

New trends and concepts of maintenance management in technical service

Katarína Štaffenová ¹, Miroslav Rakyta ², Miroslav Fusko ³, Marek Štepo ⁴

¹ University of Žilina, Faculty of Mechanical Engineering, Department of Industrial Engineering

Univerzitná 8215/1, 010 26 Žilina, Slovakia

katarina.staffenova@fstroj.uniza.sk

miroslav.rakyta@fstroj.uniza.sk

miroslav.fusko@fstroj.uniza.sk

marek.stepo@fstroj.uniza.sk

Annotation: This article deals with new trends and concepts of maintenance management to improve processes in technical service. The critical part will also be the description of maintenance management in the Industry 4.0 concept. Correct and optimised maintenance can reduce operating costs, ensure the safety of employees and reliability of the equipment and the working environment. Due to new technologies and methods need to be improved and implemented into factory processes. E-Maintenance is one of the newer approaches in the maintenance solution.

1 Introduction

We live in a time when our technology is spread across all fields of our lives. The same is true for factories. Increasingly they rely on advanced technology and equipment as honest human work. The truth is that advanced and disrupt technologies and machinery increase quality and productivity, but it also means increasing the maintenance processes and effective care for these devices. Maintenance is a set of operations (complex work) that are being made to ensure the specifications, an operational state of the art object, and define and assess the actual condition. The main objective of the maintenance is to minimise the total cost of production and profit maximisation while maintaining system quality - date - price - reliability [1].

Correct maintenance is primarily a prerequisite for maintaining the safety and reliability of equipment and the working environment. Secondly, maintenance represents hazardous activities and must be done safely by maintaining the protective measures in the case of maintenance staff and other people in the workplace. Nowadays, our classical conditions in our lives and the factories too, are transforming into smart and intelligent ways with sophisticated devices, machines and equipment. It is not possible to solve only routine maintenance of machinery and equipment anymore. Therefore, we have to solve an expansive complex of works, also called technical service [2].

This wide range of activities requires the use of theoretical and practical knowledge from multiple disciplines. The issue of maintenance has become a studied topic of multiple disciplines in the last few years, like mathematical models, network analysis, processes of wear and fatigue of materials, theory of operational reliability, methods and the technic of maintenance, technical diagnostics, information systems, applications CAx technology and many others. The economic consequences of optimising maintenance management and recovery using diagnostic techniques are extensive and represent significant operational cost savings. Implement a suitable maintenance management system will increase operational efficiency and quality in each factory. Within the system, there are collected, monitored and analysed not only failures but also the wear of essential units and components and designing of logistics purchase of parts and materials. The strategic objectives of maintenance management can then include:

- initiating and promoting lifelong learning of maintenance manager;
- initiating and promoting lifelong learning of maintenance specialists;
- organising of specialised courses as needed in maintenance practice.

2 Methodology

The maintenance strategy, as time changed has developed together with each factory. It changed from maintenance after failure through periodic preventive maintenance to diagnostics maintenance, based on discrete or a continuous monitoring of the technical condition and predicting the next period of use to limit state for maintenance, while respecting the principle of proactivity when performing maintenance.

Nowadays, informatisation and digitisation predominate in society. This process cannot avoid technical service. New maintenance strategies develop "at a distance" with integrated software technical subsystems such as CNC and NC controllers of machine tools or automobiles [3]. Using new strategies and disrupt technologies is possible to say that the technical service also enables highly developed telecommunications technology. At present, it is no problem to, e.g. technical condition of machine bearings or the technical condition of selected components of cars was be monitored remotely even from long distances with the intention that the fault is removed or the device will be arranged at a distance. This is done without the presence of staff of technical services, and operators are instructed to only what they have to perform.

Nevertheless, it must be pointed out that the machines and equipment will always require maintenance performed by technical services workers. There will always be necessary to provide highly qualified personnel, technical information, spare parts and materials, finance, workshop infrastructure, and tools and diagnostic equipment. In the future, the theoretical basis for developing maintenance programs and diverse strategies will be the reliability

of technical systems, risk management, unique engineering technology, information technology, project management, queuing theory, electronics and electrical engineering, economics and many others. In the future, it will also be necessary to avoid ideas and mistakes of the past that kind of maintenance trend and predictive maintenance will solve everything. This can be only a basis for the factories, what to build on. I think it is important that factories have undergone a maintenance system from the beginning (e.g., maintenance after fault, preventive maintenance, TPM and so on) because in other ways, factories will not understand how they operate and will not find the optimal solution for their operating conditions [4], [5].

3 Industry 4.0

Society 4.0 and Industry 4.0 concepts have become fundamental development programs of more economics for the following few years. It blends the efforts of scientists and industry into an integrated system. Industry 4.0 is built on the latest technology applications, as is the Internet of Things (IoT) and cloud computing, which, together with the industrial system, creates cyber-physical systems (CPS). At present, we are talking about the Industry 4.0 concept as the future of productivity and growth in the manufacturing industry. Industry 4.0 concept change everything from designing, production and operation to the maintenance of products and production systems. The connection and interaction between parts, machines and people allow the production system to be up to 30% faster and 25% more efficient, which will promote mass customisations to a new advanced level [6].

The SMART phenomenon has recently been fully settled among people. We are surrounded by SMART THINGS as telephones, TV, cars, machines, washing machines, cookers (fuzzy logic), fridges, and others when we look around us. It is the next stage of human development (Fig. 1), connecting all the knowledge people have learned in different areas. At present, it is already expected that companies have automated their processes. This is the first proposition of the smart factory. Traditional production systems use information and communication systems (ICT). In a few years, each device will be connected to the Internet. Internet of Things (IoT) is already nowadays one of the vital strategic technologies of our time. One of the premises for the formation of Industry 4.0 was research in the domain of Digital Factory, reconfigurable systems, intelligent systems, automation and simulation, etc. [7], [8]. These areas, we also deal with at the Department of Industrial Engineering at the University of Žilina.

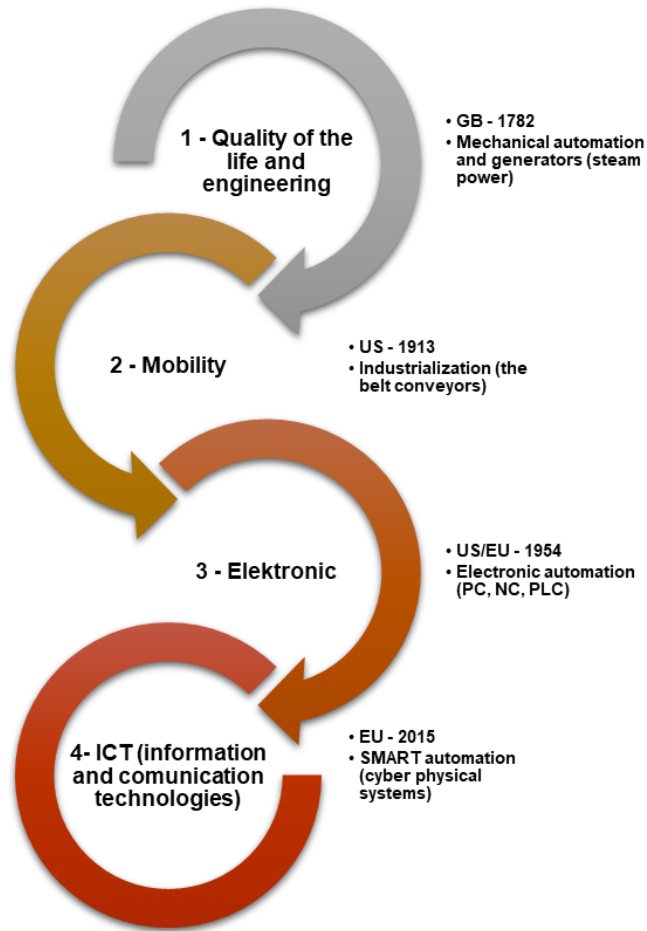


Figure 1 - The development of the industrial revolution

3.1 Maintenance 4.0

Whenever industry has developed, or something new was found, the maintenance has also adapted. Today it is the same way. Maintenance management already has the premise to become SMART. Maintenance 4.0 will be an advanced distribution system of components that provides information about the condition and reliability of distribution components for correct maintenance management strategies and asset management. This information about the condition and reliability of distribution components are vital issues for the correct maintenance management strategy and asset management (Fig. 2). Prysmian Group has developed an advanced system for monitoring the distribution components to guarantee actual savings in maintenance costs. For example, "Par-SMART Aden" is a solution based on the label containing the product details on the RFID tags. Using this smart label on the distribution component, we will record the history of monitored components. This solution will be able to watch new and old parts [9].



Figure 2 – Gather information in real-time showing on tablet [10]

Hereabouts, raises the question: “Is this still maintenance?” At the fair in Munich, the company Apple introduced a variety of smartphones and tablets configured for maintenance equipment. Known service provider Bilfinger introduced a new mobile information system and the concepts of data management for cloud-based solutions. Based on these arguments, it can be said that the Internet of Things (IoT) has walked into the world of maintenance. Visitors could take a picture by their mobile phones and tables and share images with colleagues and business partners in real-time.

3.2 e-Maintenance

Maintenance gained much attention from experts and people from praxis for her impact on the operation of the business and business processes by ensuring safety, reliability and reducing the system's life cycle costs. However, maintenance costs are a significant part of the total operating costs for many businesses and factories due to they represent 15 – 40 % [6] of the cost of manufactured products. Poor maintenance can cause damage to the system and the lack of quality that represents financial losses due to delay, customer complaints and distorted product specifications.

The concept of e-Maintenance is increasingly used in many factories in advanced countries like the United States or Western European countries. This concept can reduce factory risks and adds value to the process in today's competitive business environment [11]. Despite the potential application of e-Maintenance, it is necessary to consider several issues for the successful implementation of e-Maintenance systems in various frameworks. Growing turbulence in the global environment, increasing the level of automation and ICT (information and communication technologies), calls for sustainability and green production, the increasing complexity of production lines and products, lack of raw materials, the instability of the supply chain, growing emphasis on knowledge generation and application, have considerable pressures on the role of e-maintenance in factories for promoting competitiveness of factories [9].

Although research in e-Maintenance in the past ten years has snowballed, there is a lack of emphasis on the development (Fig. 3) of conceptual frameworks that integrate the fragmented vital topics in the research of current e-Maintenance. E-Maintenance research is currently still imperfect.

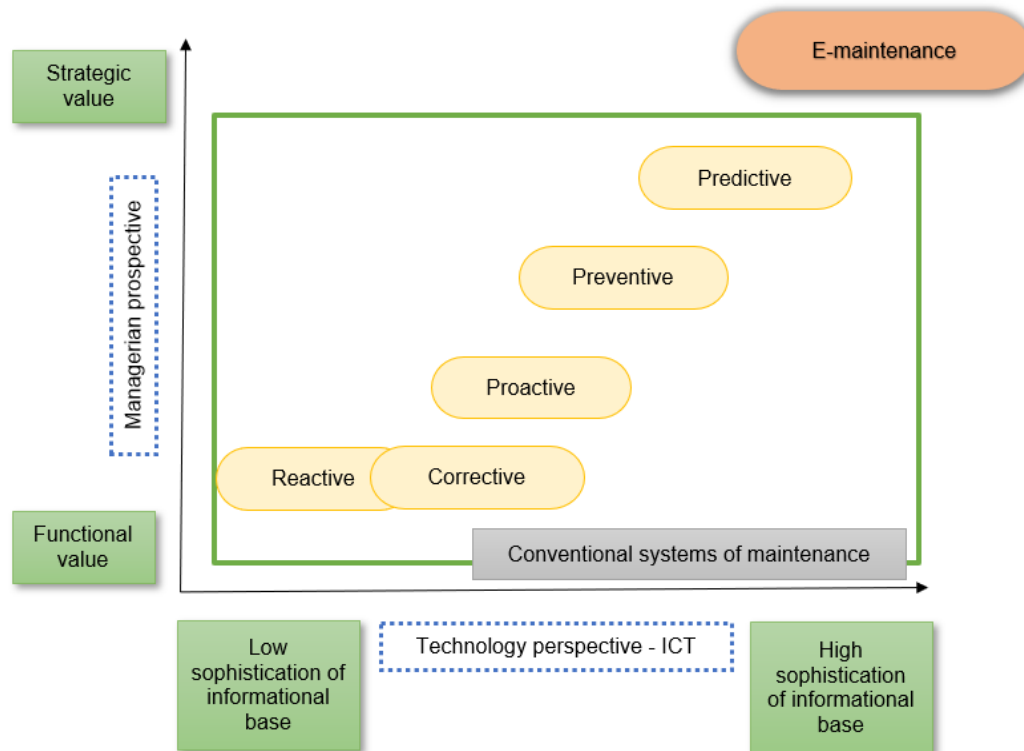


Figure 3 - Position of e-maintenance in development of maintenance

There is a lack of standard definitions and universally recognised basic theory, an unclear scope of use and a lack of commonly defined components associated with e-maintenance. Attributes of e-Maintenance approach [6]:

- e-Maintenance is strategy;
- e-Maintenance supports decision making at different factory levels;
- e-Maintenance has excellent possibilities for cost-effective decisions to be made;
- e-Maintenance blends principles of maintenance with e-business or e-application technologies such as telecommunications and web services, mobile, wireless and portable devices and other forms of electronic collaboration;
- e-Maintenance monitors and manages systems and assets via the Internet connection;
- e-Maintenance blends production and maintenance systems;
- e-Maintenance gather information and feedback from remote customer locations and blends it into the top levels of factory applications;

- e-Maintenance forms dynamic and real-time information about maintenance that allows us to use the knowledge of the assets and manufacturing systems;
- e-Maintenance introduces scientific approaches and methods which forecast a system accuracy and increase productivity for better competitiveness.

4 Discussion

Today, we have trends of optimisation and process improvement, especially in production and logistics systems. There are applied innovative and disruptive technologies like digital factories, smart solutions, reconfigurable systems, adaptive logistics systems, artificial intelligence, etc. The problem that we see is in forgetting about administrative and service activities.

With the rapid development of science and technologies, more sophisticated machines and equipment are also developed. With such machines, routine maintenance cannot take advice. The greater standardisation will have to be implemented (but not excessive). The spread of information and communication technologies (ICT) and various hardware will help technical service workers. In the future, there will be, for example, a production line composed of many robots, manipulators and various devices that will carry out their activities.

If a fault occurs on a device, technical services staff will have to enter the failure with the essential tools and information. What can he expect? In the future, one person will have, for example, in charge of several machines, equipment's or robots (depending on the complexity). The production will be automated and will be performed by machinery, equipment or robots. People will have to do everything to make the entire process of work. The workers must be notified about the failure and get to it as soon as possible, either through SMS, email, sound or visualisation system. These technologies and new processes will reduce the failure times and its quick remedy.

5 Conclusion

Since the beginning of 2015, we have known the phrase Industry 4.0. Gradually with this term comes the other, for example, Society 4.0, Smart Factory, Maintenance 4.0, Factory of the Future, Logistics 4.0, etc. With these terms come factories mass customisation, more complex value chains, more than ever must be carried out controlling resources, assets and processes and regularly have to be reconfigured. The requirement has the data in real-time, reducing failures and interruptions, optimisation of resources using. Accordingly, it is necessary to have a solution that will give factories more comprehensive availability, productivity, flexibility and quality. Based on these premises, is it necessary to implement innovative and disruptive solutions in factories and the development technical service department in the factories.

As long as the factories will implement only high-tech and production or logistics and technical services will not develop, such systems' long-term sustainability will not be possible.

Acknowledgements

This work was supported by the VEGA 1/0248/21 – Research of innovative solutions for segmentation and sustainability of product regarding assembly operations.

References

- [1] TREBUŇA, P. – KLIMENT, M. – TROJAN, J. – MIZERÁK, M.: Digitalizácia výrobných procesov a systémov. - 1. vyd. - Košice : Technická univerzita v Košiciach - 2020. - 343 s.. - ISBN 978-80-553-3781-4.
- [2] ANTONIUK, I. – KRAJČOVIČ, M. – SVITEK, R. – KOLESNYK, O. – DULINA, Ľ.: *Design of automated logistics system in a digital factory area*. In: Technologie, procesy i systemy produkcyjne [print]. - 1. vyd. - Bielsko-Biala: Wydawnictwo naukowe Akademii techniczno-humanistycznej w Bielsku-Białej, 2018. - ISBN 978-83-65182-97-5. - s. 11-18 [print].
- [3] TSANG, A. H. C.: Strategic dimensions of maintenance management. In: Journal of Quality in maintenance Engineering, 2015. 8 (1), s. 7-39. ISSN: 1355-2511.
- [4] BUBENÍK, P. – ČAPEK, J. – KOVÁČOVÁ, L.: Blockchain and its application in industry. In: Technológ [print]. - ISSN 1337-8996. - Roč. 11, č. 2 (2019), s. 75-78 [print].
- [5] MOZOL, Š. – GRZNÁR, P. – ORAVEC, M.: Manufacturing paradigms and their change in time. In: Průmyslové inženýrství 2020 [electronic] : Mezinárodní studentská vědecká konference: Sborník příspěvku. - 1. vyd. - Plzeň: Vydavatelství Západočeské univerzity v Plzni, 2020. - ISBN 978-80-261-0969-3. - s. 163-168.
- [6] ABOELMAGED, M. G. S.: E-maintenance research: a multifaceted perspective. In: Journal of Manufacturing Technology Management. roč. 26, č. 5, 2015. 606-631 s. ISSN 1741-038X.
- [7] KOVÁČ, J. – RUDY, V. – TÓTHOVÁ, J. – RUSNÁK, J.: Application of virtual reality in machine and equipment maintenance. In: Transfer inovácií: internetový časopis o inováciách v priemysle. - Košice (Slovensko): Technická univerzita v Košiciach č. 41 (2020), s. 82-86 [online]. - ISSN 1337-7094.
- [8] PEKARČÍKOVÁ, M. – TREBUŇA, P. – K VÁ, J. – EDL, M.: Procesný manažment. 1. vyd. - Košice : Technická univerzita v Košiciach - 2020. - 235 s.. - ISBN 978-80-553-3750-0.
- [9] LHOPITEAU, B.: Maintenance 4.0 for the worker of tomorrow. Siveco China Newsletter, 2015 [online]. 2021 [cit. 2021-09-15]. Available at the Internet: <http://newsletter.sivecochina.com/en/reliability/maintenance_4-0_for_the_worker_of_tomorrow/#.VSdm2_6U5gA.linkedin>

- [10] Gather information in real-time showing on tablet. 2021 [cit. 2021-09-15]. Available at the Internet: <<https://www.rolandberger.com/en/Insights/Publications/Autonomous-production-Rise-of-the-machines.html>>
- [11] LEVRAT, E. – LUNGA, B. – MARQUEZ, A. C.: E-Maintenance: review and conceptual framework. In: Production Planning & Control. ISSN 0953-7287. 2008, roč. 19, č. 4, pp. 408-429.