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A shortage of skilled professionals and an aging workforce and the consequences are increasingly imposing demands on workplaces in manufacturing. The researchers at the Fraunhofer IFF are developing new technologies for safe human-robot collaboration, making robots humans' helpers.

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»» We are striving to improve working and living conditions for people. Our research focuses on people, the creative and practical controllers of technical systems. ««



Prof. Michael Schenk, Director of the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg.

Editorial

Germany is striving to be a leader in the advancement and use of digital services. Digital goods and technologies have long been providing us consumers support, taken for granted in our everyday life, and affecting our life together: how we work, communicate, and engage in society.

These changes of digital transformation are affecting the German economy to an even greater extent, though. Industrie 4.0 – far removed from being just the “latest buzzword” – is the natural refinement of intelligent industrial processes. Interconnected manufacturing holds the capacity to reorganize value chains and business models fundamentally.

Responsiveness instead of Rationalization

And, make no mistake: While Industrie 4.0 is also about rationalization, it is even more about responsiveness. Whereas new automated solutions frequently meant the replacement of humans by machines in the past, the goal of digitization is different: Companies are primarily interested in enabling their manufacturing operations to re-

spond agilely and flexibly to customer demands, supplier relationships or competitors, for instance. Interconnected manufacturing needs people to do this.

This will generate new fields of work and an increasing amount of knowledge work, autonomous work and interdisciplinary collaboration. This makes it important for staff to understand and be able to help organize the process of digital transformation in their company.

“Good Digital Work”

In our research and the projects completed together with our clients and partners, we are striving to improve working and living conditions for people. Our research focuses on people, the creative and practical controllers of technical systems.

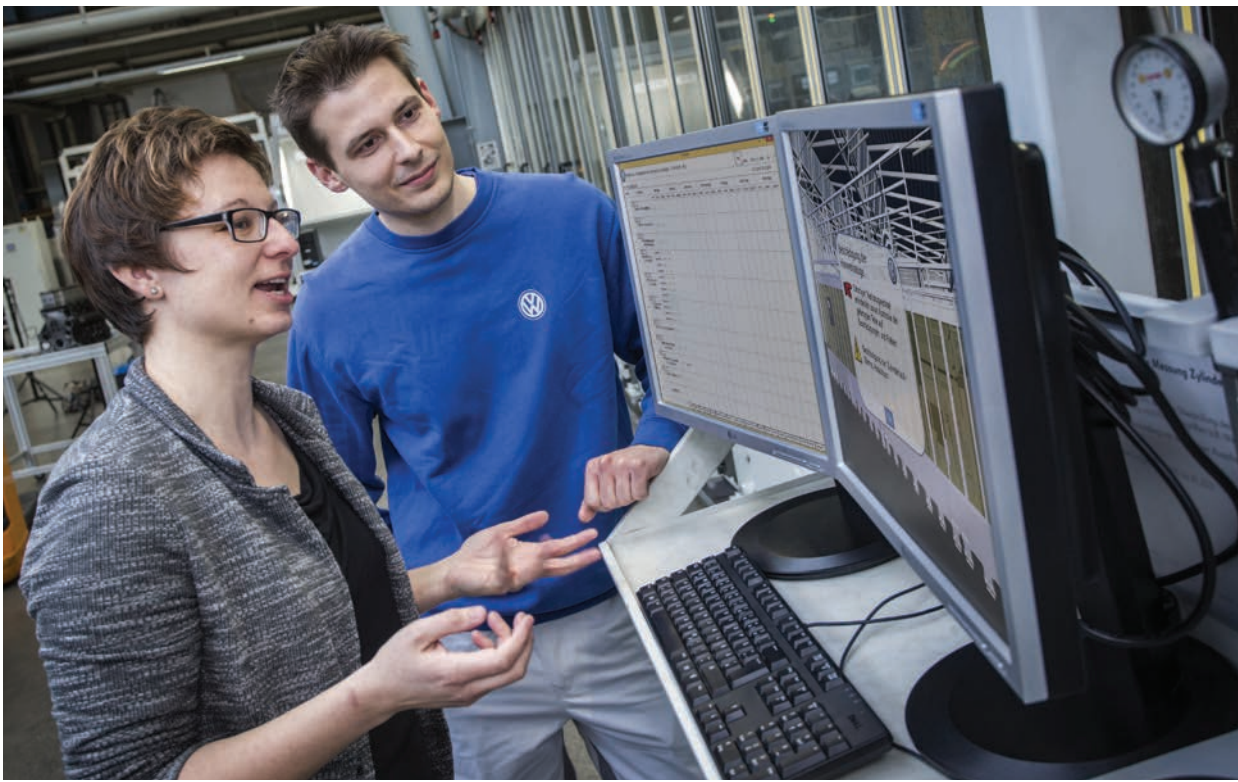
We are therefore developing technical systems that provide exactly the information necessary to help people make complex decisions. We plan automated solutions for ergonomic workstations. And we are interconnecting people, products and infrastructures

– for more reliability, efficiency and awareness. We prepare companies to transition from Industrie 4.0 to Work 4.0.

With our research on digital assistance, smart supply chains and efficient manufacturing operations, we are creating custom solutions for companies and their service providers as they transition to interconnected manufacturing. You will find some examples of how we put this into practice in this issue of our IFFocus.

Your Michael Schenk

A handwritten signature in black ink, appearing to read 'M. Schenk', written in a cursive style.



Digital Assistance System for Quality Control

Errors can be spotted early and resources can be conserved when a large number of people share knowledge in a company. This is the case with a honing machine used to hone crankcases at VW's engine plant in Salzgitter: A digital assistance system will enable significantly more workers to ensure the quality of the honing process and honed crankcases in the future.

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Hybrid Assembly System of the Future: From the Idea to Mass Production

Can automated systems optimize efficiency, quality and ergonomics in final assembly assembly workplaces? A collaborative robot will actively assist humans at BMW AG in the future.

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Perfect Picking with the RFID Wristband

Picking processes can be monitored completely without losing time: A reader integrated in a wristband and passive RFID transponders on every compartment of small parts bins make this possible.

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Digitally Capturing Manufacturing Processes

Errors that creep into a manufacturing process or equipment that malfunctions require a rapid response. Otherwise, they can increase costs. Digital documentation improves transparency and makes manufacturing more efficient.



Sharp Minds

Who earned a doctorate? Who is new? Learn more about the people at the Fraunhofer IFF.

Central German Researchers Are Developing a Dynamic Control Center for Smart Grid Management with Siemens



Prof. Martin Wolter from the Department of Electric Power Systems (I.) and Dr. Przemyslaw Komarnicki, expert in electric power systems at the Fraunhofer IFF Magdeburg (r.), are among the researchers collaborating at the DynaGrid-Center in Central Germany.

A new testing laboratory, where researchers can simulate and study the challenges in the high voltage grid of the future is taking shape in Central Germany. Together with Siemens AG, universities in Saxony-Anhalt and Thuringia will be developing control technologies over the next three years, which will prepare the German power transmission grid for the demands of the energy transition.

The growing input of wind and solar power and their resultant transport over long distances is making processes in the grid significantly more complex and dynamic. Current monitoring and control mechanisms will foreseeably no longer satisfy future demands.

So-called smart grids that supply energy efficiently are one major focus of this research project being supported by the Federal Ministry for Economic Affairs and Energy with around five million euros. They interconnect, control and monitor power producers, storage systems, distribution grids and consumers. Smart grids are, for instance, able to identify and respond to malfunctions caused by lightning strikes, damage from excavating equipment, birds or short circuits within hundredths of a second.

The Smart Grid Laboratory already in existence at Otto von Guericke University Magdeburg will be involved in the new research project. They are working to put electricity on the optimal path through the grid to supply consumers from renewable sources in re-

sponse to demand. A dynamic grid control center that remotely monitors and controls the simulated high voltage grid in Magdeburg and manages the data smartly is being created in the project at the Technical University Ilmenau.

Researchers from the Fraunhofer IFF are contributing their expertise to, among other things the design of a future-proof, automated IT and communications infrastructure in substation systems and the entire energy control system. "Automation is only feasible with standard, secure interfaces and data formats. That is our research mission in the DynaGrid project," explains Dr. Przemyslaw Komarnicki from the Fraunhofer IFF.

Siemens, provider a comprehensive portfolio for the entire high voltage range, will be coordinating the research. The DynaGrid Center will be doing more than just designing the demonstrator spread over two states, according to Siemens project manager Prof. Rainer Krebs. "We have internationally recognized experts in Central Germany to meet the specific challenges as we modify our energy supply system. We aim to establish a long lasting research network that refines high technologies jointly here."

Researchers from the Fraunhofer IOSB-AST in Jena and Ruhr University in Bochum are also involved in the project. (pm/akw) ■

WindNODE Is a Smart Energy Showcase

On December 1, 2015, Federal Minister for Economic Affairs and Energy Sigmar Gabriel, gave the go-ahead for five select model regions to study innovative technologies and methods for the future energy supply. The grant program Smart Energy Showcases: Digital Agenda for the Energy Transition (SINTEG) is intended to smartly interconnect production and consumption by using innovative grid technologies and operating concepts.

The showcases are intended to serve as blueprints for widespread implementation of energy interconnectivity in all of Germany," explained Sigmar Gabriel.

Saxony-Anhalt is one of the model regions with WindNODE, short for Wind in North-east Germany. The showcase covers the five eastern German states and Berlin. The goal is to efficiently integrate production of renewables in a system made up of the power, heat and transportation sectors. Systems supported by IT will be tested under the lead management of transmission system operator 50Hertz in order to be able to incorporate renewables in the grid even when they account for 100 percent of energy consumption or more. The consortium includes 50Hertz's so-called control zone. This will enable them to develop complete solutions for the entire energy system. Priority will be given to digital technologies. Producers and consumers will be extensively interconnected digitally, thus establishing an Internet of energy.

WindNODE is an endeavor of a consortium of forty-four strong technology and industry partners and sixteen other associated partners. Members include innovative companies from the renewables sector, IT specialists, energy producers and consumers, system operators, and research organizations. Saxony-Anhalt is involved through the Fraunhofer IFF and In-fraleuna. (akw) ■



www.windnode.de

Renewable Energy Cluster Is Dynamizing Saxony- Anhalt's Companies



Prof. Styczynski presenting the CEESA report to State Secretary Dr. Tamara Zieschang. The brochure provides information on the cluster's completed projects and future priority topics in the field of renewable energies. Photo: André Naumann, ZERE e.V.

CEESA is a high-energy network. It has developed and overseen groundbreaking projects with over fifty companies in the past five years. That corresponds to one third of the companies in Saxony-Anhalt working with renewable energies. CEESA further attests their great potential for the regional economy. Research coordinator Prof. Zbigniew A. Styczynski in Magdeburg invited interested companies to join the Saxony-Anhalt Renewable Energy Cluster.

The state of Saxony-Anhalt is a leader in renewable production in Germany. There are days on which more electricity is produced from renewables in the state than is consumed. On such days, Saxony-Anhalt exports its "green energy". Then, the state proves to be playing a leading role in the energy transition. This achievement is due in large part to the Saxony-Anhalt Renewable Energy Cluster CEESA, which is bringing companies and research organizations together with its networking. It enables its partners to exchange experiences and informs them about the latest developments in the industry. Supported by the state government since 2009, CEESA is dynamizing the regional economy.

Saxony-Anhalt Renewable Energy Center ZERE and the Anhalt Technology Transfer and Innovation Support Agency ATI are coordinating the Saxony-Anhalt Renewable Energy Cluster's work. Dr. Tamara Zieschang, State Secretary from Saxony-Anhalt Ministry of Higher Education, Research and Economic Affairs, presented information on results and projects at the ZERE executive board meeting. "The results of the cluster's work are impressive. Its initiation and implementation of many research projects have made CEESA

instrumental in strengthening Saxony-Anhalt's leadership in renewable energies. We will continue to rely on effective collaboration in the future, too," explained Zieschang. (akw) ■



www.ceesa-org.de

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Industrie 4.0 Is Coming to the Factory Floor



Industrie 4.0 for plant engineering: Here too, digital technologies are the prerequisite for successfully interconnecting systems.

Federal Minister of Education and Research Johanna Wanka.

The Fraunhofer IFF's project "Process Assist", for instance, is intended to cut manufacturing costs. Maintenance and servicing of chemical plants, for instance, and the provision of the requisite data are very time-consuming, costly and labor intensive, especially in the process industry. New Industrie 4.0 methods and tools could conserve resources substantially and expedite work steps required of workers. Complex documentation is compiled dynamically and all necessary data is aggregated coherently by flexible and smart networking and in real time.

Industrie 4.0 is confronting German SMEs with major challenges: digitally interconnecting machinery in operation, integrating staff in interconnected operations or implementing reliable IT solutions that protect company data. SMEs are transforming and the German government is helping them take optimal advantage of the opportunities of digital transformation. With its initiative "Industrie 4.0: Research on the Factory Floor", the Federal Ministry of Education and Research is launching nine applied research projects that will

show SMEs how Industrie 4.0 solutions can be implemented.

"SMEs are crucial to the success of Industrie 4.0 in Germany. We intend for our projects to demonstrate how Industrie 4.0 can function for SMEs. I'm sure that these examples will be motivating and contribute to Industrie 4.0 actually being implemented in companies, that is, reaching the proverbial factory floor. We intend to organize the new industrial revolution in Germany successfully," says

The initiative "Industrie 4.0: Research on the Factory Floor" is part of the new high-tech strategy with which the German government is turning ideas into innovations and establishes ties between science and industry, research and society. This will create opportunities for the future and the jobs of tomorrow. (pm/akw) ■



www.produktionsforschung.de

Knowledge 4.0: Industrie 4.0 Knowledge Platform

Digitization and increasing networking of the widest variety of systems will change our work routine, create new opportunities to add value, and be a basis for new business models, as far as the world of research and academia is aware.

"Eighty percent of small and medium-sized companies still don't know what Industrie 4.0 is and can give them in business practice," said Prof. Schenk at the Knowledge 4.0 project meeting on November 17. This is precisely where academic and applied researchers are starting with their work.

Knowledge 4.0 is pursuing two objectives: Planning a nationally visible center of excellence for basic and advanced training in the

field of Industrie 4.0 and piloting central elements. The plan entails modifying educational and training curricula directly for specific industry demands. Training contents are taught in specialized block courses or programs for professionals to fit their schedules and different qualifications.

In his role as board member in the Verband der Metall- und Elektroindustrie Sachsen-Anhalt, Mr. Probian, CEO of MTU Reman Technologies GmbH, stressed the importance of such a knowledge platform for continuing education and networking of young professionals in companies.

It will be essential in the long term to provide a comprehensive program of customiz-

able and combinable continuing education modules – knowledge-as-a-service. The field of business development will especially be expanded further. This will both boost companies' innovativeness sustainably and improve academia's networking with industry. It is intended to reach companies in the automotive sector, machinery and equipment manufacturing, electrical appliance manufacturing and energy systems engineering, among others. The digitization of products and processes and fitting continuing education actions will generate numerous benefits. Following the initial planning phase, the work begun on Knowledge 4.0 begun will be continued in follow-up projects. (dm) ■

Gabriel at the Workstation of the Future

On his summer trip through the eastern German states, Federal Minister for Economic Affairs and Energy Sigmar Gabriel visited the Fraunhofer IOF on August 25, 2015. Along with colleagues from Jena, the Fraunhofer IFF in Magdeburg also presented work from the 3Dsensation consortium to the minister.

Researchers from the Fraunhofer IFF presented an assembly workstation equipped with visual technologies to the minister during the press tour. Sigmar Gabriel tried it out right away and was visibly amazed at how a technical assistance system assists with an assembly operation, thus boosting quality in manufacturing.

A similar assembly system from the Fraunhofer IFF is already being used in the field. Step by step instructions for assemblers are displayed on a monitor at Kolbus in Rahden, North Rhine-Westphalia. Computer generated visualizations overlaid the real assembly situation, thus providing workers assistance with their work. The system can additionally compare the actual output during assembly with the target output in real time. The system immediately detects errors during assembly and displays information for the worker, who can then correct the erroneously assembled modules. That saves time and prevents lost output. Such technical assistance systems will become established in the future, especially in manufacturing. (akw) ■



Federal Minister for Economic Affairs and Energy Sigmar Gabriel at a workstation of the future: Complex modules are hard to assemble without instructions. Printed instructions are neither practical nor helpful in manufacturing. Steffen Sauer's (r.) team is relying on visual assistance and augmented reality.

Mobile Robots for Aircraft Manufacturing



José Navarro from IDPSA and José Saenz from Fraunhofer IFF examining VALERI's application of sealant on an aircraft part.

With the EU project VALERI, researchers and their industry partners demonstrated that mobile manipulators, i.e. mobile industrial robots, are excellently able to collaborate with people side-by-side. Robots in the project applied sealant to a plane fuselage or inspected aircraft parts.

The teams of experts coordinated by the Fraunhofer IFF in Magdeburg especially wanted to automate manufacturing tasks,

which are hazardous to health or are very monotonous and physically strenuous. They also intend for a single mobile robot to perform tasks in aircraft manufacture, which recur through many steps, in the future. Rather than replace them, robots will help and assist technicians with their jobs.

The researchers in the VALERI (Validation of Advanced, Collaborative Robotics for Industrial Applications) project laid the technical

foundations for human and robot collaboration side-by-side. They used the application of sealant to aircraft fuselages the inspection of parts at the Airbus-DS facility in Seville as examples to demonstrate the possibility of removing barriers and other safeguards from manufacturing facilities in many cases in the future. Then, humans and robot will work side-by-side, perhaps even on the same part, yet independently. By installing a second inspection sensor in the VALERI robot system, the project partners additionally demonstrated the general capability to implement the system in other manufacturing operations. The experts are using VALERI to lay the cornerstone for making their ideas for human-robot collaboration and the aerospace industry reality and for taking the next steps toward Industrie 4.0.

The industrial users Airbus DS and FACC, industrial robot manufacturer KUKA Robotics GmbH, system integrator IDPSA and research partners PROFACTOR GmbH and PRODINTEC were involved in the VALERI project, which was funded by the European Commission's 7th Framework Program "Factories of the Future" with € 3.6 million. (akw) ■

First "Hol's Holz" Industry Event

Uwe Knauer from the Fraunhofer IFF (r.) explaining the capabilities of hyperspectral scanning for agriculture and forestry to Dr. Hermann Onko Aeikens, Saxony-Anhalt Minister of Agriculture and the Environment, Franz Prinz zu Salm-Salm, President of the Saxony-Anhalt Association of Forest Owners and Dr. Ina Ehrhardt, Fraunhofer IFF (l. to r.). It is used for airborne collection of data on forest conditions.



The industry event "Hol's Holz" (Get the Wood) intended to raise public awareness of timber as valuable, efficient and green construction material, raw material and fuel was held in Magdeburg for the first time on October 29. Some one hundred government, industry and research experts, including experts from the Fraunhofer IFF, gathered. Among other things, the presented a project at the "Opportunity Market", which uses hyperspectral system to ascertain the forests' health and nutritional status expeditiously and economically. Such sustainable, green and high-yield management detects pest infestation early and likewise prevent the lost of entire timber stands.

Saxony-Anhalt's approximately 532,000 hectares of woodland are an ideal place for the timber and forestry industry to invest, as sales figures confirm: Primary and secondary wood processing companies in the state make around € 600 million every year and are simultaneously instrumental in reducing emis-

sions by at least thirteen percent every year by sustainably managing forests.

The "Hol's Holz" industry event was held during "Forest Week", initiated and supported by Minister of Agriculture and the Environment Dr. Hermann Onko Aeikens. (ms/akw) ■

Revealing Faded Frescos



The upper cloister of Brandenburg Cathedral: Details of the wall frescos such as horses are now coming to light in spots where only traces of pigments had been discernible (left). A hyperspectral camera with specially engineered software has revealed the images (right).

The ravages of time have severely damaged the wall and ceiling frescos in the upper cloister of Brandenburg Cathedral (Brandenburg an der Havel). Much is no longer discernible with the naked eye. Often only fragments of what were once women with elegant garments and headgear standing together can be seen today. No matter how long one looks, images are indiscernible from the traces of pigments. A hyperspectral camera captures quite a different image with software developed by researchers from the Fraunhofer IFF in Magdeburg: It is bringing many of these faded frescos to light again.

Over Fifty Color Channels Detect the "Invisible"

"Whereas humans assemble every perceived hue out of the colors red, green and blue, the camera has fifty-one color channels," explains Dr. Andreas Herzog, a researcher at the Fraunhofer IFF. "It is therefore capable of distinguishing hues that appear identical to the human eye." Where only blue is visible, for instance, the system divides the reflected light into the minimum of different hues, thus detecting structures that are actually no longer visible. This new technology additionally helps determine whether pictures were

painted in several stages or were restored at some time. Even if the paints might have looked the same to the artist, they could never have been mixed fully identically. The camera uncovers the differences.

Rather than the camera, the specially developed software is the centerpiece of this development. It uses the data produced during hyperspectral imaging to compile around one hundred images on some of which structures such as painted figures of women or horses come to light. Art experts examine and interpret these images.

First Trial in Brandenburg Cathedral

The researchers from the Fraunhofer IFF have already tested their technology successfully in the upper cloister of Brandenburg Cathedral, which is celebrating its 850th anniversary this year: The wall frescos there were long thought to be lost until they were rediscovered a few years ago and then painstakingly restored. The cloister's secret has thus been revealed and, with the hyperspectral camera, even a large number of other details are being revealed as well little by little. (pm/akw) ■

Tracking Systems Improve Airport Logistics

Dense fog is hanging over an airport apron. Even when tow tractors, pushback tractors and tankers are moving at merely a snail's pace, collisions can always occur, be they with other vehicles or with aircraft. Tanking and loading of luggage, air cargo, and catering takes significantly longer in fog or driving rain than when visibility is clear. Passengers end up sitting at departure gates longer than planned, and the schedule for cargo containers is jeopardized, too. Poor weather conditions will impede work on the apron far less in the future. Researchers at the Fraunhofer IFF in Magdeburg are establishing the basis for this in the EU project e-Airport together with various European partners.

"We are developing a tracking system that will increase safety on the apron," explains Olaf Poenicke, a researcher at the Fraunhofer IFF. "It will additionally make it possible to utilize airport capacities more efficiently because the system allows logistical operations to run in a significantly more structured way than

The positioning systems developed in the EU project e-Airport help control operations on airport apron more efficiently.



before." One important aspect: The steady increase of air traffic is compelling airports either to build new runways and terminals or to utilize the existing infrastructure's capacities more efficiently.

"We at the Fraunhofer IFF are contributing our expertise in air cargo to this control center, modeling the processes, and speci-

fying the job orders received by a tow tractor driver," explains Poenicke.

The project is being funded by the European GNSS Agency as part of the EU's Horizon 2020 research program. The researchers presented the e-Airport project at the BVL's International Supply Chain Conference in Berlin from October 28 to 30. (akw) ■

Machinery Manufacturers' Alliance for the Future: Learning from the Best

Since Industrie 4.0 interconnects products with manufacturing and business networks, it is only logical that no company can go it alone. Machinery manufacturers, suppliers, service providers and research institutes are joining forces in the Machinery Manufacturers' Alliance for the Future to exchange know-how.

Machinery manufacturing is one of Germany's most important industries. Machinery, plants and automated systems from German companies are in demand all over the world. The machinery manufacturing industry cannot and does not want to rest on its laurels: Competitors, especially from Asia, the demographic trend and changed customer demands are necessitating utterly new responsiveness and innovativeness from companies and their staff.

Industrie 4.0 is an issue for the future. Major companies now have clear ideas about smart factories and are launching components and tools for interconnected manufacturing on

the market. Small and medium-sized enterprises sometimes still have problems recognizing and implementing the potential and opportunities of Industrie 4.0 for themselves in their industrial operations.

Many companies will have to change in order to safeguard their futures: Manufacturing operations have to become more efficient. Work will have to be organized more flexibly. Business models will change. Staff members will have to be trained for such changes. One company alone cannot do this. Small and medium-sized enterprises often lack the resources to digitize, and established standards on which they could orient themselves are lacking. Moreover, demands for Industrie 4.0 projects often come from other companies, suppliers, service providers or customers.

This is precisely where the Machinery Manufacturers' Alliance for the Future is starting. The platform is intended to provide German machinery manufacturers suggestions and ideas for product and service innovations

continuously and to identify capabilities to boost efficiency in every industrial operation. Effective concepts and best practice models will help companies develop new ideas of their own. Already tested technologies will thus reach all small and medium-sized enterprises faster.

This national innovation network was established at Hannover Messe in April of 2015. For the moment, seventeen partners (systems suppliers, research institutes and engineering and consulting partners of machinery manufacturing) have joined forces in the alliance for the future.

Conferences and workshops will facilitate regular exchange of experience and knowledge. The Alliance for the Future provides its members interdisciplinary task forces and checkups for industrial operations. It establishes contacts for collaboration and research with partners from machinery manufacturing, the supplier industry and manufacturing engineering. (dm) ■



Harald P. Schenk and Judith Apold from Adam Opel GmbH in Rüsselsheim talking with Prof. Dr. Rainer Müller from ZeMA gGmbH.

Where is the pain threshold? Knowing this is important for safe human-robot collaboration.



Dr. Matthias Reichenbach, process development engineer at Daimler AG.



The Digital Engineering conference attracted over 160 attendees.



Magnus Hanses from the Fraunhofer IFF explaining the research work in the Isabel project



Olaf Katzer, Head of vocational and continuing education at Volkswagen.

Impressions

of the 18th IFF Science Days on June 24 and 25, 2015

Minister Möllring (r.) trying out digital technologies himself – not without comment from Director Prof. Schenk (l.) and University President Prof. Strackeljan.



Conference attendees listening to Dr. Roland Wischnewski from RIF Institut für Forschung und Transfer e.V.



Prof. Dieter Spath, CEO of Wittenstein AG.

Prof. Dr. Frank Kirchner from DFKI and Dr. Norbert Elkmann, Manager of the Robotic Systems Business Unit at the Fraunhofer IFF.



Attendees learned about and discussed the latest research in the field of human-robot collaboration with experts as they toured the Fraunhofer IFF's testing facility.

200 attendees accepted Dr. Norbert Elkmann's invitation to the conference "Safe Human-Robot Collaboration".



Patrick Dittmer, Bremer Institut für Produktion und Logistik GmbH BIBA.

Karl-Heinz Daehe, former Minister of Regional Development and Transportation, at the packed Magdeburg Logistics Days.



Dr. Frank Ryll from the Fraunhofer IFF with Dr. Jürgen Seeger and Manfred Weuda from Precis Maschinen und Anlagen Service GmbH.



Wolfgang Müller-Pietralla, head of the FutureResearch and Trend Transfer Unit at Volkswagen AG, and Holger Schneebeck, Deutsche Post DHL Innovation.

State Secretary Klaus Klang from the Ministry of Regional Development and Transportation conversing with Prof. György Sárközi North Hungarian Traffic Management Center in Miskolc, Hungary, and Prof. Béla Illés, Director of the Department of Logistics at Miskolc University in Hungary.



Industrie 4.0 and Smart Working Environments

Interview with Prof. Raimund Klinkner, Chairman of the Executive Board, Bundesvereinigung Logistik

The interview was conducted by Daniela Martin.

The digital transformation of our day-to-day lives – with a vision of smart environments, processes and everyday objects constituting an “Internet of Things” with their digital sensors and interconnectivity – is prompting a change in business and society. How well are we prepared for these changes? What role will people play and how will our living and working environments change?

What is your interpretation of Industrie 4.0?

As an integral part of the solution to changing customer demand. Industrie 4.0 and matching supply chains make it possible to respond to market demand rapidly and to customize products at competitive prices.

Autonomous, self-organizing cyber-physical manufacturing and supply chain systems are helpful. Industrie 4.0 enables responsiveness while keeping processing speeds high, error rates low and operating costs down. “Smart factories” are typified by versatility, resource efficiency, ergonomics and customers and business partners integrated in business and value added processes with coordinated supply chain systems.

Why is Industrie 4.0 also called the “fourth industrial revolution”? What about it is new? Factories already have computers and networks.

Because current developments are clearly going beyond “evolution”. The change expedited by Industrie 4.0 not only includes tech-

nological developments but also constitutes a paradigm change: Following mechanization, industrialization and automation, we are now experiencing an interconnection of smart manufacturing engineering by embedded control systems. This is distributing hitherto centralized intelligence.

How close is Industrie 4.0 actually? Will it arrive soon – or is that still wishful thinking?

It is reality and future, depending on how prepared companies and their management are to accept change and create it actively. Company size hardly plays a role. We are seeing companies that have completely interconnected every business unit already. Others are on their way and still others have not yet begun.

In the medium-term, rigid value chains will be reorganized into dynamic networks. Digital transformation enables interconnecting hitherto autonomous systems and makes manufacturing and supply chain operations efficiently responsive. Key factors are enthusiastic people on every level of the hierar-

chy, sufficient digital data for improved predictions and more systematic process control, synchronized supply chains and shorter manufacturing and innovation cycles beyond the boundaries of one’s own company’s.

What is in store for companies? And how will work change for employees?

Around fifty percent of the jobs in supply chain management and logistics are affected by change caused by digital transformation. BVL members indicated that to us in a survey. Managers and skilled professionals consider rapid and sufficient employee training to be a major challenge and mission for companies.

On the whole, the supply chain sector is looking to the future optimistically: Ninety-four percent of those surveyed see opportunities through digital transformation. Only seventeen percent of those surveyed feel their own jobs could be “endangered”. By contrast, three positive impacts of digital transformation on their own jobs crystallize: Sixty percent of the panel participants expect to be able to work more efficiently, fifty-eight percent expect centralized data management to



Prof. Raimund Klinkner, Chairman of the Board, Bundesvereinigung Logistik. Photo: BVL/Bublitz

What opportunities and risks do you see in the implementation of Industrie 4.0 for and in Germany?

Longstanding factory structures and traditional planning methods collapse under dynamic restrictions. Long and medium-range planning is hardly possible. Lean and simultaneously flexible manufacturing require near real-time transparency to control processes and more rapidly and systematically will improve exactly this transparency.

Digital analysis and provision of market and product information in real time deliver new knowledge, for instance, from big data analyses, and save time because essential information can be provided highly consistently down to the factory floor faster. Digital transformation improves interaction perceptibly. Actions can be significantly more flexible. "Lean" and "flexible" coalesce into "flean". This entails both opportunities and risks and much depends on the companies' innovativeness, creativity and readiness to invest.

Investments will also be needed to be able to tap the potential of Industrie 4.0 and Logistics 4.0. The profitability of the transitional phase we are currently experiencing is frequently still unclear, though. Data series or benchmarks are lacking. Moreover, employees have to be trained for the demands of the digital world, and mandatory standards have to be defined, and problems with IT security have to be solved.

What role is Fraunhofer playing in the digital transformation of manufacturing and manufacturing operations? What can research and development contribute to meeting future challenges?

Fraunhofer Institutes have – as with many innovations now long since taken for granted – taken the lead in different places. As I see it, the institutes in Magdeburg, Dortmund and Stuttgart in particular have done this with digital transformation. Practice needs research's thinking outside of the box – and research needs an open ear to learn about practical issues.

simplify their work, and more than half expect better communication among facilities, units and employees.

What can businesspeople expect when Industrie 4.0 is implemented? How can staff be involved, too, and get involved in digital transformation in their own companies?

Meeting customer demands more rapidly and systematically at competitive prices. Implementing conditions to change corporate structures that have evolved over time will necessitate a firm commitment from everyone involved to play an active role in changes.

Knowledge of technology is necessary, but even more a readiness for changes that affect not only others in the company but also one's own job. Like continuous improvement processes, this requires workshops and training courses. Benchmarks for orientation are needed. The BVL has been presenting such positive examples for many years, for instance, at regional chapter events.



BRIEF BIOGRAPHY

After earning a degree in mechanical engineering from the Technical University of Munich, Prof. Raimund Klinkner (* 1965) was in charge of, among other things, supply chain planning, buying and factory control at Porsche AG from 1991 onward.

He earned his doctorate with a dissertation on "Quality Integrating Manufacturing Strategies in the Automotive Industry" in 1994 while working full-time.

In 1998, Raimund Klinkner switched to Gildemeister (now DMG MORI AG) President of Production, Buying and IT and was appointed Vice-President in 2003.

From 2007 to 2011, Raimund Klinkner was president of the board at Knorr-Bremse AG.

In 2012, he founded the Institute for Manufacturing Excellence. Raimund Klinkner is the institute's managing partner and holds a variety of positions in industry and research.

For instance, he is president of the executive board of the Bundesvereinigung Logistik (BVL) e.V., president of the advisory board of DMG MORI AG and supernumerary professor of industrial logistics at TU Berlin.

Digital Assistance System for Quality Control

Tina Haase





The honing machine at VW's plant in Salzgitter. Experts from the Fraunhofer IFF in Magdeburg have developed a digital assistance system for quality inspection and integrated it in the production process.

Errors can be spotted early and resources can be conserved when a large number of people share knowledge in a company. This is the case with a honing machine used to hone crankcases at VW's engine plant in Salzgitter: A digital assistance system developed by Fraunhofer researchers will enable significantly more workers to ensure the quality of the honing process and honed crankcases in the future.

Every manufacturing operation, be it in the automotive industry or another, has to run flawlessly. Wear on even the smallest tool can have unpleasant consequences. Finished parts may no longer satisfy quality standards and have to be rejected. That is annoying for more reasons than just the costs. Cost and resource efficiency also make it essential to eliminate sources of defects and ensuing rejects.

Since this is Volkswagen's mission in Salzgitter, too, they are optimizing process control for honing machines, which hone crankcases, before they can be installed in engines. They finish piston ring faces so that the parts meet specified tolerances and shapes exactly and fit in engines well. Cylinder bores are honed to obtain the surface quality required of crankcases. This minimizes frictional losses in an engine later. Workers are unable to see how this massive machine concealed behind its housing does this specifically. All in all, staff has difficulty assessing and analyzing the machine's relevant parameters.

Quality control has therefore been in the hands of one single expert until now. He examines the honing machine at the engine plant in Salzgitter, armed with a printed out checklist. It tells him what to inspect where. An eye has to be kept on numerous parameters. Are tools worn? How is the required emulsion foaming? How much graphite has deposited itself on the machine itself and on the honing tool? And what is the quality of the finished surfaces, i.e. the crankcase? One single expert cannot have his eyes everywhere at once, especially since the honing machine runs three shifts. Occasionally, errors go undetected at first and rejects are produced as a result. A crankcase is relevant to costs, too, since it is one of a vehicle's most complex and expensive parts .



Jörg Rudolph, a specialist at VW, inspecting honing tools for damage.

Assistance System Guides Users through the Quality Check

The engine plant in Salzgitter would like to share knowledge about the machine among several individuals in the future. Then, any employee working on the machine will be able to assess crankcase quality and to inspect the honing machine – and take appropriate action, e.g. change a tool, whenever necessary. This is being made possible by a digital assistance system developed by researchers from the Fraunhofer IFF. It guides workers through the daily quality check on the machine step by step. A digital checklist as well as virtual models and the expert's know-how are stored in the system. The researchers deliberately kept the user interface simple. After all, not every user is a computer expert. Workers see a complete virtual model of the equipment to the right on a large monitor and the checklist to the left. Any tool

up for inspection on the checklist is marked by the system on the virtual model of the equipment. Technicians thus not only receive information on the tool they should inspect but also on its location. The system also provides assistance during inspection itself. Images show users what the tool should look like ideally and what signs of wear preclude further use – and, for instance, what it will look like if it gets through one more shift.

The system also assists staff with measured parameters, especially when they are assessing and evaluating collected data. The system compares measured values entered in the checklist by employees with stored tolerances. If the value deviates unduly from the specification, the relevant measured value is highlighted red. Employees also receive an automatically generated message with what to do in response. Can they correct the problem themselves? Then, they receive the

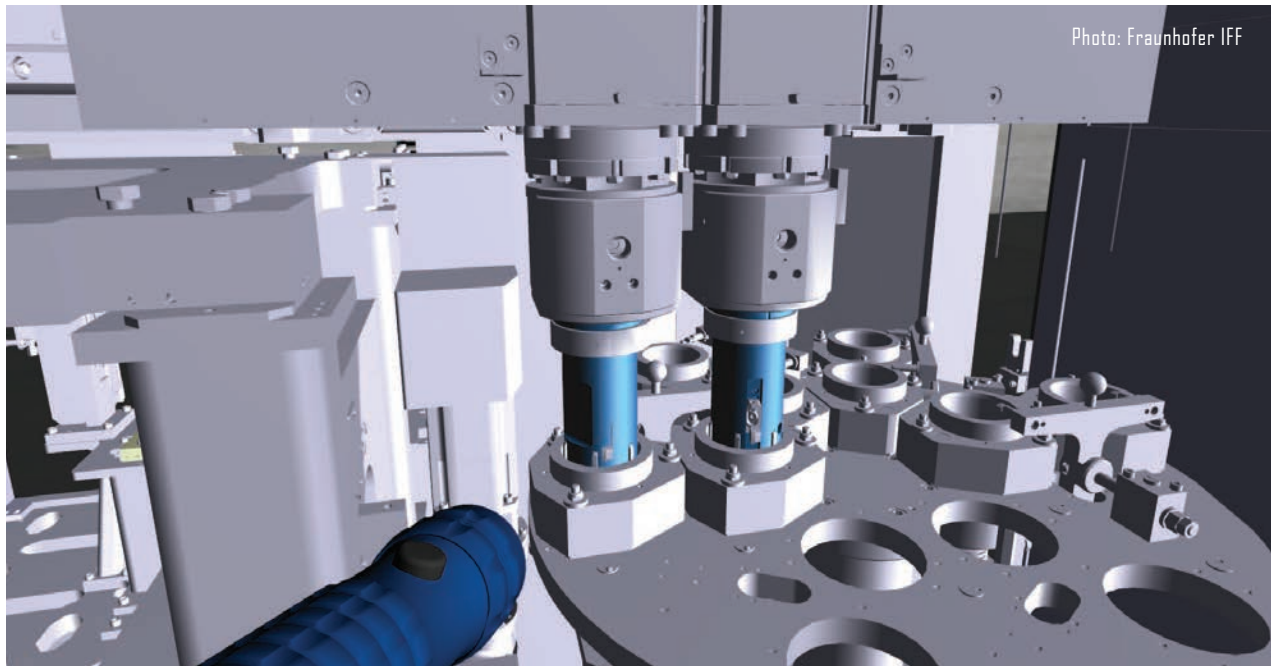
appropriate instructions. Or is advisable to report the problem and consult an expert?

Specifications in the Database Can Be Viewed Anytime

The researchers designed an open digital assistance system. In other words, workers can decide themselves whether they use digital assistance. The system is available anytime they need information. If they know what to do, though, they can start with the quality check without assistance since forcing assistance on technicians would be an annoying imposition in the long run. This way, the researchers compensate employees' different levels of knowledge with their development. Despite all their autonomy, all workers are required to do one thing: They must enter the data they collected during their visual inspection in the digital form and store it in the database by clicking the save button. Unlike

» We expect the use of a digital assistance system to disseminate previously pooled knowledge in order to control complex processes preventively and improve them sustainably. «

Jörg Rudolph, engineering specialist at VW's engine plant in Salzgitter



The virtual model of the honing machine explains step by step what requires attention during visual inspection.

paper forms, this data can be retrieved and viewed anytime. The system does not record who enters data: Individuals neither have a special login for the computer, nor do they have to enter names in the system. Data is thus anonymized.

Knowledge Transfer in the Company

The carmaker aims to use the digital assistance system to enable all employees to analyze and correct the process themselves. This will share knowledge among several individuals. Such knowledge transfer is fundamental, especially for key processes. Rather than merely reacting to defective manufacturing, employees should be acting, i.e. intervening preventively and rectifying errors long before rejects are produced, thus conserving valuable resources. The visualization also

surmounts language barriers among staff. Technicians are guided visually and assisted when they interpret the results.

The system is currently a prototype. VW intends to employ the digital checklist at the end of 2015. The researchers from the Fraunhofer IFF are planning to expand the assistance system in another step. Whenever a defective product, in this case a crankcase, is produced, workers have to correct the manufacturing process. What is the impact when certain parameters are changed? Laypersons have difficulty understanding this, especially when a system is as complex as a honing machine.



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Hybrid Assembly System of the Future: From the Idea to Mass Production

Sebastian Häberer



Can automated solutions optimize the efficiency, quality and ergonomics of final car assembly workplaces? Researchers from the Fraunhofer IFF analyzed this together with project partners from BMW. One of the findings was that collaborative robots could actively assist humans with their work in the future.



Automotive manufacturing is steadily growing more complex. The growing variety of models as more products are customized is intensifying the pressures on carmakers tremendously. As quality increases and product life cycles grow shorter, costs have to be minimized, too. Yet a conflict exists in final assembly between a stable, automated production system and a highly flexible, manual work system. A production system that takes advantage of the particular strengths of humans and robots therefore seems to be an essential success factor for assembly systems of the future. Subprocesses will have to be divided among humans and robots to have a positive impact on criteria such as quality, productivity and ergonomics as well as cost effectiveness.

Reorganizing Work Processes

Where can processes be designed based on the principle of human-robot collaboration? How can humans and robots collaborate and optimize assembly processes? Although this technology is rapidly being refined, it is still relatively rare in final assembly. A team from the Fraunhofer IFF in Magdeburg scrutinized BMW's manufacturing unit in Leipzig together with partners from BMW in 2014 to identify potential applications. With their background in factory planning, they analyzed the work and workplace conditions and analyzed the assembly systems for need for optimization. "Human-robot collaboration is a field of technology of the future in which many new applications can be developed," says Alexander König, project engineer at BMW. "We went through the applications with the researchers from the Fraunhofer IFF in an organized way and developed a kind of guideline."

The project team identified one concrete use case right away: manual cleaning of the roof opening of a BMW-i3 body with isopropanol. Why is the roof opening cleaned in the first place? Along with conventional vehicles, BMW is also concentrating on electric vehicles at its innovative facility in Leipzig.

Rather than the usual steel, their bodies are made out of carbon fiber reinforced polymer or CFRP for short. Since welding them is technically unfeasible, the roof is bonded with the CFRP body. The bonded surfaces have to be absolute free of grease particles and dust to ensure a firm bond. The bonded surfaces must be cleaned right before the roof is mount. At present, final assemblers do this by hand with microfiber cloths moistened with isopropanol.

Why did the team of experts from the Fraunhofer IFF and BMW select this of all processes? This step is ideal for automation to make it a stable production system with integrated quality control. Another rationale is cost effectiveness. The microfiber cloths are discarded once they have been used fifty times as required by BMW AG's high quality standards. After studying the requirements and capacity analysis, there were no objections ergonomically. Working height and the finger forces were the only conditions categorized "yellow". Yellow conditions in an ergonomics evaluation indicate that design optimizations or actions are neither required nor necessary but fundamentally ought to be reviewed. Isopropanol use is rated safe based on the project teams' measurements and analyses. The project partners from the Fraunhofer IFF and BMW nevertheless agreed that employees should be prevented from directly handling isopropanol.

Developing New Concepts

Once processes had been analyzed and potentials for optimization identified, new concepts were to be developed. To this end, it was first necessary to analyze exact process specifications and the work requirements of upstream and downstream processes. While developing their concept, the researchers from the Fraunhofer IFF basically questioned everything, including the cleaning agent. Is cleaning the bonded surfaces with isopropanol at all practical? Or would other cleaning methods be better suited, e.g. cleaning with nonthermal plasma? The analysis concluded

Fraunhofer researcher Sebastian Häberer (3rd from left) studying supply chain processes in a factory in Leipzig together with his project partners at BMW. The factory planner is especially occupied with the question of how to use human-robot collaboration to organize assembly processes to be healthier and more ergonomic as well as more efficient

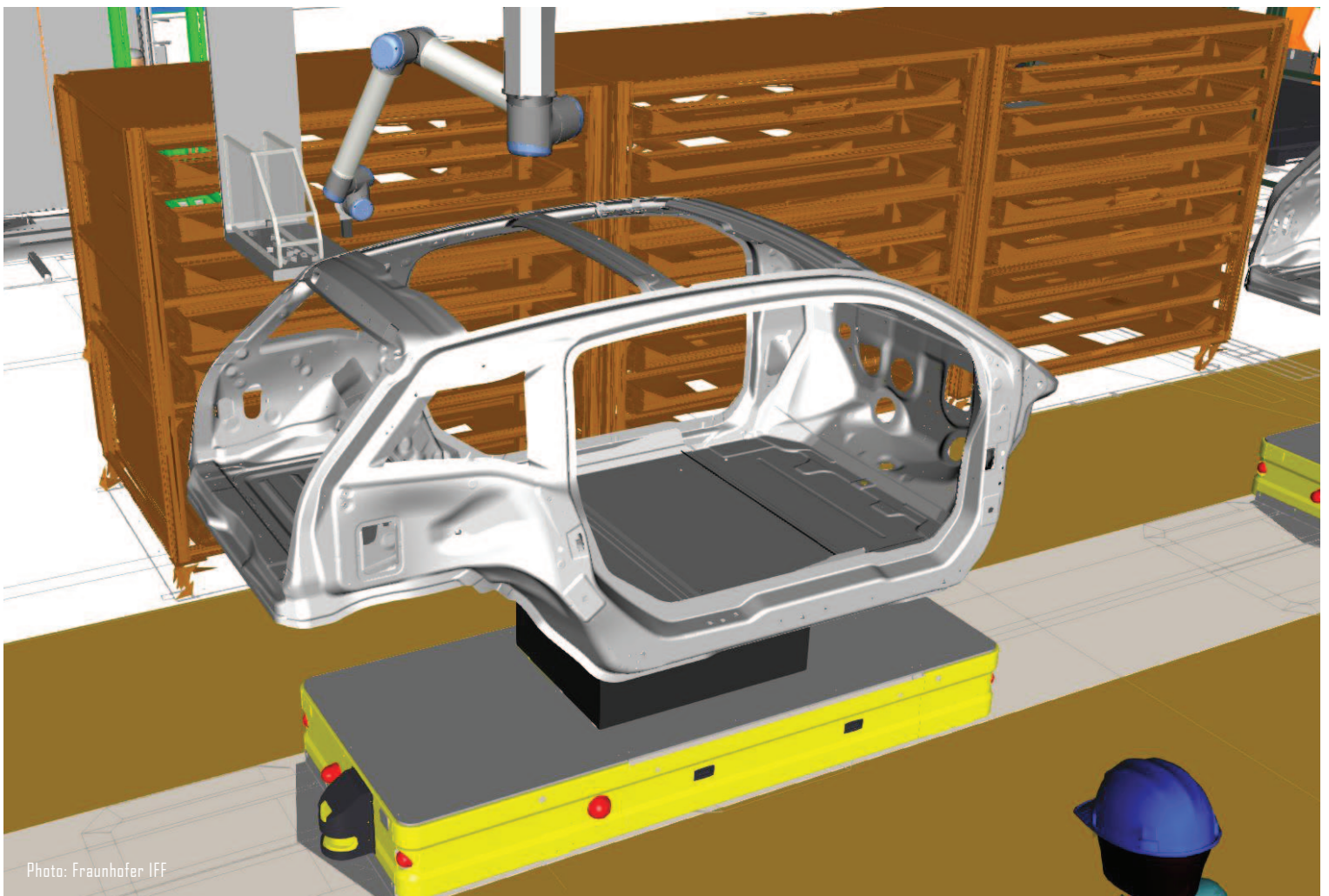


Photo: Fraunhofer IFF

The concept envisions a robotic arm guided from above cleaning the roof of the body. This spares assemblers from constant contact with isopropanol and posture that is strenuous in the long run.

that isopropanol stays. The entire robotics product portfolio was also analyzed. Not only the robot itself required discussion but its position in the future production system is also crucial. Factoring in possible contingency plans and maintenance actions, an open question was whether the robot should perform its job hanging from the line's overhead frame or laterally from a platform. Another challenge of concept development was the issue of conveyor synchronization. This was significant, since the bodies in the manufacture of the BMW-i3 are conveyed from work cycle to work cycle on automated guided vehicle systems. Rather than always stopping on exactly the same spot, they occasionally end up as much as one centimeter in front or behind. Various alternatives for verifying exact position were therefore analyzed and discussed by the project team, too.

The outcome of this study is a morphology that forms the basis of concept development and is additionally also intended to be applied to other production systems. In the case of the cleaning process, the project team used the morphology to develop three alternatives. Which of the alternatives should be implemented was the question. The project team agreed that all of the different user groups had to be involved in decision making to ensure the success of the project. When implementing a new technology such as human-robot collaboration, this fosters employee acceptance and eliminates employees' misgivings about having to share their work space with a robot in the future. With the aid of a visualization of the concepts and an evaluation matrix, the project team at the BMW factory in Leipzig asked the managers of the maintenance and workplace safety

teams from the assembly line to evaluate the concept. With success: This participatory approach was well received and open issues and misgivings were eliminated directly in one-on-one conversations. The concept rated best in terms of quality, cost effectiveness, ergonomics and other criteria, was subsequently simulated. This had different advantages: On the one hand, the robot's fulfilment of the requirements of technical feasibility was verified once more in the simulation. On the other hand, the groups of individuals involved were able to view the planned workflow directly in the simulation. Following involvement in evaluation, this additionally boosted acceptance among technicians and thus the prospects for success of the implementation project.

Ergonomic and Cost Effective

What does the new concept look like exactly? A one-armed robot dangles above the body and cleans the requisite surfaces of the roof opening from above. Felts are used instead of microfiber cloths. This solution was derived and designed based on another process in the factory in Leipzig. The specially developed cleaning tool picks up the felts from a pre-defined position. Then, a hose line along

application partner BMW in Magdeburg, are now building a prototype on which they can perform different tests. Among other things, different safety system options are being tested to ensure that humans and robots work safely in one work space. Once the system has been built and the tests have been conducted, the results will be presented to the carmaker's management. Afterward, a decision will be made about incorporating this production system in mass production of

production systems are already in the full version. The morphology for developing hybrid assembly systems, which was prepared at the start of the project, proved to be very helpful. The groundwork made it possible to organize the planning process more efficiently, too. The project team expects to transfer the concepts developed to mass production at the end of the project. The methodology developed together with BMW will be applied throughout the company once the project

» Human-robot collaboration is a field of technology of the future in which many new applications can be developed. «

Alexander König, Project Engineer at BMW in Leipzig

the robot supplies the isopropanol to the felt. Cleaning starts once the robot is positioned and ends when the used felt is discarded. The process and backpressure are monitored by flowmeters to ensure high quality cleaning. Staff no longer having to clean actively. Not having direct contact with isopropanol is demonstrably beneficial. They perform other work in this cycle other and still have plenty to do by moving work from upstream and downstream processes. The concept economizes the use of isopropanol. The use of felts instead of microfiber cloths also introduces potential savings and helps organize the production system more cost effectively.

The entire project team, consisting of staff from the Fraunhofer IFF, the Department of Automation at Brandenburg University of Technology Cottbus-Senftenberg and

the BMW i3. "In collaboration with the researchers from the Fraunhofer IFF, state-of-the-art was implemented in an applied innovation," says König, assessing the project team's work to date. The results and experiences of this project will be compiled in another step with the intention of using them for other applications in Leipzig as well as in other BMW factories.

Concepts beyond Cleaning

Apart from the cleaning process, the project team also identified other assembly tasks with potential for optimizing ergonomics, quality and cost effectiveness. The concepts for the other

ends since everyone involved in the project agrees there are many more applications in manufacturing in which humans and robots could collaborate in one work space to improve the quality, ergonomics and cost effectiveness of production systems.



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A hand is shown holding a small, square, metallic RFID wristband over a shelf of blue plastic bins. The bins are arranged in a row and have white labels with black text. The labels include the text 'Art. 05-43450', '8326', 'Art. 05-41678', and 'Art. 07-582'. The background is a blurred industrial setting with more bins and a sign that partially reads 'RF', 'Ba', and 'Mor'.

Perfect Picking with the RFID Wristband

Manfred Schulze



The smaller the parts, the bigger the problem in supply chains: Generally so-called small standard parts from bolts to fittings and even push-buttons are quite something. The differences between the thousand or so items are not always discernible at first glance, and small parts requested by customers for repairs have to be picked solely by hand. High manual labor and high risk of mix-ups during picking are good reasons to look for new solutions.

This issue has preoccupied Pascal Monsorno from Volkswagen Original Teile Logistik GmbH & Co. KG (OTLG) for some time. The quality manager at OTLG's North Distribution Center is familiar with the challenge employees have to meet every day at carousel and small parts storage systems. Every day they have to supply around 7,500 parts from a total of around 35,000 storage locations for orders arriving from workshops. That is an average of 700 parts each employee has to pick every day for the right customer and order based on order number, quantity and item description. The compartments in drawers are different sizes, the smallest units having up to five in a row. Some of the parts in them only look slightly different, too. Moreover, very small parts do not have item numbers directly on them. "Since use of a handheld scanner for this would be relatively time consuming, thorough training and regular breaks have been relied on," says Monsorno. In OTLG's experience, use of a barcode scanner lowers productivity by as much as twenty two percent, especially when drawers are very small. On the other hand, this "double verification's" error rate of up to 0.25 percent is still higher than the mark permitted by OTLG's quality standards. Cutting the respective additional labor is therefore an important goal.

The Fraunhofer IFF Magdeburg's booth at a conference on RFID in the fall of 2014 caught Pascal Monsorno's eye. Olaf Poenicke, who has been researching the use of electronic microtransmitters to monitor movements of

The RFID wristband has made small parts picking significantly faster and more reliable. It proved itself in a field trial at Volkswagen Originalteile Logistik GmbH & Co. KG.

Photo: Fraunhofer IFF



» The wristbands do not interfere with work. They are easy to use. They function reliably. «

Pascal Monsorno, Quality Manager at Volkswagen Original Teile Logistik GmbH & Co. KG

goods with his team for several years, outlined an idea for him there, which would resolve his problem simply and at a reasonable cost: A reader integrated in a wristband and passive RFID transponders attached to every compartment of small parts bins could be used to monitor picking processes completely without losing time. Pickers only wear an RFID wristband reader on their wrists, which has virtually no impact on their actions. They do not have to handle anything else such as a barcode scanner. "Directly scanning storage compartments during picking also increases process reliability significantly. When reading performance is set optimally, the order and the picked part can be clearly crosschecked, even in relatively small storage compartments of only ten by ten centimeters," explains

Poenicke. The read range can be adjusted on the device easily to prevent writing on adjacent RFID tags. The important findings of the field trials at OTLG in Norderstedt were that it is faster, more reliable, easy-to-use and highly accepted by employees. "We were really impressed at how fast the Fraunhofer team prepared this," recalls Pascal Monsorno. The trials in August of 2015 not only tested the picking process's reliability with the RFID system but also compared it with a barcode system. "We equipped a carousel rack with RFID transponders and confirmed approximately 3,500 picks with the RFID wristband during the field trials," reports Olaf Poenicke. All small parts pickers were involved in the trials conducted under conditions equivalent to those on the job.

The findings, which were discussed at a workshop at the end of September, were quite clear: Since the system uses an optical and acoustic signal to signal correct or incorrect picking, the series of trials ran virtually without any errors. The wristband is absolutely relentless after any error message: An alert does not disappear until the error has been corrected and the right part has been picked. Pickers picked 176 parts per hour with the RFID wristband in the trials. By comparison, the outcome with a hand scanner was a significantly poorer 137 parts per hour. The test subjects' assessment was also positive: "The wristbands do not interfere with work. They are easy to use. They function reliably," reports Monsorno. Importantly, employees feel they are being guided rather than



Photo: Fraunhofer IFF

RFID wristband design and a wristband being put on.



Photo: Fraunhofer IFF

overseen by the sensors. Features in need of improvement, which were mentioned during interviews, can be handled easily: a louder confirmation signal or a different material for the wristband. Its size and weight – around 116 grams at present – will certainly be refined when the pilot modules are manufactured professionally, reassures Poenicke.

Only one demonstration software has been used in the trial. Although it compiles picking lists and allows crosschecks, it is not intended for commercial use. The next step will entail further modifications such as integration in inventory control software or the search for a suitable manufacturer of the RFID wristband. All of the storage bins in the carousel racks have to be equipped with passive RFID

transponders, too, so that the system can be used in the daily routine. “I am optimistic that these technical hurdles can be overcome in relatively short time and we will then be able to test the decision from a business perspective at the company,” says Pascal Monsorno, confidently.

The team from the Fraunhofer Institute in Magdeburg is also confident that the RFID solution will be universally usable in small parts supply chains. “Transferring the solution to other industries is no problem,” says Poenicke. Given the extremely large

number of heterogeneous part shapes and sizes of delivered shipping units, automating order picking everywhere has not been and will not be possible or expedient any time soon. Pressure on error rates and delivery reliability can now be eliminated, though.



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Digitally Capturing Manufacturing Processes

Tobias Kutzler



Digitization helps in outdoor storage facilities: Large parts with integrated RFID chips can be located in outdoor storage facilities anytime. A part to be shipped is identified in the storage location immediately. What is more, inventory is always current because the system takes it every day.



Errors that creep into a manufacturing process or equipment that malfunctions require a rapid response. Otherwise, they can increase costs. Digital documentation improves transparency and makes manufacturing more efficient. A digital system can perform well in giant outdoor storage facilities, too. Wind turbine manufacturer Enercon recognized this and integrated a system from the Fraunhofer IFF in its manufacturing.

We all know how slips of paper are supposed to help us remember certain things. How often are they nowhere to be found when needed, though? While paperwork may be convenient, it is ineffective and ought to be avoided, especially wherever effectiveness is desired, in manufacturing for instance. Yet many companies still routinely document longstanding: manufacturing operations on slips of paper, which are collected first and entered in spreadsheets later. Such media changes harbor potential for errors and the typing consumes a lot of time.

Slips of paper will fall by the wayside in the future: Manufacturing processes will become smart under the catchphrase Industrie 4.0. This will only function, though, when manufacturing information is recorded digitally and saved. Real manufacturing operations have to be digitized. Digitization provides great benefits. Manufacturing becomes more transparent. Shift management can immediately record and correct problems that occur.

Pioneer Enercon: Digitally Capturing Production Data

Wind turbine manufacturer Enercon has made this transition and digitized its manufacturing. It is using a system developed by a team of experts from the Fraunhofer IFF. Employees used to document production by hand: They pulled out pencil and paper and wrote down the times when they started and finished a step. They usually did this at the end of the operation. Since remembering the exact times of the twenty to thirty steps for a rotor blade was impossible, Estimates were usually entered. Precise information on the length of individual manufacturing steps could hardly be provided. The reason for failing to adhere to estimated manufacturing times was unclear at times: Had there been a shortage of staff? Had a piece of equipment malfunctioned?

A look in the factory buildings presents a completely different picture: Employees view upcoming manufacturing steps on a touch screen and the sequence of their completion. Before starting a manufacturing step, they touch the respective information on the screen. The color in which the manufacturing step is displayed changes to green and the system saves the respective time. Employees do the same once they have completed a step. Then, the manufacturing step disappears from the list and the next instructions are displayed. Other information can also

be documented quickly and easily by making appropriate entries: How many employees were involved in the manufacturing steps? Why was there a delay? Documentation proceeds so quickly that it does not disrupt the actual work. Moreover, it is significantly more precise and informative than before. Weekly evaluations provide employees an overview of production runs. Another benefit is that shift management sees what happens in manufacturing in real time and can respond to delays or problems immediately. Previously, they had to do a walk-through or pick up a phone when they wanted to be informed.

Along with production data, the system also captures ambient conditions during manufacture of a part. How warm is it? How humid is the air? This simplifies quality assurance. In the event of complaints about rotor blades, a check can be run whether defects were caused by one of the ambient conditions, e.g. unduly high or low humidity, during manufacturing.

Digital Part History Records

Digitization at Enercon goes far beyond manufacturing. Employees laminate an RFID transponder into every part, hidden beneath the surface. Every part, e.g. a rotor blade, with an RFID chip has a digital history record containing all data, starting with the serial number and part type to production data up through information on distinctive features such as integrated heating.

In the workday routine this means that technicians hold the RFID chip up to a reader before starting to manufacture a part. Part numbers and other part information are already saved on the chip. This tells the system which manufacturing steps are necessary and it displays them on the touchscreen. Toward the end of manufacturing, employees laminate the chip into the part in a predefined location and save the current data on it.

Goodbye to Time-Consuming Searches in Storage Facilities

Once finished, parts are stored in a giant outdoor storage facility. This entails a multitude of tasks, though. If a rotor blade is supposed to be loaded on a truck a bit later and driven to a construction site, for instance, its precise

storage location must be known. Until now, the storage location was recorded manually and relayed by phone. Sometimes information got lost or was out-of-date since the part had been moved to another spot. Documentation of inventory is therefore connected with substantial labor and searches on the expansive premises consume much time. Annual



The RFID chip on a part contains its digital history record and transmits its location to the central server as soon as the part is moved.

» The Fraunhofer IFF's digital process monitoring system and inventory management system enabled us to improve transparency in manufacturing and internal supply chains quite a bit. Making systematic improvements and taking advantage of capabilities to optimize also made our manufacturing and supply chains significantly more efficient. «

Volker Ziem, CEO of the Enercon Group in Magdeburg

inventories also are also difficult. Employees need several days to identify and list all of the parts on hand.

Those days are over. The digitization system developed by researchers from the Fraunhofer IFF covers not only factory buildings but also outdoor storage facilities. This enables management to know where which part is stored all the time. The system takes inventory, otherwise taken once a year, once a day and does so virtually without work for employees. It could be called live inventory.

How is that possible? Employees attach a tracker on a part and couple it with the RFID chip before it is unloaded in the outdoor storage facility. That means they scan the chip in the part and the chip in the tracker with a handheld device and link their data. The tracker is also equipped with a motion sensor, which registers the loading of the part by a forklift and sends its exact location to a central server. Then the tracker switches to sleep mode to save energy. The motion sensor wakes the tracker whenever the part is loaded again and moved to another spot in the storage facility. The tracker also wakes itself once a day and sends its location data and battery level to the server, thus enabling daily inventory.

Employees remove the tracker from parts leaving the storage facility and hold it in a certain position that is not routine. This

automatically changes the part's status to "shipped". Employees used to have to do this themselves. They noted the part number and called and gave another colleague the number, which the colleague entered in a spreadsheet. That colleague's telephone rang as many as twenty times a day because that many parts left the storage facility every day. Now it is far calmer: All communication runs through a central system. The removed trackers are reused, thus creating a closed cycle.. Theoretically, the parts could also be tracked to the construction site. After all, every tracker contains a SIM card that permits GPS tracking.

Seventy-Five Percent of All Steps Are Captured Digitally

The digital system makes data acquisition, transmission and management vastly easier. Nearly all, or more precisely, approximately seventy-five percent of the steps for a part – from the first manufacturing step through leaving the storage facility – are captured digitally. Only the grinding and painting are not recorded digitally yet. That is merely a question of time, though: Since the system is flexible and upgradable, these processes can also be

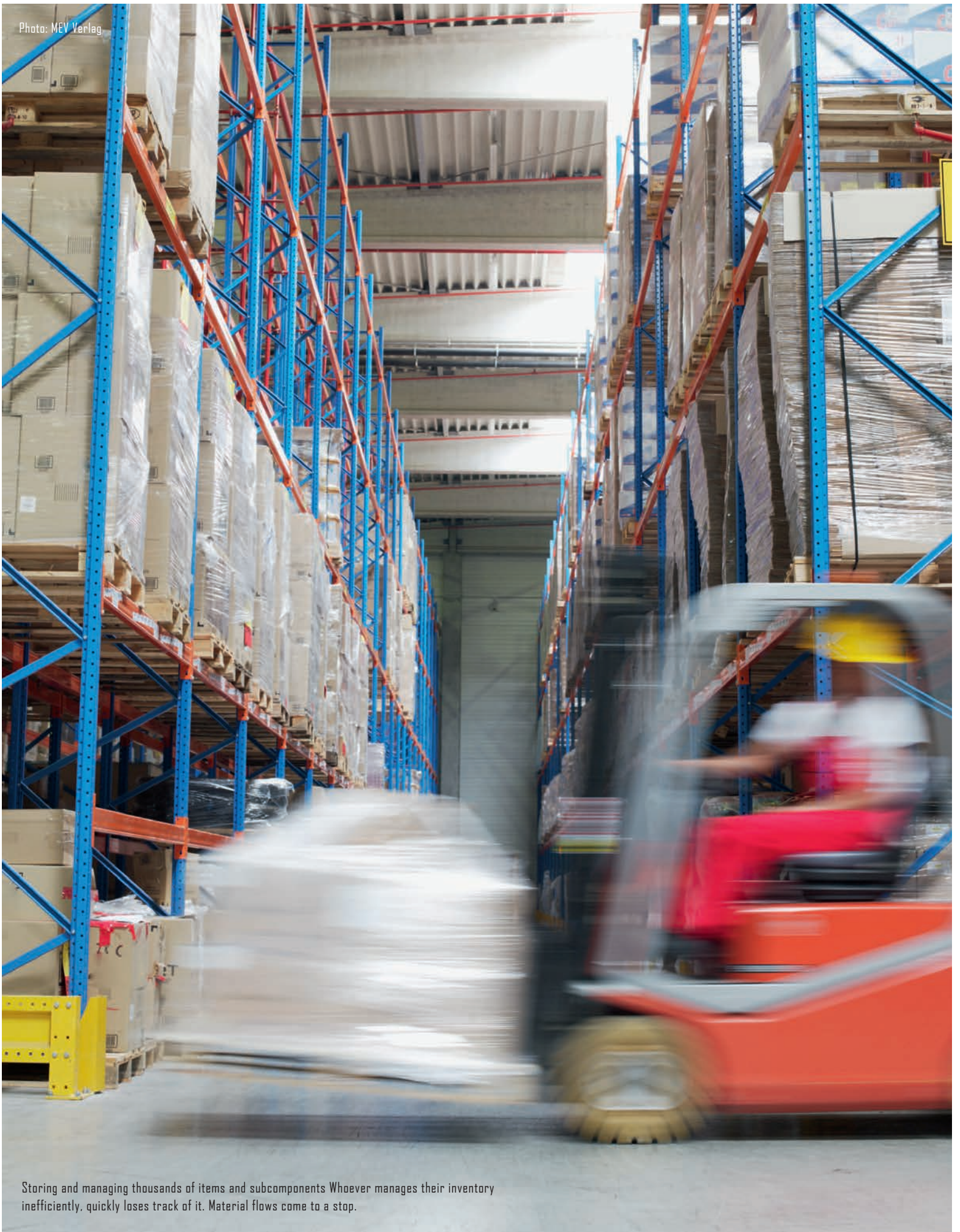
integrated. This makes continuous monitoring possible. "The Fraunhofer IFF's digital process monitoring system and inventory management system enabled us to improve transparency in manufacturing and internal supply chains quite a bit. Making systematic improvements and taking advantage of capabilities to optimize also made our manufacturing and supply chains significantly more efficient," reports Volker Ziem, CEO of the Enercon Group in Magdeburg. Implementing the system in other company units and transferring it to other wind turbine components manufactured in Magdeburg is thus the next logical step. Enercon and the Fraunhofer IFF are already collaborating on this intensively.



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Photo: MEV Verlag



Storing and managing thousands of items and subcomponents Whoever manages their inventory inefficiently, quickly loses track of it. Material flows come to a stop.

On a Major Tracking Tour

Manfred Schulze

Until now, only complex tracking systems using transponders have secured warehouse supply chains. A new system based on the visualization of movement now makes this easier.

The giant facility of a major supplier that manufactures modules for several carmakers resembles an anthill. Forklifts and entire convoys are constantly driving through the warehouse with boxes and pallets and setting down the items in a seemingly chaotic system. Seconds later, they are moving again with new loads, which they bring to the spot where the items they contain are processed further. New deliveries from the global supplier network are constantly arriving at the building's loading ramps where they are introduced in the warehouse management system. Finished modules have to be readied for shipping.

The system, which provides only a few minutes of leeway, is no longer manageable by one person. Nearly every finished module is customized. The number of parts to be forwarded by supply chains is correspondingly high. Suppliers unable to deliver just-in-sequence no longer receive orders. Whoever is unable to ensure that every part reaches

the right place at exactly the right time in the chaos of thousands of destinations has a huge problem.

Specialized in the visual process monitoring of supply chain systems, VLS Engineering in Cologne has been building systems for such jobs for years, which use cameras and small transmitters on handheld scanners to monitor supply chains in factories or even outdoor storage facilities. At the same time, cameras mounted on the building's ceiling – easily more than several hundred in large factories – film high resolution images of all the work around the clock, which can be saved on the factory's own servers. "This way, our clients always know where what pallets with what contents are located. If necessary, the image sequences serve as a record, which can be provided even after several weeks," states CEO Udo Rieger. The system is widespread now. VLS Engineering's booth arouses great interest at trade fairs and conferences such as the Bundesvereinigung für Logistik's Interna-

tional Supply Chain Conference at the end of October every year.

Udo Rieger met Jewgeni Kluth from the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg about three years ago at the BVL conference in Berlin. Kluth had an idea of a task force at the institute in mind and Rieger had contacts to clients that might venture testing the new approach under technical conditions. "Once I had scrutinized what the researchers from Magdeburg had developed for a plan, I was sure that it was worth a try," says Rieger now. The new system dubbed with the project name of MarLO (Marker-Base Local Tracking) reduces the cost of monitoring supply chains significantly and delivers a number of additional security and error-proofing benefits.

MarLO can be used wherever items in a warehouse can only be moved with industrial trucks because of their weight. "You can cer-

tainly view it as a small technical revolution in our sector," says Rieger now.

Somewhat simplified, the idea is essentially to be satisfied with tracking the movements of pieces of handling equipment since no item is moved without them. Drivers scan barcodes during loading, thus coupling the data of the items being moved with their forklift. A marker, a kind of digital label like those scannable by smartphones, well placed on the ceiling supplies computers a data set on routes and times of movements in the building in addition to the images still filmed.

"In a situation of a building on ground level, markers can be tracked virtually without interruption. The regular routes are known," explains Jewgeni Kluth.

The most difficult challenge faced by the computer scientists was developing algorithms that can ascertain the location of a marker and thus the moved item with minimal computational complexity. "The system searches the camera's image section for fa-

miliar shapes, which we identify beforehand markers, and screens out virtually everything else," says the researcher. The marker's location is computed from the camera's live images every half a second. The team of experts from the Fraunhofer IFF has long been considering also using smart cameras in the future. This registers a vehicle's given location and direction when stopped or moving, speed and time.

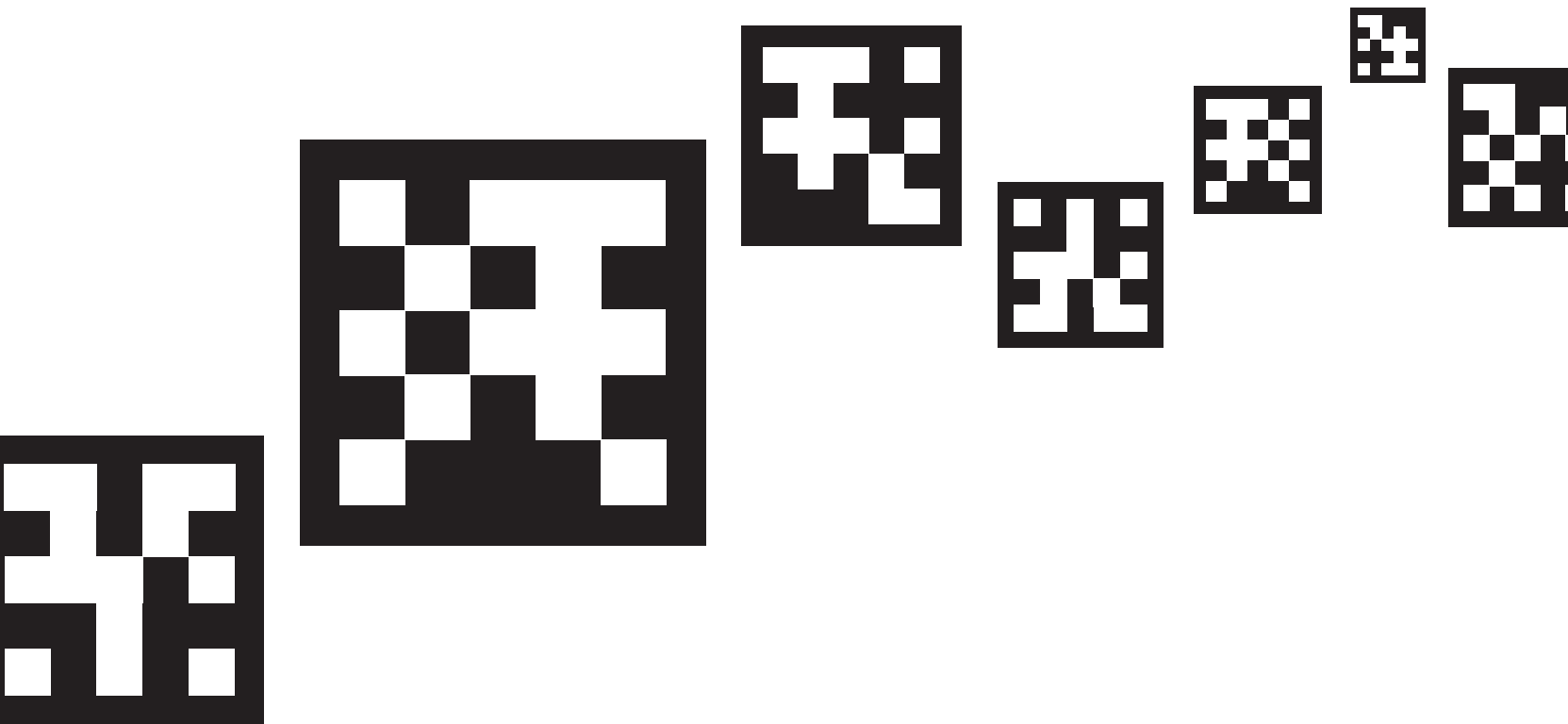
"Until now, finding anomalies that occur in recorded film material has required time-consuming viewing because an location is scanned only every few hours," says VLS Engineering CEO Udo Rieger. All that can now be retrieved with a few clicks when the bulk or single item number is entered. Then, the

computer delivers precisely the image sequences sought. "Another good thing about this is that we can retrofit existing camera systems quite easily since the visualization requirements are no greater," he can tell his clients. Moreover, costs can be cut significantly. Conventional tracking systems require installing and wiring receivers everywhere in a factory, amounting to around € 80,000 Euro in an average warehouse of approximately 10,000 square meters. "Naturally, the software also has to be maintained but this is a significant cost advantage over transponders," affirms Udo Rieger. MarLO tracking systems deliver other advantages as well. On the one hand, wireless signals no longer experience interference, caused primarily by metal structures. Like dust or climatic



» You can certainly view it as a small technical revolution in our sector. «

Udo Rieger, CEO of VLS Engineering GmbH



conditions, they can cause malfunctions or interference. Constructing such a stable, interference-free wireless system among, for instance, forklifts and receivers in metal works with numerous sources of reflection and interference, which drive complexity up, is challenging. The same applies when metal storage cages are stacked. Cranes in some outdoor facilities such as port facilities can make it difficult or impossible to put up additional towers for transmitters and receivers. Since it only requires vision and lighting, which is normally on hand, the MarLO system

has a clear advantage for tracking shipments because it solely relies on visual tracking of markers on forklift roofs.

To date, MarLO is also the only system that provides a security function. Since the system not only reactively tracks movements but also transmits a signal to drivers when they deviate from specified routes, rare errors during movement are already detected when they occur and prevented by a corresponding warning. Saved data still have to be used to locate a box stored incorrectly. MarLO will make this unnecessary.

The first and thoroughly successful large-scale trial at the facilities of a client from the automotive industry lasted six months. "We will now be launching MarLO in the market. Experts at the last BVL conference were very, very interested," says Udo Rieger, pleased.



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Inspections in Times of **Industrie 4.0**

Janine von Ackeren

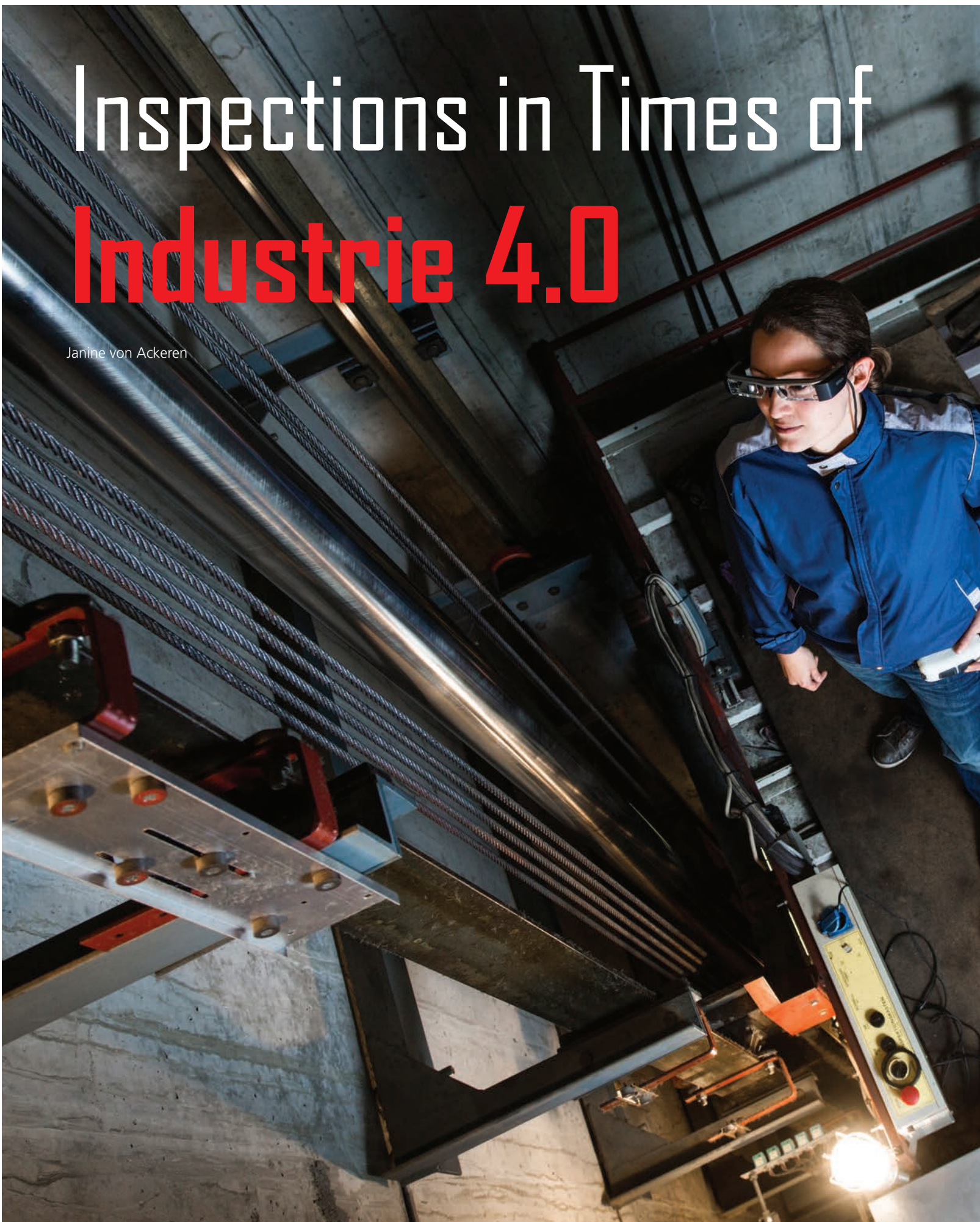




Photo: Fraunhofer IFF

Industrie 4.0 is intended to interconnect manufacturing systems with each other and the Internet, making manufacturing more flexible. These changes also affect traditional testing and certification. Researchers studied uses of digital technologies for inspections in a pilot project with TÜV NORD.

Day to day work of elevator inspectors from TÜV NORD is really something: With a laptop in hand, they climb into elevator shafts where they set up their test systems and then squeeze into a tight control room. They usually have their laptops in their hands during testing there, too. There is rarely a table or other spot to set the device down and the cords are usually not long enough to put the laptops on the floor. In addition to performing these tests, the experts inspect elevators visually. Is wear visible anywhere? Inspectors document their findings, without photos, though. Since organizing workers' routines as simply as possible is essential, they should not have to carry a camera with them in addition to their laptops and test systems in cases.

TÜV NORD staff face challenges when performing other inspections, e.g. in industrial facilities. Industrie 4.0 is making manufacturing facilities and equipment smart, connecting them with each other and the Internet, and enabling them to perceive their environment by sensors. In short, systems are growing significantly more complex and so are the jobs awaiting inspectors.

Head-Mounted Displays

How can these and other inspection jobs be made easier for the specialists? How well do head-mounted systems function in industrial inspection and certification environments? Researchers from the Fraunhofer IFF studied this in a pilot project together with developers from TÜV NORD and developed a por-

Tight, dark and loud: Elevator inspectors workplaces are not always the most comfortable. Routine inspections of elevators are essential, though. That is why researchers from the Fraunhofer IFF are working together with TÜV NORD on making inspections of elevator and other technical systems easier with digital technology.

table inspection system. Elevator inspection served as the example. First, the usability of different head-mounted displays or HMDs was tested. Such displays are more or less a kind of laptop worn like goggles. What the user sees depends on the kind of goggles: Wearers of semi-transparent goggles see their environment as well as contents overlaid direct in their field of view. This may be information on the elevators being inspected or on the individual steps of the inspection procedure, which would otherwise be displayed for inspectors on their laptops.

have significant advantages: Instead of having to carry bulky laptop back and forth, wearers have their hands free and are thus

able to climb elevator shafts better. Most HMDs also have an integrated camera. Inspectors can be document any defects discovered in elevators with photos and respond to client questions better later. Head-mounted displays also have disadvantages, though: Whereas laptops accept entries from a mouse or touchpad, HMDs employ either a plug-in control element or cell phone or buttons on the HMD itself have to be activated. Since such buttons are very small, this entails a lot of hunting. This can quickly become inconvenient when a lot of entries have to be made, especially when also wearing work glove that diminish finger sensitivity. Another drawback is that HMDs slip easily. The buttons on the goggle frame are a suitable input system only

when interaction is minimized. This is not the case during elevator inspection. Other control element such as cell phones are not optimized for industrial use and are just as difficult to operate on the side and with gloves.

Different Input Systems

This is why the developers from the Fraunhofer IFF and TÜV NORD sought alternative input systems for HMDs. How suitable are gesture recognition or voice command, for instance, for routine inspections? The answer: not very. Preliminary tests revealed that image artifacts in gesture recognition cause numerous false entries and the changing light conditions in elevator shafts also im-



Photo: Fraunhofer IFF

Inspections of technical systems such as elevators will be easier and more ergonomic in the future. Head-mounted displays will overlay test report data for inspectors situationally. Individual work steps or reports of defects are acknowledged by a newly developed programmable control element.

»» We are using the knowledge obtained from the pilot project to be prepared for the demands of digital elevator inspection and to make our specialists' inspection routines easier. ««

TÜV NORD

pede entries. Voice command was not robust enough, either. Reverberations and loud ambient noises caused interference. A throat microphone did not have the desired effect, either. The project team therefore developed an entirely new input system of a wireless programmable control element worn on inspectors' belts. Its two control buttons and its scroll wheel are designed for use even with gloves. The click is also perceptible, thus letting inspectors know that their input was successful.

How Suitable Are the Systems for Everyday Use?

In several tests on site, the researchers tested the performance of the developed control element and different goggle models in use. Are inspectors able to work with the system? Or do problems with the goggles or software arise that do not improve inspection as hoped? The results indicate that the portable inspection system's software holds great potential. TÜV staffers worked well with the control element, too. Users were especially pleased by the reduced weight of the goggles. There was one "but", though, and a very big one at that: The goggles are not very comfortable to wear. Since their weight

has been minimized, their weight is centered poorly, often directly on or to the side of the nose. The goggles slip easily forward or sideways. Bending forward becomes a feat, at least when wearers try to keep the goggles on their nose. In other words, HMDs can only be recommended to a limited extent for elevator inspections entailing some climbing.

Inspectors were impressed with the portable inspection system itself, on the other hand. The researchers are modifying it in another step so that it functions without the sliding goggles. They are relying on smartphones instead. Since inspectors have to hold them in their hands, they do not have both hands free all the time. Unlike a laptop, they can put such a small device in their pants or jacket pocket when climbing, though, thus keeping it safe and only using it when it is needed. The system should be ready for use, even with smartphones, by mid-2016. "The excellent collaboration with the Fraunhofer IFF enabled us to adapt the HMD technology very quickly and evaluate it under real conditions. We are using the knowledge obtained

from the pilot project to be prepared for the demands of digital elevator inspection and to make our specialists' inspection routines easier," states TÜV NORD.

HMDs could be thoroughly practical for other inspection jobs, however. The establishment of head-mounted displays in numerous jobs can be expected, especially in the wake of Industrie 4.0. Their suitability for industrial use is always contingent on the field of activity, though. The pilot project clarified much. TÜV NORD is now very able to identify industrial applications for which HMDs can be used.



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Emergency Call Boxes

Will Be Lifesavers in the Future, Too

Manfred Schulze





Recently while on a business trip, Tobias Kutzler read an unsettling message on his car's display: "Attention! Wrong-way driver on A 9 between exits" He had long since passed the danger zone. The wrong-way driver was either a false alarm or had already exited the stretch of road. "Unfortunately, the timing of information is very inexact, as notifications of accident and traffic jams repeatedly demonstrate," notes the computer scientist with annoyance.

There are already numerous options for transmitting such important, in extreme cases, even vital information practically to motorists without delay. Vehicles only have to be better connected with each other or with a roadside communications infrastructure. "That will be possible soon," says Tobias Kutzler with certainty. His confidence is well founded. The computer scientist at the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg is working on a solution himself. Together with several partners from industry and academia, he has been involved in a project for two years, which is intended to improve traffic management and information.

The automotive industry has been working for several years on interconnecting vehicles and infrastructure so that information exchanged between vehicles, usable in a vehicle to generate a unified view of the vehicle's surroundings or notifications of hazards, construction or congestion, will be communicated from vehicle to vehicle practically in real time, rather than rather than circuitously by radio stations and the police. The project ANIKA I, funded by the states of Lower Saxony and Saxony-Anhalt and the EU, is building upon technical developments of mobile vehicle communication and aims to significantly improve and facilitate this communications specification. This will be done by using an existing infrastructure – emergency call boxes located on every highway will be upgraded with wireless modules and for new and advanced communications technology.

What sounds somewhat futuristic at first, is already available in many individual com-

ponents. Tobias Kutzler notes the new data transmission technologies, which are known as Car2Car or Car2Infrastructure communication and will be installed in cars in the future. Wireless systems are primarily used, which are similar to WLAN but capable of establishing significantly faster connections and operating more efficiently. Such wireless systems have technical limits, though. "WLAN range is not very large, hardly more than 250 to 300 meters even with directional antennas if power consumption is not supposed to be too high," say the Fraunhofer expert. Despite the rapid transmission standards common today, the wireless systems used in many systems to transmit traffic information do not provide unlimited possibilities, either. "As soon as traffic becomes congested on the autobahn, so many users are logged into the local cell towers and transmitting data that the transmission rates drop very low since all users have to share the available bandwidth," explains Kutzler.

This is where the "ITS automotive nord" transportation research cluster in Braunschweig comes into play. A few years ago, it had the idea of using the infrastructure of the existing emergency call box network on autobahns to supplement other infrastructure components for such network traffic. ITS automotive nord just like the Fraunhofer Institute in Magdeburg belongs to a consortium of companies and research organizations, which has been involved in evaluating the approach to upgrading emergency call boxes since 2013. The orange boxes, which used to be the sole means to summon help when on had a breakdown, have been in danger of becoming obsolete since a cell phone is usually on board vehicles. Some 16,000 boxes operated by the association of German car insurers are still operational on autobahns. They are reported to still to be used around 70,000 times a year.

The boxes have power and data lines. This ultimately served as the basis for launching the

Smart emergency call box upgrades: In the ANIKA project, the existing infrastructure of emergency call boxes on German autobahns will be linked with communications technology, thus contributing to smart, digital traffic management.

» The project partners used technical analyses and we used simulations to test whether the idea with emergency call boxes is actually practicable. Naturally, we eventually hit a performance limit on heavily traveled sections of autobahns with six lanes or more. But the system based on emergency call boxes delivers substantial value added. «

Tobias Kutzler, Fraunhofer IFF

ANIKa project in which nearly a half a dozen companies such as OECON Products and Services, Nordsys GmbH, ifak system GmbH, Tonfunk Systementwicklung and Service GmbH as well as research organizations such as Otto von Guericke University Magdeburg's Galileo Test Bed and the Fraunhofer IFF are collaborating with ITS automotive nord.

Apart from fitting software solutions for vehicle communication and a transceiver module being upgraded for emergency call boxes, the feasibility of implementing the systems approach to actually be able to use the existing infrastructure first had to be verified with simulations, among other things, under existing parameters, e.g. box spacing, transmitter range and power requirements. "The project partners used technical analyses and we used simulations to test whether the idea with the emergency call boxes is practicable, how the available cables and power lines can be used,

and what data capacities would be available with the wireless modules," reports the researcher. Boxes are located every one to two kilometers on the shoulders of both sides of the autobahn, usually at emergency pull-off bays or autobahn exits and entrances. Normally, one distribution station serves at least ten but usually more boxes. The transmitters' power requirement adds up to substantial wattages. In addition, cables are many kilometers in length and lose substantial power. Moving traffic also causes reflections and interference. Since entire convoys of trucks are frequently in transit in the right lane in particular, the boxes on both sides of the autobahn have to be integrated in the system. "Otherwise, continuous or maximum wireless coverage would hardly be attainable," explains Tobias Kutzler.

Transmitter modules that only require a few watts of power are ultimately supposed to

be developed in another project. Integration of a small battery or solar power has also been studied. This might be necessary in the event too many boxes are connected to a single power line. "Naturally, we eventually hit a performance limit on heavily traveled sections of autobahns with six lanes or more but the system based on emergency call boxes delivers substantial value added. Since only very few vehicles with advanced Car2Car technology are on the road in these early stages and thus only very few vehicles information can communicate with each other, the upgrade modules on emergency call boxes in particular will transmit traffic and safety information," the researcher affirms.

The Car2Car communications technology, which will be installed in vehicles in growing numbers in the future, and the communications modules planned for the emergency call boxes have a maximum range of 300 meters.

How can emergency call boxes be used for vehicle-to-infrastructure (V2I) communication? The ANIKA project team is testing whether data aggregated from vehicles can be relayed to a control center. If, for instance, a traffic jam is detected or a wrong-way driver is on the road, emergency call boxes can transmit warnings to control center, traffic broadcasters, the police and an following vehicles.

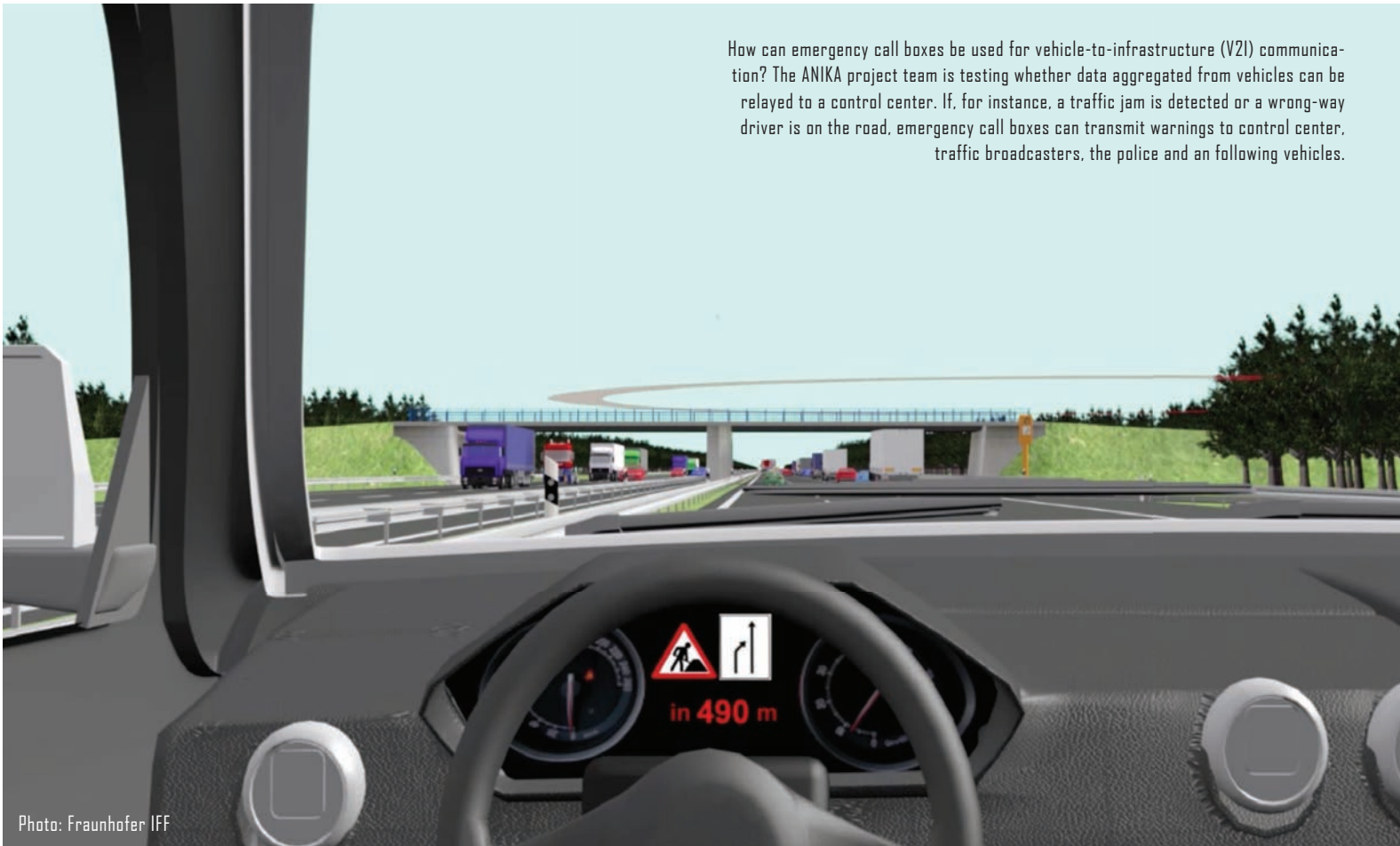


Photo: Fraunhofer IFF

That is less than the distance between boxes. Since cells at emergency call boxes are logged into and information relayed among vehicles in less than one second, brief stretches without reception and interruptions are tolerable. Boxes interconnected with data cable transmit all messages generated by vehicles or traffic management control centers to other emergency call boxes so that information gets where it is needed fast – in vehicles that may be approaching a hazardous situation. In the case of the aforementioned wrong-way driver, a warning could be displayed in every endangered vehicle including the one going the wrong way on the autobahn within seconds. The vehicle would not be stopped automatically, though, although that might be technically possible in the future. Such intervention is not legal at this time. That could change, though, at the latest with autonomous vehicles, which are no longer that far off.

The researchers have already demonstrated the gain in safety from the selected approach with emergency call boxes bringen with the first driving tests on a test track of Otto von Guericke University and the Fraunhofer IFF's Galileo Test Bed. A hazard triangle and a brief message blink on the vehicle display in enough time before a construction site simulated with cones to reduce lanes. This is exactly how a warning functions before a traffic jam behind a mountaintop or a broken down vehicle in a curve. Notification of the safely simulated wrong-way vehicle is also transmitted before it appears.

Next other sections will be equipped with the first system prototypes for testing. This will deliver results from continuous tests for the first time,



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Detecting Skin Cancer Quickly

Anna Mahler

Melanoma is aggressive and life-threatening. If it is not detected early, the prospects of recovery diminish. Screening is complicated, though. Together with several project partners, Fraunhofer researchers have developed an assistance system that helps dermatologists with diagnosis.



researcher Dr. Christian Teutsch and dermatologist Dr. Daniela Göppner performing a test with the dermatological scanner. The prototype is being used at Magdeburg University Hospital and will assist doctors with screening in the future.

Photo: Fraunhofer IFF

» The new fully body, early skin cancer detection system makes an approximately standard evaluation of skin condition and changes possible for the first time. «

Prof. Harald Gollnick, Director of the University Clinic for Dermatology and Venerology, Magdeburg

According to the German Cancer Society, around 200,000 people contract skin cancer every year. Melanoma is particularly dangerous. Once it has penetrated deeper layers of skin, the prospects of recovery drop to less than ten percent. Routine screening is the only way to detect critical skin changes at an early stage. A doctor uses a dermatoscope – a magnifier that peers into deeper layers of skin – to examine abnormal moles, called melanocytic nevus by experts, for features such as size, texture and edges and to observe whether they change over time. Since most people have many moles, the procedure is time consuming. What is more, keeping an eye on changes such as the growth of individual moles is difficult since a doctor is often unable to identify them with absolute certainty during a follow-up exam.

Fully Body Scanner Helps Diagnose Skin Conditions

At the initiative of and together with the University Clinic for Dermatology and Venerology in Magdeburg as well as the partners Dornheim Medical Images GmbH and Hasomed GmbH, researchers at the Fraunhofer Institute for Factory Operation and Automation IFF have developed a full body dermatological scanner intended to help doctors diagnose skin conditions in the future. "The scanner delivers standard data for the evaluation of skin. At the same time, it improves documentation of the development every single conspicuous mole," says Dr. Christian Teutsch from the Fraunhofer IFF. When the exam starts, the surface of the patient's skin is scanned from different positions and broken down into approximately one hundred individual scans. Such image documentation already exists. "The crucial point, however, is that the actual size and changes in

growth cannot be clearly discerned solely on the bases of scans," explains Teutsch. That is why the Dermascanner generates additional scanned 3D data, which are fused with the 2D scans, thus assigning a scale to every single pixel in the image. The experts are integrating several 3D sensors in the scanner so that this functions. The sensors and cameras are calibrated so that their location in space is known precisely. The beams of light from the camera striking the mole can be assigned a precise 3D distance. Even when different scans have not been taken from the exact same distance – which is hardly likely – the doctor can apply the scale to determine the actual proportions precisely. The scanned data and scans are fed into analysis software and analyzed and presorted by automatic classification. The software compares any existing earlier scans of development with current images. "Our technology detects growth upwards of half a millimeter," states Teutsch. Another advantage is that the scanned 3D data enables a doctor to clearly locate every single mole again.

"Frequently, a single patient has several hundred moles," says Prof. Harald Gollnick, Director of the University Clinic for Dermatology and Venerology. When such a high risk patient visits the doctor again after a while, common methods of examination cannot discern whether the location and size moles on skin covered with pigmentation spots are still identical. According to Gollnick, "The new fully body, early skin cancer detection system makes an approximately standard evaluation of skin condition and changes possible for the first time."

"The diagnosis itself is and remains in the view of the doctor," stresses Teutsch. Doctors have both the scan results

with an additional 3D depth map, which records the distance of the individual pixels in the scan, at their disposal to make a diagnosis. Since minimal changes of an abnormal mole can already be significant, the scanned and image data have to be comparable at any time and also among different equipment. That is why another important aspect of development was the standardization of the Dermascanner – another of the Fraunhofer IFF's specializations. "We calibrate every relevant element such as light sources and convert the scans into a standard color space," explains Teutsch. This assures that effects such as fading luminosity over time do not affect the results.

The Dermascanner is just about ready to be marketed. The first pilot systems have been built. What is more, the project team was recently awarded the 2014 Hugo Junkers Award for Research and Innovation in Saxony-Anhalt for its development by the Ministry of Higher Education, Research and Economic Affairs (www.hugo-junkers-preis.de). Now, investors have to be found in order to mass produce the skin scanner.



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Reliability is a major issue for logistics companies. Smart identification and tracking systems are one means to make supply chain processes even more reliable and more efficient. Wind turbine manufacturer Enercon, for instance, relies on a digital inventory management system with GPS and RFID identification, which was developed by the Fraunhofer IFF. Inventory of large parts in the giant outdoor storage facility runs continuously in the background and all of the data are current and can be retrieved in real time.





Robots as humans' assistants and safe collaboration and interaction between humans and robots without protective barriers are major issues of current robotics research. Erik Schulenburg (l.) is demonstrating Strobas, a stationary robot assistance system for the manufacture of casting dies. Strobas assists technicians when they handle heavy die casting dies. New technologies for safe human-robot collaboration make this possible. The ring-shaped input device continuously monitors whether a worker is gripping the ring with both hands. If the worker lets go, the robot stops automatically, thus precluding any risk of injury to the worker.



Research Needs a **Cosmopolitan Climate**



Teams of international researchers such as Hui Guo from China, Alexander Pelzer from Germany and Dr. Bartłomiej Arendarski from Poland, all in the Process and Plant Engineering Business Unit, work together at the Fraunhofer IFF.

The current debate about immigration and asylum is affecting society, occupying the media, and confronting government with challenges. Apart from the fact that an aging society also needs immigration, research has a special view of things since it is and always has been international. The Alliance of Science Organisations in Germany, to which the Fraunhofer-Gesellschaft also belongs, has issued a statement.

It reads, "Scientific knowledge does not observe national borders. Ideas from people of different cultures, religions and nationalities foster creativity and ultimately enrich us all.

Over 300,000 students now come from abroad. Over 56,000 foreign researchers sponsored by German research organiza-

tions are contributing their experience and ideas to research and teaching. Such high international attractiveness can only be sustained when researchers from all over the world and their families feel welcomed and supported everywhere in Germany. Research and government are already collaborating very effectively in this spirit.

The people working here are just as diverse as research. This should benefit the prosperity and security of us all. The organizations in the alliance strongly advocate for joining all forces so that Germany remains an open, tolerant and international center of research." (pm/akw) ■

Ceremony for the First **Dual Degree Graduates**

Anastasia Skvortsova and Egor Repyev, the first graduates of the dual degree programs in logistics, received their diplomas on September 18. Prof. Jens Strackeljan (OVGU) and Prof. Vjacheslav Prikhodko (MADI), the presidents of the two universities, personally presented the graduates their diplomas at MADI in Moscow.

Anastasia Skvortsova and Egor Repyev each now have one Russian and one German master's degree. The partnership between Otto von Guericke University Magdeburg (OVGU) and Moscow Automobile and Road Construction State Technical University (MADI) also established a dual degree program.

The dual degree program has been in effect since 2014, following the signing of the cooperation agreement during a Russian delegation's visit to Magdeburg in 2013. It stipulates that every enrollee in the program completes the first half of the program at his or her home university and the second half at his or her host university.

Anastasia Skvortsova and Egor Repyev are pleased with their master's degrees from two universities.



This enables students to become acquainted with the logistics sector in both countries directly and in the field. Likewise, they also cement their knowledge of a foreign language and culture, thus meeting global demand for interculturally and multilingually educated specialists. They can write their theses at both universities. To date, three students from MADI have attended OVGU and two students from OVGU have attended MADI. The Fraunhofer IFF, partner to both universities, is deeply involved in this exchange program

and has repeatedly been involved in research projects since 2004. This provides students a firm and valuable applied foundation during their training here as part of their dual degree program. Fraunhofer researchers additionally advise research seminar papers and master's theses. (ms/akw) ■

Best Master's Graduates in Logistics Recognized

Every year, the best students in logistics are recognized at the Bundesvereinigung Logistik's Central German Logistics Student Conference. Two graduates from Otto von Guericke University Magdeburg (OVGU) won over the jury with their master's theses in 2016.

Tom Assmann won in the category Logistics Systems with his thesis on "The Integration of Cargo Bicycles in Logistics Systems". He was a student assistant at the Fraunhofer IFF from April 2014 to February 2016 and is now working as a graduate assistant in the

Department of Logistics Systems at Otto von Guericke University Magdeburg.

Tobias Kubasch, winner in the category Energy and Resource Efficiency, also attended OVGU. "It's nice to see that two people from Magdeburg were able to prevail in a field of competitors from Berlin to Essen," stated Tom Assmann elatedly.

The award with a purse of € 1500 was awarded in three categories at the 7th Central German Logistics Student Conference on April 29, 2016. (dm) ■



Tom Assmann presenting his Master's thesis.

WLO Alumni e.V. Gathers Logistics Graduates in Magdeburg for the 10th Time

Over 140 graduates, students and instructors from the Logistics Engineering Management program at Otto von Guericke University gathered for their annual summer party on June 27, 2015. Bidding farewell to the year's graduates at has become tradition.

The event was held in the Galileo Test Bed for Localization, Navigation and Communication in Transportation and Logistics in the Port of Science – a fitting setting for future logisticians. Two graduates even made the extra trip from the USA where they now work.

Master's graduates are given either a tie or a scarf with a logistics theme as a memento. The bachelor students were delighted with the beer mugs bearing their names.

The Association of the Logistics Engineering Management Program or WLO Alumni e.V. for short, organizes the party together with the VDI suj, the BVL's student chapter, the Institute of Logistics and Material Handling Systems (ILM) at Otto von Guericke University Magdeburg (OVGU) and the Fraunhofer IFF in Magdeburg.

Everything began in 2005 when Tobias Regelin from the first year of WLO graduates founded the alumni association together with



Bachelor's graduates of the Logistics Engineering Management program being given a farewell at the 2015 summer party.

six fellow students. Nearly 100 WLO graduates are now active paying members of WLO Alumni e.V..

The Logistics Engineering Management program was started by Prof. Ziems at OVGU in

1997. Whereas only nine students enrolled in the first year, some 100 students now begin a degree in logistics at ILM at OVGU every year, making it possible to celebrate the 700th WLO graduate this year. (akw) ■

With Hometown Roots to His Doctorate

What impact will transportation policies, e.g. the use of LHV's or increase of tolls, have on freight transportation in the future? This question has occupied Fabian Behrendt in recent months, especially in his doctoral dissertation in which he developed a "Process Model for the Analysis of Multidimensional Impacts on Freight Transportation Systems". His doctoral advisers Prof. Michael Schenk, Prof. Béla Illés and Dr. Karl-Heinz Daehre, awarded him "summa cum laude" for it.

Transportation infrastructures have been accompanying Fabian Behrendt for a while. He works intensively on this subject in the Federal and State Commission "Future of Transportation Infrastructure Funding" of Dr. Daehre, former Saxony-Anhalt Minister of Transportation.

Fabian Behrendt was born in Magdeburg in 1985 and earned a degree in logistics engineering management at Otto von Guericke University Magdeburg. After a stint in To-

Emptying a half liter mug of beer is mandatory and the final step to a successful doctorate for Fabian Behrendt (3rd from left.) and is scrutinized just as attentively by his doctoral advisers Dr. Daehre, Prof. Schenk and Prof. Illés.



ronto, Canada, he returned to Magdeburg to complete his doctorate. He has been working here at the Fraunhofer IFF since 2013 as manager of the head office of the Fraunhofer Group for Production in which eight institutes geared toward manufacturing engineering collaborate. In the head office, Fabian Behrendt coordinates joint research and development or organizes trade show appearances at which the range of the member institutes work and services is presented

There is a lot to do, but his new doctoral degree was still celebrated, of course. The tra-

ditional doctoral initiation at the monument to Otto von Guericke in downtown Magdeburg is an absolute must. Colleagues, friends and doctoral advisers paid tribute to Fabian Behrendt with a lighthearted encomium and a mortarboard designed to match to his dissertation.

By the way, Fabian Behrendt is going to become a father for the second time soon. He willingly forgoes his hobbies such as bouldering or jogging for the joy his small family brings. (dm) ■



Prof. Gerhard Müller, Deputy Director of the Fraunhofer IFF in Magdeburg.

At the meeting of the VDI Executive Board on November 19, 2015, VDI President Udo Ungeheuer presented the VDI medal to Prof. Gerhard Müller for his years of unflagging

VDI Medal for Professor Gerhard Müller

service to the advancement of the engineering sciences.

Gerhard Müller attended Otto von Guericke Technical College in Magdeburg where he earned his Diplom degree in engineering and then joined its Department of Factory Automation and Operation as a teaching assistant and senior engineer, earning his doctorate in engineering in 1986. He switched to the Fraunhofer IFF in Magdeburg in 1992 and advanced through a variety of management positions to become Deputy Director. A particular focus of his professional and volunteer work has always been the development of young professionals.

Gerhard Müller is an unflagging promoter of the engineering sciences in Saxony-Anhalt and enjoys a reputation outside the state as an outstanding researcher and networker. The Fraunhofer IFF in Saxony-Anhalt owes its excellent reputation in cutting-edge manufacturing, supply chains and power engineer-

ing to his vision of applied and sustainable research and his intense promotion of collaboration between research and industry.

He was particularly dedicated to and publicly advocated for introducing young people to engineering and supported technical education. An initiator of numerous partnerships with schools, a facilitator of VDI partner schools in Saxony-Anhalt and a mentor to young engineers, he, along with the applied research institute of the Fraunhofer IFF in Saxony-Anhalt, offers long-term career prospects.

Gerhard Müller has been supporting the Association of German Engineers VDI locally in its Saxony-Anhalt Chapter as well as technically and scientifically as a member of the executive and advisory boards of the VDI Production and Logistics Society and as a member and the vice chair of numerous technical committees since 1997. (pm) ■

Dr. Elkmann Is Teaching Robotics



Dr. Norbert Elkmann and Prof. Frank Urtmeier, School of Computer Science at Otto von Guericke University Magdeburg.

Dr. Norbert Elkmann, Manager of the Robotic Systems Business Unit at the Fraunhofer IFF, is a new supernumerary professor in the School of Computer Science at Otto von Guericke University Magdeburg (OVGU). He devoted his inaugural lecture on November 4, 2015 to the topic of "Assistive Robots Transitioning to Become Humans' Helpers: Current Challenges and Fields of Research". Dr. Elkmann will now be teaching assistive robotics, focusing on safe human-robot collaboration, intuitive interaction, mobile robots and mobile manipulation. (akw) ■



University President Jens Strackeljan presented Dr. Norbert Elkmann with his certificate of appointment. Pictured on the right is Prof. Andreas Nürnberger, Head of the Data and Knowledge Engineering Group at the School of Computer Science at OVGU.

Cross of Merit for Prof. Michael Schenk

Minister President Reiner Haseloff presented the Cross of Merit awarded by German President Joachim Gauck to Prof. Michael Schenk at the state chancellery on February 25, 2016 for his decades long career in research and academia.

This decoration recognizes his service as a professor and institute director fostering and advising young and future engineers and strengthening small and medium-sized businesses.

Prof. Michael Schenk has worked outstandingly and above and beyond his position as a professor at Otto von Guericke University Magdeburg and as Director of the first Fraunhofer Institute based in the state of Saxony-Anhalt to build an innovative and future-viable society in the new states and the Federal Republic of Germany. He has demonstrated his vision of corporate innovation in a number of social activities and in numerous positions on advisory boards. He has been a driving force personally engaging in and advancing dialog and close collaboration between business and research. (pm) ■



Prof. Michael Schenk received the Cross of Merit for his career in research and academia. It was presented to him by Minister President of the State of Saxony-Anhalt Reiner Haseloff.

Upcoming Events

Meet up with researchers from the Fraunhofer Institute for Factory Operation and Automation IFF at these events.

January 26 – 28, 2016

LEARNTEC, Hannover

March 9 – 10, 2016

Manufacturing Colloquium: SME 4.0: Smart Manufacturing Technology for Small and Medium-Sized Enterprises, Magdeburg

March 14 – 18, 2016

CeBIT, Hannover

April 6, 2016

Resource Wood, Hundisburg

April 25 – 29, 2016

Hannover Messe, Hannover

May 21, 2016

Long Night of Science, Magdeburg

May 31 – June 3, 2016

CeMAT, Hannover

June 1 – 2, 2016

VDI/DEh Maintenance Forum, Aachen

June 21 – 24, 2016

19th IFF Science Days, Magdeburg

June 21, 2016

Cooperation in Plant Design Industry Working Group, Magdeburg

June 22 – 23, 2016

Plant Design of the Future Conference, Magdeburg

June 22 – 23, 2016

Magdeburg Logistics Days: Rethinking and Reorganizing Supply Chains, Magdeburg

June 21 – 24, 2016

Automatica, Munich

June 23 – 24, 2016

Innertext, Chemnitz

September 20 – 23, 2016

InnoTrans, Berlin

October 18 – 20, 2016

International Suppliers Fair, Wolfsburg

October 19 – 21, 2016

BVL International Supply Chain Conference, Berlin

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IN MEMORIAM

The Fraunhofer Institute for Factory Operation and Automation IFF mourns the passing of its former director and founding father Prof. Eberhard Gottschalk.

We have lost a highly esteemed individual who was closely associated with our institute for years. We are grateful to him for his invaluable service. We will always honor his memory.

We extend our condolences to his family.

The Staff and Management of the Fraunhofer IFF



19TH IFF SCIENCE DAYS

JUNE 21 – 24, 2016

 **Fraunhofer**
IFF

How is digital engineering paving the way for plant design 4.0? How are digital construction sites organizing the complex work at major construction sites more reliably? And what technologies and methods do smart supply chains need? Talk with experts from industry and research about applied solutions and current research projects at the plant design and supply chain conferences at the 19th IFF Science Days.

www.iff.fraunhofer.de