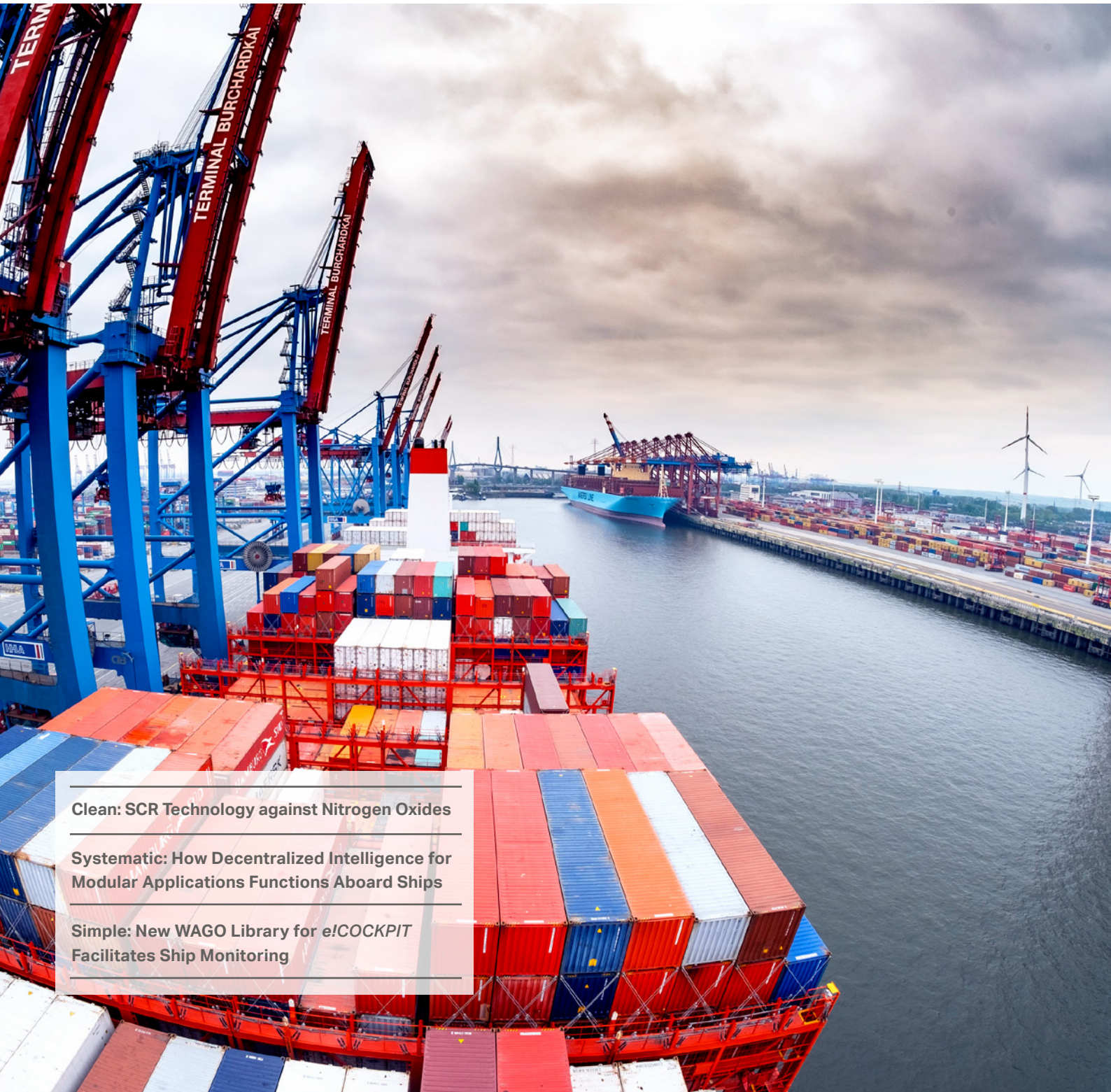
DIRECTPROCESS

New Worlds on the High Seas

Effective Sustainability: Digital Opportunities in Shipping



Doubled Monitoring
of All Signals

Collecting, processing, visualizing, generating alarms: The WAGO applicative redundancy concept for controls increases system availability on ships. Construct a simple, reliable and cost-efficient concept, for example, an alarm and monitoring system!

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EDITORIAL
GREENER THROUGH DIGITIZATION

Dear Reader,
Two years ago, SMM 2016 was the central focus of WAGO Direct. Looking back, we knew then (and still believe today) that it's simply not enough to collect a wealth of knowledge that merely reduces cycle times. Rather, we felt the goal was (and still should be) harvesting relevant information that is conducive to more efficiently configuring a ship's operations. Two years ago, we outlined potential applications and control limits; we discussed remote access with Andrea Grün from the DNV GL, and we spoke with Dr. Karl-Heinz Niemann about IT security in globally networked systems. And now?

In 2016, we proposed that every technical change must bring commercial utility; today, this thesis is validated by our report about the use of digital data analysis in modern fish farming. While the primary considerations in aquaculture involve oxygen content, currents, temperature or salinity, shipping focuses on saving time and fuel. The emphasis placed on resource efficiency now extends beyond traditional fuels, and includes hybrid engines. You can read two exemplary applications about methods for cleverly combining different propulsion units, and the practical opportunities offered by all-electric drives.

There is no innovation without economics. This view is shared by sector experts, like Hannah Ohorn from Hamburg Süd and Professor Holger Watter from the Flensburg University of Applied Sciences, who sat down for interviews with us. Both also see enormous potential for efficiency gains, if the sector succeeds in closing the deep chasms known as interfaces. Systems on the sea and on the shore are still unable to communicate with one another reliably. Which is why WAGO has a solution for consistent and reliable data recording and processing using the WAGO-I/O-SYSTEM 750.

While performing research for this issue of **WAGO DIRECT**, we continually identified another major goal: Making the different subprocesses on board more transparent via digitization to improve the total system. This total system also extends beyond the individual ship's railing. When the ship arrives in a harbor, the next elements in the delivery chain must be ready to move. Digitization provides valuable assistance from the construction of ships through their operation up to an improved coordination of sailing routes. That is why digital processes must be shaped in concert with all actors. Let's work on this together!

I am excited to see what we will report about two years from now.

Enjoy the articles!

Norman Südekum

COVER STORY

New Worlds on the High Seas

Efficiency, sustainability and safety define the maritime sector in practically every area – only the perspectives are changing due to the use of advanced digital networks. From the shipbuilder through the system integrator up to the shipowner and the classification societies: By attentively listening to these different maritime groups, it quickly becomes apparent that the focus is not only about saving fuel – maritime shipping is currently undergoing major structural changes.

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SCR technology makes shipping a bit cleaner.

USING UREA AGAINST NITROGEN OXIDES

As a part of the exhaust gas system, the SCR systems are located on the ship directly downstream from diesel engines in the exhaust gas system. The urea is stored in a separate tank and is guided to the metering device in the exhaust gas system via conduits.

Diesel engines are currently at the center of environmental debates – not only in the auto industry, but also in maritime shipping. This is because ocean-going vessels can generate substantial amounts of environmentally damaging pollutants. The nitrogen oxides (NOx) created specifically during the combustion of diesel fuels are considered hazardous to human health, as they can damage the respiratory tract and the cardiovascular system. Göteborgs Energy Systems AB (GESAB) manufactures systems with Selective Catalytic Reduction (SCR) for use in diesel engines in larger ships. As a result, nitrogen oxide emissions are substantially reduced.

Exhaust gas cleaning in the Ternsund class – a series of four petroleum and chemical tankers driven by LNG – is carried out using selective catalytic reduction (SCR). Göteborgs Energy Systems AB (GESAB) has specialized in manufacturing these systems.

The global shipping industry is under a lot of pressure to reduce exhaust gas emissions due to stricter regulatory guidelines and rules. Consider two examples from Scandinavia: In Sweden, all ships pay an emissions levy upon entering a new harbor; in Norway, a tax is levied per kilogram of nitrogen oxide emitted by each ship. One effective strategy for shipping companies needing to reduce NOx emissions while saving money through lower taxes and fees is based on SCR technology. "Selective Catalytic Reduction" technology initiates a chemical reaction that converts damaging nitrogen oxides in the exhaust gases into nitrogen (N_2) and water (H_2O).

Cleansing Effects of Urea

GESAB, headquartered in Göteborg, has built these types of nitrogen oxide reducing systems for the shipping industry for more than 30 years. Johan Svenberg, Business Unit Manager at GESAB, explains that, "By using an SCR system and a specific, yet relatively simple method, up to 95% of the nitrogen oxides can be removed from the exhaust gases." An additional clean side effect: the engine can be be adjusted to run at low particulate levels. The amount of soot in the exhaust gas flow can also be reduced. In the method used by GESAB, a reducing agent is added to the exhaust gases which mixes with the NOx. A metering module is used to inject a reducing agent, a non-toxic and odorless solution consisting of highly concentrated urea in de-ionized water, into the exhaust gas system. A catalyst converts the nitrogen oxides contained in the exhaust gases into harmless nitrogen and simple water; the chemical reaction requires only a few seconds to be completed. As a part of the exhaust gas system, the SCR systems are located on the ship directly downstream from diesel engines in the exhaust gas system. The urea is stored in a separate tank and is guided to the metering device in the exhaust gas system via conduits.

PFC200 for Optimal Control

The amount of urea solution supplied to the exhaust gases in an SCR system depends on the engine load – the higher the output, the more agent is required. "An electronic controller forms the core of the method. It uses important engine parameters, like operating temperature or speed, to precisely determine the amount of urea," explains Svenberg. This is because the optimal effect can only be achieved and the high cleaning rate for nitrogen oxide emissions can only be ensured if the exhaust gas and urea amounts are precisely matched. Therefore, GESAB relies on the WAGO PFC200 Controller, which has both a powerful processor and supports numerous ETHERNET protocols. Adding additional added value to the WAGO controller: It is possible to establish connections to higher-level IT systems. Users can access a visualization, which runs on a web server that is directly integrated in the PFC200, via conventional

web browser. Signals are connected to one another using the modular, robust and compact WAGO-I/O-SYSTEM 750. “We have been collaborating with WAGO for more than five years, and are completely satisfied with their products,” according to Svenberg. In addition to maritime certifications, from DNV GL among others, the electromagnetic compatibility, resistance to interference, security against faults and fieldbus-independent interfaces tipped the scales in favor of an automation system manufactured in Minden. “Due to WAGO’s wide assortment of products, we can concentrate on a single supplier, which is an important part of our environmental program at GESAB,” emphasizes Svenberg. WAGO is a reliable partner, who ensures reliable connections for critical interfaces.

TEXT KAJSA IHRE
JOHAN LYCKE | WAGO
PHOTO GESAB

NOx reductions are achieved by selective catalytic reduction (SCR). The device is surrounded by heating coils that spiral around it. GESAB‘s extensive experience in heating with waste gas heat ensures efficient heat recovery.

What makes nitrogen oxides so dangerous?

Health risks

Nitrogen dioxide concentrations occurring in the environment pose a particular danger to asthmatics, because the compounds can cause bronchial constrictions that are intensified by allergens, among other things.

Effects on ecosystems

Nitrogen oxides, especially nitrogen dioxide, can damage plants, causing the leaves to turn yellow (necrosis), and also causing premature aging and stunted growth. In addition, nitrogen dioxide bonds with water to form acid rain, which contributes to over-fertilization and the acidification of soils and bodies of water.

It's in Your Hand!

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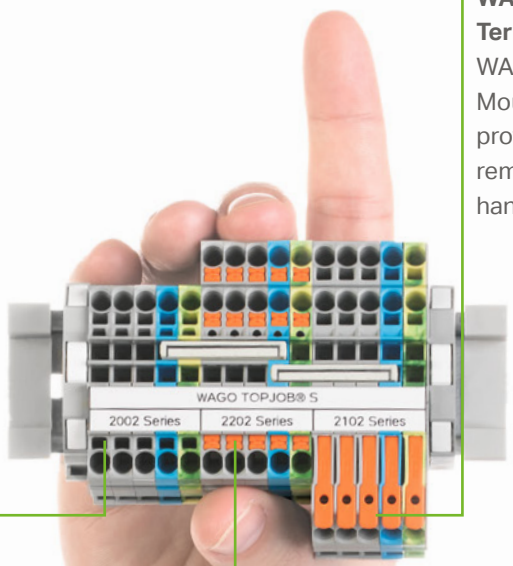

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NEW WORLDS ON THE HIGH SEAS

Effective sustainability: Digital opportunities in shipping

Efficiency, sustainability and safety define the maritime sector in practically every area – only the perspectives are changing due to the use of advanced digital networks. From the shipbuilder through the system integrator up to the shipowner and the classification societies: By attentively listening to these different maritime groups, it quickly becomes apparent that the focus is not only about saving fuel – maritime shipping is currently undergoing major structural changes.

Whoever saves fuel is, without a doubt, acting sustainably. However, in the maritime industry, where this aspect may amount to savings of around one percent through individual measures, it is still a long way from achieving the status of a "game changer." When the maritime branch discusses automation and digitization, it involves more than a mere savings of one percent. Expectations are much higher for digital solutions related to targeted data collection and data processing for optimizations that are not related to the drivetrain. Low construction numbers and continually rising costs in the transport sector are driving these expectations. Basically, process optimizations over the entire logistics chain can provide encouraging results, primarily through increasing networking in the global container ship routes. Where to apply this type of fine tuning depends on the roles of the participants.

Those designing ship automation systems consistently seek to reduce design and commissioning times in order to finish projects faster Reductions in new construction and renovation times in the shipyards owe a debt to these developments. Consequently, there is an increased demand for subsystems that are commissioned in advance. These can potentially pick up the pace of commissioning; however, only if the interfaces can communicate. And this is the major catch within maritime technology. Participants on panel discussions and in maritime industry conventions are consistently reminded of how much interfaces, communication and data protocols occupy the attention of the electronic firms. Interfaces, that have not been previously tested, act like sand in a transmission. Every day that does not function smoothly because of this has a noticeable impact through longer commissioning times – and that costs money.

This backdrop explains WAGO's intensive work in providing a broad basis for the MTP protocol. The "Module Type Package", (MTP) uses the OPC UA language, preferred in maritime applications. It functions like a printer driver by enabling a functional, digital twin of a subsystem to be linked into the ship's overall automation system. The file includes visualizations, a func-

Control room below the deck: Expectations are very high relative to digital solutions for targeted data collection and its processing for optimization – away from the drivetrain.

tion description and defined data points (more on page 48).

Increased Data Transparency for More Efficient Processes

The shipping companies and their crews likewise profit from consistent interfaces and data structures during the operating phase of a container ship, to select one example. Björn Sellschopp, an expert in project management and CEO of HMPP GmbH from Hamburg, imagines that routine ship maintenance could be performed more quickly if operating data were consistently available and could be processed in a central app. This would enable periods in dry dock to be scheduled like a Formula 1 pit stop. "In quickly and out just as fast," according to Sellschopp, who requires a common platform for this to provide a structure for everyone to work on. "This is the right track, even if it will take time until everyone gets accustomed to it." It remains difficult to permit others to view one's own data and to share information. "This will require trust and transparency. Digitization by itself will not solve our problems, because poor processes are not improved by making them digital."

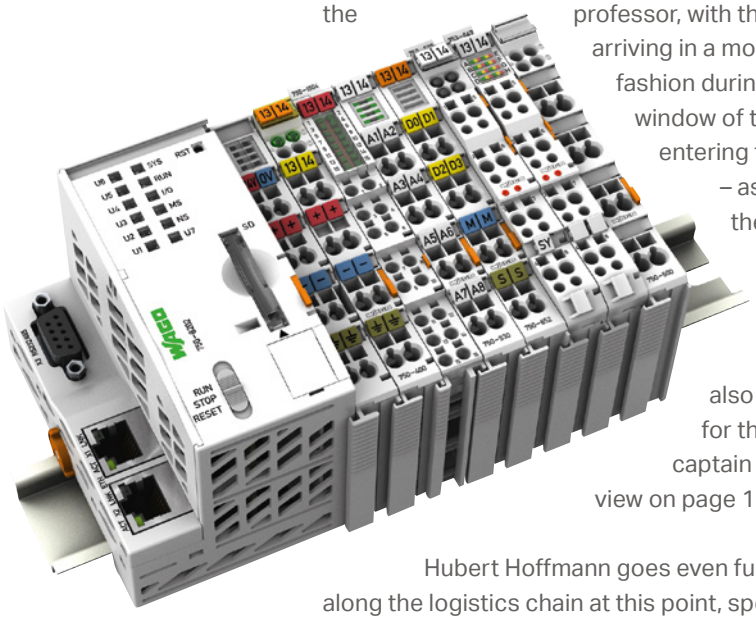
Proof of this is easily found along international trade routes. "In Brazil, the ship must arrive at the roadstead within a specific window of time. After around ten days of travel to reach my goal, I only get into the harbor itself three days later. The order is determined by who arrives first," explains Hannah Ohorn, Superintendent at the Hamburg Süd shipping company (see interview on page 24). Those who have the idea that the ship could theoretically arrive in Brazil after 13 days and then sail directly to a berth in the harbor, are gravely mistaken. In this case, the quay wouldn't be reached for 16 days. "If communication were better, then this would be easy to change. I would know, for example, whether a pier were occupied, and not just two hours before a ship is due." That which already functions quite well in European harbors is not necessary common in other regions. According to Ohorn, "Operational planning offers a lot of potential. There is really an opportunity there;

however, every country deals with it differently. Digitization would significantly increase efficiency here."

Data Files – not Reams of Paper

These are precisely the topics that could be easily solved by digitization, according to Professor Holger Watter at the Flensburg University of Applied Sciences. Let's stay with the example of the container ship, that after ten days, plus X in the roadstead, wants to dock in Brazil: energy efficiency could be increased by using better map-based controls on the route. This functions like predictive driving in a car. "It makes no sense to steam at 18 knots across the Atlantic and then sit outside of a harbor for three days," explains Watter. "The faster I travel, the more fuel I consume, and that ratio is cubed." This means that doubling the speed multiplies the fuel consumption, to eight times as much. The converse is also true: Traveling at half the speed uses only one-eighth as much fuel. "I can influence these operating variables," underscores the professor, with the goal of arriving in a more timely fashion during a ship's window of time for entering the harbor – as long as the prevailing berth occupation data are also available for the ship's captain (see interview on page 16).

»It makes no sense to steam at 18 knots across the Atlantic and then sit outside of a harbor for three days," explains Watter.«



The WAGO-I/O-SYSTEM 750 provides a foundation for easily collecting different data formats, which can be bundled, precisely processed using freely programmable algorithms and subsequently output.

Hubert Hoffmann goes even further along the logistics chain at this point, specifically with respect to consistent data storage. Hoffmann, who has a degree in computer science, works as the CIO/CDO for the MSC shipping company in Hamburg, and has described paper bills of lading as his personal enemy during a presentation at a convention. Instead of using paper, which is cumbersome and involves flipping back and forth to find information, it is more elegant and economical if, for example, "the trucker, with whom we have a contract, can directly access MSC's data services. This direct exchange of information would lead to a perfectly planned infrastructure in the logistics chain after unloading – even if the ship remains outside of this schedule. Ohorn also sees the linking of the ship into the harbor logistics as an essential point that represents, "An exciting field for optimization." In addition, the classic method of reporting from on board the ship could also profit because messaging routines are easier when using automation and digitization. It remains customary that the cargo documents arrive on board in paper format. "They are then checked by hand, even though the data have to be digitally available; otherwise I would not be able to print them out," criticizes the superintendent of Hamburg Süd. "That is ridiculous for those who have to do this on site." If the data arrived directly at the ship, "we could save a lot of time." This also includes the noon report, for which consumption and output data must be entered by hand.

TEXT THORSTEN SIENK
NORMAN SÜDEKUM | WAGO
PHOTO THORSTEN SIENK, WAGO

"We must be visible for the crews, and we need to seek out dialogue." says Hannah Ohorn, Superintendent of the Hamburg Süd shipping company. She is convinced that efficiency measures can only be profitably implemented if there is good personal contact between the ship and the office.

Conclusion

What is truly at stake in digitization for shipping: Data, in and of itself, is not as important as the information that can be derived from it. Merely collecting data at X number of points in a ship, and drawing conclusions about how to get the vessel to harbor most quickly is the wrong approach. Instead, the point is setting goals and acquiring the necessary information to meet them. And as with all the technological possibilities that digitization offers, one cannot forget that the people on board have to live with the consequences. Hannah Ohorn, Superintendent at the Hamburg Süd shipping company is convinced, with good reason, that efficiency measures can only be implemented profitably if there is good personal communication between the ship and the office. "We have to be accessible for the crew and must seek out dialog with them," states Ohorn. In addition, it is important to critically question our preconceptions in order to mutually gain new insights. "We are colleagues and share the same goals; only the locations differ." Hubert Hoffmann firmly believes that, "We must mutually establish digital processes in order to move faster. With digitization, I can simply try something out."

»ON BOARD A SHIP, YOU ARE PAID TO THINK THINGS THROUGH!«

Interview with Professor Dr.-Ing. Holger Watter from the Flensburg University of Applied Sciences about theory and practice in education.

"Your practical knowledge is the theoretical." Professor Holger Watter repeats this statement three times during our interview about increasing automation in maritime technology. We are sitting in the university cafeteria in Flensburg, where he has served two years as president. What does digitization contribute? What do trainees and students need to acquire by the end of their apprenticeships if they plan on smooth sailing in a maritime 4.0 world? And why, with as much as we love high-resolution line charts, network systems and tables on large monitors, do we still actually need analog displays?

Professor Watter, will analog displays on ships eventually be consigned to the dust bin, considering the possibilities that modern visualizations currently offer?

» **Watter:** Analog displays still have specific advantages. When I enter a room, I can see at a glance the pointer's position and whether everything is in order. That is a true ergonomic advantage. Digital data are analyzed more slowly by the brain. Previously, we had sketchbooks and paper diagrams on board, so you could keep an eye on everything. Currently, it is harder to get a complete overview on a PC. Even though analog displays are expensive, their utility justifies the cost. «

Isn't the goal of digitization to make everything more transparent, easier to analyze and more simple overall?

» **Watter:** I don't think that the work will get simpler, because information overload is often a problem. There is no question that digital systems provide valuable support; however, if an error occurs, the operator has to think things through and solve the problem. Automation can't replace piston rings or oil filters, and human intervention is necessary during an alarm. «

Does this mean that we need a mix of automation, digitization and strong common sense?

» **Watter:** Basically, we must achieve ways to support humans on board ship with modern tools, primarily in the form of logically processed data. However, this begs the question as to which data I collect, how I evaluate it and what data I then send to land. Shipping companies, customers and crews have very different interests. There are companies that consider their ecological balance sheet in their transport routes, and are willing to pay for this information. The shipping companies are currently being prompted to install the necessary systems; however, if there is no commercial pressure on this point, then the shipping companies see no economical benefit. Simply collecting data is not an end in itself. «

You used the phrase, "ecological balance sheet." Is fuel consumption driving digitization?

» **Watter:** If you keep in mind the fact that a modern, large container ship burns the equivalent volume of a single-family house in fuel every day, then yes, the shipping companies are incredibly interested in energy savings.

According to Holger Watter, students must be taught mathematics in greater depth. "I must be able to correctly interpret numerical values from a cloud of data – and the best way to do this is to apply statistical probabilities."

For Professor Watter, digital systems provide valuable support; however, he relies on the common sense of his students. "If an error occurs, the operator has to think things through and solve the problem."

The interest in sailing in a way that reduces emissions also increases when customers ask questions about the ecological balance sheet along their economic and delivery chains, if not sooner. In contrast, the ship's energy balance remains on the sidelines only if the interest is in moving goods as cheaply as possible from southeast Asia to Europe. That is an unfortunate truth. Automation has a place in making ships more efficient and economical. The added value here lies in the increased transparency of the overall processes and their dependencies. «

What do you teach your students who want to work as maritime technicians on ships?

» **Watter:** For our students, who are just starting their careers, the relationships between CO_2, nitrogen oxides and sulphur are enormously important. If we accept energy-efficient sailing as part of the key emission figures, then we are talking about consumption. However, this also depends on a number of other factors: load, draft, route, trim, speed. «

These can be easily measured.

» **Watter:** Yes, however these are often measurement results that I usually define as "noisy." This is why the engineers on board must perform their own diagnostics. We must teach our students how to deal with this noisy data. When does it make sense to apply a Gaussian distribution to the data to obtain a logical curve. «

That sounds like math.

» **Watter:** True. We have introduce our students to mathematics in greater depth. I have to be able to correctly interpret numerical values from a cloud of data – and the best way to do this is to apply statistical probabilities. The problem here is that few have any desire to learn more math. What are standard deviations? What is a normal distribution? These young people have come from three years of on board training to become ship mechanics, and now their professor comes and says, "Your practical knowledge is theoretical". Previously, they learned how to draw boiler water, which key figures are important for oil checks, and even which way the hammer is swinging. I don't want to exclude the practical part, as it is important for our theoretical education. However, I have to focus on other points in their secondary education. After all, scientific standards are increasing the demands on my students' abilities to analyze data. On a ship, they will be paid to think things through. We are lucky in Germany that we mix the practical and theoretical. First, there is the practical education in maritime mechanics, and then a theoretical course of study on top of that. Digitization will provide us with new tools in the future, which will create added value only if the crew also understands how they work. We have to include the crews in all of these technical possibilities. The next generation will – hopefully – show a greater affinity for this. «

Holger Watter, thank you for the conversation.

»If you keep in mind that a modern, large container ship burns the equivalent volume of a single-family house in fuel every day, then yes, shipping companies are incredibly interested in energy savings.«

Prof. Dr.-Ing. Holger Watter

Ship and system technologies are Holger Watter's focal points in his activities as professor at the Flensburg University of Applied Sciences. Born in Flensburg, Watter has spent his entire working life around shipping: Educated as a marine officer, he traveled the oceans with the German navy for twelve years, during which time he also earned his degree. Afterwards, the father of two began teaching, and has presented his research and knowledge at numerous expert panels. Watter serves on the board of the Maritime Cluster for North Germany (MCN) and heads the "Ship efficiency" technical group.

»YOU CAN ONLY SAVE A LIMITED AMOUNT OF ENERGY FROM LAND.«

It comes down to the crew: Interview with Hannah Ohorn, Superintendent for the Hamburg Süd shipping company.

Some 10,500 containers in total – then the Cap San Raphael is fully loaded. The ship has traveled the world's oceans for the Hamburg Süd shipping company for five years. According to load, route, and weather conditions, this ship and its five sisters burn between 90 and 100 tonnes of fuel per day. They are the largest of the 46 ships in Hamburg Süd's bright red fleet. Hannah Ohorn, Superintendent at the Hamburg Süd shipping company, sees substantial potential for savings in this number, without sacrificing convenience. At more than 400 dollars per tonne, the work quickly pays for itself. We spoke with Hannah Ohorn in Hamburg to learn which measures the shipping company – a new member of the Danish Maersk Group – will implement and how they plan on including the vessel's crew.

We are currently standing on the bridge of a container ship, which is considered one of Hamburg Süd's most modern vessels. Are there any possibilities left for increasing efficiency in shipping?

» **Ohorn:** Oh, yes, of course there are. One goal of our energy efficiency projects is, for example, to save one tonne of fuel per ship every day. This can be implemented in a relatively easy way if everyone on board looks closely at things and makes an effort. «

Where exactly should people be looking?

» **Ohorn:** Let's use the seawater cooling pumps as an example. These supply the necessary amounts of cooled water to the engines over multiple circuits when the ship is in motion. If the ship is docked, or if the primary engine is running at a reduced load, then the cooling requirements are reduced significantly to the point where it makes sense to switch pumps off. However, this means that after docking, someone has to think about this and go down and turn off the pumps. Then, it also becomes necessary to close this valve or that one in order to prevent pressure losses. «

It that a lot of work?

» **Ohorn:** No, but it is additional work and that can irritate the crew sometimes. I know this myself from my time on board. If a shipping company stipulates these types of activities as necessary for increasing energy efficiency, then the crew must also understand the reasoning behind them. The company has to calculate how much the crew saves by switching off the pumps in the harbor. These types of small actions can quickly add up over the day to fuel savings of more than a tonne. «

Does your shipping company reward crews that think about such activities?

» **Ohorn:** We are considering a bonus program at Hamburg Süd and have held discussions about it. The people backing this include the captains, chief engineers, first officer and the second engineer. «

How has that turned out as a whole?

» **Ohorn:** We have jointly decided against a monetary program of bonuses, because we feel a moral obligation to save energy. We have agreed

Hannah Ohorn

It is advantageous to know the view from both sides of the desk. Ohorn traveled the oceans for three years as a ship's engineer aboard one of the fiery red container ships before returning to land as a technical inspector for the Hamburg Süd shipping company. Since 2014, everything has revolved around increasing efficiencies in ship operations, just like the Northern Lights hovering near Lübeck. She began by studying nautical science in Bremen, and concluded with a degree in marine engineering.

that at Hamburg Süd, we are ultimately paid to bring ships safely and efficiently into harbor. In general, however, the question remains as to how we can correctly configure such a bonus system. We have discussed this internally for a long time. «

Do you have another example for effective efficiency measures?

» **Ohorn:** Yes, the diesel generators. There are five installed on this ship, with each having an output of 4500 kW. Now let's assume that the current load is 3600 kW. I see it all the time: Two generators are running, even though the need could easily be covered by one system. An optimal operating level for a generator is an 85 percent load. Due to undefined safety considerations, when one generator is running at an 80 percent load, then a second is often switched on; this means that both will run at just a 40 percent load. This gains nothing, because fuel consumption exorbitantly increases due to the poor efficiency. And we are precisely interested in specifically optimizing fuel consumption. «

For that, you need to measure and evaluate everything. How do you collect the data?

» **Ohorn:** We collect the data available on board using a Bluetracker and provide this to the crew. In additional, we run an evaluation at the office so that we can compare different ships with each other. We are currently at the beginning of the evaluation and validation phase. «

What is so difficult about that?

» **Ohorn:** First, we have to make sure that the sensors, which are installed on board, are actually suited for the purposes that we want. It gets particularly interesting when the data does not agree with what is displayed on board. We continuously discover how much work lies in the interfaces alone. «

How do the data arrive at your organization?

» **Ohorn:** Live data is transmitted to us on land every five minutes. Our performance monitoring system records around 800 data points. We are nearly finished retrofitting all Hamburg Süd and Alianca ships with this tool. «

What kind of data are you getting?

» **Ohorn:** We gain an overview with regards to

the load status of the ship, about the number and type of containers. Engine and navigation data are also available, which we can use to determine whether the measures agreed upon with the crew are being maintained. That would be the control function, which is not viewed as favorably on board. «

How do you deal with skeptics?

» **Ohorn:** We have to create acceptance for what we do – and we are always well aware that the ship is autonomous. Data can be manipulated, transmissions can be interrupted – however, both have not yet happened at once. «

The Cap San Raphael is underway for the Hamburg Süd shipping company – data recorded on board is collected by a Bluetracker and provided to the crew. The live data at sea are transmitted to the land-based office every five minutes. The performance monitoring system records around 800 data points. Hamburg Süd relies on WAGO's I/O system as the core of the data logger in the Bluetracker.

Does this mean that digitization has arrived at Hamburg Süd?

» **Ohorn:** The availability of reliable data is an absolutely basic requirement before anyone can enjoy the advantages of digitization in any economic sector. The Bluetracker plays an important role in this. We receive data that is transmitted to our office for further evaluation; however, the crew has the current access. Thus, they have the potential to react immediately if there is a decline in any of the performance values. By using data tracking, we want to achieve a point where we can actively react while the fuel is being combusted – and not after it is already gone, due to time delays. The ship's crew must be able to see what needs to be done. That is why the ability to determine system states more easily has become so important. «

But your colleagues are trained for that …

» **Ohorn:** Trained, yes; no question. They also understand how the relationships function. However, one cannot pay equal attention to everything on board a ship over the course of the working day. That is perfectly normal. «

Do you see improvements here through digitization?

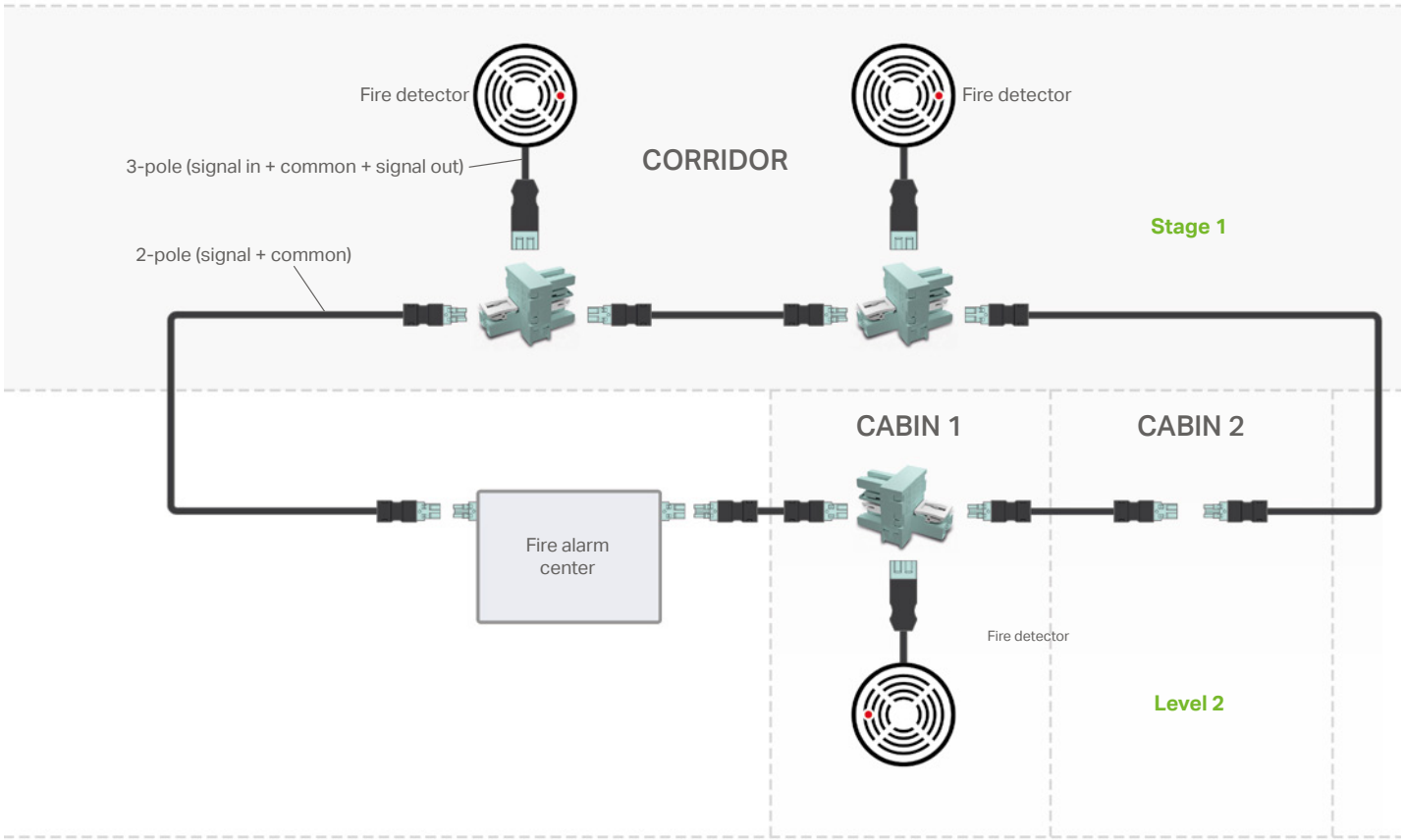
» **Ohorn:** Intelligent systems are tools that we pass into the hands of those on board, so that they can more easily determine system states. We create an awareness – even if only through the fact that someone from outside is also looking at the data. This increases the focus. However, it must be clarified that those at sea and in the office on land are all colleagues, who are pursuing the same goal – we just do it from different locations. «

Where have you already run into limitations?

» **Ohorn:** Architecturally, we cannot do much more. The hull of the Cap San Raphael and her sister ships has been optimized for two depths and speeds using mathematical modeling. If other traveling profiles are required, the shape of the bulbous bow can be changed. There is scarcely any room for improvement linked to ship's trim. «

Hannah Ohorn, thank you for the conversation.

THE PLUGGABLE SOLUTION FOR FIRE ALARM SYSTEMS



The fire alarms are installed in two stages for the same loop:

Stage 1: During commissioning: installation of all fire alarms, or every other fire alarm, in the corridors
Stage 2: Subsequent connection of in-cabin fire alarms during commissioning

The *WINSTA*® Pluggable Connection System for modern marine engineering offers a simple, economical and efficient solution for manufacturers of fire alarm systems on ships and in shipyards. A distribution box introduces a pluggable connection for fire alarm system loops, and WAGO's flexible system also allows subsequent connections, e.g., for additional fire alarms installed in cabins, without extensive downtime. The system is perfectly tailored to the requirements of on-board fire alarm systems and complies with the **DNV GL** and the **MED Directive**. All components are **DNV GL**-approved (further approvals upon request).

BENEFITS:
- Simple pluggable connection of an additional fire alarm within the line
- Time-consuming, on-board wiring replaced by plug-and-play configured cables
- Simple setup of a temporary fire alarm network at the time of commissioning

Shipping in the digital transition

THE CLOUD FOR SMART SEA ROUTES

Providing, collecting, evaluating and using data: In addition to the PFC100 and PFC200 IoT Controllers, WAGO is expanding its digital performance portfolio with the new WAGO Cloud capability. This pioneering technology enables even the rather conservative shipping sector to function more efficiently.

By using pioneering cloud technology, ship operations and operating procedures in harbors should be optimized and secured.

The trend towards digitization presents organizations in both ship construction and operation with a few challenges: Increasing cost pressures in more competitive international markets, increasing demands to meet more challenging environmental regulations and specialized safety aspects. These challenges all demand more flexibility in development, production, ship operations, and harbor logistics while maintaining lower costs. The solution? It won't be easy, but it is clever: Smart shipping provides many answers to digital questions about the future so that sector participants can stand up to competitive pressures – even in the future. Prerequisites include transparent information about processes and performance. Although a vast amount of data is collected in maritime processes, this data is usually spread across different, incompatible systems, where it remains – on board and unevaluated. By using cloud communication, new opportunities for networking arise for the shipping industry, especially for optimizing ship operations and safeguarding operating processes in harbors and the logistics chain. Shipping companies have been obligated to monitor a number of key figures since the "Measuring, Reporting, and Verification" regulation (MRV) went into effect in 2018. Cloud technology provides the foundation for

introducing data analysis to comply with this regulation. The result? Improved predictions regarding optimal routes, fuel consumption and machine maintenance.

Flexible Access to Process-Relevant Data

WAGO has dealt extensively with these requirements and can offer specific solutions for ship operators. WAGO Cloud, which manages and monitors all WAGO PFC Controllers, as well as their applications and data regardless of time or location, has recenlty been included. A Web portal serves as a user interface for the cloud service hosted by Microsoft Azure. Through this gateway, users have access to functions like project, controller and user management, controller status monitoring, alarm functions and email messaging.

Texts, tables, diagrams, display elements and command buttons can be easily placed on a dashboard for seamless and intuitive operation. The OPC UA protocol is provided for direct communication between the automation and the higher-level control systems. The MQTT protocol is also included for communication with the cloud solutions, which offers potential for optimizing performance, for example, through fuel consumption monitoring or predictive maintenance applications. These allow users to detect faults and to initiate repairs before malfunctions can lead to serious damage or failures, which affect chartering rates, for example.

A Cloud Solution in Just a Few Steps

Both the WAGO-I/O-SYSTEM 750 and 750 XTR connect to sensors, and a PFC Controller can transmit data to virtually any cloud – the newest PFC generation is IoT-ready out of the box and has all required maritime certifications, as well as approvals for the use in hazardous areas. IEC programming of one application with the corresponding library transforms the controllers into IoT devices in just a few simple steps.

Ships' locations can be tracked via the cloud to economically coordinate capacities, routes and deadlines. Value-added chains can be configured to extend continuously and be efficiently utilized beyond the boundaries of individual systems and facilities.

Following this, status information such as Run/Stop, connection status, device information and variables defined in the IEC program can be transmitted to the cloud and visualized.

The IoT controllers communicate with the selected cloud service via TLS-encrypted MQTT protocol. The cloud connection data is configured via Web-based Management (WBM). Libraries for ***e!****COCKPIT* are also included in the scope of delivery. The variables that will be transferred to the cloud can be defined using the IEC program. Sensitive data are securely transmitted from the controller to the cloud. Thus, the WAGO PFC100 and PFC200 Controllers form the platform that links elements from the real and digital worlds. They also offer a variety of interfaces, forming the perfect foundation for an IoT gateway. These modular and scalable controllers collect every field signal, communicate in all common industrial protocols and even enable cloud connection to sensors and actuators that themselves have no Internet interface.

Everything at a glance – the effect of digitization is clearly visible in ship control centers: Cloud communication provides new opportunities for networking in the shipping industry.

Securely Buffer Data at Sea

One requirement for having data available globally and around the clock using cloud technology is stable Internet access. What happens if this is interrupted on the high seas and valuable information gets lost? WAGO is ready with a storage solution designed specifically for shipping: Data transmitted from the controllers to the cloud are stored in the RAM working memory in an intermediate step and forwarded from there. If the network connection fails, the transmitted data build up in this working memory and are forwarded once Internet connectivity is reestablished. However, if there is an electrical failure, then the data buffered in the RAM are also lost. Therefore, WAGO offers a possibility for intermediate buffering. The information can be buffered on an SD card and sent to the cloud later once communication is reestablished.

Secured from Hackers

The ability to view process data from anywhere in the world – it sounds practical, but is it secure? WAGO considers cybersecurity to be a mandatory criterion for digitization. The PFC100 and PFC200 IoT Controllers therefore comply with the highest security standards, as they encrypt data via SSL/TLS 1.2 security protocols directly in the controller – optionally, they also securely transmit data to higher-level systems via OpenVPN tunnel using public communication channels. The controllers are based on a Linux® platform with a real-time expansion, which, as an open-source operating system, offers long-term availability, scalability, updates and supports tools for data security and recovery, such as Rsync. This allows them to be used as secure gateways.

The Linux®-based, WAGO controllers are both a solid long-term investment and serve as integrated security mechanisms to prevent cybercrime. Security is an important prerequisite for ship-to-land communication, and also for data recording, controlling, monitoring and networking in onboard subsystems. They also support essential security protocols and ensure continuous updates and refinements through the Linux® community. WAGO devices thus support IT security by design: All IT security mechanisms are integrated into the controller and cannot be disconnected by external access.

As a member of the WAGO Group, M&M Software from St. Georgen, Germany also has a close and integrated partner for developing industrial and technical software solutions. M&M collaborates closely with Microsoft on digital topics, like the cloud and the Internet of things, to implement corresponding solutions, primarily using Microsoft Azure. WAGO Cloud cloud computing platform is highly scalable and provides a detailed overview of computing power, data storage, transactions, availability and security standards. It offers a quickly growing number of services and tools to provide an optimal foundation for implementing solutions tailored to specific applications for users in the process automation sector.

However, customers are also not limited to Microsoft Azure. The WAGO Controllers can transmit the data to other platforms, like Amazon Web Services or IBM Cloud, according to what the user prefers or requires. Connections to third-party solutions are also feasible due to the standardized MQTT protocol.

Try the WAGO Cloud for free at **www.cloud.wago.com**.

TEXT NORMAN SÜDEKUM | WAGO
DIRK VOLKENING | WAGO
PHOTO THORSTEN SIENK, WAGO

WAGO considers cybersecurity to be a mandatory criterion for digitization. The PFC100 and PFC200 IoT Controllers comply with the highest security requirements.

Project GMV Zero:

ZERO EMISSIONS, DOUBLY SAFEGUARDED

Fewer emissions are good for the environment and human health: The Astrid Helene is one of the first all-electric ships in the world.

Supported by the Arctic University of Norway in Narvik (UiT) and funded by the Norwegian government, the shipbuilders at Grovfjord Mekaniske Verksted (GMV) have developed an energy management system (EMS) for a zero-emission ship with an all-electric drive. This visionary project was realized with the help of WAGO, which contributed to the central automation.

In November 2017, the Astrid Helene was launched on her first test cruise. The all-electric fish farming catamaran, which requires no emergency diesel generators, is the result of a cooperation between GMV and the Arctic University of Norway. The project was called "GMV Zero", with zero standing for 0 fossil fuels, 0 emissions and 100 percent environmental protection. Charging the batteries can occur over night and during the day when the ship is located at the fish farming site – for example, during the crew's lunch or during work that does not require movement of the catamaran, which measures 13.97 x 7.6 meters.

Redundancy as a Requirement

One special challenge during the development of the Astrid Helene: The vessel was initially required to provide redundancy for any single failure according to specifications from the DNV GL classification society. The EMS was accordingly designed, even though an exemption was obtained later that reduced the redundancy requirements. During the implementation of the "warm standby," WAGO contributed with valuable experience and ready-to-work solutions that could also be used in future projects on larger ships, which are also subject to stricter redundancy requirements. "We were working on a 'warm standby,' a concept for redundant operating systems. Our project caught the interest of Bjarte Hoff, a professor at UiT, who came aboard as a collaborator," recalls Tor Erik Næbb, Chief of

»The interaction between the different management systems from WAGO facilitated our work, and assisted in simplifying the energy management overview.«

Anders Breines, Project Manager at GMV

The Astrid Helene ...

... has a crane on board that can lift 32 tonnes. The catamaran is equipped for numerous operations required in fish farming with its electric, twelve-tonne anchor winch, two three-tonne capstan winches, and a hydraulic pressure washer. Both fixed pitch propellers, one in each hull, are driven by two permanent magnet motors with outputs of 107 kW each. An electric bow thruster increases maneuverability, so that neither transmissions nor clutches are required. The maximum speed is 10 knots. In order to reach the maximum estimated range of 26 nautical miles, the average speed is set at eight knots. Vacon, a supplier of quality frequency converters, is the source for the power converters used in the drives. The network topology is divided into two separate networks. Communication with the battery packs is arranged in two star-shaped systems. A star topology is also used to communicate with the converters. The power supply system is based on a DC bus that supplies the converters with power.

Industry and Automation at WAGO Midt & Nord Norway "Warm standby was conceived of for multiple uses and is a general solution; however, it is particularly geared to this application," according to Næbb The control system consists of two controllers from the new PFC200 family and remote I/O module in a redundant Ethernet network. The collaboration resulted in a completely redundant EMS for GMV's battery-operated ship. "For us, it was extremely exciting to work on an actual project where we could particpate in programming the operating systems and user interfaces," states Professor Hoff with satisfaction.

Electric Back-Up

Warm standby consists of two parallel operating systems, where one is active and covers all EMS tasks. The other takes over when a fault occurs. Thus, no single fault related to the EMS system can lead to a total loss of propulsion. Trond Østrem, Project Manager at UiT, likes the final

solutions. He considers the use of warm standby to be a very useful and cost effective way to design these types of energy management systems. Anders Breines, Project Manager at GMV, also has confidence in the EMS. “The interaction between the different management systems from WAGO facilitated our work, and assisted in simplifying the energy management overview. Now, we just need to collect data from the boat so that we can fine tune power distributions in different situations, which will enable us to determine how to use the energy to the best possible effect.”

TEXT TOR ERIK NÆBB | WAGO

PHOTO MICHAEL ULRIKSEN

Electric Revolution on the Water

Due to government incentives, Norway has become a global leader in the introduction of electric vehicles and related infrastructure. More than 130,000 eVehicles are underway in the country between Oslo and the Northern Cape. With five million inhabitants, Norway is, in absolute numbers, the third-largest market for eVehicles in the world, after China and the United States. This development on the streets has also influenced the shipping industry: Norway is pioneering the electrification of ocean travel and supports this development with large government subsidies. Among other innovations: The Fjellstrand Shipyard produced the world’s first all-electric car ferry in 2014, the “Amperer Stavanger”, which now runs north of Bergen. Another five ferries have been commissioned into service, and city water taxis, excursion boats, and service ships for offshore wind farms are plying the waves with their silent electric engines.

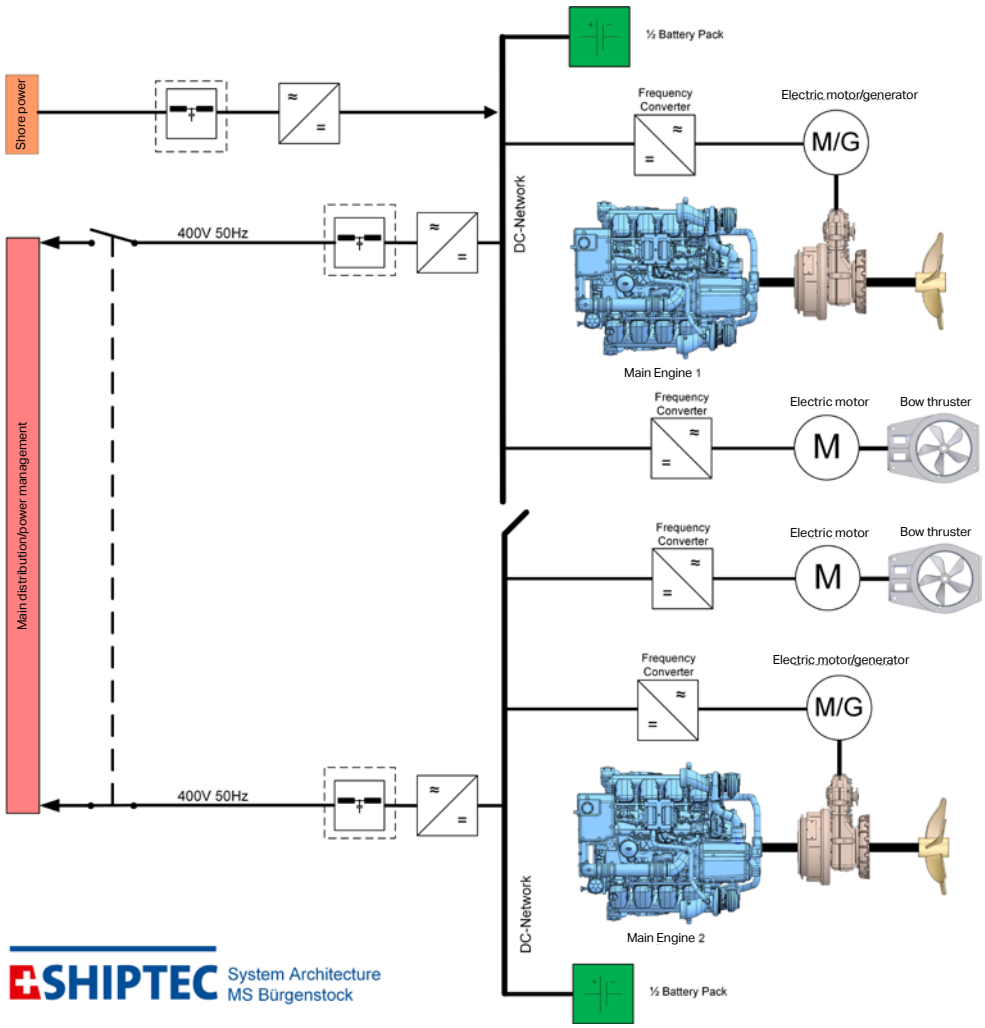
The hybrid vessel Bürgenstock protects the Swiss environment with an innovative drive control from Aventics.

THE LAKE IS CALM AND STILL

Embedded in a stunning, idyllic mountain setting, Lake Lucerne provides a traditional atmosphere with its fjord-like straights and winding inlets. Right in the middle of this beauty is a daily shipping route bearing tourists between Lucerne and other popular travel destinations, like Weggis and Bürgenstock. While it may sound less than idyllic, it actually boasts an intruiging eco-friendly twist. The MS Bürgenstock, the new motorized vessel belonging to the Lake Lucerne Navigation Company (SGV), sports a quiet and fuel-efficient hybrid drive. Aventics, a specialist of hybrid drive controls in ships headquartered in Laatzen, ensures optimum control between the electric motors and diesel engines. Several years ago, Aventics expanded their solutions by using the WAGO-I/O-SYSTEM 750.

Two years of design and construction came to fruition at the end of May: SGV's new shuttle, the MS Bürgenstock, embarked on her maiden voyage on the lake, where she navigates the Lucerne-Kehrsiten-Bürgenstock route daily – from early morning to after midnight. Visitors during the initial launch, who expected the typical clatter of diesel engines, were surprised by silence instead. The catamaran, designed as a shuttle by Shiptec AG,

The Lake Lucerne Navigation Company (SGV) has a new motorized vessel, the MS Bürgenstock, which is equipped with a particularly quiet and fuel-saving hybrid propulsion system.



The propulsion system in the MS Bürgenstock includes two Scania diesel engines, each with an output of 552 kW, and two permanently excited synchronous electric motors from Siemens, each with an output of 180 kW.

was specifically developed to cruise the Lucerne basin in electric mode, supplied by batteries – the diesel engines are required for only half of the route as determined by the captain. According to Rudolf Stadelmann, CEO at Shiptec, "The MS Bürgenstock is a modern, innovative, and ecologically sound 'bridge' between Lucerne and Bürgenstock resort." It is, however, also a fast bridge, as the ship travels at up to 35 kilometers per hour and reaches its destination in a mere 23 minutes.

»All data in the propulsion system is recorded, evaluated and forwarded in the WAGO-I/O-SYSTEM – our controller then works in principle like a normal telecontrol device that exchanges information with the WAGO system. An experienced team that functions well together.«

While designing the drive technology, Shiptec determined the most economically advantageous variant. Using similarly sized ships, comparable travel profiles were developed, and the requirements and consumption by the propulsion system and onboard networks were recorded. Based on this data, they decided on a parallel hybrid power and propulsion system. Martin Einsiedler, head of Ship Design and Engineering at Shiptec, explains that the propulsion systems include two Scania diesel engines with an output of 552 kW each, and two permanently excited synchronous electric motors from Siemens, each with an output of 180 kW. "Basically, we use the diesel engines for travel outside of the harbor areas," states Einsiedler. "The electric motors function as generators here to supply power for the ship and the system batteries. These batteries, in turn, provide the power for the electric drive and the onboard network in the Lucerne basin. The all-electric system is used for about 50 percent of the entire trip.

Complex System, Reliable Solution

The demands on the drive controls are quite high in order to smoothly perform the complex processes in this hybrid propulsion and energy management system, while guaranteeing fast, reliable transitions

Precision was necessary for the installation of the modular drive unit, which weighs several tonnes. In May, 2018, the MS Bürgenstock began using its hybrid propulsion system to cruise Lake Lucerne.

between the two power sources. As explained by Marius Mudroch from Aventics, "The complications in hybrid technology lie in the fact that we have two types of drives that differ in their dynamics and behaviors. The captain always has the option of selecting between the drives or cruising with the combined system, depending on the travel profile," according to Mudroch, who has specialized in the development of hybrid controllers in ship automation during a decade at Aventics; he supervised the Swiss project. The different travel profiles are stored in the controller; in the case of the Bürgenstock, this is a CAN controller from the WAGO-I/O-SYSTEM 750.

"Our own controllers have a limited number of digital and analog inputs and outputs. Therefore, on larger projects with a lot of interfaces – like a hybrid propulsion system – we have used the WAGO 750 Series several years now," states Mudroch. These controllers are specifically prepared for Aventics devices and are programmed so that the modules can be flexibly combined. "The true practicality of the 750 Series is that we can determine the number of modules ourselves; in the case of our hybrid engine, there are 10 total. The WAGO CANopen Controller (750-837) was selected as the head, which enables CODESYS programming." Another advantages lies in its fast boot time: when the system is switched on, the controller is operational within a few seconds. "We connect our controller and WAGO's using the CAN bus, and everything runs." The functions in the hybrid system are programmed using the WAGO-I/O-*PRO* software tool in the WAGO controller, which is based on CODESYS 2.3. "Our controller then works in principle like a normal telecontrol device that exchanges information with the WAGO system," explains Mudroch. All characteristic curve switchover operations are programmed in the 750 Series I/O System, which is where the data is evaluated and forwarded. For example, if the captain selects the electric motor, then the controller prepares the hybrid propulsion system for electric mode. Depending on the demands, the electric motor can then be used as an additional thruster in boost operation, or as a wave generator. In addition, the controller provides analog values, like the diesel engine torque or the lever position. Due to variables stored in the memory, it can be both programmed and also parameterized – parameters represent, for example, when delay times or other functions should be used that must be switched on or off. "There is a good interaction between our controller and the one from WAGO," emphasizes Mudroch.

Hybrid Propulsion Becomes More Innovative

Two different propulsion sources, more signals – Marius Mudroch points out that the number of potential faults also correspondingly increases. Faults that occur must be treated by the controller so that the ship reacts

The modern MS Bürgenstock catamaran carries tourists between Lucerne-Kehrsiten-Bürgenstock throughout the year (the eponymous Bürgenstock resort is visible in the background)

according to the demands, particularly because it is not immediately obvious to the captain of a hybrid which part of the drive has generated the fault message." A step chain is generated for each change of mode. After each step, the controller verifies whether it was executed completely. "The regulations from the classification societies determine how the ship should behave in the case of a fault," explains Mudroch. On a seagoing ship, the last running state during a fault should preferably be maintained so that the captain can decide whether to continue or switch the engine to emergency stop. "Inland waterway ships like the Bürgenstock quickly switch the engine off during a fault, because they can make it to shore relatively quickly," continues Mudroch.

Mudroch estimates it took around a week to develop the controller, "I have my philosophy and my previous experience to guide how I implement characteristic curve switchover operations. However, the demands placed on hybrid propulsion systems for ships have changed a lot in the past few years." While the hybrid drives were initially developed as redundant drives in his early projects to forestall failures, the electric drives of today assume a more active part in the systems. The Bürgenstock is actually not the first ship with an electric drive to cruise Lake Lucerne – in 2017, its predecessor model, the MS Diamant, was commissioned by the SGV. Due to its light weight, optimized hull shape, and the hybrid drive, this passenger and event ship saves around 20 percent of the energy required for a comparable, conventional, diesel-driven vessel. "Although the MS Bürgenstock is equipped with similar components to its predecessor, we got a bit more innovative," states Mudroch. While the Diamant is equipped with an auxiliary diesel for covering high onboard network loads – specifically in the case of large events – this was omitted on the Bürgenstock to reduce noise and exhaust emissions,

and to save space. The principle of the drive controller also represented another development, as the Aventics engineer emphasizes, "With the predecessor ship, the engine had to be shifted into neutral in order to switch between propulsion options. This switchover could take a few seconds." In the Bürgenstock, the diesel switches over to the electric drive while running, once the captain has given the command. "Passengers feel neither the switchover nor the recoupling nor shaking of any kind – everything is compensated for on the drive side." For Mudroch, they have not reached the end of development – not be a long shot. "As long as I can expand my own controller via programs, inputs, and outputs on WAGO's controller, then there are still plenty of possibilities." This also applies to a future digital data transfer between the controller and the cloud, "We don't yet have remote access to the system, which is probably because the controllers we use are not cloud-capable. However, if the customer specifies this request, then a solution using IoT controllers from WAGO would surely be one option."

TEXT LARS KÜHN | WAGO
ALBERTO ALONSO MALO | WAGO
PHOTO ROGER GRUETTER, SHIPTEC AG, WAGO

There is a lot of WAGO in the MS Bürgenstock

The company from Laatzen relies on many WAGO products, in addition to the controller components, that Aventics uses in the Bürgenstock's hybrid controls. "For example, we currently use Series 870 rail-mount terminal blocks; for future projects, we want to install TOPJOB® S," states Mudroch. In addition, the company is using a 857 Series Converter, in order to transform input signals into suitable frequency signals. "WAGO addressed our specific requirements individually and quickly – we received firmware in a format that no one else has." For example, in ships with variable pitch propellers, one needs not only linear characteristic curves, but also buckling curves that have one or more support points. This requirement was programmed into the converter. The interface is the same as for the WAGO-I/O-SYSTEM 750, which is incredibly practical. "Our partnership with WAGO has strengthened over time. For us, the fast and flexible support is a positive; we also benefit from using components from a single source," explains Mudroch.

About Aventics

Aventics is regarded as a leading manufacturer of pneumatic components and systems. The pneumatic specialists offer products and services for industrial automation and within the food and beverage, life sciences and energy sectors. In addition, the company develops solutions for commercial vehicles, marine and railway technologies.

Aventics has become a pioneer in user-centric, environmentally friendly solutions by integrating electronics, using modern materials, and concentrating on machine safety and industry 4.0. With this expansion into digitization, Aventics is positioning itself for the future.

Aventics counts on 150 years of experience in pneumatics, and employs over 2,000 employees worldwide. From production locations in Germany, France, Hungary, the USA and China, Aventics supplies its products through direct sales and vendors to more than 100 countries. www.aventics.com

Digital data analysis for increased animal health and economic efficiency

AQUACULTURE LEAPS INTO THE DIGITAL AGE

The notion of the fisherman sailing off to the open seas is scarcely more than nostalgia. In the meantime, according to information from the wildlife and environmental protection organization, WWF, almost half of all fish consumed by humans comes from aquaculture, and the trend is increasing. Fish farmers do not rely on bait, but instead on digital data analysis in order to catch the fattest fish – and to keep their breeding stocks healthy and economically viable. WAGO technology is there to support them.

According to the WWF and the United Nations Food and Agricultural Organization (FAO), fish farming is one of the fastest growing branches in the global food supply. While animal rights activists complain about underwater factory farms, investors celebrate extremely lucrative profits. However, by using automation and digitization technologies with WAGO components, the Norwegian firm Embicon is reconciling these two positions. Afterall, the decisive economic factor in fish farming remains the health of the fish.

Data-Driven Optimization

Fish farming presents numerous challenges to aquaculturists: Is the oxygen content correct? How is the temperature? The salinity? How are the sea currents? These and even more values are import-

ant parameters that convey something about the health of the fish, and ultimately, the economics of the fish farm. Therefore, they must always be current.

"Aquaculture is a young and expansive industry that is willing to use brand new and advanced solutions to optimize and secure operations," explains Lars Magne Endresen, CEO at Embicon. Stepping into the age of digitization should not present a large hurdle for the sector. By using maritime control systems and underwater communication solutions, Embicon specialized early in aquaculture, and is established as a provider of automation solutions.

Embicon developed cloud-based systems for the aquaculture industry as early as 2009. "Today, it is natural to be online almost regardless of where you are; with our solution, it is possible to receive important information about the processes displayed directly on a smartphone, tablet or PC. The customer tells us which parameters should be monitored, and we will find the most suitable sensors for the task," explains Endresen.

Reactions Become More Streamlined

Reliable measurements of important parameters form the foundation for good decision-making.

Founder and CEO of Embicon, Lars Magne Endresen stands next to an Embilink-A2 measurement station. Equipped with controllers from WAGO's PFC family, sensor data from a variety of manufacturers is collected and transmitted wirelessly, via cable or optical fiber to a server, which then stores the measured values in a database. Both real-time data and historical measured values can be graphically displayed on computers, smartphones and tablets.

The aquaculture industry is interested in advanced technology in order to optimize and secure processes – Embicon and WAGO provide support through digital solutions.

"We have seen that people are gradually beginning to grasp what digitalization and the Internet of Things can provide for streamlining operations," says Endresen. The solution we have developed combines important operating data and transfers it to a cloud solution. Operators can then receive processed real-time or historical data, which is presented in a user-friendly manner."

However, in order to collect the data and store it so that the end user can obtain useful information, a number of technologies must be combined, based on experience from different operating conditions. All of these controllers and future solutions are developed by Embicon in close cooperation with end users.

Technical Desires: Robust and Versatile

Almost every fish farm requires specialized solutions. The technology must often adapt to a harsh marine environment. This is where WAGO comes in. "The partnership with WAGO started a couple of years ago," recalls Endresen. "We were looking for a supplier that could meet our need for management and communication. Among other things, we scoured the Internet to find a good vendor, and we quickly saw that WAGO could fulfil our needs." A good partnership developed very quickly from the first joint venture. The broad product portfolio is impressive, and the support that was provided was excellent.

Embicon uses a variety of WAGO products to collect data and transmit it to a cloud solution, such as, I/O modules, rectifiers for current regulation, terminal blocks and a PLC with an MQTT software expansion. Thus, the IoT-capable PFC200 is installed on the floating net as a data logging unit, in order to record salinity and oxygen levels, for example. In case function controls become necessary, the PLC from WAGO can easily execute those tasks as well. Among other things, the controller organizes the collection of data and its transmission to the cloud – Embicon uses its own cloud solution and thereby employs

The Embilink platform transmits encrypted key data to the cloud so that real-time monitoring can be accessed anywhere in the world. The first Embilink system was installed at Tubilah's innovative halibut farm. WAGO controllers are the primary components in the system.

another advantage of the PFC family: A high level of flexibility. The user determines whether the controller sends the data to the WAGO Cloud, or to Microsoft Azure, Amazon Web Services, or IBM Bluemix. Connections to third-party solutions are also feasible due to the standardized MQTT protocol.

Electricity at the floating fish farm is generated exclusively by solar panels. To protect the controller from current or voltage interruptions, Embicon relies on WAGO electronic fuses with telecontrols and a UPS charging and control unit for establishing an uninterruptible power supply. This guarantees reliable functionality in the control cabinet, which is exposed to the open water in all seasons.

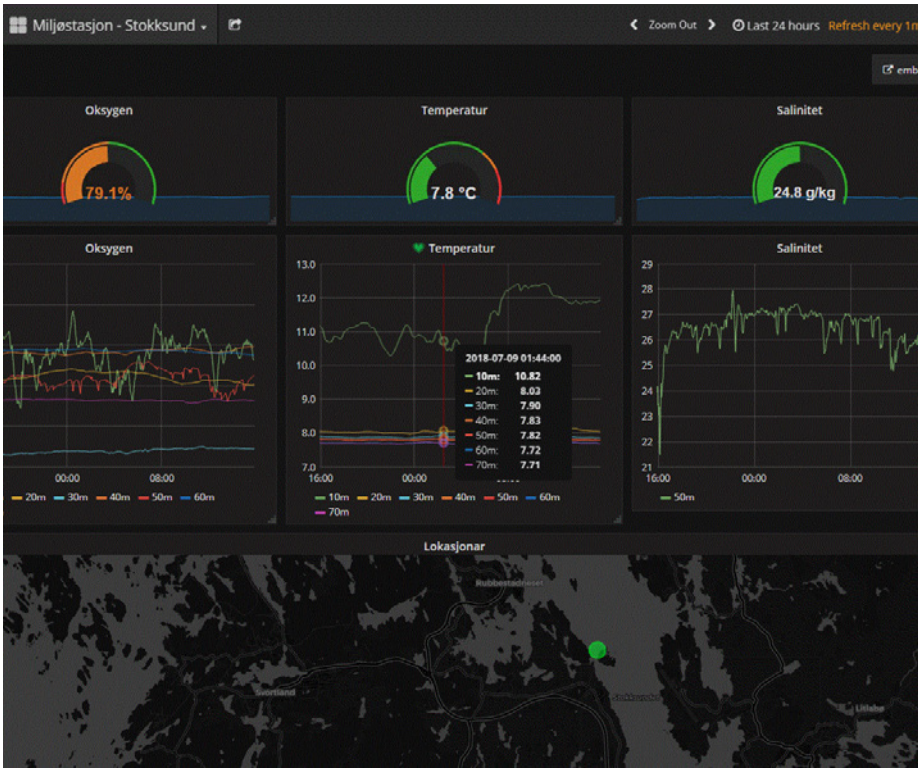
Competitive Niche Player

"Our philosophy is that solutions should stand at the forefront of technology development," says Endresen. This strategy can give a small company like ours a clear, competitive edge. But then it's also crucial that our partners share the same philosophy. We believe that this is the case at WAGO," emphasizes Endresen. It's possible that Embicon and WAGO will try out solutions that no one has tested before.

Currently, standards are being developed that simplify data communication between technical and administrative systems. Endresen is convinced that IT (Information Technology) and OT (Operational Technology) will merge, facilitating development work. "If we collaborate with a technology provider like WAGO, then our work is even easier," he says.

TEXT MARIUS ØKLAND + FREDRIK HAUGSGJERD

PHOTO EMBICON AS



Oxygen, temperature, salinity – Embilink, Embicon's web-based tool, provides real-time measurements for this fish farm in the Stoksund fjord, for example. It collects and processes important information that forms a basis for decisions about fish farming and provides added value. The IoT-capable WAGO PFC200 is installed to ensure reliable data transmission to the cloud.

About Embicon AS

Embicon AS provides automation solutions for aquaculture, shipping, and other marine environments. Among other its many advancements, the Norwegian company has developed the Embilink platform. This system records relevant data in fish farming, like oxygen levels, ocean currents, temperature and salinity, as well as technical parameters, like the tank fill level of a generator, or water throughput in a conduit.

Decentralized Intelligence for Modular Applications in Shipping

REDUCING COMPLEXITY ADVANCES EFFICIENCY!

With DIMA (Decentralized Intelligence for Modular Applications), WAGO has developed a concept to increase efficiency in process engineering – and it has already been tested, and proven, on land. But can this method be adapted to maritime transport? And if so, how?

Today, shipyards are essentially forced to meet delivery dates, and they must do so perfectly. Mastering complex processes and systems thus becomes an important challenge. In fact, automation and software are already determining a ship's complexity: Terabytes of data are collected aboard ships. However, the work of shipyards and system integrators is complicated by the ubiquitous requirement to create the conditions for data collection. The shipyards must work closely with the supplier of the higher-level monitoring and control system to synchronize systems from different manufacturers during commissioning. Ultimately, this total system integrator has a key function during commissioning. The integrator is required to make changes and perform the integration test on board. Work is sometimes only possible with one job being performed right after the other, and these hours are generally more expensive than those in the workshop. For their part, shipping companies must now concentrate more than ever on their core business: The mapping of a global logistics chain. If they need data from their ships, they rely heavily on the integrator who provides the ship's integrated monitoring and control system. Changes in subsystems, such as the bunkering system or the boiler, mean that the boiler supplier has to come aboard, for example. In addition, the integrator must also enter the additional variables or measured value ranges into the higher-level system.

The boiler supplier, as an example of any sub-system manufacturer, must be permanently involved in the extensive coordination with many monitoring and control system manufacturers to ensure a viable and standard-compliant visualization of the boiler circuits. If there is any doubt, even the regulation of subsystems will be performed at the management level.

How Can DIMA Function on a Ship?

With the complex system landscape on a ship, it makes sense to allow each member of the value-added chain to focus on their core competencies: Subsystem manufacturers construct their own systems, including automation and visualization. The system integrator and the shipyard as-

semble the subsystems. The ship owner handles logistics, receives greater investment protection for their ships and reduces their dependency on key suppliers. This procedure already reflects reality on the mechanical engineering side. However, in the field of electrical engineering and software components, interfaces are less standardized, yet the subsystems are very closely linked – even at the management level. They are also usually centrally automated.

By implementing the following measures, decentralized intelligence for modular applications could also be implemented on a ship:

First, a decentralized automation structure must be established in the subsystems.

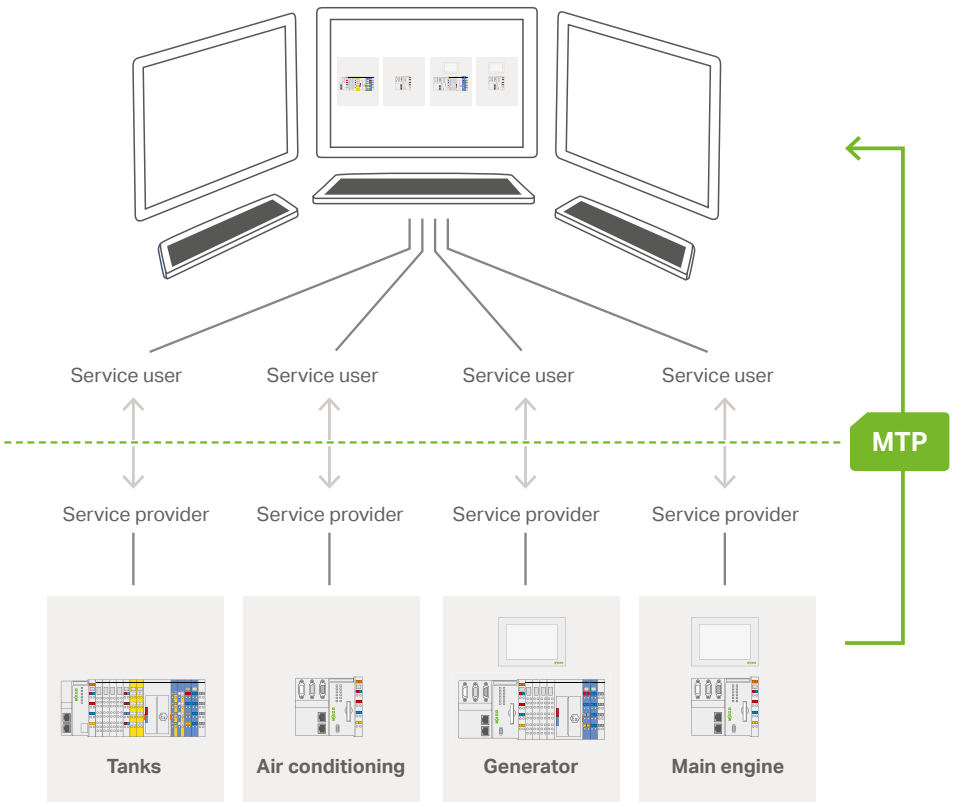
Second, a software interface with a high degree of abstraction must be described. The high degree of abstraction in this case means that the subsystem is considered a service. Services can be started, stopped and parameterized, among other things. It is technically the same for the process control system, which then becomes the process control level, regardless of whether it starts the main engine, the boilers or the air-conditioning system.

Third, information is exchanged instead of data. All of this should be performed using a uniform standard that provides vendor independence.

Increasing Complexity Requires New Solutions

To this end, WAGO has worked together with Germany's Helmut Schmidt University in Hamburg and the Dresden University of Technology to develop the DIMA concept for process engineering. DIMA (Decentralized Intelligence for Modular Applications) covers the requirements mentioned above and currently flows into the VDI/VDE 2658

Integrated Control System



Module Type Package

- Manufacturer-independent description of a service
- Contents of the MTP:
  - Services
  - Visualization
  - Data connection between module and integrated control system

Implementation

- XML file based on AutomationML
- Contents of the MTP:
  - Services: ISA 88 PackML state machine
  - Visualization: standardized elements from eCl@ss
  - Data connection: OPC UA

guideline and the NAMUR NE148 recommendation. At the heart of the method is the Module Type Package (MTP) for services and information. It describes the exchange of information via OPC UA. Service orientation is ensured by a state machine, which is standardized per IEC 61512. The visualization is described in the subsystem by means of AutomationML (Markup Language) and is thus functionally identical in the local control as in the machine control room or on the bridge. Only the representation follows the design of the respective manufacturer.

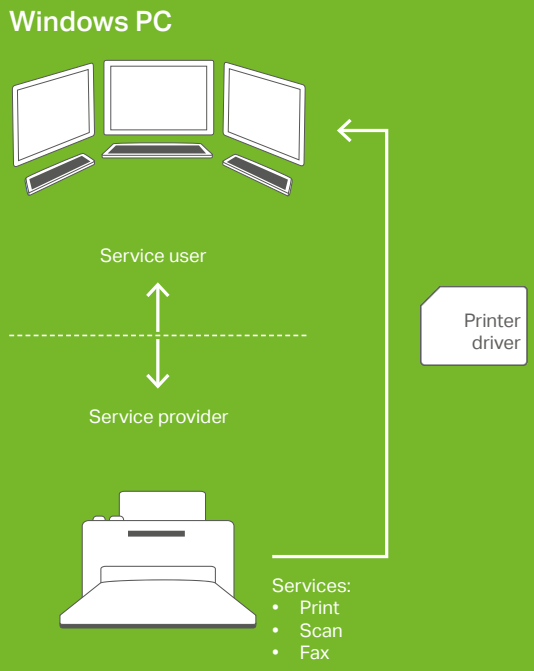
Tests on a pilot plant of the process engineering showed that plant commissioning is possible within 2.5 minutes. In the case of conventional commissioning, this would otherwise have taken several working days to adapt the control system. The positive experience in process engineering and the broad manufacturer support in the field of automation lead to the theory that the advantages of service-oriented software used in automation can also lead to efficiency improvements in shipbuilding.

TEXT NORMAN SÜDEKUM

PHOTO WAGO

IT Leads the Way

The model for the modular, decentralized automation of process technology systems via DIMA comes from the IT world, in which components can be integrated with relative ease into existing systems. For example, a printer can be connected and used without reprogramming its operating system. By using DIMA, system modules can be integrated into the system architecture and used just as easily. This is comparable to exchanging the printer used by a PC, which the user can immediately activate due to the standardized interface for the printer. DIMA MTP likewise uses a software driver for the production modules: The “Module Type Package” (MTP) contains the digital description of the manufacturing module and is thus the virtual description of a physical module. The MTP describes the functions of the production module in detail, including its visual representation in the production control processor, diagnostic information, and technical data. If it is structured in AutomationML, then it is generated by the PLC program – when using the ***e!****COCKPIT* Engineering Tool, this becomes as easy as pressing a button.



WAGO-I/O-SYSTEM 750 XTR: TWELVE NEW EXTREME POSSIBILITIES

WAGO has expanded its XTR portfolio to include twelve new I/O modules. XTR stands for extreme. This is WAGO's I/O system for extreme applications that place exceedingly high demands on temperature and vibration resistance, as well as immunity to impulse voltages and electromagnetic interference. These new XTR modules are primarily used in the control and distribution cabinets for outdoor applications, mobile systems (such as trains and streetcars), as well as in the renewable energy and process industries.

The twelve modules joining WAGO's 750 XTR I/O System include new analog/digital inputs and outputs, function and technology modules, modules with CAN communication capability, as well as supply and segment modules. As with all members of the XTR family, these new modules are engineered to work reliably, are fail-safe and provide a long service life in extreme environments.

Advantages for the Automation and Heavy Industries:

- New possible solutions for applications using module functions such as counter, SSI, incremental encoder, CAN gateway, power supply with fuse holder
- Compliance with maritime and railway system requirements
- Universal connection possibilities for conductors up to 2.5 mm² (14 AWG)

When the Going Gets Tough

The 12 new modules seamlessly integrate into the WAGO-I/O-SYSTEM 750 XTR, which performs in an extended temperature range of -40 to +70°C without additional air conditioning. System vibration resistance also defies acceleration forces up to 5g. With its immunity to impulse voltages and electromagnetic interference, the system is also a great fit for medium-voltage systems.

WAGO facilitates alarm and monitoring functions with a library for *e!COCKPIT*

SETTING PARAMETERS INSTEAD OF PROGRAMMING!

Whether it's a megayacht, freighter, or a cruise ship, subsystems – diesel generators, boilers, air conditioning, fuel metering systems – are decentrally automated. Sensor data flows into an alarm and monitoring system (AMS) as variables, and are processed here. The programming expense for this type of decentralized AMS is, however, time intensive and diverts the project engineer from the core task of process automation. Setting parameters instead of programming is therefore WAGO's slogan. The company has developed a simple solution for users that saves them a lot of work: a library for the ***e!COCKPIT*** programming environment.

The new WAGO library for the ***e!COCKPIT*** programming environment allows users to quickly set up a distributed RMS using pre-programmed functions, visualizations and database connections.

More oversight onboard – the WAGO-I/O-SYSTEM performs classic alarm and monitoring tasks:

- Modular and distributed system
- Bus-independent and scalable solutions
- Network technology and automation from a single source

Collecting, processing and visualizing data, as well as generating alarms – routine, yet important, tasks in shipping that the WAGO-I/O-SYSTEM 750 easily handles with its modular system. A decentralized alarm and monitoring system can represent both the interface to a higher-level control system, and also support the system designer during commissioning. Thus the time-intensive aspect for the user is programming the AMS: The tasks for each individual controller must be specifically programmed in. This requires staffing levels that are often not available. WAGO accepted this challenge and developed a library for the ***e!****COCKPIT* programming environment. The goal is quickly assembling a decentralized AMS using preprogrammed functions, visualizations and database connections. Because this system solution emphasizes parameterizing, system designers have more time for their core tasks. Inputs can be created and limits for alarms can be set with the aid of a configurator. All requirements of the DNV GL classification society are taken into consideration, like history, handling, acknowledgement of alarms and reading in.

The Three Elements of the *e!COCKPIT* Solution:

- Function block for calculating and converting input data. The parameters, which are set using the configurator, evaluate the input data and convert it. This is monitored via an integrated alarm handler. Warnings and alarms that occur are subsequently visualized in preprogrammed "Alarm tables." In addition, there is an opportunity to display the values in a "Measured value table."
- The alarm handler monitors the parameters set using the configurator, and provides the programmer with a structure (array) in which all alarm states are listed.
- A data logger with an SQLite database represents the third element. All incoming and outgoing alarms are designated as water compliant. All measurement points are stored parallelly in the database at predetermined time intervals. The stored values may be accessed at the user's convenience in an alarm history or in a measured value history.

On the one hand, diagnostic functions for the manufacturer of systems arise during commissioning due to the mentioned functions. On the other hand, centralized diagnostics are also created for the operator. In parallel to this, it is possible to establish a connection to a centralized, higher-level control system using standardized protocols, like OPC UA, for example.

Systems that are already present can be expanded by the system integrator to include a decentralized AMS. These likewise benefit from the fast adaptations of preprogrammed functions, visualizations and database connections, and avoid complex handling of alarms.

TEXT STEFFEN FRIEDRICH

PHOTO WAGO

The WAGO redundancy concept for controllers offers customers, particularly those in the offshore sector, significant advantages due to the use of intrinsically safe modules and the transmission of the most important secondary variables according to the HART protocol.

Increase availability in the central alarm and monitoring system by using two parallel controllers

DOUBLED RELIABILITY ON THE SEVEN SEAS

Crewless ships instead of the romantic notion of a sailor? Initiatives for autonomous ships are driving this development. However, the path from the engine room, which can currently operate for a maximum of 24 hours without direct intervention, to an autonomous ship, which should be able to operate for up to six weeks without human intervention, is still long. WAGO's redundancy concept for controllers is shortening this path and offers a solution for compensating for faults occurring in the automation systems and for ensuring the continued operation of technical systems.

The greatest challenge over the course of increased automation in shipping remains establishing onboard systems that are so reliable that outside interventions are unnecessary. This can be achieved by using a larger proportion of standardized components on board, while maintaining high availability of security relevant systems through redundancy. In order to guarantee the automation systems' reliability, the voltage supply and the communication medium (e.g. ETHERNET), in addition to the PLC, must satisfy the technical system's uptime requirements. WAGO provides a simple and economic solution for its maritime customers that uses an application-based redundancy concept for controllers.

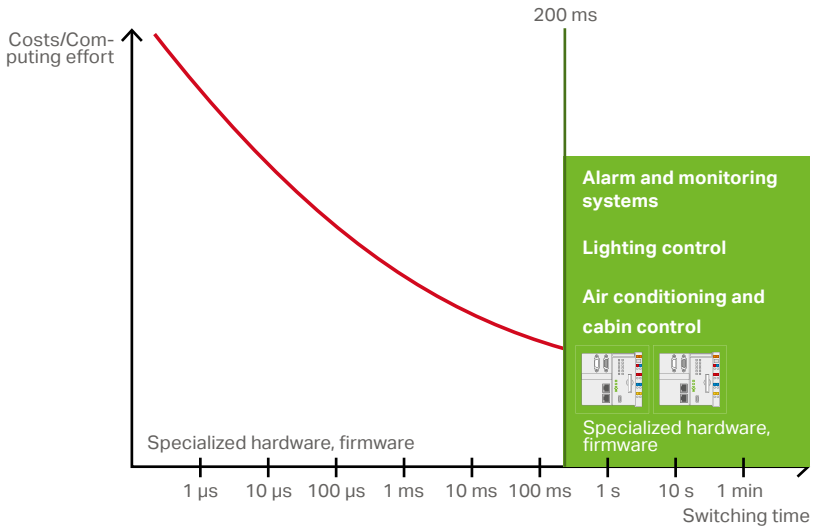
WAGO's ***e!****COCKPIT* engineering software tool is used as the programming environment for the controllers. The multi-node programming environment can easily transmit the PLC program to both PLCs. In order to use the application-based controller redundancy, a software library with the necessary synchronization functions must be integrated into the master PLCs. The library offers the potential to redundantly link subnodes using a dual-LAN. The subnodes, also known as smart couplers, do not have to be programmed; they can be simply booted from an SD card and then configured using an integrated webserver. The analog input/output modules and digital input/output modules are detected automatically by the smart coupler; process mapping is likewise automatically made available to the higher-level Master PLC. The master PLC can communicate with higher-level SCADA systems via the Modbus-TCP protocol. The redundant connection is carried out over two separate networks.

The solution design corresponds to an SPOF-tolerant system (single point of failure), which means that any occurring fault – like a voltage supply failure, the LAN connection, switches, or controller – can always be compensated for. Doubling the ETHERNET topology and the redundant message transmissions enable instantaneous switching during a network fault. Typical switching times after the failure of a PLC are easily below the requirements of DNV GL when used in traditional alarm and monitoring systems.

TEXT NORMAN SÜDEKUM

PHOTO WAGO

The standard components used by WAGO guarantee high availability, low expenses and substantial cost advantages.



What can the application-based controller redundancy (ACR) from WAGO do?

- Increases availability (increased runtime, decreased fault effects)
- Collects and bundles data
- Generates media redundancy both via ring and doubled network infrastructure
- Modular and scalable

Additional advantages:

- Easy commissioning of the entire system with WAGO's standard hardware.
- Simple/slow control loops can be mapped
- Lower switchover times (in accord with classification society requirements)
- Intrinsically safe modules are available
- Transmission of the most important secondary variables using the HART protocol

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