

Fraunhofer IGP

Fraunhofer Institute for Large Structures in Production Engineering IGP

Annual report 2022

Welcome



Dear Readers,

This annual report looks back on an eventful year in 2022. One of the year's highlights was marking Fraunhofer's 30th anniversary in Mecklenburg-Vorpommern. We celebrated the occasion in style on June 1, 2022, with other Fraunhofer research units from our state and many other guests. The event showcased the sheer variety of technical solutions that can be offered to customers, due in large measure to our work together here at the institute's location.

It also marked the launch of the "Biogenic Value Creation and Smart Farming" project. We are involved in this project together with the Fraunhofer IGD, IIS, EMFT and IVV. The goal is to adjust our technology portfolio to align with applications in agriculture, thereby implementing more sustainable and effective approaches that conserve resources in value chains in the agricultural sector.

The second major new topic is the development of the Anwendungszentrum Wasserstoff (Hydrogen Application Center) in Mecklenburg-Vorpommern (MV) in tandem with the Leibniz Institute for Catalysis (LIKAT) and the Leibniz Institute for Plasma Science and Technology (INP), both in MV, and with the University of Rostock. This initiative is geared towards sustainability, in this case with a focus on low- and zero-emission maritime transportation and the challenges this poses for drive technology, retrofitting, and logistics. The center made its debut in September, at the 7th Rostock Large Engine Symposium. Our researchers will work at a testing unit for large engines at the Rostock shipyard location, a core element of the Hydrogen Application Center. They will further develop and refine energy converters for the sustainable use of green energy sources and devise solutions for integrating them into existing and newly constructed ships, among other projects. Through these activities, the Fraunhofer institute aims to support the green transformation of the maritime industry in particular.

IGP added staff again in 2022. Now that several institute branches have moved to the new building section, which offers additional space and technical capacity, not only is there more room for our employees, but our Demonstration Center 4.0 also allows us to showcase our solutions more transparently and "up close and personal" for customers.

Best regards,



Prof. Wilko Flügge
Head of Fraunhofer IGP

Contents

The Fraunhofer Institute for Large Structures in Production Technology 6
Introducing the Fraunhofer IGP management 6
Overview of the institute 8
Organisational chart 9
Demonstration Center 4.0 wird deticated 10
Selected acquisitions 16

Research for the real world 26
New materials and processes for offshore wind turbines 28
Green solutions for the maritime industry 32
New smart farming projects launched at Fraunhofer IGP 36
Retrofitting for smart ship engines 40

Annual review, 2022 44
30 years of Fraunhofer in Mecklenburg-Western Pomerania 46
Fraunhofer-IGP-Prize 2022 50
Seat#12: Balancing science and art 52
Events and trade show attendance 54
Social Media 56

Career 58
Join us! 58
Vocational training at Fraunhofer IGP: Exciting new questions each and every day . . . 60

Project overview, 2022 62

Service 67
Associations, alliances and committee work 67
Publications 2022 69
Contacts 74
Publishing notes 75

Introducing the Fraunhofer IGP management

We are delighted that Fraunhofer IGP continues to grow. To deal more effectively with the challenges that this growth has brought, institute director Prof. Wilko Flügge has had a highly capable management team by his side since 2020.
Aside from the director himself, the team consists of Prof. Knuth-Michael Henkel (Deputy Institute Director and Head of Department "Production Technology"), Prof. Jan Sender (Head of Department "Production Systems and Logistics"), Dr. Michael Irmer (Head of Department "New Materials and Processes"), and Lisa Knaack in the role of Head of Administration.

The five members of the management team specialize in different areas, so they bring diverse perspectives to their leadership roles. One thing they all have in common is their drive to further establish the institute and advance its interests in this professional and economic setting. Each and every one of them also contributes their personal motivation in the process:



Dr. Wilko Flügge
Institute Director

"Industrial customers are constantly coming to our institute with new challenges that we can respond to with tools from our research. This lets us combine scientific freedom with the certain knowledge that what we work on is in fact needed. Working together as part of a highly engaged and committed team is also really motivational."



Prof. Knuth-Michael Henkel
Deputy Institute Director and Head of Department "Production Technology"

"Through the innovations stemming from our practical research, we can contribute directly to keeping Germany competitive as a production location."



From left: Prof. Jan Sender, Lisa Knaack, Prof. Wilko Flügge (institute director), Prof. Knuth-Michael Henkel, Dr. Michael Irmer

Prof. Jan Sender
Head of Department "Production Systems and Logistics")

"Our goal is to work with our industry partners to develop and apply innovative solutions for the production of the future."





Dr. Michael Irmer
Head of Department "New Materials and Processes"

"In-depth expertise, right up to the doctoral study level, as we work on technically challenging projects with wider social impact revolving around the energy transition and ship building — that's what drives us to develop new materials and processes."

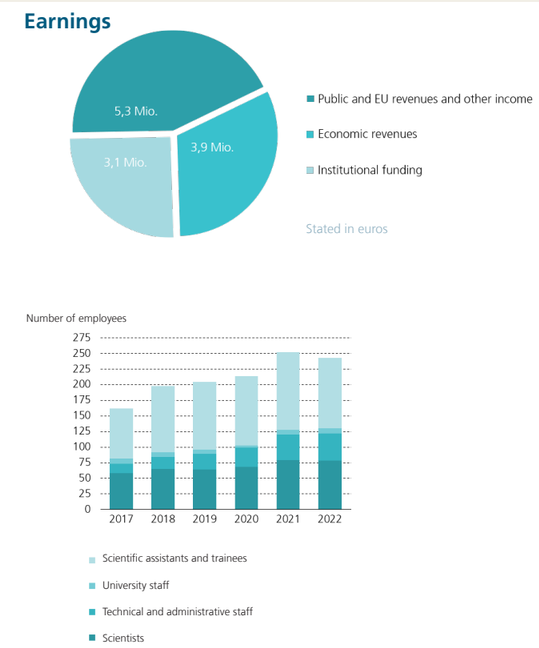
Lisa Knaack
Head of Administration

"I get fresh motivation each day from the exciting and varied tasks that come up across a wide range of thematic areas, working with many different people, and the challenges, too, since I always learn something from them."



Overview of the institute

Facts and figures

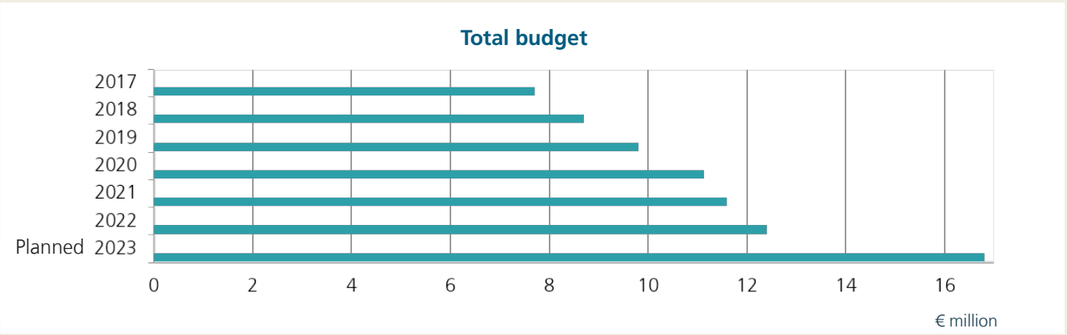


Earnings

The earnings for 2022 amount to a total of 12.3 million euros. The planned targets were achieved again in 2022, with industrial revenue of 35.4 percent. The Rostock Fraunhofer institute again achieved a balanced budget in 2022 with a positive carryover. The budget as a whole is continuing to grow steadily.

Employee figures

Fraunhofer IGP has 244 employees in all in 2022. The majority of our scientists have a degree in engineering or industrial engineering or a master of science. This year, there are 114 research assistants supporting the work of the Fraunhofer staff. In addition, as in the previous year, three trainees supported the team.
In cooperation with the chairs of production technology and joining technology, eight university employees work closely with Fraunhofer IGP in research and teaching.



Organizational chart

Last updated: November 2023

Institute Director Prof. Wilko Flügge	**Deputy Director** Prof. Knuth-Michael Henkel	**Assistants to the Institute Director** Sabine Wegener Virginie Rogge	**Head of Administration** Lisa Knaack
Production technology Prof. Knuth-Michael Henkel	**New materials and methods** Dr. Michael Irmer	**Production systems and logistics** Prof. Jan Sender	**Supporting departments**
Forming joining and shaping Pascal Froitzheim	**Adhesive technology** Linda Fröck	**Production planning and control** Dr. Konrad Jagusch	**Education**
Mechanical connection technology Dr. Maik Dörre	**Fiber composite technology** Dr. Stefan Schmidt	**Industrial robotics** Konstantin von Haugwitz	**Public relations**
Thermal joining technology Dr. Andreas Gericke	**Coating, weathering and corrosion protection** Valeska Cherewko	**Automation technology** Steffen Dryba	**Quality management**
Alternative propulsion systems Dr. Björn Henke		**Measurement of large structures** Dr. Michael Geist	
H2 research fab Dr. Benjamin Illgen		**Factory and work organization** Florian Beuss	

IT services	
Technical services	
Test laboratory	
Testing, monitoring, and certification body according to LBO	

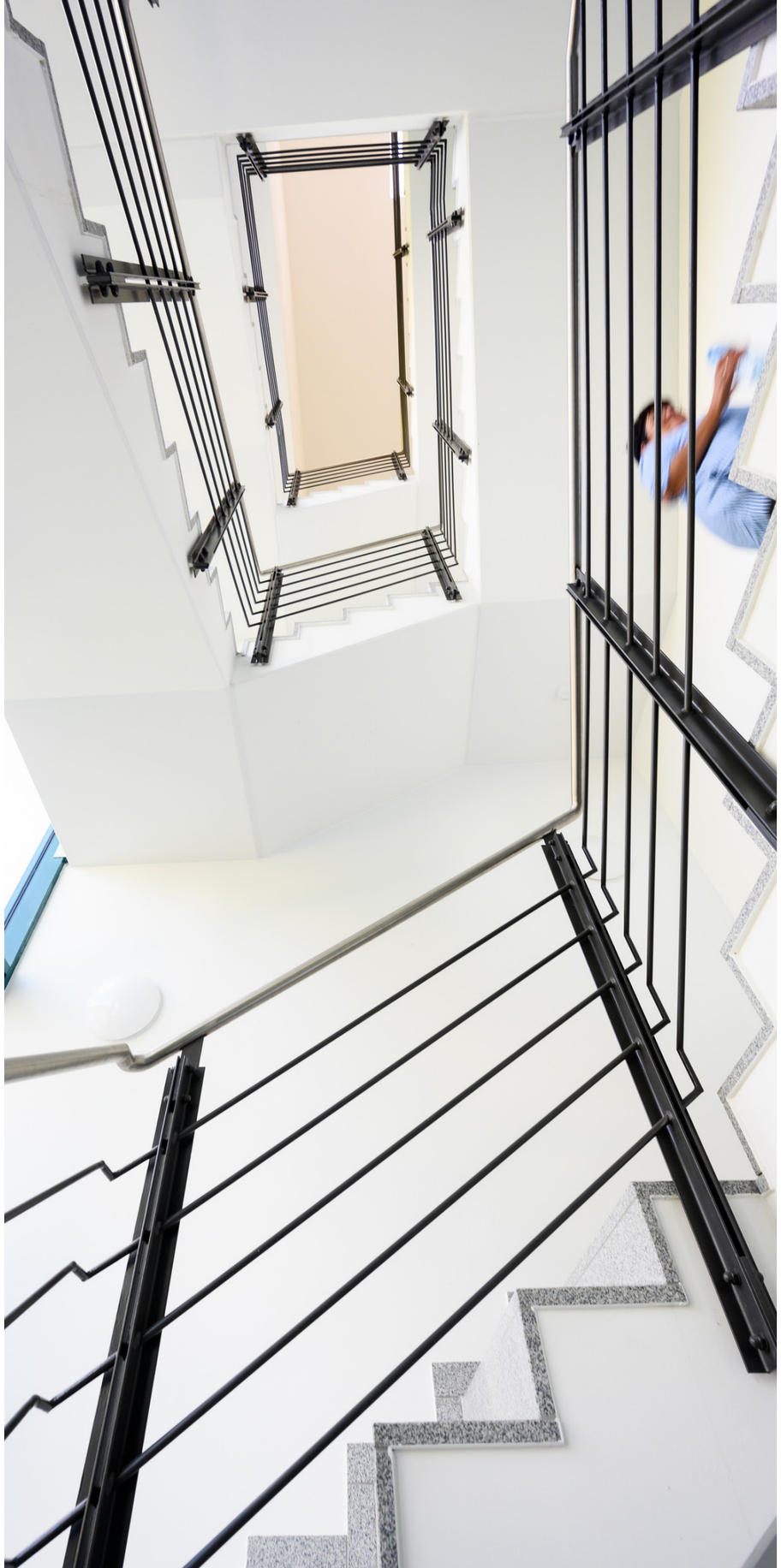
Demonstration Center 4.0 dedicated

Fraunhofer IGP reached two big milestones in the past two years: We officially became the first Fraunhofer institute headquartered in Mecklenburg-Western Pomerania on January 1, 2020, and in the summer of 2021, our scientists moved into the fourth building section, the Industry 4.0 demonstration center. The official celebration of the institute's founding had to be postponed due to the coronavirus pandemic, something we plan to make up for in 2023 with the dedication ceremony for the new building.

The number of employees at Fraunhofer IGP has risen steadily since 2017. The fourth phase of construction, completed in 2021, added much-needed space to the Fraunhofer IGP complex. The new building has a total of 1,915 m² of usable space and houses 23 offices, four labs, and a pilot plant. The pilot plant features a ten-meter crane height and 715 m² of space, which now makes it possible to do research on even larger construction parts and structures. Our researchers are also excited about the expanded lab capabilities. Additions include a new welding lab, which includes a high-performance coating system, along with a robotics lab and the Industry 4.0 lab. There are several conference rooms in the new building section, inviting the research sector and industry to come together to network and share knowledge in the future.

Growth at the IGP

In its role as an important research partner to industry in Mecklenburg-Western Pomerania and beyond, Fraunhofer IGP has further expanded on its cooperative relationships since 2020. "We have been a reliable and strong research partner to industry in Mecklenburg-Western Pomerania and beyond for years now. Going forward, we will continue to actively promote our expertise in the area of large structures," says institute director Prof. Wilko Flügge. The Industry 4.0 demonstration center at Fraunhofer IGP is a physical reflection of our institute's steady growth.



The stairway inside the new building complex

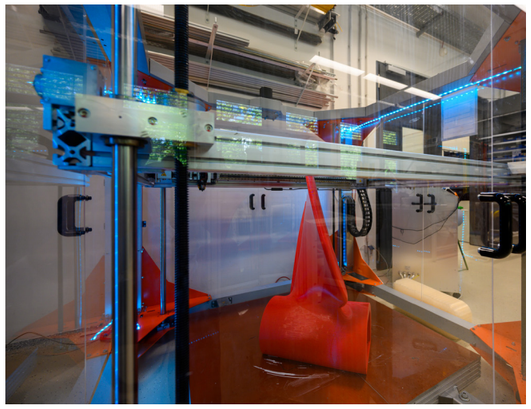


Exterior view of the back of the new building complex at Albert-Einstein-Strasse 30











New labs and an additional pilot plant offer a wealth of space for new research activities.



Demonstration Center 4.0 — exterior view of the new building complex





Solar array on the roof of Demonstration Center 4.0

Sustainability

Excellent building energy efficiency was a key focus during the first three phases of construction of our institute as well, and that remained the same during the fourth and most recent phase. A solar array was also installed on the roof of the new building with the capacity to generate up to 50 kW of electricity. It covers about 15% of the IGP's electricity needs.

IGP fourth construction phase — quick facts

Function:	Testing and production space, offices and seminar rooms
Builder:	Fraunhofer Gesellschaft e. V. Munich
Construction period:	2019–2021
Total usable space:	1,915 m²
Construction costs:	€10.7m gross

The 4th construction phase of Fraunhofer IGP was funded by:

EUROPÄISCHE UNION
Europäischer Fonds für Regionale Entwicklung

MV tut gut.

Planning and execution

Like the existing parts of our institute, the fourth building section, the Demonstration Center 4.0, was also designed and planned by architect Hans Joachim Tunnat and architecture firm Fehr Architekten GmbH. The new building was constructed over a three-year period (2019–2021), completing the building complex at Albert-Einstein-Strasse 30. Two meeting and conference rooms in the new building were named in memory of Tunnat, who died in 2021, before the building was completed.

The European Union provided 9.5 million euros (51.6%) of the funding for the fourth construction phase. The financing came from the European Regional Development Fund (ERDF). The state of Mecklenburg-Vorpommern contributed 4.46 million euros (24.2%). The German Federal Ministry of Education and Research (BMBF) provided 4.46 million euros (24.2%). In addition to the Fraunhofer-Gesellschaft, engineering and planning firm INROS LACKNER and the city of Rostock (construction supervision) monitored and supported the construction process.



The meeting room "Tunnat": plenty of space for professional dialogue and networking

Selected acquisitions

- Putting screw connections to the test
- Fraunhofer IGP testing lab dedicates new large-scale testing unit
- Versatile new high-performance coating center at Fraunhofer IGP
- From “digital shadow” to “digital twin”

Putting screw connections to the test

Screw connections are among the most common joining methods. They are also used to connect large and very large components and assemblies, such as those found in wind turbines.
The idea is always to connect two or more components in such a way that they behave like a single cohesive component when under strain. Screw connections have a clear advantage there: Compared to other methods of joining, such as welding, components that have been screwed together are relatively easy to take apart, for example if needed for repairs. The process is generally nondestructive. The possibility of joining components that have already received their final coatings on site is another economic advantage due to the high level of prefabrication involved.

As the requirements that apply to large structures become ever more strict, so do the requirements that screw connections need to meet. And with increasing strain involved, the screws are getting physically larger. Sizes up to M80 are found in large numbers in wind turbines and offshore structures, for example. Owing to the give in the components under tension and the influence of tools, operators and geometric factors, and above all due to variations in friction conditions in the threading and how the nuts are screwed on, there is a huge amount of spread in the relationship between the tightening torque applied and the pretensioning force involved. This means that the tightening torque cannot be converted precisely to the pretensioning of the screw during assembly.

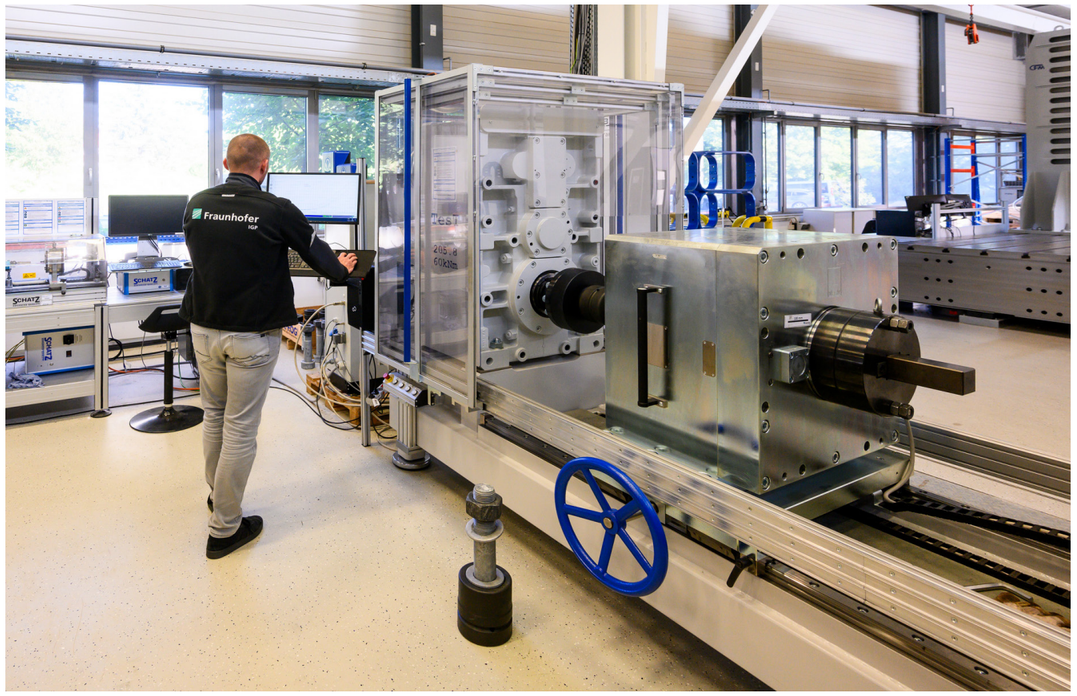
The tightening test unit helps to analyze this context and the factors involved individually for each use case up to a nominal diameter of M80. This facilitates tasks like conducting approval studies for new connection elements, testing methods and procedures for heads and unusual combinations of materials, and drafting individual tightening rules for specific screw cases, all to help ensure safe and secure assembly and installation.

The test unit is used for both customer-specific solutions as part of industry projects and various work packages in publicly funded research projects. It provides a working range up to tightening torque of 60,000 Nm, a feature found nowhere else in the world.

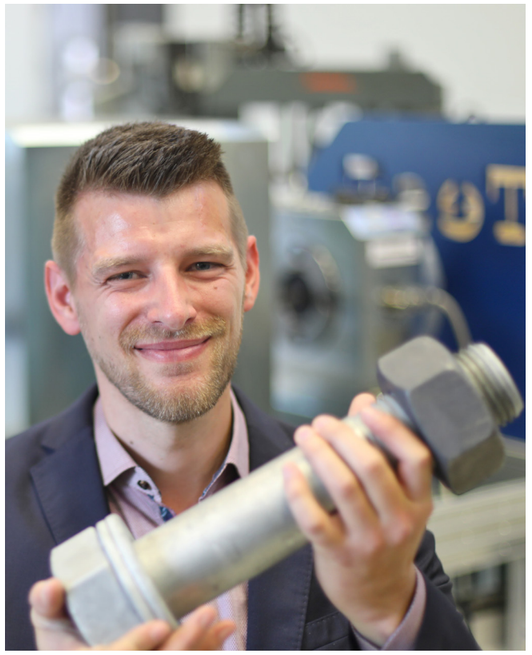
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Putting screw connections to the test







Top: the screw testing unit in action; bottom left: various HV bolt assemblies in large dimensions; bottom right: Maik Dörre with an M64 size bolt

Fraunhofer IGP testing lab dedicates new large-scale testing unit

One new addition to our testing lab as part of the institute's expansion is the 2MN resonance pulsator. This testing unit allows for dynamic testing of components and materials in terms of endurance and fatigue strength. It is extremely versatile and can use both flat and round tensile test specimens.
The range of applications is broad, encompassing accurate determination of fatigue strength and structural durability, exact control of load cycles with a software module, and specific analysis software for stair-step testing and Wöhler lines. The machine is highly resistant to lateral forces.

Fraunhofer IGP test lab

The Fraunhofer IGP test lab works closely with ongoing research projects at the institute and also does testing work for industrial customers. Our lab has DIN EN ISO/IEC 17025:2018 accreditation and a flexible scope in category A.

Since the lab was first founded, we have built a vast body of specialized knowledge in the areas of materials testing, connecting elements, connections, and coating systems. We perform testing to standards and other formats, along with component testing, and emphasize high quality standards and reproducibility. Our expertise lies especially in life span testing, for which we continuously add to our range of machinery.

Contact

Test laboratory
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Technical data:

Maximum testing force:	±2,000 kN
Maximum dynamic amplitude:	±1,000 kN
Maximum vibration displacement:	6 mm
Test chamber height:	2,500 mm
Test chamber width:	999 mm
Test chamber depth:	1,200 mm
Accuracy class:	Class 1
Test frequency:	30–80 Hz

Fraunhofer IGP testing lab dedicates new large-scale testing unit



Holger Brauns, head of the test lab at Fraunhofer IGP, in front of the institute's new testing machine, a 2MN resonance pulsator

Versatile new high-performance coating center at Fraunhofer IGP

The thermal joining technology group at Fraunhofer IGP has been highly active in the field of thermal spraying, also known as thermal coating, for many years now. To accommodate rising demand, a fully integrated high-performance coating center from GTV was purchased in the course of the institute's expansion. This coating center uses various methods to create thermal spray coatings to customer specifications.

The new unit can handle arc spraying using a standard and innovative open torch concept with elevated particle speed (torch types Shark 400 RE, Shark 400 HV), along with atmospheric plasma spraying with modern cascaded torch technology and multiple powder feed lines (three-anode torch, Delta type). These highly effective methods can be used to apply customized metal and ceramic coatings in just a short time. Flame spraying with powder (axial powder injection, torch type 6PII) completes the range of equipment in the area of mobile and robust technology for on-premise use. In addition to compressed air, other gases (especially nitrogen) can be used for arc spraying to improve the coating quality.

The unit is controlled entirely via the built-in PLC controls, which encompass not only flexible workpiece manipulation by way of a tilt-turn table and industrial robot, but also configuration of all process parameters and monitoring of filter and supply technology. This guarantees easy adaptability to the relevant requirements while also allowing for coating of large and complex components and small series for research projects and industry. Finally, all of the relevant parameters of the coating process are logged automatically, so they are available for further analyses in the course of subsequent coating development and optimization.

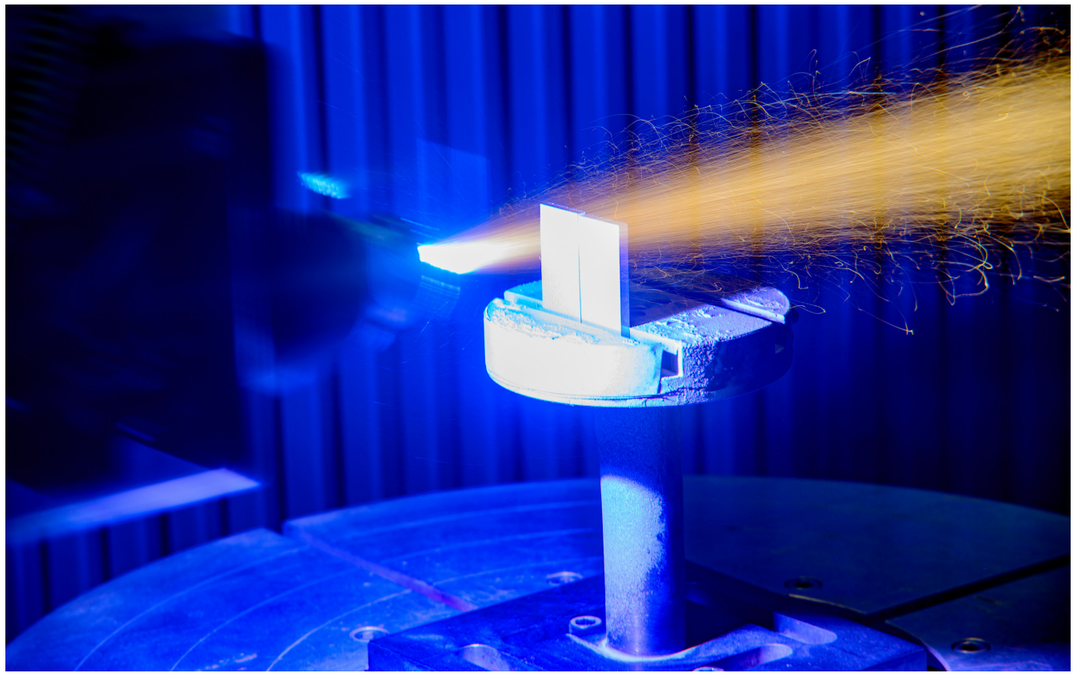
Thermal spraying/thermal coating

Thermal spraying, also known as thermal coating, features a broad range of possible additional materials to add functional properties to surfaces, including metals, composites, and ceramics. A stream of gas is used to feed the material to an energy source. The material is heated there to the point of malleability or even the melt point, and then the particles formed are sprayed onto the prepared surface. Once there, the particles form a coating, primarily through mechanical contact followed by solidification. This coating has different properties depending on the method used. Because no liquid phases are mixed in, almost any material can be applied this way, including to components that may be temperature-sensitive, for example.

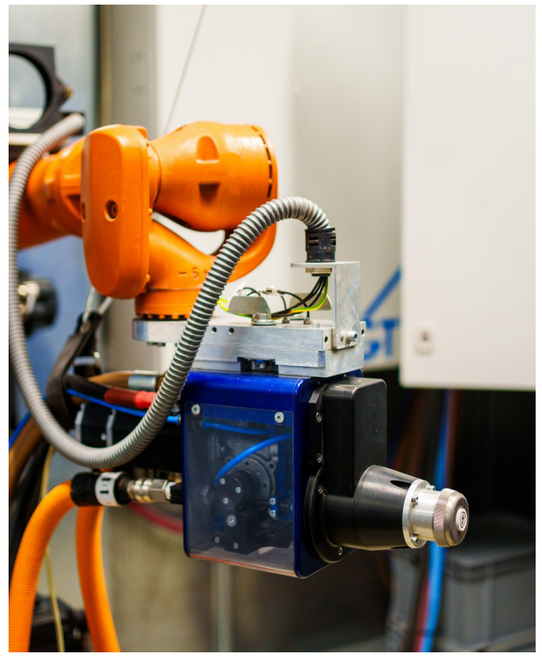
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Versatile new high-performance coating center at Fraunhofer IGP







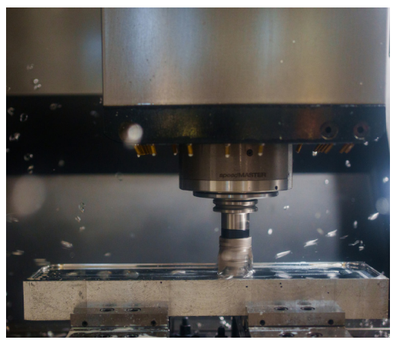
Top: in use — coating a specimen with Fraunhofer IGP's new high-performance coating center; bottom left: Pratidhwani Biswahl works at the coating center's fully integrated PLC controls; bottom right: Shark 400 RE torch for arc spraying

From “digital shadow” to “digital twin”

A modern milling center was installed in the course of re-equipping the pilot plant at Fraunhofer IGP. The plant serves primarily to produce samples and prototypes at the institute’s own production facilities. This reflects the challenges of the IGP’s research partners and customers (low unit quantities, geometric configurations or processing steps that rarely repeat). The new purchase made it possible to equip the machine with high-precision sensors and a large number of measuring points before it even left the plant. The data collected yields what is known as a digital shadow. This term describes the current situation, mirroring the physical counterpart in virtual space. Movements and conditions can be visualized in near real time in a machine model. Processing of relevant parameters up to exact visualization of the spindle position shows the possibilities that external machine monitoring enables. Objective decisions can be made as part of the overarching production plan. Defining threshold values or critical states also makes it possible to operate multiple machines at once and reduces downtime, a key advantage amid the current shortage of skilled workers and with smaller and smaller workforces on the job.

Targeted use and interpretation of data turns a digital shadow into a digital twin, which facilitates real-world decisions. The scientists are working on using the current status and data basis to predict future machine and component behavior. Efficient processing and the expected quality features play a significant role in this. Another aspect that has dominated past development work is consideration of energy consumption. The idea here is to use processing optimization to prevent load peaks where there are alternatives available.

The demonstrator that has been created is undergoing ongoing development and refinement. It serves as a practical application scenario. Companies can also observe the research work in progress during tours and workshops and define further challenges and approaches. This is especially helpful, since the functions that have been shown have already been tested in research and industrial projects and supply further useful findings for applied work.

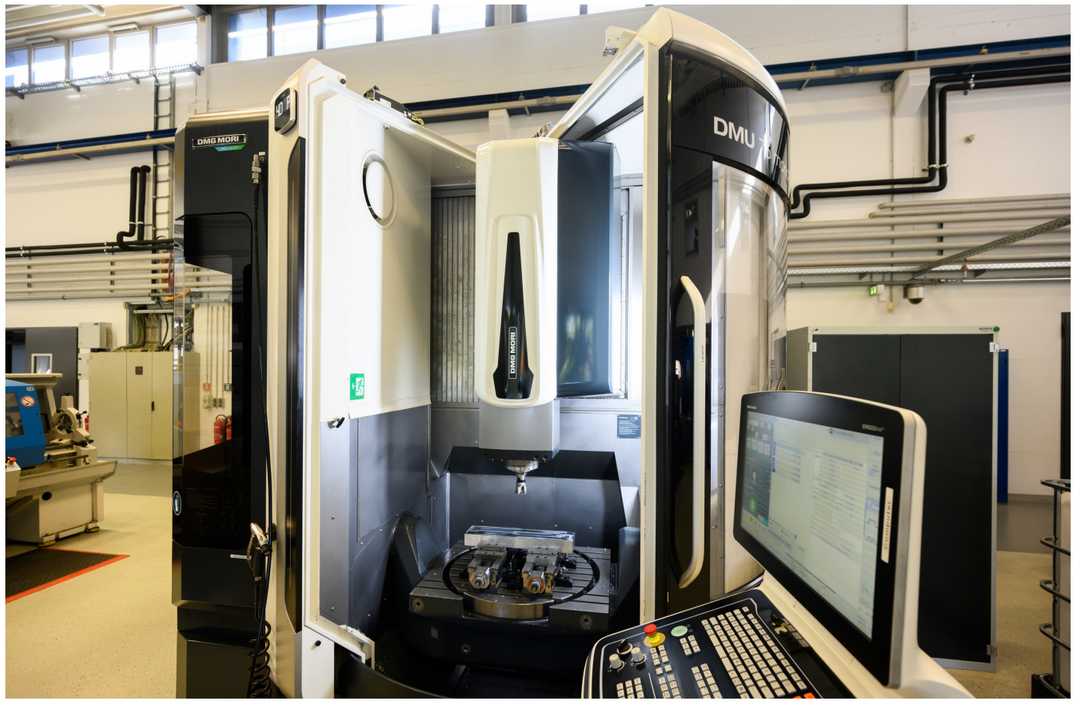




Left: Closeup of DMU 75; right: Sebastian Woche operates the milling center.

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Top: New DMU 75 for sample and prototype production at Fraunhofer IGP;
bottom: Laura Knitter and Konrad Jagusch develop the digital twin of in-house production

From research to practical application

From the offshore wind industry to smart farming and from development of alternative propulsion systems for ships to automation of production processes, Fraunhofer IGP researchers always work closely with partners engaged in real-world practice in various industries. What are the current topics and challenges involved in this? We checked in with some experts to find out.

New materials and processes for offshore wind turbines

Our contribution to the energy transition

Wind energy, and especially offshore wind energy, has become a key component in global energy production in order to meet demand for sustainable energy while also reaching climate targets. The rise of this industry has brought sharp increases in the manufacturing volumes of these kinds of systems.

Fraunhofer IGP's expertise can be harnessed to work on the entire life cycle of these wind turbines, from design and configuration to simulation, production and joining methods, testing and verification to repairs and recycling. Our many and diverse customers along the entire wind turbine value chain turn to Fraunhofer IGP as a capable point of contact for development projects and a reliable testing lab for the use of new materials and methods.

The 8th Energy Research Program launched by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) also calls for the use of equipment that is more efficient and more reliable, performs better, requires less maintenance, and has longer life spans. In the research segment, Fraunhofer IGP can meet these requirements by developing new materials optimized for specific applications and ways to automate production of components and systems.

For example, corrosion protection has a significant influence on the efficiency of operating these kinds of installations. Establishing and testing innovative coating materials and the techniques used to apply them could help to achieve significant improvements in this area. In cooperation with coating companies such as Krebs Korrosionsschutz GmbH and offshore wind farm operators, researchers are investigating the use of thermal spray aluminum (TSA) on monopiles, among other lines of inquiry. Adjusted testing and documentation methods geared toward real-world application have allowed the researchers to gain a deeper understanding of how TSA works under the conditions found in the Baltic Sea. These studies have been instrumental in advancing the body of knowledge on this innovative form of corrosion protection and thus establishing the unique selling proposition of Krebs Korrosionsschutz GmbH — automated TSA application systems — on the market. Right now, the Baltic Eagle offshore wind farm is being equipped with TSA, the second farm of its kind to undergo the procedure. Fraunhofer IGP is monitoring and supporting the process. This is one of our contributions to reliable and affordable electricity from renewable energy sources, making it an important building block in the energy transition as well.

New materials and processes for offshore wind turbines





Solutions for ambitious expansion goals

In conversation with Dr. Michael Irmer from Fraunhofer IGP



Dr. Michael Irmer, Head of Departmenmt "New Materials and Processes"

What subjects is your department working on right now?

Most of our research questions deal with topics from the wind industry, especially offshore, and shipbuilding.
In the wind segment, we're mainly interested in two things. First is further developing and refining production of rotor blades, with a focus on fiber composites and on adhesive bonding as a joining method. Second, we are working on protecting steel structures against corrosion. We always have to think about the entire life cycle of our building elements, from FEM simulation to design and configuration, through to production and joining methods, and then beyond to repair and recycling.

What challenges and trends are there right now in your research segment, and what are you planning next?

The expansion goals in the offshore wind energy sector are enormous, and they will be difficult to impossible to reach with existing concepts and production methods. There's still a wealth of potential here for the development of new materials and processes that have less environmental impact, allow for more effective joining, can be designed and configured with greater accuracy, permit repairs and continued use — and, of course, can be returned to the material cycle at the end of their life cycle.

One big area we're working on right now is the shipping industry and the transformation to a clean fleet. This will require retrofit* concepts that meet the requirements for new fuels such as methanol, ammonia, and hydrogen while also permitting flexible integration into the geometric restrictions of an existing fleet. For the building of new ships, too, we are currently working on new standards for adhesive bonding, which will then ultimately make it possible to use a wide range of different materials as needed. So we plan to keep working hard on shipbuilding and wind energy. We have plenty to do there, now and into the future.

Where does your department's expertise lie?

We generally think about things from the perspective of the material and the joining method. For our part, we can meet the tasks arising from the energy transition and the shift to green shipping by developing new production methods or by using joining technology in new fields of application. Beyond that, of course, we can offer our customers expertise and experience when it comes to things like approvals and testing for safe and secure market launches of new materials and processes.

*Retrofit: see explanation on p. 32

New developments in corrosion protection enable longer service life and operating time for offshore wind turbines

An interview with Andreas Biermann from Krebs Korrosionsschutz GmbH

What are the big topics of interest for your company right now?

We just worked on the first monopile in the U.S. with some of our colleagues from Rostock at the new production site in the United States. This field will continue to be of interest for us, as a lot of projects in the offshore wind energy segment are due to come online in the U.S. in the next few years, with support from generous government subsidies.

How are the ambitious goals for expansion in the offshore wind turbine segment affecting the Krebs group of companies?

We are directly facing the need to work on multiple coating projects at the same time and constantly switch back and forth between them in order to meet delivery deadlines for the various projects. That means conditions are always shifting. These days, we're hardly ever able to work on one project step by step before moving on to the next. Our whole company has to respond very flexibly to this under time pressure, which is challenging for our people, equipment, work preparations, and planning.

Where do you expect the market for coating materials for offshore structures to go in the next few years?

There's a definite focus on longer service life and operating time for offshore wind turbines. One emphasis we're seeing right now is the use of epoxy-based coating materials, which are reinforced with lamellar glass flakes to give them extreme resistance to friction and corrosion. For offshore areas with salt content like that found in the Baltic Sea along the coast of Germany, we do continue to have high hopes for the use of thermal spray aluminum (TSA) as a way to protect monopiles against corrosion, of course.

What is needed in particular right now, especially in the coating technology segment?

Especially in the current phase, where there are many new market players, there's a lot of divergence in customer expectations regarding what coating systems can do at cost-effective conditions. What is needed there is close and extensive dialogue with end customers, steel companies, manufacturers of coating materials, and application companies, ideally during the project planning phase. We try to contribute our expertise there in cooperation with the coating material suppliers.

What will be the most urgent topics in the near future?

The expected scale-up in monopiles will be an urgent subject in the near future. With diameters of up to 15 m and total weights of as much as 5,000 metric tons, there are extreme challenges ahead in terms of both heavy transport logistics and coating. Another challenge for us will be holding on to our highly qualified workforce through the coming demographic changes. We see potential solutions here in expanding the scope of automated processes involved in surface preparation and coating. We expect that to reduce the amount of personnel and energy required, and in general to bring a shift away from manual jobs involving heavy physical labor and toward engineering and technician jobs.



Andreas Biermann, Managing Director of Krebs Korrosionsschutz GmbH





On the grounds of Krebs Korrosionsschutz GmbH

Green solutions for the maritime industry

The Anwendungszentrum Wasserstoff (Application Center for hydrogen technologies) is a new branch lab of Fraunhofer IGP. Research here focuses on alternative, sustainable propulsion systems for the maritime sector, among other areas.

The Anwendungszentrum Wasserstoff (Application Center for hydrogen technologies) is part of the Forschungsfabrik Wasserstoff MV (MV Hydrogen Research Factory), a regional research cooperation for hydrogen-based technologies, which was jointly founded by Fraunhofer IGP, the Leibniz Institute for Catalysis (LIKAT), and the Leibniz Institute for Plasma Science and Technology (INP). It is funded by the Mecklenburg-Western Pomerania State Ministry of Economics, Infrastructure, Tourism and Labor. Its aim is to develop holistic application orientated solutions for the transformation towards a climate-neutral hydrogen economy. While LIKAT and INP concentrate on generation of green hydrogen and on alternative fuels as well as storage materials, the application center's work revolves around developing technologies to transition these fuels to practice cost-effectively, especially in the maritime sector.

The centerpiece of the Application Center for hydrogen technologies is a large engine testing rig, which can be used to develop and test new engine technologies for the sustainable use of PtX fuels,* particularly in maritime applications. "We study how hydrogen can be used as a primary fuel or additive. We also work on combustion of hydrogen derivatives like methanol and other e-fuels," says project manager Dr. Benjamin Illgen. The large engine testing rig can be used for a variety of applications and is also available to companies to test their engines and components.
At the same time, the team, headed by Dr. Benjamin Illgen and group menager Dr. Björn Henke, is also building expertise in the field of fuel cell technology and, related to those activities, in battery technology as well. "Our goal is to reflect the research field of energy converters as an overall system to the greatest extent possible," Illgen explains. To achieve that, a strategic partnership has been established with the Department of Piston Machinery and Internal Combustion Engines (LKV) at the University of Rostock and with FVTR GmbH.
Beyond that, the Application Center for hydrogen technologies will also contribute to establishing a circular carbon economy. Under the specialized leadership of the Leibniz Institute for Catalysis, the team plans to develop technologies to capture and reuse CO_2 before and after combustion of e-fuels containing carbon.

Another of the application center's development fields is the topic of retrofitting** existing fleets. Ships have long life cycles, so efficient retrofit solutions are essential if the process of transforming the maritime industry is to be successful in time. To get current models of ships ready for sustainable technologies, the Fraunhofer institute is also researching retrofit solutions for tank systems, conduits, and pipes. Aspects relating to logistics, optimization of installation space, and ship structure will also be explored going forward.

* PtX — stands for "power-to-X," which in this context describes electricity-based fuels
** Retrofit — modernization or replacement of existing systems, equipment, and operating materials (typically older ones that are no longer being produced)

Green solutions for the maritime industry



Photo: Leibniz Institute for Catalysis (LIKAT)



Research on alternative propulsion systems at the Application Center for hydrogen technologies

In conversation with project manager Dr. Benjamin Illgen



Dr. Benjamin Illgen,
Project Manager
MV Hydrogen Research Factory

What topics is your team working on right now?

The development team "Alternative Propulsion Systems", which is part of the Application Center for hydrogen technologies, is currently working on the process of transforming the maritime industry to ensure the transition to climate-friendly technologies. The medium-term focus is on retrofitting internal combustion engines (ICE) for use with alternative fuels such as methanol. The first step in this is to develop and test components and operating strategies to enable safe, reliable, and efficient operation. To achieve that, Fraunhofer IGP recently leased appropriate infrastructure with two engine test rigs in the multi-MW range, among other things.

What challenges and trends should we expect in the near future?

The challenges of the next few years will lie in forging ahead with the various transformation paths in parallel, since there is still a great deal of uncertainty on both the technological and regulatory levels with regard to which potential solutions will ultimately make the grade. Technological leaps, costs, availability, and safety and security risks will be crucial factors there. We also believe that different parallel technologies will become established in the future, depending on the use case. And that, in turn, leads to major challenges for the relevant logistics chains.

What are you planning next?

One of our overarching development goals for the future is safe, reliable, and efficient operation of a full maritime engine in the MW range based on methanol. We're also planning to build a modular lab testing unit for alternative powertrains. The goal there is to create an infrastructure for different fuels, corresponding reformer technologies, and fuel cell systems. This infrastructure is intended to serve stakeholders in the region and beyond as a basis for developing new technologies.

Where does your group's expertise lie?

The group's expertise lies in retrofitting and upgrading, operating and optimizing ICE on the basis of alternative fuels, marine diesel (MDO) and natural gas. We focus especially on high power classes to make sure our work is applicable to the maritime industry. Our expertise is complemented by our strategic partners, including the two Leibniz institutes, LIKAT and INP. We also work closely with the LKV at the University of Rostock and with FVTR GmbH, which, for example, provide support for development of combustion methods at a smaller scale and simulation of cause-and-effect relationships in internal combustion engines, thereby complementing the expertise of the development team "Alternative Propulsion Systems".

Challenges in developing sustainable technologies for shipping and the offshore industry

Interview with Robert Laade from MEYER NEPTUN Engineering

What are the big topics of interest for your company right now?

We're really focusing on the development of sustainable solutions for the maritime industry. Reducing emissions and developing ecofriendly technologies lie at the heart of our efforts. That encompasses both, propulsion and operation of the ships. The transition to renewable energy sources and reducing the carbon footprint are crucial here.
We are working with Fraunhofer IGP to convert both new ships and the existing fleet to alternative energy sources. As a part of the MEYER NEPTUN Group, we also see great potential for new business opportunities in the offshore wind energy sector.

What trends are you seeing on the market right now?

Demand for global trade routes, transportation of goods and passengers, and development of new offshore energy resources are all on the rise. Advances in technology are also opening up opportunities for innovative solutions, efficiency gains and ecofriendly alternatives. New markets such as the expansion of offshore wind farms, development of autonomous ships and modernization of port infrastructures all offer room for growth and investment. But there are also challenges caused by cost increases, inflation and legal uncertainties. Still, the industry's innovative strength and rising demand offer potential for future growth and positive change.

What is especially needed right now?

A clear and coherent policy direction in the maritime sector is crucial to attract long-term investment and promote the growth of the industry. That includes creating favorable overall conditions, legal certainty, and targeted support programs. In light of rapid technological developments and increasingly stringent environmental rules, it is very important to implement innovative solutions swiftly, both for inland waterways and in deep see shipping.

What path does MEYER NEPTUN Engineering plan to take to meet the challenges of the future?

MEYER NEPTUN Engineering has defined a clear course forward to successfully meet the challenges of the future. Our focus is on sustainable alignment in the shipping sector, based on green technologies, new market segments like offshore wind, retrofit solutions, and internal cooperation within the MEYER NEPTUN Group. At the same time, promoting employee development ensures that the company has the talent it needs to develop innovative solutions and secure future growth.



Robert Laade,
Operations Manager of
MEYER NEPTUN Engineering

New smart farming projects launched at Fraunhofer IGP

The “Biogenic Value Creation and Smart Farming” initiative of the Fraunhofer-Gesellschaft focuses on applied research in the field of food and agriculture — from crop farming and livestock care to agricultural use of moorland. Researchers from five Fraunhofer institutes (IGD, IGP, IIS, IVV and EMFT) work in interdisciplinary teams, contributing a wide range of expertise from the sectors of robotics and automation, sensors, analytics and actuators, AI and big data, as well as construction, production and process engineering. Their aim is to develop new technologies for the sustainable production and processing of agricultural products — from seeds to finished products.

Research for the initiative at the Fraunhofer Institute for Large Structures in Production Engineering IGP is focused on mapping efficient technical solutions for smart agriculture. This centers on automation, robotics, lightweight construction and the use of relevant sensors and artificial intelligence. The institute combines the performance of traditional agricultural technology with modern automation solutions while developing individual solutions to be transferred to specific applications.

The institute also works on the following topics:

- Robots and special kinematics designed to customer specifications
- Application-specific handling systems and end effectors
- Structure optimization, design and dimensioning
- Shaping of selected components
- Integration of electric drive systems
- Process data processing and machine learning
- Optimization of production and logistics systems
- Use of new materials and alternative production methods

This gives rise to the first five initial projects:

- “PlowAnalysis” (Till Braun):
Validation of a new method of soil sampling using RFA and NIR (sensor fusion)
- “PlasmAGRAR” (Julia Schubert in cooperation with Leibniz INP):
Study on the use of plasma-treated water in agriculture
- “TSL” (Lukas Möhrke and Michél Hauer):
Feasibility study of thermal coating of tillage tools
- “Seedling Robot” (Martin Kristandl and Klara Pejić in cooperation with Karls Markt OHG):
Development of a system for automated planting of Frigo seedlings
- “NitroDetect” (Christian Scharr and Karsten Weiher in Cooperation with the Mecklenburg-Vorpommern State Research Institute for Agriculture and Fisheries (LFA M-V)):
Determining the C:N ratio of legumes as winter catch crops

New smart farming projects launched at Fraunhofer IGP





High-performance technical solutions for smart agriculture

In conversation with Kai Potthoff from Fraunhofer IGP



Kai Potthoff, who is in charge of projects for the "Biogenic Value Creation and Smart Farming" initiative at Fraunhofer IGP

What subjects is your department working on right now?

Right now we're working on individual automation solutions for fruit-growing and garden applications, e. g. with planting robots, and on developing alternative biogenic value creation models, such as those involving efficient use of agricultural residues. Our focus in that area is on building prototypes. We're also working to build and implement a systematic approach and research infrastructure for performing field testing with agricultural prototypes, both for our own devices and for customer machinery. This will serve purposes including systematic optimization and parameter identification for existing processing tools for large-scale agricultural activities.

What challenges and trends are there?

Right now, the industry is facing challenges such as climate change, difficulties with the energy supply, cost pressure, and demographic change. That's why we're focusing on further automating processes and on ensuring interoperability among different systems. Through practical demonstration projects we want to promote the acceptance of alternative value creation models.

Where does your group's expertise lie?

In the smart farming segment, our group has expertise in areas like the design and creation of agricultural machinery and tools. We realize prototypes that then undergo systematic testing in practical field tests. The real-world load data form the basis for mechatronic design and configuration processes. This is all complemented by complex sequence controls, HMI programming, and AI-based process control.

What are you planning next?

Right now, we're planning our first multi-year joint research project in the smart farming segment with an industry partner and another research institution. The project aims to develop methods for efficient nitrogen fertilization. We also plan to expand our branch lab in Kritzkow. A mobile lab is also being created in this context for practical field testing. We would also like to expand our network with industrial partners and research institutions within and outside the Fraunhofer-Gesellschaft. Naturally, we are also seeking close collaboration within our own institute, for example with the H2 Research Factory and SOT (Smart Ocean Technologies).

"We support farmers with their operations and industrial engineering step by step on the path toward the digital transformation"

Interview with Oliver Martin, owner, FarmBlick

How do you personally define "smart farming" and how long have you been working on this topic?

To me, "smart farming" is all about using cutting-edge technologies to achieve a deeper understanding of plants and soils and then put those findings to work in the most effective ways. It's all about being smart in what we do and making agriculture more sustainable and more effective with intelligent solutions.

What are the big topics of interest for your company right now?

Especially when it comes to software, we really focus on maximizing user friendliness. That's why we're increasingly incorporating complex individual topics into seamless processes. That means today's farmer, who might have to work with five different other parties now, will need just a single click tomorrow. At that point, our AI system takes over the automated coordination of the necessary service providers and processes and supplies the farmer with the data in a format that is easy to understand. We think this is highly important, especially in terms of spot spraying, as legal decisions will mean that crop protectant use will have to be significantly reduced in the years to come. We're harnessing our technology here to enable efficient, ecofriendly application of crop protectants.

What future developments or improvements would you like to see in the area of smart farming technologies?

Harmonization and simplification of rules and data access in agriculture would be an important step in further driving the digital transformation and the use of smart farming technologies and making agriculture more efficient and more sustainable as a whole.

Where do you see a need, or where do you require support from independent institutions or research units?

Cooperation with research institutions allows us to benefit from the latest scientific findings and continue to grow and expand our knowledge. This helps us develop innovative solutions and further improve our technologies so we can meet the challenges in the agriculture sector even more effectively.



Oliver Martin, founder of FarmBlick

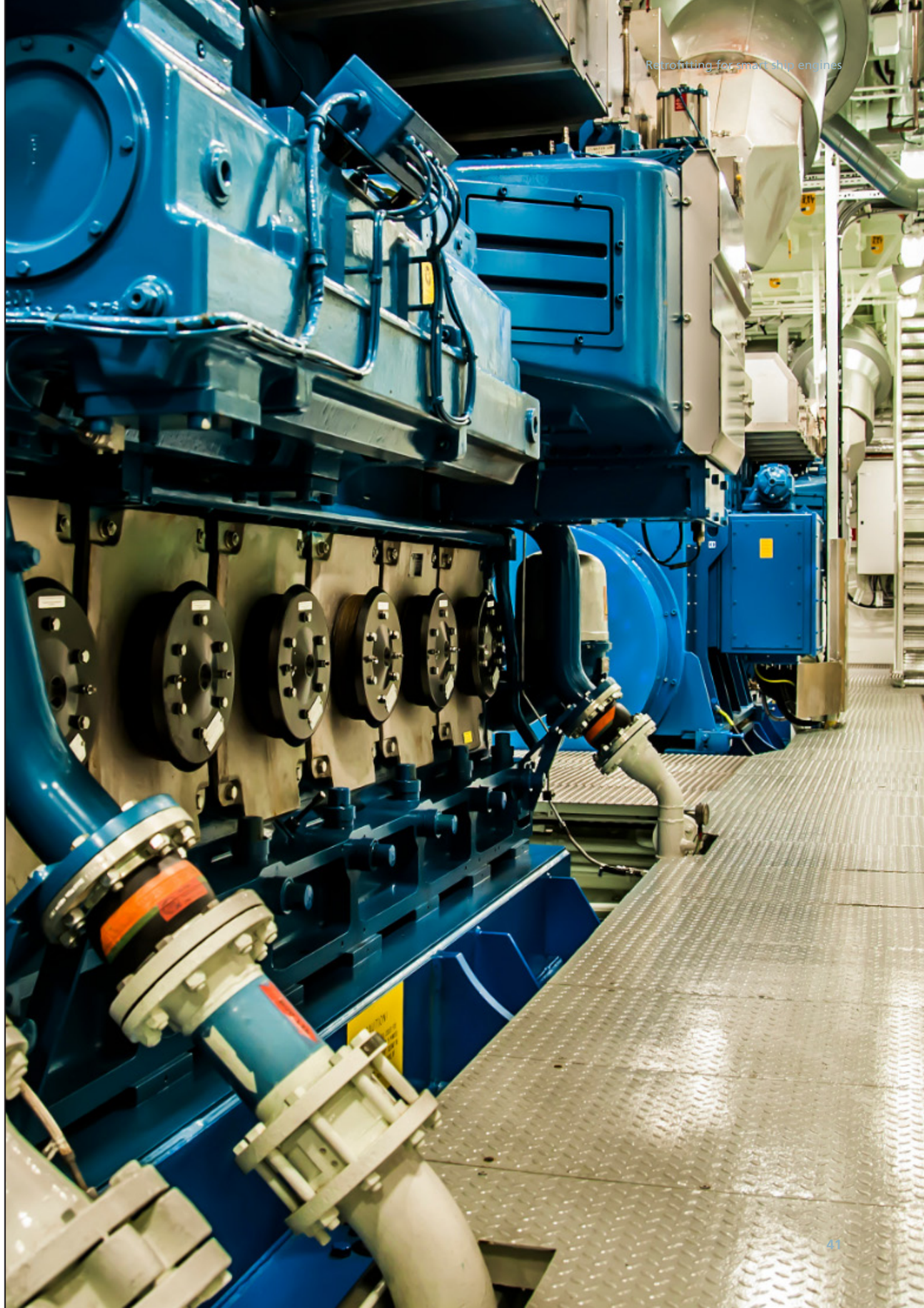
Retrofitting for smart ship engines

When it comes to the tasks and challenges involved in system monitoring and control, the general trend holds true — data is the key. However, the available data is often insufficient in scale or lacking in quality, especially if the goal is to develop a digital twin of a real-world system to assess system behavior and determine future behavior. A digital twin is a virtual counterpart of something that exists in the physical world. In addition to machines, the goal is to replicate processes and products of all kinds.

In one project, AKKUT, a digital twin of a large-scale engine like those used in ships is being studied. The twin will be used to describe the current and expected states on the data side. The engine will be retrofitted with an acoustic sensor system to capture signals during operation. Since ships can operate for 30 years or more, very few engines are equipped with ways to gather data and use it to describe system behavior. For this reason, signals are processed and assessed by experienced users (the "human-in-the-loop" approach). This method is used to continuously train an artificial intelligence.
Then, later on, the system can interpret future data. This makes it possible to predict issues, thereby minimizing costly downtime.

The project showcases the possibilities opened up by innovative retrofitting, which in turn enables useful and practical use of AI. The human-in-the-loop approach described above also captures the experts' experiences working with large engines in digital form. This results in an objective assessment of the relevant operating states and in less work for operators.

Retrofitting for smart ship engines



Process understanding helps optimize production planning and control

In conversation with Konrad Jagusch from Fraunhofer IGP



Konrad Jagusch, Head of the research group "Production planning and control" at Fraunhofer IGP

What research questions is your team working on right now?

The production planning and control research group works on digital twins, among other things. Given the focus of Fraunhofer IGP, a digital twin here generally embodies individual products produced with the output quantity 1 in a process landscape focusing on the trades. That means there isn't much repetition, and there's less data overall. Even so, it's possible to discern patterns of behavior in even small amounts of data if you have the right focus, and possibly by modifying algorithms. In addition, systems can be modeled and processes simulated that way — which is one approach when it comes to examining measures and their effects without having to test them in real-world systems. At the same time, cycles are growing ever shorter, so ad-hoc decisions can be made when there is even so much as a minor discrepancy between the target and actual status.

What challenges and trends should we expect in the near future?

The push for a proactive approach is a clear trend. The idea is that errors, disruptions, and scheduling discrepancies shouldn't be allowed to come up in the first place. Still, that does contrast with planning specifications, which are generally rough and end up being compared against equally rough milestones to see whether those have been achieved. The standard IT solutions available don't have the necessary dynamism, nor can they achieve the requisite level of automation. By collecting all of the available data and modeling processes virtually, the group develops applications that optimize current production process. Algorithms are used to identify corrective actions to actively intervene in current processes and events when discrepancies are detected. If gaps are found in the data sets during analysis, location and identification systems are used to fill in the blanks. Extensive information management modules add to the existing system landscapes. They contribute to both generating and providing data. That's a must in the case of production with a heavy manual focus in order to provide the right data to the relevant employees on a process-specific basis.
The shortage of skilled workers and demographic change that are talked about so frequently also make it crucial to preserve experience and knowledge and be able to harness them in the long term. By assessing calculated specifications, commenting on the data provided, or evaluating measured system states, algorithms can be refined to that end. This makes it possible to use findings in additional areas and across different processes, which in turn helps to prevent errors.

Where does your group's expertise lie?

The research group's primary strength is in process analysis, followed by modeling. This lets us recognize complex issues and break them down to the essentials. One key prerequisite here is an understanding of production and an eye for the relevant requirements. Incorporating innovative technologies and IT systems creates a bridge between these two worlds. When the later users are included in the development work, user-centric solutions are the result. And one solution can be a digital twin, which embodies the approaches described earlier.

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Arndt Kritzner from Logic Way GmbH on collaborating with Fraunhofer IGP in the AKKUT project

What are the big topics of interest for your company right now?

With increasingly stringent requirements in play for the sustainability and resource efficiency of processes, many procedures and processes still have a wealth of untapped potential that can be unlocked through digital modeling and intelligent control.
For a company like ours, which focuses on engineering and system technology, automation and sensors and has its own software and electronics development and production operations, there are many interesting possibilities for optimizing agricultural processes, quality assurance tasks, or machine operation in general.

What trends are you seeing on the market right now?

After the experiences of the past few years, there are apparently actually efforts under way in the German business sector to grow our autonomy and system capabilities and scale back disruption-prone globalized dependencies. As a company with extensive system expertise and a high level of vertical integration, we are seeing a robust volume of orders.

How important do you think research is in all this?

Recognizing when maintenance is needed or identifying wear and operating states in engines, gearboxes, bearings, and other component assemblies based on their sound patterns is a highly research-intensive undertaking with an eye to determining characteristic connections and patterns and implementing reliable detection methods in products.
Research and the innovation arising from it are instrumental in safeguarding our companies' competitiveness, and thus their future. Incorporating a steady stream of new communication and processing options into our product development activities makes sure that we have a high-performance, competitive portfolio.

Where does the research project fit in?

The AKKUT research project is working to automatically make ongoing detailed assessments that could otherwise only be made by people with equal measures of experience and training. In a manual process, it would only be possible to cover this task on a point-by-point basis anyway, based on service and maintenance intervals and random samples.

Are digital twins just a passing fad?

Digital situation mapping and process understanding are the bedrock of any present-day automation solution. Digital twins are an essential building block in the efficient design and optimized operational management of technical systems, and their importance is only growing.

How would you rate the project's results?

As part of the AKKUT project, we were able to work with all the other parties involved to commission and test new technical systems and approaches. Valuable experience was gleaned through practical application involving power generators and river cruise ships in terms of both the technical architectures and methods that should be used and a processing logic that serves the intended purpose. The project provided significant new impetus for the development of new connected noise and vibration sensors within our organization.



Arndt Kritzner, Head of Development at Logic Way GmbH

Annual review 2022

30 years of Fraunhofer in Mecklenburg-Western Pomerania

Fraunhofer has been shaping the research landscape in Mecklenburg-Western Pomerania for 30 years now. We boost the performance and efficiency of companies in the area, promote the acceptance of new technologies within society, and help train the future generation of scientists and engineers the economy so urgently needs. We work closely with universities and other higher education institutions in the state of Mecklenburg-Western Pomerania and with chambers of commerce and industry and contribute our expertise as part of the "Mittelstand 4.0" competence center and various other networks and committees.

The Fraunhofer organization in Mecklenburg-Western Pomerania is made up of the Fraunhofer institutes IGP, IGD, and IZI, along with the Fraunhofer research group Smart Ocean Technologies SOT. On June 1st 2022, all of the Fraunhofer offices located in Mecklenburg-Western Pomerania came together with guests from the fields of politics, science and industry in the heart of Rostock's fishing port at Studio 301 to celebrate the anniversary. There was an extensive program focusing on Fraunhofer's history in Mecklenburg-Western Pomerania and the research done there. To tie in with the institutes' developments and the podium discussion held among the three heads of Fraunhofer IGD, IZI, and IGP, there was a "science mall" where guests were invited to explore scientific and technical research projects.
In her ceremonial speech, Susanne Bowen, Mecklenburg-Western Pomerania State Secretary for Science, emphasized the importance of the practical focus of the work done by the Fraunhofer institutions in the state, noting that it has raised the state's profile within the region and beyond. The Fraunhofer Society's work strengthens Mecklenburg-Western Pomerania as a powerhouse of science and technology, and the latest initiatives revolving around hydrogen technology and smart farming will continue in the same vein.

Applied research in northeastern Germany

- Contract research for industry, business, and government
- Studies, analyses, and evaluation
- Consulting, support, and training
- Testing and certification
- Creation of concepts, models, and practical solutions
- Development of new technologies, prototypes, and all-in-one solutions
- Licensing of Fraunhofer technologies



30 YEARS Fraunhofer in Mecklenburg-Western Pomerania

"The three-decade history of cutting-edge research by the Fraunhofer-Society in Mecklenburg-Western Pomerania is cause for both gratitude and optimism."

Susanne Bowen
Mecklenburg-Western Pomerania State Secretary for Science

Podium discussion with (from left) Prof. Steffen Mitzner (Fraunhofer IZI), Prof. Uwe Freiherr von Lukas (Fraunhofer IGD), and Prof. Wilko Flügge (Fraunhofer IGP)











Snapshots of the celebration marking Fraunhofer's 30th anniversary in Mecklenburg-Western Pomerania at Studio 301, in the heart of Rostock's fishing port

Fraunhofer IGP Prize for 2022 goes to leading ship propeller manufacturer from Mecklenburg-Western Pomerania

The Fraunhofer Institute for Large Structures in Production Engineering IGP in Rostock presents the Fraunhofer IGP Prize for 2022 to a longstanding project partner from the town of Waren: Mecklenburger Metallguss GmbH (MMG). The company is an important employer in the local area and, at the same time, a driver of innovation in the further development and refinement of highly efficient ship propellers and new drive technologies.

Mecklenburger Metallguss GmbH has received the Fraunhofer IGP prize for 2022. The company was founded 150 years ago and has produced ship propellers at its location in the town of Waren, on the shores of Lake Müritz, for over 70 years now. It currently has 200 employees. "Especially in the maritime industry, implementing new technologies in production processes is crucial to boosting productivity and quality. MMG is traditionally an innovation driver in this area, and it relies on simulation-supported processes and robotics and on state-of-the-art optical measurement and analysis methods along the entire value chain. We look back on a long and fruitful research partnership with MMG focusing on development of innovative automation solutions, especially in the areas of large-scale robotics and additive manufacturing," says Steffen Dryba, group manager of automation technology at Fraunhofer IGP.



Mecklenburger Metallguss GmbH (MMG) has received the Fraunhofer IGP prize for 2022. Dr. Lars Greitsch, managing director of MMG, accepts the prize.



Prof. Wilko Flügge, institute director of Fraunhofer IGP, presents the IGP Prize for 2022 to MMG managing director Dr. Lars Greitsch. From left: Christian Klötzer-Freese (MMG), Ronja Topp (MMG), Fabian Thiemann (MMG), Tobias Kruse (MMG), Dr. Lars Greitsch (MMG), Prof. Wilko Flügge (Fraunhofer IGP), Steffen Dryba (Fraunhofer IGP), Alexander Jentsch (Fraunhofer IGP) (Photo: MMG)

One important milestone in the two parties' project work together was the 2015 introduction of a large-scale, simulation-based robot that uses sensors to drill markings into cast propeller blanks. "Thanks to this robot application, we were able to significantly increase the positioning accuracy of depth markings, thereby further improving product quality while considerably reducing throughput times," says Dr. Lars Greitsch, managing director of MMG. The research engineers at MMG and IGP are currently working on the next development step. They plan to use an advanced version of the large robot, including state-of-the-art sensor technology, to automate the grinding process that follows the drilling step.

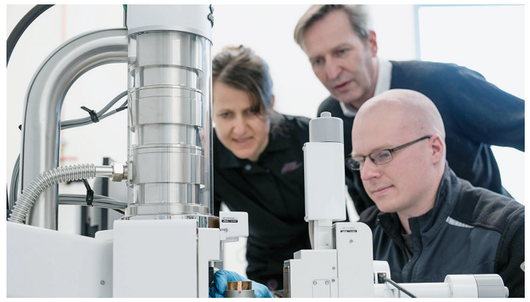
"Our work with Mecklenburger Metallguss GmbH is a prime example of Fraunhofer's approach of transferring knowledge from research to application. Through this partnership, both sides gain highly qualified personnel, and the state of Mecklenburg-Western Pomerania is home to a company that is successful all around the world," explains Prof. Wilko Flügge, institute director of Fraunhofer IGP. "MMG has a long history and has now managed to stand up to the stiff competition in the maritime industry for 150 years. One major reason is that the company is consistently and rigorously committed to efficient and automated production and keeps its eye focused firmly on the future through its R&D activities."

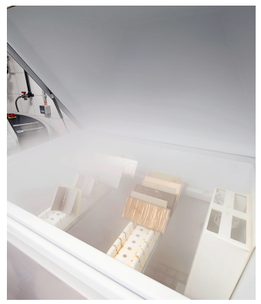
Fraunhofer IGP has been awarding a technology prize to one winner annually since 2018. The prize is given out in recognition of outstanding achievement in the field of production technology. It calls attention to the technological, economic, ecological, and social utility value that is gained through close cooperation between research institutions and industrial partners.

Seat#12: Balancing science and art

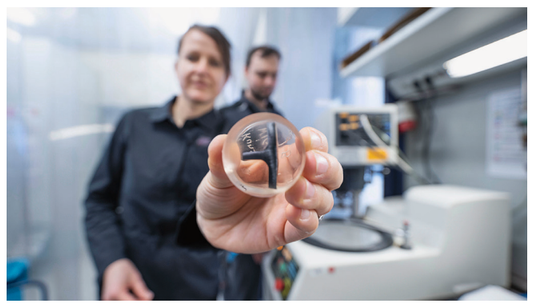
In cooperation with artist Jenny Brockmann and the University of Rostock, the Fraunhofer Institute for Large Structures in Production Engineering IGP launched an art project in 2022. Under the title "BALANCE Prototype" interdisciplinary collaboration took place between the artist and the researchers in Rostock.

Local residents had already had the chance to see Berlin-based artist Jenny Brockmann's installation ***Seat#12*** as part of the "Experiment Zukunft" (Experiment of the Future) exhibit at Kunsthalle Rostock in 2019. Attendees were invited to sit down on ***Seat#12*** and rock back and forth as they shared their thoughts on the Hanseatic city's 600th anniversary.
The interactive seating sculpture, which features 12 seats, was reassembled in 2022 for a collaborative project between the artist, Fraunhofer IGP, and the University of Rostock. Our scientists spent several months working with Brockmann to adapt the piece. New materials and methods were used in the process.









Researchers from Fraunhofer IGP and artist Jenny Brockmann work together to develop new materials and methods for Seat#12.



The interactive sculpture Seat#12 on its base in front of the Fraunhofer IGP institute building

Seat#12 is a kinetic sculpture with room for 12 people to sit on it. The sculpture evokes a round conference arrangement and invites people to try to balance together. With its swing-like movements, ***Seat#12*** creates an unusual situation: Any movement, no matter how slight, by anyone sitting in any seat directly affects all eleven other sitters' positions. Equipped with 12 aluminum arms connected in the middle, the futuristic object serves the purpose of direct and indirect communication alike.

A dialogue inevitably arises between those sitting on it, with both spoken and felt dimensions.

The discursive work of art has now found a permanent home in front of Fraunhofer IGP at Albert-Einstein-Strasse 30, in Rostock's Südstadt area. Another base for ***Seat#12*** is being set up on the Südstadt campus of the University of Rostock. This will make it possible to use the seesaw-like structure for events at two different locations on campus.



*In dialogue:
From left: Hanna Rickert (Fraunhofer IGP), Jenny Brockmann, Prof. Knuth-Michael Henkel (Fraunhofer IGP), Prof. Wolfgang Schareck (rector, University of Rostock) and Mario Aehnelt (Fraunhofer IGD)*

Events and trade show attendance



Fraunhofer IGP at WindEnergy 2022 in Hamburg



Girls' Day 2022 gave girls insight into the work done at our research institute



In discussion at EuroBLECH in Hannover



Fraunhofer IGP at the SMM trade show in Hamburg



EFB Joining Technology Colloquium at Fraunhofer IGP in Rostock

Social Media



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The 13th Rostock Corporate Run, in 2022, drew 3 teams from Fraunhofer IGP



Dr. Oliver Brätz and Dr. Andreas Gericke at the 75th IIW Annual Assembly and International Conference in Tokyo



Long Night of the Sciences on the Südstadt campus in Rostock — Fraunhofer IGP adhesive station creates a “sticky” situation



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We are always open in these situations and will tackle the topic together with you. Come to us as an assistant and who knows, maybe you will stay to do your doctorate right afterward.

Or are you looking for an internship?

Depending on the capacity available, we offer required internships in accordance with the study regulations of the relevant university and voluntary internships lasting up to three months, along with internships for secondary students.

Trainees wanted!

We offer our trainees the best possible start to their professional careers. This includes more than a first-class working environment: Practical work with a lot of freedom. With the knowledge you gain at Fraunhofer under your belt, you will have excellent opportunities for a subsequent degree or as a qualified specialist after your vocational training.

For information, visit
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Vocational training at Fraunhofer IGP: Exciting new questions each and every day

In conversation with Matteo Brosch, who is completing a vocational training program to become a machinist at Fraunhofer IGP

Matteo Brosch started his vocational training at Fraunhofer IGP in 2020 and is due to complete it shortly. We asked him why he wanted to complete the program at the Fraunhofer Institute for Large Structures in Production Engineering IGP specifically and what he found especially exciting about it.

Why did you decide to do a vocational training program with us?

I was interested in working at a research institution and learning a bit about what the scientists do. You don't always have to do the same thing. You have a lot of different tasks. I was also excited about the development and continuing education opportunities at the institute.

What have been the biggest challenges during your program?

Getting started in working life was a bit of a challenge at first, having a set schedule and managing my time. Especially at the start, there were a lot of new things and a lot of new material to learn. That was quite a change, but then I got used to it.

What have you especially liked about doing your training at IGP?

I've really liked the fact that the whole team sort of pitched in to train me, that I got the chance to learn something from everyone. I also really liked that the other departments showed me what happens with the workpieces we make in the shop at later stages. Another thing I really like is all the variety at Fraunhofer IGP. With so many research projects and questions being explored, there's always something new to do.

What do you especially remember from your time at IGP so far?

The warm welcome I got within the team and the communication with my colleagues, but also the cross-team collaboration was something I thought was really great about working at Fraunhofer IGP.

So what are your plans for when you finish your program?

I already work really independently a lot of the time now that I'm close to the end of the program. It works out well, and I like it. I hope to stay at IGP after I finish. Then, as a skilled worker, I'll work completely independently, manage my own time and workload, and complete projects on my own.



> **"With so many research projects and questions being explored, there's always something new to do."**

Matteo Brosch,
trainee at Fraunhofer IGP

Project overview 2022

Project name	Researchers
SmartBond — Joining innovative materials in shipbuilding production using an automated bonding process	Linda Fröck/ Christian Scharr
ASiMof — Analysis, simulation, and modification of the anisotropic properties of fiber-reinforced adhesives	Matthias Lang
HybridComp — Fire-resistant hybrid fiber composite materials based on optimized organic/ inorganic systems	Nicco Stroetmann
MNE Retro Tank — Realizability of retrofit solutions for tank systems for green shipping	Nicco Stroetmann/ Lukas Steinmetz
Pre-tensioned hybrid joints in hot-dip galvanized steel structures exposed to complex stresses	Justus Mantik
Production and use of shear-cut holes in mechanically joined connections using high-strength steel grades in steel construction in case of cyclical stresses	Alexander Holch
Cost-effective joining through analysis of fatigue strength of punching functional elements	Christian Denkert
Further development of notch classes according to EC3 for non-welded construction details using the synthetic Wöhler line, with consideration of manufacturing practices typical of steel construction	Florian Kalkowsky
Mittelstand-Digital Center, Rostock — The digital transformation takes SMEs into the future	Florian Beuss
EnergiePro — Energy-autonomous production facilities with office space — TBI feasibility study with Hallenbau Stieblich	Oliver Kühn
AutoTrans MV — Development of a transformation network for the automotive supply industry in Mecklenburg-Vorpommern	Ulrich Streckfuss
H2Go ViR — Use of an asset administration shell to collect and process manually generated data during stack production and/or assembly/dismantling and transition it into a digital twin	Jan Tschirner

Project name	Researchers
Automated robot cell for welding — Digital integration of a robot-based additive welding method using RoboDK	Klara Pejić
PlowAnalysis — Validation of a new method of soil sampling using RFA and NIR (sensor fusion)	Till Braun (with Dr. Friederike Habedank)
PlasmAgrar — Study on the use of plasma-treated water in agriculture	Julia Schubert (with Leibniz INP)
TSL — Feasibility study of thermal coating of tillage tools	Lukas Möhrke
Seedling robot — Development of a system for automated planting of Frigo seedlings	Martin Kristandl/ Klara Pejić
NitroDetect — Determining the C:N ratio of legumes as winter catch crops	Christian Scharr/ Karsten Weiher
X-KIT — Connecting and supporting the AI projects in the agricultural domain receiving German Federal Ministry of Food and Agriculture (BMEL) funding in GAIA-X	André Siegrist/ Justus Palisaar
Greta — Total Fuselage Eco-efficient Technology Application	Jacques Biltgen (Partners: LWF, Airbus)/ Felix Holleitner
Smart process chain — forming, tensioning, and joining with automated machine learning	Christan Scharr/ Lukas Kappis
TherMoBaum — Thermal monitoring of trees near tracks for rapid detection of damage	Karsten Weiher
BIM-Leb — BIM-based life cycle assessment for bridges	Christoph Heinze
DIQUK — Optical methods for digitalization of cold plastic shaping through continuous quality control	Christopher Karberg
Vesselscanning — Ship surveying under water (SOT project)	Christopher Karberg

Project name	Researchers
Refit as subsequent weld seam post-treatment to extend the life span of fatigued steel structures	Carl Christian Nehls
Hiddensee island outdoor exposure	Valeska Cherewko
Optifüla — Fatigue-appropriate optimization of the use of joining methods from forming technology using the local concept	Maximilian Schlicht
QA riveting — Cross-life cycle quality assurance for joining connections from forming technology for wrought aluminum alloys using impact sound analysis	Felix Holleitner

Funded by:

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FOSTA Forschungsvereinigung Stahlanwendung e. V.
ptj Projektträger Jülich Forschungszentrum Jülich
EFB
EUROPÄISCHE UNION Europäischer Fonds für Regionale Entwicklung
DVS FORSCHUNG
FSM
RUBin Regionale unternehmerische Bündnisse für Innovation
TZI Technologie-Beratungs-Institut GmbH
MV tut gut.
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DECHEMA Gesellschaft für Chemische Technik und Biotechnologie e.V.

Associations, alliances, and committee work

Fraunhofer Group for Production

The Fraunhofer Group for Production is a research and development partner for the manufacturing industry. More than 2,200 employees from eight institutes and three Fraunhofer research institutions provide their knowledge and experience. Using the latest findings from production and engineering sciences as well as computer science, the Fraunhofer Group for Production offers a range of services that encompasses the entire product life cycle and the entire value chain. Research and industry are closely linked here on an interdisciplinary basis.
www.produktion.fraunhofer.de

Fraunhofer Traffic and Transportation Alliance

Since March 2003, various Fraunhofer Institutes and facilities have been pooling their transport-related competencies in the Fraunhofer Traffic and Transportation Alliance. The members of the alliance have set themselves the goal of developing and implementing suitable technical and conceptual solutions for public and industrial clients through transport-related research. By means of close, topic-related cooperation, comprehensive system and network solutions as well as new areas of application can be developed for customers through know-how transfer in the transport sector. This selection and pooling of a wide array of competencies ensures that needs-based solutions can be offered to the customer.
www.verkehr.fraunhofer.de

Committee work

Forschungsvereinigung Schiffbau und Meerestechnik e.V.
Prof. W. Flügge — member of the technical advisory board
Prof. K.-M. Henkel — member of the technical and scientific committee

German Welding Society (DVS)
Prof. K.-M. Henkel — chair, Mecklenburg-Vorpommern state association; chair of the committee of state associations; DVS vice-president
Research Association for Steel Application (FOSTA)
Prof. W. Flügge — member of the technical board of trustees
Kooperationsverbund RIC MAZA MV e.V.
Dr. J. Sender — member of the board
Prof. W. Flügge — member of the advisory board
Technologie- & Innovationskreis Wirtschaft/ Wissenschaft M-V
Prof. M.-C. Wanner — member
Wissenschaftliche Gesellschaft für Montage-Handhabungstechnik-Industrieroboter — MHI e.V.
Prof. M.-C. Wanner — member
XXL Products working group
Prof. W. Flügge — member
Deutsches Institut für Bautechnik
Prof. R. Glienke — member of the expert committee on metal and composite construction
European Research Association for Sheet Metal Working (EFB)
Prof. Ralf Glienke — chair — joint DVS / EFB committee AGMF3/V10.3 mechanical joining — blind rivets and lock bolts
M. Schwarz — vice chair — joint DVS / EFB committee AGMF3/V10.3 mechanical joining — blind rivets and lock bolts
Dr. C. Denkert — vice chair/secretary — joint DVS / EFB committee AGMF4/V10.4 mechanical joining — functional elements
Dr. C. Denkert — member — joint DVS / EFB committee AGMF7/V10.7 mechanical joining — design, construction and calculation
M. Dörre — member — joint DVS / EFB committee AGMF4/V10.4 mechanical joining — functional elements

GfKORR — Gesellschaft für Korrosionsschutz e.V., wind energy working group
Dr. M. Irmer — member
Wind Energy Network e.V.
Dr. Michael Irmer — board member **Hanse Aerospace e.V., Hamburg**
Prof. W. Flügge — deputy chair of the scientific advisory council
REFA Landesverband Mecklenburg-Vorpommern e.V.
Dr. J. Sender — board chair
German Society for Maritime Technology (STG)
Prof. M.-Ch. Wanner — head of the work organization and production technology working group and member of the technical and scientific advisory board
Kompetenzkreis Industrievermessung (KKIV)
Dr. M. Geist — member
DVS technical committee
Dr. A. Gericke — member — working group V 2.5 submerged arc and electroslag welding
Prof. K.-M. Henkel, Dr. O. Brätz, Dr. A. Gericke — member — working group V 4 underwater technology
Prof. K.-M. Henkel, Dr. A. Gericke — member — working group A 6.1 welding in shipbuilding and maritime technology — welding methods, production
Prof. K.-M. Henkel, Dr. A. Gericke — member — working group A 6.2 welding in shipbuilding and maritime technology — damage to welding constructions in shipbuilding
Dr. A. Gericke, B. Ripsch — member — working group Q 1 design, construction and calculation
Linda Fröck — member — DVS expert committee 11 joining plastics; DVS working group W 4.14 joining of endless fiber-reinforced plastics
DVS research association
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Prof. K.-M. Henkel, P. Andreazza, Dr. A. Gericke — member — expert committee 07 soldering
Prof. K.-M. Henkel, Dr. O. Brätz, Dr. A. Gericke — member — expert committee V4 underwater technology
Working Groups of the International Institute of Welding
Dr. O. Brätz — member — IIW Commission II Arc Welding and Filler Metals
Dr. A. Gericke — member — IIW Commission XII Arc Welding Processes and Production Systems
Dr. O. Brätz, Dr. A. Gericke — member — IIW Commission IX Behaviour of Metals Subjected to Welding
Dr. A. Gericke — member — IIW Commission XIII Working Group 2 Techniques for improving the fatigue strength of welded components and structures
Dr. O. Brätz — member — IIW Commission XV Design, Analysis, and Fabrication of Welded Structures
German Materials Society
Dr. A. Gericke — member — "Material Technology Steel" joint committee
Dr. A. Gericke — member — "Material Fatigue" working group
Strategierat Wirtschaft-Wissenschaft Mecklenburg-Vorpommern
Prof. W. Flügge — member
Maritimer Zukunftsbeirat Mecklenburg-Vorpommern
Prof. W. Flügge — member
Regionale Innovationsstrategie Mecklenburg-Vorpommern (RIS)
Prof. W. Flügge — head of mechanical engineering action field

Expert reviewer activities

Arbeitsgemeinschaft industrieller Forschungsvereinigungen "Otto von Guericke" e.V.
Prof. W. Flügge, Prof. K.-M. Henkel, Prof. M.-Ch. Wanner — expert reviewers
German Federal Ministry for Economic Affairs and Technology
Prof. M.-Ch. Wanner — expert reviewer for funding program "Innovativer Schiffbau sichert wettbewerbsfähige Arbeitsplätze"
German Research Foundation (DFG)
Prof. W. Flügge, Prof. M.-Ch. Wanner — expert reviewers

Standardization work

Deutsches Institut für Normung e.V.
Prof. R. Glienke — member of the advisory board NA 092 DIN-standards committee on welding and allied processes (NAS)
DIN standards committee on welding and allied processes
Linda Fröck — member — DIN working group NA 092-00-28 AA: adhesive technology (DVS working group V 8); DIN working group NA 092-00-28-01 AK: adhesive technology process chain; DIN working group NA 092-00-28-02 AK: adhesive bonding of fiber-reinforced plastics

Publications 2022

Report

Schlicht, M.; Spak, B.; Nowak, K.; Fiedler, M.; Flügge, W.; Kästner, M.: **Reibungsbasierte Rissinitiierung bei umformtechnisch gefügten Verbindungen von Bauteilen aus Aluminiumknetlegierungen.** Final report dated April 28, 2022, on IGF project no. Aif no. 20300 BR. In: Fraunhofer Publica, 2022

Essay in book

Stepputat, M.; Beuss, F.; Flügge, W.; Sender, J.: **Time reduction in online programming — An approach to hand guided teaching für small batch robot machining. In: Advances in system-integrated intelligence.** pp. 405–414. ISBN: 978-3-031-16280-0

Klötzer, C.; Wanner, M.-C.; Flügge, W.; Greitsch, L.: **Implementation of innovative manufacturing technologies in foundries for large-volume components.** In: Annals of scientific society for assembly, handling and industrial robotics, 2021, pp. 229–240. ISBN: 978-3-030-74031-3

Lauer, S.; Rieck, S.; Wanner, M.-C.; Flügge, W.: **Partial automated multi-pass-welding for thick sheet metal connections.** In: Annals of scientific society for assembly, handling and industrial robotics, 2021, pp. 399–410. ISBN: 978-3-030-74031-3

Glienke, R.; Schwarz, M.; Denkert, C.: **Beurteilung der Schwingfestigkeit von Schrauben grosser Durchmesser im Maschinen- und Anlagenbau unter Berücksichtigung von Herstellungs- und Randschichteinflüssen** In: Schraubenverbindungen 2022, pp. 3–26, ISBN: 978-3-18-092403-8

Fröck, L.; Flügge, W.; Kästner, M.; Nowak, K.; Schlicht, M.; Spak, B.: **Untersuchung des Prozesses zum Unterwasserkleben von Halterungssytemen**. In: Klebtechnik im Glasbau 2022, Ernst und Sohn, ISBN: 978-3-433-03391-3

Schwarz, M., Glienke, R.; Wegener, F.; Seidel, M.: **Nachweis der Ermüdungsfestigkeit exzentrisch belasteter Schraubenverbindungen in Flanschverbindungen von Windenergieanlagen**. In: Schraubverbindungen 2022. pp. 491–XVI, ISBN: 978-3-433-03391-3

Holch, A.; Dörre, M.; Klakowsky, F.; Glienke, R.: **Experimentelle Untersuchungen zum Tragverhalten von Schrauben und Schliessringbolzensystemen unter kombinierter Axial- und Querkraftbelastung**. In: Schraubverbindungen 2022. pp. 449–460, ISBN: 978-3-433-03391-3

Journal articles

Dörre, M.; Glienke, R.; Schwarz, M.; Henkel, K.-M.: **Zur Querkrafttragfähigkeit reibschlüssiger Schraubenverbindungen mit erhöhtem Nennlochspiel**. In: Materialwissenschaft und Werkstofftechnik, Volume 53 (02), pp. 139–155, 2022

Gericke, A.; Hauer, M.; Ripsch, B.; Nehlsen, J.; Irmer M.; Henkel, K.-M.: **Fatigue strength of structural steel-welded connections with arc-sprayed aluminum coatings and corrosion behavior of the corresponding coatings in sea water.** In: Journal of Marine Science and Engineering: MDPI, 2022, Volume 10 (11)

Denkert, C.; Kühne, D.; Süsse, D.; Glienke, R.; Fiedler, M.; Dörre, M.; Kästner, M.; Henkel, K.-M.: **Numerical and experimental studies on press-bolt joints for sheet metal applications — Static strength assessment**. In: Journal of advanced joining processes: Elsevier B.V., 2022, Volume 6, Art. 101132

Ummenhofer, T.; Kuhlmann, U.; Henkel, K.-M.; Flügge, W.; Weidner, P.; Armbruster, K.; Gölz, L. M.; Gericke, A.; Ripsch, B.: **HFH-Nachbehandlung höchstfester Baustähle — Erweiterung der DASt-Richtlinie 026 — Kerbfalleinstufung unter Berücksichtigung geometrischer Fertigungsimperfektionen.** In: Stahlbau: Ernst und Sohn, 2022, Volume 91 (10), pp. 671–682

Stranghöner, N.; Makevičius, L.; Flügge, W.; Henkel, K.-M.; Glienke, R.; Dörre, M.; Schwarz, M.; Rudolf, A.; Fiedler, S.: **Gleitfeste Verbindungen mit Imperfektionen**. In: Stahlbau: Ernst und Sohn, 2022, Volume 91 (7), pp. 442–453

Brätz, O.; Klett, J.; Scheithauer, T.; Henkel, K.-M.; Maier, H.-J; Hassel, T.: **Induction heating in underwater wet welding — thermal input, microstructure and diffusible hydrogen content.** In: Materials: MDPI, 2022, Volume 15 (4)

Rieck, S.; Gericke, A.; Dryba, S.; Henkel, K.-M.; Flügge, W.: **Intelligente Schweissroboter — Wie künstliche Intelligenz die Prozesssicherheit beim automatisierten MSG-Schweissen steigern könnte.** In: Zeitschrift für Wirtschaftlichen Fabrikbetreib: Carl Hanser Verlag, 2022, Volume 117 (10), pp. 697–701

Brätz, O.; Henkel, K.-M.: **Investigations on the microstructure of drawn arc stud welds on structural steels by quantitative metallography**. In: Welding in the World: Springer, 2022, Volume 67, pp. 195–208

Dörre, M.; Wegener, F.; Glienke, R.; Henkel, K.-M.: **Beitrag zu einem analytischen Berechnungsmodell querkraftbeanspruchter Schraubverbindungen mit Langelöchern**. In: Schraubverbindungen 2022: VDI — Wissensforum GmbH, 2022, Volume 2403, pp. 267–282

Glienke, R.; Schwarz, M.; Marten, F.; Eichstädt, R.; Schwerdt, D.; Hagemann, M.; Dörre, M.: **Zur Ermüdungsfestigkeit grosser Schrauben im Stahlbau unter Berücksichtigung von Herstell- und Randschichteinflüssen — Teil 2: Versuchsergebnisse und Bewertung**. In: Stahlbau: Ernst und Sohn, 2022. Volume 91 (1), pp. 20–38

Glienke, R.; Schwarz, M.; Marten, F.; Eichstädt, R.; Schwerdt, D.; Hagemann, M.; Dörre, M.: **Zur Ermüdungsfestigkeit grosser Schrauben im Stahlbau unter Berücksichtigung von Herstell- und Randschichteinflüssen — Teil 1: Versuchsergebnisse und Bewertung**. In: Stahlbau: Ernst und Sohn, 2022. Volume 91 (1), pp. 10–19

Vallée, T; Fricke, H.; Myslicki, S.; Kaufmann, M.; Voss, M.; Denkert, C.; Glienke, R.; Dörre, M.; Henkel, K.-M.; Gerke, T.: **Modelling and strength prediction of pre-tensioned hybrid bonded joints for structural steel applications.** In: The journal of adhesion, Volume 98, 2022

Jagusch, K.; Gerds, P.; Knitter, L.; Sender, J.; Flügge, W.: **Sustainable data use in the craft trade sector.** In: Zeitschrift für wirtschaftlichen Fabrikbetrieb, Volume 117 (11), pp. 749–753, 2022

Knitter, L.; Jagusch, K.; Scharr, C.; Heinze, C.; Sender, J.; Flügge, W.: **Human-in-the-loop-Ansatz vereinfacht maschinelles Lernen für das Störungsmanagement**. In: Zeitschrift für Wirtschaftlichen Fabrikbetrieb, Volume 117 (10), pp. 623–628, 2022

von Arnim, M.; Eichler, S.; Brätz, O.; Hildebrand, J.; Gericke, A.; Kuhlmann, U.; Bergmann, J. P.; Flügge, W.: **Effiziente Nachweiskonzepte für geschweisste Mischverbindungen im Stahlbau.** In: Stahlbau, Volume 91 (10), pp. 660–670, 2022

Fröck, L.; Glück, N.; Flügge, W.: **Untersuchung des Prozesses zum Unterwasserkleben von Halterungssystemen**. In: Wiley Online Library, Volume 5 (3), pp. 41–45, 2022

Jagusch, K.; Sender, J.; Knitter, L.; Eggert, M.; Flügge, W.: **Digital tracking of non-designed components in large structures.** In: Procedia CIRP, Volume 107, pp. 405–410, 2022

Jericho, D.; Jagusch, K.; Sender, J.; Flügge, W.: **Digital representation for process coordination in one-of-a-kind production.** In: Zeitschrift für Wirtschaftlichen Fabrikbetrieb, Volume 117 (5), pp. 288–293, 2022

Jagusch, K.; Sender, J.; Jericho, D.; Flügge, W.: **Process control measures in reaction to assembly adjustments in one-off production**. In: Procedia CIRP, Volume 106 (3), pp. 258–263, 2022

Spak, B.; Schlicht, M.; Nowak, K.; Kästner, M.; Froitzheim, P.; Flügge, W.; Fiedler, M.: **Estimation of fatigue life for clinched joints with the local strain approach**. In: Procedia Structural Integrity, Volume 38, pp. 572–580, 2022

Backens, S.; Ofe, S.; Schmidt, S.; Glück, N.; Flügge, W.: **Influence of peroxide cross-linking temperature and time on mechanical, physical and thermal properties of polyethylene**. In: Materials Testing, Volume 64 (2), pp. 186–194, 2022

Denkert, C.; Ganschow, J.; Dörre, M.; Glienke, R.; Flügge, W.: **Untersuchung zur axialen Tragfähigkeit selbstschneidender Gewindeeinsätze**. In: Konstruktion, Volume 74 (01-02), pp. 56–66, 2022

Illgen, B.; Sender, J.; Flügge, W.: **Performant algorithm for spatial scheduling of large structures within computing-intensive simulation projects**. In: Procedia CIRP, Volume 107 (4), pp. 167–172, 2022

Handreg, T.; Ehle, R.; Berteloot, F.; Flügge, W.: **Development of an application for a safe operation of automated crane systems in aircraft manufacturing**. In: SSRN Electronic Journal, 2022

Heyser, P.; Wiesenmayer, S.; Frey, P.; Nehls, T.; Scharr, C.; Flügge, W.; Merklein; M.; Meschut, G.: **Consideration of the manufacturing history of sheet metal components for the adaptation of a clinching process.** In: Proceedings of the Institution of Mechanical Engineers Part L; Journal of Materials: Design and Applications, Volume 236, Issue 6, pp. 1203–1215, 2022

Marquart, T.; Momber, A.W.; Kelm, D.: **Fractal dimensions of blast-cleaned steel surfaces and their effects on the adhesion of polymeric foil systems with integrated pressure-sensitive adhesives**. In: International journal of adhesion and adhesives, 2022

Wald, C.: **Zerstörungsfreie Prüfung schiffbaulicher struktureller Klebverbindungen.** In: Adhäsion KLEBEN&DICHTEN, Volume 66. pp. 44–47, 2022

Weiher, K.; Heinze, C.; Pankrath, H.; Vierhub-Lorenz, V.; Werner, C.; Geist, M.: **Laser Sensing System for Contactless Detection of Subsurface Defects in Concrete Tunnel Lining**. In: International Symposium on Non-Destructive Testing in Civil Engineering (NDT-CE 2022), Special Issue of e-Journal of Nondestructive Testing (eJNDT), ISSN 1435-4934, Vol. 27(9)

Heinze, C.; Scharr C.: **Wenn der Motor stottert.** In: VSM Zeitschrift "Schiffbau-Industrie" 02/2022, Verband für Schiffbau und Meerestechnik e.V., 2022

Momber, A.W.; Irmer, M.: **Distribution parameters of a plastic-elastic transition function for normal force effects on the abrasive wear of organic coatings.** In: Journal of Coatings Technology and Research, Volume 19, Issue 6, pp. 1909–1911, 2022

Wickmann, C.; Osten, J.; Gericke, A.; Henkel, K.-M.; Uhrlandt, D.;Gött, G.: **Entwicklung eines Flammrichtprozesses für Aluminium.** In: Schiff und Hafen, Volume 3, 2022

Banaschik, R.; Otto, A.; Gericke, A.; Henkel, K.-M.: **Wirtschaftlich und prozesssicher schweissen: Elektrogasschweissen in der schiffbaulichen Praxis der Neptun Werft Rostock**. In: Der Praktiker, Volume 4, pp. 146–151, 2022

Presentations and posters

Brätz, O., Gericke, A.; Luther, A.; Henkel, K.-M.: **Qualitätssicherung in der Schweissnahtbehandlung zu Verbesserung der Schwingfestigkeit — Überblick aus Norm, Praxis und Forschung.** Presentation: 12. Rostocker Schweisstage, November 22–23, 2022, Rostock

Denkert, C.; Kühne, D.; Glienke, R.; Fiedler, M.; Dörre, M.; Henkel, K.-M.; Kästner, M.: **Fatigue resistance of sheet metal sections generated by press-bolt joints in cold forming**. Presentation: Fifth international conference on railway technology I RAILWAYS 2022, August 22–25, 2022, Montpellier

Ganschow, J.; Denkert, C.; Dörre, M.; Henkel, K.-M.; Flügge, W.: **Direct bolting of railway aluminium vehicle components with flow drill screwing (FDS)**. Presentation: Fifth international conference on railway technology I RAILWAYS 2022, August 22–25, 2022, Montpellier

Denkert, C.; Kühne, D.; Glienke, R.; Fiedler, M.; Dörre, M.; Flügge, W.; Kästner, M.: **Fatigue resistance of sheet metal sections generated by press-bolt joints due to cold forming.** Presentation: Join trans 2022: 6th European Conference "joining and construction of railway vehicles," May 11–12, 2022, Warsaw

Jagusch, K.: **Digitaler Prozesszwilling — Technologien und Potenziale, Digitaler Zwilling in der Fabrik der Zukunft**Presentation: Rostock, August 31, 2022

Cherewko, V.; Irmer, M.: **Underwater coating application as a smart repair process for coating damages on offshore structures**. Presentation: EuroCorr 2022, August 28–September 1, 2022, Berlin

Kelm, D.; Irmer, M.; Marquardt, T.: **Robot-assisted precoating of edge sections in maritime structures**. Presentation: EuroCorr 2022, August 28–September 1, 2022, Berlin

Irmer, M.; Marquart, T.; Momber, A.W.; Kelm, D.; Lauer, S.: **Innovative surface protection solution to replace multi-layer spray-applied liquid coating systems for offshore wind tower structures.** Presentation: EuroCorr 2022, August 28–September 1, 2022, Berlin

Conference presentations and papers

Glienke, R.; Schwarz, M.; Marten, F.; Eichstädt, R.; Schwerdt, D.; Hagemann, M.; Dörre, M.: **On fatigue strength of large-size bolt-assemblies in steel constructions under consideration of manufacturing and surface condition related impacts.** Conference: ISOPE, 2022

Hagemann, M.; Schwarz, M.; Glienke, R.; Schwerdt, D.; Henkel, K.-M.; Flügge, W.: **Tragverhalten von zugkraftbeanspruchten Lockstud-Systemen zur Herstellung von wartungsfreien Verbindungen.** Conference: 12. Gemeinsames Kolloquium zur Mechanischen Fügetechnik, 2022, Rostock

Scheithauer, T.; Brätz, O.; Maier, H. J.; Henkel, K.-M.; Hassel, T.: **Ermüdungsfestigkeit von nass geschweissten Offshore-Stählen**. Conference: DVS Congress — Large welding technology conference, 2022, Koblenz: DVS-Berichte, Volume 382, pp. 656–661

Glienke, R.; Kalkowsky, F.; Hobbacher, A. F.; Holch, A.; Luther, A.; Ripsch, B.; Günther, H.-P.; Kersten, R.; Henkel, K.-M.: **Bewertung der Ermüdungsfestigkeit von Rundnähten in Türmen von Windenergieanlagen — Ein Vergleich von experimentellen Untersuchungen und numerisch gestützter Nachweisführung auf Basis örtlicher Konzepte**. Conference: DVS Congress — Large welding technology conference, 2022, Koblenz: DVS-Berichte, Volume 382

Gericke, A.; Gött, G.; Uhrlandt D.; Henkel, K.-M.: **Einfluss von Schweissparametern auch Werkstoffübergang und Zu- und Abbrand von Legierungselementen beim Unterpulverschweissen mit Massiv- und Fülldrähten.** Conference: DVS Congress — Large welding technology conference, 2022, Koblenz: DVS-Berichte, Volume 382, pp. 315–331

Dörre, M.; Glienke, R.; Mantik, J.; Henkel, K.-M.: **Use of slotted holes in bolted connections for commercial vehicle construction**. Conference: 6th international conference on steels in cars and trucks, 2022, Milan

Schwarz, M.; Glienke, R.; Blunk, C.; Henkel, K.-M.: **Use of lockbolt joints for vehicle construction**. Conference: 6th international conference on steels in cars and trucks, 2022, Milan

Brätz, O.; Wolf, T.; Osten, J.; Hassel, T.; Henkel, K.-M.: **Nominal stress fatigue assessment on underwater wet SMAW fillet welded non-load-carrying attachments of construction steel**. Conference: ISOPE-2022 Shanghai Conference — The 32nd international ocean and polar engineering conference, June 5–10, 2022, Shanghai

Dörre, M; Glienke, R.; Henkel, K.-M.; Wegener, F.: **On the preload-time behavior of slip resistant preloaded joints in steel construction under cyclic loads**. Conference: ISOPE-2022 Shanghai Conference — The 32nd international ocean and polar engineering conference, June 5–10, 2022, Shanghai

Kalkowsky, F.; Glienke, R.; Dörre, M.; Henkel, K.-M.: **Experimental investigations on joints with blind rivets to extend the design rules according to Eurocode 3 for lightweight steel structures made of high-strength steels.** Conference: ISOPE-2022 Shanghai Conference — The 32nd international ocean and polar engineering conference, June 6–10, 2022, Shanghai

Hauer, M.; Gericke, A.; Allebrodt, A.; Henkel, K.-M.: **Thermal barrier coatings based on arc spraying of amorphous fe-based alloys and NiCrAlY for Cryogenic applications**. Conference: International thermal spray conference and exposition, 2022, Vienna

Gericke, A.; Brätz, O.; Luther, A.; Henkel, K.-M.: **Qualitätssicherung in der Schweissnahtbehandlung zu Verbesserung der Schwingfestigkeit — Überblick aus Norm, Praxis und Forschung**. Conference: DVS Congress — Large welding technology conference, 2022, Koblenz: DVS-Berichte, Volume 382

Kappis, L.; Karteusch, N.; von Cramon-Taubadel, E.; Froitzheim, P.; Flügge, W.: **A contribution to the automation of roll bending of heavy plates by upgrading roll bending machines with artificial intelligence**. Conference: Engineering proceedings — The 28th Saxon conference on forming technology SFU and the 7th international conference on accuracy on forming technology ICAFT, 2022, Chemnitz

Klink, S.; Beuss, F.; Flügge, W..; Sender, J.: **Time-based occupancy planning method for assembly areas at production site of large structures.** Conference: Procedia CIRP — 16th CIRP Conference on INTELLIGENT COMPUTATION IN MANUFACTURING ENGINEERING innovative and cognitive production technology and systems, July 13–15, Volume 16, Naples

Hayduk, M.; Sommer, R.; Kühn, O.; Beuss, F.; Flügge, W.; Gulden, J.: **Integrated planning tool for cost and 3D structural planning for offshore wind farms for the generation of H2.** Conference: Proceedings of WHEC 2022 — 23rd world hydrogen energy conference: Bridging continents by H2, 2022, Istanbul

Wendt, P.; Preuss, H.; Kleinhempel, W.; Renkewitz, H.: **Frankenstein goes swimming: software architecture of a modified blueROV2 heavy for underwater inspection and maintenance**. Conference: OCEANS 2022, Hampton Roads, October 17–20, 2022

Preuss, H.; Cherewko, V.; Wollstadt, J.; Wendt, A.; Renkewitz, H.: Blue crawfish goes swimming: hardware architecture of a crawling skid for underwater maintenance with a BlueROV2 Conference: OCEANS 2022, Hampton Roads, – October 20, 2022

Dryba, S.; Vincon; A.; Klötzer, C.: **Extra-large-scale robotics: Applications and advances**. Conference: ISR Europe 2022, 54th international symposium on robotics, June 20–21, 2022

Jagusch, K.: **Digital tracking of non-designed components in large structures**. Conference: 55th CIRP Conference on Manufacturing Systems, Lugano, June 30, 2022

Jagusch, K.: **Process control measures in reaction to assembly adjustments in one-off production**. Conference: 9th CIRP Conference on Assembly Technology and Systems, Leuven, April 6, 2022

Flügge, W.; Glück, N.; Fröck, L.; Wald, C.; Gude, M.; Koch, I., Tittmann, K.; Düreth, C.: **Lebensdaueranalyse für Klebverbindungen in grossen FKV-Strukturen mit variierenden Klebschichtdecken (Levadi).** Conference: 22nd colloquium: Gemeinsame Forschung in der Klebtechnik, February 15–16, 2022

Flügge, W.; Glück, N.; Fröck, L.; Gatzke, J.; Maier, H.J.; Hassel, T.; Vaccari, L.: **Untersuchungen und Optimierung der Prozessparameter und Werkzeuge zum Unterwasserkleben von Halterungssystemen (Unterwasserklebprozess)**. Conference: 22nd colloquium: Gemeinsame Forschung in der Klebtechnik, February 15–16, 2022

Froitzheim, P., Handreg, T.; Scharr, C.; Hildebrand, E.; Dryba, S.; Geist, M.; Woernle, C.; Flügge, W.: **Automatisierung eines Umformprozesses von Grobblechen im Schiffbau aufbauend auf bestehender Pressen und Handhabungstechnik.** Conference: EFB colloquium, 2022

Pionteck, A.; Wald, C.; Ambroast, T.; Rieck, S.; Geist, M.; Flügge, W.: **Automatisierung der Inspektion von Windenergieanlagen mittels optischer Messtechnik.** Conference: Tagungsband 3D-NordOst. Ed. G. zur Förderung angewandter Informatik. VDE VERLAG and Wichmann Verlag, 2022, pp. 27–35.

Kühne, D.; Hollas, L.; Denkert, C.; Dörre, M.; Glienke, R.; Kästner, Fiedler, M.: **Entwicklung eines Strukturspannungskonzeptes für umformtechnisch gefügte Funktionselementverbindungen**. Conference: DMK 2022 — Dresdner Maschinenelemente Konferenz, April 26–27, 2022, Dresden

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