MIT Technology Review

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Advanced Manufacturing

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Overview

Global Manufacturing

After decades of stagnation and handwringing over jobs moving to Asia, a manufacturing renaissance has begun.

The forces driving change and fostering global competition are complex, but one thing is certain: as the era of cheap labor fades, it is technology that will define the future of manufacturing.

In the recent 2013 Global Manufacturing Competitiveness Index, a collaboration between Deloitte Touche Tohmatsu Limited and the U.S. Council on Competitiveness, data from more than 550 senior manufacturing leaders was analyzed to understand the trends that are contributing to a hyper-competitive global manufacturing environment.

"If a country is going to innovate, it needs to be manufacturing things. The two processes are inherently interlinked."

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Advanced Manufacturing

Drivers of Manufacturing Competitiveness

(10=High 1=Low)

Index	Driver
9.22	Talent-driven innovation
7.67	Cost of labor and materials
7.31	Energy cost and polcies
7.26	Economic trade, financial and tax systems
7.15	Quality of physical infrastructure
6.62	Government investments in manufacturing and innovation
6.48	Legal and regulatory system
5.91	Supplier network
4.01	Local business dynamics
1.81	Quality and availability of healthcare

The 21st-century factory is already transitioning from assembly-line production methods to high-tech factory floors that employ 3-D printers to create—layer by ultrathin layer—jet-engine fuel nozzles one week and medical equipment the next. This new model, called mass customization, uses software and robots to create products according to customer specification at a massive scale.

Meanwhile, a new generation of cheaper, safer and more advanced robots are helping boost productivity.

Further propelling a new industrial stage are rising wages in low-cost economies such as China, volatile prices of energy and raw materials, and rising shipping costs.

Key Trend

3-D Printing

New possibilities are triggering innovation and out-of-the-box thinking among design engineers.

● Additive manufacturing, also known as 3-D printing, has been celebrated as one of the most important industrial paradigm shifts in the last 20 years. Objects or parts are created by spray-painting thin layers of stainless-steel or ceramic powder fused with a liquid binder. Layer by layer, a three-dimensional object gradually emerges.

Market Info

The Additive Manufacturing Market

2010 ..... $1.3 billion
2013 (projections) ..... $2.5 billion

SOURCE: WOHLERS ASSOCIATES

Customers

Automotive is the biggest user of additive manufacturing, but the method is also being used by aerospace, medical-device, consumer-goods, and electronics firms

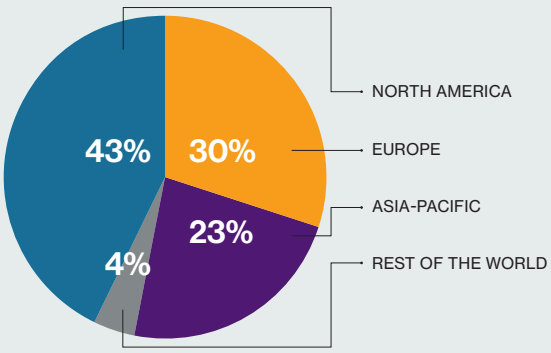
How Much Will a 3-D Printer Cost You?

Personal ..... $1,300–$20,000
Professional ..... $20,000–$250,000
Production ..... $250,000–$950,000

Industry Outlook

By 2030, machines will be able to create products from a range of materials, quickly and with a high level of precision, making additive manufacturing fully competitive with traditional manufacturing.

Global Market



Poised for Growth

25%–35%

Rate at which the additive manufacturing market is expected to grow annually

8x–10x

Number or times larger that the industry will grown the next decade

PHOTO SOURCE: THE SELF-ASSEMBLY LAB, MIT

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Spotlight: 3-D Printing

The Maker Movement

A technological offshoot of the do-it-yourself (DIY) movement is working to create a homegrown, local style of manufacturing

● Although most are hobbyists, some "makers" have found a profession in forging a new breed of "personal factories" where small groups work collaboratively and share equipment like 3-D printers, laser cutters, and other manufacturing tools.

Though small-scale, these personal factories could one day compete with larger companies, offering personal-fabrication technologies that could eventually transform how we conceive manufacturing.

Market data on the sub-culture is scarce, but a survey by MAKE magazine and Intel found that hobbyist makers intended to spend $2,000 on manufacturing annually. Their fullt-time counterparts planned to spend around $6,000.

Key Trend

Robotics

Manufacturers must increase productivity and become more responsive so that they can adjust quickly to changing customer needs.

● Improvements in microprocessors, sensors, and algorithms have advanced robotic technology, making robots more reliable and safer for use in manufacturing and able to perform a wider range of tasks. Until now, industrial robots have been confined in large cages (because a quick swing of a robot arm could knock a worker's head off) and assigned more repetitious jobs, such as welding.

Though not as powerful as traditional industrial robots, a new class of machines is safer for human interactions.

● The new humanoid robots are lighter than traditional industrial robots and can't carry as heavy loads, but they are much safer for interactions with people.

Robot Math

The artificial intelligence segment that includes robotics, chat bots, voice recognizers, and business intelligence systems is expected to be valued at about $900 million by the end of 2013.

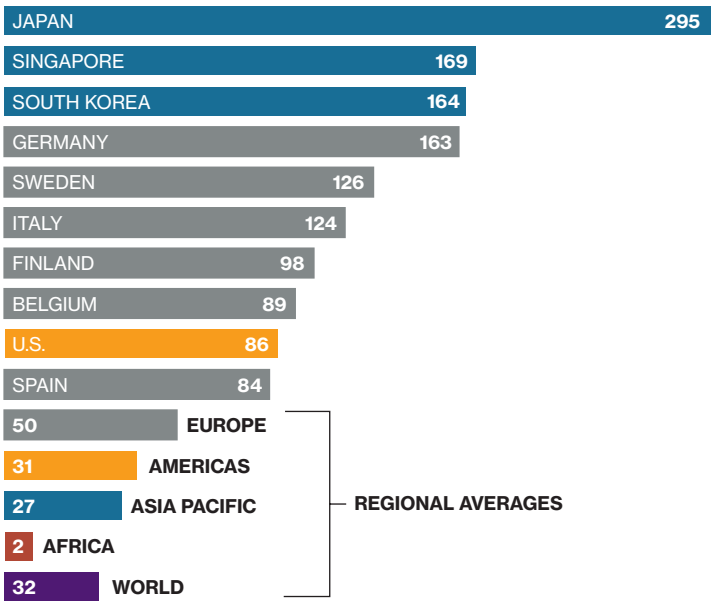
Between 2013 and 2015, robot sales worldwide will jump 5 percent, according to the International Federation of Robotics (IFR).

Emerging consumer markets for robots, according to IFG, are:

- Southeast Asia
- Turkey
- The Middle East
- BRIC countries (Brazil, Russia, India, and China)

Top 10 Countries by Robot Density

(industrial robots per 10,000 manufacturing workers)



SOURCE: HTTPS://WWW.INNOVATIONMANAGEMENT.SE/2012/04/16/PART-2-THE-MARKET-FOR-MASS-CUSTOMIZATION-TODAY/

SOURCE: DELOITTE AND THE U.S. COUNCIL ON COMPETITIVENESS. 2010 GLOBAL MANUFACTURING COMPETITIVENESS INDEX. AVAILABLE AT: HTTP://WWW.DELOITTE.COM/VIEW/EN_GX/GLOBAL/INDUSTRIES/MANUFACTURING/A1A92C646D0692105VGNVCM200000BB42F00ARCRD.HTM

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Key Trend

Mass Customization

Taking the pressure off of managing inventory levels

● One application of 3-D printing has been mass customization which means delivering a product to the specifications of individual customers in a way that is still efficient on a mass scale. Adopted by the consumer goods industry, mass customization also caters to the manufacturer that no longer wants to store a huge inventory of merchandise.

Key Trend

Creating New Materials

Innovations in nano- and biotechnology will enable breakthrough products.

● The fast-paced development of new materials is making it possible to create new, more advanced breakthrough products. Among them are more lightweight materials, nanomaterials, and biomaterials.

Dominant industries with mass customization offerings

Category	Description	Exemplary Products	Frequency
1. Personalized Media	Flat prints on paper or "near paper" objects, such as canvas	Book, calendar, canvas, wallpaper	96 19.2%
2. Personalized Fashion & Textiles	Mostly printed T-Shirts plus other fabrics	T-Shirt, blanket, underwear	78 15.6%
3. Food & Nutrition	All you can eat or drink	Chocolate, cereals, tea	57 11.4%
4. Personalized Look	Prints on non-paper materials	Bag, mug, skin	49 9.8%
5. Made to Measure Apparel	Women's and men's formal apparel	Suit, shirt, jacket, skirt	48 9.6%
6. Jewelry & Bag & Accessories	All the things which improve your personal appearance	Ring, sun (glasses), watch, bag, belt	41 8.2%
7. Misc	All the things which do not fit into the other categories	Toys, intruments, stuff	38 7.6%
8. Household & Furniture	Big and small things you use at home	Garden shed, bed, table, pet equipment	31 6.2%
9. Sports	Sports equipment	Bike, skateboard, golf ball	30 6.0%
10. Footwear	All that covers your feet	Shoes, boots, Flip Flops	23 4.6%
11. Computer & Electronics	Different electronic products	PC, notebook, accumulator	9 1.8%

SOURCE: HTTPS://WWW.INNOVATIONMANAGEMENT.SE/2012/04/16/PART-2-THE-MARKET-FOR-MASS-CUSTOMIZATION-TODAY/

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Key Trend

Localization

Reversing the trend of decoupling production and R&D

* There is an increasing awareness that geographic location plays a role in innovation, especially with rising fuel costs. According to Sergey Boev, of RTI Systems, "Localization is important not only in terms of reducing the cost of the components, but also for the technological independence of a country. The localization process optimizes the overall economic result."

Bridging Divides

Proactive Government Policies and Partnerships

Advanced Manufacturing thrives under supportive government policies that advocate for partnerships among government, industry, and academia. More than other industries, it needs substantial and continued investment, for making technological breakthroughs and for cultivating business, according to the Institute for Defense Analyses. Investments are made as grants or public-private partnerships.

As governments and investors work to attract manufacturers, they need to think about local regulations and pro-innovation policies that can attract manufacturing businesses and provide access to capital. They also need to invest in the building of facilities and in speeding up production startup and time-to-market. "This is one of the reasons local manufacturing is so critical – the time from the bench to revenue accelerates," said Martin Schmidt of MIT.

In different countries new government Advanced Manufacturing programs are developing.

A leading example of government-industry-research cooperation for manufacturing is the Fraunhofer Institute, founded in Germany in 1949 as that country worked to rebuild after World War II.

It is credited for Germany's advances in manufacturing innovation Rising employment industry is credited for helping Germany sail through the recent economic downturn.

A unique part of the model is having leading companies fund university research to solve specific manufacturing challenges. This helps accelerate the process from lab to factory floor.

Fraunhofer's example influenced the U.S. in its new additive manufacturing institute in built with the help of a $30 million federal grant and another $40 million in matching industry funds. The plan is to eventually launch a network of up to 15 manufacturing innovation institutes.

Another country making sustained investments is China, home to Zheijiang University's National Engineering Research Center for Industrial Automation. Research includes modeling, production scheduling, management decision making, and industrial processes

The European Union has invested 1.2 billion Euro in "The Factories of the Future", which facilitates manufacturing-related projects among various EU countries while sponsoring research in production, nanotechnology, and materials with a focus on small and medium-sized businesses.

Advanced Manufacturing

Global Snapshot

Innovation in Manufacturing

Manufacturing encompasses a wide range of industries with highly variable distribution and production models that range from heavily labor-intensive to outsource- and R&D-focused. McKinsey Global Institute reports that there are five broad groups that require very different inputs.

Says McKinsey: "To make sure location decisions line up with these input needs, we recommend a more nuanced 'total factor performance' approach. This takes in not only all the variables that can affect the total landed cost of a product (transportation and labor costs, access to commodities, energy prices, talent availability, proximity to suppliers, customers, and research clusters, regulation etc.), but also the risks."

● High ● Upper-middle ● Lower-middle ● Low

Zero percent of global manufacturing value added

GROUP	INDUSTRY	SHARE	R&D	INDUSTRY	CAPITAL	ENERGY	TRADE	VALUE
Global innovation for local markets	■ Chemicals	34%	●	○	●	●	●	●
	■ Motor vehicles, trailers, parts		●	○	●	●	●	●
	■ Other transport equipment		●	●	○	○	●	●
	■ Electrical machinery		●	●	○	●	●	●
	■ Machinery, equipment, appliances		●	●	○	●	●	●
Regional processing	■ Rubber and plastics products	28%	●	●	●	●	●	●
	■ Fabricated metal products		○	●	○	●	○	●
	■ Food, beverage, and tobacco		●	●	●	●	○	○
	■ Printing and publishing		●	●	●	●	○	●
Energy- and resource-intensive commodities	■ Wood products	22%	○	●	●	●	○	○
	■ Refined petroleum, coke, nuclear		○	○	●	●	●	○
	■ Paper and pulp		●	●	●	●	●	○
	■ Mineral-based products		●	●	●	●	○	○
	■ Basic metals		○	○	●	●	●	●
Global technologies/ innovators	■ Computers and office machinery	9%	●	●	●	○	●	●
	■ Semiconductors and electronics		●	○	●	○	●	●
	■ Medical, precision, and optical		●	●	●	○	●	●
Labor- intensive tradables	■ Textiles, apparel, leather	7%	●	●	○	●	●	●
	■ Furniture, jewelry, toys, other		●	●	●	○	●	●

DATA SOURCES: HARVARD BUSINESS REVIEW, WOHLERS ASSOCIATES VIA IDA; 3D SYSTEMS

Advanced Manufacturing

Regional ecosystems are also a tool for building economic prosperity. Having a critical mass of industry and research institutions in a particular area allows innovation to flow. In contrast, not having such hubs makes an industry less sustainable because a supply chain is lacking.

The United States, Germany, and the United Kingdom lead advanced manufacturing activities

Russia: Manufacturing costs are lower in Russia than in neighboring European countries. Asia poses less of a threat than it did in the past, as workers there demand higher wages and better conditions. Russia's main challenge is to modernize its traditional manufacturers.

Solidoodle, the desktop 3-D printer manufacturer, announced plans recently to launch stores in Russia, Ukraine, Kazakhstan, and Belarus.

United States: Excels in 3-D, robotics. The Obama administration allocated $1 billion to boost the country's advantage in digital manufacturing and design, with a focus on lightweight and modern metals manufacturing and next-generation power electronics for military and general markets. The government sees an expanding market for wind turbines, medical devices, engines, and armored combat vehicles.

Germany: a leader in the field is known for materials expertise including powdered additives, also precision engineering, machinery, and equipment.

UK is investing in Catapult centers which bring academia, industry, and government together to push technology and facilitate skills in manufacturing and other sectors.

China is interested in innovation, and it is becoming more high-tech as wages rise, but still lags behind. The government has reportedly pledged an investment of 1.5 billion yuan ($245 million) toward becoming a global leader in 3-D printing. The Asian Manufacturing Association, a Chinese organization, predicts that the 3-D printing market on mainland China will reach 10 billion yuan ($1.63 billion) by 2016.

China's population is an asset for attracting more manufacturing investment and it has the highest number of undergraduates studying science and engineering in the world, followed by the European Union.

Gulf States: In a bid to diversify economically and led by UAE, there is an emerging semiconductor industry Living in desert climates, they are developing new technologies to make air conditioning more energy-efficient.

Forecast

The Future of Manufacturing

The innovations in automated manufacturing assisted by sensors, robotics, and faster 3-D printing techniques could one day replace traditional labor-intensive manufacturing.

● Manufacturing is in the midst of change not seen since the introduction of the assembly line. New materials, tools, and processes are bringing about a more agile, smaller-scale, specialized manufacturing segment. As the trend toward localization takes hold, countries will come to rely on their unique strengths—such as a highly trained workforce or rich natural resources—to achieve success.

Robotics: Robots will move beyond the factory floor to tackle unsavory jobs such as sorting trash and cleaning up environmental hazards, using artificial intelligence to distinguish between harmless organisms and pollutants such as hazardous waste and oil.

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Advanced Manufacturing

3-D printers: The dropping cost of 3-D printers will propel the continued evolution of manufacturing design and production. In the future, 3-D printers might even be able to print components of human hearts.

New materials: The development of new materials and chemical processes over the next five to 10 years will be essen tial in making all of this new technology work in areas such as biotech, batteries, and solar power. But the pace of that change is still an open question, in part because of cost.

Mass customization: Tremendous growth is forecast in mass customization, which has already found special success in the sporting goods industry. Analysts predict more opportunities in health-related products designed to fit individual specifics such as age, body measurements, and lifestyle.

The crowdsourcing of designs is also driving the mass customization market. Crowdsourcing can speed up production cycles and reduce risk, especially for startups wary of mass production projects and high costs. Even the U.S. military has tapped into crowdsourcing, producing a military supply vehicle based on designs submitted and voted on by the general public.

Policy-makers: To produce the skilled workforce required for Advanced Manufacturing, governments need to ensure that students receive the necessary background in science, technology, engineering, and math. A highly skilled labor pool, rich in scientists and engineers, has been found to be the most important factor in manufacturing competitiveness, according to a 2010 report by Deloitte and the U.S. Council on Competitiveness. Countries with stringent academic standards and good postsecondary education are most likely to have strong workforces in innovation fields like Advanced Manufacturing.

As governments and investors work to attract manufacturers, they need to think about local regulations and pro-innovation policies that can attract manufacturing businesses and provide access to capital. They also need to invest in the building of facilities and in speeding up production startup and time-to-market. “This is one of the reasons local manufacturing is so critical—the time from the bench to revenue accelerates,” says Martin Schmidt of MIT’s Production in the Innovation Economy project.

The challenge for industry and governments is to harness public enthusiasm for manufacturing and use it to encourage young people to enter the profession. Currently most science-minded and entrepreneurial students are more drawn to high tech and startups. Apprenticeships in a trade—common among German and Swiss high-school students—would be one way to attract young people to manufacturing.

As supply chains are more divided—i.e., large companies no longer own both the “mines and the means” of production—it is even more important to coordinate the various players involved and help them agree on a longer-term technology trajectory. And with more localization, more supply chains will be local. ■

Drivers of Global Manufacturing Competitiveness

SOURCE: DELOITTE TOUCHE TOHMATSU LIMITED AND U.S. COUNCIL ON COMPETITIVENESS, 2010 GLOBAL MANUFACTURING COMPETITIVENESS INDEX