Bosch Rexroth

Observatory: Other

Case summary

At its establishment in Lohr am Main, Bosch Rexroth develops, produces and sells components and systems for electric drive and control systems for machines. The company uses a range of digitisation technologies for different purposes. Internet of Things (IoT) technologies are deployed throughout the establishment to monitor production processes and the conditions of the machinery. Metal and polymer 3D printing are used in the production line, and sand 3D printing is used for the production of sand cores employed in metal casting in the foundry. Finally, augmented reality (AR) technology is used to enhance training methods while virtual reality (VR) technologies have been recently piloted in the establishment to enable virtual tours of the local facility. The driver behind this latter innovation was the need to provide alternatives to the physical tours which were no longer possible due to the travel restrictions imposed during the COVID-19 pandemic. The Bosch Rexroth case not only provides insight into the introduction of multiple digital technologies in a large establishment but also illustrates a process characterised by a high level of employee involvement through the existing social dialogue structures, particularly the Works Council. It also depicts a formalised approach that addresses concerns arising from the use of digitisation technologies and aims at neutralising potential negative impacts of technological change on employees.

About

Case study name: Digitisation in the workplace (/case-study-names/digitisation-in-the-workplace)

Establishment profile

Bosch Rexroth is a German stock company, wholly owned by Bosch GmbH after the merger of Mannesmann Rexroth AG with the Bosch Automation Technology division in 2001. Since 1964, Bosch's majority shareholder has been the Robert Bosch Stiftung GmbH, a charitable foundation, currently holding 92% of company shares. The company develops, produces and sells components and systems under NACE code C28.

Bosch Rexroth is present in over 80 countries and has 18 establishments in Germany as well as six regional sales centres and 14 service centres. Globally, Bosch Rexroth employs 31,000 people of which 22,400 are working within the European Union. The Lohr am Main establishment is the headquarters of Bosch Rexroth, where activities include worldwide coordination and planning of research and development (R&D), manufacturing/production, sales, corporate development, quality management, environmental protection, and other commercial areas as well as administrative tasks. In Lohr am Main there are 5,700 employees of which 260 are apprentices. The establishment has a variety of positions, ranging from administrative personnel to production employees and R&D technicians. The manual assembly of products is one of the main activities on site and production workers make up 50% of employees which are also affected most by all three technologies. Products assembled include hydraulic valves and blocks, cylinders and power units. Apprentices and students are trained to become electrical engineers, technical computer scientists and to work in mechatronics and industrial engineering.

Employees at the establishment are represented by a local Works Council and IG Metall trade union. In Lohr am Main, Bosch Rexroth's local Works Council consists of 25 people, six of whom are released from professional activities. In some cases, such as for digitisation, a small working committee is set up within the council. The remaining 19 members deal with the day-to-day issues in their work environment and department. The Works Council represents the rights of all employees in the establishment and has a right

of co-determination in matters such as: working hour regulation, temporary reduction or extension of working hours, remuneration policies, the introduction and use of technical and digital devices for monitoring employee behaviour or performance. The Works Council looks at projects in terms of potential effects on employees by gathering and analysing employee feedback. The trade union, IG Metall, is occasionally asked for advice.

Technologies adopted and embeddedness in the workplace

All three digitisation technologies - IoT, 3D printing and AR - have applications at Lohr am Main and have moved beyond the pilot phase.

The IoT is considered by the company as a main driver of industry 4.0 and is deployed throughout the establishment. Bosch Rexroth is both a provider and user when it comes to digital products, creating and using machine controls, communicating drives and other products. A range of IoT technologies have been used in the establishment since 2010 to monitor production processes and the conditions of the machinery. This enables operators to be alerted about machine failures, such as leaks or decreases in production speed. In the establishment IoT technologies take many forms. Examples of the technology embeddedness include radio-frequency identification (RFID) tags, IoT gateways and a manufacturing execution system (MES) that monitors machine parameters for predictive maintenance and production efficiency by connecting data from different machines in the production line. Every machine is connected to the data gathering system; employees are able to unlock only those machines they have been trained on. The list of machinery to which employees have access to is stored on an RFID tag that they wear (serving as an access key).

The production facility in Lohr am Main has been using polymer 3D printing since 2015, while sand and metal 3D printing were introduced in 2017. Polymer 3D printing is integrated into the apprentice programme to increase the number of future employees capable of working with the technology. Both metal and polymer 3D printing are used in the production line, and sand 3D printing is used for the production of sand cores employed in metal casting in the foundry. A complex form cast out of metal traditionally required a combination of sand moulds, resulting in holes that needed to be filled in a separate step. The 3D-printed sand cores allow complex shapes to be produced. Instead of having to produce multiple moulds, a single structure can be produced with sand printing, increasing end-product integrity. Metal 3D printing has received attention over the last five years and has been an area of focus of the local competency centre for manufacturing technology at Lohr am Main as it allows for complex structures with high stability. Furthermore, one senior blue-collar member of the production department has been explicitly trained and tasked to operate and oversee the metal 3D printer available on the shop floor, creating prototypes, spare parts and small series of parts for customers. Metal printing has proved to be an adequate response to weaknesses in the traditional production of certain metal forms. Before the introduction of metal 3D printing, production of metal forms required welding, resulting in a potentially unstable product because of welding spots. Metal 3D printing has addressed this challenge, eliminating the weakness of welding spots and creating a consistent component that avoids problems further down the production line. Further progress in the implementation of 3D printing depends strongly on the cost, speed and efficiency of future 3D printers.

AR technologies were introduced at its Lohr am Main plant in 2011 and used in sales, customer service and training. As Bosch Rexroth's subsidiary RE'FLEKT offers software for AR solutions, the establishment has good access to the technology. In the establishment, AR supports training for manual assembly work (work for which the parts are too complex for machines to assemble). Previously, in order to train someone in these tasks, it was necessary for two employees to work together, with one receiving the training and the other working in a supervisory role. AR enhances efficiency in training as it allows employees to learn more on their own (without senior supervision) in both mandatory and elective training. It also allows apprentices to observe the work of a trainer in situations where the trainer and trainees would not have physical room to work together (such as for certain machinery repairs). Because of the large number of different products offered by Bosch Rexroth, repair technicians in the field sometimes require expert guidance. Previously, this was carried out over the phone.

While this system has been improved in recent years, the company is now piloting an AR solution for its technicians in which they receive expert feedback and instructions on a head-mounted display for real-time hands-free support. Since 2019, the training department at Lohr am Main has also run a pilot virtual hydraulics facility to fully immerse apprentices in VR training, rather than them simply receiving additional information overlaid on the real world, as in AR. Lastly, in response to the travel restrictions imposed

during the COVID-19 pandemic, the establishment began a VR pilot allowing virtual tours of the local facility, which in the future could be extended to enable overseas customers to inspect products or prototypes without physically travelling to the plant.

While AR and IoT technologies employed within the establishment are developed internally, for 3D printing the company is reliant on an external supplier for order and maintenance. In general, digital technologies originate from three organisational units. The first is the central innovation centre at the parent company, where employees investigate possible applications of novel technologies on the market. For more sophisticated technologies, local competency centres for each technology at specific establishments of Bosch Rexroth tend to take the lead, introducing technologies to employees, training them and leading discussions with the local Works Council. Lastly, the local departments at the establishments mostly apply the end-result of the technology development pathway but are encouraged to introduce new ideas via a bottom-up approach.

Future plans in the area of digitisation include the integration of artificial intelligence (AI) in the company's management decision making processes. This is considered the next big step in the digitalisation procedure and an increased focus for HR recruitment efforts, in particular concerning new talent with skills in data analytics, database architecture, programming and AI algorithm construction.

Drivers to technology adoption

The underlying motivation for technology introduction is efficiency, either in processes or products. According to interviewees, efficiencies can be introduced bottom up or top down. While top-down approaches are more common in the establishment, bottom-up also occurs. 3D printing is most directly related to efficiency improvement, and simultaneously, the use of additive techniques reduces manufacturing waste compared to subtractive procedures.

AR was introduced in the context of training and field/customer service where there is a need for expert knowledge without an expert present. AR in training is an example of a bottom-up introduction of a new technology, as a production employee identified the possibility at a trade fair and introduced the concept in the company. Management is in favour of all technologies that increase training efficiency in terms of availability, duration and accessibility.

The IoT is fully embedded within the company's activities and processes and is present in many applications at the establishment, making it difficult to identify a singular motivation for its introduction as a technology. In general, a desire for improving planning capacity, accountability and process optimisation led the company to understand the benefits of connecting machines together in an overarching system.

Initial expectations and strategy to technology adoption

The initial introduction of the technologies aimed to increase productivity and product viability as well as support employee well-being by reducing strain and recurring tasks. Introduction and implementation were not however without risks, and complications which needed addressing included issues that could arise from the use of employee monitoring, mostly related to IoT and AR, including access permissions, data storage and third-party access. Other issues included unfamiliarity with the system, the need to ensure the participation and acceptance of the relevant departments, and the budget and time required for understanding new systems.

The general strategy for the introduction of new digital technologies at Bosch Rexroth is a three-step process including development, testing and application. The Works Council is deeply involved in this process in the company's German establishments. The consultation of a dedicated IT committee is required for the introduction of each software. Since 2014, the committee of digitisation and work organisation of the Works Council addresses all industry 4.0 issues potentially affecting employees. The aim of the committee is to assess, in advance, the changes and potential negative effects for employees via a risk assessment considering employee concerns, their experience and examples from other companies. As a result, the expected impact is agreed upon with the management board/project leader and the proposed changes are monitored by the responsible project leader, who communicates impacts with the Works Council via regular meetings.

Since 2016, the procedure has been formalised in a central company agreement between the Works Council and the management board. It offers overall guidance for all German establishments which each establishment can build upon, including the involvement of employees and data protection concerns

arising from the technologies. As a minimum, the technology impacts on the following points need to be discussed with the Works Council:

- types of occupations and occupational levels of the concerned employees
- numbers of personnel deployed
- ergonomics and physical workplace design
- the working days and working hours (including overtime)
- the application of the relevant provisions of the BDSG (Bundesdatenschutzgesetz, Federal Data Protection Act)

The overall procedure starts with providing information to employees to clarify whose activities might be affected, to which degree, and the underlying rationale. Employees may give feedback, which is incorporated into the decision making, and afterwards, the implementation plan is presented to the Works Council. Here, remuneration or employee behaviour or productivity monitoring are considered an issue due to GDPR compliance and employee acceptance, and a detailed description on data access is required. The procedure includes the development of an outlook for training needs and a training strategy. Both are based on a competence matrix and the assessment of the training needs for employees, which considers the level of their expected involvement with the technology. Additionally, if an employee is not capable of performing the new task envisaged, or if their work will no longer be necessary, the employer is required to offer them a similar position and training to perform at the same level.

Impact of the technologies in the workplace

Business model

Overall, IoT has allowed the management of Bosch Rexroth at Lohr am Main to gather information on the machines operated in the production process, offering more management insight into performance and equipment status, leading to a more efficient business model. The use of 3D printing has not displaced other production processes in Lohr am Main, but it allows the company to produce highly complex shapes in low quantities. This addresses the unique demands of customers and does not require economies of scale to keep the price low. Since the 3D printing technology is not developed in-house, its use leads to higher dependence on suppliers. While the use of AR technology has not yet impacted the business model in Bosch Rexroth, future plans include offering customers virtual inspections of their products via AR, reducing their need to travel.

Work organisation

Internal organisation and decision-making

At establishment level, the Industry 4.0 working group at Lohr am Main was said to collaborate with many departments due to the increased uptake of digital technologies. The working group supports the introduction of the technology, assessment of training needs and evaluation. All three technologies impacted the internal establishment organisation. The connection of machines to higher-level systems via IoT allowed for the monitoring of the plant efficiency, increasing transparency for improvement processes and allowing for predictive maintenance. In particular, it enabled supervisors to plan shifts more precisely via a Manufacturing Execution System (MES), drawing on automatically gathered and processed data.

AR enabled a more flexible approach to training as employees could work more autonomously and experts could guide field service operators from a central location with increased precision. In the case of 3D printing, the production line was adapted to fit the new process better, allowing the incorporation of 3D printers. As such, a second production line for 3D-printed parts was incorporated, operating separately to produce more complex products.

Task definition and content

For all technologies in the scope of this report, the overall task definition of employees has not changed significantly but was often enriched, for example through access to additional training via AR or through the addition of AM to the task range of production employees. The most pronounced example given during the interviews was that of the work supervisor responsible for calculating the KPI for the overall equipment effectiveness for further analysis by the higher-level management. With the introduction of IoT, equipment effectiveness was automatically monitored, freeing the employee’s time for other tasks. Due to

the increased automation of process monitoring via the connection of machines, work supervisors' time spent on administration was freed up and their responsibility was therefore expanded to include the planning of work schedules, previously done by higher management.

With regards to both AR and AM, interviewees agreed that employees had to extend their task content as they had new tools at their disposal. Particularly in the case of AM, specific training was necessary in order to familiarise the employee with the new technology as they were now required to operate the 3D printing facilities. For AR, tasks such as customer service in the field are also carried out differently where applicable.

Workflows, quality controls and standards

In the case of 3D printing, the organisation of work processes and the shop floor was adjusted by internal specialists from the local competency centre, including changes in machinery arrangement. New rooms were constructed to host a 3D printer without compromising employee health, and as a safety precaution, metal printing is restricted to employees over 18 years of age.

As with IoT, the technologies changed workflows slightly for some employees, as the processes are done without the involvement of employees in a system, now presenting finished data to the employees. At the same time, this introduced a higher emphasis on product quality control in the process. Finally, AR changed the way training is delivered by giving employees more autonomy in their choices. On the work floor, it allowed for better real-time communication for service engineers.

Employee monitoring and control

All interviewees were in unison when it came to employee monitoring - strictly denying that technologies are used at the establishment to 'spy' on employees. In Germany, laws underpin these statements. In addition to the data privacy policy, the Works Constitution Act enables the involvement of the Works Council when it comes to monitoring technology. Therefore, before implementing new technologies, impact and risk assessments are agreed upon between the Works Council and the management board.

According to the interviewed HR manager, this is one of the main concerns when introducing a new technology and is outlined in detail in the central company agreement. It is explicitly stated in the central company agreement that, while feasible, neither behavioural nor productivity control is a goal for technology introduction. In contrast, one interviewee noted that in establishments of the company in China, different rules apply. There, GPS trackers on the shop floor are commonly used to monitor the location of employees.

In the case of AR in training or support, data is only evaluated in the context of the training efforts and discarded afterwards. For data resulting from machine connection via IoT, a manual clarifies who has access to the data and to which degree. While someone planning work might be able to access more data, direct supervisors only have limited access due to privacy provisions. With this, it is ensured that no performance monitoring takes place, neither in the workplace nor in training.

Job quality

Physical environment

At Lohr am Main, IoT had little impact on the physical environment of employees. VR allowed for remote inspections, thus placing the inspector outside the actual work floor. In contrast, 3D printing was said to shift risks in the working environment. While there is a reduction of risks such as flying metal and sparks encountered at cutting machines, metal powder used for printing can be potentially harmful to respiratory systems. However, these risks were reported to be equal if not lower when wearing the right equipment. Additionally, measures such as a separate room for the machines are taken to ensure that employees do not come into direct contact with the powder. Other initial concerns raised by the local Works Council, such as fatigue due to AR glasses, were not confirmed by employee feedback later during implementation.

Social environment

There was a reduced social component as a result of training with AR. From the employee's perspective this could be balanced by providing the possibility to elect to do specific training elements in person. Also, remote VR inspections led to fewer person-to-person contacts, although in the current COVID-19 situation this could be considered the 'new normal'.

On a more general level, technology innovation was described as an issue that could cause psychological risk and discomfort. Some employees want to work with a new technology whereas others do not. If the technology is mandatory or is replacing an old one, it can lead to resistance, rejection or less performance which in turn can negatively affect work and the working environment. Information provision and awareness raising were found to be very important, and while no direct change management approach was adopted, continued engagement in talks with employees were key.

Working time quality and work intensity

The adopted technologies tended to lead to a decrease in work intensity while at the same time increasing the need for qualifications. 3D printing allows for more diverse tasks in employee routines, leading to more engagement and higher job motivation. Polymer 3D printing is seen as a tool to decrease work intensity as it reduces steps involved in manual labour, such as assembling parts. In contrast, metal 3D printing increased staff responsibilities since the technology is not as developed. Due to its novelty, fewer fail-safes or automated warnings are implemented that are usually common in production machinery. Therefore, employees are entrusted to work precisely as mistakes are likely to have larger consequences. For 3D printing, the employees' work is split between time working at the printer and other tasks while the printer is running. However, all tasks are done within the limits of regular shifts.

Regarding IoT, most employees did not experience changes other than having to identify themselves through an ID-card when operating machinery. Some initial training was required for direct supervisors (foremen) to familiarise with data production and analysis. The data is initially analysed by the supervisor and then by higher level of management resulting in a short-term increase of work intensity as new skills were acquired. It then reduced the need for planning maintenance tasks, offering more time for other added value tasks.

With regard to the use of AR for training, while tasks and work remain the same, it simplifies access to specific courses and allows for the independent training of employees. In VR for maintenance, inspection at a distance requires less travel for employees performing inspections.

Skills and discretion

As digital technologies are incorporated into the workplace, job profiles evolve. This results in a potential skills gap that is filled via a variety of in-person, AR, and online training, provided internally via inhouse learning portals. In addition, partnerships with external providers for training such as 'LinkedIn Learning' allowed employees to advance their skillset from soft to technical skills.

While training is mandatory for employees working with specific machinery and technology, it is also made available to other interested employees. These personal advancement training opportunities range from technical skills to soft skills and languages. As the requirements of working with a technology change throughout its lifecycle, mandatory training is planned ahead for each stage in order to ensure the required roles are available. A HR department representative noted that skills that had been explicitly stated in the past, such as familiarity with Microsoft Office programmes, are now implicitly expected. As such, and with a high penetration of the technologies in the company, most employees are involved in learning new skills. However, interviewees stated that the acceptance of the technologies varied strongly between employees, with no identifiable patter. While some employees not working with 3D printing are keen to learn more about the topic and have a 3D printer at home, others resist the innovation. In the latter case it has been proven that simply providing a detailed explanation of the underlying reasons for the technology introduction, its benefits and effect have allowed for more acceptance. Due to the novelty of the technologies, sometimes foremen, who would regularly be asked for assistance, are not able to assist with questions or issues, as is the case in metal 3D printing.

Prospects and earnings

Digital technologies are not used to evaluate performance at Bosch Rexroth and therefore are not tied to earnings. However, the establishment's management indicated that new technologies always allow for career opportunities if employees are trained to work with them – an opportunity which they have on a voluntary basis at the establishment. It was mentioned that further training and development is a necessity, as the number of employees at the establishment is no longer increasing due to labour market shortages. Therefore, career development becomes a more relevant factor both for the employee and the establishment.

In the case of metal 3D printing, the added responsibilities in terms of machinery operation are financially rewarded. Management is considering formally creating a new position within the establishment for this expertise with a further monetary reward to attract the interest of other qualified employees.

Employee involvement

At Lohr am Main, employees are directly involved in the decision-making process during the different stages of technology implementation, and they are informed of plans to incorporate a new technology in the work processes before the concept is finalised. While their concerns and feedback considered, they are generally not required to work on specific solutions as this is done via the project team and Works Council. Further employee involvement at the establishment comes in the form of the pilot deployment of a technology, where frequent feedback is required. Therefore, employee involvement shapes the introduction of all technologies through the involvement of the formal employee representation and/or direct involvement. The labour union is also responsible for Industry 4.0 topics but has been mainly involved in knowledge exchanges and guidance with the Works Council who is handling the procedure at the establishment level. All employees are encouraged to trigger bottom-up technological change by providing their ideas and feedback to higher hierarchy levels in the company which can lead to the introduction of new technologies in the company.

During the potential pilot, but also before the technology is first applied at the workplace in the establishment, employees get the chance to familiarise themselves with it and the effects on their workplace. This includes training provision, either by the internal training department or an external trainer. Training procedures are prepared in conjunction with the HR department. Should the implementation of the technology include a pilot, employee feedback is continuously evaluated and acted upon. Later, when the technology is approved and implemented, Works Council working groups at the department level keep monitoring the impact on employees but no formal routine evaluations are done. However, evaluations are set in motion when the same technology is introduced in a different context in the establishment, requiring a new evaluation round which includes feedback from the workplaces where the technology already is applied. While this is the general procedure, interviewees working with metal 3D printing stated that the employee operating the machinery is encouraged to give feedback on a continuous basis in order to improve the usability and feasibility of the technology. In the Lohr am Main establishment, technology acceptance by employees has played a crucial factor in its success. Here, the most successful efforts to generate acceptance involved providing comprehensive information covering not only need-to-know facts about the technology, but also implementation reasons, expected changes to the employee's workplace and the potential roll-out and foreseen developments. This reduced resistance most successfully in the long term. However, similarly, the overall opinion of the employees within the establishment on new technologies was also an important factor of acceptance. When the majority was positive regarding one technology, stragglers would be more likely to accept it. Providing employees with a clear rationale for the technology introduction helped to foster a culture willing and open to digitisation.

Commentary

All in all, the adopted technologies have impacted positively on job quality either by reducing work intensity, increasing workplace safety, or enriching and diversifying work tasks. However, these benefits do come at the cost of increased qualification requirements that need to be addressed by training of employees (based on a competency matrix). As a result, the work intensity might increase in the short term due to the added need of familiarisation with the technology. However adequate training provision can be a buffer to work intensification, and also foster greater acceptance of technological change, enabling a more successful uptake of the technology.

Both direct employee involvement as well as the strong involvement of the Works Council has proven to be a crucial factor for the introduction of digital technologies at Bosch Rexroth. Early direct involvement including information and feedback and later involvement in pilots give the employees the chance to familiarise themselves with the technology and to raise concerns that are then taken into account in the discussions between the management team and the Works Council.

The case of Bosch Rexroth also shows that strong communication between Works Council and management can result in a reliable, fair and safer roll-out strategy for new technologies. Having the procedure formalised in a set of rules and processes, with a focus on monitoring the process and the effects of the technologies in the workplace, helps to facilitate technology integration in the workplace and fosters greater employee engagement. A key component for a successful introduction of a digital technology is to foster acceptance for it among employees and encourage employee buy-in. According to interviewees, providing ample information about the technology (by informing employees timely about the reasons behind the technology adoption, its effects and potential benefits) has a positive impact on

employees' willingness to incorporate it into their work routine. However, it is also apparent that the process needs time and commitment to gain momentum in a company, informing all employees rather than only a select few. While this is not formalised in a change management approach yet, this could be a way forward in the future.

Information sources

Interviews conducted with a company's digital innovation manager, an HR Manager, a Works Council representative and three employees working with the various technologies.

Company web site: https://www.boschrexroth.com/en/dc/ (https://www.boschrexroth.com/en/dc/)

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Revision log summary