Shaping the Future Together

Robotics of the Future: Interview with Bernd Liepert, KUKA AG

Efficiency in Plant Manufacturing: Optimal Value Added for Customers

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Dear Readers,

Since it was founded on 1992, the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg has been one of the institutions shaping the research and business scene in Saxony-Anhalt. It is a professional research provider for industry and a consultant for companies and municipalities. Our work also includes supporting promising technological developments, assessing potentials and anticipating future needs of industry. On this basis, our engineers develop new solutions and tools with which companies can operate and manufacture better, faster and more cost effectively.

This maxim is the basis for the development of our expertise in the field of digital engineering. This new field was already made a priority in Magdeburg early in the 1990s. Today, many companies, both large and small, rely on our digital technology know-how. The completion of our Virtual Development and Training Centre (VDTC) in 2006 once and for all established the Fraunhofer IFF’s standing as a top national and international center of digital engineering. The equipment and plant manufacturing industry as well as the chemical plant manufacturing industry have been profiting from this.

You will additionally learn about interesting details of current projects the Fraunhofer IFF is working on together with industry clients, which concern efficient and value added use of virtual realities in industry. For instance, virtual technologies can improve welder training and they make it far easier for industry to plan sustainable sites.

As always, in addition to learning the latest news from and about the Fraunhofer IFF, you will also be introduced some of our up-and-coming researchers and their exciting research topics. Much of their current work and studies will provide the foundation for successful business of tomorrow.

I would like to thank all the authors who contributed to and everyone who collaborated on this issue of our IFFocus and I wish you enjoyable reading.

Prof. Michael Schenk
NEWS

4 Bangkok: The Fraunhofer IFF Presents Digital Engineering

Magdeburg Intends to Become a Model City for Renewable Energies

5 Minister Presidents Conference: State Leaders’ Spouses Visit the VDTC

6 Saxony-Anhalt Powered Up

7 Looking Back Fifteen Years Ago: Construction Begins on the Institute’s Building

Virtual Reality against the Shortage of Skilled Labor

8 Malaysia: Fraunhofer IFF Supports Technology Transfer

The Robot Century

9 Growing Success

10 State is Supporting Lanxess and Fraunhofer Research Project with € 1.93 Million

11 First private Electricity Customers in 2010

Father Christmas at the Fraunhofer IFF

IN A FLASH

12 Impressions

13th IFF Science Days on June 15-17, 2010

INTERVIEW

14 Robotics of the Future

Interview with Bernd Liepert, CTO of KUKA Aktiengesellschaft

RESEARCH AND DEVELOPMENT

16 Efficiency in Plant Engineering: Optimal Value Added for Clients

20 Together into Plant Engineering’s Digital Future

26 Perfectly Assembled: Optical Assistance Systems for the Manufacture of Bookbinding Machines

30 Broad Expertise for Custom Equipment Manufacturing: Virtual Reality for Equipment Simulation
MAGDEBURG INTENDS TO BECOME A MODEL CITY FOR RENEWABLE ENERGIES

The Federal Ministry of Education and Research is promoting municipal energy conservation concepts with its “Energy Efficient City” competition. Magdeburg was one of five winning cities – also thanks to the Fraunhofer IFF’s cleverly devised concepts.

“With their trendsetting concepts they are pioneering innovations, which will be transferable to other cities and municipalities,” observed Minister of Education and Research Annette Schavan when she honored the five cities that won the competition against sixty-seven other cities and municipalities.

Saxony-Anhalt’s capital has ambitious goals indeed: Among other things, it intends to cut its carbon dioxide emissions by 2020 by two thirds over 1990. Over twenty partners from business, research and municipal bodies have joined forces and developed concepts intended to make the city a model for renewable energies.

BANGKOK: FRAUNHOFER IFF PRESENTS DIGITAL ENGINEERING

Thailand is facing major challenges. In order to be able to hold its own in the globalized economy, government and business are working intensively on shedding the image of an “extended workbench”. Qualification, cooperation and innovation are extremely important aspects of this transformation into a knowledge society.

Intent on supporting this process actively, the Thai Ministry of Labor organized an international conference in Bangkok on “Mega-Trends in Human Capital and Labour Productivity”. Over 2,000 international guests attended the conference at the downtown United Nations Convention Center, which was also prepared and organized by the Fraunhofer IFF’s Regional Office in Bangkok, among others.

The Fraunhofer IFF chiefly highlighted digital engineering. Over 140 representatives from government, industry, research and academia attended the Magdeburg institute’s event. The presentation concentrated on digital engineering’s commercial potentials and prospects as well as the latest tools and methods. The interest of the attendees of the conference in Thailand in the Fraunhofer’s know-how was also readily apparent during the accompanying exhibition. Our colleagues were especially pleased that Thailand’s Premier Minister Abhisit Vejjajiva stopped by at the Fraunhofer IFF’s presentation booth.
To this end, the Fraunhofer Institute for Factory Operation and Automation IFF coordinated a feasibility study in which fifteen actions were selected from an original thirty ideas for implementation during the project. It considered technical, organizational, economic and temporal criteria as well as potentials to conserve energy and reduce CO₂ and transferability to other cities and municipalities.

The research institute itself contributed two implementation concepts. Its logistics experts formulated plans for so-called mini-distribution centers. Among other things, the concept relies on state-of-the-art localization systems and an intelligent swap body concept intended to make the distribution of low-volume urban freight transport more energy efficient. In addition, the Fraunhofer IFF’s process and plant engineers are planning to construct a plant that recycles all of Magdeburg’s green waste and generates power and heat from it. “Anybody can burn wood. But the utilization of green waste and foliage in conventional systems was difficult,” explains Sascha Thomas, coordinator of the Fraunhofer IFF’s contribution. New compact fluidized bed technology from the Fraunhofer IFF will eliminate the problem. At a thermal firing capacity of three to four megawatts, it attains an overall efficiency of eighty percent.

The city of Magdeburg successfully relied on its own strategies, technologies and innovative services for the nationwide competition. It aims to cover over fifty percent of the city’s energy requirements (excluding transportation) with renewable energies and low emission incineration of waste by 2020.

MINISTER PRESIDENTS CONFERENCE: STATE LEADERS’ SPOUSES VISIT THE VDTC

The annual conference of the minister presidents of the German states was held in Magdeburg on October 21 and 22, 2010. As part of the extensive supporting program, the state leaders’ spouses also visited the Fraunhofer IFF’s Virtual Development and Training Centre in Magdeburg.

The interested visitors learn how virtual reality is used at the Fraunhofer IFF to engineer plants, for instance. Photo: Martin Stiller

The tour through the VDTC’s technical facilities and laboratories, which was featured as a “Landmark in the Land of Ideas” in 2006, included a stop in the Elbe Dom. With a diameter of sixteen meters and a projection surface of three hundred square meters, this 360 degree large laser projection system is Germany’s largest mixed reality lab for the virtual interactive planning and development of factories, plants or entire sites on a scale of 1:1.

A virtual stroll through the historic downtown of Lutherstadt Wittenberg enabled the visibly fascinated visitors to experience first hand the possibilities the spectacular system provides Fraunhofer engineers and their clients. As a farewell, the VR specialists demonstrated how the downtown’s appearance changes by integrating modern architecture by clicking a mouse. The Fraunhofer IFF has already implemented this scenario for a number of cities.

Magdeburg is already one of Germany’s greenest cities. The metropolis on the Elbe also intends to become a model city for renewable energies. Photo: Erich Kasten, pixelio.de
SAXONY-ANHALT POWERED UP

What will future transportation with electrical vehicles look like? One thing is certain: Not only will it have to function smoothly. The power needed ought to stem chiefly from renewable sources. However, suitable networks and logistics systems hardly exist so far. The crucial testing phase for the Harz electric vehicle network began in Magdeburg in the fall of 2010. It is intended to demonstrate the feasibility of “clean transportation”.

How we travel our nation’s roads electrically in the future depends on many criteria. One of them is the development of so-called “smart grids” that flexibly coordinate the supply of and demand for energy. One of the major challenges will be reliably and securely assuring communication among all the elements involved in the grid.

Testing of the Harz Electric Vehicle Network started in Magdeburg in the fall of 2010. Systems created for grid communication and energy logistics are being field tested. The concept and the related technologies were developed in the Federal Ministry of Education and Research’s project Harz.EE-Mobility. Lead managed by Otto von Guericke University Magdeburg, fifteen top regional and national partners from business, academia and research are collaborating on the implementation. The Fraunhofer IFF is primarily responsible for the development of the important logistics control center and the integration of the necessary communication technologies.

However, electric vehicles themselves play a leading role in the overall concept. They are intended to be part of an intelligent mobile electricity storage system. The basis for this are new vehicle batteries with energy recovery capability. This technology enables electric cars both to store energy and return it to the grid as required. A central digital control center developed for this by the Fraunhofer IFF continually registers the energy level of all registered electric cars and manages their power supply while allowing for the electricity supply. If the grid is low on electricity, it can draw energy from vehicles parked long-term and connected to the system.

Electric test vehicles have been rolling through Magdeburg and the Harz since September 2010. Above all, private individuals, commuters and companies are using the new electric vehicles. The test phase in the Harz and Magdeburg regions will conclude by the end of 2011.

New electric vehicles will not only “fill up” with electricity but also return it to the grid, thus making them mobile electricity storage systems in future grids. Photos: Viktoria Kühne
LOOKING BACK FIFTEEN YEARS AGO
CONSTRUCTION BEGINS ON THE INSTITUTE’S BUILDING

The Fraunhofer IFF was bursting at the seams: its researchers were working so successfully at three locations that continual growth was causing real space problems: in the TBZ on Elbstrasse, in offices at the Technical University Magdeburg and in the branch in the Innovations- und Gründerzentrum in Barleben. Since its founding in 1992, the number of employees had tripled to over ninety. Luckily, there was a prospect to improve the situation: at the end of the year, construction started on a new institute building on Askanischer Platz. Alternative locations were also discussed, e.g. the present premises of Magdeburg University of Applied Sciences, other abandoned former Russian army facilities or even the commercial port.

VIRTUAL REALITY AGAINST THE SHORTAGE OF SKILLED LABOR

“Day-to-day business without virtual technologies will be difficult to imagine in the future,” declared Minister of Economics and Labor Reiner Haseloff at the launch of the ViReKon project in May 2009. The validity of this assessment was demonstrated by the subsequently great interest in the project intended to transfer virtual reality technologies to medium-sized enterprises in the processing industry in Saxony-Anhalt.

The impetus for the ambitious project came from the Fraunhofer Institute for Factory Operation and Automation IFF, which, contracted by RKW Sachsen-Anhalt, is also responsibly for the majority of its implementation. Director Michael Schenk especially emphasized the new technologies impact on the feared shortage of skilled labor, which should not be underestimated in the face of demographic change. He underscored the necessity of action since the fundamental problems to follow must be counteracted by current actions.

The ViReKon project has been running two years. Therefore, developers and users gathered for a corporate conference at the Fraunhofer IFF’s Virtual Development and Training Centre VDTC in Magdeburg in October 2010. The assessment thus far was very positive. The goal of not only familiarizing regional SMEs with advanced virtual reality technology but also implementing concrete applications has already been more than met. The expectation that the resultant better qualification of skilled labor would improve competition has also been fully confirmed according to project coordinator Dr. Hans-Joachim Clobes from RKW Sachsen-Anhalt. This pioneering work has already been performed for six industrial companies and two educational providers. Now it is up to other companies to also get on board for the future.
The Robot Century

Mars researchers, powerful industrial workers, precise assisting surgeons or multilingual museum guides – robots can perform diverse jobs in our world. Yet, how long will it take until everyone not only has a PC but also a PR, i.e. a personal robot? How far is robotics? What capabilities do robots have today? Will robotic pioneers’ visions be fulfilled? The exhibition “The Robot Century” at Magdeburg’s Allee Center was intended to answer these questions. It ran from October 11 to 23 and displayed many extremely interesting exhibits of the history and present and future visions of robotics.

In addition to the exhibition, the organizers also delivered action. Spectacular robot competitions, workshops for school students and introductory courses for children and youths, which were given by Otto von Guericke University and RobertaRegio-Zentrum, were intended to make this technology more accessible, above all for young people.

Sunday, October 16 was especially exciting when Otto von Guericke University Magdeburg’s Department of Automation presented interactive research robots under the motto “Robots with Feedback”. At the same time, Otto von Guericke University and the Fraunhofer IFF’s joint RobotsLab presented “Robots on Two Legs”, specifically the so-called walking robots “Katharina”, “Anton” and “Rotto”. These multi-legged, particularly agile robots adjust extremely well to uneven terrain. They are able to surmount obstacles and are thus especially suited for use in inaccessible environments or in danger zones.

Malaysia: Fraunhofer IFF supports technology transfer

To this end, the Fraunhofer IFF 2010 conducted an industrial user workshop in Malaysia in 2010. A number of top ranking representatives from industry, government and research were present at the well-attended event. The Fraunhofer IFF presented its best practice solutions for the petrochemical industry, power engineering, the aviation industry and urban planning to inform attendees comprehensively about the potential benefits of advanced virtual reality technologies.

Building upon industrial pilot projects, there are plans to build and operate a national user center for virtual reality in Malaysia in cooperation with the Fraunhofer IFF.

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Saxony-Anhalt is increasingly becoming a center of cutting-edge research and business innovation. In order to continue to foster and support this development, Saxony-Anhalt’s Minister of Economics and Labor Reiner Haseloff and Minister of Finance Jens Bullerjahn started the campaign “Growing Success” in Magdeburg’s Fraunhofer Institute IFF on October 27, 2010. It is focusing on success stories in the state’s innovative industries and the systematic support of sustainable sectors of the economy with the aid of The European Regional Development Fund ERDF.

“Saxony-Anhalt’s potential for innovation has grown tremendously in recent years. Whether traditional industries such as equipment manufacturing or young industries such as renewable energies – nationally and internationally competitive products and process innovations are being produced here. The intense efforts to attract companies with research and development activities to Saxony-Anhalt is increasingly successful. An efficient infrastructure for innovations is advancing the region’s position in international competition. At present, three new research institutes are being established with funding of € 142 million. The European Union’s development fund is a key part of this success. The twentieth anniversary of reunification and the midterm evaluation of the current EU development fund period are good reasons to draw the public’s attention to these achievements,” said Haseloff at the kick-off at the Fraunhofer Institute for Factory Operation and Automation IFF’s Virtual Development and Training Centre VDTC.

Minister of Finance Bullerjahn emphasized that “Saxony-Anhalt has been profiting from the ERDF since 1991. Between 2007 and 2013, € 1.93 billion and from 2007 to 2009 over € 300 million flowed into 1,283 research and development projects. This is not only boosting Saxony-Anhalt’s competitiveness but also its tax revenues. With the strategic approach of consolidating the budget while simultaneously setting priorities, among other things, for investments in innovative sectors and research and development, we are establishing the conditions to create high quality and sustainable jobs.«

The campaign is addressing five exemplarily innovative sectors: renewable energies, equipment manufacturing and metalworking, automotive, chemicals and synthetics and biopharmaceuticals.
STATE IS SUPPORTING LANXESS AND FRAUNHOFER RESEARCH PROJECT WITH € 1.93 MILLION

High tech membranes for water treatment systems will be developed and manufactured in Saxony-Anhalt in the future. In Magdeburg on November 4, 2010, Minister of Economics and Labor Reiner Haseloff presented three grants totalling € 1.93 mill. for the joint research project between IAB Ionen austauscher GmbH in Bitterfeld – a wholly owned subsidiary of the specialty chemical company LANXESS – and the Fraunhofer Institutes for Factory Operation and Automation IFF in Magdeburg and for Mechanics of Materials IWM in Halle. Other partners in the joint project are Martin Luther University Halle-Wittenberg and the Leibniz Institute of Polymer Research IPF in Dresden. The core of the project is the computerized optimization of the membrane manufacturing process and the development of novel chemical and biochemical methods to treat their surface. LANXESS is currently building a new chemical plant for around € 30 million in Bitterfeld-Wolfen where state-of-the-art membrane technology for water treatment will be developed and later also manufactured.

“With this grant, we are investing in a technology of the future, which will also open good job prospects in the state in the medium and long term,” said the minister. Growing strongly worldwide, the water treatment sector provides outstanding export opportunities. Haseloff continued, “it is all the more important that we beat out numerous international locations and brought not only the production but also the development of this novel membrane technology to Saxony-Anhalt. The involvement of many prestigious research partners is promising for very successful research.”

Head of research and development in the Business Unit Ion Exchange Resins (BU ION) at LANXESS, Dr. Michael Schelhaas emphasized this as well when he said, “the outstanding research scene here in Saxony-Anhalt was a decisive factor when we decided to locate in Bitterfeld-Wolfen. We consider this an opportunity in Saxony-Anhalt to implement results obtained from research directly in the improvement of manufacturing methods and product quality in Bitterfeld-Wolfen.”

Professor Michael Schenk, Director of the Fraunhofer IFF in Magdeburg, sees the start of the large-budget research project as an affirmation of the strong standing of Saxony-Anhalt’s research institutions. “Collaboration between business and research is traditionally one of the Fraunhofer Institutes’ key tasks. Two Fraunhofer Institutes, one Leibniz Institute and one major state university are represented in this joint project. The high regard internationally operating corporations have for these research partners is proof that Saxony-Anhalt attracts companies as a center of research.”
FIRST PRIVATE ELECTRICITY CUSTOMERS IN 2010

The federal government hopes to see at least one million electric cars driving Germany's roads and thus less CO₂ emissions in just under nine years. The first electric cars have been commercially available for a while. Slowly but surely, there will be more. “Filling up” has also been made somewhat easier for electric vehicle pioneers, albeit the charging stations needed are still not available everywhere.

The first private customer used the charging station at the Fraunhofer IFF’s Virtual Development and Training Centre VDTC shortly after it opened. Steffen Krause, a teacher from Halle an der Saale, occasionally drives his electric car the distance of roughly 100 kilometers between his hometown and the capital city of Magdeburg.

He learned from the news that one of the first electricity charging stations had opened in Magedeburg when the test phase of the “Harz Electric Vehicle Network” started in the fall of 2010. He spontaneously established contact. The teacher is happy that he can always rely on one charging station in the capital for his electric car on his trips. He does not mind the prior registration required in the least. “This way, I know at least that the plug isn’t taken whenever I arrive,” he says grinning. When the test phase of the Harz Electric Vehicle Network proceeds as successfully as the engineers from the Fraunhofer hope, planning his trips could get even easier soon. As close to all electric vehicles as possible will be equipped with state-of-the-art systems that display all the charging stations located in the vicinity and their own charge. They will be able to conveniently announce the best charging stations in advance, book them in advance for the next day or be guided to alternative charging stations. All in all, this ought to simplify electric vehicle networks significantly. At any rate, “filling up” will be convenient. At the moment, charging at the charging station in Magdeburg’s Port of Science is even free. In the future, a complete charge would cost around five euros. That is currently the normal price for the amount of energy needed to drive 100 kilometers with an electric car.

FATHER CHRISTMAS AT THE FRAUNHOFER IFF

This year’s Christmas party for the children of Magdeburg’s Fraunhofer Institute’s employees was a wonderful event. Frosty temperatures and snow outside and even homemade cake and cookies inside made for ideal spirits in the Christmas season. The children passed the time until Father Christmas arrived by playing, painting and dancing together to Christmas carols. Then, the wait was finally over. Father Christmas strode into the room and had brought something for all the children, which they naturally received only after reciting a poem or singing a song. In short, it was a good afternoon for big and small.

Halle native Steffen Krause was the first private electricity “customer” at the new charging station for electric vehicles in Magdeburg’s Port of Science. Photo: Martin Stiller

Father Christmas was also at the Fraunhofer IFF and brought something for all the children. Photo: Dirk Mahler
KUKA AG is one of the world’s leading manufacturers of robotic and control systems. The company is one of the driving forces behind a European strategy for the development of future robot applications. Bernd Liepert, CTO of KUKA AG, discussed the Strategic Research Agenda or SRA for robotics with IFFocus editor René Maresch.

Mr. Liepert, robots are still rather awkward and, forgive the expression, dumb helpers for humans. Will they ever be able to be our partners in our daily work?

Robots are only as “smart” as we make them. However, with the right software, robots are anything but dumb. The age of service robotics has long since dawned. Applications already exist in which robots work hand-in-hand with humans and support them in their everyday work.

In industry on the other hand, the robot is the quintessential universal automation component. After all, it is not specialized in one concrete job or one concrete field of application. This makes it so flexibly implementable. Further development of safe robots has made space-saving cell concepts possible here. Moreover, this opens the door to human-robot applications in assembly operations, for instance.

For some time, KUKA has been developing solutions in which robots actively support humans by acting as their “assistant”. This technology could, for example, be implemented as a manufacturing assistant in assembly and even as a nursing robot that enables the elderly to live independently at home longer.

With its integrated sensor systems and low deadweight, KUKA’s lightweight robot, for example, is suited for just such tasks. As part of a design study, it was mounted on a mobile platform. The study is a mobile manipulation technology demonstrator and being used to develop and evaluate new technologies.

KUKA is the lead partner in the formulation of the SRA, the Strategic Research Agenda for robotics. A large number of different European industry and research partners, all leaders in their field, has united to collectively deliberate on the future of robotics. Why is such a complex initiative necessary?

This initiative is so complex because the technologies and the tasks being dealt with are so complex. Issues such as our aging society, climate change, security, green production are all challenges facing our society, which require ongoing discussion and call for state-of-the-art technological concepts, which can
only be developed collaboratively. EUROP, a technology platform with 130 members, is addressing precisely these challenges. The Strategic Research Agenda for robotics is intended to identify potentials in industry.

The agenda was published in 2009 and contains a mix of clear strategy and vision. What’s the situation now?

SRA already began to make an impact during its development. Many, who contributed in advance, were already influenced by the SRA’s content at this early stage. The participants in the consensus meetings held to prepare the agenda also established many new contacts. First and foremost, this helped interrelate the different sectors, namely industrial robotics, domestic and professional robotics, service robotics, and space and security robotics. Thus, the agenda’s sixth recommendation (supporting cross-fertilization to maximize the impact of R&D) was being tackled before the SRA had been finalized.

Furthermore, the first stages of the strategy are already being implemented in the research project euRobotics (www.eurobotics-project.eu). It includes work packages that explicitly deal with implementing number 4 (Focus on the right research and technologies), number 5 (Create new markets through SME support and technology transfer), number 6 (Support cross-fertilisation to maximise the impact of R&D), number 7 (Enhance robotics training and education) and number 8 (Avoid ethical, legal and societal issues becoming barriers).

The second work package is intended to enhance the image of European robotics and simultaneously also cover recommendation number 1 (Take advantage of robotics technology in all aspects of life) as well.

Given the aims of the SRA, we will presumably be encountering robots very soon in many domains, even ones hardly imaginable today. Should we get ready for surprises?

How surprising was the arrival of the age of the Internet? How much do smartphones still surprise us? All these are routine, even though we all literally dialed numbers as children. Robotics is going to help and support us and make life easier in many domains. It’s hard to say whether it is going to surprise us. But I’m sure, it’s going to get us excited.

How will future robots differ from present robots?

Future service robots will differ from the robots familiar to us from industry in many ways. They will be lighter and more sensitive. They will move on mobile platforms and cooperate with humans.

What will the key challenges be? What technologies have to be advanced?

Autonomous navigation and sensor systems are examples of issues we will also be working on in the future.

How does KUKA envision manufacturing and services in 2025?

I believe that manufacturing will be inconceivable without robots in 2025 and there will be many fields of application in the service sector. By the way, your readers can look at a realistic preview in the SRA you mentioned at www.robotics-platform.eu/SRA.

BRIEF CV

Bernd Liepert, CTO of KUKA Aktiengesellschaft

1990, Diplom degree in mathematics from the University of Augsburg

1990-1996, staff member, Development Unit, KUKA Schweißanlagen und Roboter GmbH

Development manager at the newly established KUKA Roboter GmbH

1998-99, member of the management board, head of development and design

2000-2009, executive board spokesman, KUKA Roboter GmbH

2010 - present, CTO of KUKA AG and head of technology and development for the entire KUKA Group

January 2011 - present, CEO of the newly established KUKA Laboratotories GmbH.
EFFICIENCY IN PLANT ENGINEERING
OPTIMAL VALUE ADDED FOR CLIENTS
Several phenomena of globalization, e.g. rapidly growing new markets and increasingly qualified but cheaper labor in threshold countries, have thrust the chemical and pharmaceutical industry in Central Europe into a dynamic competitive situation. They lack the proximity to major and growing markets and new suppliers are taking over the leadership of commodities markets. The process industry’s reactions to these challenges are to specialize, to boost efficiency and to build and operate its own plants in these markets. The same mechanisms are at work when these plants are engineered and constructed: Local engineering services and local equipment suppliers normally have lower labor costs. This is also placing plant and equipment manufacturers under pressure.

Just as the process industry must continuously develop new products and processes to maintain its competitiveness, plant manufacturing is also being compelled to boost efficiency and pursue new directions, which must lower investment and life cycle costs. Especially wherever the innovative process industry cooperates with the plant manufacturing industry and equipment suppliers, new solutions are being produced, which cannot be imitated very quickly and provide everyone involved a competitive edge.

This coordinated approach with plant manufacturers generates potentials for value added for a plant’s future operation. At the same time, Central European expertise in developing systems and processes that conserve resources, e.g. energy and raw materials, creates a business advantage over competitors in threshold countries, which have been relying on economies of scale.

This edge in innovation and efficiency is stabilizing Central Europe’s industrial structure and generating new sectors of growth. The following examples show that this is working.
New Products Require New Concepts

New products, which incorporate nanotechnology for instance, require completely new manufacturing concepts in new plant, which in turn are managed with new methods. Textbook unit operations could no longer be implemented to manufacture the carbon nanotubes (Baytubes®) invented by Bayer. Traditional process equipment engineering was also unable to meet the requirements imposed. Novel components based on microreactors were developed in collaboration with small and medium-sized enterprises.

Microreactors (Photo 2) have become established and have “intensified” different processes for manufacturing common chemicals, thus cutting manufacturing cost in half. Thus, for example, the new BAYQIK® process for manufacturing sulfuric acid eliminates constraints that have existed for fifty years:

- Emissions have been cut by a power of ten.
- Energy efficiency has been increased by twenty-five percent.
- Catalyst consumption has been cut in half.
- Capital expenditures have been cut in half.

An example from the pharmaceutical industry plainly reveals how greatly plant concepts have changed. The development of so-called disposables, i.e. inexpensive components that are disposed of after one use, is radically affecting construction and operation. They require more planning services than classic plant planning but fewer hours of planning, less space and less investment. In addition, implementation times, plant documentation, manufacturing regulations (standard procedures) and required inspection and monitoring are all reduced.

Photo 4 conveys an impression of how BaySHAKE® can replace common 5 m³ chemical reactors. Such radical changes in plant engineering make it necessary to modify classic plant planning.

Virtual Reality for Planning, Construction and Commissioning

More and more, specific problems are being worked on with high-end and therefore special IT tools, which include simulations of physical targets (process, fluid and reaction dynamics, dynamic loads, malfunctions, energy fluxes, etc.) and of economic targets (value stream mapping, supply chain optimization, availability studies, layout optimization, etc.). However, the individual findings must be consolidated and the tools integrated more greatly.
Here too, Magdeburg’s Fraunhofer Institute for Factory Operation and Automation IFF has made groundbreaking advances in the integration of virtual reality and flow simulation. These methods deliver information, which is not only needed for plant engineering and construction but also used to manage plants more efficiently after commissioning. This enables operators to develop a potential for value added, which sets them apart from competitors. Among other things, this includes asset management, maintenance planning and continuous optimization. Asset management has become established among many companies for open and closed loop process control components. However, the instrumentation and equipment still entail challenges.

Operator Training Optimizes Plant Operation

The introduction of operator training simulators (OTS) has had the single greatest impact on traditional plant engineering. OTS are systems like flight simulators and are used both for basic training and for training and support of plant operators during operation. The development of the training simulator altered the structuring of projects and planning of decision-making milestones significantly. More than half of the work of process control engineers has been completely restructured.

The additional work already pays off through virtually perfect planning and trouble-free commissioning shortened to a quarter of the time. In later operation, plant operators use the tool for continuous optimization. Ultimately, this changes the job of plant operators. Instead of being “manual laborers” in the control concept, they are in charge of optimizing the operating results.

These examples demonstrate that plant engineering is now fully integrated in the plant life cycle, from an innovation to operation, and provides the basis for optimal value added during a plant’s entire service life. Thus, Central European industry has responded to the challenges of global competition and has once again become the leader in innovation and efficiency. Keeping this edge will require rigorously building upon the incipient development. Two issues will hold the key to success:

1. Integration of small and medium-sized enterprises in holistic solutions;
2. Progress in the integration of digital engineering and simulation systems.

Dr. Ralf Sick-Sonntag, Bayer MaterialScience AG, Head of Contractors Management

Photo 3: The BAYQIK® sulfuric acid system.

Photo 4: Bayer Technology Services’ BaySHAKE® in the development lab and in production.
Photos: Bayer Technology Services GmbH
The rapid development of innovations in countries such as India and China is radically changing the basic conditions of the global chemical market and thus the plant manufacturing industry, too. German chemical companies are global leaders. However, they will have to prepare themselves and their plants for noticeably different new market conditions by 2020. In addition to output and plant availability, competitive edges such as resource and energy efficiency and environmental compatibility and optimal plant maintenance concepts will have to be maintained and refined.

Priorities in this development are no longer only maximum availability, maximum automation and minimum capital expenditure but also altogether optimized plant life cycles. German plant manufacturers will need more than innovative solutions to stay at the top of international markets. Reaching these goals will necessitate engineering plants to be state-of-the-art and continually optimizing them. In addition to German plant engineers’ world famous know-how, new technologies such as digital engineering and virtual reality (VR) are increasingly playing a role.

“We have to do more.”

Despite the clear advantages of digital engineering and development in equipment and plant manufacturing, their broad use is still subject to obstacles. Not least, the great diversity of the available software tools and the networked structures of suppliers, subcontractors and operators are often more of a hindrance than a support. Thus, industry’s structural problems far too frequently hinder the use of digital engineering tools. Work still needs to be done on transferring knowledge to companies so that data can be used and reused in the plant life cycle.

However, if we intend to assure the industry’s success in the long term, we will have to do more than just point to the present quality and level of development of our research and leading industrial companies. It is essential that we take small and medium-sized enterprises with us into the digital future of plant engineering. To do so, we will have to not only enable them to work with state-of-the-art software and technology and implement them efficiently in often extremely complex and networked corporate structures. We will also have to promote the exchange of technical experience among them. After all, the smaller companies that attempt to go it alone in global competition will have the most difficulty. However, comprehensive using digital development tools and thus increasing a plant’s value added by boosting efficiency and utilizing data...
throughout the entire life cycle can become another unique selling point for Central European companies and thus a significant edge in international competition.

**Networking to Transfer Knowledge**

This know-how transfer and technical support for companies through the integrated use of digital engineering technologies also plays a major role at the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg. Very early on, its researchers already identified effective company networking as elemental to long-term success. Therefore, shortly after it was founded in the 1990s, the institute became one of the initiators of the Saxony-Anhalt Association for the Promotion of Mechanical and Plant Engineering or FASA.

The restructuring of the Eastern German economy and restart of the chemical industry necessary at that time confronted local companies with tremendous challenges. Given the internationally nearly unprecedented investments in the Central German chemical triangle, the scientific and holistic approach to engineering, equipping and operating complex technical systems and plants pursued by the association’s members was a practicable and, as it turned out, a very effective solution for regional companies. The Fraunhofer IFF assumed a key role, especially in the development and integration of new methods of digital engineering for equipment and plant manufacturers.

**Foundations of Digital Engineering**

Effective information architectures, which supported operations in the bid phase based on requirements, were already developed as part of an “integrated engineering system” in 1996. They also additionally aimed at supplying future operations structured information in the operator phase. The software systems involved in the four levels of data, tool, process and user were analyzed. Thus, necessary information from the widest variety of applications were integrated on the data level.
as a common data model. The next task the Fraunhofer IFF and its partners and clients worked on was mapping all of a process plant’s data for life. This involved their engineering, construction and operation by regionally supplying digital information on products and services or their providers and exchanging data cross-company on the basis of standardized interfaces such as STEP or EDIFACT.

Finally, the tool IDAS97 was developed in 1997. It essentially supported the reorganization of maintenance units. IDAS97 is a maintenance data management system, which can be imported to any rapid development application systems and thus ideally integrated in individual EDP environments. This enabled engineers and operators to estimate future maintenance expenditures based on and in conjunction with existing empirical knowledge.

Despite these major advances, the road to today’s digital engineering was still long. Another step in this direction was the development of holistic quality control loops based on RFID chip systems and advanced service systems. The core of this development was diverse industry projects completed by the Fraunhofer IFF together with plant operators, engineers and suppliers. Past and present partners include companies such as DOW, LURGI, Babcock, SAP, Voest Alpine, Weber Rohrleitungsba, Stahlbau Magdeburg, Lindner Isoliertechnik and many others. These projects continually met new challenges and developed visions, which constitute the foundation for today’s digital planning and digital engineering.

Active Support

In addition to its work with FASA, the Fraunhofer IFF launched the conference series “Plant Engineering of the Future” in 2000. These two extremely successful platforms very systematically put plant manufacturers in the position to act on innovations faster and implement them more promptly. Held every two years, the conference “Plant Engineering of the future” has even become one of the most important industry events at which plant manufacturers from all over Germany gather to exchange experiences.
Beyond these central events, providing companies active support for quite specific challenges as well is extremely important. The Fraunhofer IFF is meeting these needs with the “Cooperation in Plant Engineering” working group and the “Efficiency in the Plant Life Cycle” initiative, among other things. The engineers are primarily working on efficiently implementing the latest virtual engineering technologies for project management, engineering, sustainable staff qualification and reliable plant operation. However, the focus is increasingly shifting from individual companies to the complete chain of development and production. Companies are in need of consulting in three points in particular:

1. developing methods of plant engineering, construction and operation oriented toward the life cycle,

2. empowering suppliers to pursue the technological challenges and

3. extending the use of methods of digital engineering to the entire plant life cycle.

The Fraunhofer IFF in Magdeburg has an excellent facility to do all this, its Virtual Development and Training Centre VDTC, which is unparalleled worldwide in terms of its technical systems for the digital engineering and 3-D visualization of technical systems. The combined engineering know-how on hand at the institute, its close ties with other research organizations such as Otto von Guericke University Magdeburg and the Center for Digital Engineering CDE, and the quality of all the environments for technical development in Magdeburg has made the Fraunhofer IFF one of Europe’s outstanding centers of digital engineering.

Virtual design reviews have become an integral part of plant engineering. At the Fraunhofer IFF’s Elbe Dom, virtual plants can be inspected highly realistically in a 360 degree projection and on a scale of 1:1. Photo: Dirk Mahler

Engineers use virtual design methods to quickly and intuitively take a realistic look at a plant during development which otherwise exists only as an abstract model. Photo: Dirk Mahler
Fraunhofer IFF as a Hub for VR Research Guided by Industry

Given its standing, the institute is playing an important role in a number of German development initiatives in the field of digital engineering such as the “Virtual Technologies Innovation Alliance”, which is integral to the German government’s High-Tech Strategy ICT 2020.

It is focused on preparing and intensifying the use of human-centric virtual technologies for industry. The Fraunhofer IFF in Magdeburg is not only a partner but also the research and technical hub for two of the Innovation Alliance’s four projects, AVILUSplus and ViERforES. In AVILUSplus, challenges and potential applications of virtual technologies are being researched, which, given the present state of development, will only be available to industry and thus in the product and manufacturing equipment life cycle long range. In ViERforES on the other hand, research is being done on current virtual and augmented reality applications for safe, secure and reliable embedded systems and thus already on concrete applications for the optimization of products in the widest variety of industries. The VIDET Innovation Cluster is yet another step forward. The companies and research organizations involved are turning the latest findings from research on digital engineering and virtual reality into new products and systems. Above all, small and medium-sized equipment and plant manufacturers are profiting from the cluster, since the implementation and integrated use of digital development tools keeps development work and thus costs and risks low and transparent. The innovation cluster has established itself extraordinarily successfully. Many of the companies involved have recognized the potential for other virtual engineering and virtual reality
applications for themselves during their collaboration with the Fraunhofer IFF and intend to collaborate with the institute in the future, too, in order to develop these potentials.

The Challenge of Full Digitization

The final analysis reveals a growing alliance of research organizations, industrial companies and government, which is expediting accessibility to and complete utilization of digital tools in production and the overall life cycle of products. Integrating the many different commercially available software tools and bridging the diverse corporate structures will be the key to success. German and European companies that want to remain globally leading producers and plant manufacturers will have to face the challenge of fully digitizing their planning and manufacturing operations. This is the only way to already identify and take advantage of hidden potentials for efficiency during development. The accompanying cuts in overall costs will enable companies to create another edge for themselves in global competition.

Prof. Ulrich Buller, Executive Board of the Fraunhofer-Gesellschaft

Even before a plant really real exists, its digital design data can be used to create realistic simulations for design reviews, service operations or training on its controls. To train staff, a real controller was combined with a virtual interactive model of a heavy machine tool. Photo: Dirk Mahler
PERFECTLY ASSEMBLED

OPTICAL ASSISTANCE SYSTEMS FOR THE MANUFACTURE OF BOOKBINDING MACHINES
Augmented reality (AR) has long since become standard for cell phones and navigation systems. Virtual computer data is superimposed on real GPS data to determine real position, a principle that can also be employed in industrial settings. The Fraunhofer IFF developed an augmented reality system for a manufacturer of bookbinding machines, which supports assemblers when they are putting together complex assemblies.

In the Middle Ages, bookbinding was an art that required great dexterity and was mastered by very few. Sheets of paper were laboriously finished, folded, glued and bound in artistically decorated covers by hand. This work is now performed by custom machines like those that Kolbus GmbH & Co. KG in Rahden (North Rhine-Westphalia) has been manufacturing for over one hundred years. More than thirty types of machine collate the sheets, bind them with adhesive, separate and cut them and produce and finish the cover until a book is finished.

However, manual labor is still being performed to a certain extent at the equipment manufacturer in North Rhine-Westphalia. Kolbus manufactures its equipment to order and only in small quantities. Thus, the machine components manufactured are extremely diverse and repeatedly switching orders every day entails time-consuming resetting every time.

Many Variants: Great Potential for Errors

Many industrial assembly operations have many variations because the products are customized. Whenever assembly is executed manually, the quality of the finished product is influenced subjectively and may be faulty. Errors made during production normally cause increased costs or even complete malfunctions of equipment.

When Kolbus manufacturers bookbinding machines, one of the many steps entails using CNC machining centers to machine blanks into finished components. For each blank, a worker must manually assemble a special holder, a so-called clamping system, from standard components. Then the blanks to be machined are clamped in the system and inserted as a unit in the CNC machine for machining.

Until now, workers at Kolbus have copied the clamping systems from photos. Screenshots of digital assembly drawings served as a template. The correctness of the clamping system's construction was not inspected. A trial run had to cautiously verify that the machine would not collide with the clamping system. This requires utmost precision. In the worst case, a collision could even mean a total breakdown of the machine. Only after the trial run, performed at significantly reduced speed to protect the system, were workers certain that the twenty to sixty individual components were mounted on the matrix plates in the correct positions and at the specified intervals. Altogether this was a time-consuming process that lasted between five and ten minutes depending on the order and the machine and significantly prolonged production times.

Together with staff from Kolbus, engineers from the Fraunhofer IFF in Magdeburg developed a solution that provides assistance and inspects quality during the complex assembly of the clamping system: An augmented reality assistance system.

Visual support by augmented reality compares the real assembly situation with digital assembly drawings in each case, thus supporting a worker's actions and helping prevent errors.

Assembly assistance system for a workplace where Unisign UniPro 5P base plates are tooled. The revolving component holder is in the foreground, the touchscreens with camera overlay and CAD representation in the background. Photo: Kolbus GmbH & Co. KG
Visual information is provided for the component being assembled or an assembly and thus clear instructions as well. Even when variants and types of assembly are constantly changing, this assures the operation is highly reliable because workers are informed exactly where which part must be mounted and how.

Camera and CAD Models as Assistants

The assistance system has two groups of input data at its disposal: the data from a video camera filming the workplace and the design data of the assembly being assembled, including every individual component in the form of 3-D CAD models.

When structures are stationary, an external reference system is employed to first determine the camera's spatial position and orientation (perspective) in relation to the assembly field one time and then align the viewing perspective of the 3-D CAD model identically with the camera perspective. The thusly generated virtual image of the real camera view allows superimposing the camera image of the real assembly scene on the CAD models of the components being assembled in the correct position and orientation. Thus, the current work step is added “virtually” to the view of the real camera image. The information on position and orientation provides a worker systematic support.

An assembly procedure presented in text form in parallel relates the component type and sequence of assembly steps. Furthermore, additional information, e.g. bolt tightening torques and the like, is displayed for the current work step or specific information is integrated in the visualization.

Alternative to the set configuration of the camera to observe an assembly scene, other cameras can be installed, which are stationary or have defined movement. This allows different perspectives of the assembly scene. This is advantageous especially for large and complex assemblies, e.g. by reducing concealment.

In addition to assistance information image overlays and texts, workers may be provided other support, which enable them to see cutaway views or other viewing perspectives.

Assistance Is Good, Inspection Is Better

Accompanying inspection of the result of assembly enhances process reliability. Once an assembly step has been completed, the presence, correct position and orientation of the assembled component and the completeness of the work step are verified. An additional camera generates a second view of the assembly scene and the object geometry of the assembled components is defined three-dimensionally in real time. A comparison with the CAD data furnishes information on the quality of a part’s presence, correctness and correct installation position. The result is visualized immediately after the assembly step has been completed and enables the worker to perform a direct inspection.

Easily Generating an Assembly Procedure

A standard industrial computer is installed as the technical basis of the system. Depending on the size of the workplace, between two and five cameras are connected to it. The entire assembly operation is planned with a program specially developed by the Fraunhofer IFF, which is already being used at Kolbus for process planning. The sequence of individual steps
of an assembly procedure can be specified either by an assembly procedure editor or already when assembly is designed in the CAD program. The assembly procedure editor calculates and recommends a potential assembly sequence on the basis of the assembled components’ CAD data. The user may select from among proposed alternatives or specify a sequence manually. The assistance and inspection system can be modified for assembly scenarios flexibly and quickly by selecting one of the assembly procedure data sets.

An Excellent Overview and Intuitive Operation

The assistance functions and the results of inspection are visualized most easily on a monitor mounted directly in the worker's viewing angle. This makes constant visual inspection possible.

An alternative in which a projector projects the assistance information directly on the component and thus provides workers intuitive support is expedient for specific applications. When workers need instructions, they can be retrieved by touchscreen or hand or foot switches. Alternatively, hand gestures may be used.

Reliable and Efficient for Complex Assembly Operations

Assistance systems based on augmented reality can be used to organize assembly operations, which are not only complex but also have numerous variations, efficiently and with high objective product quality. Assisted assembly makes it easier even for workers themselves to switch mental gears when the type of assembly and even every process is constantly changing.

This accelerates the steps of assembly. Integrating real-time inspection in the operation assures this and eliminates tedious trial runs at reduced speeds. Ultimately, this significantly reduces setup times and thus order processing times while simultaneously increasing process reliability. Time consuming and costly reworking are eliminated and, all in all, the expensive CNC machines are used significantly more efficiently.

"We had been looking for solutions that would complete every new production order at full speed starting with the first workpiece. The shorter setup time is a milestone in the use of our CNC machines," reports Hans Hasse, Production Division Manager at Kolbus, with satisfaction.

The overall system is the outcome of joint development work between Kolbus and the Fraunhofer IFF. "Our new development is highly interesting for firms that, like us, have a large variety of parts and must produce small order quantities cost effectively," explains Hasse. The system is modifiable for every scenario as long as CAD data is available and the cameras installed are stationary or at least have defined movement. Thus, it can be implemented for any complex assembly operation.

Other fields of application for stationary AR assistance will be developed in the future. At present, the Fraunhofer IFF and Kolbus are developing such a system for a portal milling machine. The particular challenge here is an enlarged work space of around five by two meters.

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Highest quality complex automation and customized solutions are the niche of many medium-sized German manufacturers. They create ranges of products that only few competitors are able to place on the market. And they do all this with great flexibility. The programming of complex machine operations constitutes a major challenge in custom equipment manufacturing and necessitates quite specialized solutions for this niche market’s needs. SM Calvörde takes advantage of the Fraunhofer IFF’s diversified expertise.
Custom equipment manufacturing lives from products perfectly customized to their customers’s needs. However, the quality of an engineered machine stands and falls with the reliability and effectiveness of the programming. Hence manufacturing with complex machines greatly depends on flawless control.

Commercial Tools Have Distinct Limits

NC programming of simpler machines or systems can be done with conventional commercial software tools. Equipment manufacturers use them to define the simple operations performed by a machine. However, commercial tools have distinct limits. More complex tasks and flexible solutions require a programmer’s intervention. Individual cycles for specific machines can only be incorporated with effort and are thus time consuming and costly. Custom solutions can no longer be highly automatic. These circumstances make it more difficult to prevent collisions by a welding system’s mechanical arm, for instance. This, in turn, is costly.

The Fraunhofer Institute for Factory Operation and Automation IFF is the contact for custom solutions for high-tech problems. Its engineers have been working in the field of virtual engineering for a long time and are specialists in equipment simulation. The researchers in Magdeburg are able to three-dimensionally describe, model, simulate or commission entire industrial plants. Above all, the experts benefit from years of experience in a variety of projects and thus have a wealth of knowledge about custom solutions at their disposal on the spot.
Solutions from One Source
Save Time and Money

“The Fraunhofer engineers’ ability to deliver all solutions from one source was certainly also crucial to the product’s quality,” explains Herbert Kraus, CEO of SM Calvörde. Otherwise, it would have been impossible to implement the project with such speed. “An approach by the way, which we also cultivate as a custom equipment manufacturer and thus greatly value.”

Among other things, SM Calvörde Sondermaschinenbau GmbH & Co. KG has specialized in manufacturing systems that weld large components for the rolling stock manufacturing industry. With up to sixteen NC axes, as in the project overseen by the Fraunhofer IFF, the equipment must effectively complete highly complex tasks in short time. Thousands of spot welds must be made on components by means of various welding and gripper arms with pinpoint accuracy. The challenge: The components have large, partly bulky dimensions and their manufacturing tolerances vary minimally. Nevertheless, a maximum of operations ought to run automatically without requiring the equipment operator’s intervention. Potential collisions, terminations and the like are tabu. They consume material and time and thus cost money.

Hence, the custom equipment manufacturer called in the researchers and developers from the Fraunhofer IFF with their expertise in the simulation and optimization of machine operations. Their work entails far more than simple 3-D simulations.

Coupling the generated control codes to a machine’s real controller makes it possible to virtually test a complete program in real time. This enables the equipment operator to test the complete operation on a monitor once more – a realistic dry run.
“Engineering plays at least just as large a role in our work as virtuality,” says engineer Torsten Böhme from the Fraunhofer IFF and in charge of the project. “If you don’t understand how a machine functions, you can’t simulate it exactly, let alone optimize it through simulation.”

**Automatic Programming and NC Simulation at Machine Level**

Crucial elements of the completed work are two new solutions: A tool for effective automatic NC programming and real time NC simulation at machine level.

The programming tool fully describes in a 3-D simulation every motion sequence and process parameter needed to machine the component. It can both import all common CAD formats into the programming environment and – this is impossible with commercial tools – integrate a machine’s specific cycles.

Many contingencies must be allowed for in such a complex system with several axes and actions. Therefore, so-called dynamic safety zones were created, which protect the machine from collisions while it completes its operations. Thus, several tool arms are also able to operate simultaneously.

All the data captured is used to generate the source code intended to coordinate the control of welding of components. However, a crucial intermediate step occurs here in order to maximize reliability and quality.

Coupling the generated control codes to the real equipment controller allows running the complete program in real time 1:1 on virtual axes. Equipment operators can test the complete operation on a monitor once more and thus execute a realistic dry run.

If they detect ineffective operations or problems crop up in the process, they can revise program yet again.

“This allows production to run at approximately ninety percent, which is extremely advantageous for operators,” explains Torsten Böhme, proudly adding that, “the basis for real time coupling comes from one of our earlier virtual commissioning projects, by the way.”

The developers involved from the Fraunhofer IFF did not have to purchase any third party codes for the entire project. A now extensive pool of solutions developed for the widest variety of specialized tasks means that a custom solution is often within easy reach, sometimes only as far away as a file folder on a shelf. This is not only convenient for everyone involved, it also saves time and resources.

**Create Custom Solutions Today and Reuse Them Tomorrow**

“Combining the NC programming environment with the NC code simulation produced an efficient package that supports both us as the equipment developer and the equipment operator,” observes Herbert Kraus, CEO of SM Calvörde.

In turn, the solutions produced in this project could bear fruit in follow-up projects as well. The process of resistance spot welding implemented in these types of equipment can be replaced by laser beam welding in new systems, thus making it possible to meet current market and customer demands since the basis for this type of equipment has been created.

“In this case, spot welds would become seam welds or have other geometric shapes,” says virtual engineering expert Torsten Böhme, looking ahead.

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Fraunhofer IFF
TIME RECORDING
UP ONE’S SLEEVE
Recording the hours worked in manual assembly operations is a key element of planning, control and remuneration in companies. It is indispensable for the management of industrial manufacturing operations. Until now, hours of work have been recorded by so-called time recorders. However, this often means stress for employees and imprecise data and high costs for companies. Automatically recording the work time of such manual assembly operations will eliminate this problem.

Difficult Data Acquisition in Assembly Operations

Recording the times of manual assembly operations facilitates the recording and analysis of operations. It provides a company an idea of the amount of time an employee needs for a particular job on average. This makes it possible to perform calculations, set cycle times and optimize operations. The more precise the data, the better a company can plan. This is essential in order to work cost effectively and remain competitive.

Work steps are broken down into individual elements to optimize and structure time recording. This might entail reaching, grasping, preparing, joining or releasing, for example. Such structuring helps to record them separately, thus making evaluation at the end significantly easier. An operation can be evaluated objectively and the total time can be optimized iteratively by reducing single controllable actions.

Until now, human time recorders have used mechanical or electronic time recording systems to record these times. They literally stood behind employees with a stopwatch in their hand. However, the objectivity of such forms of data acquisition is limited since a subjective element is always influencing the recording. Moreover, this form of time recording entails substantial labor or technical complexity and high costs.
Hence, the need for more precise, simpler and cheaper solutions is great. In addition, any new system ought to be as small as possible and easy to operate. Ultimately, workers may not be hampered during an assembly job if the operation is to be recorded as realistically as possible.

Together with the engineering firm ingenieurbüro Dr. Gruendler in Magdeburg, the Fraunhofer Institute for Factory Operation and Automation IFF came up with the idea of developing a new automatic measuring system. They decided on a measuring system based on inertial sensors. Small, light and close to an assembly worker’s limbs, they can be used to record the duration of a person’s motion sequences objectively and highly precisely.

Self-orienting Inertial Sensors

These microelectromechanical sensors are ideal for the intended task. The size of a matchbox and attached to a worker’s arm, they record acceleration, angular velocities and magnetic fields in three axes directly on a moving object. Accelerometers and rate sensors are used to measure the amount of translational and rotational movement. A data processing unit compensates the undesired shares of gravitational acceleration and the earth’s rate of rotation measured by the sensors and subsequently defines parameters of movement such as position, spatial orientation, velocity and effective acceleration.

The inertial measuring system’s great advantage over other systems is its independence from any reference and infrastructure. Other motion tracking systems such as GPS, camera and ultrasound systems always need a reference infrastructure to function, e.g. satellites for GPS. In addition, they must be complexly calibrated and often need additional orientation markers, which are unable to deliver any motion data when obscured. Inertial sensors detect practical orientations and positions of objects in space without any external reference system or other infrastructures.

The thusly obtained measured data is modeled to reconstruct the motion. Various process variables such as length of movement, gripping position and angle of rotation are determined from the three-dimensional trajectories. Then, they can be assigned to the known actions in an assembly operation and analyzed at the same time.

There is a problem, though. Intertial sensors’ signals normally drift during the course of a measurement. The resultant orientation and position errors would cause the measurement errors to increase as the measuring time increases. To compensate for these errors, the Fraunhofer IFF developed a mathematical correction algorithm based on a biometric model of the human body. The new algorithm functions perfectly when applied and drift no longer occurs.
Time Recording System Up One’s Sleeve

So, how does the new system function? A special sensor sleeve, in which three linked sensor modules for the upper arm, lower arm and hand were integrated, was developed in order to measure the movement of an arm or hand with utmost precision – and comfort for the worker. The sensors in the snugly yet comfortably fitting anatomically shaped oversleeve follow the worker’s movements during an assembly operation extremely precisely and assure comfort while being worn.

Altogether, the system consists of two oversleeves with three inertial sensors apiece and one computer application, which calculates and reconstructs the recorded assembly operations and motion structures. The system provides a simple option to structure the manufacturing operation and a tool teach in the measuring points directly at the assembly workplace. The management of the recorded assembly operations and motion structures makes it easier for an operator to document and analyze the time recording.

Automatic Time Recording in Detail

So far, the new methods can map logistics (sorting and packing), manufacturing (manual and mechanical labor) and assembly scenarios for sitting workplaces.

Time recording is completed in four steps:

1. Preparation:
The manufacturing operation is analyzed and the individual stages of the operation are entered in the computer application.

2. Data acquisition:
The worker executes the cyclical job. The sensor system in the oversleeve captures the data automatically.

3. Analysis:
The computer application analyzes the motion data automatically and calculates the allowance times.

4. Evaluation:
The data are exported for statistical analysis and to optimize the total time.

Automatic Time Recording Is Objective and Cost Effective

Above all, the objective analysis of assembly operations by automatically recording time with the inertial sensor system and a minimal system structure is particularly advantageous. Allowance times can be determined very easily and quickly.

“Time can be recorded even at several workplaces simultaneously without additional labor. This significantly reduces the labor required for work studies,” according to the work designer Gruendler. “This helps us record and analyze hours worked quickly and cost effectively for our clients tremendously.”

Great Potential for Workplace Organization

So far, the system is limited to sitting workplaces. Hence, the next stages of next development will concentrate on workplaces with an increased radius of action. Then, it will also be possible to analyze assembly procedures in which a worker moves from one workstation to the next executing different jobs.

Measuring the time of manual assembly operations in work studies is only one application scenario for motion tracking with inertial sensors. When complete postures are determined in conjunction with weights handled and forces applied, it will be possible to upgrade the developed system and later use it for studies of ergonomic workplace design. Then, the additional measurement of physiological parameters, e.g. pulse, blood pressure and heart rate variability, will also make it possible to also analyze workloads and individual stresses for example.

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VIRTUAL WELDING

VIRTUAL REALITY ENHANCES WELDERS’ TECHNICAL TRAINING

Alexander Kroys and Henry Orlick
The Schweißtechnische Lehr- und Versuchsanstalt Halle GmbH (SLV Halle GmbH) has been training professional welders for many years. In the past, this was done in a welding booth with virtually no changes under an experienced teacher’s intensive guidance. However, this required large quantities of consumables and energy. The organization developed a computerized welding trainer to remedy this. Trainees use it to practice the first steps of their training efficiently and, above all, non-destructively. Among other things, they also use virtual interactive training scenarios.

A trainee’s first day of classic welder training initially begins in a welding booth. After a briefing on the appropriate welding power source, the first welding bead is introduced. Trainees attempt to ignite an arc and melt away the filler material. This primarily requires motor skills that enable one to ignite an arc and keep its length constant, maintain a certain welding speed and guide the torch at the correct approach angle. As they make their first attempts, beginners use up considerable amounts of base and filler materials as well as tungsten electrodes, shielding gas and, naturally, electrical power.

SLV Halle GmbH has developed a digital welding trainer in order to counter this situation and work more effectively. Instead of using real materials and equipment to learn the profession, trainees are now executing procedures simulated on a training unit equipped with digital and optical measurement systems – the GSI-SLV welding trainer. Future welders can use it when they start their training to learn sequences of movements hands on and also reinforce their theoretical knowledge of the material.

Individual Welding Exercises

The welding trainer opens entirely new opportunities, particularly at the very start of practical training. Instead of practicing

The program introduces trainees to the welding trainer step by step. First, they familiarize themselves with the unit’s components in detail. Then, they learn industrial safety. The training follows later. Trainees use this sequence to practice working with the welding trainer virtually before they handle the real unit. Mistakes are detected and displayed immediately.
on real welding equipment, trainees learn the fundamental procedures with a real but weak arc. Thus, the “welding samples” can be used for a large number of exercises. While their work used to be judged based on the results they achieved, a computerized camera and measurement system now records all the significant parameters. Welding speed, arc length and torch angle are all monitored. Mistakes are detected immediately. Anyone working too quickly or applying an incorrect angle or the like during an exercise receives immediate notification. In addition, the entire procedure is recorded in detail. This enables trainees to review and trainers to objectively evaluate their work on a computer once they have finished an exercise. Since the entire system is designed modularly, the particular training level can be customized for the trainees’ skills and proficiency.

The system is intended to support not only the practical but also the theoretical part of training. Therefore, SLV Halle GmbH additionally developed educational software for its welding trainer. It empirically introduces trainees to practical topics of welding training, which are treated in-depth later in the theoretical training. Thus, they amass valuable prior knowledge on the computer, which they can revert to in later practical training.

Integration von Virtual Reality

Despite the new system’s clear advantages over conventional training methods, trainees still have to be briefed on the welding trainer before they start training. This, in turn, consumes time and ties up training staff. The same holds true when trainees are prepared for the use of welding equipment in compliance with industrial safety. Therefore, SLV Halle GmbH decided to add a virtual educational program to its welding trainer in collaboration with the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg. Once they have completed the program, trainees should be able to work with the welding trainer on their own.

To this end, the Fraunhofer IFF developed a functional VR model of the welding trainer, which trainees use to prepare for work. An animated 3-D model was created for the VR model from the welding trainer’s design data (CAD data) and the trainers’ know-how. Depending on the intended objective, its modules can be extended with manipulation functions.

Trainees use the educational modules, which build upon one another, to familiarize themselves with the system easily and intuitively. An initial exploratory mode introduces the welding trainer’s main components. In the process, the virtual model is always linked with all relevant design metadata. Thus, a description of any of the unit’s functions can be retrieved from the user manual at any time with a click of the mouse. In addition, the virtual welding trainer model can also display information on hazards from the user manual.

While saving time and money, this enables welding trainees to easily familiarize themselves with the equipment before their first exercise. The program’s virtual interactive educational modules introduce them to the unit’s individual functions step by step. Before they use the real system for the first time, trainees first intuitively practice the fundamental basics and important actions of its operation in the computer’s virtual environment based on their own proficiency.
The educational medium’s high availability is particularly advantageous since it can be used to conduct standardized training of entire seminar groups simultaneously. Above all, the trainers’ irreplaceable wealth of know-how can be permanently retained once it has been integrated in the virtual scenarios and then provided to a theoretically unlimited number of trainees at any time by implementing the functional VR model directly on the welding trainer or in a perfectly ordinary classroom.

The system greatly aids the welding trainer when basic skills are being taught outside of a conventional welding booth. This new development is interesting for SLV Halle because the model of the real welding process saves considerable amounts of material, energy and training time.

**Virtual Materials Testing**

However, an educational medium supported by VR does more than just ease the trainers’ workload and intensify learning. Virtual reality is able to make the invisible visible and simulate the laws of physics. This also opens other great opportunities to further improve the content and quality of welder training. The individuals in charge at SLV Halle and the Fraunhofer IFF recognized an opportunity to simultaneously use the virtual training system to provide training in ultrasonic testing for nondestructive materials testing, e.g. to inspect weld seams.

An acoustic method, ultrasonic testing is used in welding to detect imperfections in the material, above all in the weld seam (discontinuities). The procedure is complex and conducted in compliance with special standards and guidelines. Extensive training is required to correctly prepare and execute the test and also be able to correctly interpret the images generated. However, at first, trainees frequently have difficulty understanding the propagation of the sound wave in a workpiece. Nonetheless, they can only decide whether a reflection is a flaw or a normal bond interface between a seam and the surrounding material when they are able to localize it in the workpiece.

**Accurately Detailed Simulation**

Therefore, SLV Halle and the Fraunhofer IFF in Magdeburg upgraded the existing software for the welding trainer and jointly developed a VR training system that interactively simulates ultrasonic tests. Here too, it was important to design its use for trainees and trainers as intuitively and thus as realistically as possible. Virtual realities have proven especially useful in such applications. They can be used to vividly visualize ultrasonic wave propagation in a workpiece, simulate various types of damage and interactively test virtual workpieces.

The implemented system functions wonderfully. Great value was placed on visualizing sound wave propagation in unwelded, welded and flawed metal plates to simulate the real operations during an ultrasonic test to optimally support training. In addition, it reproduces an A scan from a classic ultrasonic scanner. Both the workpiece parameters, e.g. dimensions, type of material, weld preparation, top seam and root properties, and the test head parameters, e.g. refraction angle, oscillator dimensions and frequency, are visualized. Different virtual workpiece specimens with different types of discontinuities are also simulated, including pores, slag, incomplete fusion, cracks and root flaws. The system also reproduces scans caused by the workpiece and seam, which are interpretable as discontinuities of the type triggered by top seams for instance.
Nevertheless, development of this test simulation is not finished. In the future, the VR presentation will simulate sound waves on complex assemblies and complicated component geometries in order to be able to evaluate their inspectability better.

Outlook

Whereas VR systems were often reserved for pilot training in the past, the development of affordable computer systems has introduced this technology to other domains of employee training. The development of the welding trainer and its continuous refinement has produced an educational aid that will change classic welder training for good. Use of this unit is not only economically expedient. This advanced and universally usable training unit also arouses interest in welder training among young trainees in particular.

Given its mobile design, the welding trainer can be used flexibly and as an advanced instructional aid for more than welder training. Its use for welding program entrance examinations or trainee aptitude tests or as an industrial safety teaching aid and more is conceivable. The development of such systems is still in its early stages. Future developments are full of promise.

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Humans’ most important sensory organ is their eyes. We tend to believe what we see. We comprehend abstract relationships faster and are able to evaluate them better when they are visualized. Not surprisingly, prior simulation in virtual interactive environments has long since become a popular and proven tool for the planning of major construction and development projects. The Fraunhofer IFF has developed a virtual interactive 3-D visualization platform for the Industrie- und Gewerbepark (IGP) Mittelelbe GmbH, which has crucial advantages over conventional methods.

A total area of 500,000 m² like that of the IGP Mittelelbe GmbH is hard to imagine. Planners from the widest variety of disciplines and fields of interest normally coordinate the development of such an area in unnumerable consultations: From architects to plant engineers and operators and back. The process is complicated and protracted and planning errors can easily occur, resulting in increased expenditures.

Transferring this process to a virtual environment in which in all objects are visualized realistically enables everyone involved to reach an agreement on all relevant issues equitably and simultaneously.
OUT OF THE PARK
The Fraunhofer IFF in Magdeburg has been developing such visualization scenarios successfully for years. The engineers, mathematicians and computer scientists use the technology and know-how on hand to visualize not only entire cities, factories or industrial parks. The Elbe Dom, for instance, enables users to preview and evaluate the objects of their planning true to scale. Convinced of the potential of the Fraunhofer IFF’s innovative visualization methods, IGP Mittelelbe GmbH also took advantage of their benefits.

Exploiting Potentials by Virtual Planning

The researchers at the Fraunhofer Institute for Factory Operation and Automation IFF have been established in the field of virtual reality for years. While the visualization of cities, industrial parks and complex plants is now widespread, every project has its distinct requirements. For instance, geographic data, legal regulations and the immediate environment vary and must always be incorporated in planning as relevant factors. The Industrie- und Gewerbepark IGP Mittelelbe to the north of Magdeburg is attractive because of its excellent location with direct connections to the highway A2 and the Elbe River and Mittelland Canal. The operators want to exploit this potential optimally and efficiently.

The operators of IGP Mittelelbe not only found the support they desired for their planning at the Fraunhofer IFF but also a virtual interactive 3-D visualization platform developed there and thus an excellent tool to create a digital copy of their industrial park. It can model the entire park with its countless elements, from various warehouses and buildings to thoroughfares or even single trees for realism and delivered the basis for the ensuing plans to redevelop the plot with its partly decrepit infrastructure.

More Efficient Communication

What sounds like a business management game in 3-D is highly scientific work. Every construction project must comply with architectural, legal and urban development regulations. Moreover, companies interested in locating there also bring wishes. Last but not least, all relevant factors ought to be optimized logistically to efficiently utilize the area and resources. In short, different experts from different disciplines have to coordinate their work. All this can be done with VR simulation cost effectively and tremendously efficiently.

“One particular benefit of this project is the capability to display problems, which may arise during planning, to all the authorities involved in decisions simultaneously on a monitor and directly discussing or even resolving them,” emphasizes Hendrik Fries, CEO of the IGP Mittelelbe GmbH. A visualization enables everyone involved to speak the same language. Misunderstandings occur more rarely and can be eliminated significantly more easily. Interdisciplinary communication concentrates on the essentials and is thus far more efficient.

The systems delivers even more benefits. The 3-D platform is not only virtual but also highly interactive. A visualization can be navigated and any necessary underlying data and additional information retrieved with childish ease, simply by clicking the mouse. Thus, plot sizes, prices, existing infrastructure, maximum building height and soil conditions can be uploaded from a plot database to a virtual 3-D model as needed and displayed by clicking on the related 3-D object.

A Planning Project Becomes a Marketing Tool

However, the quality of a site, such as the premises of the IGP Mittelelbe GmbH in this case, is not determined by the characteristics of the open areas alone. Background information on companies there, information on the macro location, a national ranking of the site up through soft facts such as educational and supply opportunities, can be retrieved from the visualization. Thus, planners or investors obtain a complex yet thoroughly meaningful overview that is comprehensible.

This enables operators to present their property to potential investors easily, e.g. on a laptop at conferences and trade shows. While videos or simple animations are descriptive, they cannot compare with the capability to interact with plans in 3-D and learn all the information worth knowing. A simulation with stereoscopic 3-D displays ultimately immerses any interested user deeply in the entire environment. Discussions of the various alternatives that show planners or investors different options for a site’s future development can be conducted as desired. Thus, a planning project simultaneously becomes a marketing tool and vice versa.

Finally, planners, engineers and operators can use the Elbe Dom in the Fraunhofer IFF’s Virtual Development and Training Centre VDTC to view planned architecture fully realistically. With a diameter of 16 meters and a projection surface mea-
suring 300 m², the one-of-a-kind Elbe Dom is the world’s largest 360 degree laser projection systems. It places viewers directly in the simulation, whence they can explore a virtual environment on a scale of 1:1 and with an all-around 360 degree view. This is an invaluable advantage when planning major properties and sites. The potentials and the exact planning of a project can be evaluated realistically and, when necessary, revised before any work has begun.

**Preventing Image Loss**

This advantage is also extremely valuable elsewhere. Major or publicly funded projects are often the subject of public assessment during and after their completion. Experience has shown that planners must also deal with the risk of a serious loss of image in the wake of inadequate preparations or insufficient communication with residents. Realistic visualization of such construction projects at an early stage can make potential deficiencies easier to detect and thus help prevent high financial losses. Considered thusly, virtual interactive 3-D development optimizes planning and saves time and money.

IPG Mittelelbe GmbH is also extremely satisfied with the digital industrial park. Its project with the Fraunhofer IFF was brought to a successful conclusion in December 2010.

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THE TALENT COMPETITION

Fascinating presentations and animated debates among researchers: The research colloquium at the Fraunhofer IFF celebrated its ten year anniversary in 2010.

The open discussion forum is a popular and well attended platform for the up-and-coming researchers. It enables them to present the results and methods of their research to a larger audience for the first time and directly profit from the exchange with experienced colleagues and their input.

The institute’s director Michael Schenk chaired the event personally, thus underscoring the value attached to supporting young researchers at the Fraunhofer IFF. Nearly thirty percent of the current full-time staff at Magdeburg’s Fraunhofer Institute are younger than thirty. Not only the outstanding conditions at the institute and its proximity to Otto von Guericke University Magdeburg play an important role. The opportunities are good to start a career at a well-known company or in research. “Fraunhofer is an attractive employer for our excellently educated young engineers,” says the institute’s director Schenk and adds that, “in return, research also continually profits from the upcoming generation’s fresh idea and new ways of thinking. We intend to continue encouraging that in the future, too.”

INTRODUCING MATHMATICIANS AND TANGIBLE MODELS

The reliability of aircraft engines is one of Sergii Kolomiichukt’s fields of research at the Ukraine National Aerospace University in Kharkiv. In 2008, the young engineer, originally from the Crimea on the Black Sea, received an offer to take part in the European Union’s Marie Curie program and continue his career at the Fraunhofer Institute in Magdeburg.

One of the products the maintenance expert has been instrumental in helping develop since then is the Fraunhofer IFF’s
established diagnostic tool Statelogger®.
He and his colleagues are continually implementing it in new, innovative applications. In order to also explain to non-experts how this method for analyzing the condition of systems functions, he and his colleagues modified a slot car track. It helps them quite easily show interested visitors without technical knowledge and even children how their system makes the operation of systems more efficient and more reliable.

Despite the greater range of his current research work, he has not lost his fascination for aircraft. This even affects his personal life. “I’ve been building model airplanes since my childhood. Earlier, my mother worried that we didn’t have enough room for them. Space is getting tight in Magdeburg too, even though the apartment is bigger.” However, the twenty-eight year old has been increasingly curtailing his hobby since the birth of his daughter Julia in 2010 and prefers to spend his free time with his small family.

MAKING A CAREER “OFF THE BEATEN PATH”

Magdeburg is the scene of international research. The Fraunhofer IFF’s staff also comes from all over the world. Yet, one doesn’t have to come from far away to work successfully at the Fraunhofer Institute for Factory Operation and Automation. Steve Schneider, a research manager at our institute since August of 2010, is a native of Magdeburg. The computer scientist earned his Diplom degree from the local university and feels quite happy at Sandtorstrasse where he has been working at the Fraunhofer IFF since 2008, first as an intern and later as a student assistant. He wrote both his senior and his Diplom thesis here. His area of specialization: Off-road navigation.

The twenty-seven year old recalls that his interest in computer science was aroused by the C64 at the latest. His ties to logistics evolved during his undergraduate studies through the opportunities at the Fraunhofer IFF’s. What the young researcher most likes about his job is the opportunity to already transform innovative ideas into action now, which will have an impact everywhere in the future. While most drivers are navigating paved roads by GPS, Schneider is thinking about all the roads and paths in the surrounding forests, which have not yet been recorded telematically.

One of the biggest research projects on which Steve Schneider has been working is Harz.EE-mobility. In this major project designing future transportation concepts for electric vehicle networks, he is involved in the development of a vehicle control center and an intelligent driver information system.

Even though he busies himself with new telematic solutions privately, he naturally needs some time off. He likes to use it to ski in the Alps. “Surely you could do some things with off-road navigation in ski areas, too,” ruminates Schneider.
SHARP MINDS

... WITH DOCTORATES
WASTE IS NOT HIS THING

Sebastian Trojahn got his best Christmas present from himself quickly in 2010. Shortly before Christmas, he successfully defended his doctoral dissertation with summa cum laude. In his dissertation entitled “Approach to Making Decisions on the Structure and Site of Distributed Plants”, Trojahn investigated the economically and ecologically smart configuration of model plants that produce power by gasifying biomass in fuel cells.

Biomass logistics and the resource efficient distribution of goods are two of several fields Sebastian Trojahn has been working on since completing his Diplom degree in industrial engineering at Otto von Guericke University Magdeburg in September of 2006.

“Logistics runs through my entire curriculum vitae,” is Trojahn’s comment on his still new carrier. In fact, he has not only optimized operations in numerous companies and implemented numerous research projects as a research manager. His high school education was shaped by natural sciences. At the latest, the now twenty-eight year old realized that his future was in logistics when he was the aide to the supply sergeant and a truck driver during his military service.

Trojahn came to the Fraunhofer Institute for Factory Operation and Automation IFF for the first time in February of 2005, first for half a year as a student assistant. Since becoming a research manager at the Fraunhofer IFF in 2008, he could now be called a commuter between the institute and the university.

Away from the duties of his job, Sebastian Trojahn has close ties to the Freibad Süd in Magdeburg where he earned his way through college as a lifeguard. He still works as a lifeguard in his free time and now works behind the scenes, too, taking care of optimizing operations and orders.

According to him, the time for his dissertation was also “sporting” for his girlfriend and him. In just two and a half years, he went from being a Diplom engineer to being a doctor – Dr. Trojahn used this time as efficiently as possible, too.
The competence center has its origins in Otto von Guericke University Magdeburg and Wroclaw University of Technology's dual electrical power engineering degree program. Graduates of this program study at both universities simultaneously and, after completion of the required five years, receive two degrees, a Diplom degree in Engineering from Wroclaw and a Master's of Science from Magdeburg. They must write and defend their Diplom/Master's theses in two languages.

The work pays off for budding engineers. In addition to receiving two degrees simultaneously, students also have the opportunity to complete an internship at the Fraunhofer IFF. Its Process and Plant Engineering Business Unit is the place to go for any research questions dealing with electrical power systems. Since they are deeply involved in everyday work, it is not uncommon for students to find exciting and particularly practically relevant topics for their Diplom theses at the Fraunhofer Institute when they are close to finishing their degrees.

Thirty graduates already have the dual German-Polish Diplom degree in their pocket and the next are in line. The two universities' networking in conjunction with Magdeburg's Fraunhofer Institute has already delivered extremely successful results. Work at the competence center has already generated some major flagship projects for the region, including such prestigious projects as ViERforES, working on the use of virtual and augmented reality to safeguard embedded systems, or the prominent related projects RegModHarz and Harz.EE-mobility, developing new concepts for nationwide ecological energy production and reliable electric transportation.

HONORARY DOCTORATE FOR PROFESSOR MICHAEL SCHENK

The Hungarian University of Miskolc awarded Prof. Michael Schenk, Director of the Fraunhofer IFF in Magdeburg, an honorary doctorate on June 25, 2010. The diploma was presented by the Dean of Economics, Prof. György Kocziszky, whose school also includes the Department of Factory Planning and Factory Organization there.

Schenk and the department in Miskolc have long had a close relationship. During his graduate studies, the logistics expert worked as a doctoral student at the Hungarian research institution. Upon returning to Magdeburg, he chiefly devoted himself to establishing and developing the Department of Logistics of the School of Mechanical Engineering at the Technical University Magdeburg. In 1992, he also became Head of the Department of Logistics and Production Process Control at the newly founded Fraunhofer Institute for Factory Operation and Automation IFF, the management of which he took over in 1994. During this time, Schenk continued to maintain his personal and professional ties with Miskolc.

The cultivation of this relationship evolved into a story of successful research collaboration for both parties. In addition to the exchange of researchers on a regular basis, various joint research projects arose, numerous professional publications were coauthored and academic events were held. The Hungarian researchers have also benefited from the Magdeburg institute’s growing reputation and the accompanying, increasing technical opportunities.

With the award of the honorary doctorate to Prof. Schenk, the Universität Miskolc honored his academic achievements and his work establishing the close relationship between it and Otto von Guericke University Magdeburg.
Augmented reality (AR) has diverse applications. Superimposing virtual information on a real environment, blends both worlds together. This technology is already routinely found on cell phones or other portable terminals with integrated cameras. This principle is also used in industry, for instance, for quality assurance in manual assembly operations. Users wear AR glasses so that they always have both hands free. They project desired information directly before one’s eyes. Thus, assemblers remain mobile and flexible.
Virtual simulations are becoming an indispensable planning tool in plant engineering, too. Planners, architects, engineers, tradespeople and operators can enter virtual objects together even before ground has been broken. Thus, for instance, design errors can be detected at an early stage, security perimeters can be specified or systems can be optimized interactively.
Robots are becoming acceptable: Long banished behind steel barriers in factories, they are becoming established in new fields of application such as manufacturing, households and nursing care. A tactile sensor system, which can be integrated in a floor or directly applied to a robot as an artificial skin, can provide the needed safety. In the future, this sensor system developed at the Fraunhofer IFF will enable machines to reliably detect contact with humans or objects and prevent serious collisions. In addition, the tactile skin also functions as an input medium to guide a robot, for instance, by converting contact into movement.
Meet up with researchers from the Fraunhofer Institute for Factory Operation and Automation at these events. Come talk with us!

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Location</th>
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<tr>
<td>2nd Virtual Technologies Innovation Alliance Status Conference</td>
<td>March 10, 2011</td>
<td>Gliwice</td>
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<td>Gliwice, Poland</td>
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<td>ISH 2011</td>
<td>March 15 – 19, 2011</td>
<td>Frankfurt am Main</td>
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<tr>
<td>8th INPROTECH Symposium</td>
<td>March 20 – 22, 2011</td>
<td>Medical Imaging BVM</td>
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<td>Lübeck</td>
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<td>19th International Crane Conference</td>
<td>March 31, 2011</td>
<td>Aachen</td>
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<td>XPRESS Status Colloquium “Knowledge-based Manufacturing – A new approach for precision assembly industries”</td>
<td>May 3 – 4, 2011</td>
<td>Stuttgart</td>
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<tr>
<td>Control International Trade Fair for Quality Assurance</td>
<td>May 3 – 6, 2011</td>
<td>Stuttgart</td>
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<tr>
<td>ICT 2011</td>
<td>May 8 – 11, 2011</td>
<td>Ayia Napa, Cyprus</td>
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<td>transport logistic 2011</td>
<td>May 10 – 13, 2011</td>
<td>Munich</td>
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<td>SPIE Optical Metrology</td>
<td>May 23 – 26, 2011</td>
<td>Munich</td>
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<tr>
<td>Long Night of Science</td>
<td>May 28, 2011</td>
<td>Magdeburg</td>
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<td>2nd Laser Scanning and Virtual Reality in Plant Engineering Industry Working Group</td>
<td>April 13, 2011</td>
<td>Timber Logistics</td>
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<td>Hundisburg</td>
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<td>14th IFF Science Days</td>
<td>June 28 – 30, 2011</td>
<td>Magdeburg</td>
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<tr>
<td>32nd VDI/VDEh Forum</td>
<td>June 29 – 30, 2011</td>
<td>Hamburg</td>
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