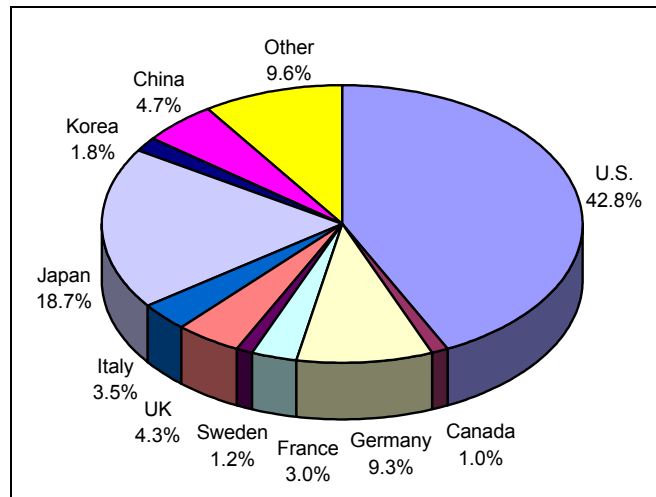
The U.S. continues to dominate the production and sales of RP systems, as shown in the following chart. Nearly 81% of the systems sold in 2001 came from U.S. machine manufacturers, essentially unchanged from the three prior years. Japan’s segment declined for the second consecutive year, dropping by two full percentage points.



Source: Wohlers Associates, Inc.

Installations by country

The following chart breaks down last year's system purchases and installations by country. As with system production and sales, the U.S. has the highest percentage, by far, of system installations. The U.S. is followed by Japan, Germany, and China.

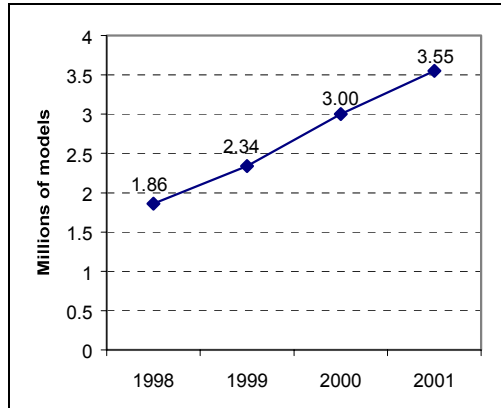


Source: Wohlers Associates, Inc.

In contrast to the steadfast hold the U.S. has on system sales, its lead in installations continues to decrease. Since 1998, the U.S. has fallen from 48.9% of the world market to 42.8% in 2001.

Number of models being produced

Despite a decline in overall industry growth, RP users worldwide produced an estimated 3.55 million models and prototype parts in 2001. This is up 18.3% from the 3 million models produced in 2000. An estimated 2.34 million and 1.86 million parts were produced in 1999 and 1998, respectively.



Source: Wohlers Associates, Inc.

Wohlers Associates believes that the contrast of growth in part production to the stagnation of system sales is in part due to equipment and material enhancements. These improvements offer higher throughput from the same number of systems. Other factors include improved capacity utilization and the growth in the concept modeling segment of the industry.

On average, two copies of a unique design are built. This means that 1.72 million distinctive parts were produced in 2001. To some, this is a staggering number of parts being produced from a class of technology that has been available for little more than a decade.

Equally noteworthy is that one company has produced more than one million parts in less than three years. Using its SLA 7000 machines, Align Technology produces hundreds of thousands of clear plastic aligners for straightening teeth. Since the company does not publish annual production rates, the 2001 total of 3.55 million models excludes those produced by Align Technology.

Service providers

Service providers, also referred to as service bureaus, offer design, CAD, data translation, prototyping, tooling, urethane casting, reverse engineering, and other engineering and manufacturing services. Last year was dismal for these companies, especially compared to earlier years when growth was constant. Many service providers were forced to down size, run very lean, and get by on razor-thin margins.

In 2001, service providers voiced a concern over a lack of incoming projects and the challenge of maintaining a positive cash flow. For some, supply and demand ratios returned to 1997–1998 levels. To compete, some companies have dropped prices as much as 50–60%, a similar response to the tough times of four to five years ago. Weak earnings and layoffs in the manufacturing sector affected service providers through the second half of 2001 and well into 2002.

An estimated 397 service providers were in place worldwide at the end of 2001, according to the *Rapid Prototyping Report*. This represents growth of 3.4% over the 384 companies in place at the end of 2000. In 2000, the number of service providers grew by 8.2%.

Rapid tooling

The demand for faster and less expensive tooling solutions has resulted in more than 20 methods of RT being developed worldwide. Many companies are pursuing the development and commercialization of RT because of its market potential. In 2001, the secondary RP market segment, which includes tooling created directly from RP processes, was an estimated \$385.7 million.

Manufacturing companies are trying to determine if the time is right to phase in one of these new approaches. Some of them believe it is time to act, and the action must entail the creation of their own solution. A surprising number of companies are developing RT methods for in-house use with no intention of licensing the technology or making it commercially available. These efforts seek an approach that will offer a strategic advantage over the competition.

Companies and technologies such as Direct Metal Laser Sintering from EOS, Ford Sprayform, Direct Metal Deposition from POM, Extrude Hone's ProMetal, RSP Tooling, Selective Laser Sintering from 3D Systems, and an ultrasonic welding process from Solidica have shown encouraging progress from the past year of work.

Tough times, bright future

2001 was a challenging year for the RP industry. It was a year that uncovered more questions than answers. Although the economic downturn had a dramatic effect, it was not solely responsible for these difficult times. Rather, it was a combination of forces that caused underlying problems, questions, fears, and confusions to surface. For years, strong sales have covered many sins. With a decline in sales, problems and doubts have been exposed.

In spite of the tough times, there is hope on the horizon. The recent rise in economic indicators suggests that the recession may soon be over. Although this is good news, the best news is that necessity will create invention. With the decrease in revenue, the necessity of profit is likely to yield powerful, innovative solutions that fuel the rapid expansion of the RP industry.

To regain momentum and to cross the chasm into the early majority of the Technology Adoption Life Cycle (TALC), a model that illustrates technology growth and decline (see <http://wohlersassociates.com/talc2.pdf> for a description of the TALC), the industry must discern what will attract buyers. Through its reluctance to spend money on RP, the early majority has voiced its opinion that RP's value proposition is lacking.

To improve the value proposition, technology development is critical, and this was one area of tremendous growth in 2001. Established companies released new technology and new materials. New companies burst onto the scene with innovative approaches to the practice of RP. Finally, and

perhaps most importantly, the stagnation of the RP industry did not quell the enthusiasm and innovation that fuels research and development.

An upturn in the economy will not give the RP industry the double-digit growth of the past. To achieve that, the industry needs the technological advancement that was such an important area of growth in 2001.

Rapid manufacturing may be the next frontier for new applications and increased research and development. Already, companies are beginning to use RP-driven processes to produce finished manufactured parts. It's unlikely that RM will ever reach the production capacity of processes such as injection molding, die casting, or sheet metal stamping, but for some companies, this may not matter. Not all manufacturers produce and sell in volumes of millions, or even tens of thousands. It is these companies that will adopt the technology to quickly and cost effectively deliver new products to their target markets.

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About the author

Industry consultant, author, and speaker Terry Wohlers is president of Wohlers Associates, Inc., an independent consulting firm he founded in 1986. Over the past decade, he has served as a voice in the rapid prototyping and manufacturing industry. He has been quoted in the *Los Angeles Times*, *LA Daily News*, *The Economist*, *FORTUNE* magazine, and countless domestic and foreign magazines, journals, and newspapers. In October 2001, Terry served as analyst in a fast-paced television show on ABC, and twice, has been interviewed on German radio. In 1994, Terry met with and presented to the Under Secretary for Technology at the U.S. Department of Commerce.



Terry has authored more than 250 books, articles, reports, and technical papers on engineering and manufacturing automation. He has presented to thousands of engineers and managers and has been a keynote speaker at major industry events around the world. In the recent past, he has given featured presentations in England, France, Germany, Israel, Japan, Puerto Rico, South Africa, the USA, and Wales. His appetite for adventure has driven him to climb the Great Wall of China, hike the rain forests of New Zealand, dive among sharks in Belize, bathe in the Dead Sea, and encounter lions and rhinos in Africa.

In 1992, Terry led a group of 14 individuals from industry and academia to form the first association dedicated to rapid prototyping. In 1993, the association joined the Society of Manufacturing Engineers (SME) to become the Rapid Prototyping Association (RPA) of SME. In 1998, Terry co-founded the Global Alliance of Rapid Prototyping Associations (GARPA) involving 14 member nations around the world. Today, GARPA serves as a catalyst for the exchange of information on rapid prototyping and tooling across international borders.

How to order the report

In the U.S., *Wohlers Report 2002* is available for \$395, which includes Priority Mail shipping. For orders outside the U.S., the price is \$425, which includes Global Priority Mail shipping.

To order one or more copies, please provide a Visa, MasterCard, or American Express number and expiration date by fax, phone, or e-mail, or send a check in U.S. dollars drawn on a U.S. bank to:

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Additional information, including an order form, is available at **wohlersassociates.com**. The website provides access to more than 200 related websites and 100 articles, technical papers, reports, and other documents on rapid prototyping, rapid tooling, 3D printing, CAD/CAM, and reverse engineering. All 100 documents are available to read on-line free of charge.

Acknowledgments

About the author

Focus of this report

Introduction to rapid prototyping and tooling

PART 1: BACKGROUND

History of RP systems

Industries being served

How RP models are being used

Installations by country

Applications

Communication

Engineering changes

Good ideas and powerful proposals

Concept models

Verifying CAD databases

Styling, ergonomic studies

Functional testing

Prototypes

Metal castings

Early input from suppliers, tool-makers

Quote requests

Rapid tooling

Rapid manufacturing

Unlimited potential

PART 2: INDUSTRY GROWTH

Number of models being produced

Revenue growth

Revenues from products and services

3D Systems dominates

Material sales

Revenues from service providers

Secondary market

Revenues from other services

Unit sales

3D Systems leads

Systems sold by region

Cumulative systems sold by region

Units sold by U.S. manufacturers

Units sold by Japanese manufacturers

Cumulative unit sales by manufacturer

Unit sales by manufacturer and year

3D printer sales by manufacturer and year

Growth trends and sales forecasts

Unit sales growth percentages

Worldwide revenue estimates

Annual revenue growth percentages

Comparing growth of RP and machining markets

Service providers

Growth and location

Mix of machines

Market segment continues to shrink

Number of models produced annually

Investment casting

Working with service providers

Challenging times

What is driving prices downward?

What lies ahead?

PART 3: TOOLING

Advances

Growing list of methods

Thermal management

Risk factors

Indirect approaches

Silicone rubber tooling

Epoxy-based composite tooling

Spray metal tooling

RSP Tooling

Ford's Sprayform

Cast kirksite tooling

RPM (rubber plaster mold) casting

3D Keltool

PolySteel

EcoTool

Swiftool

PHAST

V-Process

Others

Direct approaches

Direct AIM tooling

SLS tooling

DMLS

POM

Others

Other considerations

Machined tooling

Laminate tooling

Hybrid tooling

Space Puzzle Molding

Tool design software

Size of tooling market

Tooling comparison matrix

PART 4: SYSTEM MANUFACTURERS

3D Systems

Materials

SLS business

OptoForm

MJM

Other developments

Arcam

Beijing Yinhua

Cubic Technologies

EOS

EOSINT P 380

20-micron metal powders

Envision Technologies

F&S GmbH

Generis

Kinergy

Objet

QuadraTempo

Support material

Sales underway

Optomec

ProMetal

R4 and R10 products

Recent developments

Sanders Design International

Schroff Development

Solidica

Solidscape

Stratasys

Dimension

Other developments

Z Corp.

Z810

ZCast

Other activities

Others

Helisys

Cubital

Röders

BMT

Aaroflex

Real cost of RP

RP stocks

Revenues and earnings

Industry consolidation

Trends and areas of interest

Outlook

PART 5: ASIA & EUROPE

Asia

Hong Kong

China

Singapore

Japan

Unit sales

Japanese strategy

CMET, Sony/D-MEC, others

Acceptance of non-SL technologies

Sheet lamination systems

Developments, trends

Lagging software development

Accelerated growth expected

Europe

RAPTIA

United Kingdom

Germany

Italy

France

Sweden

Finland

Denmark

The Netherlands

Belgium

Other regions

Brazil

India

South Africa

Australia

Canada

RP groups and associations

PART 6: RESEARCH & DEVELOPMENT

Developments, patents

3D printers and concept modelers

Denken Engineering

Solidimension

BMT

Speed Part

Metal and ceramic parts

AeroMet

CAM-LEM

SRI International

Others

Small parts

microTEC

MEMGen

Mesoscale Integrated Conformal

Electronics (MICE)

Others

Large objects

Generis

Others

MIT's 3DP technology

3DP process

Major areas of focus

ProMetal

Z Corp.

Soligen

Specific Surface

Therics

Others

U.S. government-sponsored R&D

NSF funding

DoD funding

DoC funding

RP academic programs

RP educational activities

Basic research activities

Applied research activities

Future trends and contributions from academia

PART 7: OTHER DEVELOPMENTS

Growth of solid modeling

Getting good estimates

Seat and revenue estimates

Unsaturated market

RP materials

Stereolithography resins

Resin business in flux

Materials for other RP processes

3D printers

Medical modeling

Medical imaging to RP

Materials for medical RP

Research

RP's impact

Reverse engineering

The technology

3D digitizing and scanning

Data modeling and surface creation

First article inspection

Note to the wise

PART 8: WHERE IT'S ALL HEADED

Tough times, bright future

Economy

Something is missing

Necessity is the mother of invention

Silver lining

Formula for success

Divergent paths

3D printing

Rapid manufacturing

What to expect

Last great barrier

New rules

Where to learn more

Internet mail list

GARPA

RPA/SME

APPENDICES

Appendix A: Glossary of terms

Appendix B: RP system manufacturers

United States

Israel

Europe

Japan

China

Singapore

Appendix C: Rapid tooling technology developers

United States

Europe

Appendix D: RP software companies

Appendix E: Material suppliers

Appendix F: U.S. RP system specifications

Appendix G: RP systems manufactured outside the U.S.

Appendix H: Material properties

Appendix I: 3D digitizing systems

Appendix J: Reverse engineering software



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