AMT
THE ASSOCIATION FOR MANUFACTURING TECHNOLOGY

tech trends

trends in brief

Insight to the Advanced Manufacturing Revolution

AMT− The Association For Manufacturing Technology advocates for the industry of advanced manufacturing, which creates some of the most innovative technologies in the world. As a leading authority on breakthroughs in our industry, AMT highlights the successes, challenges, and needs of the advanced manufacturing community and collaborates with member companies to leverage market access and intelligence.

AMT seeks manufacturing technology developments with significant influence noted and validated by our members including researchers, academia, Original Equipment Manufacturers (OEMs), builders and integrators of technology, and Tier 1 parts and materials manufacturers. These members serve the aerospace, defense, oil and gas, heavy equipment, and automotive industries.

This collaboration uncovered three substantial trends in the manufacturing technology industry: **Automation and Robotics**, **Digital Factories**, and **Additive Manufacturing**. These top three technology trends are highlighted in AMT's ***Tech Trends***, a comprehensive 50-page research report outlining some of the most potentially impactful technologies, challenges, and R&D for the manufacturing technology industry.

The full Tech Trends report is available at: http://www.amtonline.org/article_display.cfm?article_id=188867

Here we present an executive summary of ***Tech Trends***, entitled ***Trends in Brief***, describing the current use of each technology along with its level of research and known challenges. We hope that this summary serves as a reference guide for the current state of manufacturing technology.

Automation and Robotics, comprised of sensing, processing, and integration, are at the center of recent advancements in manufacturing technology. Areas of progress include embedded tactile and vision sensing systems. Higher fidelity cameras, faster communication, and improvements in safety are solidifying the reliability of robotics and also allowing for robots and humans to work side by side in a more collaborative manner.

Current **research** is focused on increasing collaboration of robotics with humans and the range of robot manipulation, including improved dexterity for flexible materials. These applications are beginning to be realized through more industrially accepted standards in safety and safety-integrated system solutions. Tactile and other modality sensory systems continue to advance within the robotics domain to improve system reliability, safety, and the aforementioned collaboration applications.

International research has highlighted multi-modal sensory systems to better ascertain robotic working environments. Additionally, both motion control and gripper-work piece interaction are subjects of recent research to increase the basic understanding of geometric and material preferences for improved robotic handling.

One current **challenge** for flexible automation and robotics within a manufacturing facility lies with the need to better understand operations at every level: individual machines, entire production areas, the shop floor, and even the entire facility. While some progress has been made through open standards, there is still a growing need for more than just machine tools to be enabled for visibility and connectivity to other pieces of manufacturing technology, such as integrating robots and lathes.

There is also a need to better respond to dynamic demand, realized by requests for low-volume custom products, as well as high-volume, production-level products. While each delivery technically is a "production run," there are obvious differences in how to respond to a custom-like production run and a more traditional long-run production program. More services are essential to accompany rapid development for ancillary components like tooling.

Digital Factories encompass coordination of all "smart" machines and instrumentation throughout the manufacturing process, as well as better enabling discrete process visibility. A specific trend has been an increase in incorporating and deploying machine tools with standards like MTConnect®. Technology sensing and connectivity have both top-line and bottom-line impacts on a business. From a top-line perspective, technology with such capabilities (machine visibility and connectivity) is viewed from the market as being adaptive and robust. From a bottom-line perspective, individual firms are finding cost savings through optimizing processes, maintenance (for improved equipment availability) and more efficient load balancing.

The ultimate goal of the digital factory is the realization of the Advanced Manufacturing Enterprise (AME) – a holistic connection of the digital tapestry throughout a product's lifecycle. As digital capabilities improve, the entire lifecycle of every machine and part, down to individual nuts and bolts, will be tracked. Creating this "digital footprint" for these physical pieces will allow better data and insight into a product's best features, points of failure, and other characteristics – giving manufacturers the opportunities to improve design and functionality in ways that previously were not possible.

Research is investigating the continuous link of the digital model throughout the life cycle of the product (rework, reuse and recycle), cyber security, and process control and mapping to improve the end product and its features. Cyber-physical security is among the top manufacturing research areas due to manufacturing's increasing digital nature. Collaborative efforts through America Makes – the National Additive Manufacturing Innovation Institute are producing material and process databases, which engineers and designers can more adequately select for products.

A **challenge** of the digital factories is to better integrate computer-aided design (CAD) with finite element modeling (FEM), which may better optimize computer-assisted manufacturing (CAM). In addition, the predictive capabilities of FEM need to more closely represent the true as-built phenomenon occurring between workpiece and tool. Other areas preventing industry from optimizing within the digital enterprise are the ability to obtain actionable information, realize the advanced manufacturing enterprise, acquire sufficient cyber-physical security, and improve end-user operation.

An additional challenge includes the implementation of AME, the industry name that encompasses the lifecycle of every machine, part, process, and practice to deliver better performance by the manufacturing enterprise.

Additive Manufacturing (AM) or 3D printing (3DP) has practical possibilities and significant economic impact. First patented in the United States in the 1980s, AM is nearing its technology maturation. It is perhaps unique among manufacturing technologies due to the attention it has gained in popular media, particularly as it has gained prevalence in a variety of settings – from industrial to academic to hobbyist. Improvements to that first patented process have allowed for its use in homes and classrooms, in addition to its growing ubiquity as an industrial solution.

While the majority of AM's end-use during these past decades centered on rapid prototyping and tooling, there have been early adopters that have begun inserting AM into all levels of the supply chain. Advanced materials and improved control systems are increasing the value and potential of AM. One of AM's greatest strengths is its potential for design complexity, which may accelerate its adoption. However, overall acceptance for AM seems to be controlled by the technology's capabilities related to industrially accepted materials and processes.

AM/3DP **research** is focused on materials development, design, process monitoring, control, quality assurance, multi-material deposition, and printed electronics. America Makes is producing material and process databases from which engineers and designers can more adequately select to meet product requirements. Advances are being made toward large-scale, reduced-cost metal machines (akin to a polymeric desktop 3D printer, but for metals) and hybrid technology applications.

Some AM/3DP **challenges** include materials, capabilities, processes, and equipment certification and qualification. Having realized value, the AM/3DP industry would benefit from reliable material databases and specifications to further design capabilities; improved CAD tools for capturing designs and generating machine build files; robust processing technologies and methodologies; and increased quality assurance for in-situ and post-processing. Lastly, the industry would benefit from the integration of AM with traditional processing methods (e.g. hybrid technologies) to yield a more optimal production capability.

This pamphlet, ***Trends in Brief***, is just a glimpse into the information AMT delivers to its members. Comprehensive data on these trends and other advancements in manufacturing technology are featured in AMT's publication ***Tech Trends***.

Offering a thorough review for strategic planning in manufacturing technology, ***Tech Trends*** documents changes occurring in manufacturing and R&D that could affect the future direction of the manufacturing industry's capabilities – an important factor in maintaining and growing our global competitiveness in addition to our economic health. By Reading ***Tech Trends***, industry leaders will gain insight into future customers, suppliers, equipment, business models, and business practices for the advanced manufacturing industry.

To learn more about how AMT's research can leverage your business, visit:

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