> Smart Maintenance for Smart Factories

Driving Industrie 4.0 through smart maintenance

acatech POSITION PAPER – Executive Summary and Recommendations

acatech
NATIONAL ACADEMY OF SCIENCE AND ENGINEERING

With Industrie 4.0, Germany is on the brink of a new industrial age in which smart factories – the intelligent factories of the future – will occupy a central role. In order to realise this vision, it will also be necessary to ensure that smart factories benefit from smart maintenance that is equipped to meet tomorrow's challenges. Smart maintenance will help to secure jobs in industry, manage the complexity within smart factories and drive Industrie 4.0 by acting as an engine of innovation and a source of knowledge.

Maintenance essentially involves the planning, organisation, implementation and monitoring of all the technical and administrative processes associated with inspecting, servicing, repairing and enhancing machines and systems. As such, it ensures the machines' availability and reliability, both of which are key to the efficiency of industrial production. In Germany alone, maintenance helps to ensure that machines and systems worth more than 2.2 trillion euros are kept running. The economic benefits of maintenance accrue both from direct maintenance work such as repairs to machines and systems, helping to maintain or even increase their value, and from preventive maintenance work that serves to prevent breakdowns and the associated costs. Since the costs resulting from a breakdown can be three to five times higher than the cost of performing maintenance, the machinery availability and productivity gains enabled by maintenance work translate into a saving of around one trillion euros a year for German industry.

The key challenge for Industrie 4.0 relates to the goal of producing tailored, customer-specific solutions. For this to be possible, manufacturing systems must possess a high degree of flexibility, availability and reliability. Accordingly, the materials, products and systems in the smart factory are fitted with sensors and actuators so that they can be connected to each other in order to form cyber-physical systems. The constant availability of timely information makes it easier to predict and plan essential maintenance work. However, combining all the elements in a manufacturing system to create a cyber-physical system also leads to a rise in the number of components requiring maintenance. This is accompanied by a rapid increase in the scale of the IT infrastructure needed to enable communication, while the higher level of complexity and new factors that could potentially affect and disrupt the system also need to be understood and managed. Consequently, maintenance services must learn to analyse and make full use of this growing volume of better-quality data so that they can plan and structure their work more effectively and develop into smart maintenance services.

However, as well as being essential from a functional perspective, smart maintenance can also provide German industry with the opportunity to use the extra capacity freed up in the smart factory's direct manufacturing activities to develop new industrial advances. Unlike manufacturing, maintenance work generally involves one-off, context-sensitive activities. It is not possible to

At a glance

- The machinery availability and productivity gains enabled by industrial maintenance translate into a saving of one trillion euros a year for German industry.
- However, this key industry is not properly prepared for the fourth industrial revolution.
- Traditional maintenance must be developed into smart maintenance. Maintenance needs to be intelligent and ready for tomorrow's challenges.
- Smart maintenance will help to secure jobs in Industrie 4.0 and to manage the complexity within smart factories.
- Maintenance involves the analysis of large volumes of data relating to machines and systems. By acquiring knowledge in this way, maintenance acts as a driver of innovation.

fully automate this type of work. In Industrie 4.0's vision of permanent availability, maintenance workers play an indispensable role in ensuring that the requirements for the sustainable implementation and ongoing operation of smart factories can be met. These requirements must be translated into the relevant strategic and operational competencies and skills. The shift from physical maintenance work towards primarily IT- and planning-based activities provides a major opportunity, since the highly complex nature and constantly changing challenges of the work serve to make smart maintenance jobs more attractive. It is important to take advantage of this opportunity to appeal to young people, increase the proportion of women and combat the ageing of the maintenance workforce.

Smart maintenance will also create jobs in the maintenance service market. In Industrie 4.0, customers will expect their high-grade German-built machines to be accompanied by the highest maintenance performance standards. The emerging market for services "Provided/Maintained in Germany" offers German industry the chance to gain a global competitive advantage. The proportion of maintenance services that are outsourced is relatively low in Germany compared to other countries, since German businesses consciously choose to keep these services in-house. Together with the competitive advantage conferred by being able to design maintenance services during the machines' and systems' development, the resulting know-how has huge economic potential for German industry. While profit margins for the sale of machinery and equipment are in the region of two to three percent, bundled services sold together with these machines and equipment can deliver returns of twenty percent or more.

In addition to its economic benefits, smart maintenance also has enormous potential in terms of information and innovation. The value of the large volumes of data generated is not confined to helping maintenance personnel predict and prevent breakdowns. Once it has been processed and disseminated by the smart maintenance service, the data also enables continuous improvements to be made to machinery and systems so that German businesses can maintain their technology know-how leadership. In order to tap into this potential, smart maintenance must serve as the link between German industry and German-made products in use throughout the rest of the world by systematically ensuring the secure feedback, storage, processing and protection of the knowledge and data acquired from these products.

This acatech POSITION PAPER shows how the vision of Industrie 4.0 will ultimately be doomed to failure if maintenance is confined to reactive firefighting measures that do no more than the bare minimum required to keep smart factories running. Traditional maintenance must be developed into smart maintenance. In addition to providing the necessary technical basis for Industrie 4.0, smart maintenance also has huge potential for driving improvements in performance and profitability. The strategic development of maintenance work will require both data management and targeted knowledge management technologies in order to make the practical knowledge contained in the heads of maintenance personnel available to everyone. In addition, sufficient numbers of skilled maintenance workers will need to be trained so that they are capable of meeting the new challenges – with the different range of tasks that this will involve – whilst still being able to perform any traditional core operational maintenance activities that continue to exist. Maintenance workers should be supported at every point in the supply chain by technical assistance systems that meet the relevant compatibility and data security requirements.

RECOMMENDATIONS

For government:

1. Smart maintenance should be accorded greater priority by government research funding, since (especially in the case of industrial services) it will be a key enabler in terms of accompanying and supporting the digitisation of industry, thereby contributing to the transformation required to achieve Industrie 4.0. It will be important to ensure rapid development of the relevant key technologies and integration and interoperability standards, as well as training of the required specialists and leaders.

2. Future industrial policy roadmaps should incorporate incentives for the deployment of efficient maintenance strategies in order to promote environmental protection and resource conservation and ensure the economic sustainability of investments.

3. In order to tap into the potential synergies offered by cooperation between research and industry, an Implementation Council should be established and tasked with the systematic and continuous planning, implementation, monitoring and improvement of maintenance initiatives of common interest.

Germany's Federal Government should support the planning and development of this body and provide the institutional and financial backing needed to ensure the comprehensive involvement of industry and in particular the inclusion of small and medium-sized enterprises.

4. The export of maintenance (e.g. condition monitoring) technologies and services to Europe and the rest of the world should be promoted. Smart maintenance offers a way for Germany to expand its maintenance market internationally. In particular, the long-term nature of typical smart maintenance business relationships will help to strengthen German industry for many years to come. At the same time, it will be necessary to develop a regulatory framework for data storage, use, access and security standards in order to prevent data misuse and theft. This will provide businesses with the legal certainty that they require to adopt new business models.

5. Traditional maintenance must be developed into smart maintenance. High-profile flagship projects featuring innovative solutions should be launched. acatech recommends the incorporation of smart maintenance into the German government's High-Tech Strategy and the establishment of research and funding programmes and flagship projects.

For business, industry, associations and institution:

6. Maintenance Data Management is essential in order to transform data into knowledge about a company's machines and systems and the significant contribution and influence of maintenance in the context of life cycle management. As a rule, maintenance data sets are rarely comparable with each other or large enough to enable valid analysis. It will therefore be necessary to develop existing statistical methods so that they are able to meet the requirements of smart maintenance. It will also be necessary to abstract and aggregate maintenance experts' know-how so that it can be made available in an appropriate format to everyone involved in the field of maintenance. This will be key to ensuring the practicality of maintenance in the Industrie 4.0 environment.

7. Maintenance workers must be thoroughly prepared for the tasks involved in ensuring the functionality and integrity of Industrie 4.0 systems. These tasks should form part of the training requirements for maintenance personnel. It will be necessary to create appropriate training models and profiles for industrial maintenance in order to take full advantage of demographic change, the potential of new technologies and the interconnectivity of Industrie 4.0.

8. It will be essential to develop collaborative business processes, standard procedures and cooperation platforms. These could be promoted e.g. through high-profile flagship projects. The establishment of appropriate regulatory frameworks for cross-company cooperation models will also be key to enabling new business models such as Build-Operate-Transfer and value proposition models.

9. It will be necessary to establish closer links between science and industry in order to facilitate the development of futureproof solutions and basic planning scenarios for implementing and managing Industrie 4.0's new, integrated manufacturing systems.

10. Efforts should be made to drive both the development and harmonisation of information and communication process standards and the standardisation of the technical components involved in maintenance work.

CONTACT

acatech – NATIONAL ACADEMY OF SCIENCE AND ENGINEERING, October 2015

Munich Office
Residenz München
Hofgartenstraße 2
80539 München

Berlin Office
Pariser Platz 4a
10117 Berlin

Brussels Office
Rue d'Egmont/Egmontstraat 13
1000 Brüssel
Belgien

T +49 (0) 89 / 5 20 30 90
F +49 (0) 89 / 5 20 30 99
www.acatech.de

This summary is based on: acatech (Hrsg.): *Smart Maintenance für Smart Factories. Mit intelligenter Instandhaltung die Industrie 4.0 vorantreiben* (acatech POSITION), München: Herbert Utz Verlag 2015. Project lead: Prof. Dr. Michael Henke, Fraunhofer-Institut IML/TU Dortmund; Prof. Dr. Axel Kuhn, ehemals Fraunhofer-Institut IML

The original version of this publication is available at www.utzverlag.de or www.acatech.de