INNOVATIE NU

December 2020
01

EMPOWERING MANUFACTURING

ADVANCED MANUFACTURING CENTER

A MESSAGE FROM THE EDITORS

We would like to acknowledge and thank the support from the following organisations:

provincie overijssel

regio Twente

Twente

GIJS BEUMKES

Research Engineer
Fraunhofer Project Center
at the University of Twente

In our everyday lives we are surrounded by technology. The presence of smart devices and digital transformation is pushing to make it simpler and easier. However many industries are still lacking the digital trend, especially manufacturing industries. Many are still severely lagging behind with their obsolete fix-it-when-broken policy. The biggest risk of under-rating innovative technologies is the potential to continuously lag behind that may eventually lead to replacement by other businesses.

Entrepreneuring technologies will benefit manufacturing industry from shop floor to top floor to allow them make more accurate decisions. Empowered by leading edge engineering, the manufacturing sector can be the biggest beneficiary of the digital transformation. By accepting these changes and evolving alongside such innovations, enhanced production can be realized. With the primary purpose to reduce dependence on human expertise and simultaneously enhance the quality of the human interaction. It is a misunderstanding that technological change will initiate job instability. On the contrary, the harmony between humans and technology can be elevated. Instead of being replaced, it should be seen as an association between humans and digital transformation that will help the organization to stay on high productivity.

Through the creation of a complete understanding of the values of digital transformation, business can challenge employees with a positive technological optic and leverage the information to their benefits. So discover how your organization can foster an environment in which growth is enabled and a competitive edge is maintained through the implementation of digital transformation in this first issue of InnovatieNU.

IAN GIBSON

Chair Professor of
Industrial Engineering (UT) &
Scientific Director
Fraunhofer Project Center
at the University of Twente

I don't believe in industrial revolutions. To me, there never was a single point in time suddenly something we refer to as "industry" came into view when before there was nothing. According to Wikipedia and contrary to popular opinion, my fellow Scotsman James Watt did not invent the steam engine. Rather he made improvements to the Newcomen engine, which was fundamental to the changes brought by the industrial revolution. But - when exactly did the industrial revolution start, and who started it?

Supposedly, the second industrial revolution was based around the switch from steam power to electric, driving the steel and automotive industries with standardised manufacturing and production lines. Vehicle assembly at Ford was a typical exemplar, but just as Watt didn't start the first industrial revolution, Henry Ford didn't start the second. William Shockley didn't start the third industrial revolution by inventing the transistor and Alan Turing didn't start the fourth through his advances in computer science and foreseeing artificial intelligence.

When does one era end and another begin? Things are not so obvious or well-defined. One can only look back in time and see when trends occurred. With the benefit of hindsight we can say that a transition took place. To me that is an evolutionary process and not a revolutionary one.

Will there ever be a 5th industrial revolution? If so, what will drive it and when will it happen? I wonder whether it will ever be because if we take Industry 4.0 to its logical conclusion, maybe we will see the demise of industry; that manufacturing will be more an organic or fully integrated process that is indistinguishable from other aspects of everyday life. The only thing for sure is that from a technologists perspective, we live in exciting times and the best is yet to come.

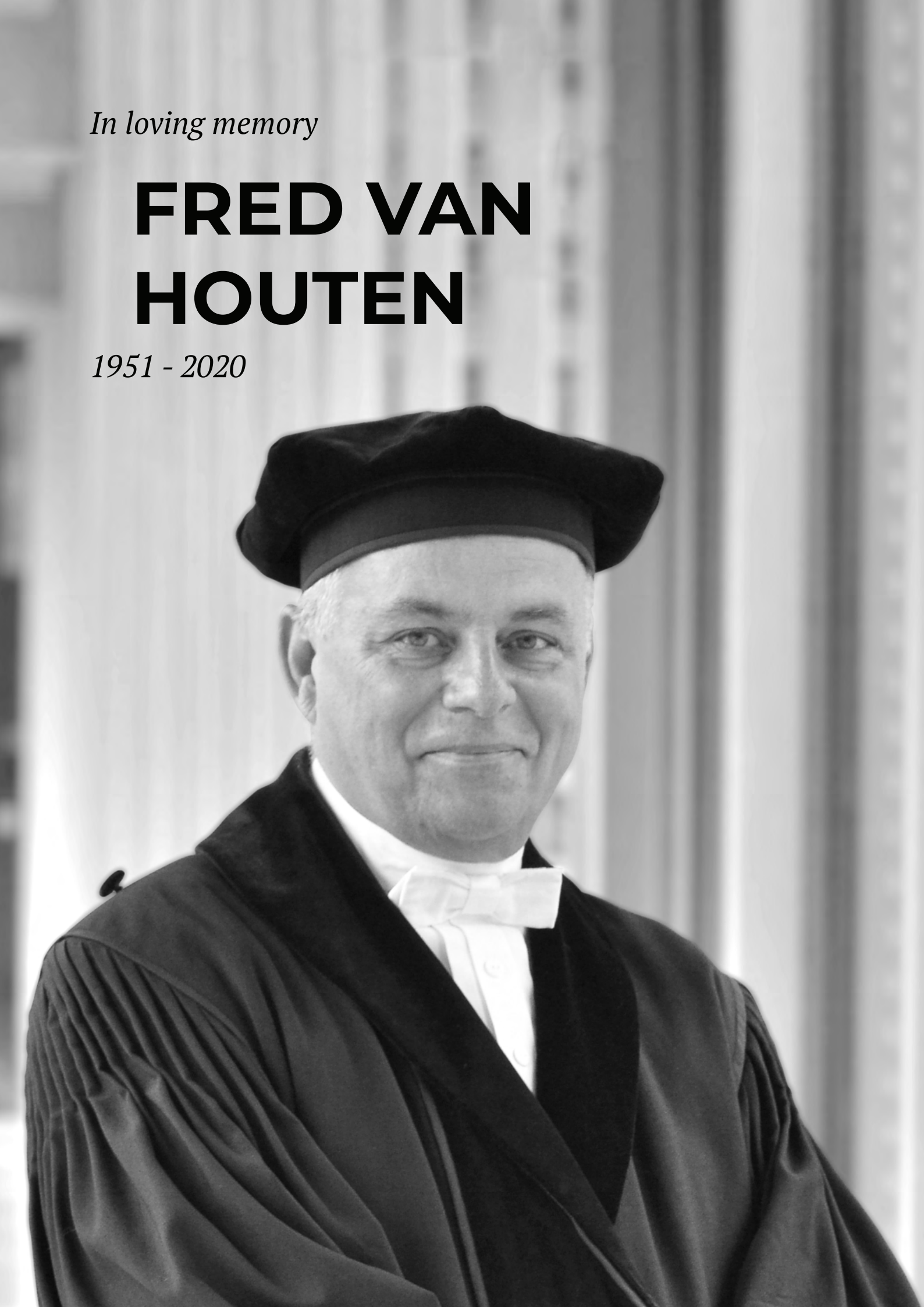
Innovatie Nu is the magazine of the Fraunhofer Project Centre and its Advanced Manufacturing Centre. We bring you new insights and perspectives based on activities feeding through our doors on topics relating to advanced manufacturing. We hope that they intrigue you enough to want to travel the next steps of industry 4.0 along with us.

Sadly, one person not joining this journey with us will be my predecessor, Prof. Fred van Houten, who passed away recently to join the other greats in manufacturing. Rest in peace Fred.

In loving memory

FRED VAN HOUTEN

1951 - 2020



A MAN OF PRINCIPLE

Throughout his career, Fred was a creative and innovative man, laying the foundations for a number of ground-breaking projects in the field of Manufacturing Engineering. His ardent support of this industry, from within the University and further afield in surrounding regions, ensured that manufacturing flourished in his home province of Overijssel. He advised industry leaders, helping them develop new technologies and facilitated the placement of his highly skilled and knowledgeable graduates in key roles within the industry.

Fred believed that engineering needed to be enterprising and socially relevant and to this day, these fundamental principles remain in place as his legacy at the University of Twente (UT). Even now, his department continues to grow and develop because they maintain adherence to those guiding principles Fred put in place in his early days at the University.

Fred attracted many honours and

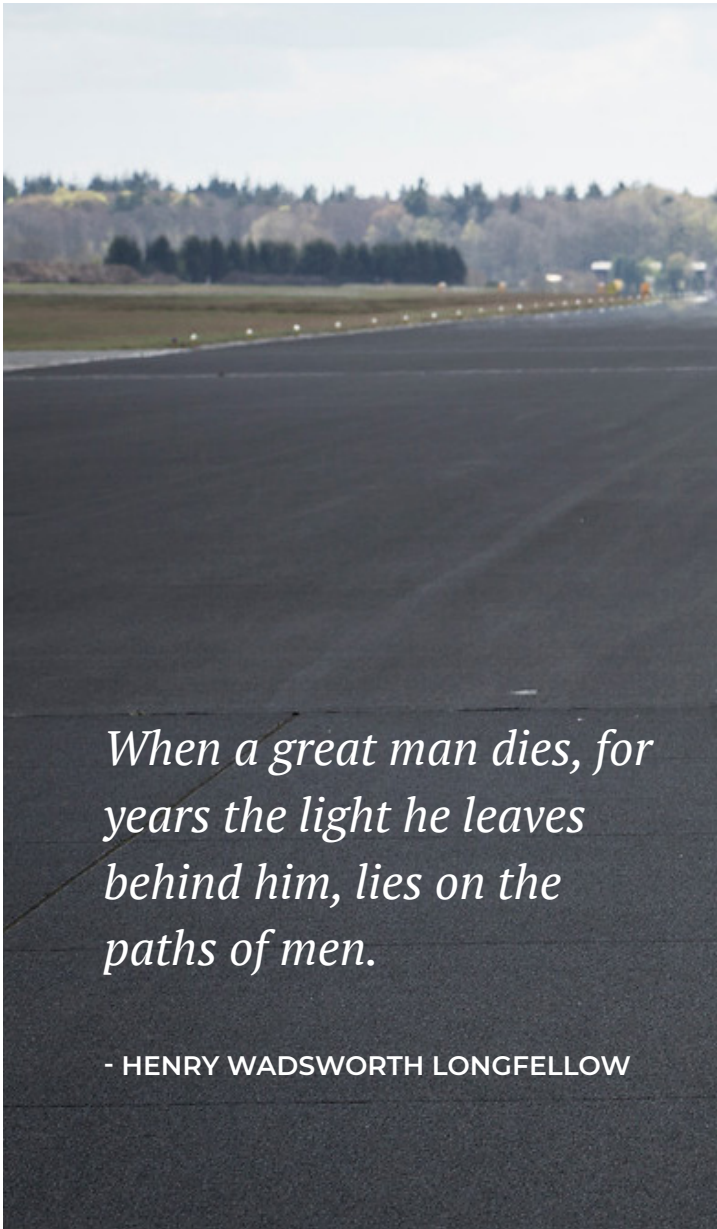
accolades, among them the Presidency of the CIRP, the world leading organisation for production engineering research. He was a UT Faculty Board member for nineteen years and was Department Chair for 15 years. A prodigious networker, Fred's connections to industry giants and scientific innovators ensured that his UT graduates received a warm welcome wherever they went.

Fred was justifiably proud of his achievements, with diplomas, medals and awards lining the walls. The many gadgets and models served as a constant reminder of works in progress and work satisfactorily completed. The quality of the wine bottles in evidence indicated that Fred was a man of discernment and taste.

His office was also a gathering place, where he would always find time to relax and chat with students or colleagues. An opinionated man, he was not one to waste words. He would rather act than sit around talking about acting. Time was precious and multi-tasking came as second nature to Fred. He would consider an evening out to dinner as an opportunity to pick his colleagues brains and share new ideas. The fact that he could also share a good bottle of red was, to him, a bonus.

Professor Fred van Houten was a driving force in the creation of the Fraunhofer Project Center (FPC) at the University of Twente, which he supported from its inception. He worked tirelessly on this project for many years, negotiating with all involved parties until the Center became a reality, opening its doors in 2017. Even though Fred had retired by this time, he remained working as a valued consultant to FPC, his steady hand and profound knowledge of the inner workings of industries help to ensure that FPC would continue to grow and thrive. His dedication to this organisation was unquestionable. Two weeks before his death, Fred was still involved in guiding FPC, continuing to promote the centre to industry leaders and investors.

On his retirement in 2017, Fred van Houten received the Medal of Honour, awarded for his work as Professor of



Design Engineering at the University of Twente. This honour is usually bestowed upon people outside the UT who have made significant contributions to the university. It is a mark of the immense esteem in which Professor van Houten was held that he was recognised in such a manner.

Fred van Houten's greatest contribution was to the people with whom he came in contact. He took a deep interest in the career development of his students, helping to guide them throughout their working lives. He was loved, admired and respected by his colleagues not only as a leading light in his field, but also as a wonderfully erudite man who was passionate about his field of expertise. He touched many lives through his support of the Engineering Industry, including founding this magazine in order to bring knowledge and enthusiasm for engineering to the masses.

He was Coby's loving husband, an outstanding friend to many, a thoughtful, giving mentor and an energetic supporter of brilliant ideas.

Go in peace, dear friend.

FUELLING

THE FUTURE

HOW THE **ADVANCED MANUFACTURING CENTER** WILL DRIVE THE RAPID TRANSFORMATION OF INDUSTRY ACROSS **THE NETHERLANDS**

The need for sustainability and resiliency in manufacturing has never been clearer as massive disruption continues to sweep across the sector. Driven by global economic uncertainty, huge fluctuations in demand, and a rising tide of technological innovation, manufacturing is joining the fourth industrial revolution, and it's poised to change our lives. But achieving growth in a time of rapid and unpredictable change presents a huge challenge, and one that's notoriously difficult for businesses to plan for.

The Advanced Manufacturing Center will help businesses overcome that universal challenge and drive innovation across the industry in the Netherlands and beyond. Set to open its doors in 2022, the open innovation center will combine people, technology, and process to develop the cutting-edge technical knowledge needed to transform manufacturing to create better, smarter, and more sustainable products. Serving as a physical and digital collaboration hub, it will support companies in their missions to digitalise, innovate, and grow. It will become a driving force in the evolution of Manufacturing 4.0.

Driving stronger collaboration with open innovation

Today's manufacturing supply chains are under

To secure the future of manufacturing, we have to secure the workforce by establishing a gateway to education both regionally and globally.

Ian Gibson

Scientific Director
Fraunhofer Project Center
at the University of Twente

In an era of disruptive technologies and constant change, where artificial intelligence is the new normal, the Advanced Manufacturing Center will become a driving force behind the transformation of the manufacturing sector across the Netherlands and beyond.

Dr. Biba Visnjicki

Managing Director
Fraunhofer Project Center
at the University of Twente

Manufacturing means employment, and to secure its future, we need to build a workforce that's educated and skilled in areas like AI and smart automation. These new skills must be in balance, along with gender equality, to become a comfort zone for future generations of engineers.

Dr. Biba Visnjicki

Managing Director
Fraunhofer Project Center
at the University of Twente

enormous strain in the face of a diverse range of threats from global trade wars, the ongoing pandemic, and rapid technological disruption. Due to these factors and others, supply chains are becoming ungovernably large and complex to the point their sustainability and efficiency are being called into question.

There has never been a greater need for interconnectivity across these supply chains. But it's not all about the integration of an increasingly disparate array of computing infrastructures. It's as much about the integration of people and process through strong collaboration and mutual support across the public and private sectors. Simply put, this is the only thing that can sustain success during the uncertainties of the years to come.

The AMC will not be a closed ecosystem, but an open innovation hub to drive digital transition in a world where science becomes business. It will serve as a point for solutions across the manufacturing sector by bringing in experts across a wide range of disciplines from around the world. This will include collaboration with hardware and software solution providers, and introduce a place where SME manufacturing companies, scaleups, and startups can develop, learn, and train.

Rapid growth and open innovation is at the heart of everything the Fraunhofer Project Center stands for. As such, the AMC will be the first of three buildings planned for Kennispark Twente, forming a major high-tech cluster to support the region.

Raising recognition for the Dutch manufacturing sector

With the exceptional knowledge and experience of key experts at the University of Twente, the Fraunhofer Project Center will be able to use the AMC as a conduit for knowledge transfer, open innovation, and applications research. This will allow the center to liaise with businesses in the manufacturing sector across the Europe to develop pathways toward smarter industry.

The AMC will drive greater recognition for manufacturing firms in the region by providing the resources necessary to innovate at scale across Europe. Moreover, with the assistance of the Fraunhofer Institute for Production Technologies (Fraunhofer IPT) in Germany, it will be well-positioned to further expand as an open innovation center with international recognition. Ultimately, the AMC will bring us the first international center for advanced production in the Netherlands.

Building a bridge between education and Manufacturing 4.0

It's often claimed that technological development will claim more jobs than it creates. In reality, the opposite is true. In many sectors, especially manufacturing, education has been unable to keep up with the rapid evolution of technology. Manufacturers across Europe are struggling to fill job vacancies that require unique skill sets that were simply unheard of just a decade ago. Employers are now casting a wary eye on the future in a time when it's near impossible to tell what that future may bring.

The lack of a suitably skilled workforce is now seen as one of the biggest challenges leading up to the fourth industrial revolution. But where there's a dearth of important skills, there are also opportunities – a chance to innovate, re-skill, and prepare for the many unknowns that the future holds. As has always been the case, manufacturing means employment, and innovation throughout the sector will continue to open up more job opportunities for those skilled in new and emerging areas like smart automation and artificial intelligence.

That is the vision of the Advanced Manufacturing Center, which will integrate education and manufacturing. The coming generations of

engineers will depend on our open innovation center, and others like it, for developing the new skills and capabilities needed to propel the rise and success of Industry 4.0. It will achieve this through development programs that combine physical, hands-on learning experiences with the scalability of online learning. All the while, it will strive to resolve the gender imbalance across the sector and mitigate the various other adverse societal and economic effects of this constantly changing environment.

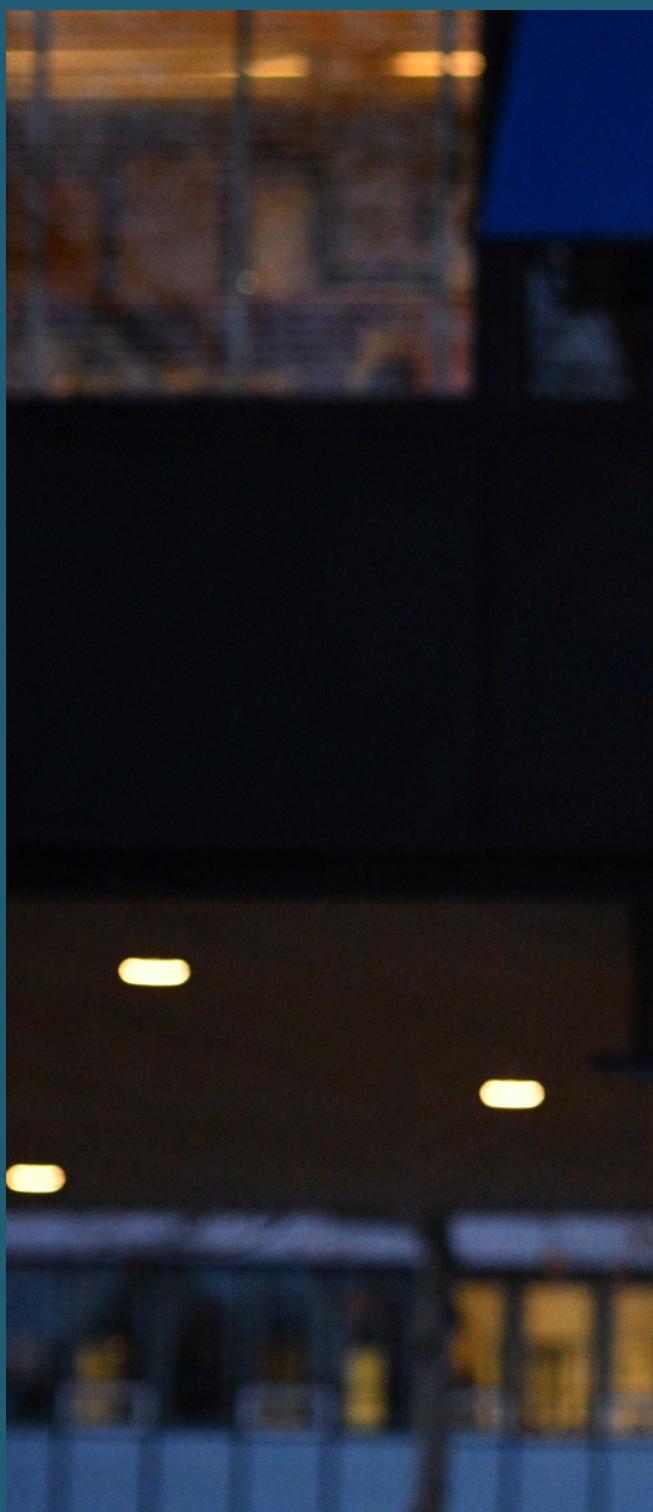
Our mission is to help guide the manufacturing sector through the tough choices to come using a combination of expert knowledge and cutting-edge technology. In doing so, it will encourage life-long learning by doing.

Powering digital growth with emerging technologies in Manufacturing 4.0

Digital technologies have advanced at a pace many SMEs have struggled to keep up with. Concerns around things like information security, reliability, and the skill-sets required to deploy and maintain these systems have long been barriers in the way of innovation. Disruptive new and emerging solutions like artificial intelligence, autonomous robotics, augmented reality, and the Internet of Things present new risks and opportunities alike, especially in times when the future of many firms is facing the heavy burden of economic uncertainty.

Above all, the future of manufacturing will revolve around artificial intelligence which, in turn, will give rise to highly advanced cyber-physical systems and a new era of automation. AI is undoubtedly the new normal, and the key driver of the fourth industrial revolution. Thanks to AI-driven automation and insights, we will be able to power sustainable and extremely reliable industrial control systems, and automate entire production lines. This will ultimately allow us to build better products and optimized processes that increase efficiency and safeguard our supply chains. We'll be able to put real-time insights to work, develop cloud solutions for the seamless integration of data and collaboration, and rapidly scale and adapt to the changing needs of businesses and their customers.

The AMC's mission is to enable the fast transition toward the digitization of manufacturing by breaking down the barriers to innovation with knowledge, education, and collaboration. This synthesis will bring together machine builders, producers, engineers, and product developers under the umbrella of a universal approach to digital transformation.



We must develop a global consensus on how new technologies, such as artificial intelligence and additive manufacturing can enable rapid digitisation

Ian Gibson

Scientific Director
Fraunhofer Project Center
at the University of Twente

ADVANCED MANUFACTURING

EMPOWERING EUROPE

Author:

Ian Gibson
Scientific Director
Fraunhofer Project Center
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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.

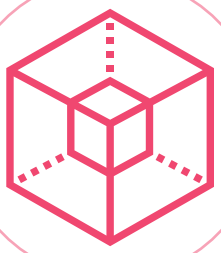
The growth of Additive Manufacturing

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.**

WHAT POST-CRISIS MANUFACTURING WILL LOOK LIKE

Author:

Dr. Biba Visnjicki

Managing Director
Fraunhofer Project Center
at the University of Twente

How short-term measures taken in response to the global pandemic will lead to the long-term transformation of the manufacturing sector. If history has taught us anything, it's that solutions adopted in response to global crises tend to result in long-term change. The transformation of the manufacturing sector was already well under way before the pandemic. Now the adoption of new technologies is diverging between those which will thrive after the pandemic, and those which won't.

The pandemic hit manufacturers in an unprecedented way. Stay-at-home mandates suddenly forced factories to send everyone home who could do their jobs from home, and global supply chains continue to see enormous disruption due to travel bans and other restrictions. While we're all hoping things will go back to normal sooner rather than later, there are some things that will never be the same. And that's not necessarily a bad thing.

It's time for manufacturers to embrace the fourth industrial revolution. The pandemic has made that need clearer than ever. Manufacturers need to look beyond today's uncertain climate and prepare for long-term changes across the industry. The trends we explore below were well-established some time ago, but now it's time to accelerate their adoption.

Normalisation of remote work and collaboration

With the exception of lights-out manufacturing facilities, shop floors still require employees to be physically on-site. However, social distancing measures have forced many plants to reduce the size of their on-site teams, retaining only a skeleton crew to operate, maintain, and repair machines.

Of course, many manufacturers are still a long way from adopting a lights-out methodology, but that doesn't mean they can't benefit from adopting a long-term remote work environment. For example, manufacturers with large customer service departments might consider shifting to permanent remote work empowered by digital communication and collaboration platforms. The same applies to a myriad of other office roles, such as those in finance, administration, marketing, or supply chain management.

The reduction in workers on the shop floor has also highlighted the value of remote diagnostic and management tools. Thanks to internet-connected industrial control systems, it's possible to integrate real-time data collection and AI-driven insights into cloud collaboration platforms. Specialists can even control certain operations on the shop floor remotely. Remote work isn't just for back-office roles anymore. It's also a new reality that will fundamentally transform manufacturing.

Rethinking manufacturing supply chains

Supply chains continue to face enormous stress, not just because of COVID-19, but also due to the looming possibility of a global trade war. Furthermore, pandemic-induced recession has forced many suppliers out of business and will continue to do so. Manufacturers, particularly those with complex global supply chains, are now focusing on ensuring continuity throughout the crisis. However, it's also important to think beyond.

For too long has manufacturing been focused on obtaining supplies at the lowest possible price. The pandemic, compounded by political tensions and rising environmental concerns, has revealed the fundamental flaws in that model. Today, consumers are increasingly wary of what they buy, including how and where it was made. Price is no longer the main purchase driver for many people. These factors continue to drive a steady shift from globalisation to regionalisation.

As part of a long-term response to the aftereffects of the pandemic, governments are likely to promote domestic manufacturing as part of their plans to increase resilience of manufacturing sectors considered critical for national sustainability. Some governments are already offering incentives to firms to bring their manufacturing back home. Even those which don't operate in sectors deemed essential, pressure to turn towards domestic suppliers will likely continue to grow.

Development of automation technologies

The consumer market has been taking advantage of cheap everyday goods for years thanks to these global supply chains, but the revival of domestic manufacturing doesn't have to mean dramatic price increases. Thankfully,

advances in technology mean it's possible to replace the race-to-the-bottom low-skilled labour costs with automation and machine learning. In fact, this should create many new job opportunities for skilled workers.

The human factor will always remain a core element of manufacturing operations. Automation replaces many low-skilled job roles, and it will continue to do so. At the same time, it leads to an increased need for digitally savvy workers. Manufacturers should focus on reskilling their workforces to prepare for these changes. Following Toyota's principle of 'automation', 10 to 20% of the manufacturing process should be addressed by human expertise, while the rest is automated.

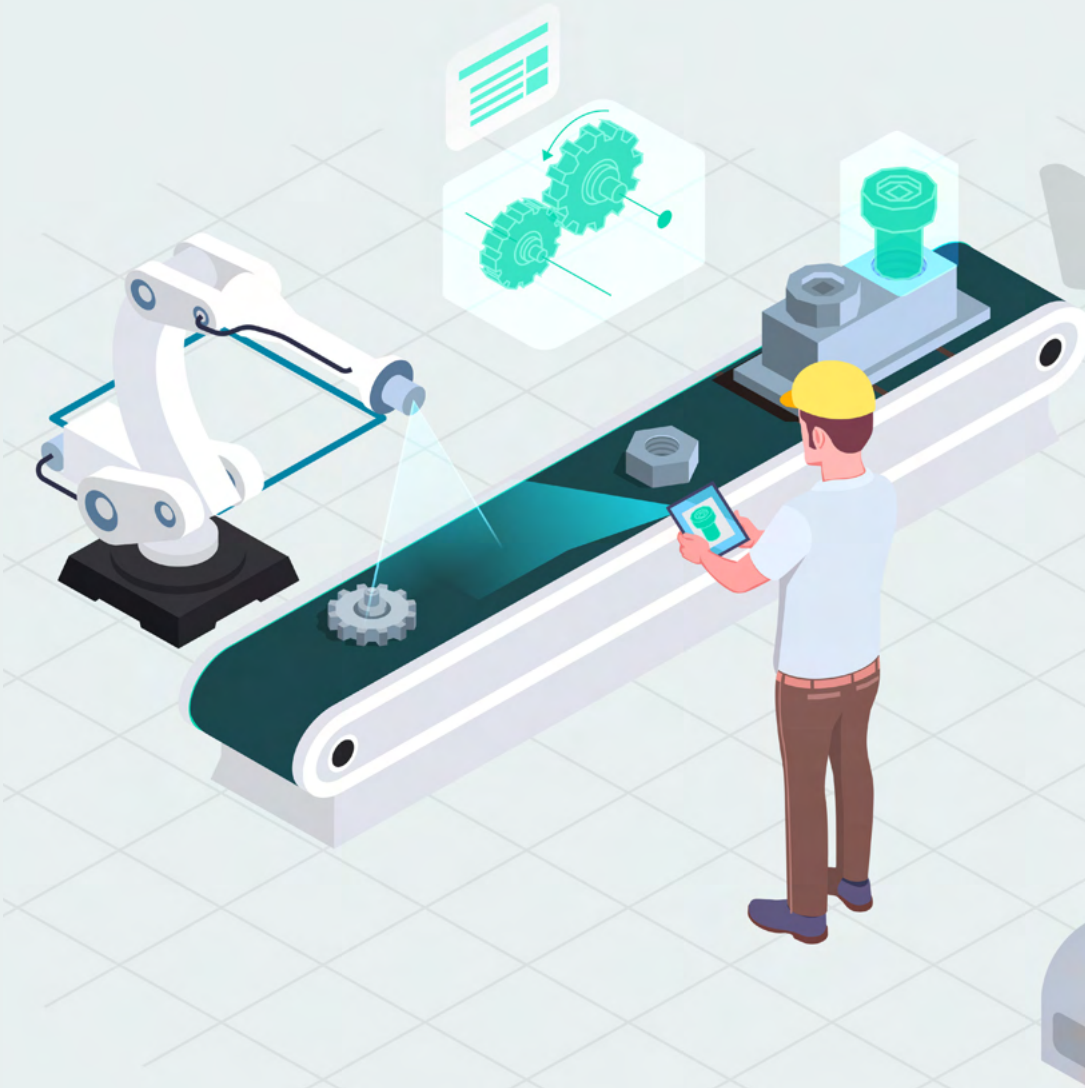
COVID-19 is already sparking a new wave of automation and robotics on the shop floor. These systems augment the capabilities of human teams, and many can be managed remotely. Once the crisis is over, manufacturers may experience dramatic and often unpredictable fluctuations in demand, with packaging and logistics requirements liable to change at a moment's notice. Automation can help respond to these needs quickly, efficiently, and with little or no additional cost. Not only does this keep disruption to a minimum – it also gives manufacturers the chance to capitalise on opportunities which they might otherwise have missed.

Final words

Flexible manufacturing won't just support the industry's recovery from COVID-19 – it will help firms prepare themselves for an uncertain future ahead. The rapid deployment of adaptable manufacturing processes brings many benefits which will be realised for many years to come:

- Improved manufacturing efficiency
- Enhanced workforce productivity and morale
- Decreased operational and business risk
- Reduced waste and environmental impact
- Better worker health and safety

Crises have always driven innovation across the manufacturing sector, and today's pandemic is no exception. While the hardships wreaked by COVID-19 are undeniable, it's also a tragedy that highlights the opportunity for people and machines to work better and innovate together.



SEE AND BE SEEN

BUILD A COMPELLING **ONLINE PRESENCE**

The world of buying and selling has changed, and even traditional industries cannot escape the radical transformation of the global market. The need for innovation as a way to preserve and add value is now greater than ever.

The manufacturing sector invests less than 2% of its revenue in IT initiatives. That's far below the 3.28% average across all industries. Despite that, investment in new technologies, such as robotic process automation and predictive maintenance, continues to grow across the manufacturing sector.

Marketing, however, has long taken a backseat. Many manufacturers still don't recognise the value in modern, technology-driven marketing. Instead, they rely heavily on direct distribution and dealer contracts for growth. For most of them, marketing doesn't extend beyond attending trade shows, maintaining their websites, or publishing the occasional brochure or whitepaper.

Digital marketing is where the real power lies. It is data-driven, and it has a potentially limitless reach across channels like email, social media, and pay-per-click (PPC) advertising.

Digital campaigns can also be carried out at massive scale thanks to newer innovations like automation and artificial intelligence.

Why do manufacturers need digital marketing? Yet digital marketing can also serve as a valuable strategic tool for empowering manufacturing change. With a scalable and strategic marketing effort, manufacturers can:

Increase brand awareness beyond their regular distribution chains

Reduce customer churn with personalised customer success and service

Demonstrate their capabilities in front of a wider audience

Identify new market opportunities with constant feedback loops

Nurture incoming leads with data-driven insights

These are just a few of the ways a comprehensive digital strategy spanning sales, marketing, and customer service can drive growth in manufacturing. Instead of making decisions based on what they think will work for their leads and customers, manufacturers can make informed decisions based on the wealth of data-driven insights available to them.

To make it happen, manufacturers first need to overcome the widespread misconception that, if they build something, customers will come. Of course, product innovation remains squarely at the heart of everything a manufacturing company does, but that doesn't mean marketing shouldn't be an integral part of that innovation process. Here are three things marketing teams in manufacturing companies should be able to do:

Growing customers with business intelligence

Combined with the efforts and responsibilities of sales and customer service teams, marketers have two key goals – acquire new customers and grow existing ones. Business intelligence solutions use AI-driven analytics to deliver crucial insights into customer behaviour and identify new sales opportunities. Business intelligence can help seek out the most promising leads, identify customers who are at risk of defecting to a competitor and find opportunities to up-sell or cross-sell to existing clients. BI makes it possible to achieve these things at massive scale too.

Establishing a competitive advantage

Clients and distributors demand greater efficiency and productivity. Price alone is no longer a strong enough competitive advantage, hence the need for manufacturers to differentiate their offer using modern, digitally-driven experiences. To fill unserved or underserved gaps in the market, manufacturers need to think about ways they can set themselves apart from their less innovative competitors. Some examples include speed order processing via digital platforms incorporating digital signatures and contracts or, for marketing, launching digital showrooms and using new techs like virtual and augmented reality to bring new products to life.

Personalising the customer experience

Manufacturers traditionally build their brands based on products, but digital marketing is more about emotions. Instead of producing products for a largely anonymous market, manufacturing firms should focus on learning about their customers and implementing personalised customer experiences with the help of an optimal combination of data-driven automation and direct human involvement. By getting to know their customers, manufacturers can tap into their needs and desires and leverage those insights into product innovation.

Final words

Digital transformation is the key to success and growth in the manufacturing sector, and it's not all about product innovation either. By bringing together sales, marketing, and customer service under an organisation-wide digital strategy, manufacturers can fuel product innovation, enable continuous improvement, and grow their customers at the same time.

Author:

Azlina Azman

Head of Communications
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3D2SKY

DRIVING QUALITY AND COST EFFICIENCY FOR THE AEROSPACE INDUSTRY

The aerospace industry has applied additive manufacturing (AM) to alleviate supply chain constraints from traditional manufacturing processes such as casting. AERONAMIC's major customers are taking major steps towards developing processes and products around AM. AERONAMIC chose Fraunhofer Project Center at the University of Twente (FPC@UT) as a technology partner in a project aimed at the acquisition of knowledge and expertise using AM.

1.5x
increased productivity

1%
porosity reduction

The aerospace industry has applied additive manufacturing (AM) to alleviate supply chain constraints from traditional manufacturing processes such as castings. An example is **AERONAMIC**, whose business is the design, production, testing and repair & overhaul of highly complex turbo machinery, motor driven systems and critical high-precision components for both commercial and defense industries. The customers of AERONAMIC are taking major steps towards developing processes and products around AM. To develop these competences, AERONAMIC chose the Fraunhofer Project Center at the University of Twente as a technology partner to gain direct access to the Fraunhofer network of knowledge in the development of processes in AM. The results of the collaboration have been encouraging with AERONAMIC recording 1.5X increased productivity, reduced material wastage and reduced porosity below 1%.

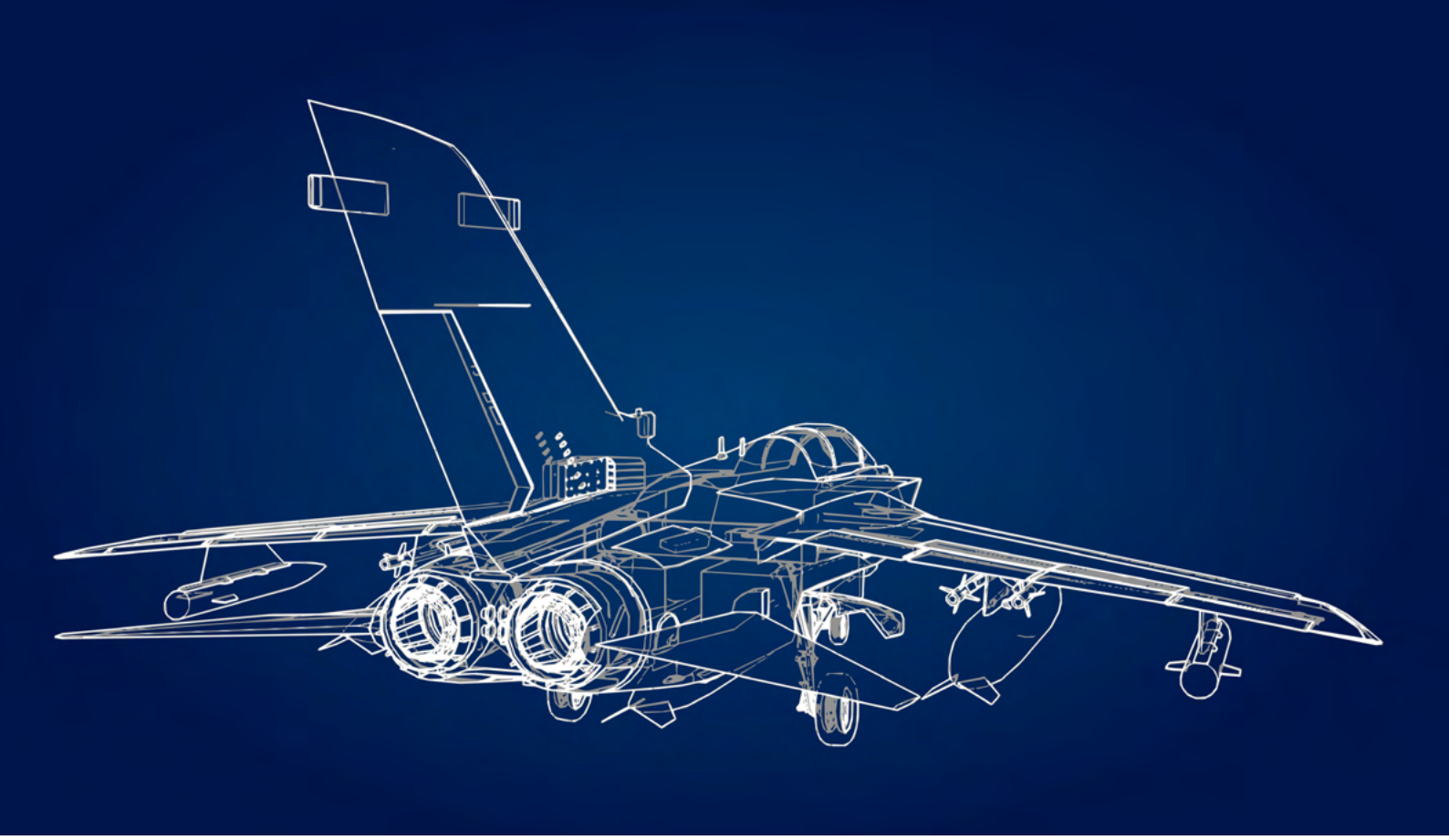
Additive manufacturing (AM) technology is on the verge of a breakthrough for many users who are considering its application in their supply chain strategy.

It is defined as the process of producing parts through the deposition of material in a layer-by-layer fashion. If businesses are to use AM, they have two alternatives. The first option is to acquire AM service providers supply parts, which they can then handle in a similar way to how they have always dealt with castings. The second option is to integrate AM knowledge and application in-house. For AERONAMIC the latter is the right path to take since it brings increased added value and provides best value to customers. Through its knowledge partner, direct transfer of advanced manufacturing knowledge into industrial practices is obtained.

AERONAMIC performs a variety of machining tasks and processes on castings that come from outside suppliers. These castings are normally of a high standard but there are chances of casting pores occurring in regions that are only unveiled after numerous machining tasks. Also, before the COVID-19 pandemic, foundries had significant challenges to keep up with increasing demand. Therefore, they wanted a solution that would reduce the reliance on an outside supplier at a critical stage of their supply chain.

"The global aviation industry is permanently searching for new production technology for the manufacture of complex components. The developed capabilities through Fraunhofer collaboration will help AERONAMIC in developing more advanced, capable, and complex aircraft that can successfully compete in the market."

Steffen de Vries
CEO
Aeronamic B.V.



Furthermore, they wanted to be in better control of the quality of the near-net shape of the part to be machined.

This became an ideal opportunity for them to explore the use of AM to replace the casting process.

At the same time, it was understood that the real benefit of additive manufacturing lies in (re)designing for AM. AERONAMIC closely worked with the Fraunhofer Project Center to develop significant in-house knowledge of AM that would allow them to prepare for future possibilities. FPC@UT was engaged to further develop the process for product optimization to gain cost efficiencies without compromising quality. A series of procedures and tests were carried out to define new parameters to obtain the best and most consistent quality. Aeronamic had already selected the machine by itself, AERONAMIC opted for an **EOS M290 machine running Inconel 718** with possible expansion to more (multi-laser) machines and other materials. In this particular case, it is interesting to note that the functionality of the part designs was not changed in any way. Fraunhofer helped Aeronamic in evaluating, selecting and developing AM processes with their supporting technologies and integration into their value chain.

Currently, AERONAMIC is working towards optimizing throughput, whilst ensuring that part quality is not affected. They are very pleased to have an in-house system that provides greater control of their supply chain. At the same time, AERONAMIC can ensure high quality and reliability in their product and process. Additional benefits include in-depth knowledge of the high-end additive manufacturing of aerospace-grade products. This makes them ready for any additional improvements that may come from the re-design of products that can take advantage of AM, such as the use of topology optimization, light-weighting, and part consolidation.

AERONAMIC's collaboration with FPC@UT on this particular project has demonstrated that through AM, optimized designs can be made in the future with fewer manufacturing constraints.

The optimization of throughput that came along with effective capacity utilisation of the machine is of particular interest.

INNOVATIVE
INVESTING IN
TOMORROW'S
PRODUCTIVITY

PUSH LIMITS

Aeronamic continuously explores new production technologies for manufacturing complex aerospace parts. We heavily invest in new techniques, challenged by customers like Honeywell and Raytheon Technologies. Our Additive Manufacturing facility is up and running!

www.aeronamic.com

AERONAMIC

A GLIMPSE INTO THE FUTURE


ADVANCED
MANUFACTURING
CENTER

“FPC is a vital link between UT and the innovation park, where science becomes business. Cutting-edge technological knowledge from the research environment will be brought into the industrial environment to create smarter, better and faster products.”

Anne-Wil Lucas

Director of Kennispark Twente

Do you want to learn more about the possibilities at Kennispark for your company?

Contact Anne-Wil Lucas, Director Kennispark Twente.

The Fraunhofer Project Center has found a new home at the Enschede Kennispark, taking the place of the soon-to-be-demolished Mai building on the corner of Auke Vleerstraat-Hengelosestraat. This new location will be home for the FPC Open Innovation Center in Manufacturing 4.0 called the Advanced Manufacturing Center (AMC). The AMC will be a 1,000m² shopfloor consisting of equipments, demonstrators, testbeds and training facilities supported by a digital backbone monitoring system health as well as extracting data for state-of-the-art AI.

Renowned for supporting companies digitize and innovate their equipment, production systems and processes, the FPC's new innovation center fits in perfectly with Kennispark's high-tech profile.

Handshake between innovation and business

Anne-Wil Lucas, the Kennispark director, was "pleased" to find a replacement for a building that "has been a thorn in so many people's eyes". This news is particularly satisfying, as it brings a knowledge institute like the FPC to our campus, which not only integrate science into business, or UT students and Kennispark companies, but also support SMEs and start-ups in the region.

Kennispark hosts hundreds of businesses in the technology sector, including the ticketing system software company Sqills and digital platform provider Equinix, totalling over five thousand employees. It offers numerous opportunities for funding and business networking as well as technological facilities.

In terms of its location, Lucas said that "though the Mai building was vacant for a long time, we think it's the best spot for FPC. We're now developing a design that best fits the kind of area strategy we want to achieve at Kennispark, and since this building is one of the most important building blocks in the overall area, the municipality of Enschede will review the design along with the owner and tenant."

MANUFACTURING 4.0 is becoming an asset of the region

Managing director of the Fraunhofer Project Center, Biba Visnjicki, said that "it's thanks to the exceptional support of the University of Twente that we got a location for the FPC and our AMC."

FPC is settling with AMC in the Kennispark with a mission to enable fast transition in digitalization of manufacturing industries.

"We are focusing on SMEs and start-ups, especially nowadays, when their future is put under heavy load of economic uncertainties and unpredictable changes in the market."

AMC will introduce new model of open innovation. Integrated knowledge of FPC partners will be enabling developments essential for machine builders, producers, product developers etc. Network and international recognition of FPC will be used to connect to knowledge available in the region and abroad and stimulate network beyond regional and nation boundaries.

AMC is first of three buildings planned for the Kennispark on the same site that are envisaged to become a major high-tech cluster to support the region.

AMCNU

BOOSTING **INDUSTRIAL GROWTH** WITH **EMERGING TECHNOLOGIES**

Together with regional government and partners, the Fraunhofer Project Center (FPC) has developed the Advanced Manufacturing Program (AMP) to establish a transitional framework towards Manufacturing 4.0 and empowering manufacturing industries in the Eastern part of the Netherlands

The Advanced Manufacturing Program (AMP) provides subsidies through the RegioDeal supported by the Province of Overijssel and the Dutch state. It aims to encourage rapid development of Twente and other regions in the East Netherlands by forming an Advanced Manufacturing hub with an outward looking European image. With this the AMP greatly enhances the region's reputation and business climate.

Within the AMP, the Fraunhofer Project Center at the University of Twente develops innovation projects around manufacturing technology themes. Every AMP project is built around solid industrial collaboration, empowering companies with relevant knowledge and new technological and industrial methodologies, Through the hub, these can be shared with other high-tech manufacturing industries in the region.

Member companies' of the AMP can solve their specific technology problems and answer their market-oriented questions. This is achieved by developing and creating demonstrators that offer participating companies direct technological insight. FPC then utilises workshops and master classes to further disseminate this newly acquired knowledge.

> ***The Advanced Manufacturing Program (AMP) is a funding program that helps us support you in your transformation to manufacturing 4.0. IT is made possible through the RegioDeal supported by the Province of Overijssel and the Dutch state.***

Rijksoverheid
provincie overijssel
regio Twente
Twente

AMBITION

How can I effectively implement Additive Manufacturing (AM) in my company? What products, services and processes would benefit from AM?

For many companies, doubts occur because it can be difficult integrating a new approach into an existing system. Additive Manufacturing's multi-faceted design and process methods enable companies to identify and enable customized AM-based solutions that work for them.

The AMBITION (project) aims to demonstrate the tangible benefits of additive manufacturing to our industrial partners, specifically tailored to their business needs. Fraunhofer Project Center works with AMBITION partners to build working models that demonstrate how AM technologies may enable efficiency in part design and production that can integrated into their systems.

Knowledge transfer plays a pivotal role in this project. At each developmental stage, we have created a stimulating, interactive knowledge transfer environment for our industrial partners, ensuring wide dissemination of insights gained and comprehensive uptake of lessons learned.

Participating companies:

TRICAS DEVELOPING NEXT GENERATION PRODUCTS

Tembo

TT ENGINEERING Maakt ontwikkeling mogelijk!

MechDes engineering

KORT

A common problem in steel-product manufacturing is the significantly high throughput time of steel products in comparison to the sum of their process times. Manufacturers have similar production methods which, upon investigation, are likely to yield improved time efficiency resulting in a higher relative touch time per product. To lower production times, it would be optimal to introduce production planning with higher levels of dynamicity, granularity and detail.

KORT is a project working towards developing a proof-of-concept solution that can reliably forecast turnaround times. This is achieved by influencing the waiting time of products through detailed production planning. The focus of this project will lie on determining the factors that influence throughput time and identifying opportunities to manipulate them. It will help to recognise and categorise the similarities our industry partners possess, based upon their physical and digital infrastructure.

This will form the backbone of a decision model which will steer the planning process more accurately. Historical and real-time ERP data is used to develop a modular framework which supports detailed and flexible production planning, resulting in a new, robust planning and control solution. We can then use this demonstrator as a new industrial standard, or an object lesson to guide steel-product manufacturers when adjusting and/or improving their production planning.

Participating companies:

GS METAAL

DISSELHORST METAAL weet't goed gemaakt!

HOEKMAN Roestvaststaal

SUPLACON plaatbewerking

VAN RAAM

UPSCALING **USER-CENTRED PRODUCTION** WITHOUT STANDARDISATION

You can find more about Van Raam on their website: **www.vanraam.com**

From specific configurations to custom modifications, Van Raam makes bicycles for everyone.

Innovation requires exploring new opportunities and inducing change. In the times of Industry 4.0, this means to digitalize all processes and collect data that supports you in making the right decisions to streamline manufacturing.

Van Raam Reha Bikes B.V. is an SME specialized in design, development, and production of bikes for people with a disability based in Varsseveld. Their bikes are tailor-made according to the needs and wishes of their customers; "We build unique bikes in a standardized production process". The biggest challenge they are facing is to continue growing while maintaining their tailor-made focus. Van Raam intends to upscale their production through optimization of processes without standardizing their unique customer tailored products. This means that they do not compromise their service and product, but dynamise rigid processes to upscale production efficiently.
To reach their goal, Van Raam decided to closely collaborate with FPC to develop a digital infrastructure and work together on reaching their vision of having a digital factory that provides a clear overview and enhances flexibility of all processes. They chose FPC to be their partner because

"We think the wide knowledge and experience in the area of Industry 4.0 and Digital Twinning combined in a mixed and international team of (young) professionals will provide us the necessary tools to speed up our digital evolution process without losing track of quality and strategy."

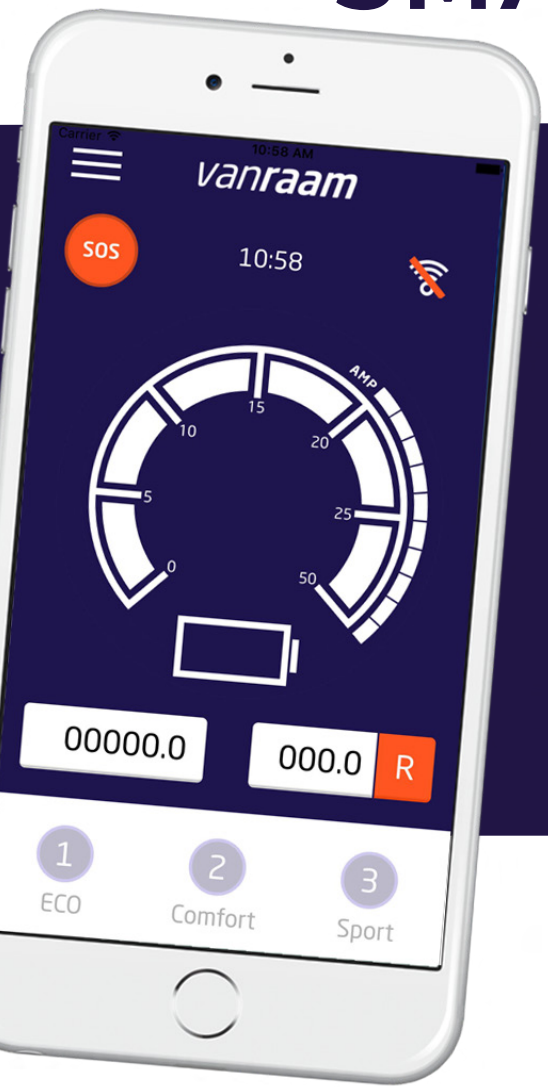
- VanRaam

Based on the needs of Van Raam, FPC developed a proposal for a development trajectory. The trajectory starts off with a current state analysis that informs the implementation plan. The result is a tailored decision-support tool based on a digital twin. Current challenges are connecting data that is acquired throughout the product lifecycle for fast and efficient decision-making. Solving this will provide deeper insight into production processes, improve the overall communication within the production environment and facilitate optimization of production for upscaling. All these factors contribute to an increased throughput of bikes, bottleneck recognition and control, and higher overall equipment effectiveness.
Additionally, the digitalization of their

production environment facilitates the incorporation of user data into the design process. This creates a foundation to enhance customer services, such as configuration to order and providing a direct communication channel to the customer. It enables digital services that improve the overall efficiency and customer experience. At the same time, it positively affects employees as the complexity in assembly processes can be reduced and direct communication between design and production can be facilitated.

To support Van Raam in the transition to digital, FPC will work closely together with their internal team to ensure the solution is tailored to their needs and supports them in reaching their strategic goals.

VAN RAAM DELIVERS ALL BATTERIES AS SMART IOT OBJECTS



Every Van Raam battery has its own built-in communication module that supports direct communication bweteen the bike and the Van Raam IoT platform. With this information end suers, delears and Van Raam technical staff are provided with analytic data about the usage and well-being of the product. The smart battery is supported with a free-of-charge app for end users and delears (Android and IOS).

The app can be used as a smart bike computer and provides advisory (push) notifications to extend the lifetime of both the bike and the battery.

Van Raam engineers have remote insight in technical data of the product. Meanwhile a data lake of technical data is filled on which future ML and AI projects can land.

CHIEF TECHNOLOGY MANAGER

CERTIFIED COURSE

ACCELEARATE YOUR SUCCESS WITH STRATEGIC INNOVATION THINKING

The rapid development of technologies is influencing business models across all industries, challenging and shaping the roles for future Technology Managers. This course is designed for **professionals with experience in technology related positions** who want to step up to **senior management roles.**

The **5-day course** delivers a unique blend of theory and practical perspectives, through interactions with industry experts, to help develop a strategic view of your organisation's technology architecture and business landscape.

COMING TO TWENTE IN 2021

REGISTER YOUR INTEREST AT
AMCENTER.EU/CTM

COURSE DEVELOPED BY INC INVENTION CENTER

BROUGHT TO THE NETHERLANDS BY FRAUNHOFER PROJECT CENTER AT THE UNIVERSITY OF TWENTE

THE IDEAL TIME FOR 3D PRINTING IS NOW

INTERVIEW WITH FRANK PETER WÜST

The Trumpf TruPrint 5000 3D is equipped to handle even the most demanding industrial applications.

Mr Wüst, we know that 3D printing has been able to provide quick support for medical technology during the corona crisis. What other potential do you still see?

3D printing has huge potential to re-establish supply chains. All sectors can in principle benefit from this, for example, the automotive and energy industries. It is not just about replacing another technology with 3D printing. Additive manufacturing processes is more about giving us an opportunity to rethink and sustainably improve supply chains. For example, a complex component can often be printed "in one piece" rather than assembled from several individual pieces. This can save time and costs as well as increase quality. A spring heat sink on our TRUMPF laser machines, for example, is made up of ten individual parts when traditional manufacturing methods are used. In the case of 3D printing, we need only one component. This has enabled us to save 30 percent in costs and to simplify assembly.

In which areas is AM most beneficial?

*3D printing offers benefits in almost every industry. At TRUMPF, we envisage plenty of opportunities in medical technology, aerospace, dental technology and the energy industry. It's not just about companies improving their products with 3D printing, but more about the opportunities for in-house production. For example, 3D printing can optimize grippers in production lines by integrating f*unctions and improving cooling and gas flow.

Supply chains will eventually be working again. 3D printers are quite expensive. When is it worthwhile for a company to invest in a system?

Whether a 3D printer is worthwhile is not just a question of investment costs but more about creating a business case for each additively manufactured part and taking all factors into account. Component costs such as for production, assembly and tools must be included in the calculation as well as system performance factors such as longer service lives

and increased capacity utilisation. 3D printing also offers added value along the entire value chain, for example, due to independence from suppliers and lower storage costs. When a company is able to take advantage of these benefits, it pays to invest in a 3D printing system physical test product.

Is the crisis a good time for companies to think about 3D printing?

Absolutely. Right now, lots of employees are highly motivated and want to be innovative and to explore the opportunities of additively manufacturing their products. This is exactly what is needed to be successful with 3D printing. At TRUMPF, we have developed a training program that helps companies to get started with 3D printing – from understanding the process to selecting components and integrating it into their own process chain.

The AM sector includes many new companies and start-ups. What impact has the corona crisis had on the industry?

One effect might be for start-ups and smaller companies to work more closely with larger firms because the former can often react faster and more flexibly than large companies in times of crisis. Large companies, on the other hand, have greater financial leeway. Cooperation is therefore beneficial to get innovative ideas implemented faster. This would provide major added value for the industry as a whole.

Does additive manufacturing now have an opportunity to move into new areas of traditional manufacturing? If so, why?

In times of crisis, companies are often under pressure to think differently and come up with new ideas. 3D printing opens up many opportunities to do this. However, fully replacing traditional technologies with 3D printing is feasible only in a few industries. The technology and entire value chain needs to be examined closely. Designers also need to free themselves from the limitations of traditional methods and learn to think "in 3D".

Frank Peter Wüst

Graduate in Electrical and Welding Engineering.

25 years' experience in welding technology and AM.

Since 2001 at TRUMPF in different departments.

TruPrint 2000

Profiteer van voordelig 3D-printen in premiumkwaliteit

Uiterst productieve premiumkwaliteit, allerhoogste kwaliteitsnormen, lage stukkosten, eenvoudige bediening

De TruPrint 2000 biedt met de kleine straaldiameter van de laser van 55 µm een hoogwaardig printresultaat, dat overtuigt door de oppervlaktekwaliteit en gedetailleerdheid. Deze beschikt over een bouwvolume (cilinder) met een diameter van 200 mm en een hoogte van 200 mm. Dankzij de Fullfield Multilaser met twee TRUMPF vezellasers van 300 watt, die de volledige bouwruimte verlichten, kunt u ook vertrouwen op maximale productiviteit. Melt Pool Monitoring en een uitgebreide procesbewaking garanderen de allerhoogste kwaliteitsnormen. Het productieproces met de TruPrint 2000 is ontworpen voor een gesloten poederkringloop onder beschermgas.

Meer informatie op www.trumpf.com

THREE CLICKS AWAY FROM THE SOLUTION

How many of you can convert 73˚Celsius into Fahrenheit? No, you are not allowed to use a unit converter.

It's difficult, is it not?

Those in their 40s and above had to learn the formula to convert Celsius to Fahrenheit. The younger generation do not need to know those formulae for conversion. If you search on google, you will get a large number of converters to do that for you

Our present and future looks exactly like this. All thanks to computer technology and Internet. A few people, who have the knowledge, build software tools and web based services. Millions of people use the tools without having full knowledge of the subject.

Nowadays, there are many webservices which provide free engineering solutions. However, these tools are mostly based on analytical solutions. The world is changing with new innovations entering the markets on a daily basis. **Many new engineering challenges cannot be solved by conventional analytical formulas anymore.** The complexity involved in these challenges require discretization of the problem (in space and/or in time) such that the governing (differential) equations can numerically be applied and subsequently solved. For most of these challenges **a digital model of the real physical situation has to be developed and simulated for different scenarios.** For instance, one can assess digitally what will happen to the tallest skyscraper when subjected to an earthquake load with a certain magnitude, or we can find a suitable method to manufacture car wheel rims with advanced high strength steels to reduce the overall car weight.

These kinds of question cannot be answered by a designer who does not have good knowledge of the subject. To answer the example questions mentioned above, one may need to be an expert in finite elements, nonlinear structural mechanics, nonlinear solid mechanics, metal forming, material science etc. Large companies have sufficient resources to hire highly skilled PhDs and software tools to answer these questions. They also have the possibilities to hire consultants to answer such kind of questions. But small and medium enterprises (SME) do not have enough resources to get the knowledge and tools in-house or to hire expensive consultants. The question is

How can we provide solutions to the SMEs, for their highly complex engineering challenges, at a low cost?

Another constraint linked to this issue is that the required knowledge is mostly accumulated at universities. The focus at Universities is mainly on fundamental research which leads to scientific output and related achievements. Application of this scientific research is not a major concern of most Universities. Therefore, it is not very easy for an SME to utilize the knowledge at the Universities, especially if the question is not scientifically challenging.

Automated Simulation Platform

Most of the world's renowned commercial finite element software give the possibility to write programming scripts for building up FEA models, running the simulation and post processing the simulation results. This gives the opportunity to build up a digital platform for simulations where users can give inputs, run the simulation automatically and read the results. Running a high-end nonlinear simulation becomes as easy as converting Celsius to Fahrenheit. Okay, so that was indeed a bit of exaggeration, but the required knowledge

RUNNING A HIGH-END NONLINEAR SIMULATION BECOMES AS EASY AS CONVERTING CELSIUS TO FAHRENHEIT

to run a high-end simulation can definitely be reduced significantly for instance to the level of design engineers, who more or less know how to work with CAD and have some process knowledge of the physical systems which need to be simulated. The SMEs may not need a highly skilled PhD to run the simulations. Neither does costly software need be purchased. The simulations can run on the server (or in a cloud) with licensed software owned by the digital simulation platform owner. The idea sounds very interesting and can definitely help the SMEs to find their answers in a cost-effective manner. But there is a saying "What comes easy, won't last, what lasts, won't come easy." So, there are definitely many challenges in realizing the idea of digital simulation platforms. To name some of them:

- Making the FEA models as generic as possible while keeping the level of automation to a maximum. If the model cannot be made too generic, different models can be made in one group to cover a wide range of applications.
- Making the FEA models robust. Simulations can easily suffer from convergence problems for example.
- Writing scripts to generate results. Different users may want to look at different results. Storing all results from a simulation may become problematic.
- Different objectives to run simulations. Some users may just want to perform a single simulation of a physical process and look at the results. Some users may want to check feasibility of a new physical process (or change in existing physical process). While some users may like to optimize their physical processes using simulations. This requires development of envelop scripts to define the architecture of data flow depending upon the objective of the user.
- Users may not have all required input data to run a simulation. For example they may not have specific material data. This may require building up of a data base to provide suggestions to users.

- Defining the business model can also be challenging.

Despite these challenges, it is still possible to develop useful and worthwhile digital simulation platforms. As software becomes more mature and the number of users and uses increase, it can become straightforward and normal to simulate all models prior to building.

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HOT DIE FORMING PROCESS DESIGN AND SIMULATION FOR SHEET METAL APPLICATIONS

HoDforming GmbH is the successor of the North Rhine-Westphalian company Amborn-Engineering which has been founded in 2000. The company focusses on high temperature forming (HoDforming = Hot Die forming) of metal sheets and hollow bodies for **research, development, production and distribution of processes and products for the shaping of metals** for the use in nearly **every field such as automotive, aviation and medical technology.**

HoDforming has proven their innovative technology in hollow part forming. But most of automotive structural parts are made from sheet steel material. The hot die forming for sheet metal parts is much more complex compared to hollow part forming. Understanding, designing and determining the hot die forming process parameters is a challenging task.

Fraunhofer Project Center at the University of Twente developed a **simulation model for sheet metal hot die forming.** This model was first used to check the **feasibility of the process, process design and optimized process parameters.** The automated platform consists on a front-end with user defined input, which is then sent to the server. The back end converts the input data into a simulation script and starts the simulation. Once the simulation is complete, the results can be downloaded by the user to their own computer.

HoDforming is now developing their machine and dies based on the results this project has generated. The simulations are completely automated and the only user interaction necessary is the insertion of the input geometry and extraction of the result file. Hence, this case study shows that **automated simulations can be easy to use and almost no advanced engineering knowledge is required.**

INNOVATION SUCCESS THROUGH PARTNERSHIPS

By definition, **"to innovate"** means to create change in something that is existing by adding new methods, ideas or products. Arguably the most important reasons behind building innovative capability within business are that new ideas and methodologies are crucial to enable and maintain growth. It is also critical to remaining competitive in a modern fast changing market that is so common in today's world, even more so due to the implications of Covid-19.

Studies and surveys, such as the **McKinsey Global Innovation Survey**, show that while 84% of executives deem innovation as critical for success, fewer than 6% of them are actually satisfied with their innovation performance. What we may be seeing here

is a misunderstanding of innovation, or a misconstrued idea of how to genuinely think innovatively.

Innovation does not only mean the creation of new and exciting breakthrough products and services, allowing us to enter new markets. Innovation can also enable greater value in existing products and services that are offered, resulting in increased performance and desirability for the end user or market. Behind the scenes, we see innovation playing a crucial role in continuously improving existing business practices, as well as being used to create new and better models.

Arend van der Sluis

Chairman of the Board of Directors, Tembo.

In 2011 Arend was appointed as CEO. Under his direction, the company is moving forward to achieve its goals of making further contributions to our customers in dynamic markets. Focusing on innovation and sustainability, where flexibility is key and where product-and machine development go hand in hand.

Tembo

Effective partnerships drive innovation

There are several key benefits in collaborating on innovation rather than acting alone. These include exposure to new approaches; potential for specialisation; reduction in costs and time to market; increased persistence of innovation; and increased comfort with risk taking.

Collaborating with other businesses and with research organisations enables more novel and commercially beneficial applications of innovative concepts. Partnerships can be the key driver of innovation and we should not underestimate the power to be gained in collaborating with like-minded, non-competing companies.

“At Tembo, we provide manufacturing solutions for mass-market single use products. Our focus is on bringing solutions for products that contribute to our planet in a positive way, for instance by providing technology to make safer and / or biodegradable variants of existing products.

One of our current biggest challenges is to provide high speed solutions able to make billions of high-quality biodegradable paper straws that will replace the hundreds of billions of plastic straws that litter our planet every year. As a first step, it is of course crucial to understand the market, the final product and the expectations of the consumer. Also, the position governments take on replacing single use plastics, and the requirements that are put by regulatory bodies on the product itself are of a major influence.

When it gets to creating the technical solution to this challenge, we try to maximize the potential of Industry 4.0 in this process. Data capturing, data analytics and output analytics (learning) are crucial factors to be able to come up with reliable and well-functioning technology in a short time. It would never be possible to achieve any of these results in this short time if we were not partnering with other companies, universities and innovation centers such as Fraunhofer Project Center.

Perron038 was created to enhance the collaboration between different companies, educational institutions and other innovation centers in the region, as well as create development programs on topics related to Industry 4.0.

Already in its first -Corona influenced- year, we at Tembo see the benefit and the huge potential of this way of working and it certainly will open up the way to even closer cooperation with the Fraunhofer Project Center in Enschede” - Arend van der Sluis.

An Innovation Hub in Zwolle

The newly established open innovation centre in Zwolle aims to bring manufacturing companies together to boost innovations. Tembo, AWL and Wadinko, the founding fathers of this regional hub, plan to create a smart space where innovative companies can meet and inspire each other.

Marius Woldberg has been appointed to make the hub successful. “In this hub, all parties that can contribute to innovation come together. In addition to the founding parties, research and educational organisations have committed themselves to this initiative. For instance, the Fraunhofer Project Center will be one of the technology partners and will share knowledge on high-tech manufacturing technologies.”

“Developments in technologies are taking place at an increasing pace. For individual manufacturing companies, it is becoming more and more difficult to keep up and to develop the applications to meet their customers’ changing specifications. The required flexibility and adaptive capabilities will be achieved more easily when companies work together” said Woldberg. Contributors to Perron038 will work on their own innovation projects and on joint projects. Perron038 acts as facilitator to make these collaborations creative, effective and efficient.

“It quickly became apparent that partnerships with other innovation centres, like the Fraunhofer Project Center and the Open Innovation Center -AMC were inspiring rapid growth in innovative ideas and methodologies across the board. Each participant shared their own unique contributions. Each gained far more from the collaborative experience than they had originally anticipated. There was no downside. It became clear that this approach to innovation would be highly beneficial to both regions.”

- Marius Woldberg

Collaboration is not only the sharing of technological tools, or the cultural willingness to work together to come up with new ideas, it’s the coming together of both of these in addition to sharing existing innovations that members have developed to solve their unique problems that makes the Innovative Hub work. When you combine them, you unlock tremendous power. Now is the time to start turning that key.

PERRON 038

Marius Woldberg

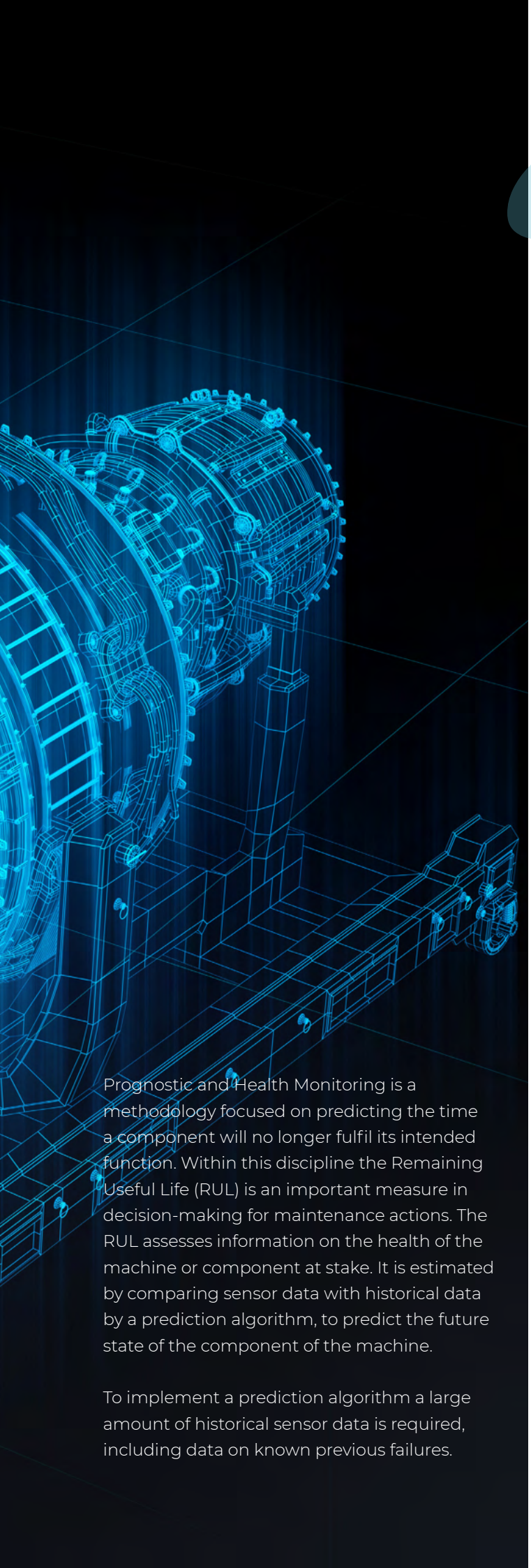
Founder and Quartermaster of Perron 038

Experienced entrepreneur, director and developer in complex project environments. The link between entrepreneurs, education and government institutions. Driving Perron 038 to be a place for innovation in advanced and flexible production technology.

PREDICT THE UNPREDICTABLE

Industries are relying more and more on machines and tools of high complexity. When relying on high complex machines the unexpected failures and downtime costs can have a high impact and result in high costs. Therefore, these machines and their components should be maintained properly to avoid unexpected failures and reduce downtime costs.

Nowadays, sophisticated diagnostic methodologies are available to improve the maintenance. The use of methodologies, such as the commonly known Failure Mode and Effect (and Criticality) Analysis (FME(C)A), enables the identification of the potential failures and prioritize them such that corrective actions can be taken. However, most of the maintenance actions performed today are on a reactive basis: The maintenance actions are performed when the fault has already occurred; therefore, downtime is not prevented. To perform maintenance actions in a **proactive** way, a shift from the traditional fix-it-when-broken (diagnostics) to a predict-and-prevent (prognostics) methodology is required (e.g. predictive maintenance). This allows industry to be more aware of the health status of their machines, components, and tools.



> **DIGITAL TWINNING CAN IMPROVE THE UTILISATION OF PREDICTIVE MAINTENANCE THROUGH MEANINGFUL TARGETED INFORMATION EXTRACTION.**

Prognostic and Health Monitoring is a methodology focused on predicting the time a component will no longer fulfil its intended function. Within this discipline the Remaining Useful Life (RUL) is an important measure in decision-making for maintenance actions. The RUL assesses information on the health of the machine or component at stake. It is estimated by comparing sensor data with historical data by a prediction algorithm, to predict the future state of the component of the machine.

To implement a prediction algorithm a large amount of historical sensor data is required, including data on known previous failures.

However, acquiring this data will take time and requires an enormous storage capacity. Additionally, it will be infeasible to measure all aspects of each component (e.g. pressure, temperature or vibrations), which means that a prediction system based on these sensors can rarely capture the complete overview of all possible correlations among the failure modes. Therefore, often the focus is put on specific components without taking the whole environment of the machine into account.

The overcome the mentioned pitfalls of the estimation of the RUL, a model-drive discipline can be used where the prediction is based on mathematical equations rather than historical (big) data. This approach allows the online adaption of a virtual representation of the machine based on real behaviour. However, prognostics and health management considered above are used solely on typical components like bearings and gearboxes. The utilisation for all the components of the machine is still very much restricted by the lack of solutions to collect, connect, control and combine the obtained information for predictive maintenance.

Digital Twin

Recent research and implementations of the model-driven approach shows that, with the use of physics based mathematical models, the lack of measuring solutions and information can be solved. In the proposed model-driven approach, gathered data by embedded sensors is analysed using the mathematical representation of the machine to gain insight in the actual behaviour of the machine. Using this technique, data can be obtained which was not accessible before (e.g. temperature flows in combustion engines). This method is also known as virtual sensing.

The detailed mathematical models of components of machines and their interaction allows the user to monitor and gather data from each individual virtual component of the machine. To ensure that the simulated data is accurate and can be used to accurately estimate the RUL, the physics based virtual model is updated using real-time data from the machine. Tuning the simulation and prognosis

algorithm based on feedback from real-time measurements will ensure the simulated functionalities approximate the functionalities of the real machine.

Just like the physics based mathematical model, the digital representation of the physical asset, also called digital twin, is a continuous evolving digital model. Digital twinning technology will not only support in better prognosis of the RUL, but by representing the machine in a virtual and visual manner, it can improve the understanding of the machine and its complex mechanisms inside.

Implementation

So how does this work in reality? And what are the steps that need to be taken? The following steps are required for the implementation of this strategy:

Start with the advanced model of the machine. Besides kinematic and dynamic modelling of

the machine, virtual sensing should be defined to update the simulation model the moment the functionality of the machine changes.. The second phase focuses on the tuning of the physics-based model. As the model is used for the RUL, the model should be as accurate as possible to prevent incorrect interpretations of the machine's health status. Actual sensor data is used as an input in the physics-based model. This step is of high importance since it determines how the change of the machine's functionality will be influenced in the simulation model. The third phase includes the RUL calculation based on the simulation outcome. The fourth and last phase focuses on the identification of the optimal time for the next maintenance action based on the RUL of the components of the machine.

Step 1. Physics-Based Model

The physics-based model is the first aspect of the development of a digital twin based prognostic maintenance strategy. The model is based on the modelling of the mechanical-, electrical- and all other functions of the machine. To reduce the computation time, some components may be modelled as black boxes (the component is modelled without any knowledge of its internal working), grey boxes (theoretical data is used to complete the internal working) and white boxes (the complete functionality is modelled).

Additionally, virtual sensors are defined in the machine to monitor and gather data from the physics-based model. It is important to define which parameters are important to monitor, to calculate the RUL beforehand. Lastly, modelling parameters are defined to update the model. These parameters are based on actual controller and sensor data from the machine with the aim to adjust the behaviour of the machine's model with respect to the actual machine.

Step 2. Tuning of the Physics-Based Model and Data Acquisition

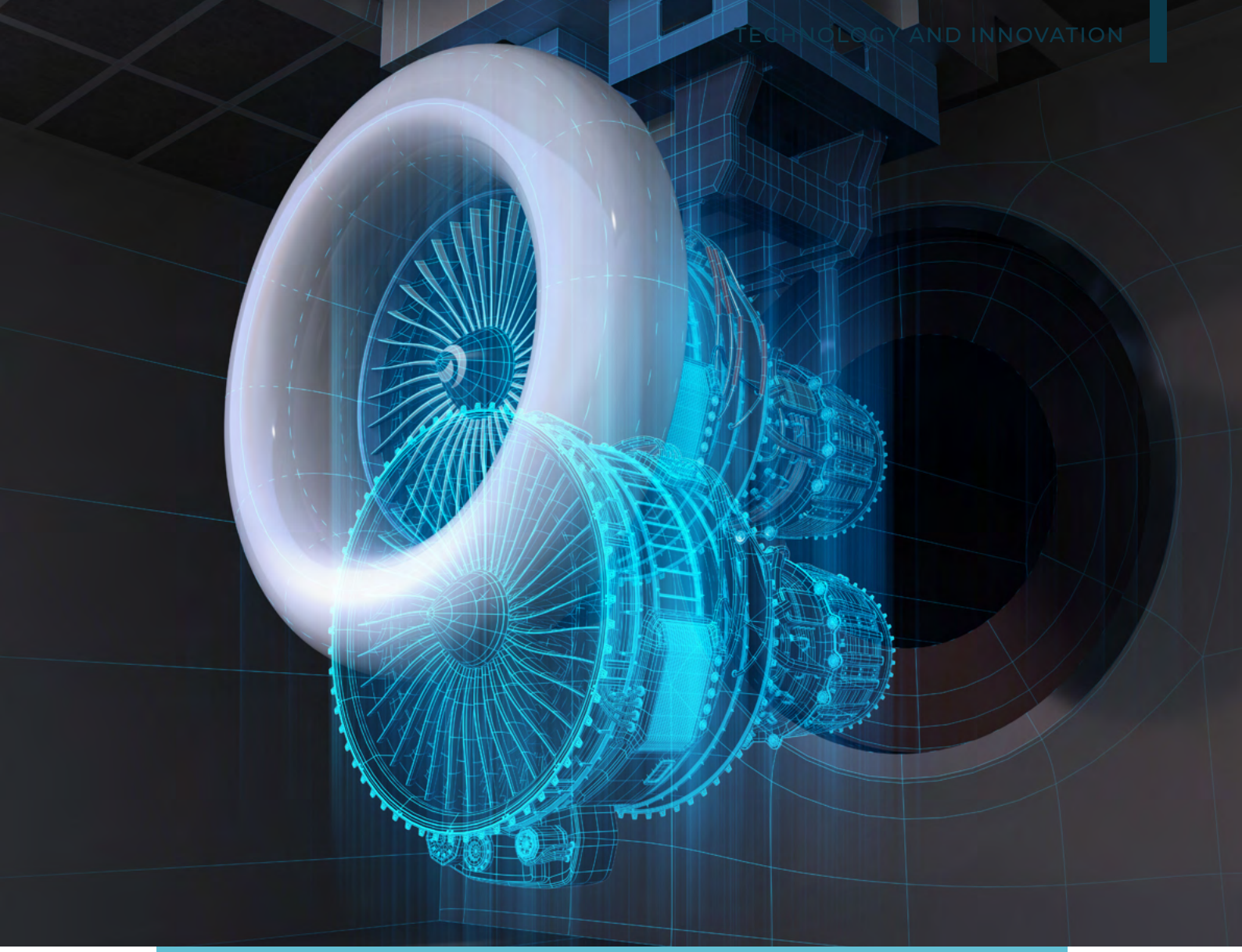
The second step is the tuning of the physics-based model. The tuning requires actual data from the machine. It is necessary to define the data that should be gathered and monitored with sensors and controllers on the machine or its components. Not all data is relevant and can be used as an input in the physics-based model. The obtained data should therefore be analysed and processed such that large amounts of unnecessary data are avoided.

The processed data is used as an input in the physics-based model and the results are compared to those of the actual machine. To eliminate the error of the comparison, an estimation of the modelling parameters should take place periodically and updated in the digital model. This tuning procedure is based on the comparison of the actual machine's component behaviour and the predicted simulation outcome. Critical components have to be updated more frequently than others that have less impact on functionality.

After the modelling of the machine and tuning during operation, the main objective is to utilize the Digital Twin. Simulations of the outcome of the performed tasks are compared to the output of the real machine in operation. A comparison is made, and the results are used to calculate the RUL. Next to that a validation of the usefulness of the information and the representation of the information for the user should be reviewed.

Step 3. Remaining Useful Life Calculation

The RUL of the machine or its components is calculated by considering the data gathered from the controllers and sensors on the machine as well as from the outcome of the simulation of the physics-based model. The necessity of the Digital Twin arises from the fact that the collected sensor data are not always adequate for the estimation of the RUL since the functionality of the machine can change over time. The virtual sensors are therefore used to capturing abnormalities in the behaviour of the real machine. Calculating the RUL the factors such as future operation plan and the model of physical degradation are checked and the simulation outcome is compared with nominal output of the machine.



Step 4. Maintenance Decision Making

The final step in the development of a prognostic maintenance planning is the time to perform maintenance actions. Financially valuable considerations should be made on whether and when to perform maintenance actions based on the RUL.

In Conclusion

Adoption of the proposed digital twin based prognostic maintenance strategy can change end-to-end business, optimizing maintenance actions and considering predictive maintenance tools to reduce downtime, improve safety, and increase profit.

With the physics-based model the ability arises to implement prognostic maintenance strategies using little data and almost no historical data. The calculation of the RUL can help to instantly check the condition of a machine as well as the future prediction of the condition of its components.

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CREATING A CHANGE THAT ACTUALLY WORKS

There's a fundamental change going on. It's about the way industrial companies manufacture their products, develop related services, collaborate with their partners, and cater to their customers. In fact, it's an Industrial Revolution – Industry 4.0 – in which the next stages of digitalization are implemented: visibility, transparency, predictability, and adaptability. It's crucial to guide employees through this massive change successfully.

Industry 4.0 impacts virtually all functional areas, from development, manufacturing, maintenance, logistics, and services to marketing & sales. It involves the introduction of new, often disruptive concepts and technologies, including holistic twins, modularization, agile production (additive manufacturing, robotics), sensing and vision (drones), and RFID/GPS. Data-driven maintenance evolves from condition-based to predictive and prescriptive maintenance.

Removing the roadblocks

Industry 4.0 is an important driver to accelerate innovation and realize more sustainability. It promises higher flexibility in manufacturing, in terms of product requirements (specifications, quality and design), volume (small series), timing, efficiency, and costs. New revenue models can be introduced, based on use instead of ownership. Advanced technologies in a manufacturing environment help to attract young, highly educated employees. With Virtual Reality you can train them for possible scenarios; with Augmented Reality you can support technicians on-the-scene. No wonder that even seemingly conservative sectors are getting started with it.

Industry 4.0 is a major change

To take full advantage of Industry 4.0, it must be treated as a major change that must be actively managed from the start. Needless to say, it takes more than great technology to deliver on the promises of Industry 4.0. The most effective change programs engage the key stakeholders in the organization, including IT, in early, open, and direct communication. Of great importance is strong C-level sponsorship so that Industry 4.0 remains a priority and everyone is held accountable for achieving the company's ambitious goals. It also requires a workforce willing to make the change, adapting the new ways of working that come with new technologies and the new approaches to development, manufacturing, and marketing.

This brings a whole new profession to manufacturing companies: the data scientist, who works with the production manager to develop applications to improve production monitoring, equipment maintenance, and safety at work in ways that were simply not possible before.

21th Century Skills

In order to bring the change process to a successful conclusion, employees must build up a relevant skillset, the so-called 21th Century Skills. These include the learning skills of critical thinking, creativity, collaboration, and communication; the literacy skills of information, media, and technology; and the life skills of flexibility, leadership, initiative, productivity, and social skills.

We believe that most employees are quite willing to make necessary changes. That's why

we recommend approaches where they are empowered, especially if employees have sufficient command of the 21th Century Skills. Good communication, together with retraining programs, can help people start moving toward new career paths, including those within the same company.

PDM's project involvement

PDM is partner in two research projects, "SAMEN" and "The Digital Plant of the Future". SAMEN is a World Class Maintenance project that answers the question how a service provider can develop a technical innovation into an effective business model. In the "Autonomous Plant" Living Lab PDM validates knowledge regarding the autonomous control and maintenance of production facilities.

The second project was initiated by the Brabant Development Agency (BOM), TNO and Eindhoven University of Technology. It's about realizing an environment where companies can experience how data-driven innovations can be integrated in production facilities. Through the use case "Collection and application of machine data" PDM clarifies the impact of datafication on the packaging, sorting, and material handling industry.

Change is a challenge

The implementation of Industry 4.0 is particularly complex because full integration of business operations must be achieved. PDM is able to establish connections between the different departments within a manufacturing organization and between stakeholders in the industrial chain. PDM understands the challenge for the industry and offers propositions to have real impact. This makes PDM the right partner to realize Industry 4.0.

During the implementation of Industry 4.0, pays PDM attention to the following aspects:

- The modular structure of the products
- Digital documentation to replace paper
- The communication between all processes in the factory
- The installation and commissioning of relevant hardware (sensors, transmitters, networks, receivers, cloud, monitors, glasses, actuators, etc.).
- Analysis of available data, based on which new services can be developed.

Based on the current maturity level of a specific company, tailor-made action plans are developed to successfully implement the digital transformation on a step-by step development path. PDM can help companies that strive for advanced manufacturing to make a change that really works.

Ask for a copy of the **PDM** white paper ***Autonomous plant – Industry 4.0 Perspectives***

CONTACT:

WALTER MESTEROM

Walter Mesterom is the owner and Commercial Director of PDM. He has a background in civil engineering, new business & product development and Industry 4.0. With more than 30 years in business, he has ample experience in industrial optimization.

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Change Management for high performance
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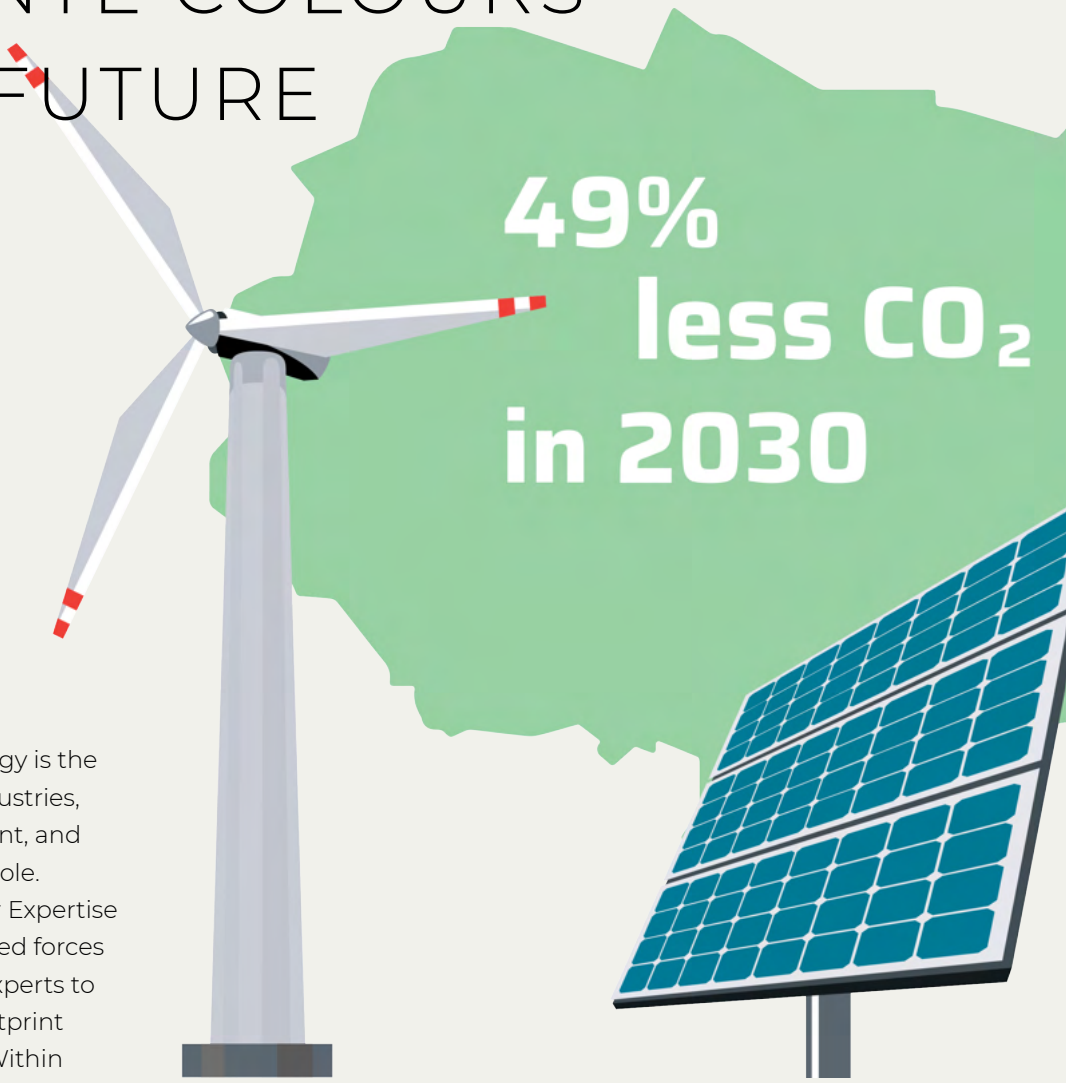
FEST

TWENTE COLOURS THE FUTURE



Renewable energy is the future – for industries, the environment, and society as a whole. Therefore, the Fraunhofer Expertise Student Team (FEST) joined forces with renewable energy experts to reduce the ecological footprint in the region of Twente. Within the past six months, students developed a tool that supports the decision-making process for the local renewable energy expert team, which allows for faster progress to realize their ambition of an energy-neutral Twente by 2050.

The project was initiated by **Regional Energy Strategy Twente**. It is an initiative drawn up by major substantive experts and representatives of the 14 municipalities based in Twente: the province of Overijssel, the Vechtstromen water board, the network operators Enexis and Coteq, the Twente housing associations, Twence, and the University of Twente. Participating in this project would make Twente's first steps to reaching its vision of **being energy neutral before the year 2050** by expanding the regional heat network, realizing a biogas network and generating more energy with solar panels on large roofs, solar fields and wind turbines.

However, generating more renewable energy for a sustainable future is only one piece of the puzzle. Other pieces include the re-engineering of infrastructure to create smart grids, the electrification of industries, and many more aspects that have to be dealt with to execute this energy transition.

A forthcoming change with this magnitude requires extensive decision-making processes which entail large numbers of stakeholders who may not always see eye to eye. One of the reasons that such processes are challenging, is the difficulty for the stakeholders to **visualise the impact their decision might have on them with respect to the global goals.**

The situation amongst the parties within Regional Energy Strategy (RES) Twente was no different. An agreement regarding the energy transition goals had to be set, which involved numerous factors that influence the creation of sustainable energy solutions in the region. These factors are merely data points rather than clear scenarios. This complicates the communication leading to inefficient meetings. Therefore, FEST proposed to use the existing data and create a **digital interface that supported the facilitation of the decision-making meetings of RES Twente.**

By collating and converting data from across the various municipalities into visuals that simulate the direct effects and results caused by the decisions made, it was easy to follow the stakeholders' decisions in real time. Moreover, the plausible total output of sustainable energy for the region as well as the individual municipalities was theorised and displayed comprehensibly by the interface. The scenarios that were determined with aid of the developed interface made it possible for presentation and visualization of more concrete arguments as well as better planning. This stimulates the decision-making process to achieve better conclusions.

As the strategy proved to be effective, it led to a follow up project with RES West-Overijssel for whom a similar interface was created. The interface has been made available to the public until June 2021 to enhance transparency. In this way, citizens can **experiment with different parameters and understand the complexity of the decisions that have been made regarding sustainable energy in an intuitive manner.** This allows the public to be actively invested in the dialogue on sustainability and energy transition as a result of the transparent environment that RES Twente provides.

EXPLORE THE TOOL:
https://www.res-twente-tool.nl/

WHO ARE FEST?

The Fraunhofer Project Center Expertise Student Team (FEST) is a student-run organization based at the University of Twente. They strive to support students in transforming knowledge gained at the University into competencies, skills, and experiences in order to build a network relevant to their upcoming professional careers. FEST's vision is to introduce the new workforce to companies through the projects they acquire. By taking on these projects, FEST aims to bridge the gap between industry and academia that most students experience upon entering the job market.

FRAUNHOFER PROJECT CENTER
AT THE UNIVERSITY OF TWENTE

UNIVERSITY OF TWENTE.
IN COOPERATION WITH Fraunhofer
SAXION UNIVERSITY OF APPLIED SCIENCES

FEST

Energiestrategie Twente
RES Twente

ENGLISH