DIFERENT APPROACHES TO THE DEVELOPMENT OF FACTORY OF THE FUTURE

ROZDIELNE PRÍSTUPY PRE ROZVOJ TOVÁRNÍ BUDÚCNOSTI

Milan KOVÁČ

Abstract
The concept of the future factory was formulated at the turn of the millennium. It is further developed and continuously confronted with technological developments and changes in the social and economic environment. The present paper analyses the key megatrends and their decomposition for future factory. It has been prepared on the basis of the current study leading research organizations and consulting firms.

Key words
factory of the future, innovation megatrends

Introduction

Manufacturing companies are adapting more digital technologies to network and transform their manufacturing processes. The "factory of the future" can be broadly defined as a future view of an interconnected manufacturing value chain, involving information and communications technology (ICT) and automation technologies. Software will holistically interconnect and manage distributed factory assets. Embedded data collectors in processing centres will be linked to cross-functional enterprise systems, enabling real-time two-way data exchange and full production quality control. In the "factory of the future", the adaption of various digital technologies will also enable the data exchange from R&D (CAD , virtual simulation tools, rapid prototyping) to the factory floor (automation/robotics, control technologies, product lifecycle management (PLM), additive manufacturing) to distribution partners (analytical applications) and back, from suppliers to OEMs to customers, and vice versa.

KPMG Top Ten Innovation Megatrends

Expert panel KPMG Industrial Manufacturing 2014 [1] identified and analysed 10 mega trends of strategic innovation in the industry. Factory of the future (FoF) mega trends is in the first place, while the other mega trends related to the FoF. Identification of the mega trends is Tab.1.

According to this study determined the development of FoF these main drivers:

- Manufacturing companies look to externalise back office services to focus on core operations.
- Risks associated with supply chain management are increasing in low-cost countries.
- Labour wage rates in offshore locations in emerging economies like China, Indonesia, Thailand and others are increasing, as workers are demanding higher wages.
- Cost of shipping goods around the world is rising due to higher fuel prices.
- Eastern Europe has emerged as a location for near shoring operations, backed by favourable factors like highly skilled talent, especially technical talent and close proximity to end markets in EU.

Tab. 1

1. Factory of the Future • Automation may be even more cost effective than outsourcing manufacturing to developing economies. • Within an interconnected manufacturing value chain, companies will face increasing industrial IT security risks. • Increase in legal provisions, regulations and industry standards.	**2. Talent Challenge** Demand for MINT talents (machinists, tool makers and machine programmers) is on the rise. • Adding to the economic pressures will be a steady increase in wages for "rare" specialists.
3. Near-shoring • Manufacturing companies look to externalize back office services to focus on core operations. • Wages in offshore locations are increasing. • Eastern Europe is expected to witness significant manufacturing inward investment in the near future.	**4. Nanotechnology / Nanomanufacturing** • Nanotechnology is expected to have a big impact on sustainability in the near future. • Unknown environmental, health and safety implications arising from nanoparticles during their lifecycle present research-based industries with significant challenges and opportunities in risk management.
5. Demand Shift to the East • Asia's economic influence on the global landscape is growing. • Increasing importance for local R&D, production and assembling facilities, regional supply chains and adapting products to meet the needs of local markets.	**6. Service Driven Business Models** • Manufacturers should find ways to sell ongoing services to their customers by taking a holistic view of customers' needs. • The challenge for manufacturers is to commercialise scientific and technological innovation into a marketable product and service combination.
7. Cluster Manufacturing Clusters will become a key pillar for strengthening the manufacturing industry in terms of innovation and efficiency. • It will be important to remain in close physical proximity to the engineering centres of major customers, as well as a scientific research institutes in Europe.	**8. Sourcing Governance** • Companies need a highly skilled procurement organization engaged at appropriate levels of the value chain employing disciplined, rigorous world-class processes. • The sourcing governance approach focuses on the complete external supply chain of the company – suppliers and pre-suppliers.
9. Resource Efficiency • Commodity prices, energy usage and logistics management will become more crucial to maintain competitiveness. • Automated manufacturing and new production technologies are expected to play a key role in reducing materials and energy usage and reducing waste.	**10. Additive Manufacturing / 3D Printing** • Additive manufacturing or 3D printing will set up new business models with effects on industries, companies and society. • Increasing importance of a company's value-chain structure to be successful in a "disrupted new supply chain world".

AMRC Analysis of the Factory of Future

The National Metals Technology Centre, University of Sheffield published a complete study of the issue FoF. [3]

The study was based on a review of published material, structured interviews with senior executives from large companies and SMEs in Europe, the USA, Japan, as well as interviews with other experts in the area.

The main findings for the manufacturing sector are:

Expected developments in the physical arrangement FoF

The desirable physical arrangements are not specifically related to industrial sectors and include factors such as:

- Smaller factories.
- High visibility with clear lines of sight of all operations.
- Perception of a light, spacious and clean working environment.
- Good workspace utilisation.
- 'Open', welcoming factories offering access to customers, suppliers, universities and the general public (with role models emerging especially in the automotive sector.
- Increased urbanisation and potential to build factories in the city.
- Factories with a 'wow' factor that are attractive places in which to work.

Technology trends that will have a significant impact on the Factory of the Future:

- The influence and use of automation & robotics.
- The consequences of environmental pressures and zero waste approaches on the recycling of materials and products within the supply chain.
- The factory is seen as digital, having increasing intelligence and or exploiting the opportunities of big data.
- Software tools are increasingly being seen as much simpler and easier to use, in addition to being more intuitive.
- Nano technology as having the potential to make a significant impact. This may be in the form of nano coatings and nano materials, which can produce a step change in materials performance.
- The technology required in the FoF is seen to be already available within the more traditional industry sectors and it is the focus on the exploitation and use of the technologies that is becoming important. For instance 5-axis CNC machine tools and robots are readily available but the optimum operation of these machines and the move from in-process measurement and monitoring and adaptive control to self-learning will be realised in the FoF.
- The FoF will include systems designed to reduce ramp up times dramatically, allow for autonomous code generation, support the quick change over from manual to semi-automatic to automatic and allow the reuse of existing equipment in new lines.
- Rapid reconfiguration and fast ramp also implies increased use of simulation and modelling, testing factory layouts and processes in a virtual reality environment, virtual factory design and virtual factories, in addition to increasing use of plug-and-play technologies.

Flexible, agile and adaptable production facilities to deliver a new value proposition and business models incorporating manufacture and delivery of smaller, more frequent, 'on demand' batches of products:

- Design and construction of smaller/reduced footprint modular facilities using standardised facility layouts and process configurations.
- Evolving incorporation/integration of single use (disposable) upstream and downstream process systems.
- Closed systems with facilities moving towards non-classified.
- Simulation tools for factory layout/bioprocess modelling/technology transfer.
- Continuous processing and automation: Process Analytical Technology, robotics and platforms for mechanical.
- Increasing complexity of global supply/value chains – local, demand- led, reconfigurable for new business models and linked to more agile, responsive manufacturing operations and improved connectivity/ integration of whole value chain (including the regulator).
- Distributed manufacturing: construction of 'vital organs' with local responsiveness in geographically diverse locations and emerging markets.
- Multi-function/multi-product processing suites: intensification in smaller footprint, scalable/phased modular build.
- Global rationalisation of duplicated 'big pharma' plants/supply chains with move towards global centres/hubs of manufacturing excellence and local supply chains.
- Bioprocess sustainability focussed on green construction, green chemistry and reduction in consumption of water, energy and cleaning.

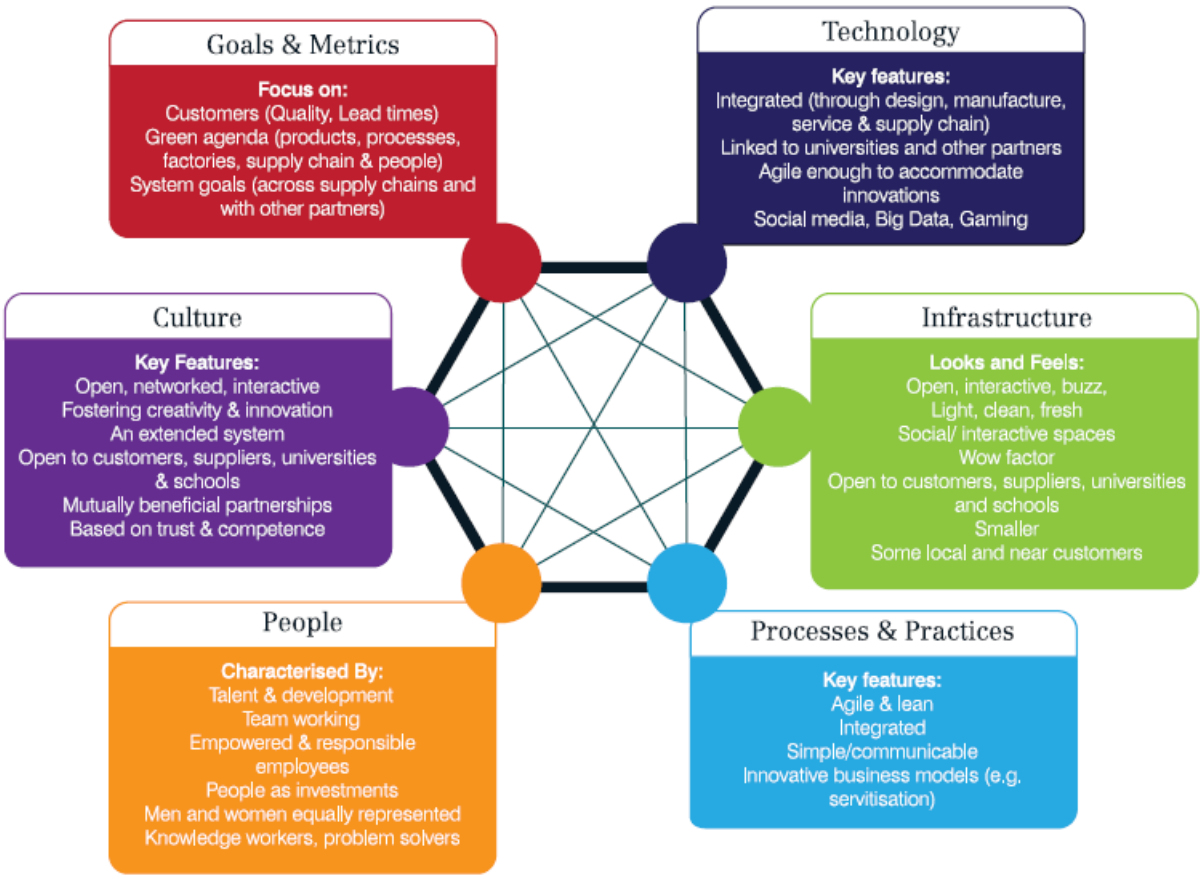

Figure 1: Characteristics of the Factory of the Future

Conclusion

The issue FoF is a complicated and complex system with shared common objectives and structural characteristics. It also has specifications for different industrial sectors and source innovative potential of individual countries and their groupings.

For research and development applications of FoF in practice for Slovakia is a key EU Programme the Factories of the Future PPP. [4]

The programme FoF initiative is a € 1.2 billion programme in which the European Commission and industry will support the development of new enabling technologies for EU manufacturing which have cross-sectorial benefits and contribute to greener production. Achieving continued growth and sustainability depends on a long-term shift from cost-based competitive advantage to an approach based on high added value. In this Strategic Multi-annual Roadmap for the FoF PPP, four major priority areas have been identified:

- Sustainable manufacturing,
- ICT-enabled intelligent manufacturing,
- High performance manufacturing,
- Exploiting new materials through manufacturing.

In response to the megatrends European manufacturing sectors need to undergo innovation-driven transformations towards the Manufacturing 2030 vision.

The Factories of the Future PPP identifies and realises these transformations by pursuing a set of research priorities along the following research and innovation domains:

- advanced manufacturing processes
- Adaptive and smart manufacturing systems
- Digital, virtual and resource-efficient factories
- Collaborative and mobile enterprises
- Human-centred manufacturing
- Customer-focused manufacturing.

Each of these domains embodies a particular aspect of the required transformations towards the factories of the future.

This contribution is the result of the project implementation: VEGA 1/0879/13 Agile, the market adapting business systems with highly flexible corporate structure

References

[1] Industrial Manufacturing Megatrends Research. 2014 KPMG AG
[2] Factories of the Future - Strategic Multi-annual Roadmap. EUR 24282 EN, 2010, ISBN 978-92-79-15227-6/v
[3] RIDGWAY, K., CLEGG, W., WILLIAMS, D.: The factory of the future. The National Metals Technology Centre, University of Sheffield AMRC 2013 ISBN-13: 987-0-9927172-0-9 53p.
[4] FACTORIES OF THE FUTURE Multi-annual roadmap for the contractual PPP under Horizon 2020 EFFRA Manufacturing Initiative EU Luxembourg: Publications Office of the European Union, 2013, ISBN 978-92-79-31238-0

Kontaktná adresa

Prof. Ing. Milan Kováč, DrSc. TU Faculty of Mechanical Engineering,
Department of Automotive Production
Mäsiarska 74, 040 01 Košice
E-Mail: milan.kovac@tuke.sk