

## RESEARCH NEWS

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### **1 Security tools for Industry 4.0**

An increasing number of unsecured, computer-guided production machinery and networks in production facilities are gradually evolving into gateways for data theft. New security technologies may directly shield the sensitive data that is kept there.

### **2 Smart grid for electric vehicle fleet**

Being able to charge up to 30 electric cars at once requires some ingenious energy management. Researchers are incorporating a mix of renewables into the design of a smart grid for Germany's largest charging station.

### **3 Effective thermal insulation with wood foam**

Insulation materials of tomorrow must be both efficient and environmentally friendly. Fraunhofer scientists are developing insulation foam made from wood that could replace petrochemical plastics in the long term.

### **4 Interactive simulator for vehicle drivers**

Maximize mileage, safety, or operating life? Driving behavior behind the wheel has a big influence on the vehicle. Fraunhofer researchers have developed a driving simulator designed to make the „human factor“ more calculable for vehicle engineers.

### **5 LED lamps: less energy, more light**

LEDs are durable and save energy. Now researchers have found a way to make LED lamps even more compact while supplying more light than commercially available models. The key to success: transistors made of the semiconductor material gallium nitride.

### **6 Getting hyperspectral image data down to a sprint**

Materials of similar appearance can be unambiguously identified by the respective color spectrum. Hyperspectral cameras deliver the requisite spectral data. A new software product can process these vast amounts of data in real time.

### **7 Virtual lab for nuclear waste repository research**

A nuclear waste repository must seal in radioactive waste safely for one million years. Researchers currently have to study them and their processes in real underground laboratories but a virtual underground laboratory will soon simplify their work.

### **8 Newsflash**

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 67 institutes and research units at locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of more than 23,000, who work with an annual research budget of 2 billion euros. More than 70 percent of this sum is generated through contract research on behalf of industry and publicly funded research projects. Branches in the Americas and Asia serve to promote international cooperation.

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## Security tools for Industry 4.0

You can hear the metallic buzz as the milling machine bores into the workpiece. Just a few last drill holes, and the camshaft is complete. The computer-guided machine performed the entire job – thanks to the digital manufacturing data that were uploaded onto its embedded computer beforehand. Everything runs without a hitch, only – the data are stolen.

Manufacturing data determine the production process for a product, and are just as valuable today as the design plans. They contain distinctive, inimitable information about the product and its manufacture. Whoever possesses this info merely needs the right equipment, et voilà: the pirated or counterfeit product is done. Whereas design data are well-protected from unauthorized outside access today, production data often lie exposed and unsecured in the computer-assisted machinery. An infected computer on the network, or just a USB stick, are all a thief would need to heist the data. Or hackers could directly attack the IT network – for instance, through unsecured network components, like routers or switches.

### Encrypting manufacturing data upon creation

Researchers at the Fraunhofer Institute for Secure Information Technology SIT in Darmstadt are exhibiting how these security gaps can be closed up at this year's CeBIT from 10 to 14 March, 2014 (Hall 9, Booth E40). They will be presenting, for example, a software application that immediately encrypts manufacturing data as soon as they emerge. Integrated into computer and equipment, they ensure that both communicate with each other through a protected transportation channel and that only licensed actions are executed. "To the best of our knowledge, no comparable safeguard has previously existed for manufacturing data that reside directly in the machine tool," states Thomas Dexheimer from the SIT's Security Testlab. Digital Rights Management (DRM) controls all important parameters of the assignment, such as designated use, quantity, etc. This way, brand manufacturers are able to guarantee that even external producers can only produce an authorized quantity, as instructed in advance – and no additional pirated units.

His colleague at SIT, Dr. Carsten Rudolph, is more involved with secured networks. At CeBIT, Rudolph will exhibit his "Trusted Core Network". "Hackers can also gain access to sensitive production data via unsecured network components. These are small computers themselves, and can be easily manipulated," says the "Trust and Compliance" department head at SIT. In order to prevent this, he called upon one piece of technology that, for the most part, lies dormant (in deep slumber) and, for all intents and purposes, unused on our PCs: the Trusted Platform Module. This relates to a small computer chip that can encrypt, decrypt, and digitally sign the data. Installed into a network component, it indicates which software is running on the component, and

assigns a distinct identity to it. "As soon as the software changes in a component, the adjacent component registers this occurrence and notifies the administrator. Hacker attacks can be exposed quickly and easily this way," says Rudolph.

"Both security technologies are important building blocks for the targeted Industry 4.0 scenario," says Dexheimer. The term "Industry 4.0" stands for the fourth industrial revolution. After water and steam power, followed by electrical energy, electronics and information technology, now, the cyber-physical systems (IT systems embedded in machinery that communicate with each other via wireless or cabled networks) and the Internet of Things are expected to move into the factory halls. "This revolution can only work if the intellectual property is sufficiently protected. And that's a tall order, because the targets of production IT will increase exponentially, due to ever growing digitization and networking," explains Dexheimer.

At this year's CeBIT, both researchers – Dexheimer and Rudolph – will present a computer-assisted machine tool using a CAD computer and a 3D printer. SIT's security software is installed both on the computer and the printer. The data are encrypted on the computer, and decrypted by the printer. The printer also validates the licensed authorization to conduct the print job. To ensure that the data are also securely embedded in the network, the scientists have built a Trusted Platform Module into multiple routers, and are displaying this as a demo. "An attacker cannot hack this there, because he or she will get nowhere near the built-in key," explains Rudolph.



**To protect the applications of Industry 4.0 – such as Fraunhofer IGD's visual computing solutions – Fraunhofer SIT engineered security solutions that safeguard both people and equipment. (© Fraunhofer IGD) | Picture in color and printing quality: [www.fraunhofer.de/press](http://www.fraunhofer.de/press)**

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## Smart grid for electric vehicle fleet

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The network of charging stations for electric vehicles is becoming more tightly meshed. In Germany, the ratio of electric cars to charging stations is currently two to one and utility companies are pushing forward expansion of charging opportunities, especially in cities and metropolitan areas. Over 2000 charging spots have already been installed nationwide and the country's largest charging infrastructure is at the Fraunhofer Institute Center Stuttgart IZS – where up to 30 electric vehicles (EVs) at a time can re-charge at AC charge spots in the Fraunhofer Campus parking garage. There is also one DC fast charging spot that has a charging capacity of up to 50 kilowatts and can fully charge a car's battery in just 20 minutes. Up to 340 kilowatts of electricity are consumed when all charging spots are occupied – equivalent to around 20 percent of the load of the entire Institute Center, which has a staff of 1500. "Charging an electric vehicle fleet poses high requirements on the energy system. Setting up an EV charging infrastructure of this kind is impossible without smart charging and load management," says Dipl.-Ing Hannes Rose, head of the Mobility Innovation Lab at the Fraunhofer Institute for Industrial Engineering IAO. Rose and his team are currently using their living lab to investigate the technology required to manage EV fleets. How do you maximize operational efficiency? How do you avoid short circuits occurring during peak load times? How do you design a smart grid that can meet all these requirements? Together with Daimler AG and the Institute for Human Factors and Technology Management at the University of Stuttgart, IAO scientists are developing both the charging infrastructure and the energy management in a project called charge@work.

The aim of charge@work is to design a micro smart grid (MSG) capable of supplying the EV fleet with electricity produced exclusively from renewable sources. This year will see the installation of a photovoltaic unit and a small wind power system at the IZS to provide power to the fleet. In addition, a lithium-ion battery storage unit will be added to the basement and a redox flow battery to the roof as temporary storage of energy. The 30-meter-tall wind turbine is delivering 10 kilowatts. Since it operates on a vertical rather than a horizontal axis, it does not have to be oriented to wind direction. Its investment costs are low. The MSG can be run in island mode in parallel to the grid operated by the local energy provider. "If our batteries are empty, we can connect the MSG to the local grid," says Rose.

What is special about this MSG is that it is designed as a direct current (DC) grid. "Photovoltaic facilities and battery storage devices both use direct current. We settled on a DC design for our micro smart grid to avoid the losses that occur when transforming alternating current (AC) into DC," explains Rose. In addition to the energy management software, the IAO scientists are also setting up a simulation environment in which to lay out their MSG and play out various scenarios, such as different weather conditions.

### Micro smart grids offer a more secure supply

Rose sees a host of advantages in decentralized power generation, but none more significant than being able to secure supply: "As Germany continues to move toward a new energy economy, increasing demand is being placed on the country's power grids. Wind and photovoltaic facilities generate electricity intermittently, which doesn't always match customer demand. The grid has to compensate for these fluctuations, increasing the risk of power outages. We can counteract this risk by establishing decentralized supplies of electricity and by optimizing the way we manage our energy. And doing so also serves to increase our independence from energy price trends by largely eliminating the need to import electricity."

In their living lab, the IAO scientists now plan to create a testing environment that will allow industrial companies, systems providers, public utility companies, communities and distributors to explore the potential of micro grids. Over the next two years, the Micro Smart Grid innovation network is to provide interested parties with an opportunity to work up new kinds of smart grid configurations and operating strategies. Using the Fraunhofer micro smart grid demonstrator, the project partners can test their hardware and software components. They can also investigate options for allowing other consumers to connect to the MSG – whether, for example, to run a building's air conditioning system or to integrate other production facilities. "Our long-term goal is to bring individual local grids together to form a large smart grid," says Rose. Researchers will be presenting a virtual model of their smart grid at the Hannover Messe from April 7-11 at the joint Fraunhofer booth in Hall 2, Booth D18.



Up to 30 electric vehicles at a time can recharge in Fraunhofer IAO's parking garage. (© Victor S. Brigola/Fraunhofer IAO) | Picture in color and printing quality: [www.fraunhofer.de/press](http://www.fraunhofer.de/press)

## Effective thermal insulation with wood foam

RESEARCH NEWS

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Climate protection is now a mandatory consideration for every building contractor. Only last October the German federal government tightened up its Energy Saving Ordinance (EnEV) even further by decreeing that in future properties will have to consume even less energy than before. The key to meeting these stringent requirements lies in the way we insulate our walls and roofs, as effective insulation prevents large amounts of our valuable thermal energy escaping unused. Buildings are insulated by lining their facades with materials that reduce the transfer of heat to the outside environment. Traditionally the construction industry uses hardboards or expandable foams based on petrochemical plastics because they are good insulators that are affordable and easy to produce. But these materials are not particularly kind to the environment, so the long-term objective is to replace petroleum based products with materials derived from renewable resources.

Researchers at the Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut, WKI in Braunschweig have adopted a very promising approach to the problem by developing a method for creating foam from wood particles. "Our wood foam can be used in exactly the same way as conventional plastic spray foams, but is an entirely natural product made from sustainable raw materials," explains Professor Volker Thole of the WKI. The scientists produce the foam by grinding wood very finely until the tiny wood particles become a slimy mass. They then add gas to this suspension to expand it into a frothy foam that is then hardened. The hardening process is aided by natural substances contained in the wood itself. In an alternative method, specific chemical processes are used to produce the final product. "It's a bit like baking, when the dough rises and becomes firm in the oven," Professor Thole explains. Wood foam is a lightweight base material that can then be made into rigid foam boards and flexible foam mats.

### Insulates as well as conventional plastic foams

Wood-based insulation materials are nothing new, but the products that are currently available have drawbacks. For instance, mats made from wood fibers and wood wool tend to shed fibers as they fibrillate and are less stable in shape than insulation materials made of plastic. "Over time, the currently used insulation mats made of wood fibers tend to sink in the middle due to temperature fluctuations and damp. This to some extent adversely affects its insulating properties," says Professor Thole. The wood foam developed at the WKI, however, is every bit as good as conventional plastic foams in this regard. "We analyzed our foam products in accordance with the applicable standards for insulation materials. Results were very promising; our products scored highly in terms of their thermo-insulating and mechanical properties as well as their hygric, or moisture-related, characteristics," Professor Thole reveals.

The Braunschweig-based scientists are currently experimenting with different types of wood to discover which tree species make the best basis for their product. Furthermore, they are working out suitable processes for mass-producing wood foams on an industrial scale. This innovative material could also be used in areas other than insulation, such as packaging. Packing materials made from wood foam would provide a long-term alternative to yet another oil-based product: expanded polystyrene.



**This wood foamed board is an entirely natural product made from sustainable raw materials.**  
(© Fraunhofer WKI) | Picture in color and printing quality: [www.fraunhofer.de/press](http://www.fraunhofer.de/press)



## Interactive simulator for vehicle drivers

Simulations are an important development tool in the automobile and utility vehicle industries – they enable engineers to see into the future. The properties of vehicle components, such as how they respond in an accident, their reliability, or their energy efficiency can be investigated using simulations before the first component is manufactured. To continue to maintain the prediction power of the results, however, all of the influences that the vehicle is exposed to later on in actual operation must be taken into account – including those of drivers and operators.

Researchers at the Fraunhofer Institute for Industrial Mathematics ITWM in Kaiserslautern, Germany, have developed an interactive driving simulator using RODOS (robot-based driving and operation simulator) with which realistic interaction between human and vehicle can be analyzed. “Driving behavior is a key factor that is often insufficiently accounted for in computational models,” according to Dr. Klaus Dreßler of ITWM. No doubt there are algorithms that are supposed to represent the “human factor” in simulations – however, these do not properly reflect the complexity of human behavior. For this reason, researchers at ITWM have shifted to a hybrid design for simulation. Hybrid here means a real person interacts with a simulation environment – a well-known example of this is a flight simulator, in which pilots regularly practice extreme situations. In the automotive and utility-vehicle sector, only a few manufacturers have had this kind of facility at their disposal, as its development involves a lot of effort and expense.

### **An enormous industrial robot manipulator simulates braking maneuvers**

The simulation facility's structure at ITWM consists of a real vehicle interior where the test driver can operate the steering wheel, accelerator, and brakes as usual. The vehicle interior is integrated into a 6-axis robotic system that looks like a gigantic gripper arm and can simulate acceleration, braking, or tight curves by leaning and rotating. “We have much greater room to maneuver than with the kinematic systems usually employed today. At the same time, the space requirements are comparatively quite low,” according to project manager Michael Kleer.

For test drivers to behave authentically, they must have the feeling they are actually situated in a moving vehicle. If movements of the simulator do not match the visual impressions, this not only influences driver reactions, it can also lead to symptoms like kinetosis. Simulator sickness is triggered by contradictory sensory perceptions, the same way motion sickness or sea sickness is. “To prevent these unpleasant side effects, we have developed our motion cueing algorithms that generate the control signals for the robot in close cooperation with researchers in cognition,” explains Dreßler. On the basis of this interdisciplinary knowledge, the motions of the simulator can be matched to visual input so they are perceived as very natural by the test drivers. At the same time, an enormous projection dome provides the external impression of real driving. 18

projectors provide a realistic 300 degree view of the situation for the driver. "You can imagine it as resembling an IMAX theater," according to Dreßler.

Driving simulations that also take into account the human effects on a vehicle may become more important in future. The increasing number of driver assistance systems will themselves make the human-machine interface in automobiles increasingly important. The demands placed on simulations will thus become increasingly more specific. "That is where we have an additional advantage with our approach: all the algorithms are proprietary in-house developments – so we therefore can match the individual algorithm parameters to project-specific problems," says Kleer.

The simulation facility at ITWM has been in operation since July 2013 – and two projects in collaboration with the Volvo Construction Equipment company are presently underway. From April 7 to 11 the technology will be shown at the Hannover Messe trade fair (Hall 7, Booth B10).



**Almost like real life: the vehicle simulator at Fraunhofer ITWM has 18 projectors that throw their images up on a huge dome. The vehicle interior can simulate nearly every driving situation.**

**(© Fraunhofer ITWM) | Picture in color and printing quality: [www.fraunhofer.de/press](http://www.fraunhofer.de/press)**

## LED lamps: less energy, more light

Incandescent light bulbs are now banned in the EU, while energy-saving lamps remain a bone of contention. In 2016, it will be lights out for halogen bulbs over 10 watts as well. LEDs (light-emitting diodes) therefore have the best chance of becoming the light source of the future. Experts reckon that LED retrofit lamps for use in standard bulb fittings will overtake traditional energy-saving bulbs for the first time from 2015. By 2020 it is predicted that LEDs will have captured between 88 and 90 percent of the lighting market. The tiny diodes offer a whole host of advantages as the most environmentally friendly source of light – they contain no harmful substances, consume less energy and, with a lifetime of between 15,000 and 30,000 hours, last longer than conventional light sources. They also work at full brightness as soon as you flick the switch.

### Coping with higher temperatures

LEDs do have one weakness, though – they are extremely sensitive to variations and spikes in power. To function properly, they need a driver that ensures a constant supply of power at all times. This driver, which takes the alternating current from the grid and converts it into direct current with a reduced voltage, has a profound influence on the light yield and lifetime of the LED lamp as a whole. The demands placed on the driver electronics are correspondingly high. This has prompted researchers at the Fraunhofer Institute for Applied Solid State Physics IAF in Freiburg to focus their attention on voltage transformers featuring gallium nitride (GaN) transistors. During practical testing, the scientists found that the drivers developed using this new semiconductor material were extremely robust. Components made of GaN can operate at higher currents, voltages and temperatures than standard silicon transistors. “Heat plays a role both in the brightness and the service life of LED lamps,” says Dr. Michael Kunzer, group manager at Fraunhofer IAF.

### Gallium nitride transistors switch at high speed

Gallium nitride transistors can also switch at high frequencies. The switching speed has a significant impact on the size of the coils and condensers built into the drivers for energy storage. In a GaN-based driver, the switch speed can be made as much as a factor of 10 faster than that of its silicon equivalent. “Applied to a smaller surface, this means it is possible to make switching cheaper. The whole LED lamp can be made lighter and more compact while delivering the same or even improved illumination,” explains Kunzer. Since the energy storage component plays a decisive role in manufacturing costs, this could have an extremely positive effect on the end price.

Thanks to the new semiconductor material’s useful properties, Kunzer and his team have been able to boost the efficiency of the GaN driver to 86 percent – between one and four percentage points better than its silicon equivalent. When compared with the

silicon transistor LED lamps available on the market., the scientists were able to increase the light output: while the luminous flux of commercial LED retrofit lamps featuring silicon components is around 1000 lumen (the unit used to measure the light produced), researchers from the IAF have been successful in increasing this to 2090 lumen. "20 percent of energy consumption worldwide can be attributed to lighting, so it's an area where savings are particularly worthwhile. One shouldn't underestimate the role played by the efficiency of LED drivers, as this is key to saving energy. In principle, the higher the light yield and efficiency, the lower energy consumption is. If you think that by 2020 LEDs will have carved out a market share of almost 90 percent, then it is obvious that they play a significant role in protecting our environment," says Kunzer. The researchers will be showcasing a demonstrator of their retrofit LED from April 7-11 at the Hannover Messe, where they can be found at the joint Fraunhofer booth in Hall 2, Booth D18.



**Gallium nitride transistors enable the compact design of this 2090 lumen retrofit LED lamp (exploded diagram for purpose of illustration). (© Fraunhofer IAF) | Picture in color and printing quality: [www.fraunhofer.de/press](http://www.fraunhofer.de/press)**

## Getting hyperspectral image data down to a sprint

RESEARCH NEWS

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Cameras with hyperspectral sensors can observe far more than the human eye. Unlike the retina, which has only three color receptors (red, green and blue), these sensors can generate 130 different color values per pixel. Using this high-grade color resolution, an entire range of different materials can be differentiated impeccably – even if, at first glance, they appear the same to the human eye. This is because every substance has its own individual color spectrum, irrespective of how its surface reflects the light hitting it. This hyperspectral technology can be used anywhere where surfaces have to be examined with a fine-toothed comb: for example, in the search for mineral resources, quality control in the production process, or food manufacturing as well as environmental monitoring from the air. The systems that are currently available, however, can only process the information very slowly. Because massive volumes of data are accumulated from the analyses. Indeed, hyperspectral cameras – which can record video images at the same time – may even accumulate up to one gigabyte per minute. All too often, the analysis lags behind, or is just plain impossible.

The Fraunhofer Institute of Optronics, System Technologies and Image Exploitation IOSB is unveiling the SpectralFinder – a software application that can record vast amounts of hyperspectral data on a mobile platform and analyze them in real time – at this year's CeBIT in Hannover from 10 to 14 March (Hall 9, Booth E40). It's an essential requirement if, for example, you want to apply it to assembly-line production. "Our expertise lies in handling large quantities of data, the real-time capability, and the intuitive ease-of-operation," explains Dr. Wolfgang Middelman, who heads the corresponding Image Interpretation Research Group at IOSB. The technology generates a 130-channel image of the surface based on the various color spectra that the camera records. "Think of it like a map, where lakes, cities, streets, fields and mountains are plotted differently using various colors," explains Caroline Stolka, a research group staff member. If the user clicks an image area on the monitor, an algorithm immediately displays where similar surfaces can be found in the live images. This is accomplished when the software compares the 130 color values within the image area with the remaining image pixels; it then displays those surfaces which have the best corresponding color values. "It also operates when the camera or the object is moving. The materials can even be classified while data is still being collected," Stolka says.

### Compact system for environmental protection

The technology is available as a prototype. Researchers have successfully tested potential application scenarios in the laboratory. The entire system consists of a hyperspectral camera and a connected computer that has SpectralFinder installed on it. The compact technology can be manually operated with ease. "This manner of detecting and classifying materials on a mobile basis provides a great benefit to the various fields – take environmental monitoring, for example, on the ground and from the air," says Mid-

delmann. The scientists have programmed the software in such manner that the recorded color spectra can also be compared with an attached materials database. The system operates from a great distance – such as when taking pictures from the air. This technology could help keep landscapes clean by quickly exposing pollution, by delivering important information about health conditions or pest infestation to land and forest management authorities, or by supporting water pollution control and identifying at-risk areas when dikes or levees are at peril of collapse.

Visitors to the CeBIT joint exhibition booth of the Fraunhofer-Gesellschaft can test the SpectralFinder by moving the camera in front of a material wall, seeing its live recordings on the monitor and applying the software. Objects from the world of mining can be studied, along with things that play a role in environmental monitoring. The scientists will also be presenting their technology in a virtual laboratory. An initial scenario can also be seen at CeBIT.



**Artificial turf (left) or real vegetation (right)?: The SpectralFinder recognizes the color spectrum of surfaces in real time. (© Fraunhofer IOSB) | Picture in color and printing quality: [www.fraunhofer.de/press](http://www.fraunhofer.de/press)**

## Virtual lab for nuclear waste repository research

RESEARCH NEWS

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The nuclear power phaseout in Germany is a done deal and is supposed to be finalized by 2022 at the latest. Where should the radioactive waste produced be put, though? Suitable sites for nuclear waste repositories have to be found as quickly as possible. This is not easy, though since waste is required to be sealed off from the biosphere for one million years. A potential site's real suitability as a nuclear waste repository can only be analyzed once such a repository has been designed, planned and studied together with its equipment modules. Various physical and chemical processes, which are very complex and interact, take place in a nuclear waste repository – the rock may be heated by the waste stored and gases may develop. Until now, researchers have studied such processes in underground laboratories such as the ones in Mont Terri in Switzerland or in Äspö in Sweden as well as in France and Belgium. Time and again, German researchers have to pack their bags and travel to the underground laboratories for their experiments where they test the quality of sealing systems for instance. The period of a study is limited, though, because none of these tests can be conducted for more than a few years.

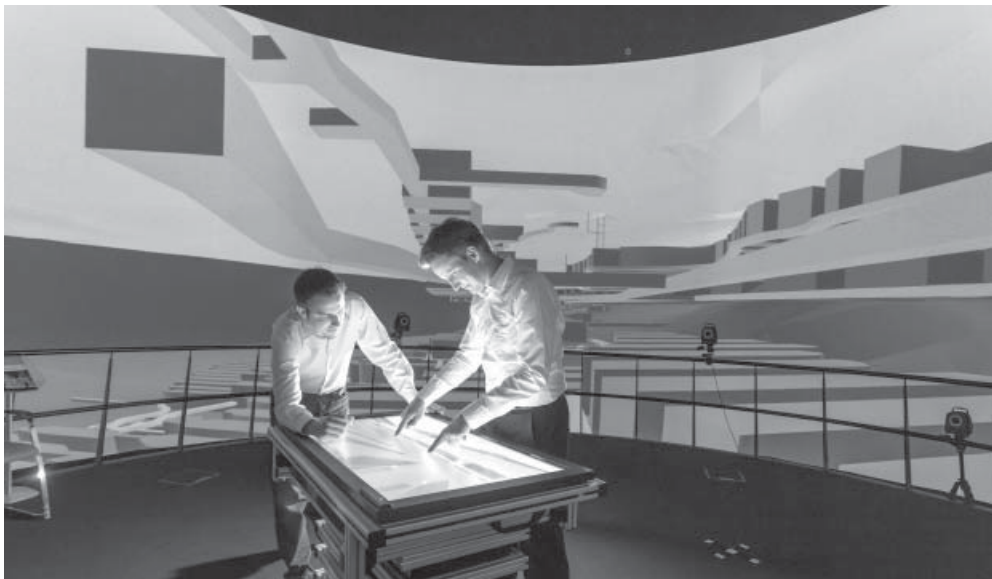
### Laying out and studying deep geological repositories virtually

The most important nuclear waste repository research organizations – the Gesellschaft für Anlagen- und Reaktorsicherheit GRS, the Federal Institute for Geosciences and Natural Resources BGR and DBE Technology GmbH – therefore need to supplement real underground laboratories. They contracted researchers at the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg the world's first virtual underground laboratory, VIRTUS. A software platform is the virtual underground laboratory's central component. It realistically represents all of the conditions there, whether the types of rocks in the soil or the physical or chemical processes that take place in a deep geological repository. This enables researchers sitting at their desks to perform virtual experiments in a realistic scenario and to review plans and sites for nuclear waste repositories down to the minutest detail.

In a first step, the researchers recreate a site's geological formations. Since concrete sites for nuclear waste repositories do not exist yet, they work with a generic model – rock formations are structured realistically but do not recreate any real site. "After all, the first task is to develop the system and to test VIRTUS's performance on the basis of initial calculations," says Steffen Masik, engineer at the Fraunhofer IFF. Users can lay out a virtual deep geological repository in this rock formation. They have a great deal of freedom in the process: They can specify the depth, area, height and width of the repository. They can also import a repository complex created beforehand and specify the locations of boreholes and adits in which radioactive waste will be stored.

Once they have created a repository complex, the researchers can commence their studies – just like in a real underground laboratory and select an area of the deep geological repository. A special interface transfers the location selected and the repository data to a simulator, which computes, for instance, rises in temperature in the repository caused by the radioactive waste. The results are visualized in VIRTUS. Users can also display cross sections of the rock together with the temperatures there. Mechanical stresses and thus the probability of crack formation can also be computed. Researchers can closely examine permeability to water or other liquids and gases. VIRTUS displays all of the calculations together with the geological model. “The software visualizes the computed thermal, hydraulic and mechanical processes in a nuclear waste repository as well as their complex interactions,” says Klaus Wiczorek, who works in the division of nuclear waste repository safety research at GRS and is heading the VIRTUS project.

VIRTUS is still in development at present. A first prototype is supposed to be publicly accessible at the end of April: In the future, visitors to the large, 360 degree projection system at the Virtual Development and Training Center VDTC in Magdeburg will be able to see the workings of a nuclear waste repository and the simulation results. “This is a good opportunity for us to win people’s confidence in our work and to develop their understanding for decisions,” says Wiczorek.



**A 360 degree presentation of a virtual model at the Fraunhofer IFF. Decisions can be arrived at more easily when everyone involved is able to view the details. (© Dirk Mahler) | Picture in color and printing quality: [www.fraunhofer.de/press](http://www.fraunhofer.de/press)**



## Adapting production processes swiftly and cost-effectively

It was surprising to get the call from the smartphone maker. Instead of the scheduled volume of electronic components, the company now needs double the amount – and two weeks sooner! It is not an atypical scenario for an electronics supplier. Individual customer requests force most medium-sized companies to administer increasingly flexible production processes. It's a complicated situation: scheduling employee shifts, ensuring machine capacities, adjusting made-to-order production rates - all of these have to be completely reorganized at a veritable instant, and typically across multiple production sites. So what is the most cost-effective solution? "There is software that helps with the scheduling of capacities. But I know of no product that analyzes the adjustments based on costs and calculates the most cost-effective variant – taking nearly every conceivable aspect into consideration while doing so," states Christian Morawetz of Fraunhofer Austria, Fraunhofer's Austrian subsidiary.

The scientists therefore developed "KoKa," working jointly with the University of Vienna and the Adaptive, flexis and Melecs companies. Once all the necessary data are uploaded, then one click suffices for the software: the user immediately sees how expensive the necessary measures are in order to adapt production, and receives an optimized production plan based on this information. Practice tests have shown that through this approach, manufacturers can save up to seven percent on production costs. "That could equal up to EUR 1.4 million a year for an electronic components manufacturer of a size that generates up to EUR 100 million in annual revenues," as Morawetz describes the added value from this now market-ready technology.

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## Shepherding a lively crowd into safe channels

Large throngs of people congregate at airports, train stations and stadiums, presenting certain challenges apropos security for those who are in charge of things. This is where SAFEST (Social Area Framework for Early Security Triggers at Airports), a German-French research project, comes in: in conjunction with partners from industry and research, scientists from the Fraunhofer Institute for Open Communication Systems FOKUS are engineering a risk detection and crisis management system for heavily frequented public spaces. SAFEST is being coordinated by the Freie Universität Berlin.

The team is taking a comprehensive approach: an intelligent guidance system detects crowds of people using infrared technology, and guides them in a targeted manner away from the danger zone – via the local WLAN, with the aid of their mobile tele-

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phones. An orderly evacuation can be brought about substantially better this way than with conventional guidance systems. In addition, security personnel must immediately identify if unauthorized persons have gained access to secured areas. A variety of sensor systems for this purpose can differentiate between inadvertent and intentional intrusion. The control room then assesses the conditions.

Researchers will introduce RIOT at this year's CeBIT. RIOT is an open-source operating system for the Internet of Things, and the foundation of SAFEST technology. Using RIOT, the team is seeking to integrate surrounding small devices swiftly and cost-effectively into the risk detection system. In emergencies, SAFEST could, for example, signal an emergency through the building's light control system, or flag the escape routes.

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**Production efficiency: putting battery devices on a virtual leash**

The Performance-Optimized Systems department at the Fraunhofer Institute for Integrated Circuits IIS in Nuremberg is concerned with the issue of how movements of objects and humans can be recorded. The researchers' solutions have a variety of applications: vehicles that automatically detect traffic participants and avoid collisions. An algorithm that knows whether humans are lying on the ground or have collapsed. For CeBIT, the scientists have transferred their software-based technology to the industrial production space. There, it is important to know, for example, if tools are being properly employed. And when it comes to cordless devices, whether these can also be found at their intended location.

The IIS software is capable of determining an implement's movements and its position. As a requisite the algorithms and the sensors are directly integrated in the device. The results are forwarded to the company's data center via Bluetooth, and once there, they are compared with the specified deployment scenarios. If these values do not correspond, then this is displayed on the device per LED. "Even cordless screwdrivers are connected to the virtual leash this way – and provide transparent information as to whether they are working efficiently," says Jochen Seitz of Fraunhofer IIS. Visitors can test the technology themselves at this year's CeBIT from 10th to 14th of March when visiting the joint exhibition booth of the Fraunhofer-Gesellschaft in Hall 9 (Booth E40).

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