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FEATURING
AUTOMATION

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SAIEE   @SAIEE   SAIEE

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Dear **watt**now reader,

Automation describes a wide range of technologies that reduce human intervention in processes by predetermining decision criteria, subprocess relationships, and related actions, as well as embodying those predeterminations in machines.

Robotic process automation has been one of the fastest-growing phenomena in the tech industry. It involves automating software that imitates human interactions with digital systems to automate processes and deployment pipeline efficiency. Read the 2023 Automation Trends on page 12.

Page 14 gives us "Condition Monitoring vs Artificial Intelligence", answering the question - of how we will use facts in the future to make decisions.

I took a deep dive into SEW-EURODRIVE's new facility in Johannesburg, which are proud to say: "we are working hard to shape the factory of tomorrow". Find the article on page 24.

Pascal Motsoasele, SAIEE Senior Vice President penned a paper on "Blockchain use case for automated municipal water payments" on page 30, discussing the proposal of a blockchain-based payment application system.

Page 36 gives us the opinion of Mr Hamilton Mann, asking, "can artificial intelligence benefit a society.?" Read it on page 36.

The January issue features Water/Water Security, and the deadline is 5 December. Please send your paper/article to: minx@saiee.org.za.

I want to take this opportunity to wish all our Members a wonderful festive season and thank those who made an effort this year to contribute to the content of the **watt**now magazine.

Herewith the last issue of 2022; enjoy the read!

Minx

THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS INVITES YOU...

ANNUAL AWARDS
in conjunction with Revive Electrical Transformers

2022

The SAIEE President, Mr Prince Moyo invites you and your partner to the SAIEE Annual Awards.

Date: 10 March 2023 **Time:** 17h30 for 18h00
Price: R400/p | R700/couple | R4 000 /table of 10
Dress Code: Formal

Venue | Indaba Hotel William Nicol Drive Fourways JHB

Cash Bar **Book** | Complete Google Form herewith **by** | 17 Feb 2022

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SAIEE EASTERN CAPE CENTRE'S SITE VISIT

The SAIEE EC Centre's visit to the wind farm near Van Stadens River and Wild Flower Reserve attracted ten visitors, including engineers, technicians and students from Nelson Mandela University. Welcome rain had recently fallen in the area making the access road muddy, but the morning's weather was sunny with little wind.

The plant started commercial operation in February 2014 and incorporated 9 x 3 MV Sinovel turbines. The Hub height is 90 m, and the rotor diameter is 113 m. Power is generated at 690 V and stepped up to 22 kV before dispatch to Nelson Mandela metropole. Windfarm output rose to approximately 1,5 MW during the visit.

Visitors were asked to acknowledge site safety requirements, and Nceba Nkosi (Site Manager: 3Energy Renewables) gave an excellent introduction and site overview and answered initial questions. This was followed by a SCADA system talk, switchgear room and spare stores visits, and a 400 m walk to the tower base of one Sinovel 3 MW turbine, which had been shut down for maintenance.

Nceba gave a professional overview of the positive attributes of renewable energy extraction from wind, its challenges and the Metrowind farm experience. The students asked insightful questions about the plant and its operation.

Discussions continued past midday with delicious lunch packs handed out by Lizl Blom (SAIEE EC Administrator).

The natural beauty of the Eastern Cape and the wind farms' contribution to the local community and greater Metropole was evident and very encouraging.

The visitors thanked Nceba Nkosi and Lizl Blom for hosting and arranging the memorable excursion. **wn**

Danfoss and Beijer Ref renew partnership agreement with expanded focus on sustainability

From left: Torben Pedersen (Division President, refrigeration and A/C Controls, Danfoss);
Stephane Nassau (President, Global Sales, Danfoss Climate Solutions); Kristian Strand (President, Danfoss Commercial Compressors), Jürgen Fischer (President, Danfoss Climate Solutions), Christopher Norbye (CEO, Beijer Ref); Philippe Duchene (Senior Vice President, Danfoss Climate Solutions Sales, European Regions); Simon Karlin (COO, Beijer Ref); Marco Curato (Purchase Group & Category Manager, Beijer Ref), Henrik Thoren (CSCO, Beijer Ref); Olivier Marchal (Director of Key Accounts Europe, Danfoss Climate Solutions) and Andrew Powles (Category Manager, Beijer Ref).

Danfoss A/S, a global manufacturer of sustainable, energy-efficient, smart technologies and solutions, and Beijer Ref AB, a world-leading wholesaler of cooling and HVAC technologies, have renewed their longstanding partnership agreement.

Under the new 3-year agreement, the partnership will, for the first time, include an ambitious project plan to deliver upon the circular economy through piloting the circularity of products in all stages of the value chain.

With the renewal of the partnership contract and intensified focus on jointly developing new circularity practices as part of the partnership between Danfoss and Beijer Ref, the two companies are taking an important step in embarking on a circular economy transformation. Furthermore, both companies share ambitious ESG (Environment, Social, Governance) and sustainability targets, creating long-term value for their customers and the environment.

Jürgen Fischer, President of Danfoss Climate Solutions, comments:
"Manufacturers and wholesalers must drive the circular economy transition. We look forward to working with a key partner as Beijer Ref to jointly accelerate and develop efficient strategies and actions to achieve product circularity, striving for high material recirculation, high utilization, and high endurance in products and service offerings."

Christopher Norbye, CEO Beijer Ref, adds that:
"We are very pleased with the renewal of our partnership, and together with Danfoss, we look forward to implementing this new and ambitious sustainability plan. In the last decade, the European Commission has established several policies to encourage circularity, and it is of great importance that we continue to support this sustainable transformation." **wn**

A tribute to the late A.D.W. (Dries) Wolmarans

- your legacy lives on...

This tribute to Dries is written in recognition of his exceptional ability as an electrical engineer of high standing in the profession, where, amongst other achievements, he made a valuable contribution to the high-voltage testing of transmission apparatus.

By Tony Britten with inputs from Sunette Wolmarans and Prof Jan de Kock

He understood that insulation level integrity is of critical importance for the reliable performance of a high-voltage transmission network and generation and distribution systems. During his long professional career, Dries became an expert in testing high-voltage insulation (tan delta and partial discharges) and the insulation provided by the oil used in transformers to prevent costly flashovers. He was also instrumental in investigating transformer oil's static electrification phenomenon.

This exemplifies his investigative curiosity and practical skills to do the necessary measurements. Not only did Dries train staff in the measurement and interpretation of discharges, but he left a lasting legacy of skills through strong leadership and mentorship, giving young practitioners excellent training to help them mature. On his retirement from Eskom in 1983, he left behind a cadre of competent engineers and technicians – a critical skill on which the South African electricity system must depend. (There are presently not enough of these trained skills available.)

Dries not only trained engineers in technical measurement, but he also acted as a commercial agent for measurement and diagnostic equipment. He was able to ensure that tests were undertaken properly and that the results were correctly interpreted. The leadership and mentorship that he gave to young engineers, clearly and unambiguously, meant that whenever a serious incident occurred, Dries would be called in to analyse the cause of the failure.

Dries was very methodical and, when investigating an issue, did not jump to conclusions; such conclusions were always based on a wealth of material he would have gathered around the problem. Dries' sound reasoning was based on technical theory and a rigorous understanding of the basic principles involved.
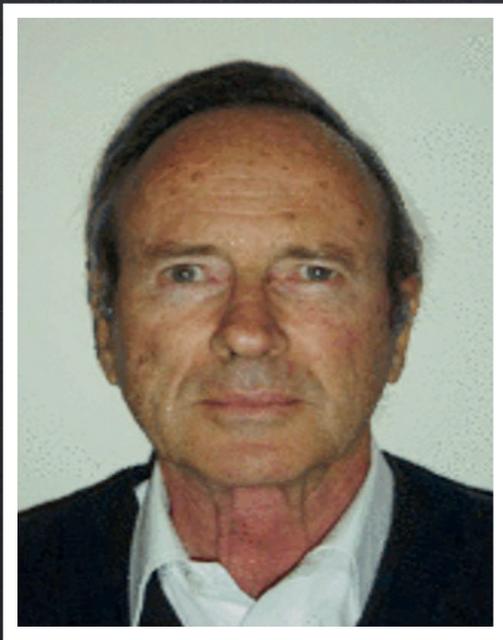
DRIES WOLMARANS
1936 - 2022

Andreas Daniel Wynand (Dries) Wolmarans was born in Kimberley, wrote matric at 17 in Heidelberg and then studied electrical engineering at the University of the Witwatersrand. He graduated with a BSc (Engineering: Electrical) in 1957, obtaining his degree in four years, a feat only 20 per cent of students achieved. Dries also obtained an MBL from the University of South Africa in 1975. He was also the author of eight articles on high-voltage engineering and electrical machines. His academic training perfectly suited his career, involving both technical and commercial pathways.

Dries spent 15 years of his career at Eskom in the Transmission Division, becoming an expert in protection and insulation. Protection work was done on the 275 kV transmission system in the Rand and OFS Undertaking in the late 1960s. Between two stints working for Eskom, Dries also worked at the Satellite Tracking Station in Hartbeeshoek and

spent time at Edwards Air Force base in the USA. Working for the Namibian electrical utility, SWAWEK, he was responsible for line and substation protection for the SWAWEK (NamPower) 550 km 330 kV line from Ruacana to Omburu and many other transmission and distribution lines in Namibia. Dries resigned from SWAWEK in 1979 after nine years of service and then developed the commercial side of his career, becoming the South African agent for the Swiss company TETTEX, which made high-grade measurement and diagnostic apparatus. He introduced technology and expertise from the high-voltage universities of Dresden, Graz and Leipzig to South African engineers, giving them access to state-of-the-art research on high-voltage transmission systems.

When the international ownership of Tettex changed, Dries teamed up with Prof Jerry Walker and continued to trade under the name Xamax Electrical until his retirement in 2018.

Dries was extremely ethical and honest in his commercial dealings with Eskom and others. He was able to tread the fine line between promoting equipment and providing impartial recommendations for measuring insulation problems. Never in it for financial gains, he remained true to the facts and therefore had high credibility with major customers. In my personal dealing with Dries, he could debate technical issues and commercial considerations with an open mind.

Dries was actively involved in Cigre and the SAIEE. He was a member of the Institute for 65 years, a fellow for 46 years and a council member for five years. Known for his gentlemanly manner and lack of ego, his legacy lives on and needs to be expanded by those fortunate enough to have engaged with him. The engineering fraternity will sorely miss Dries and his unique skills.

Dries leaves behind his wife of 59 years, four children and nine grandchildren. **wn**

Large WEG Motors assembled, commissioned on Oil Rigs

Classified as hazardous areas, offshore oil rigs require that any equipment installed on them is designed and certified accordingly – including electric motors to drive critical gas compressors.

Foster Yeboah, Zest WEG's regional sales manager for the West African Region, says that WEG electric motors for these applications comply with IEC standards and associated hazardous area specifications, which certify equipment for use in 'explosive atmospheres'. Considering the hazardous marine environment, all the WEG machines were supplied with tough epoxy paint and conformed to an IP65 rating.

Six large WEG motors are being installed on an oil platform off the coast of Ghana, over a staggered schedule from late 2020 through 2022.

Four of the new motors are large 9,500 kW, WEG MGW800 machines, and two are 7,000 kW MGW710 machines. With weights of up to 23 tonnes, these electric motors exceeded the 19 tonne weight limit of the oil platform's crane which meant that the motors were shipped to site in component form, for assembly on site.

"Despite Covid-19 disruptions and challenging logistical conditions, Zest WEG is successfully supplying, testing and installing these motors for the customer," says Yeboah. "These six WEG motors are upgrades of previously installed WEG motors, which have been operating successfully on this site for over a decade."

"Of course, the Factory Acceptance Test (FAT) is always vital, so this has to be conducted on all the motors after they are manufactured and tested," he said. "Covid-19 initially made it impossible for the client to be physically present at the factory in Brazil, so some tests were witnessed virtually."

To deal with the weight restriction of the crane on site, the electric motors then had to be dismantled in the factory before shipping, he explains. Rather than being shipped as a single unit – as is normally done – the motors were carefully packaged into component form. Particular care had to be taken with protecting the rotor during shipment.

"The rotor is a critical item, and it is crucial that great care is taken when transporting this item," he says. "The packages are then shipped and stored at the customer's warehouse in Ghana, before being taken to the offshore oil rig."

Zest WEG technicians assemble the electric motors on the oil platform, including the various electrical and hydraulic connections and piping.

Commissioning and testing are done before the system goes online. The first of the six installations had to be done when Covid-19 restrictions required quarantining periods – adding to the complexity of planning.

The large WEG motors in this application are cooled using the IC81W air-water cooling principle, says Yeboah. Air is circulated through the motor base where the rotor and stator generate the most heat. A heat exchanger then extracts the heat from the internal circuit air flowing through it. **wn**

The coupling between the WEG motor and the compressor.

Foster Yeboah, regional sales manager for West Africa, based at the Zest WEG Ghana branch.
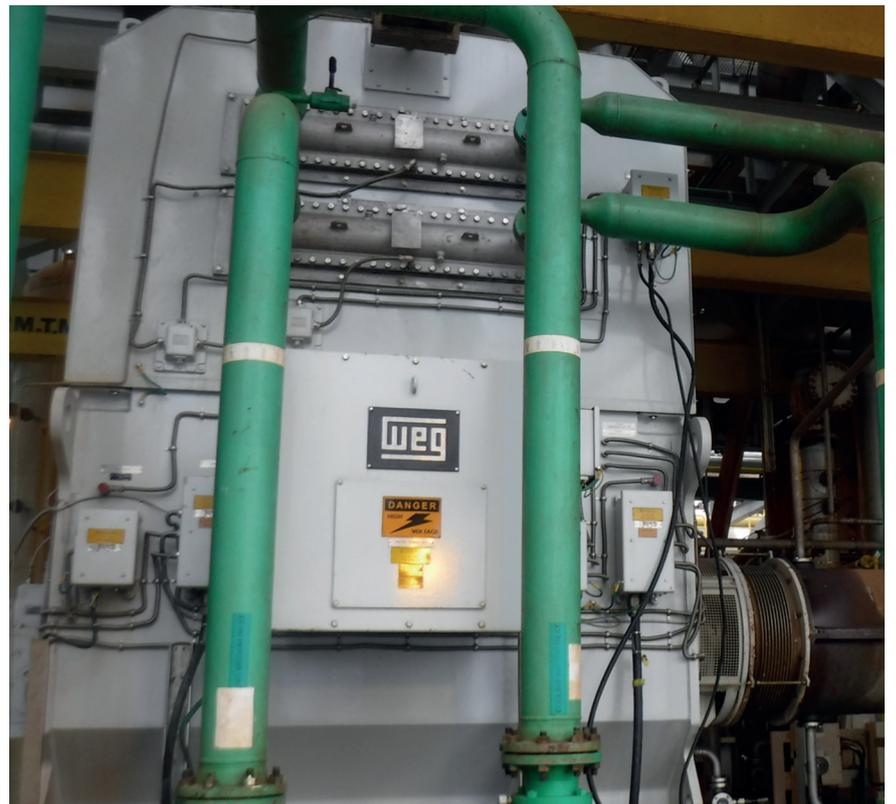
A view of the cooling water pipes.

2023 Automation trends

THESE ROBOTIC PROCESS AUTOMATION TRENDS WILL CONTINUE TO GAIN PROMINENCE IN 2023 AND BEYOND

Robotic process automation has been one of the fastest-growing phenomena in the tech industry. It involves automating software that imitates human interactions with digital systems to automate processes and deployment pipeline efficiency. The pandemic was a major trigger that enhanced the adoption of robotic process automation trends and applications. By leveraging the abilities of an RPA application, businesses can improve process quality, speed, and productivity. This has become a reality because companies have shifted their focus to automating repetitive processes such as handling data entry, customer queries, customer ID verification, etc.

The top robotic process automation trends for 2023 will empower the industry to advance growth and development.

The global robotic process automation market has come a long way, and its development is here to stay. Most businesses leverage this opportunity to increase human worker productivity and reduce error rates. Here are the top 10 robotic process automation trends that will dominate the industry in 2023.

Robotic process automation will divert to low-cost RPA and hyper-automation systems.

The core RPA technology system has become a commodity as many low-cost RPA vendors have jumped into the RPA bandwagon. This phenomenon has created pricing pressures for vendors. Hence, several world-class RPA vendors have begun packaging complementary hyper-automation technologies such as AI, process mining, workflow, and others.

INCREASED ADOPTION OF MANAGED RPA

Historically, RPA's technical complexity has been a barrier to adoption. Several RPA service providers have begun to offer managed RPA services at a low cost to alleviate this. In 2022, the market witnessed enhanced adoption of managed RPA, and the trend is about to continue for 2023.

RISING NUMBERS OF RPA COE

An RPA Centre of Excellence is a centralised group responsible for implementing RPA processes in a business. The RPA CoE comprises IT experts, RPA consultants, process managers, and functional experts representing various global tech teams.

Experts believe that 2023 will witness the establishment of various RPA CoEs to improve the efficiency of the bot development cycle and integrate RPA with IT.

SEMANTIC AUTOMATION

Semantic automation demonstrates a diverted course from a rules-based approach where robots learn simply by observing an activity or task and emulating it without detailed instructions.

By deploying semantic automation, bots can easily understand processes and the data required to move the pieces required to complete the workflow.

ADOPTION OF RP AMONG SME ADOPTERS

Based on reports, most global companies have embarked on the path of adoption of RPA applications and intelligent automation. As mentioned, small and medium-sized enterprises realised the importance of robotic process automation as soon as the pandemic hit to stay competitive and resilient. In the coming years, SMEs are definitely going to adopt more RPA software and applications to streamline their processes and become more efficient.

RPAAAS WILL BECOME MAINSTREAM.

As soon as SaaS was introduced into the industry, organisations took it upon themselves to innovate cutting-edge solutions and services. Banking on the popularity of RPA, RPAaaS is bound to take over the industry in 2023. Automation will continue to cement its position as a crucial component for business growth and development.

MORE RPA-DRIVEN MSPS

Due to rising RPA deployment costs and the extended time for the solution to roll out, businesses are turning to managed service providers which offer RPA as a service to outsource their automation tasks. MSPs can provide businesses with automation possibilities without requiring any RPA infrastructure or training and at reduced prices in the short term.

INTELLIGENT SYSTEMS

RPA will be more integrated with AI and machine learning techniques by 2023. The line between bots and digital workers will become clearer. RPA bots will focus on tasks based on logged procedures with rules.

Meanwhile, AI that mimics human behaviour will aid in the completion of increasingly difficult jobs. This will also aid in connecting automation islands and achieving more seamless process automation and departmental interconnection. RPA's increasing cognitive AI app development will help prevent bottlenecks.

MORE AUTOMATION-RELATED ACQUISITIONS

Consolidations and acquisitions in automation and RPA have risen considerably in 2022 and will continue to rise over the next few years. Automation providers will combine their foundations to handle all parts of the usefulness of the robotisation value chain rather than focusing on providing the greatest standalone capabilities.

Bringing ERP and legacy systems up to speed is one of the biggest challenges organisations face nowadays. Industry analysts say that integrating RPA in ERP applications will definitely experience a dramatic shift where AI and automation will play an important role in 2023 and beyond. But RPA can be leveraged for ERP purposes in various ways. **wn**
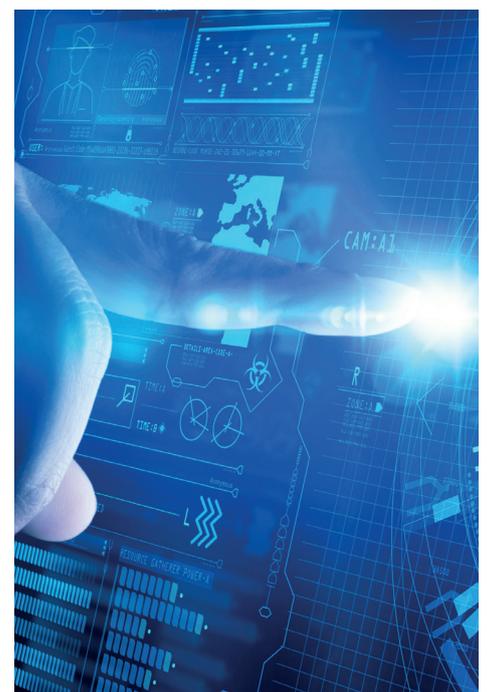
Condition Monitoring versus Artificial Intelligence

HOW IN THE FUTURE WILL WE USE FACTS TO MAKE DECISIONS

Humanity has long dreamt of possessing complete knowledge, but this dream has remained unfulfilled. The desire to understand the world's inner workings, or at least that of machines and people, is similar. Even Goethe's Faust, in his famous study, enthuses, "That I may understand whatever binds the world's innermost core together".

By Eberhard Klotz from Festo

And so, condition monitoring has been used for years to detect which conditions are prevalent in machines and processes, where changes are likely to occur, or what will happen tomorrow – and why. This milestone is now within reach thanks to the help of artificial intelligence (AI), as hundreds of requests at Festo show every year.

For 50 years, our machines and production facilities have been equipped with central electronic controllers, PLCs for short, or process control systems (PCS). Over the years, more and more sensors have been installed, but their evaluation was time-consuming, complex, expensive and inflexible too. So initially, the focus was on having relevant data for process control and reducing the error messages to what was technically (or legally) necessary.

Another problem was that there were no consistent definitions of what constituted an error or a significant deviation. In other words, when or how severe the error had to be before a category such as an alarm, warning, caution, or note was appropriate. Globalisation and a public increasingly sensitive to legal issues and new requirements such as product liability exacerbated the situation. More recently, trends such as Industry 4.0 and digitalisation are becoming extremely important.

This article shows how, over the last 20 years, various associations have laid the foundations. This has resulted in the development of sophisticated, differentiated diagnostic and condition monitoring systems. In more recent years, a consistent and far-reaching stage has emerged. With

the standardisation of data interfaces between IT and OT created within the framework of Industry 4.0 and with the availability of increasingly better and cheaper memory and processor performance, modern analytical tools such as artificial intelligence can make huge advances in the evaluation of mass data and finally help predictive machine diagnostics to achieve a breakthrough.

ACT, DON'T REACT

Diagnostics and condition monitoring in automation have a great future ahead of them. For a good reason: unplanned downtime is expensive. In some cases, one minute costs up to 10,000 euros! The Festo brochure "Diagnostic Management" in 2006 already mentioned this – a groundbreaking statement.

The trend is to actively increase the process reliability and productivity of systems by designing diagnostics as asset management (Fig. 1). Innovative diagnostic concepts, fully diagnostics-capable products and numerous data-based algorithms and services - nowadays also with the help of artificial intelligence (AI) – costs of plants and ensure a faster return on investment (ROI) with increased competitiveness. Reliability is provided by measuring OEE (overall equipment effectiveness) or TPM (total productive maintenance).

The goal is to have a diagnostic portfolio aligned with clear Industry 4.0 standards that is open, integrable and fit for the future. And to have scalable concepts that enable virtually 100% machine availability.

DIAGNOSTIC MANAGEMENT: A NEW CHAPTER FOR EFFECTIVE MAINTENANCE

The complexity of systems, machines and plants makes diagnostics and condition monitoring an indispensable factor in factory and process automation. Thanks to data-based algorithms and AI services, their importance will grow rapidly in the coming years. As global competition becomes ever fiercer, sophisticated, individual diagnostic concepts provide decisive competitive advantages by significantly increasing the overall efficiency of expensive systems. Since any chain can only be as strong as its weakest link, the principle of continuity also applies to diagnostic concepts. Good concepts also integrate smaller machine and system parts from the outset and provide continuous diagnostic capability (Fig. 2). A common

occurrence of process errors in pneumatics, such as the combination of runtime and peripheral errors, was included in diagnostic solution concepts for the first time in 2006.

The challenge is that a conscious business decision for strategic diagnostic and asset management has to be made to increase productivity. This is the only way to guarantee optimum overall equipment effectiveness (OEE), which opens up the possibility of offering concepts such as pay-per-use.

IMPORTANT BASIS: CONDITION MONITORING

Even today, the normal technical method is still to carry out preventive maintenance at certain intervals and times: simple monitoring for greater reliability and predictability.

This type of maintenance is often based on the experience of the operators/maintenance technicians, running times

Effektive Instandhaltung
Effective maintenance

Diagnose
Diagnostics

Vorausschauend
Predictive

Zustandsabhängig
Condition Based

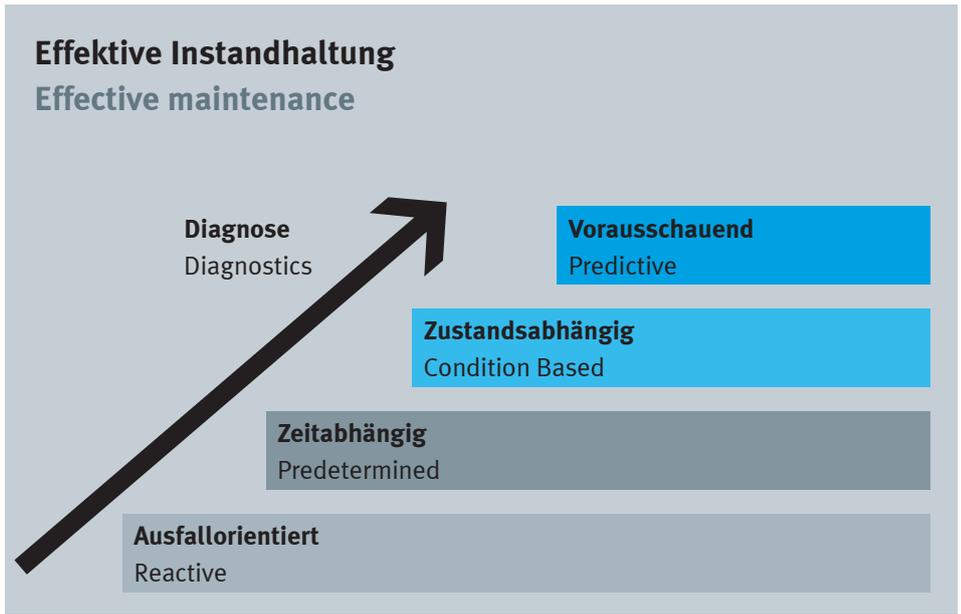Zeitabhängig
Predetermined

Ausfallorientiert
Reactive

Figure 1: The road to more effective maintenance (source: Festo 2006). The latest possibilities with AI models even allow descriptive maintenance (prescriptive) as the next level: what exactly will fail, and what is to be done?

of the drives, switching cycles or stroke counters, but also on sensors such as flow sensors, which observe and analyse the "fever curve", i.e. the condition of a pneumatic system, for example.

Condition-based and predictive maintenance : Condition-based maintenance defines the ideal time window much more individually and precisely; regularly monitoring a system

Diagnostic data from Festo valve terminals

Undervoltage per module
- Electronics -25%
- Load -10%/valves -25%
- Emergency off ≤10 V

Error memory
- Last 40 messages
- With a time stamp
- Detecting sporadic errors

Undervoltage per valve block
- Additional supply for valves monitored separately
- Load/valves -25%

Selecting wire break
- Per channel
- Per module
- Per valve
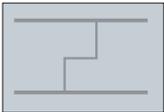
Selectable short circuit
- Per channel
- Per module
- Per valve

Upper/lower limit value
- Per analogue channel
- Voltage
- Current
- Temperature
- Pressure
- Counting

Condition monitoring
- Setpoint specified per valve
- Monitoring downstream mechanics/processes
- Preventive diagnostics/maintenance

Advanced analytics
- Parameterisation errors
- Condition monitoring
- Overload sensor
- Measuring range exceeded

Fig. 2: Comprehensive diagnostic data from an intelligent valve terminal CPX/MPA from 2002 are the basis for predictive maintenance (or predictive quality) concepts using artificial intelligence (source: Festo 2021)

using suitable sensors and recording diagnostic data results in better maintenance control. Timely reporting of malfunctions makes it easier for the maintenance engineer to plan maintenance and purchase parts. The big advantage is maintenance work can be carried out during non-productive times. Predictive maintenance is the further development of preventive maintenance and thus becomes the best form of maintenance. The subtle difference is that modern AI methods and trend analyses determine when a component should be replaced dynamically and depending on the operation.

However, the core of predictive maintenance is and remains the interpretation and evaluation of the data that has been collected. When it comes to implementation, the real added value lies in the domain know-how of experienced staff and partners who can relate their knowledge to the specific context. At the same time, AI alone can provide initial insights and, above all, complex correlations.

The decisive advantage is that, for example, the effects of changing environmental conditions or dynamics are recorded more effectively than they would be with a schedule based on rigid intervals. While condition monitoring is the basis, especially for downstream complex, interlinked manufacturing processes, modern AI evaluation is the major key to success.

Guaranteed synergies: If AI algorithms are taken up by both production and automation professionals, the data can often be used several times, not just to improve predictive maintenance but also to assess quality aspects, for energy efficiency topics or to look at additional important factors that influence the OEE reference data.

Strategies for modern diagnostics and condition monitoring : Figures 3 and 4 show that setting up a good condition monitoring system requires extensive preparation and know-how, which is why many companies still shy away from it. This effort can be reduced thanks to state-of-the-art IIoT technologies such as smart products, IoT networking and AI models for data evaluation. Even better, these approaches can also be used to develop basic procedures that can be adapted for all machines and manufacturing processes. Here are the individual and essential steps again:

Step 1: Detecting faults – monitoring
Monitoring is an ongoing measurement activity to detect faults or failures and is usually carried out using a single sensor signal or a characteristic value.

Step 2: Finding faults
Diagnostics detect current or impending faults based on characteristics and symptoms and locate them. It evaluates directly measurable signals using a cause-and-effect mechanism (Figure 3). Alternatively, diagnostics can also be model-based (e.g. by using AI).

Step 3: Identifying faults
If the drives used are critical for safety or high quality, it is advisable to use more in-depth diagnostics to identify the type of fault (Fig. 4: Internal or external leakage).

Further steps: process diagnostics and system diagnostics
In process diagnostics, the focus is on the causes of errors. Through their link to the process, process faults will also be evident in any electric or pneumatic components that are functionally integrated with the process. For example, if a jammed component changes the cylinder movement, the actuator becomes a sensor for process diagnostics in machine diagnostics

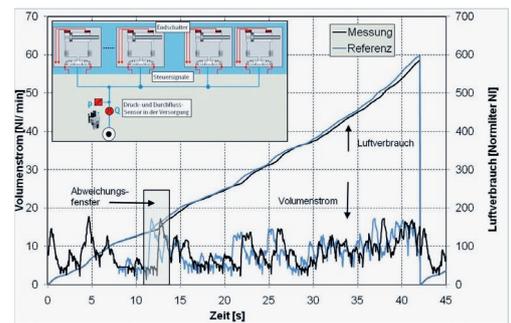*Figure 3: Preparations for condition monitoring with flow rate and consumption analysis on a pneumatic system*
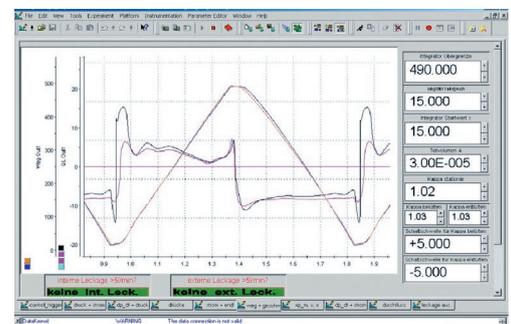

Figure 4: Indirectly determined cylinder leakage by comparing the identified position with the actual or reference position

Figure 5: Process diagnostics, bottleneck analysis and 15% higher output on an assembly line for valves (source: The Festo Scharnhausen Technology Plant)

Festo AX

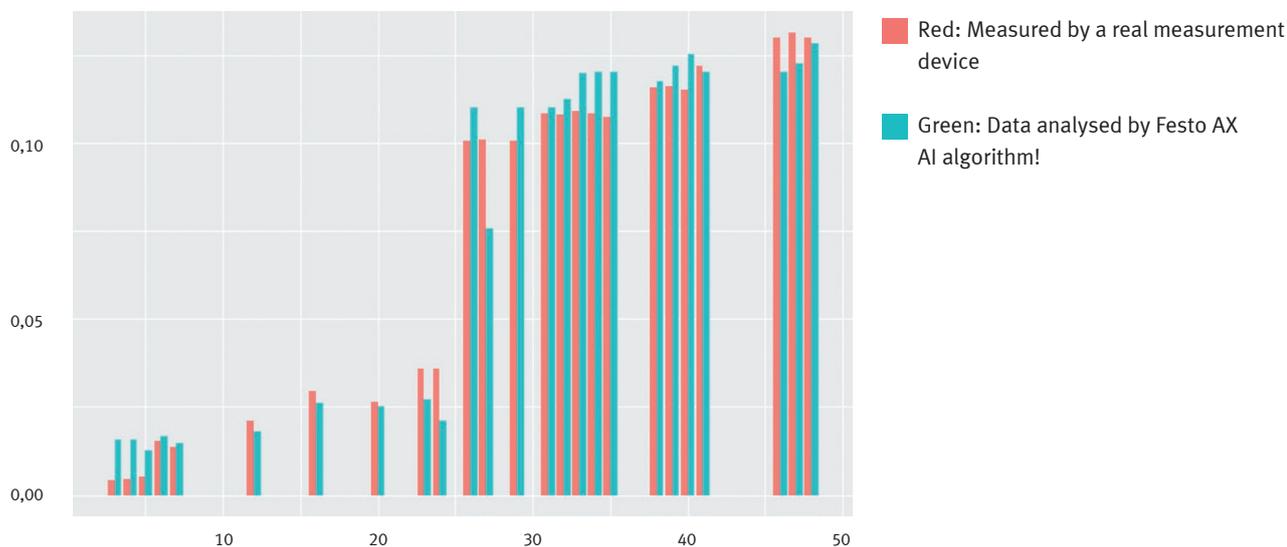Predictive notifications of decreasing quality – Metal parts produced by a tooling machine

Figure 6: Predictive quality: System functions with AI-based evaluation on a machine tool (Source: Resolto Informatik)

systems. Using this method, you can locate and eliminate bottlenecks on a modern assembly line in your production facilities and increase productivity by 15% (Fig. 5).

System diagnostics goes even further with AI-based methods and models already available today. This means that system-oriented diagnostic methods (e.g., AI-based models) are becoming increasingly important, as they can save the need for sensors and thus reduce costs and provide excellent customer benefits through proximity to the system function. Figure 6 shows an AI application for "predictive quality", i.e. the prediction of whether a machine/system will still be able to produce quality tomorrow.

The graph compares results calculated by AI with results measured by a real device (source: Resolto Informatik) and shows quite a good correlation. Several clients are already testing these approaches.

SMART PRODUCTS AND FUNCTIONS BASED ON DATA AND AI

Leading manufacturers are now developing products that use these methods and these technologies so that condition monitoring can quickly and easily offer better results. For example, multifunctional sensors are available on the market that record temperature, vibration, installation position, etc., pre-compress the data thanks to statistical evaluation and make it available via common IIoT interfaces/formats such as OPC-UA or MQTT.

Smart products that already integrate the sensor technology close to the process and can thus evaluate and autonomously readjust a complete subsystem go even further. This Motion Terminal (Fig. 7) is a smart product, also called "digitised pneumatics", when it was launched in 2015. App-controlled functions can be changed at any time; integrated sensor technology enables controlled, adaptive processes and model-based

process optimisations can be made thanks to integrated knowledge based on AI methods. These models made it possible to increase the cycle time of several customer applications by up to 15% while simultaneously increasing process quality and the availability of all digital data for further analysis and optimisation.

A second example is the valve terminal families CPX/MPA and CPX/VTSA, where the routine diagnostic and condition monitoring functions on PROFINET can currently be retrofitted as MQTT data sets.

Other smart functions based on AI are planned: for example, customers can configure their subsystems in the Festo Automation Suite (FAX) (which sensor belongs to which cylinder/valve). They can then start a machine learning algorithm that creates a reference for condition monitoring in the subsystem, monitors it in great detail using AI and
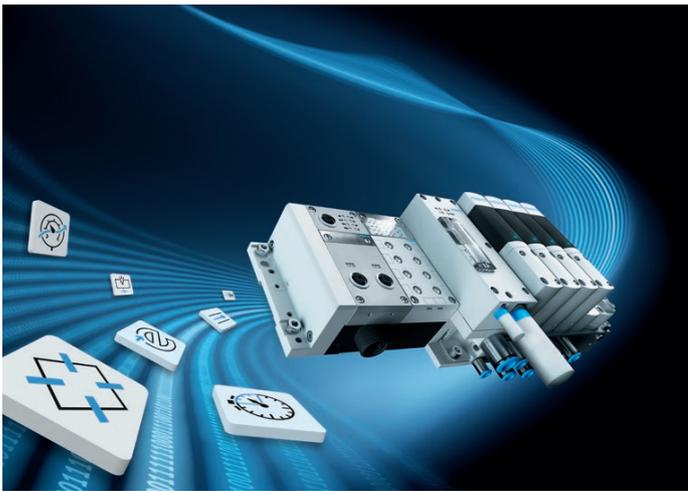
Figure 7: Festo Motion Terminal as digitised pneumatics with integrated, model-based algorithms and flexible apps for controlling and optimising subsystems (source: Festo, White Paper Dr Roos, 2018)
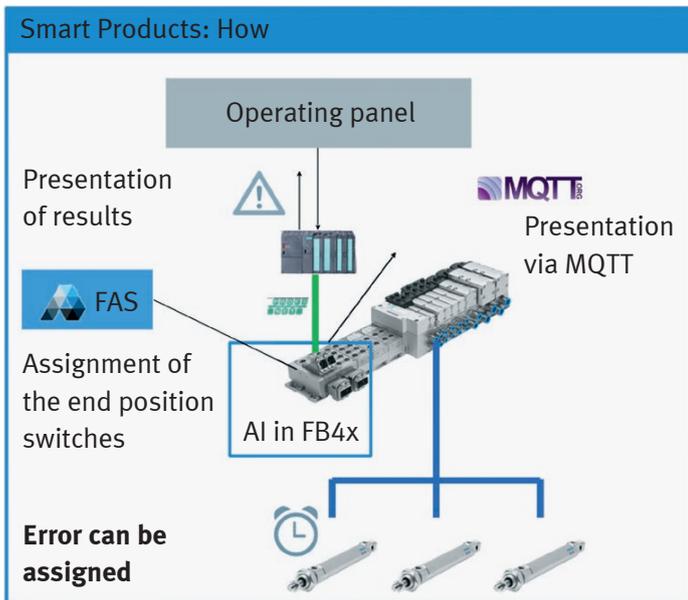

Figure 8: AI models in the PROFINET Fieldbus node of a valve terminal can be adapted and trained to a subsystem via the Festo Automation Suite (source Festo) .

evaluates it in real-time (Figure 8). Even the smallest deviations are thus detected over time, and predictions about failures can be made. These universal algorithms work even when customers connect a competitor's cylinder.

However, the freely configurable system approaches with Festo AX go much further. These algorithms can be applied to all data, products (even if they come from other manufacturers) and machines/processes. They are immediately available and ready to be implemented in customer applications. This also includes the software solution CPX-IOT-S for an IoT gateway on a server. Customers who use a large number of valve terminals can use it to simultaneously address all the valve terminals in a factory network and collect the information and results in a data lake, for example.

WHICH IS BETTER:
DATA ANALYSIS USING BUSINESS INTELLIGENCE (BI), CONDITION MONITORING OR AI?

Collecting data from the shop floor and machines has been around for a long time. These data sources already help with diagnostics and root cause analysis. Machine logbooks and maintenance databases are also valuable sources.
However, they all have several historical disadvantages.

- Some are still done on paper or created using simple office tools like Excel.
- The data formats are not standardised.
- They are not networked/linked to each other.
- Especially not with live data from the machine/plant, such as diagnostics/condition monitoring.

Initial conclusions can nevertheless be drawn from this data. For example, Pareto analyses can detect the most frequent errors and their causes. They can be allocated to a particular shift, operator, maintenance staff, or production batches. In complex production plants, for example, classic BI tools (Figure 9) help to determine what happened and why.

THE APPROACH – AND THE DIFFERENCE BETWEEN BUSINESS INTELLIGENCE AND AI/PREDICTION

AI-based models are useful because they can capture and correlate mass data cheaply. However, a lot of data and correlations are completely left out and far too complex and expensive for traditional programming and, thus, classic condition monitoring. Important questions such as "what will happen tomorrow" and even "what should I do ahead of time" cannot be answered. And thanks to feedback from the experts, they get better and better over the years and ensure this knowledge remains available throughout the company.
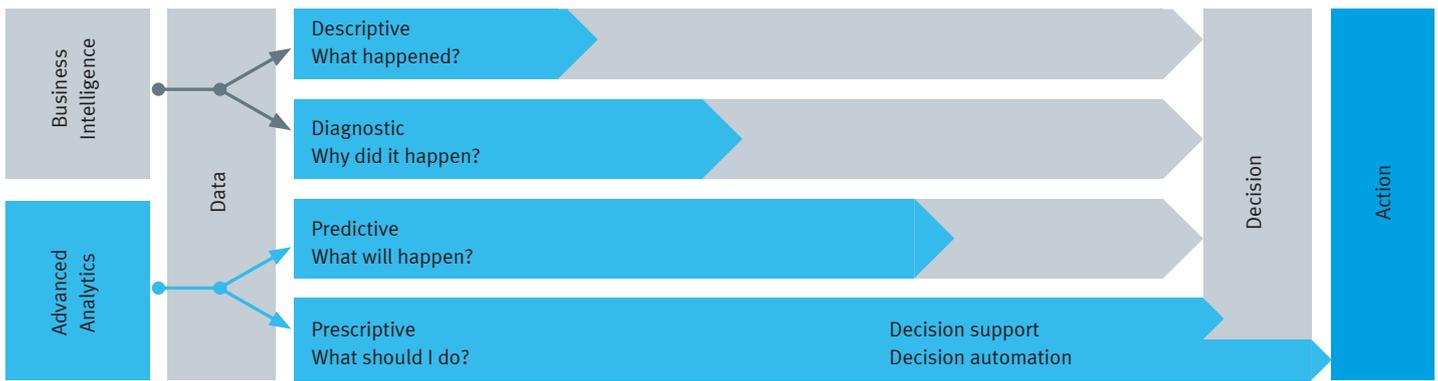
Figure 9: Analyses using business intelligence can help to identify, justify and assign causes but not to draw any conclusions for the future (Source: Resolto Informatik)

Example: Anomaly detection and classification and the difference with condition monitoring
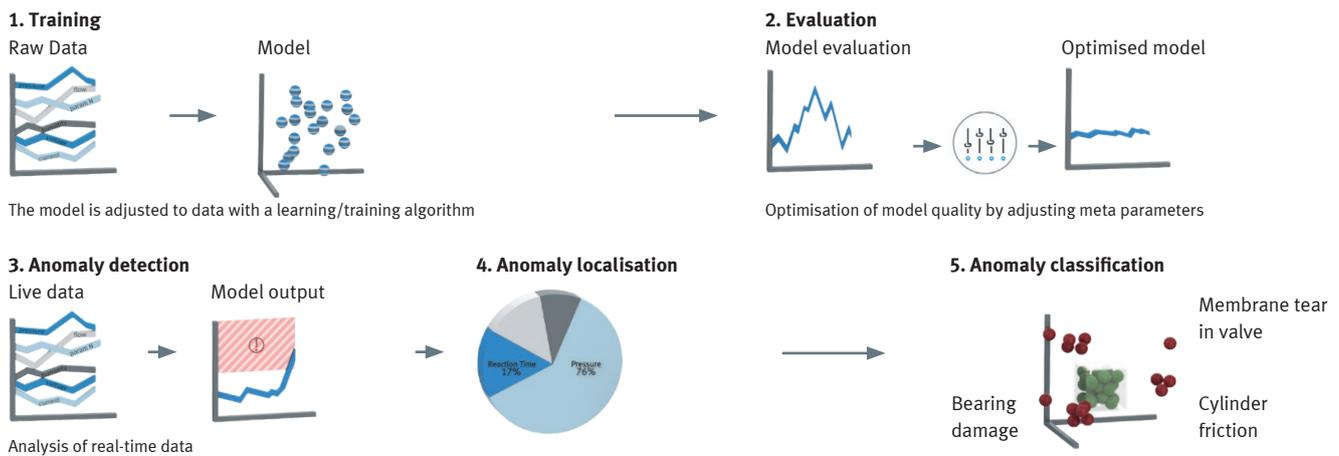
Figure 10: Machine learning AI methods combine frequent data patterns into point clouds and thus make even unknown or unexpected correlations transparent without prior knowledge/programming. This can lead to better results in the next step, thanks to appropriate domain knowledge. (Source: Resolto Informatik)

Example:
Imagine you are asked to compare five parameters from raw sensor data. In traditional programming, you can compare 25 = 32 combinations, provided all combinations are meaningful or relevant. You could just about program that for condition monitoring. But what happens in larger scenarios with 50 or 500 parameters or even more? Unfeasible and far too expensive. Figure 10 shows how AI approaches and works in a completely different way. Once trained, it automatically groups all combinations into clusters or points clouds. An experienced data scientist then evaluates these to train

and optimise it to create a good, well-founded AI model (e.g. how robust or how sensitive it should be). Machine learning (ML) requires learning data (in the simplest case, "good states" of the machine), which are then modelled as a reference.

Alternatively, an ML algorithm also learns when data sets are verified ("labelled") in detail by domain experts. From step 3 onwards, the model is compared with the live data and anomalies are reported and localised, as Festo's ML models are built and optimised to enable traceability. Experts can now give feedback to evaluate and classify the anomaly.

This is how an AI model based on ML learns over time. It can not only make the knowledge of the company and its employees' accessible to everyone over long periods and maintain it but also continuously improve the decisions and recommend conclusions.

EXAMPLES FROM CUSTOMERS AND PRACTICAL APPLICATIONS
In many companies, ideas about digitalisation are either in preparation or in an early phase of implementation, e.g. with pilot projects. As an innovation leader, Festo believed early on in the future of Industry 4.0 and thus digitalisation and artificial intelligence,

AI versus condition monitoring – analytical graph of a robot welding gun in a car body shop
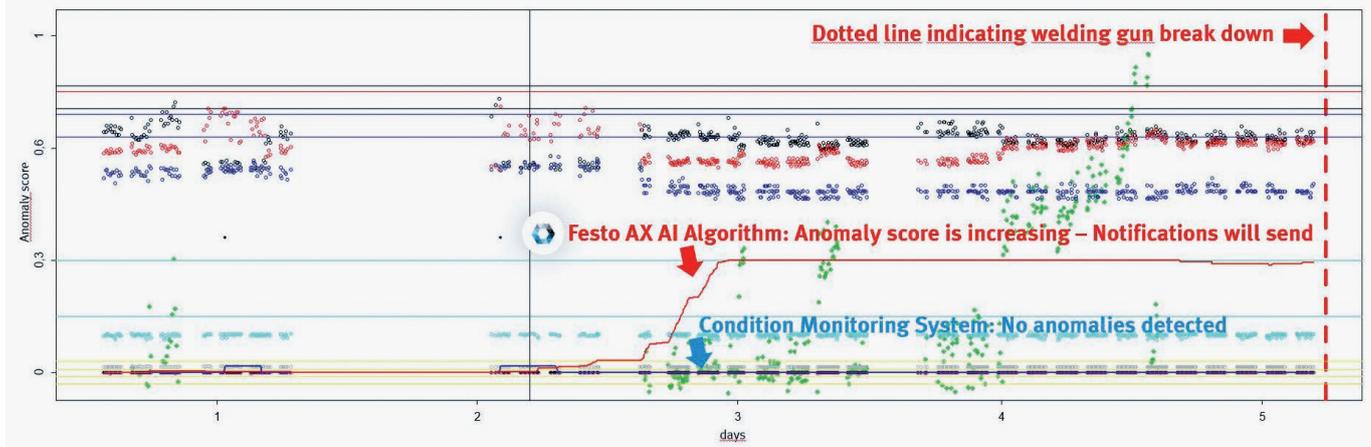
Figure 11: Fault patterns of a welding gun. While any relevant deviations are not yet reported by monitoring the condition of individual operational units, the AI model shows a significant increase in anomalies in the overall system during the two days before the failure.

and has already successfully implemented many ideas in its factories. Customers benefit significantly from this experience because suppliers who can offer mechanical know-how, process knowledge, automation technology, and AI are rare. This applies to both factory and process automation.

Every year, hundreds of requests for AI models are processed at Festo, whereby a distinction can be made between:

- Small applications that can be created within a few weeks/months
- Larger requests that take months to a year, depending on the complexity
- Extremely complex tasks that result in joint development partnerships over many years with hundreds or thousands of AI applications
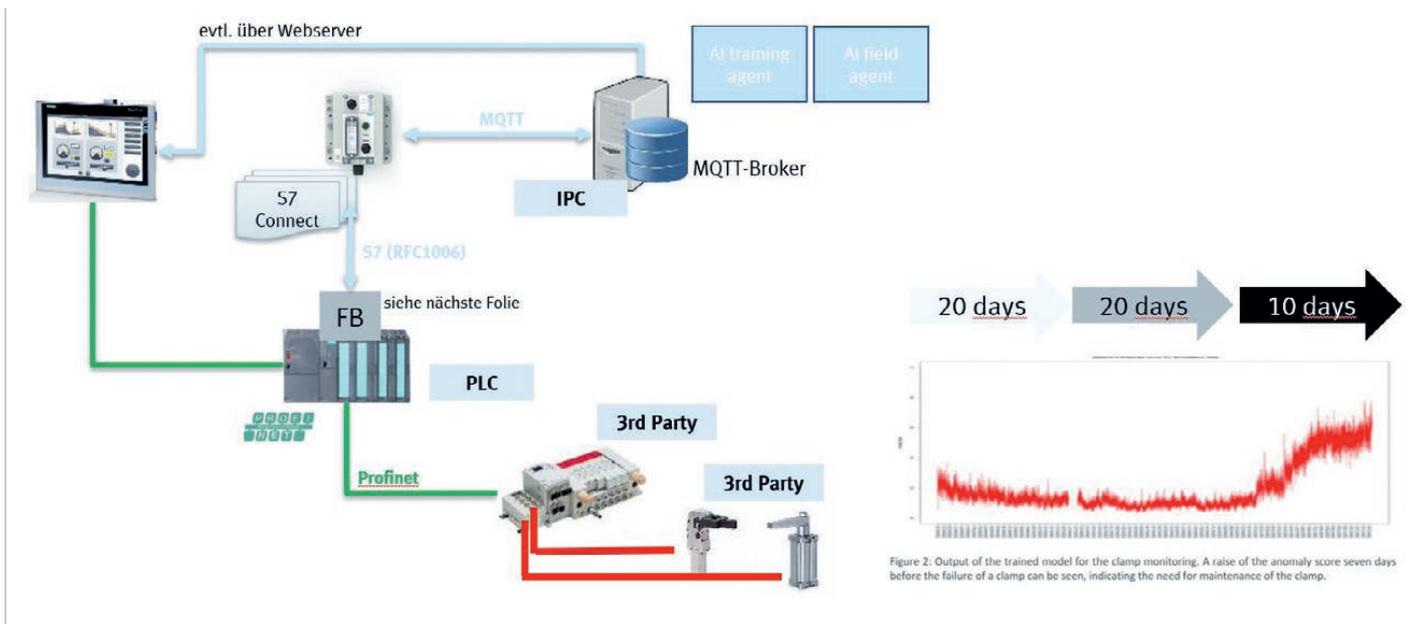
Figure 12: Probability of failure of the clamping cylinders in a welding application: predicted accuracy 10-14 days. In addition, performance deviations need to be recognised, and possible productivity losses of several per cent avoided. Solution: smart valve terminal CPX/VTSA with PROFINET FB4x and independent AI model based on Festo AX. (Source: Festo)

Welding gun IoT project: improved quality and availability (OEE). Less downtime. Better asset management. Cheaper maintenance.

Figure 13: Asset management and performance analysis on servo-pneumatic welding guns: decentralised intelligence in the subsystem, early success with agile methods, and a model-based solution. Thousands of welding guns have been connected online over the years, and savings of more than 20% in maintenance have been made.

Classic IO/NIO checks
Only detects NIOs with random checks, but does not prevent them

↓

Automate quality checks
e.g. by image detection with AI

↓

Correlate with production data
Get information about possible root causes for poor quality

↓

Predictive quality
For every workpiece with early detection of quality loss

Detecting blowholes in Scharnhausen (Festo)

Figure 14: Optimisation of vision applications, e.g. to detect cavities in castings. The predictive quality approach avoids unnecessary production steps on rejects (source: Festo)

CONCLUSION

The algorithms and methods used by artificial intelligence (AI) perfectly complement existing diagnostic and condition monitoring systems. On the one hand, they enable the evaluation and correlation of large amounts of data.

Conversely, the new methods can react flexibly to deviations and new developments. That means there is no need to know everything that can happen (and program this), but it is possible to train the self-learning algorithm and thus use it adaptively and flexibly.

In many cases, testing in a pilot project has proven to be the best way to start, as the knowledge gained can then be extended to a machine, a line or a factory. Festo AX has integrated the knowledge of experts into the models, and the system is constantly improved.

Successful implementation requires cooperation with highly experienced users and operators since understanding the application, the mechanics, the production processes, and the selection of relevant data is extremely important.

Complete implementation from a single source, from the workpiece to the cloud, with visualisation, the generation of workflows, and, if necessary, a mobile, digital solution for maintenance can already provide you with considerable added value for optimised manufacturing today – and makes the future look inviting.

This article has shown all the main steps and used practical examples to demonstrate the benefits and uses. The technical and commercial advantages are clear.

Figure 15: Optimisation in logistics. Use case 1: Database analysis of complex system error messages to analyse maintenance trends. Advantage: even existing data can be used for online forecasts and evaluations. Use case 2: Pilot projects to predict failure of motors, frequency converters, or problems with wheels/rails caused by wear, imbalance, etc. Advantage: maintenance is optimised, unplanned downtimes are avoided, capital tied up in spare parts is reduced
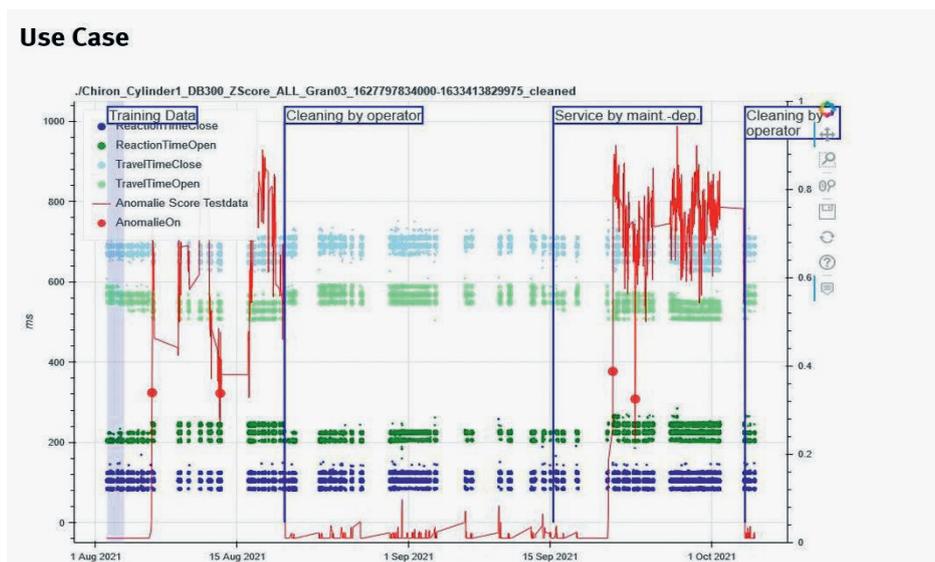*(source: Festo)*

Fig. 16: Optimisation of OEE by preventing failures of machine tools, e.g. on tool change flaps. AI-based condition monitoring on simple drives enables them to be cleaned in time. ROI is less than one year for one machine, which is extremely attractive if several similar machines are used (source: Festo)
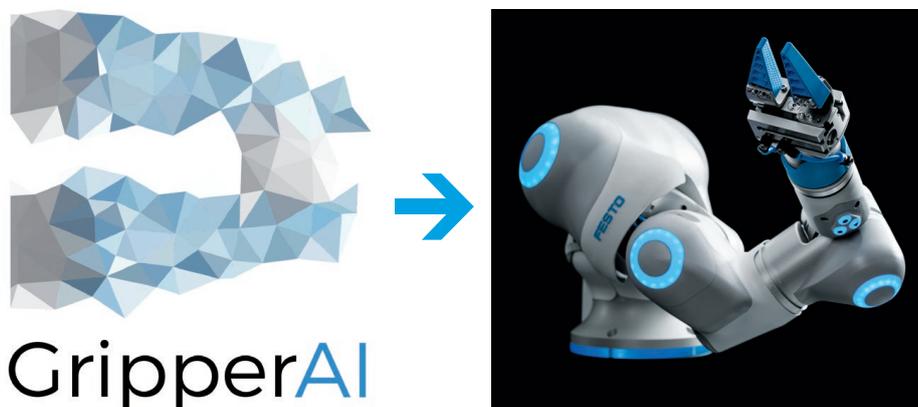

Figure 17: Autonomous gripping or "blind reach into the box": modular and universal AI solution for all robots, can be implemented on edge, on-prem or cloud-based and can be retrofitted. Advantage: Robots do not need to be trained/programmed. This often saves several days of work per workstation. Optional employee retraining and educational programmes from Festo Didactic (source: Festo) **wn**

SEW-EURODRIVE

– AUTOMATING THE FUTURE

Automation is the application of machines to tasks once performed by human beings or, increasingly, to tasks that would otherwise be impossible. Although 'mechanisation' is often used to refer to the simple replacement of human labour by machines, automation generally implies the integration of machines into a self-governing system. Automation has revolutionised those areas in which it has been introduced, and there is scarcely an aspect of modern life that has been unaffected by it.

By Minx Avrabos

The term automation was coined in the automobile industry in 1946 to describe the increased use of automatic devices and controls in mechanised production lines. The origin of the word is attributed to D.S. Harder, an engineering manager at the Ford Motor Company at the time. The term is used widely in a manufacturing context. Still, it is also applied outside manufacturing in connection with various systems in which mechanical, electrical, or computerised action is a significant substitution for human effort and intelligence.

Advanced systems represent a level of capability and performance that surpass in many ways the abilities of humans to accomplish the same activities. In general, automation can be defined as a technology concerned with performing a process using programmed commands combined with automatic feedback control to ensure proper execution of the instructions. The resulting system is capable of operating without human intervention. The development of this technology has become increasingly dependent on the use of computers and computer-related technologies. Consequently, automated systems have become increasingly sophisticated and complex as evident in SEW-EURODRIVE's latest feat.

HISTORICAL OVERVIEW

Banker Christian Pähr founded Süddeutsche Elektromotorenwerke, SEW, in Bruchsal, North Baden on June 13, 1931. The start-up's product line consisted of various electric motors and gear motors, the Millicut electric band saws, the Simplitt planers, the Circuit electric circular saws, and the Poliglitt grinding motors. Unfortunately, Mr Pähr didn't see the great success of his company, as he died four years after starting this business. His widow, Kunigunde Pähr, ran the company after his death, supported by their daughter, Edeltraut.

In 1945, although the bombs rain down on Bruchsal, and most of the SEW building remains miraculously intact, the end of the war ushers in the era of the

Christian Pähr
Founder, Süddeutsche Elektromotorenwerke (SEW)

SEW's founding employees

still-young company's most formative personality: Ernst Blickle. Born in the Swabian Alps, Blickle takes over the company's reins from his mother-in-law. He rapidly acquires engineering expertise and begins directing the rise of SEW with a visionary, entrepreneurial spirit.

In the spring of 1948, most of Germany was still in ruins, but Blickle, who took over the management of SEW only three years before, was not only thinking about reconstruction - he wanted to expand.

The factory halls in Bruchsal no longer have enough capacity to meet the growing demand for gear motors.

As a result, he laid the cornerstone for a 10 000 square meter manufacturing facility in Graben, ten kilometres away.

In the wake of a plant expansion at a later time, Ernst Blickle also had social rooms constructed for his employees and training workshops.

In 1960, around 600 employees worked in the SEW offices and production halls in Graben and Bruchsal. In one decade, from 1950 to 1960, SEW's revenues jumped from 1.4 million DM to around 20 million DM.

Alongside the sales system in Germany, which was divided into North, South, and Central regions, SEW's first foreign subsidiary also contributed to this meteoric rise. In 1960, SEW USOCOME, the first foreign subsidiary, opened in Haguenau, Alsace.

In the 1960s, a new entrepreneurial attitude made inroads that the entire company must be consistently aligned with the market's needs. The market needed drives that satisfied the special requirements of various industrial sectors and production processes. Before this time, these customer-specific gear unit-motor combinations could only be realised at an extremely high cost.

The solution was modularity: a modular system of gear units and motors that could be combined flexibly and affordably.

The modular system can be implemented perfectly in industrial series production with low unit costs. This means that production should be organised centrally in a small number of plants with high output quantities.

In 1968, the assembly plant in Jönköping, Sweden, opened its doors. Rainer and Jürgen Blickle can still remember the camping vacation and the moment in which their father, Ernst Blickle, said that he would set up a new SEW location "Here, exactly on this spot."

The company's "seven-league boots" carried its European expansion to Italy that same year. Two small offices in Milan and Bologna ring in the SEW era in "bella Italia."

In Scotland Yard, SEW found a solution for all issues related to drive technology in the offices of a former police station in Normanton, England.

Ernst Blickle spent over four decades developing a medium-sized family-run operation from Bruchsal into a global player: SEW-EURODRIVE. His death in July 1986 marks the end of an era of German entrepreneurship and leaves behind a gap that needs to be filled. In 1987, Rainer and Jürgen Blickle took office as co-presidents of the SEW-EURODRIVE Group. Before that, Rainer Blickle ran SEW-EURODRIVE in Brasil for ten years, and his brother Jürgen worked for SEW-EURODRIVE in Canada.

Rainer and Jürgen Blickle drive the company's further development forward with new ideas and foresight. They acquired a majority holding in Pfeffer & Partner Getriebebau GmbH in 1990. In 1992, the company founded SEW-EUROCOME SA, a subsidiary of SEW-USOCOME in Forbach, in eastern France. This is yet another example of the company's steady growth trend.

SUCCESS IN AFRICA

SEW-EURODRIVE opened its offices in South Africa in 1986 and today has four factories: in Johannesburg, Cape Town, Nelspruit and Durban, with a warehousing operation in Gqeberha.

In February 2022, SEW-EURODRIVE moved into its highly anticipated new state-of-the-art African headquarters based in Johannesburg. The new complex is three times bigger and offers exciting developments to the African markets.

Built and equipped for R200 million and modelled on SEW-EURODRIVE's showcase factory in Graben-Neudorf in Germany, the facility – which accommodates approximately 150 employees– makes extensive use of 4IR technologies to network people, processes, services and data effectively.

The investment reflects SEW-EURODRIVE's confidence in the future of both South Africa and the African continent. The company points out that Africa is regarded as the world's next growth market. Home to 17 % of the global population in 2019, it is expected to account for 26 % by 2050 and an estimated US$16,2 trillion of combined consumer and business spending.

Raymond Obermeyer, Managing Director at SEW-EURODRIVE South Africa, says the investment represents the company's confidence in the South African economy and will allow it to take advantage of the opportunities available on the African continent.

"We are working hard to shape the factory of tomorrow with system solutions for Industry 4.0 and a focus on raising productivity, implementing smart maintenance while providing ergonomic support for the people working in these facilities," he says.

He adds that the factory of the future requires a high degree of flexibility, maximum efficiency and implementation of batch sizes of just one unit – all the while optimising costs. Smart future factories will increasingly be designed with industry 4.0 technologies at the heart of their operations. This will allow individual modules to make decentralised and autonomous decisions based on digital data.

Over a three-to-five-year period, SEW-EURODRIVE plans to incorporate many of these same technologies, including automated assembly machines and guided vehicles, at its new South African facilities at an anticipated cost of an additional R200 million. Not only does this give the company an opportunity to showcase its extensive capabilities and help customers take advantage of Industry 4.0 technologies, but it will also

be a key element of the company's drive to more efficiently service customers in South Africa and Africa.

Obermeyer reports that SEW-EURODRIVE currently services 23 countries throughout the African continent from South Africa. "With the implementation of the African Continental Free Trade Area (AfCFTA) and a push to grow manufacturing capacity on the continent, we expect African markets to account for around 50% of our turnover within the next few years."

Global supply chains, which are still battling to recover from Covid-19 pandemic-induced bottlenecks and delays, are at additional risk due to the war in Ukraine.

An assembly factory and expanded warehousing facility at its new Aeroton facilities, reveals Obermeyer, will mitigate and alleviate the risks of constrained global supply chains by allowing the company to increase its local stockholding. "This will allow us to service customers more efficiently, reducing the high cost of unplanned downtime and allowing them to adhere to their scheduled maintenance programmes. Ensuring our customers' continued productivity has been a key driver behind developing our new high-tech facilities," he said.

Obermeyer says that the company expects to attract business from drive users from Africa and across the world who may be experiencing long delays when they find they need to replace a gearbox.

The new facility will play a pivotal role in allowing SEW-EURODRIVE to efficiently service the burgeoning African market. It houses the group's African head office, an industrial gears and electric drives
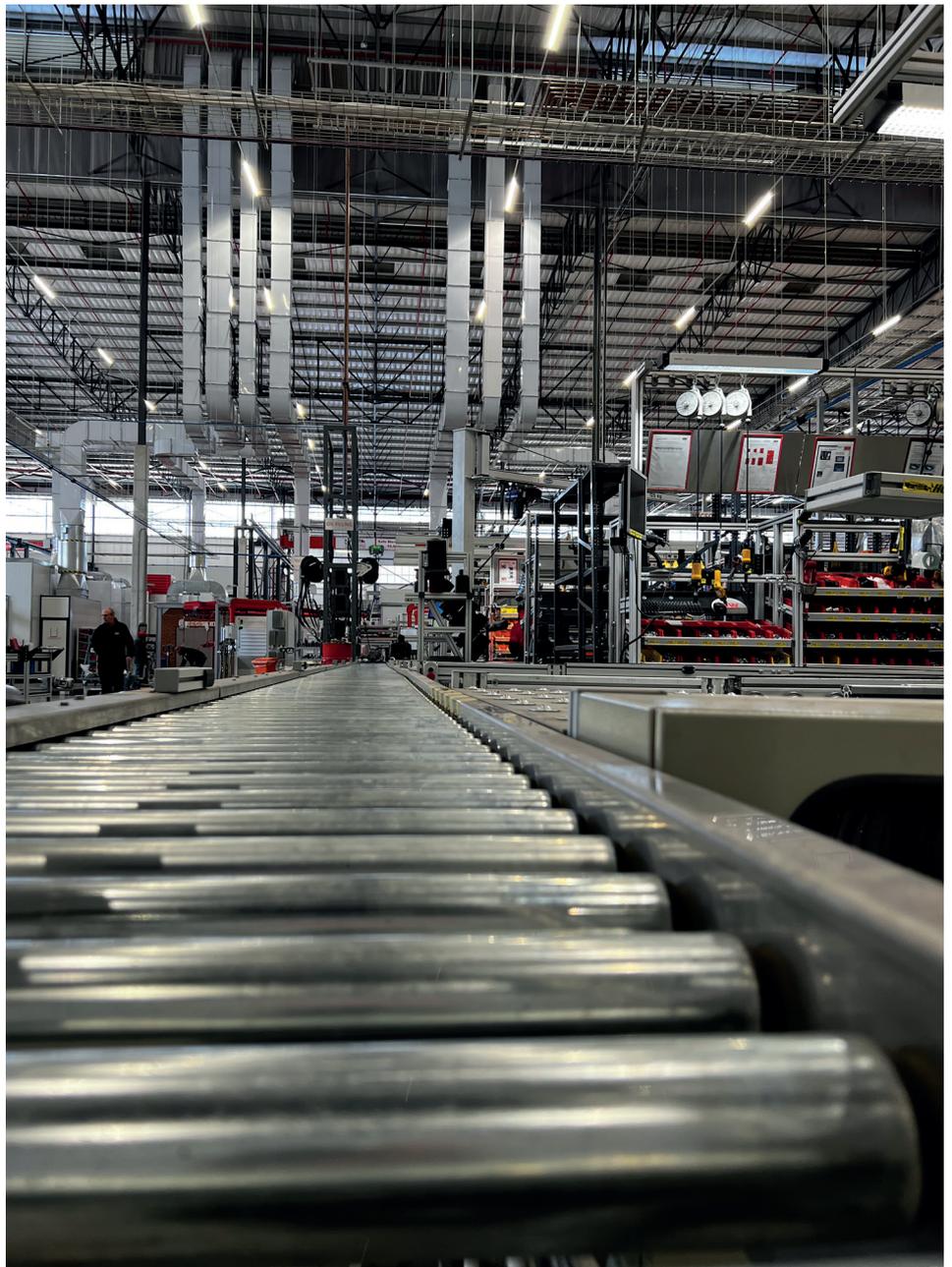
SEW-EURODRIVE recently installed a MOVI-C system at its Aeroton facility.

assembly plant, and expanded central warehousing and repair facilities.

In addition, a specially designed clean area within the facility will be used to conduct the assembly and repair of Variable Speed Drives (VSD), AGVs and servo motors. A team of skilled mechanical, electrical and mechatronic engineers are available to further support customers, particularly with technical enquiries.

All assembly and logistics processes have been incorporated into SEW-EURODRIVE's SAP system, facilitating traceability and visibility of all orders as they move through the assembly processes.

Further, the new assembly line equipment and a test bench have been installed that precisely replicate Finland's SEW-EURODRIVE assembly and testing capability. A significant investment that

again sees the company leading the marketplace.

The new facility, unlike any other service in this market sector, also accommodates SEW-EURODRIVE's unrivalled Drive Academy, which delivers product awareness and maintenance training to customers. Through this, online and virtual AR training and support are now available and directly support SEW-EURODRIVE's social development plans.

The expanded warehousing gives SEW-EURODRIVE the ability to increase stock levels, a huge benefit given the problems currently affecting the global supply chain. It means the company's customers in Africa can get orders – for new equipment or spares – fulfilled with minimal delay.

"The new facility allows us to service our customers more efficiently, reducing the high cost of unplanned downtime and allowing them to adhere to their scheduled maintenance programmes," Obermeyer states. "Ensuring our customers' continued productivity has been the key to developing our new premises."

SEW-EURODRIVE has used its own technology to automate operations at the Aeroton facility. The main production conveyor is based on the company's high-tech MOVI-C® all-in-one modular drive solution, which is now being introduced to the African market. MOVI-C® had its official African launch at the recent Electra Mining Africa 2022 show in Johannesburg.

In essence, MOVI-C®C is a suite of products – including controllers (PLCs), variable speed drives, gear motors and servomotors – that automates drive applications, whether simple or complex.

The new generation MOVI-C.

The installation – which has resulted in a 40 % productivity gain – includes the MOVIGEAR® mechatronic drive system, which combines an energy-efficient IE5 motor, gear unit and corresponding drive electronics in a single housing – which drives the production conveyor, controlled by the MoviPLC®. The modular nature of the installation means it can easily be extended in the future should the need arise.

The assembly line for geared motors can accommodate 7 000 units per month. In comparison, the assembly of industrial gear (IG) units are currently ramped up to between 100 to 140 IG units per month, doubling the current capacity. New spray booths and automated oil filling stations have been installed to cater for these volumes.

All local assembly is conducted following SEW-EURODRIVE's global quality standards, with the assembly of VSDs, servo motors and other sensitive equipment being conducted in an isolated clean area – with copper grounding and anti-static mats – of the facility. The assembly and logistics processes are also now incorporated into SEW-EURODRIVE's SAP system, which gives better traceability and

visibility of all orders as they move through assembly processes.

Among the products produced at the new facility are SEW-EURODRIVE's modular air-cooled condenser (MACC) drives. They have already experienced excellent sales in South Africa, with two units recently installed in the Northern Cape and 24 units at a Limpopo site, with another 24 on order.

Forming part of SEW-EURODRIVE's MC-Series modular IG range, the MACC is a purpose-designed gearbox solution for driving the modern fan-based air-cooled condenser systems used in steam-driven power generation units.

SEW-EURODRIVE will stock a single casing size with multiple components and specific ratios depending on which power station requires the drive. This modular approach will enable the new facility to custom assemble MACCs at a rate of approximately two to three units a week, drastically cutting the long lead times associated with equipment of this type.

Illustrating the benefits of the new Johannesburg facility, SEW-EURODRIVE anticipates assembling and testing customised M1 units within two to three weeks of an order being placed. Previously they had to be imported from overseas with lead times of between 16 and 20 weeks. These are single-stage high speed low ratio industrial gear units. Typical ratios will be from 1.12 to 5.5:1.

Innovative strength, tradition and customer focus are the cornerstones of SEW-EURODRIVE's success. With a comprehensive product portfolio and a wide variety of customer-oriented service modules, SEW offers their customers added value and measurable benefits. **wn**

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A Blockchain use case for automated municipal water payments

Rand Water, a bulk water utility in South Africa, supplies bulk potable water to municipalities, which distribute and sell to residential households and businesses within their borders. As of 31 June 2021, the total overdue municipal debt to Rand Water stood at R3.9 billion (Rand Water, 2021). This overdue debt is growing monthly due to certain municipalities continuing to default on payments and reneging on negotiated work-around agreements.

By Pascal Motsoasele
PrEng FSAIEE

This will eventually force Rand Water to take drastic measures like water throttling or even discontinuing services. However, the non-provision of water to the defaulting municipalities would impede the delivery of municipal services to the populace, which could result in violent unrest in the impacted communities.

This is further exacerbated by claims from some quarters of the population that they always pay their municipal bills and, therefore, should not be penalised for the failure of their municipality to honour payments to Rand Water.

An innovative blockchain-based payment application is proposed herein, allowing bulk water utilities like Rand Water to receive payments directly from the residents and thus reduce the burden on the municipalities. Development work can be executed in-house and will require ten (10) weeks at an estimated cost of R123, 000.00.

OVERVIEW

Rand Water is South Africa's largest state-owned bulk water utility, supplying an average of 4,380 million litres of potable water per day to about 15 million consumers around Gauteng, North West, Free State and Mpumalanga provinces. The utility is mandated to abstract raw water from the Vaal River System, purify and treat it to potable standards, and supply it in bulk quantities to recipients within its designated service area.

The utility's biggest water consumption and revenue clients are the municipalities, which comprise over 90% of the customer base (Rand Water, 2021).

THE BUSINESS CHALLENGE

Rand Water's corporate risk table features 19 risks, of which "Credit and Debt Management" is rated as number 2 in terms of impact and priority. A deep dive into the reasons for its high-risk ranking necessitates a closer look into the product value chain from Rand

Water's points of delivery (PoD) billing meters through the customer's (in this case, the municipality) distribution network and down to the municipality's customer (i.e., in this case, the end-user) 's billing meter.

THE CUSTOMER – MUNICIPALITIES

The increasing financial difficulty faced by the municipalities is a growing concern. The 2021 Integrated Annual Report concedes that Rand Water had failed to meet its target of 45 debtor days last year (performance was 75 days). The report also reveals that, of the R3.9 billion that is currently on the debtors' book, irrecoverable trade debt sits at R1.9 billion for the year, of which R243 million is due to non-payment by municipalities (Rand Water, 2021).

A quick debt trend analysis suggests that the historical debt continues to rise monthly as a number of the municipalities continue not to make full payments on their current debt unabatedly.

THE CUSTOMER'S CUSTOMER – END CONSUMERS

The municipality's customers are predominantly businesses and residential households; they are some of the end consumers of Rand Water's products. One revenue management step that Rand Water executes is to curtail supply to municipalities that default on payments. As water is a basic human right enshrined in the Constitution of the Republic of South Africa, this is implemented in such a way as to not completely shut off the flow of water to the defaulting municipalities but rather to throttle the flow and thus allow the basic minimum prescribed by Law.

However, in some municipalities, there have been numerous protests by civil society when these remedial actions are implemented, with the end users claiming to have made their monthly payments to the municipalities and, therefore, not deserving of such treatment (Petersen, 2019; Seleka, 2020; Viljoen, 2019).

Rand Water continues to search for innovative ways to incentivise the municipalities to meet their payment obligations towards it. Towards this challenge, the development of a water payment software application is proposed and positioned for future consideration.

PROPOSED SOLUTION TO THE CHALLENGE

For Rand Water to achieve its vision of being "a provider of sustainable, universally competitive water and sanitation solutions for Africa", the company needs to embrace innovative ideas from its workforce and nurture the development of those ideas for its benefit. The proposed water payment software idea is aimed at tackling the non-payment issue by the municipalities that Rand Water services. It has not been proposed to the company yet but will be submitted once the in-house newly established Innovation Hub puts its ideation process into full operation.

THE RAND WATER INNOVATION HUB

In March 2019, Rand Water appointed a new Chief Executive Officer (CEO), Mr Sipho Mosai, who was previously the company's Chief Operating Officer (COO). Mosai immediately started an organisational restructuring exercise and introduced an Innovation, Research and Development division to house the Rand Water Innovation Hub. Championed by the narrative of an "innovation-driven risk-based strategy", Mosai hoped to leverage Rand Water's innate innovative capacity, coupled with years of conducting postgraduate scientific and engineering research, to entrench a high-performance culture that would see the company marching aggressively towards exponential growth, possible expansion of our service area footprint, and be amongst the best run bulk water utilities in the world (Mosai, 2018).

Finding an innovative solution to the municipal debt challenge is thus aligned with Rand Water's recently-defined Innovation-driven Risk-based Strategy.

CURRENT PAYMENT METHOD

The following calculations are based on the 2020 water tariffs, meant to illustrate the proposed solution at a generic level, not necessarily the exact Rands and cents in the 2022 going rates. One only needs to adjust the numbers below to reflect the 2022 tariff rates.

Rand Water's product to the municipalities within its service area is potable drinking water, which they charge at ZAR 10,09 per kilolitre (i.e. R10,09/kℓ) (Rand Water, 2020). The municipalities, in turn, supply the end users (e.g. farms, factories, industrial plants and residential households) within their municipal boundaries at a premium that adds a markup to the cost of Rand Water. The biggest municipal customer, the City of Johannesburg, charges their customers a stepped
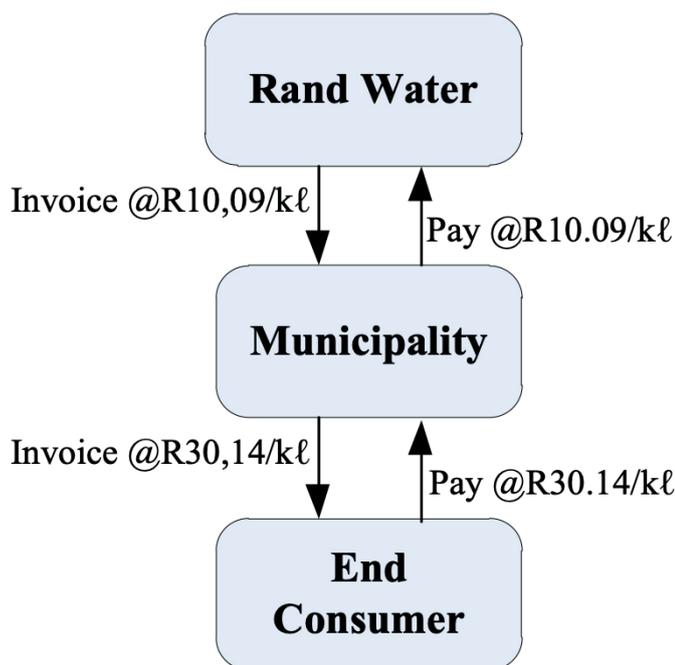

Figure 1: Depiction of the flow of invoicing and payments currently

tariff ranging between ZAR 10,68 to ZAR 49,60 per kilolitre (i.e. R10,68/kℓ – R49,60/kℓ) depending on several factors such as amount consumed, type of metering used (i.e. prepaid or post-paid), customer classification (i.e. indigent, blue-collar worker, industrial business, etc.) (Johannesburg Water, 2019).

For ease of calculation, we shall assume an average municipal charge of R30,14/kℓ levelled against the end consumers. Figure 1 shows the flow of payments for the water product between Rand Water, the municipalities and the end consumers.

NEW PAYMENT METHOD – PRODUCT IDEA

The new product proposed to alleviate municipal debt is called Khokhamanzi® payment App. The idea is for end consumers to effect payment of water consumption invoices they receive from the municipality through Khokhamanzi®, which they can access online or as a cellular phone App. The App will then pay through Rand Water's portion of the

payment and release the rest into the municipality's bank accounts.

PRODUCT DESIGN, FUNCTIONALITY TESTING AND PACKAGING

The main enabling technology behind the proposed Khokhamanzi App is the blockchain. A blockchain is a growing list of records of distributed transactions, called blocks, which are related using cryptographic techniques. In this use case, the proposal is to leverage blockchain technology as a distributed ledger for effecting peer-to-peer water billing transactions between Rand Water and its direct customers (i.e. municipalities) and between the municipalities and its direct customers (i.e. residents) via the Khokhamanzi App as the transaction broker.

Consider the following abstract example to illustrate the product design and functionality:

- Rand Water sends an invoice and charges R10,09/kℓ to a municipality for water supplied.

- The municipality, in turn, sends an invoice to a customer charging them a rate of R30,14/kℓ.
- A copy of the municipal invoice gets sent to Khokhamanzi.
- When the end consumer makes a payment at R30,14/kℓ into the Khokhamanzi, the platform compares the payment against the invoice, splits the payment based on the particular end consumer's number of kℓ consumed, pays Rand Water R10,09/kℓ consumed, and channels the rest of the money to the municipality referencing the end consumer so that the municipality will have a record of the transaction and the knowledge that this particular consumer has made their payment for the month.
- The municipality then consolidates all monthly water payments received (from Khokhamanzi). Any outstanding amount will be for the account of the municipality, which we will call 'water balance' in this example. It is the difference between what Rand Water had supplied and invoiced for and what the municipality supplied and invoiced the end consumers.

Figure 2 illustrates how the Khokhamanzi App will function.

In terms of packaging, the proposal is to develop the software application in-house at Rand Water and integrate it with the billing systems of customer municipalities so that it receives copies of invoices, collects end-consumer payments and executes online payments to Rand Water and the municipalities. Once it is constructed, it will go through a testing phase to troubleshoot and iron out all the bugs and possible snags it might have before it is put into production.

VALUE PROPOSITION – BUSINESS IMPACT OF THE PRODUCT

All three parties stand to benefit from this product:

RAND WATER:
- The benefit includes receiving timely payments directly from end consumers, thus improving debtor days.
- This will also reduce unavoidable municipal debt impairments.
- The advanced cryptographic techniques inherent in blockchain technology offer a secure, trusted and distributed transactions ledger, making it easy to extract an auditable financial trail of all transactions made since inception.
- Rand Water is likely to see a reduction in threats against its

employees by irate communities for poor water delivery.
- Another benefit to Rand Water is the reduction of damage to its property by enraged communities as a result of implementing credit control measures such as water supply throttling, and also a reduction of scenes where communities picket at the Head Office campus demanding that the water supply be restored at full capacity.

MUNICIPALITY:
- The municipality will see a reduction in the burden of owing Rand Water exorbitant amounts. The municipality will only pay for its internal water usage and network leaks.
- An added benefit is the reduction of service delivery protests because Rand Water's water supply is throttled.

END CONSUMER:
- Effectively bypassing the municipality and paying directly to Rand Water means the end consumer never has to worry about owing for the water service and thus never getting their water supply throttled.

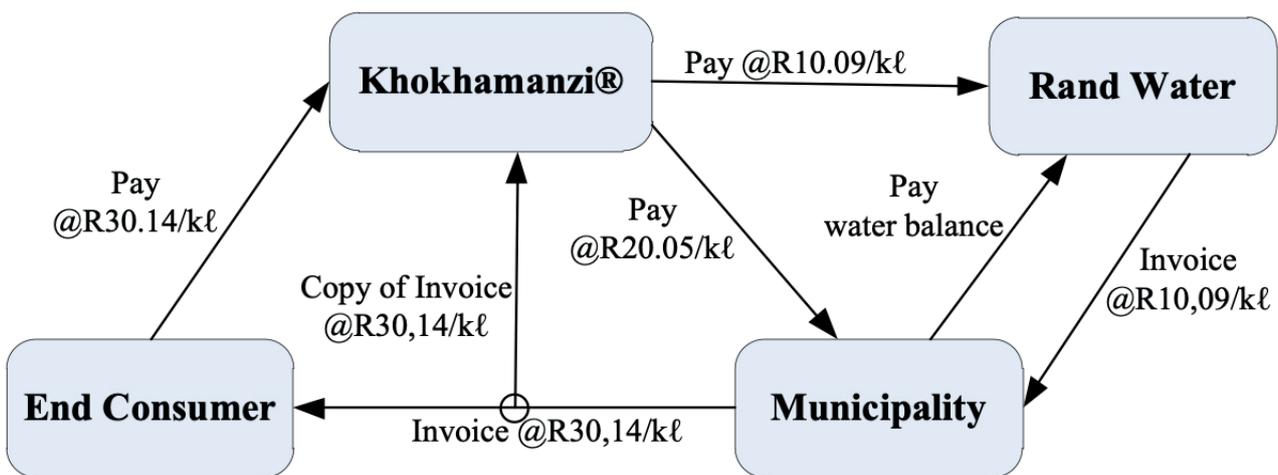These benefits are by no means exhaustive but illustrate the simple

Figure 2: High-level depiction of money flows through Khokhamanzi® App

yet novel idea towards addressing the municipal debt problem. The App could be developed in-house at Rand Water, thus cutting development costs while empowering staff to sharpen their skills in blockchain and App development.

This could be a project which may follow a project management schedule like the one below:

PROJECT MANAGEMENT

PROJECT SCOPE

- Develop the Khokhamanzi software application under the ambit of the Rand Water Innovation Hub. This should be executed in collaboration with various stakeholders from the municipalities.
- Ensure integration with the existing billing system, including those of the municipalities. This is required so that the application may pull invoicing data from municipal systems for easy comparison and execution of payments to Rand Water and the municipality.

PROJECT RESOURCES

This kind of project requires competencies in software development and lifecycle management. As a minimum, the following technical project resources are necessary:

- Project Manager - To manage project execution from initiation to close off.
- Software Developer - To design and execute the programming and development of the App.
- Software integrator - To ensure integration of Khokhamanzi with existing billing databases and systems.
- End user - To proof-test the functionalities, sign off and operationalise Khokhamanzi.

PROJECT COSTS

Since this will be an internally driven project, the costs will be man-hours only, thus excluding the need to purchase a separate computer and program

#	Resource Type	Hours Worked	Rate/hour	Cost
1	Project Manager	50	R900.00	R45,000.00
2	Software Developer	48	R900.00	R43,200.00
3	Software Integrator	32	R900.00	R28,800.00
4	End User	8	R750.00	R6000.00
	TOTAL COST			R123,000.00

Deliverables, Milestones and Timelines

development software since these are already available. The costs in the table below are sunk costs, placed here only to illustrate a monetary value for internal staff use. It is the ballpark amount Rand Water may expect to expense should they outsource the App development work.

CRITICAL SUCCESS FACTORS

Key to project and product approval and execution is political will and buy-in at senior levels of the company and municipalities. This will require good stakeholder management.

STAKEHOLDER MANAGEMENT

The Project Management Institute's PMBOK® Guide (2000) prescribes "Interest" and "Power" as the rating metrics used to determine the personalities that we need to lobby and

influence for project buy-in. Only high-level stakeholders are shown below for simplicity reasons.

KEY STAKEHOLDERS

The Influence Matrix highlights the various stakeholders in terms of:

- Those we need to keep satisfied.
- Those we need to manage closely.
- Those we need to monitor.
- Those we need to keep informed.

The stakeholders marked in red circles are the most critical persons that will need to be influenced – they have the potential to derail the project if not adequately lobbied. The ratings for "Interest" and "Power" were determined through a mathematical model, which could not be attached as an annexure to this article due to its size.

Personality	Job Title	Interest	Power
Mahlomola Mehlo	COO – Rand Water	8	8
Ntshavheni Mukwevho	COO – Joburg Water	6	6
Fortune Mabunda	COO – Ekurhuleni Metro	4	4
Larry Steyn	COO – Rand West Municipality	4	3
Stanley Khanyile	Munic. Manager – Sedibeng Municipality	5.5	7
Thinus Bekker	GM IT – Rand Water	8	6
Simon Xaba	GM Operations – Rand Water	3	3
Tshidi Nyembe	CFO – Rand Water	9	5
Fawcett Ngoatje	Head – RWI (Innovation Hub)	6	4

Key Stakeholders: we need buy-in from the above stakeholders.

CHANGE MANAGEMENT

According to Prosci (2014), "any amendment to platforms, processes, organisational functions and work profiles has a 'technical side' and a 'people side' that should be dealt with". Thus, most change management efforts should be directed at the company employees. They are going to be impacted by these changes. We will need their buy-in and ownership of the project.

CONCLUDING REMARKS

The provision of potable water to households is enshrined in the Constitution of South Africa. Rand Water thus does not have the option to completely discontinue services to defaulting municipalities. Rand Water may opt to throttle the water pressure to these municipalities, thus assisting in reducing their monthly consumption and thus throttling the growth of the overdue amount. However, this has not always panned out, as it leads to violent community protests.

A blockchain-based App, Khokhamanzi, has been proposed to eliminate or reduce Rand Water's dependence on the municipality to pay for services. The App allows an end consumer to make payments through it, which are then split, and both Rand Water and the municipality receive their portion of the payment. This eliminates the issue of municipalities collecting money and not effecting payments to Rand Water for the water received.

If approved, the project to develop Khokhamanzi is expected to take ten (10) weeks, after which it will be operationalised. Staff from both Rand Water and the municipalities could be trained to use and embrace it. It would be user-friendly and easy to install or access online. Development work could cost Rand Water R123, 000.00, and support for in-house project execution could be requested to absorb this cost as an operating expenditure.

FURTHER WORK

A similar business case can be developed to extend this blockchain-based payment app idea to other utility services like electricity. Eskom is currently struggling to receive payments from municipalities. The platform can be customised to extract Eskom's portion of the payment being made by a resident and then forward the rest to the municipality. wn

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Is not intelligent « what » wants

CAN ARTIFICIAL INTELLIGENCE (AI) BENEFIT SOCIETY?

Artificial Intelligence is exclusive by nature.

Since the beginning of human history, we have always been very good at building products that meet certain people's specific needs, thus excluding others.

By Hamilton Mann

This search for the ultimate differentiation, this obsession with designing things that will respond to market demand and suit a very particular target audience, and this know-how that we may have learned in school or on the job shape the image we have of the world, and the way we see ourselves in it, how we behave in it, most of the time.

Undoubtedly, this mindset is in tension with inclusiveness and diversity. The better we are at designing and offering products and services that will perfectly suit a specific audience we are purposely targeting, the better we become at our ability to discriminate against other audiences that are not targeted and therefore cast aside.

Reflecting the mental, moral, and ethical values of those who built it, artificial intelligence is made in this same mould: it is not inclusive but exclusive by nature. And paradoxically, it is already everywhere.

The global artificial intelligence market was estimated at US$87 billion in 2021 and is expected to hit US$1597.1 billion by 2030. Its continued and increased adoption propels it into the heart of many organisations around the world:
- With more and more hardware and software components,
- In increasing industrial sectors such as automotive, health, retail, finance, banking, insurance, telecoms, manufacturing, agriculture, aviation, education, media, and security, to name a few.
- In more and more functions and professions, such as human resources, marketing, sales, advertising, legal, supply chain, and many more.

WE ARE ONLY AT THE BEGINNING.

How do we ensure that the biases or segmentation patterns in the data that power artificial intelligence do not lead to operations that treat individuals unfavourably based on characteristics such as their gender, colour, religion, disability, sexual or political orientation? This is one of the big questions raised by the development of artificial intelligence.

ARTIFICIAL INTELLIGENCE IS NOT SO... ARTIFICIAL.

With the exponential and rampant development of artificial intelligence, using AI to establish new modes of differentiation and unparalleled targeting

approaches, for more economic growth, for more competitiveness, will become increasingly tempting.

There is a tension between, on the one hand, the need to have organisations and individuals capable of tolerance vis-à-vis diversity while understanding the issue of inclusivity to build more equality in society. On the other hand, the global economic system, which encourages and exacerbates more than it restrains behaviours leading us into these forms of competition were differentiating, therefore discriminating, leads to success.

This tension is amplified by what artificial intelligence can codify in a systematic and systemic way in our digital society: it is one of the greatest challenges of our time.

AI is already penetrating every pore of society, including but certainly not limited to:

▪ Personal assistants are now virtual and allowed to perform basic daily tasks.

▪ Machines can now perform market analysis, delivering detailed competitive and market research reports.

▪ Data related to usage behaviours, buying processes and customer preferences are scrutinised by CRMs that integrate more and more intelligence and can make accurate predictions about customer needs.

▪ Customer service is also provided by Chatbots capable of answering the questions most frequently asked by visitors to a website.

And all this is only an appetiser alongside the developments of possible applications, already emerging, and at least part of a future that is fast approaching with:

▪ Autonomous vehicles (bicycles, cars, trains, planes, boats, etc.),

▪ Robotic-assisted surgery

▪ The creation of content (videos, music, articles, etc.) entirely produced by the work of the machine

▪ Public policies whose measures would be prescribed and whose performance would be predicted by the analysis of large volumes of data

▪ and so much more

Given the societal challenges it poses for the future of humanity, artificial intelligence is far from being as artificial as it might suggest. Either we plan to use artificial intelligence to increase our ability to eliminate visible and invisible inequalities to levels never achieved before, or we (un)consciously plan to increase them to the same scale. In the era of artificial intelligence we are entering. There will be fewer and fewer in-betweens.

ARTIFICIAL INTELLIGENCE OPENS A NEW ERA FOR HUMAN LEARNING.

We, humans, are responsible for what Machine Learning - essential to all AI - learns and how it learns what it does and does not learn. This implies that we

must continue to learn how to develop our intelligence and also understand and document how machines themselves "learn." How we teach what the machine should learn is at the heart of 21st-century AI ethics discussions.

Machine and human learning face similar challenges:
- Supervised vs unsupervised learning
- Structured vs unstructured learning
- Few-shot Learning vs "Blink" learning (Malcolm Gladwell)
- Long/short-term learning vs "forgetfulness vs retention" tradeoffs
- Zero-Shot learning vs "dream" learning
- Visuomotor Learning vs Multisensory Learning (AVK)

By learning how machines can learn, we discover and will discover new ways of learning that until now have not been explored or even imagined. These could well revolutionise the standards we know about our way of learning to increase human intelligence. But make no mistake about it. Intelligence and knowledge are not synonymous, and increasing our knowledge is a necessary but insufficient condition for increasing our intelligence. Increasing our human intelligence is increasing our ability to question, challenge the status quo, arouse our curiosity and bring new questions into our minds for the discovery and rediscovery of what we think we know and of who we are.

ARTIFICIAL INTELLIGENCE IS MUCH LESS INTELLIGENT THAN WE IMAGINE.
Without going so far as to imagine an artificial intelligence capable of imitating human feeling, there is something that inevitably distinguishes artificial intelligence from humans: the application and apprehension of context. Context is made up of as many parameters, some ostensibly visible

to the naked eye, and others more discreet, finer, subtle, and weak signals and details, all parameters that count in characterising a context. Given the nature of perpetual evolution specific to any context, it will take time before artificial intelligence can appreciate the complexity of a situation-specific context.

Artificial intelligence algorithms cannot do everything. Building the AI technology we need for the good of society requires vision. That which allows us to understand the tasks which are and will be best performed by machine intelligence as opposed to those which are and will be best performed by human intelligence will require careful research. The framework we use to establish what AI should and should not do will shape the future of all humanity, not only in terms of many innovations and new forms of competitive advantages which will change the laws of markets as we know them today but much more importantly, on a global, sociological level. A legacy that will impact future generations to come.

Most of the time, when we think of "machine learning", our mental model leads us to think that it is a strictly one-way approach in which we teach the machine and give it as much as possible means to learn on its own.

Artificial Intelligence is causing a profound change in this link between humans and machines, which will become increasingly critical and exciting to explore because it is already more bidirectional than ever.

So the question is posed to us: what can we learn from the machine's intelligence to improve us [in what we do] as human beings?
We must rethink machines' role in our society and how they can potentially

augment human behaviour. We will also have to seize new opportunities to expand our intelligence and expertise in those disciplines that only humans can master.

ARTIFICIAL INTELLIGENCE INTERFERES WITH DECISION MAKING
Suppose artificial intelligence and its recommendations open up unsuspected opportunities to increase our intelligence and the nature of the relationships and emotional attachments we might develop with machines in the future. In that case, it also opens up delicate questions of Environmental and Social Responsibility.

But first, ask ourselves, at what point will AI evolve past decision support into the ultimate decision maker? This complicated question is on our doorstep. The answer can take on as many nuances as there are people. This is why applications, devices, and any technological equipment powered with some form of Artificial Intelligence will have to be the subject of clear readability as to the limitation of the parameters that the algorithm takes or does not take into account, as to the potential implications that could represent a danger to oneself or others, to help promote responsible use of the said artificial intelligence of these machines, and to prevent the risks of inappropriate use.

Artificial intelligence forces us to take up the great challenge of making it capable of being explicitly explainable to everyone. For everyone, on the causalities of the results, it offers to guide decisions that will increasingly impact our lives and society. If paradoxically, as humans, we do not know how to explain everything about the why of many of our decisions in the sense that the greatest number would understand them and in the sense that these explanations would be correct and fair.

MEMBERSHIP FEES EFFECTIVE 1 DECEMBER 2022

The Council meeting held on 2 September 2022 approved subscription & entrance fees as from 01 December 2022 as per schedule indicated below.

PLEASE NOTE: In terms of Bylaw 3.2 annual subscriptions are due on 1st December 2022

MEMBERSHIP FEES CAN BE PAID IN MONTHLY RECURRING PAYMENTS

Council agreed to a discount for fees paid before 31 March 2023. Members are therefore encouraged to pay promptly to minimize increase impact.

Grade of Membership	Annual Subscriptions paid before 31 March 2023		Annual Subscriptions paid after 31 March 2023		New Members FEES * see Notes 1 & 4 below.	
	RSA incl VAT (R)	Outside RSA excl VAT (R)	RSA incl VAT (R)	Outside RSA excl VAT (R)	RSA incl VAT (R)	Outside RSA excl VAT (R)
Student	165	143	198	172	198	172
After 6 yrs study	1 714	1 491	2 057	1 789	2 057	1 789
Associate	1 714	1 491	2 057	1 789	2 057	1 789
Member	1 895	1 648	2 274	1 977	2 274	1 977
after 6 years	2 214	1 925	2 657	2 310	2 657	2 310
after 10 years	2 317	2 015	2 780	2 418	2 780	2 418
Senior Member	2 317	2 015	2 780	2 418	2 780	2 418
after 6yrs/age 40	2 511	2 184	3 013	2 620	3 013	2 620
Fellow	2 511	2 184	3 013	2 620	3 013	2 620
Retired Member (By-law B3.7.1)	1 065	926	1 278	1 111	n/a	n/a
Retired Member (By-law B3.7.3)	nil	nil	nil	nil	n/a	n/a

1. The fee for all new applications is R3224.00, including an entrance fee of R950.00. On election to the applicable grade of membership, the new member's account will be adjusted accordingly, and refunds/additional payments will be made on request. The entrance fee for Students is free, and new Student applicants require payment of R198.00.

2. Transfer fee to a higher grade is R504.00 for all grades of membership (except Students within three months of qualifying).

3. Members are encouraged to transfer to a higher grade when they qualify. It will be noted that the fees of Member and Senior Member grades after 10 and 6 years, respectively, are equal to the fees at the next higher grade.

4. Members elected after May 2023 pay a reduced subscription fee.

5. By-law B3.7.1 reads, "Where a member in the age group of 55 to 70 years has retired from substantive employment in the engineering profession, such member may make written application to Council for recognition as a retired person and a reduced membership fee".

6. By-law B3.7.3 reads, "any member complying with the conditions of B3.7.1 but who has been a member of the Institute for not less than 25 consecutive years, shall be exempt from the payment of further subscriptions." Members who comply with the requirements of By-Law B3.7.3 may make written application to Council for exemption from paying subscriptions".

7. By-law B3.9 reads, "any member in good standing who has been a member for fifty (50) consecutive years shall be exempt from the payment of further subscriptions."

8. Members not in good standing by failing to pay their subscriptions by the end of June of each year will, subject to Council decree, be struck off the SAIEE membership role.

9. Members in good standing, no longer in substantive employment, and do not receive payment or salary for work done, may apply to Council for a reduction in their annual subscriptions.

10. The members' monthly magazine ("wattnow") is available online. Members who require a hard copy may acquire the same on request and for a nominal fee subject to minimum uptake numbers.

11. Members who wish to pay their membership fees in recurring payments should activate the payments on their banking portal. Members will only receive the early bird discount if their fees are fully paid by 31 March 2023.

ARTIFICIAL INTELLIGENCE WILL PROFOUNDLY CHANGE THE VALUE OF WORK

Some fear that Artificial Intelligence will come to replace humans.

Suppose the imagination of a science-fiction artificial intelligence supplanting humanity, like the Terminator, is scientifically fictional. In that case, a paradigm is necessary to include in what the digital society is hatching within it: AI can be better than humans at performing certain tasks, and yet is not and will not be better than humans at performing all tasks.

With the developments in artificial intelligence, we are increasingly experiencing a transformation from a knowledge economy towards a trust economy, motivated on the one hand by the need for more predictability, more precision, and more efficiency, and on the other hand by the need for more fairness, more transparency, and more sustainability.

For the future of "knowledge workers", digital technology, and in particular artificial intelligence, will bring about five types of change, which will, for each of them, disrupt society on a greater or lesser scale, with more or less impact, according to the predominant natures of work and its relative value in each continent of the planet:

- Starting with what can be a primary source of anxiety largely fueled by the imagination of an artificial intelligence disseminated by pop culture, there are, first of all, the professions that will disappear. And this is nothing new. At other times, during other industrial revolutions, this phenomenon has already existed.
- Then there are the jobs that will be augmented by artificial intelligence. Again, this is nothing new. By analogy, this phenomenon has also already existed in other times, resulting from precedent industrial revolutions.
- Then there are those jobs that will evolve to become tech jobs.
- And those are quite difficult to imagine now because their usefulness is intrinsic to the needs of our societies, which we still know little or nothing about.
- But we must not be naive: the development of AI is already creating. It will increase the emergence of precarious and crutch jobs to compensate for the lack of intelligence of artificial intelligence. This is to ensure, for example, that certain despicable and unbearable content is prohibited from access via the platforms we use - because they break the law - with the impact that the viewing of such content can have in the long run on the mental health of these "workers".

Those are, for example, shadow workers who label tons of data in a frenzy of particularly repetitive tasks to help artificial intelligence learn.

Which of these five changes brought about by artificial intelligence will impact the evolution of work in our societies? Hard to predict. However, even if this is not the only moving force in the kinetics of the transformations that characterise our century, it will be up to us to decide.

ARTIFICIAL INTELLIGENCE HAS NO OTHER ETHICS THAN OURS.

Machines have no ethics: it is simply a question of ours and ours only.

Artificial Intelligence somehow inherits the ethical genes of its creator. Our ethical principles are ultimately, for artificial intelligence, an integral part of the functional requirements, which consequently digitally codify the biases of which we are intellectual owners. Making the invisible codes of our societies visible is probably one of the most transformative advances artificial intelligence will allow humanity to achieve.

Such a level of transparency on the unsaid and the unwritten thus brought to light will help achieve greater equality and profoundly redefine the citizen demand for justice in our societies.

It is also an opportunity to make any machine intelligence that will interact with ours, and that will coexist with us become, as much as possible, the product of collective intelligence or the receptacle of the wealth that synergies can produce, resulting from human diversity, in all its forms of intelligence.

The increase of our intelligence by that of the machine will always and even more in the future be confronted with the existential question of the human cause that we decide to give to this intelligence the mission to serve.

Therefore, we must make "artificial intelligence" an intelligence inspired by the quintessence of what is best in our humanity, excluding all the dark parts of human nature. This is probably the most dizzying question but also the most decisive for the future of humanity.

It is an ethical question to which only our humanity has the power and the responsibility to provide an answer, constantly renewed, to build the future we wish to live. **wn**

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17/11/2022	ACTOM's Technological offerings on Lesotho
21/11/2022	Power Systems Protection
22/11/2022	Construction Regulations from a Legal Perspective
28/11/2022	Technical Report Writing
29/11/2022	Introduction to 5G Communication Networks
30/11/2022	Road to Registration
30/11/2022	An introduction to Artificial intelligence for Professionals

DECEMBER 2022

06/12/2022	SANS 10142 Ed 3
06/12/2022	Anatomy of Wind Turbine
07/12/2022	Fundamentals of Power Distribution
13/12/2022	Cable Jointing and Equipment Selection
13/12/2022	Design Thinking and Innovation for Engineering Professional
13/12/2022	Hack Lab

JANUARY 2023

24 - 26/01/2023	SAUPEC CONFERENCE

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