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Content

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Smart and Networked Manufacturing

Preface

In our late-modern mindset, the industrial society's logic of the general, incorporated in the concepts of high volume production, is more and more replaced by the logic of the particular, the individualized, accompanied by the awareness of the need to taking care of our planet. We value the exceptional – unique products and objects, experiences, places, individuals and communities which are beyond the ordinary and which claim a certain authenticity. This decade will be dominated by society's changes e.g. in the thinking of mobility, which clearly affects the production industry. Among key enabling technologies, future manufacturing will change the way people and machines physically interact taking into account safety and ergonomics. Digitalization, connectivity and interoperability are of central importance for the next generation of manufacturing systems to connect products, machines, people and the environment – aiming for operational excellence, autonomous capabilities and the creation of physical value by using information. Cyber Physical Production Systems (CPPS) ultimately represent a central entity.

The 5th Wiener Produktionstechnik Kongress – WPK 2022 – addresses challenges of smart and highly adaptive manufacturing systems and the appropriate information technology including the application of machine learning algorithms for fast process adaptations. Top-ranked national and international experts from governmental organizations, industry and research institutions give insight into the newest results of technological, functional and implementation issues for industrial applications.

The WPK 2022 strives to connect decision makers, production managers and manufacturing engineers with a network of experts – an opportunity to discuss best practice solutions and to contribute in shaping the future of manufacturing. We are convinced that the topics of the WPK 2022 help to accelerate your progress in future manufacturing.

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The European Manufacturing System

K. Beetz[1]

[1]EIT Manufacturing

Keywords:

manufacturing, production, innovation, circular economy, sustainability, augmented workforce

1 Introduction

Key elements of process innovation deployment, including people, processes and technologies, are central to a successful implementation of digital transformation. Like in most industries, the transformation of manufacturing is impacted by the skills, well-being and innovative capacity of the workforce [1]. People, with their experiences and knowledge, are the most valuable assets [2] of the European industry leveraging a human-centred approach to Industry 5.0, as it is proposed by the European Commission [3].
Manufacturing is an integrated socio-technical domain, organising processes and logistics management frameworks through a methodical combination of best practices, while still allowing for continuous innovation and improvements. These manufacturing systems often determine the management philosophy as well as manufacturing operations strategy. The main objectives of existing manufacturing systems are to produce products in a competitive way, while reducing overburden and inconsistency as well as eliminating waste that has significant implications on process value delivery.

2 Manufacturing Systems

Many traditional manufacturing systems primarily focus on the optimisation of the constraints quality, time and cost [4] by designing processes that deliver the required results by reducing inconsistency. Multiple tactical and critical improvements in waste reduction and elimination ensure that processes are as flexible as necessary.
The Toyota Production System [5] (TPS) is one of the best-known production systems worldwide. However, it still has its shortcomings, especially when it comes to High Mix/Low-Volume Manufacturing processes and suitability for software-empowered human-machine interaction.

3 Current challenges and developments

With the emergence of global uncertainty in supply chains and unforeseen events like the COVID-19 crisis or man-made calamities like the war in Ukraine, it has become apparent that supply chain resilience and sustainability have gained tremendous importance in the minds of many individuals and society at large [6]. There has been increasing awareness to look at sustainability and flexibility as key drivers which have the same importance as quality, time and cost. Sustainability, circularity and environmental effects of production like decarbonisation and energy consumption have become determining factors that need to be considered when products are designed, engineered, manufactured and reused, thus adding additional constraints to modern manufacturing processes.

In response to numerous interrelated socio-environmental challenges, circular economy is a means of realising sustainable development. This is a notable shift from the current linear economy to a closed-loop system, which prioritises value retention, regenerative design and re-manufacturing of critical materials. It is imperative to see that the expected impact of sustainability, flexibility and resilience in combination with today's increased manufacturing capabilities through emerging technologies, new manufacturing concepts and value chains, requires a newly designed approach towards manufacturing systems [7].

4 Outlook

Therefore, EIT Manufacturing, in cooperation with its partners and network of contributors, is taking initiative by postulating the "European Manufacturing System" as a strategic objective for the European manufacturing industry, with universal implications. The "European Manufacturing System" is a vision to overcome traditional barriers, especially between enterprises, through an ecosystem approach. It features dual transition with sustainability as a decisive factor, while integrating emerging enablers, deep-tech technologies, e.g., artificial intelligence, quantum computing, smart sensors, VR/AR technologies, autonomous automation, trust-based cybersecurity and collaborative robots. Such deep-tech enablers are characterised by core features, e.g., connectivity, integration, intelligence, adaptation and socialisation. In addition, innovative manufacturing concepts like servitisation of manufacturing will be deployed in European value networks to improve resilience and flexibility. The "European Manufacturing System" provides a roadmap to the vision of autonomous, self-organised production and logistics.

Supported by the European data infrastructure Gaia-X [8], it is a foundation for a future-oriented business philosophy that becomes reality in the traditional manufacturing industry, impacting the workforce and society at large.

The "European Manufacturing System" places the PEOPLE at the centre. E.g., for data analytics systems, process know-how and strong tech skills are essential, but often only inherent in the minds of front-line workers and engineers. Technologies, methods and processes should augment and amplify human capabilities to enable a future of industrial work that is inclusive and accessible. This human-centric approach benefits all, the European industry and economy, the European workforce and the European societies to achieve resilience and sustainability.

Europe needs to overcome the potential weaknesses of its present manufacturing systems. By strongly driving the "European Manufacturing System", the EIT Manufacturing community actively supports the European Union in its strategic goals to move towards a true twin transition. A renewed, competitive, green and digital European industry can be achieved through skilled people, emerging technologies and strong innovation capabilities – the key instrument of EIT Manufacturing.

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Learning what we already know: On the 50th anniversary of "The Limits to Growth"

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The seminal report to The Club of Rome "The Limits to Growth" was published in 1972 and it had a huge editorial success. Millions of copies were sold, the book influenced public agendas and created a wide debate, still ongoing. But overall, humanity did not find its pathway(s) towards equitable human wellbeing within a healthy biosphere, rather the contrary. We are now at a more critical moment than 50 years ago, with a multiplicity of emergencies converging into a suicidal path. In a new report to The Club of Rome, "Limits and Beyond", we suggest that the deep reconfiguration of societal patterns required for desirable futures can emerge from the present state of emergency. But positive emergence cannot be planned nor is it guaranteed. At the very least, it calls for allowing ourselves to explore a wider space of possibilities. Could we liberate our processes of learning from the incumbent mental frameworks which keep us imagining the "solutions" with the same lenses that created the "problems" in the first place?

We propose to question how research, innovation and technology are currently framed. This is the core intention of The Fifth Element program, recently launched by The Club of Rome. It is an invitation to put upside down the existing model of knowledge creation in order to respond to the challenges humanity faces today, which the disciplinary structures of conventional academia are unable to address. Rather than targeting supposedly universal solutions in a top-down manner, this approach bets on a multiplicity of pathways towards wellbeing in the biosphere, in which cultural and geographic contexts, traditional ecological knowledge, relational wisdom, and the best of modern science are woven together. As the name of the program suggests, the process intends to create patterns of learning inspired in how Life works. This has deep consequences on how we conceive economic processes, including the reinvention of the role of industry for desirable futures.

Gaia-X and the Federalisation of Dataspaces via an Open-Source Architecture Framework.

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Abstract

Gaia-X represents the next generation of data infrastructure ecosystem: an open, transparent, and secure digital ecosystem, where data and services can be made available, collated and shared in an environment of trust. The architecture of Gaia-X is based on the principle of decentralisation. Gaia-X is the result of many individual data owners (users) and technology players (providers) – all adopting a common set of policy, technical, and labelling rules and specifications – the Gaia-X framework. Together, we are developing a new concept of data infrastructure ecosystem based on the values of openness, transparency, sovereignty and interoperability to enable trust. What emerges is not a new cloud physical infrastructure, but a software federation system that can connect several cloud service providers and data owners together to ensure data exchange in a trusted environment and boost the creation of new common data spaces to create digital economy. The scope of this paper is to give an overview for the reader of the core concept of the decentralisation principle, which defines the Gaia-X Framework, and its' applicability via its business projects (also known as the lighthouse projects).

Keywords:

Gaia-X, ecosystem, trust framework, data space

1 Introduction

In a digitally globalised and interconnected world, data has become a central tenant of all our daily lives – whether we are aware of it or not. As the key driver for the digital economy, data is a source of economic opportunity. But the collection, processing, use and sharing of data comes with certain risks, especially where consumers do not have control over their own data. Gaia-X wants to give control back to the user by creating a common data ecosystem for users and providers across various public, industry and research domains.

2 Gaia-X

Established as a not-for-profit Association in 2021[1], Gaia-X brings together a broad range of organisations (large companies and SMEs, developers and users of technology, industrial players, and members of academia) around one common goal: to boost the European data economy by enabling the creation of common data spaces, in full alignment with the objectives of the EU's 2022 data strategy [2]. To this end, Gaia-X focuses on building a common standard for an open, transparent, and secure digital ecosystem that will serve as the basis for a new model of data infrastructure guaranteeing safe and trustworthy data exchange. Open to anyone but aligned with the European values of human-centricity, transparency, openness, and sovereignty. Gaia-X aims to deliver a framework for numerous individual data owners (users) and technology actors (providers), which would be in sovereign power to adopt a common set of policy, technical, and labelling guidelines and requirements. As a result, it would reduce the dependency on non-controllable technologies while reflecting Europe's need for data and cloud sovereignty.

3 Current challenges and developments

Gaia-X is an association that strives to be a standard-setting organization while not being configured as a formal standardization body. Gaia-X works on an open-source architecture that would set standards for data exchange, while also providing the required technological components to allow this standard to be validated and enable data owners (users of technology) to design their own data spaces to operate on infrastructure and technology owners (providers) to be compliant.

In turn, the creation of specific sectoral data spaces will enable the development of services based on a larger set of data collected along the whole

value chain, providing each participant more insight and control of the value chain, and in the end, gaining a competitive advantage in their market.
To achieve a significant competitive advantage, however, the sectoral data space must be compliant at least with the Level 1 of the Gaia-X Compliance and Labelling framework, which defines:

- Data protection.
- Transparency.
- Security.
- Portability.
- Flexibility.

While the Level 1 Labelling criteria are open to non-European entities, who are only required to fulfil ENISA's European Cybersecurity Scheme – Basic level. Levels 2 and 3 extend the above-mentioned standards and promote European-based service providers. At Level 2 the user must be given an option of a European service location, while for Level 3 it is mandatory. Nonetheless, labelling and verification standards were defined by the Label Owner with the support of the Gaia-X. As it stands, the entity that owns the Gaia-X label exercises its sovereign right to define the label's scope and applicability within the federated dataspace architecture. On April 21, 2022, Gaia-X released labeling criteria [3], followed by Trust Framework on May 20, 2022 [4], and Gaia-X Architecture Document on May 25, 2022 [5]. The trust framework defines the mandatory baseline requirements for joining the Gaia-X Ecosystem, which allows for the identification, authentication, and authorization of trusted participants. The Gaia-X label comes in three levels, each showcasing a different level of conformity to the Gaia-X rules. The trust framework brings transparency, whilst the labels express values to businesses. In this way, users and technology providers will gain a better knowledge of each other, enabling easy and trusted decisions that, without Gaia-X, cannot happen.

4 Conclusion

Gaia-X is creating an open-source architecture for interoperable, federated data ecosystems, which enables the compositions of services across multiple providers. The establishment of interconnectivity solutions between dataspaces, Gaia-X works upon the European Union 2020 data strategy, which defines the criteria of data protection, and competition law. The environment, therefore, will be based on openness, transparency and security and sovereignty of all parties. Gaia-X released labeling criteria on April 21, 2022, followed by the Trust Framework, and Gaia-X Architecture Document.

The Architecture Document is one of the guiding documents of Gaia-X that enables a data infrastructure ecosystem. It has been designed to familiarize users with the fundamental concepts of Gaia-X and their relationship among them. It integrates different groups, like Providers, Consumers, and Services and depending on their role, it establishes a connection between them, and how they can act and deliver services on the basis of the guiding elements of the Architecture document.

The trust framework establishes the necessary baseline conditions for entering the Gaia-X Ecosystem and allows trusted individuals to be recognized, validated, and authorized. The Gaia-X labelling enables an optional three levels of compliance, each representing a different level of adherence to the Gaia-X standards. The trust framework enables openness, while the labels represent business ideas. Users and technology suppliers will gain a better understanding of one another, allowing for simple and trusted decisions.

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Technical, Economical and Ecological Potentials of Electrified Roads

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Abstract

Electromobility is the backbone of modern emission-neutral transportation systems. Contactless energy transfer via induction is the associated complementary technology that significantly improves the user-friendliness of energy supply in various use cases such as static or dynamic contactless power transfer (CPT). The functionality of CPT for electric vehicles is extensively demonstrated, but up to now, no automatable manufacturing processes exist to produce them in large scale.

Therefore, this contribution presents the opportunities of dynamic CPT and describes the manufacturing process chain for producing coil modules of inductive power transfer (IPT) systems for electrified roads.

Keywords:

Inductive Power Transfer (IPT), Wireless Power Transfer (WPT), E|ROAD, production systems

1 Introduction

Oil dependence, air pollution, and climate catastrophe are the long-term environmental motivations for the shift to electric mobility. The majority of oil-supplying countries do not share the values of Western liberal democracies and are linked to ongoing political conflicts. Local air pollution especially in large metropolitan areas are related to deaths according to WHO figures. Only the transport sector has so far failed to achieve CO_2 emission reductions. At 71%, road-based individual transport accounts for a significant share of this [1].

2 Potentials of E-Mobility

Battery electric vehicle (BEV) have the highest possible energy efficiency in a well-to-wheel analysis, which will further increase by technological development on the infrastructure and vehicle side. Internal combustion engine-powered vehicles (ICE), on the other hand, lose a large proportion of the energy contained in the fuel through heat losses from the engine. Also, high-energy expenditures are required to refine and provide the fuels. Electric vehicles with hydrogen fuel cells (FCEV) likewise achieve poor efficiencies due to the energy-intensive conversion processes of hydrogen electrolysis and hydrogen fuel cells [1].

For drive concepts based on electrical energy, energy efficiency determines emissions in the operating phase and infrastructure costs (even with a fully decarbonized operating electricity mix). Electrified roads (E|ROAD) enable IPT-compatible BEVs (IPTEV) to have smaller accumulators with initially additional energy transmission losses, and thus in turn lower driving energy requirements, vehicle acquisition costs and vehicle production emissions [2, 3].

3 IPT Approach

Electrified roads can be technologically implemented using conductive or contactless (e.g., inductive) energy transmission. Inductive power transfer operates by a high-frequency output stage generating an alternating magnetic field on the primary side via coil modules integrated in the infrastructure. This magnetic field induces currents in the coil module on the vehicle side, which are rectified and finally made available to the energy storage system or directly to the drivetrain [4].

The efficiency of the power transmission is determined by the coupling factor and the quality factor. For loose coupling in driving operation, high efficiencies are achievable by high quality factors of the coil modules. This requires an optimal design of the magnetic circuit as well as the use of semi-finished products and production processes that contribute to minimal losses in the coil module [5]. The functionality and scalability of the IPT technology has been demonstrated in a large number of test tracks. For further penetration of the technology, automatable manufacturing processes are required in order to implement the infrastructure equipment at low cost [4, 5]. The following figure shows the main process steps in coil module production:

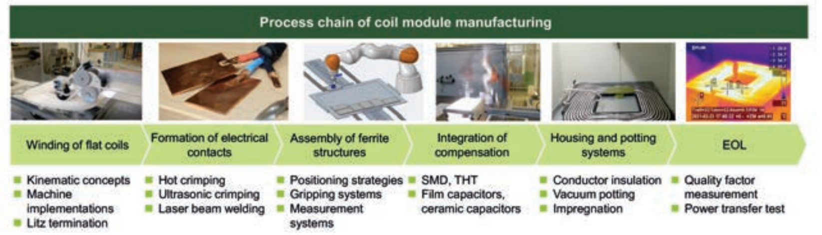

Figure 1: Process chain of coil module manufacturing [5].

The FAPS Institute is addressing this issue in various research projects and, together with an industry consortium including VIA IMC, Risomat and Electreon, will equip an approx. 1 km long section of the federal highway as an E|ROAD by 2025.

4 Summary

This contribution describes the long-term motivators for electrification of the transportation sector. The BEV appears to be the ideal technological solution, but technological, ecological and economic advantages can be developed in conjunction with electrified routes. Inductive power transfer to implement E|ROADs is technologically feasible in this context and scalable using automated manufacturing processes.

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Industrial AI-augmented Data-Centric Metrology for Highly Connected Production Systems

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Abstract

Modern production equipment and operations are connected together due to rapid growth in the industrial internet of things. Hence, the relationship between different quality operations can be easily evaluated in a multistage manufacturing system. This work presents the concept of Industrial Artificial Intelligence (AI) augmented data-centric metrology for highly connected production systems. The concept is a combination of the Industrial AI Ecosystem, Cyber-Physical Systems and Stream-of-Quality™. This kind of integrated framework is much important for understanding process-to-process relationships and predicting the quality at each stage of operation.

Keywords:

industrial artificial intelligence, metrology, quality control, cyber-physical systems

1 Introduction

Due to massive growth in industrial internet-enabled technologies, manufacturing assets are now well connected in a multistage manufacturing system, and data from them is easily accessible in real-time. Hence, a data-centric architecture is developed to share and understand the data with a unified description between highly connected production systems. The key components in the data-centric architecture are data label, data quality, data augmentation, feature engineering, etc. Utilizing the data from the kind of data-centric architecture, the potential of Industrial AI can be leveraged to improve the yield and reduce metrology efforts using the concept of virtual and predictive metrology. This Industrial AI-augmented data-centric framework is much helpful in enhancing decision-making and root-cause analysis in highly connected production systems.

2 Methodology

Evaluating complex relationships between different operation stages of a production system is challenging and needs large amounts of data. The application of traditional quality management methods in the context of a multistage manufacturing system leads to a lack of knowledge about the links between individual processes. With the advent of Industry 4.0 transformation, better connections between production operations and equipment can be achieved. Leveraging the capabilities of industrial internet systems along with industrial AI technology, a sophisticated quality management system known as Stream-of-Quality™ (SoQ) can be developed (Figure 1). Industrial AI is a systematic methodology and discipline which combines four technologies, Data Technology, Analytics Technology, Platform Technology and Operations Technology, to provide highly accurate generic solutions to industry problems [1]. The concept of Industrial AI technologies may be better comprehended when it is aligned with Cyber-Physical Systems (CPS). Cyber-Physical Systems (CPS) are interoperable systems consisting of information gathering ability, intelligent analytics, and actuation mechanism that interact with the physical world to support real-time decision-making and guarantee system performance [2,3]. In manufacturing systems, the systematic implementation of four technologies of Industrial AI is very important to establish the connection, conversion, cyber, cognition, configuration, or 5C layers of CPS for fleet-level asset and quality management.

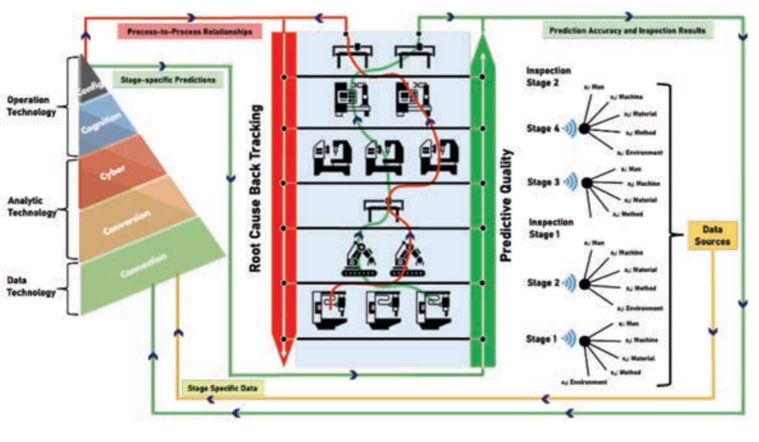

Figure 1: Industrial AI-augmented SoQ methodology for data-centric metrology.

As discussed earlier, in multistage or highly connected production systems, the usage of Industrial AI technology is very important to establish an advanced quality management system, i.e., Stream-of-Quality™ (SoQ) for virtual and predictive metrology. SoQ integrates product quality using a blockchain-based information stream from various stages of manufacturing to increase the accuracy of performance predictions, prevent common failures and increase the traceability of process-to-process relationships [4].

SoQ keeps track of product quality at each stage and uses machine learning algorithms to predict the final product's quality by correlating individual stages' uncertainty with various quality attributes at part, process, and performance levels. To employ mathematical tools for correlating multi-parameter process data with stage-specific product quality, SoQ needs data from the following sources: 1) Man: Critical performance metrics defined by humans interacting with manufacturing machines. 2) Machine: Multisensory data is gathered from different machines' locations during production. 3) Material: Properties of the material used for manufacturing and their safe operating thresholds. 4) Method: Stage-specific operating conditions that are used for the physical transformation of material. 5) Environment: Knowledge about the effect of ambient conditions that are external to the manufacturing process but still influence the final product's quality.

3 Case study

The major battlefield in semiconductor manufacturing will be the advanced process technologies for 7 nm / 5 nm / 3 nm. TSMC and Samsung are the only foundry players that make chips using the 5 nm process node. TSMC is planning high volume production of 3 nm process in the fourth quarter of 2022; Samsung plans to start mass production using 3 nm process node in late 2022. New transistors and materials (FinFET vs GaaFET), new EUV scanner, new atomic layer deposition, smart process virtual metrology and inspection, yield improvement, and packaging will be the key technical challenges for 3nm and beyond. There are several areas using data-centric metrology for machine and recipe calibration that necessitate major breakthroughs. We have developed a digital twin methodology for integrated machine and recipe calibration for 7 nm / 5 nm / 3 nm manufacturing processes (Figure 2). Currently, we have received NIST funding to develop a Roadmap for Intelligent Metrology Systems for high mix semiconductor manufacturing.

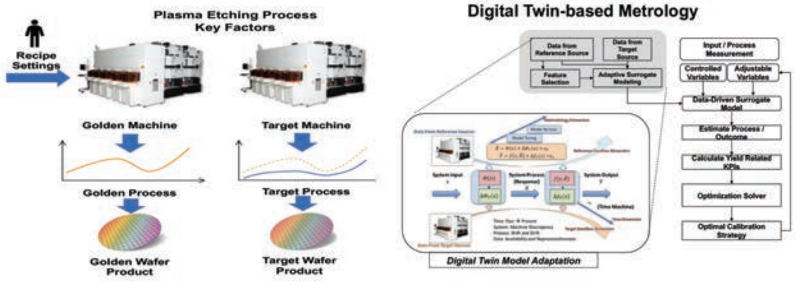

Figure 2: Digital twin methodology for integrated machine and recipe calibration for 7 nm / 5 nm / 3 nm manufacturing.

4 Summary

This article describes the concept of a data-centric metrology framework with the integration of Industrial AI and Cyber-Physical Systems, and SoQ. Real-time data collection, real-time decision making, root cause analysis and process-to-process relationship modelling, and optimization are some of the advantages that can be leveraged by implementing this kind of framework in highly connected production systems. The concept has been briefly explained with its implementation in semiconductor manufacturing.

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Sustainable Aviation: Aircraft Concepts and Production

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Abstract

This article deals with sustainability in aviation industry. Sustainability aspects are explained concerning operation of aircrafts, future aircraft concepts and the machining of integral parts. Here, adapted raw materials, machining strategies, NC-simulation and use of machine tool aggregates lead to improvements in the shop floor footprint and sustainability.

Keywords:

sustainability, aircraft, materials, machining, NC-simulation

Sustainability has become the most challenging strategic goal for the next decades to stop climate change. In aviation sustainability is now an integral part of business strategies and operations – whether through products, industrial sites or people. Specific targets for the main fields of sustainability are clearly defined by timeline and key performance indicators like reduction of CO_2-emission, energy, waste etc. for products and industrial footprint including the supply chain.

Civil air traffic produces roughly 2% of overall CO_2-emission caused by humans [1]. New aircraft concepts, more efficient turbofans and developments based on hydrogen propulsion are massively forced. Airbus has the ambition to develop the world's first zero-emission commercial aircraft by 2035. Earlier CO_2-emission reduction can be achieved by fostering a full value-chain in Europe to produce synthetic sustainable aviation fuel (SAF) at a large enough scale to allow testing in existing logistic infrastructures and in normal flight operations in Europe. The objective for commercial aircraft is to achieve certification of 100% SAF in flight by 2030 [1].

When looking closer to the production of aircrafts, of course, the structures, their materials and manufacturing methods become more important. Bionically inspired lightweight designs lead to optimized aircraft structures and parts, while Aluminum alloys compete with composite based materials for application. Composites might have advantages concerning weight but disadvantages concerning recyclability and cost. Sustainable low-cost lightweight structures might be realized by mainly using Aluminum material with best recyclability. Beside composite and Aluminum, Titanium, Inconel and steel parts will still be used for high temperature and/ or for high stress applications [2].

Due to very high part variety for aircraft integral parts with relatively small batch sizes, machining out of plate material is still widely in use with a high ratio of scrap, up to 98% [2]. Despite sorted recycling of chips and remaining material of clamping connections has been implemented for years, more near net shape raw material like die forgings, extrusions, castings and additive manufactured blanks will alternatively be fostered to minimize material and machining energy resources. Especially two additive manufacturing methods are under development: metal powder bed fusion and wire welding. Premium AEROTEC is already qualified for manufacturing parts made by Titanium powder bed fusion and delivers for example manifolds for the A320-family [3].

For the machining processes several new approaches and developments will lead to more sustainability. However, in the price driven global market for machined parts sustainability just starts to become a unique selling point. High performance machining technologies enables higher material removal rates with higher outputs per machine. According to the Kienzle equation, higher feed rates cause less energy consumption per removed material volume. E.g. for Aluminum machining, doubling the feed rate reduces energy consumption of a milling cutter by more than 15% per part [4].

But it is well known, that most of the energy consumption of machine tools are caused by aggregates. Here, especially coolant supply systems are in focus for energy savings. Frequency-controlled coolant medium pumps improve efficiency [5]. Today, machining operation specific coolant pressures can be chosen in NC-programs. Current developments in technological NC-simulations of milling processes will enable a calculation of current loads of operations with minimized coolant flow rates that are actually needed. Of course, specific energy control systems will more and more adapt energy consumption to different modes.

Hard metal machining leads to high tool wear. For Titanium machining Premium AEROTEC investigated tool wear depending as a function on cutting conditions like cutting speed, feed per tooth and width of cut. The developed tool wear model implemented in the technological NC-simulation enables a prediction of tool wear and simulated tool life times for the different machining operations in seral production [6]. Another research project deals with an automatic tool wear measurement for solid carbide milling cutters to minimize the removed material when regrinding. The overall target for reduction of the resource solid carbide by these activities is -30%.

The technological NC-simulation is another enabler to improve sustainability in machining. For new parts, that have to be produced, already optimized NC-programs reduce the number of iterative evolutions to get a qualified NC-program ready for serial production. By using technological NC-simulation, milling loads can be optimized, chattering can be detected and also tool deflection be can visualized [5]. More efficient milling processes with better part quality, less scrap and shorter machining times per part lead to more sustainability.

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Innovation in Challenging Markets: How Efforts in the Manufacturing Business to Build Ecosystems are about to Change

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Abstract

This document gives an overview about how current efforts in the tooling industry, in terms of building own ecosystems compared with the market standards need to be reevaluated. This combined with the approach of MAPAL to solve key questions in this aspect and how this translates to the demands of customers in the manufacturing industry.

Keywords:

digitization, ecosystem, tool industry, strategy

1 Introduction

Innovation is one of the value drivers for technology companies – digitalization is one of the key topics that has driven the developments in the past and will be in future as one of the major enablers in the aspect of process efficiency. In a time where change in different aspects, as are insecurity for market trends, demographical challenges, geopolitical powershifts, ecological problems and the influence of connectivity towards our society, finding the right focus is a big challenge.

This document gives a brief overview in which way this challenge can be encountered from the standpoint of a service and solution-oriented company that has its roots in developing customized cutting tool solutions for manufacturing features or designing whole processes for series production in diverse market segments. This with a high claim towards honest partnership that MAPAL gives, when moving things forward together with its partners.

2 Where the industry stands today

To understand where these challenges arise, a neutral perspective can help to understand the trustworthiness, relevance and significance of own efforts measured against the market standards. The markets standards when it comes to innovation in terms of successful business models, driven by a digital approach or by digital core competences are undoubtful defined by the big players in the markets: Google, Amazon, Meta, Apple, and Microsoft. Those companies deliver apparently simple solutions like Alexa serving you when it comes to do daily task, the iOS or Android Appstore's to extend your mobile with new capabilities, or standard operation systems that run 24/7 on billions of computers. To be able to deliver on a standard that enables the world to use those products on a world-class level those companies have spent a combined $126.900.000.000 in R&D efforts only in 2020 [1].

On the example of the amazon ecosystem, which are in some elements quite elementary as developing solutions for the questions "when is AI / Alexa allowed to talk or not", it is clearly visible where we stand today. This translated to the metal cutting industry and the trend, pushed by industry 4.0, where a lot of companies were putting in high efforts to build own ecosystems whilst developing all the elements in a high technological depth is quite contradictory. This also considering the market volume of the metal cutting industry.

Combined with the trends on the side of manufacturing companies, that are pushing towards focusing on own core competences which in most of the relevant cases is not focused on the cutting tool process itself. It is rather following the trends of their customers towards requirements that result out of the customization trends, the lack of resources and societal trends. This unavoidably causes a commoditization of the machining process with rising cost pressure. Out of this the scalable availability of metal cutting core competence in OEM quality is a key issue. Towards this issue and the question on how knowledge and the according provisioning and securing of it can work –the current approach of building own ecosystems is no solution.

3 How that translates into a strategy

To see ways out of the perspective of MAPAL to deliver towards those challenges first focus shall be on existing touchpoints. These touchpoints can be clustered in three main elements aligned to the customer process where MAPAL delivers services:

- Selection and consulting from product catalogue to project setup.
- Logistics, purchasing and operations as elements of tool management.
- Production process performance from optimizations to series production support.

To be more precise the following will only concentrate on the latter two since those are mainly affecting the customers cutting process in terms of efficiency in the use phase of the products.

There MAPAL has a full stack of solutions that are based on an open cloud platform, provided by an independent company within the MAPAL group, the c-Com GmbH. This open platform offers a collaborative approach to link customers with suppliers, supported by three main software-solutions: Tool-Management 4.0, Tool-Lifecycle-Management and Machines Analytics Solutions. Within Tool-Management 4.0 again you find services such as purchasing, logistics, presetting etc., and within those services again products like tool-cabinets including state-of-the-art tool management-software. Or as super summary: the complete technology stack from low-level-hardware up to a complete cloud-infrastructure. That stack is live for more than 8 years now and simply represents the common approach for building ecosystems, that MAPAL consequently implemented as core approach of being a technology leader that is in tune with its partners. Although the platform is open and state-of-the-art in all relevant aspects, as are service-oriented architecture, security, technology – the approach is very holistic from a customer perspective. Because in the end part of key processes (logistics, purchasing, data-management) run on the platform. And from a platform partner perspective, which can be other tool suppliers, coating companies or service companies, trust is always a key topic when acting in a common market. To overcome those challenges in line with the developments in the markets MAPAL has developed a strategy. This is based on knowledge, capabilities, and experience that MAPAL has now and the shift to deliver core competence in a secure, reliable, and qualitative way. The approach is splitting the parts that are already there, into so called manufacturing performance neurons – or better the smallest possible elements of value-add for customer processes in a first step. Whereas in the second step the leverage on key elements together with best practice technology partners are be dramatically increased. How this translates into practice can be seen in an apparently simple element – MAPAL vending machines core competences in sales, software- and hardware-development and after-sales are now enabling other industries and partners to deliver to the specific needs and challenges in their markets without reinventing what is already there. This delivered as an analogue and digital business services. What can be done with the most irrelevant piece – vending – is in development to work for relevant parts that are directly linked to the tool-performance on the machine.

4 References

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