Digital Transformation Monitor

Digitising mechanical engineering: leveraging the potential of the cloud and data

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The digitalisation of mechanical engineering presents immense benefits for European companies in terms of productivity and performance. The sector’s ‘cloudification’ is facilitating the access of European SMEs to cloud-based high-performance computing that is highly customisable and cost-saving. To unlock the full potential of the cloud and data for SMEs, more action is needed to standardise data treatment and scale-up investments in digital infrastructure.

The benefits of increased digitalisation for SMEs

The advantages of smart industry are enormous, including increased productivity, improved resource efficiency, reduced energy use, reduced total machine downtime and maintenance, reduced defects, and reduced time-to-market.

The digital transformation of mechanical engineering drives significant leaps in performance. On average, companies foresee a reduction of their operational costs by 3.6% per annum.

New and emerging players

The Industry 4.0 ecosystem and value chain is equally becoming increasingly complex. New market actors include providers of internet service connectivity, high-performance cloud computing, data storage solutions, big data analytics, digital service platforms, simulation, SaaS, 3D modelling and cybersecurity.

Industry 4.0 increases the need of companies to integrate and process data from various external sources leading to new models of collaboration. Along the value chain and throughout the product lifecycle, strategic alliances between different companies offering complementary technologies and services is becoming the standard.

Driving the modernisation of the EU Industry

Mechanical engineering driving the European economy

Accounting for a large part of the value creation potential of Industry 4.0, mechanical engineering covers design, prototyping, quality control, metrology, analysis, machining, production, maintenance and operation of industrial equipment.

With a significant share of the world market, the European Union is the world’s largest producer and exporter of machinery. According to estimations, the mechanical engineering sector employs around three million people. Moreover, the outlook for this industry is positive, with an expected growth of 3.8% per year over the next 10 years.

The rise of digitalised mechanical engineering and smart industry

Europe’s industry is central to its economy, with a value added reaching 15% of GDP. However, since the 1980s it has started losing some ground to tough competition from emerging markets.

The digitalisation of the mechanical engineering industry has been progressing steadily and essential functions of its value chain are increasingly being digitalised - with the introduction of digital, data-based services.

Figure 1: Mapping of new players and likely entrants in mechanical engineering

Source: McKinsey Digital 2015
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Tapping into the EU’s technological advances

Technological enablers of mechanico-engineering

‘Cloudification’ and ‘servitisation’ as key trends

Key trends driving the digitalisation of mechanical engineering and manufacturing are closely linked with ‘cloudification’, ‘digital glue’, ‘servitisation’, hybridisation of products and services, rapid prototyping, digital automation and mass customisation.

Some of the key technological enablers underpinning the digitalisation of mechanical engineering and production – as part of Industry 4.0 – include: 3D modelling, scanning and simulation, computer-aided design and engineering, cloud-based high-performance computing (HPC), lasers, cyber-physical production systems, robotics, connected manufacturing equipment, and advanced 3D metrology systems.

Next generation, cloud-based mechanical engineering services

The shift from ordinary computer-assisted design (CAD) and computer-aided engineering (CAE) software run on local machines to cloudified, on-demand, engineering applications is revolutionary for engineering firms. Due to ‘cloudification’, high-performance computing is now much more accessible to manufacturers, including SMEs. This is impacting production processes, from product design and prototyping to factory floor automations.

The delivery of cloud-based HPC services empowers manufacturers and engineers with on-demand access to scalable computing services tailored to their specific company needs, without the need for costly local infrastructure and software.

Cloud-based HPC services can also act as an enabler for the development of better, faster and cheaper solutions to engineering and manufacturing challenges.

The remote use of HPC services, integrated within engineering workflows, provides manufacturers access to increasingly computationally demanding data analytics, virtual product development and digital prototyping, 3D modelling and simulation tools.

In recognition of the benefits of the cloud, according to a survey carried out by the Digital Transformation Monitor, one third of the businesses in the mechanical engineering sector surveyed have adopted or invested in cloud-based technologies over the past three years.

Data is the new ‘digital glue’

While the key technological enablers of Industry 4.0 underpin the digitalisation of mechanical engineering, data is the ‘digital glue’ or ‘digital thread’ that connects and ties all the components together. Industry 4.0 and its technological enablers are above all data-driven. The paradigm shift is from the focus on physical assets to the optimisation of how data, treated as a valuable asset, is processed, analysed and shared across the entire value chain and product’s lifecycle.

New market opportunities through data

Massive quantities of data are created by employees, customers, processes, businesses, products and machines. The generation, collection, processing and sharing of this Big Data across companies, geographies and system domains, and within supply and value chains, and its transformation into smart data, is essential to take advantage of the Industry 4.0 enablers.

More than anything else, market opportunities and new value will be derived from this data – providing business insights along the entire value chain and optimising decision making.

Digital service infrastructures

A key enabler for ‘cloudification’ and ‘servitisation’ take-up

The realisation of collaborative engineering and manufacturing entails dedicated digital service communication infrastructures and architectures and the exchange of data in real-time.

Ultra-high-speed broadband connectivity

The development and expansion of fast and reliable Internet connectivity is essential to deliver next generation digital mechanical engineering support services. Indeed, the bandwidth-intensive services like cloud-based HPC and simulation require ultra-high-speed connectivity. However, access to ultra-high-speed broadband in Europe is still far from universal.

Network of Data and HPC centres

The generation of massive amounts of data requires data management, processing, storage, security, and vast IT resources – where cloud-based HPC will be a central resource. A pan-European, integrated network of data storage and processing facilities and HPC centres for industrial use would help to pool together IT resources for collaborative engineering and manufacturing.
Ownership, data flow and financial challenges

In order for industries to fully exploit the benefits of digitalisation, favourable framework conditions in Europe are needed, including a harmonised data protection regime, the free flow of data, and financial support for uptake.

Concerns over data ownership

A major challenge for the digitalisation of manufacturing and the ‘cloudification’ of mechanical engineering support services are doubts over ownership and protection of sensitive data. The digitalisation requires the clear determination of who owns the data generated and who will be allowed to control, access and analyse the data generated in the production process.

The conversion of the data generated into highly valuable and sensitive industrial knowledge reveals how manufacturers produce and distribute their products. For this reason, it is essential to ensure the legal protection of this data under an adequate and harmonised data protection regime.

The generation of vast quantities of information, collected and shared with partners in a value chain network, and stored and analysed in the cloud, calls into question who owns the data generated, and who will be allowed to analyse it - the creator, manufacturer, engineering SaaS provider, the cloud vendor or HPC service provider, etc.

Barriers to the free flow of data

The free flow of data in Europe is a fundamental prerequisite for Industry 4.0, collaborative manufacturing, cloud-based computing and digital mechanical engineering services. The removal of both restrictions on data flows within Europe and regulatory barriers is thus a central part of the Digital Single Market (DSM) strategy, the Cloud Computing Strategy and the reform of Europe’s data protection framework.

The 2014 ‘Trusted Cloud Europe Report found that the development of cloud-computing services is hampered by uncertainties related to legal/regulatory barriers that restrict the possibility of storage and processing of certain data outside the territory of the Member State in which the data is generated. Restrictions can also be rooted in the perceptions of institutions or companies, relating to the frameworks governing cross-border data flows. Moreover, the types of barriers that were identified in a workshop by the European Commission in February 2015, included explicit and implicit compliance obligations on the basis of legal acts and requirements related to user preferences.’

What is essentially lacking and required is a clear, transparent and harmonised regulatory system in the EU that permits the free flow of data across borders. The General Data Protection Regulation (GDPR) addresses the diversity of national data protection laws and covers personal data, but does not adequately address non-personal data. Non-personal data generated by machines without any personally identifiable information remains mostly unregulated.

Lack of interoperability and standards creates data silos

In order to establish collaborative engineering and manufacturing, the collection, processing and sharing of data across companies, value and supply chains, and clouds needs to be realised. The data interoperability challenges that arise from the diversity of systems, standards, processes and tools etc. limits collaborative manufacturing and engineering.

The sector still lacks a uniform, industry-wide standard for industrial data creation and sharing. In addition, the construction of walls around and between business processes and along supply and value chain networks has resulted in data islands of information, leading to inconsistent and/or redundant data at the value chain level.

Addressing financing gaps and required investments

The uptake of big data and digital platforms in mechanical engineering and the implementation of Industry 4.0 solutions in particular are new to many companies and require considerable need for investment. Often, the entire production capacity has to change to benefit from digital technologies.

Roland Berger estimated that Europe has to invest EUR 90 billion per year in the next 15 years to take the lead in smart industry. This amounts to a total of EUR 1,350 billion.”

On top of that, the aversion to risk and uncertainty regarding the integration of the new technologies is one of the main barriers to the adoption. Beyond buying the required technologies, companies need to also transform their organisation and culture.

The Investment Plan for Europe

The economic crisis negatively impacted investment across Europe. Coordinated efforts at European level are needed to address this downhill trend. The European Commission set out a strategy based on structural reforms, fiscal responsibility and investment.

At the heart of this strategy, the Investment Plan for Europe was launched, focusing on reducing investment obstacles and providing technical assistance to investment projects.

The European Fund for Strategic Investments was created and Member States are working together with the European Investment Bank in setting up investment platforms.

Figure 3: Obstacles to take up of cloud and data of EU companies

Source: CARISSA

Rise of smart industry

3.8% expected annual growth of the EU mechanical engineering sector over the next 10 years
Enabling manufacturing SMEs to digitalise

The digitalisation and ‘cloudification’ of mechanical engineering processes and services provides manufacturers/ engineers with access to scalable computational services. Firms that use cloud-based HPC services can benefit from better, faster and cheaper solutions to address design and manufacturing challenges.

At the core of the European industrial renewal are European manufacturing SMEs. It is, therefore, crucial that SMEs are equipped with the new tools available to support their activities. SMEs are, however, significantly slow to catch the digitalisation train and often have only limited resources to exploit the opportunities of digital transformation.

Manufacturing SMEs face immense difficulties to access the financial sources necessary to invest in the adoption of new technologies and digital mechanical engineering services. The production of complex products increasingly requires tailored design applications that are often too costly for manufacturing SMEs.

SMEs have, therefore, much to gain from the cloud, since access to HPC solutions would otherwise be out of their reach. Cloud-based services can be feasibly procured and used on-demand. Engineers can search for the digital services best suited, and simply rent the service on a temporary basis.

Support experiments, demonstrations and large-scale pilot projects to show SMEs the road to digitalisation

Before significant investments are made, SMEs require technology uptake support and funded experiments or pilot projects to reveal the concrete examples of implementation with functioning business models and demonstrated results in improved productivity and resource efficiency.

To achieve an impact, the experiments must be results-driven and not technologically-driven – addressing also the needs of low-tech sectors.

SMEs need to start off with experiments, in order to alleviate scepticism towards the new technologies and services, and before proceeding with the required long-term investments.

Europe’s I4MS initiative (ICT Innovation for Manufacturing SMEs) constitutes an excellent example of a financial support instrument dedicated to supporting the digital transformation of SMEs through experiments, focused on HPC, lasers and simulation.6 Not only SMEs will benefit from this increased uptake and demand. Digital engineering service providers, for example, will better know how to invest in the enhancement of their services and technologies that caters to SMEs, and how to broaden and mature the field of their applications, ultimately opening up new markets.

Deploy vouchers for digital mechanical engineering services

There is a need for facilitating and funding the SME uptake of the Industry 4.0 enablers and digital mechanical engineering services through the use of voucher programmes, which have also worked well in other areas for SMEs.

Digital Manufacturing Innovation Hubs

However, the main barriers to SMEs’ adoption of these new technologies/services are not only financial, but also skills-related. SMEs require access to competences that can help them master the digital transformation. Competence centres, in conjunction with other relevant actors spread across Europe, can provide support to SMEs.

To tackle these challenges, a key element of the Digitising European Industry strategy includes the Digital Innovation Hubs (DIHs). Competence centres participating in these DIHs support SMEs in their digital transformation.10

Box 1: Ergolines: HPC-cloud-based simulation of steel casting

The Italian manufacturing company Ergolines produces a wide range of products for the production of specialty steels. The company faced problems with slag carry-over from the ladle to the tundish that led to impurities in steel, waste or poor ladle yield.

Ergolines obtained insights about the physics of the system and the different ladle-emptying mechanisms through dedicated HPC-based simulations and case validation. The results enabled the development of a new slag monitoring technology, that is only feasibly available through a HPC system. Crucially, due to the significant computational load, Ergolines opted for cloud-based HPC system, which reduced the running costs of a dedicated infrastructure and the need for specialised skills concerning its operation.

The HPC resource not only contributed to improved product design, productivity and occupational safety, but also reduced the time to market processes. Compared to a production of 1 million tonnes annually, a medium-size factory could save around 6,000 tonnes of steel, which does not need to be re-melted. This in turn enabled total savings of around EUR 490,000 to EUR 670,000 for Ergolines.11

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About the Digital Transformation Monitor

The Digital Transformation Monitor aims to foster the knowledge base on the state of play and evolution of digital transformation in Europe. The site provides a monitoring mechanism to examine key trends in digital transformation. It offers a unique insight into statistics and initiatives to support digital transformation, as well as reports on key industrial and technological opportunities, challenges and policy initiatives related to digital transformation.


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