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ARTICLE FEATURED ON:
INNOVATIE NU | DECEMBER 2020

ADVANCED MANUFACTURING

EMPOWERING EUROPE

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> *The EU and its industries have strongly embraced advanced manufacturing in recent years. We are seeing manufacturers of all sizes find value in new technology across industrial sectors. However, many are unaware of new technologies around the corner that can add value to their operations.*

Looking at advanced manufacturing, we observe significant differences in policy and practice when comparing Europe to the rest of the world. American government policy and political climate have taken an introspective and capitalist route in recent years. However, USA is still regarded by many as leading advanced manufacturing innovation. Research institutes, government organisations and private sectors have invested heavily in related technologies, especially in aerospace and defence.

In Asia we see China, Japan, South Korea and Singapore focusing on advanced manufacturing. Japan are world leaders in industrial robotics and automation, driven from an active automotive sector. Nissan Motors recently announced US$300 million on next generation electric vehicles. South Korea are known for high quality machine tool production and rank highly uptake of industrial additive manufacturing. China, the world's largest manufacturing economy, are currently phasing in their 'Advanced Manufacturing Industry Fund'.

Europe leads as the most advanced sector supporting the consumer industry. Also, Europe is clearly demonstrating great social responsibility in environmental consciousness through policy decisions and focused initiatives on circular economy. One should see Europe as a benchmark for other regions to hopefully aspire to in this respect.

A typical European initiative is the EU Taskforce for Advanced Manufacturing, coordinating efforts towards a competitive manufacturing industry through three main objectives:

- Accelerating dissemination and

commercialisation of advanced manufacturing technologies
- Boosting demand for advanced manufacturing technologies
- Reducing skills shortages and competence deficits

Another driver is the Green Deal for Europe, working to reduce carbon emissions to zero by 2050. This sees manufacturers taking a close look at energy consumption and emissions. Opportunities exist through supply of renewable products and services such as electric vehicles, energy generation and more sustainable production machinery.

6 Major Predictions in Advanced Manufacturing

For those looking at implementing new technologies into their existing workflows or processes, the wealth of information can be overwhelming. However, here are 6 major predictions and trends that we may expect to see in the near future.

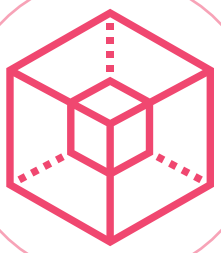
The growth of Additive Manufacturing

In the early days of additive manufacturing, people were sceptical of use in wider industry for applications like direct manufacturing. The most common concerns were that technologies were not fast, accurate or cheap enough to be of use in how we currently make products. The more commonly hyped applications in the early days were rapid prototyping of end use parts or niche gimmicks. Recent examples are much more compelling and convincing. As more individuals, firms and industries adopt such technologies we can expect to see accelerated acceptance.

A recent industry sentiment index published by 3D printer manufacturer Ultimaker paints an interesting picture of the current situation. They interviewed over 2000 industry professionals from 8 countries around the world. A few key statistics from the survey included are depicted in the next figure.

67% of respondents were aware of 3D printing

35% adoption rate with printers used in the respondents' business



APPLICATIONS
- prototyping
- production tooling
- end-use parts

The technology readiness of additive technologies has leapt forward in the past 10 years.

Developments in equipment and materials are pushing towards wider utilisation. In the last few years, we have seen significant upscaling into large volume production. Manufacturers in Europe now have access to:

Continuously expanding material options

The days of printing with a limited selection of materials such as ABS and PLA are long gone. Modern advances provide materials such as carbon filled polymers using continuous strands or as a bulking material. There is an increasing variety of functional engineering materials with excellent strength and durability.

Advanced manufacturing is enabling cleaner energy uptake in new ways. Such as the rapidly deployed 14.5MW Sekdoorn floating solar project in the Netherlands.

Commercially suitable solutions for SMEs

Early small business adopters with limited resources had no choice but to use hobbyist level machines and push them to their limits. Such equipment lacked the capacity, functionality and reliability needed for commercial applications. Now a huge range of technologies are affordable and accessible to smaller businesses.

Large format metal printing

Metal powder bed fusion systems are becoming more commonplace with larger bed sizes, faster and higher quality processing as well as continuous material feeds. This is allowing for higher part per print cycles with lower costs driving into new downstream applications and sectors.

Additive Manufacturing as a service

Often people dismiss additive manufacturing as too expensive when looking at the capital investment costs. This is where Europe's digital innovation hubs come into play. These hubs act as incubators of knowledge, services and networks allowing businesses

to find value and take first steps in additive manufacturing.

Implementing AM into the whole manufacturing process. A seemingly missing link:

The most important aspect to integrating additive technologies is a need to rethink process chains. We cannot continue to use design processes, behaviours and ideologies that matured through subtractive manufacturing and mass production. Mass customisation and leveraging on the benefits of additive are something more available and scalable. Product designers have only just begun to understand and explore this new arena of manufacturing.

Industry 4.0

Industry 4.0 in manufacturing is seeing the transformation towards interconnected cyber-physical systems across varying scales. Digital communication and the ever expanding 'internet of things' (IOT) are changing the way we do business. Some of the opportunities are reduced labour costs and increased operational efficiency by eliminating wasted effort and resources.

Digitally connected hardware such as conveyer belt systems, automated machinery and smart logistics can all be used to create a full feedback loop of data. Such data can be used to push and pull manufacturing operations in sync with live market demand or more accurate forecasts.

However, the technologies driving competitive advantage in manufacturing reach far beyond the factory walls. They are enabling truly smart systems where almost every piece of information can be processed and tracked within a business's product ecosystem. We can see stock count in receptacles automatically calling up replenishment purchase orders from dynamic supply chains. Storage conditions such as temperature and humidity can be transmitted and accessed by staff in real time, even when in transit, sending automated alerts when unsatisfactory conditions are logged. Interconnected network sensors can control the storage environment by triggering a change in the facility HVAC or prompting the use of sensitive materials approaching their optimum use date.

Simply implementing plug and play solutions into existing processes and operations likely won't see the best value-add to a system. One key consideration for those trying to embrace these new technologies is to rethink and redesign workflows and processes. It is pivotal to firstly identify value in a technology offering, before applications move towards gaining competitive advantage.

Complex Supply Chains

Advanced manufacturing is completely reshaping supply chains. The global economy relies on extremely complex networks of parts and material distribution. Industry 4.0 is the main driver of change in supply chain management, connecting manufacturers with suppliers.

The need for better supply chain management has become all too obvious due to the COVID-19 pandemic, making the world acutely aware of how vulnerable we are to severe disruption when supply can't meet demand. Smart database technologies can be used to setup supply solutions that are automatically reactive to disruption and fluctuation.

Smart manufacturing enabled by Industry 4.0 technologies can reach another level when embedded sensors can begin to automatically identify machine wear or prevent failure. An alert and supply event can begin in real time with information being sent along the supply chain instantly. The cost and time savings in maintenance alone are enormous when a machine can speak and communicate via virtually connected embedded sensors.

With additive technologies, we see firms and suppliers changing the way spare parts are delivered. Metal printing technologies can provide fully functional machine parts to be rapidly manufactured on-demand, eliminating the need for maintenance and

Comparative testing of different metal Additive Manufacturing Technologies and materials for a bike pedal arm.

service part storage. We predict companies will be taking a closer look at the necessity of keeping warehouses full of part stocks given the on-demand manufacturing and procurement technology that is becoming readily available. Smart manufacturing enabled by Industry 4.0 technologies can reach another level when embedded sensors can begin to automatically identify machine wear or prevent failure. An alert and supply event can begin in real time with information being sent along the supply chain instantly. The cost and time savings in maintenance alone are enormous when a machine can speak and communicate via virtually connected embedded sensors. With additive technologies, we see firms and suppliers changing the way spare parts are delivered. Metal printing technologies can provide fully functional machine parts to be rapidly manufactured on-demand, eliminating the need for maintenance and service part storage. We predict companies will be taking a closer look at the necessity of keeping warehouses full of part stocks given the on-demand manufacturing and procurement technology that is becoming readily available.

Technology Convergence

Innovation in manufacturing technology has accelerated over the last few decades. Technology convergence in this sector is bringing many new challenges and opportunities to explore where we see an interchange and blurring of boundaries between previously discrete entities.

On the digital front of modern manufacturing it is predicted that we will see artificial intelligence and IoT becoming commonplace. A growing number of machines will pass assessments like the Turing test to be considered as truly intelligent.
The new wave of technology is extending beyond what many consider traditional manufacturing. We are starting to see vastly different industry sectors such as medical, nano-technology, energy, food and consumer goods applying and developing technology at similar maturities and scale. With similar technologies being implemented across diverse applications, we see new opportunities through cross-sector collaboration. Companies and research institutes are now sharing development opportunities and problem solutions, crossing boundaries and rapidly diffusing the uptake of and advancement of manufacturing technology.

Furthermore, technologies are becoming more accessible. As well as becoming more affordable, they are easier to find, use and implement. All this further fuels the development process.

Climate Change and the Environment

Climate change, the natural environment and the future state of the earth are all becoming increasingly important focal points for consumers voices, business strategy and EU policy making. Consumers and businesses

NESTING OF LARGE FORMAT 3D PRINTERS SUCH AS THE SLM800 ARE DRIVING CHANGE. CAPABLE OF PRODUCING PARTS SUCH AS FUNCTIONAL TURBINE COMPONENTS AND ROCKET ENGINE COMPONENTS.

are talking with their conscience and wealth, increasingly supporting those that operate in a sustainable and responsible manner. Advanced manufacturing will have increased impact on the way we produce products into the future, enabling companies to operate in a more environmentally responsible manner.

The way we generate and utilise our energy is trending towards zero emissions. Europe leads the world in clean energy production, but advanced manufacturing is taking this even further. Technology is allowing energy generation to become decentralised. Companies can run micro-grids to harvest their own clean energy in ways beyond the installation of a few solar panels on a roof.

Healthcare and a Growing Population

The healthcare industry has seen tremendous positive change as a direct result of advanced manufacturing technologies. Additive manufacturing allows implants to be customised to an individual patient. Biometric data from MRI and CT scans can be used to create highly accurate and digital computer models of body parts, changing the game for medical implants and prosthetics of all kinds. A patient can now have a titanium or stainless-steel implement designed and printed to replace the removed bone with a perfectly fitting interface. Advances also give surgeons vital insights into human anatomy. The ability to digitally reproduce organs and complex anatomies gives opportunity for exploration and learnings before a patient is in an operating theatre; a step above even the best medical imagery. Surgeons in training can also take advantage of this technology with the use of biometrically enhanced training devices.

At a larger scale, advanced technologies are assisting in the management of a growing population, especially in caring for the elderly. Technology convergence and IoT enabled devices are seeing a boom as assistive technologies. There are a growing number of affordable assistive devices that are enabling better care and quality of life for the elderly and disabled sectors of the population.

In Conclusion

Europe is leading the world in many aspects of advanced manufacturing. Whilst technology can and is being developed all over the world, Europe leads in terms of smart and sustainable application. Of course we all have to improve upon this, as well battle against social, economic and political pressures that potentially prevent us from travelling in the right direction. Manufacturing is a huge user of energy and other resources that need to be used efficiently and wisely. Advanced manufacturing technologies can help in this, but the choice of their use is still a human one.

ADVANCED MANUFACTURING CENTER

At the **Advanced Manufacturing Center (AMC),** the Fraunhofer Project Center at the University of Twente, we can help guide manufacturing industry through the tough choices mentioned above. With the exceptional knowledge and experience of key experts from the University of Twente, Fraunhofer Project Center spearheads applications research, demonstrators and knowledge transfer through the AMC.

The AMC is an open innovation hub for companies interested in the latest manufacturing technology and techniques, developing pathways towards smarter industry.

Furthermore, via the Fraunhofer network in Germany, we are able to extend a wealth of knowledge and expertise to the industrial community in Twente and the rest of the Netherlands. We do this in cooperation with our German partner Fraunhofer Institute for Production Technologies (IPT). To strengthen that community, we are focusing on further expansion of the AMC as an open innovation center.

Collaboration between companies, knowledge institutions, FPC and its AMC will bring us **the first international centre for advanced production in the Netherlands.**