Fraunhofer IESE

Fraunhofer Institute for Experimental Software Engineering IESE

Annual Report 2021/2022

In Focus

Digital Healthcare – the digital transformation in healthcare

Prof. Peter Liggesmeyer has been driving digital innovations as the Executive Director of Fraunhofer IESE since 2015.

Dear readers,

The topic of "health" concerns us all. But hardly any other industry deals with more sensitive data than healthcare. This makes it all the more important, of course, to protect this data and treat it confidentially. But what would our decision be if it were a matter of life and death? In an emergency, would we not be more likely to decide that the emergency physician should be allowed to see our medical record in order to provide us with the best possible care? Protecting data, but only when it makes sense, and defining in advance exactly in which situations one releases one's data for specific people – this is exactly what Fraunhofer IESE can realize with its solution for data usage control called "MY DATA Control Technologies".

When it comes to digitalization in the healthcare sector, there is a clear need to catch up. The poorly interoperable digital systems in the medical sector make it difficult to use data in a meaningful way. For example, in an average hospital, there are a large number of largely unconnected systems. This is dramatic in that sharing data could greatly improve many processes. And it is, of course, also important to think beyond hospital walls and link the entities that are needed in an emergency, for example. With the "Central Statewide Treatment Capacity Indicator ZLB 2.0", for example, we help to ensure that in an emergency, a hospital with the specific treatment options required and currently available is identified quickly and directly in order to ensure the best possible care for patients.

The lack of medical care in rural areas is another central topic of our research. Together with other Fraunhofer Institutes, we have founded the Fraunhofer Center for Digital Diagnostics in Potsdam. Here the focus is on the targeted development of digital diagnostics solutions, including advanced telemedicine solutions. We consider them to have the potential to significantly reduce the problem of medical care in sparsely populated regions.

In the area of digitalization in healthcare, we not only contribute our competencies from the areas of "Digital Ecosystems" and "Data Usage Control". Fraunhofer IESE is also a sought-after partner when it comes to the topic of "Industrie 4.0" in pharmaceutical production. For example, our Fraunhofer lighthouse project "RNAuto" is specifically concerned with how to automate the production of cancer drugs individually tailored to patients – which until now have been extremely expensive – with the help of our middleware BaSyx and thus produce them at lower cost – and thereby save lives.

The topic of "Digital Healthcare" is particularly close to my heart because it involves each and every one of us. That is why we have dedicated the cover story of this year's Annual Report to this focus. But, of course, we also have articles for you on our other trend topics such as "Autonomous Systems", "Smart Farming", and "Production and Industrie 4.0".

I wish you an interesting read!

Best regards

Peter Liggesmeyer

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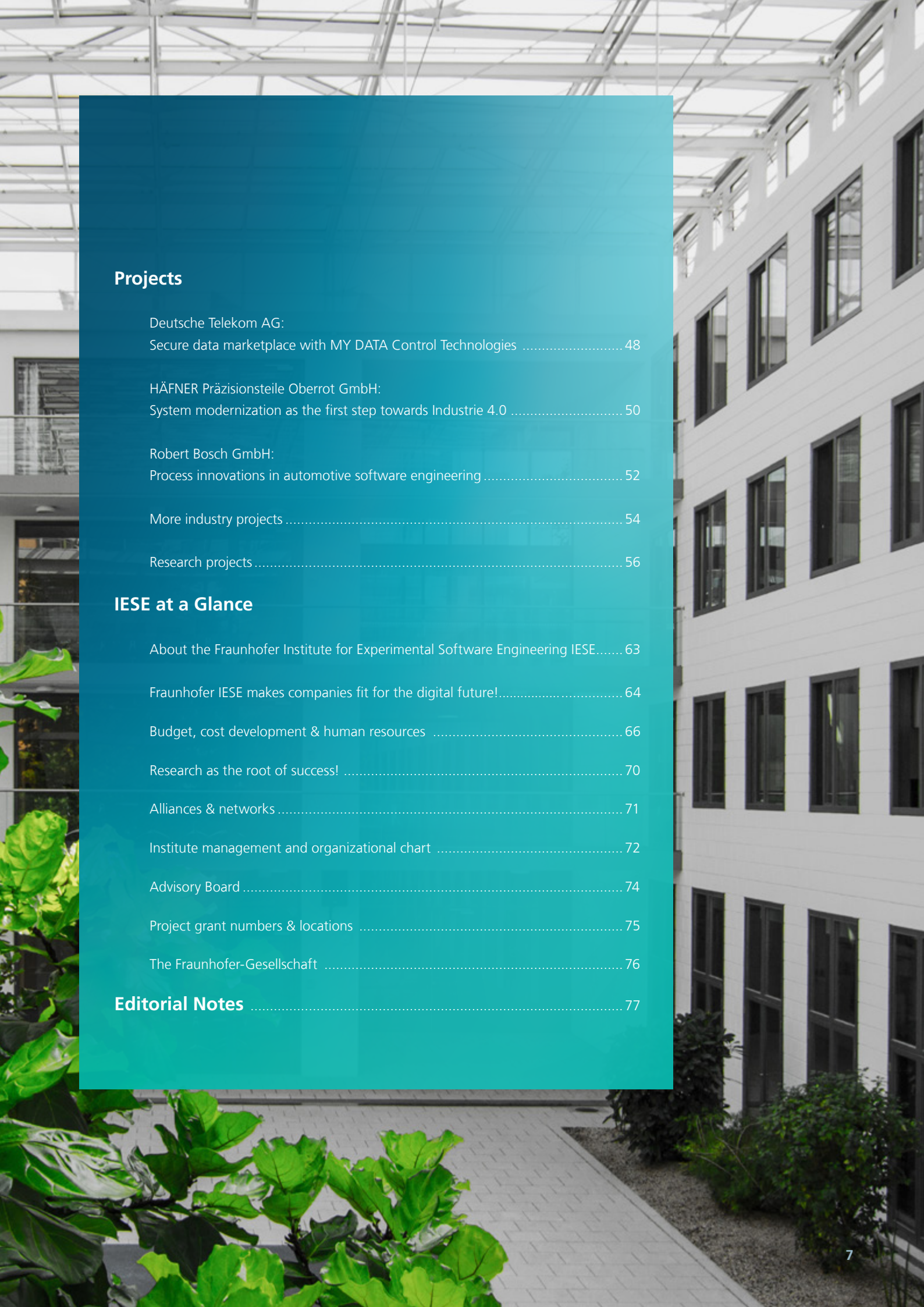


Projects

IESE at a Glance

Cover Story

Digital Healthcare – the healthcare industry in transition

How does IESE support the digital transformation in the healthcare industry?

In the interview: Rolf van Lengen, manager of the research program "Digital Healthcare" at Fraunhofer IESE

In the medical sector, there is a lot of potential for digitalization. This is why Fraunhofer IESE supports the healthcare industry on its way to the digital future with its research program "Digital Healthcare". The goal is to increase the efficiency of the healthcare system, improve patient care, and thereby reduce costs.

What are the fundamental challenges facing the healthcare sector?

The healthcare industry is currently undergoing a gigantic upheaval. One important aspect of this is demographic change. This means that we are getting older and older on average, which of course also has an impact on the healthcare system. On the one hand, there are more and more patients to be treated, and on the other hand, medical and nursing staff are also getting older. This means that the workforce in this area is shrinking and must be replaced urgently. One thought that immediately comes to mind is that the system can become more efficient with the help of intelligent solutions from the IT sector. And indeed, many digital solutions are already being used in the healthcare sector.

The problem, however, is that these are isolated solutions that work in individual areas, but are not yet interconnected with each other as a whole. A good example of this: In Lithuania, there is a digital patient file for every patient, which can be accessed by any doctor from any location with the patient's consent. We have not come this far yet in Germany.

Why has this not been implemented yet in Germany? What exactly is the problem?

I do not think that the problem is technology. We have many intelligent solutions, but we are not yet ready to network across healthcare sectors – i.e., hospital, doctor's offices, etc. We are still in the preparatory stages, even though we have been talking about digital patient records in Germany for 15 years.

Let's now turn to the IESE research program "Digital Healthcare": Is this also about supporting this networking?

Yes, that is correct. This is an important topic of research at Fraunhofer IESE: Starting with the data that is collected, via data usage control – i.e., which data belongs to the patients, who is allowed to read this data, for which purpose, and how long this data may be kept – all the way to the networking of entire systems in healthcare.

But it is best to take one step back: The research program "Digital Healthcare" was initiated at IESE to identify innovative

topics in healthcare. We are looking for efficient IT solutions to problems in the medical field and are investigating how we can best contribute our competencies as experts in software and systems engineering to such projects.

To get a better overview: In which areas is Fraunhofer IESE active in this research program?

On the one hand, we have the public sector – public healthcare – and on the other hand the healthcare industry as a second large cluster in which we can position our projects. I would like to highlight an important topic from the public sector. For more than ten years already, it has occupied a special place in our research – preclinical care. These projects focus on rescue services, disaster control, and emergency medicine.

What are some specific examples of projects related to preclinical care?

To name just a few: There is SPELL, whose focus is on disaster control. In this project, we collect historical data and real-time data, combine this data with AI support to create value-added services, and offer these to control centers, for example, so that they can respond more quickly in the event of disasters.

I would also like to mention DENIT – the German Center for Emergency Medicine and Information Technology – where we also deal with issues from the preclinical area. In this project, which is funded by the Ministry of the Interior and for Sports of the State of Rhineland-Palatinate, we are optimizing processes by harmonizing hospital and care data as well as the processes involved throughout the state and mapping them in the corresponding IT systems.

Another project from the area of rescue services is ViTAWiN. This project is about the training of emergency medical staff with the help of virtual reality. You can imagine this as follows: A team consisting of two people is each equipped with VR glasses and trains an emergency scenario in the virtual world.

What is unique here is the so-called crew resource management training. An important aspect of this training is the assignment of tasks within the rescue team and the coordination of who takes on which tasks.

Rolf van Lengen, manager of the research program "Digital Healthcare" at Fraunhofer IESE

What other projects are there at IESE in the area of Digital Healthcare?

We have a whole range of projects there. As I already mentioned, we distinguish between public healthcare and industrial applications. I already said some things about the former. In terms of industrial application, we are active in the field of ATMP, among other things. ATMP stands for "Advanced Therapy Medicinal Products". These are therapeutics that are manufactured individually for a patient. The problem here is that they are very expensive to produce. They are used, for example, in cancer diagnostics, and the treatment of a single patient costs about 300,000 euros.

And why is that?

Because these drugs are manufactured manually with great effort – without much automation. We are working on the digitalization and automation of the manufacturing process of individual pharmaceuticals in the sense of Industrie 4.0 – our specialty. The new Fraunhofer lighthouse project RNAuto also deals exactly with this topic.

But the overarching goal of all our projects in the research program "Digital Healthcare" is to drive the digital transformation in healthcare in order to improve patient care. We are on a good path, but there is still work to be done.

Managing crises better with Artificial Intelligence

In this interview: Stephan Theis, Head of the Rescue Service Department, Ludwigshafen Integrated Control Center

The research project "SPELL" provides decision-making support for control centers in the event of a disaster

"SPELL" stands for "Semantic Platform for Intelligent Decision-Making and Mission Support in Control Centers and Situation Rooms". In the event of a disaster, the work of control center teams is characterized by complexity. The goal of the research project SPELL, which is funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWK), is to be able to initiate measures for hazard prevention, emergency aid, and care for the population more quickly and in line with the situation in crisis situations – and to do so with the help of Artificial Intelligence (AI). The Ludwigshafen Control Center is the project management center for the SPELL project, and Stephan Theis knows exactly what he wants from Artificial Intelligence.

What are the differences at the control center between normal operation and in the event of a disaster?

First of all, it is one of the basic tasks of an integrated control center that we answer calls made to the emergency number "112"; we provide assistance on the phone and at the same time alert the emergency forces of the fire department, the civil protection forces, and emergency medical services. In other words, we coordinate the entire rescue effort. We cooperate intensively with the German Red Cross and the Ludwigshafen Fire Department, in particular.

In "normal operation", you have more time to devote to individual cases and, for example, give instructions regarding resuscitation or first aid measures on the phone. In the event of a disaster, on the other hand, the challenge is that very many people call the emergency phone number at the same time – we also call this a major incident. it is difficult to stay on top of such a large number of calls. For example, during a severe weather event, many people from the same locality will call about flooded basements, but there could also be a caller from the same locality calling at the same time about a medical emergency, such as a heart attack. Good crisis management is necessary to handle such a volume of calls in a meaningful way.

How can SPELL help to improve crisis management?

My wish would be that in the case of such a major incident, the AI-based services of the SPELL platform can be used to classify where the calls are coming from, how likely it is that a caller wants to report the same emergency, or whether there is perhaps another reason after all. In general, Artificial Intelligence can be used to provide additional data and information that can be of great benefit to us in the control center in terms of making decisions and thereby also managing the crisis.

What are some concrete examples from day-to-day work at the control center?

Here in Ludwigshafen, there are always emergency calls related to the Rhine River. If someone calls Speyer, for example, and reports a person floating in the water, the position of that person will naturally change rapidly. In this case, an intelligent prediction of the person's position – calculated on the basis of flow velocity, water level, and wind speed – could save that person's life. Accordingly, the local fire department and the emergency medical service could then drive at the right time directly to the right place, i.e., the place to which the person has been carried by the water until the arrival of the rescue forces.

Another example comes from the medical

"In SPELL, data is provided in an intelligent manner to help alert the public faster in the event of a crisis."

Stephan Theis,
Ludwigshafen Control Center

field. If two medical emergencies – such as a traffic accident and a person with hypoglycemia – were to happen at the same time and also in close proximity to each other, the intelligent system could coordinate the two missions in such a way that help could be provided quickly to both injured persons. The available emergency forces must be distributed optimally. This intelligent decision about which route to take or the assignment of the rescue team and the rescue vehicles can provide the decisive time advantage in life-threatening situations.

And ideally, this targeted background information would be made available in a graphically visualized form so that we in the control center can gasp it quickly and at a glance.

To clarify once again – how is a disaster situation handled with AI support?

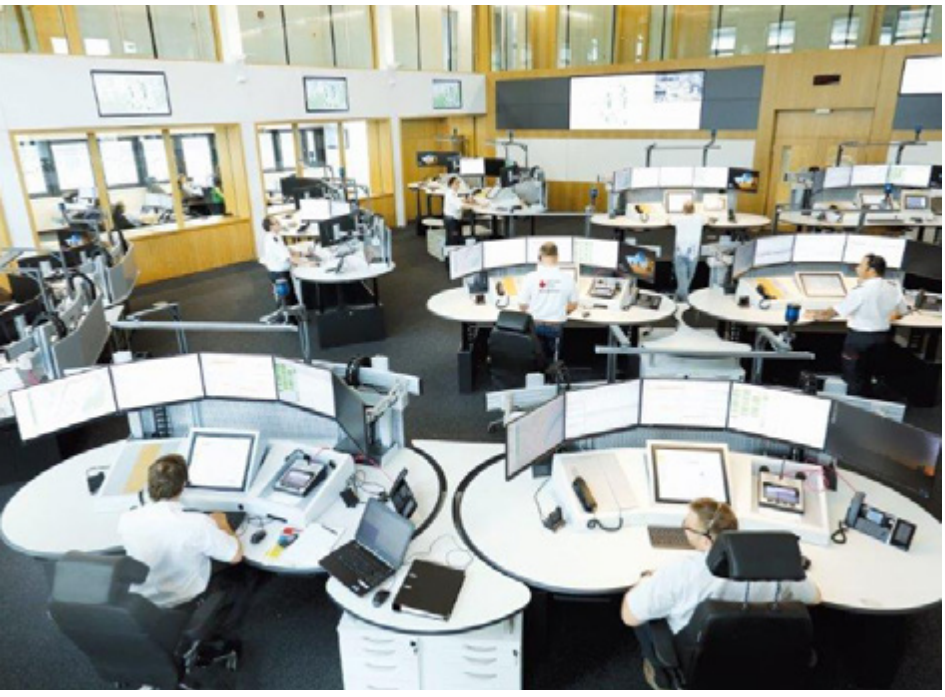
With the help of Artificial Intelligence, it is to be hoped that certain values and developments will be recognized at an early stage during the course of the mission in the event of a disaster, will be received by the mission leaders, and will enable them to quickly issue appropriate warnings to the public.

If, for example, a building is on fire in Kaiserslautern and hazardous substances are measured in the air, then how this cloud of smoke develops naturally also depends on the air pressure, the wind speed, the temperature, and many other things. The AI could use the current weather data to calculate in which direction the cloud is likely to move and which measures need to be taken. Whether, for example, a hospital, a senior citizens' home, or a school must be warned about the toxins or even needs to be evacuated.

What are the advantages of SPELL – in a nutshell?

A decisive advantage of the AI-supported ecosystem is that a lot of data and information is collected, bundled, and evaluated in crisis situations – and that this happens with a stable level of high quality. At 3 o'clock at night, I am, of course, not as fit as at 9 in the morning. Although this is human, it does influence my decisions. I would therefore be grateful to have a system at my side that accompanies me and provides me with assistance.

With such an assistance system, SPELL can make the work of my colleagues in the control center much easier. With fast, targeted information and decision-making aids!



The Ludwigshafen Integrated Control Center is the project control center in the research project "SPELL".

More information on the project:
spell-plattform.de/

Automated manufacturing processes for mRNA active substances

RNAuto – for sustainable and economical healthcare

In the interview: Prof. Dr. Dr. Ulrike Köhl, Institute Director of the Fraunhofer Institute for Cell Therapy and Immunology IZI, and Prof. Dr.-Ing. Peter Liggesmeyer, Institute Director of the Fraunhofer Institute for Experimental Software Engineering IESE

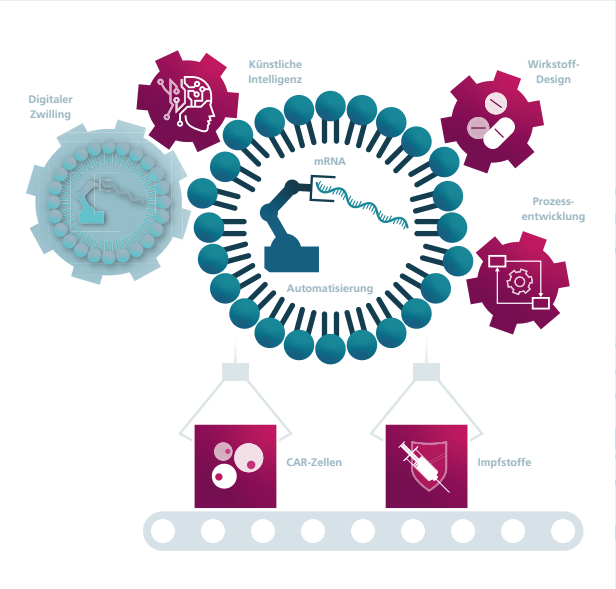
Vaccines based on mRNA as well as gene and cell therapeutics are innovative drugs with which infectious diseases, hereditary diseases, and cancer can be treated or even prevented. In recent years, they have undergone extremely dynamic development in clinical research and application – not least as a result of the Corona pandemic. In the future, they are to be available to an even greater number of patients in an affordable healthcare system. This requires automated production technologies that produce them safely and reliably according to the high requirements for pharmaceuticals. This is precisely the goal of the Fraunhofer lighthouse project RNAuto!

In order to develop an AI-controlled, digitally controlled, and automated production process in the sense of Industrie 4.0 by the end of 2025, the consortium bundles interdisciplinary competencies from medicine, biology, and engineering. The project is led by Prof. Dr. Dr. Ulrike Köhl – institute director of Fraunhofer IZI. Fraunhofer IESE with its institute director Prof. Dr.-Ing. Peter Liggesmeyer is also part of the project team, so that experience gained from Industrie 4.0 research can also be incorporated into the production of medicine. We spoke with both institute directors and took a closer look at the lighthouse project RNAuto.

As laypersons, we know mRNA mainly from the Corona vaccines.

What exactly is mRNA and why could the Corona vaccine be produced so quickly with it?

Köhl: mRNA molecules are found in all cells. By the way, mRNA stands for "messenger RNA". Its task is to transfer some genetic information, the blueprint of a protein, from the DNA inside the cell nucleus to the ribosomes, where the information is translated into a functional protein. Since it is usually the proteins of pathogens that trigger a response from the immune system, the idea of using the body's own protein synthesis to trigger an immune response - through vaccination - springs to mind. The fact that a vaccine based on mRNA technology could be developed



Automated production technologies of mRNA-derived vaccines as well as cell and gene therapeutics

Prof. Dr. Dr. Ulrike Köhl,
Institute Director of Fraunhofer IZI

»mRNA vaccines are very flexible and can be adapted quickly to a new target.«

quickly in the context of the Corona pandemic is mainly due to two aspects. On the one hand, research on this technology has been going on for several decades – especially in cancer medicine – so development did by no means start from scratch. On the other hand, mRNA technology is very flexible, meaning that active substances can be adapted to a new target and produced rather quickly.

The lighthouse project RNAuto is also about mRNA. What are the medical challenges with mRNA and in the lighthouse project RNAuto?

Köhl: In clinical application, the safety and quality of a drug or vaccine have the highest priority. To date, the development of corresponding production technologies has not kept pace with the rapid biomedical progress in these areas yet. Therefore, automated and digitally supported production technologies are needed to produce mRNA drugs quickly, safely, and reliably in accordance with pharmaceutical standards. This concerns the entire manufacturing chain, including formulation and packaging. A particular focus in the lighthouse project RNAuto is on technologies for non-viral gene transfer that enable more variability and cost efficiency in the manufacturing process. In the area of vaccines, we want to manufacture optimized, so-called self-replicating mRNA vaccines. In the area of gene therapeutics, on the other hand, mRNA is used as a critical starting material in manufacturing.

How is the production of pharmaceuticals optimized or automated in the RNAuto project? And how can the Industrie 4.0 middleware BaSyx and Digital Twins help to do this?

Liggesmeyer: An important goal of RNAuto is the establishment of a flexible, modular, and automated production process consisting of scalable production modules. The Industrie 4.0 middleware BaSyx realizes the required flexibility of the process and performs the digitally controlled and AI-supported automatic production and monitoring. The required complex quality controls can also be automated on the basis of this technology, which simplifies the proof of compatibility with good manufacturing practice – also known as GMP for short. Digital Twins enable extensive virtualization for manufacturing and quality control. Automated screening systems also serve to ensure the optimal composition of active substances.

What are the resulting benefits for the healthcare system and for patients?

Liggesmeyer: RNAuto aspires to achieve high throughput at low manufacturing cost. We want to make this very promising therapy

available to a large number of patients by increasing the amount available and reducing the cost.

For which specific use case will the mRNA therapeutics be produced in the project?

Köhl: Within the scope of this lighthouse project, a vaccine candidate for immunization against the West Nile virus is being developed and manufactured. This virus is becoming increasingly important since it is also spreading more and more in Europe and the first infections have also been recorded in Germany, among other places.

In the second use case, mRNA-induced gene therapeutics based on "natural killer cells" or NK cells for short will be developed for the treatment of lymphomas. These immune cells are equipped with an additional receptor that enables them to bind to cancer cells and specifically destroy these. This principle of "living cancer drugs" is already known from therapies with modified, patient-specific T cells. This is now to be transferred to NK cells from healthy donors in order to further reduce costs and significantly increase the availability of these immunotherapies.

Can this project revolutionize pharmaceutical production? What are the long-term goals?

Liggesmeyer: As already mentioned, the use cases "West Nile virus vaccine" and "Allogeneic NK cells" are considered in RNAuto. However, the goal is to design a modular production process that can be easily adapted for the manufacturing of other comparable substances. Therefore, RNAuto offers the potential to revolutionize the production of mRNA-derived vaccines as well as cell and gene therapeutics.

»With RNAuto, we aspire to achieve high throughput at low manufacturing cost.«

Prof. Dr.-Ing. Peter Liggesmeyer, Institute Director of Fraunhofer IESE

Using virtual reality training to improve emergency care

In the project ViTAWiN, all professional groups involved in an emergency practice patient care together in a virtual environment

Virtual worlds are conquering more and more industries. For example, we can use VR (virtual reality) glasses to explore the most remote vacation paradises from the comfort of our living rooms or simulate a shopping experience and thoroughly test products and their functions. So why not use Virtual Reality for further education and training as well? This is exactly where the research partners in the project ViTAWiN step in by developing a virtually augmented training program for continuing education and training in interprofessional emergency care.

How do virtual realities work?

Extended Reality (XR) comprises different technologies and human-machine interactions in combined real and virtual environments. The goal is deep immersion in the virtual world in order to provide a distinct spatial illusion. Virtual realities are computer-generated artificial environments. VR technologies usually use a three-dimensional, navigable virtual environment displayed using projection technology. For this purpose, VR glasses are used that are attached to the head and completely enclose the viewer's field of vision – this is also known as a "head-mounted display" (HMD for short). With this technology, the viewer completely disconnects themselves optically from the environment for the duration of the application. The environment displayed by the HMD is generated either on the basis of 360° videos or images, or on a digital basis.

Augmented Reality (AR), on the other hand, enriches the real environment with artificially generated content, such as objects, textual information, or icons. Special data glasses make this virtual world visible and tangible for the user. AR glasses are similar to ordinary glasses in terms of ergonomics. Using hand gestures (in the case of holographic projection) or operating controls situated on the glasses, the users can interact with the virtualized content. For example, they can select a menu item from a list. Such systems are already widely used in industry, mainly for complex tasks where employees receive instructions on the correct positioning of parts or warnings in the event of incorrect actions via the AR glasses.

ViTAWiN focuses on the educational needs in emergency paramedic training and in continuing education in emergency

nursing care. Here, the aim is to make an immersive and collaborative training and learning environment usable by introducing state-of-the-art XR technologies. The multi-user Extended Reality simulation environment even enables joint training of the two professions in real time.

Interprofessional collaboration in emergency care

Paramedics and emergency paramedics provide initial care for injured and sick people. Due to their state of health, the patients require immediate assistance or specialist care on the way to the hospital. If this is necessary, it is done together with the emergency physician colleagues on site or, in some cases, remotely via a tele emergency physician. Patients are usually handed over in the emergency room or in specialized units such as the shock room or the stroke unit – primarily to the respective physicians and to nursing staff with or without specialized training in "emergency nursing care".

Now, when several professional groups in interprofessional teams jointly provide patient care, complex situations arise, which, due to the dynamics of the patient's condition, can be characterized by openness of action and decision-making under uncertainty. A key feature is that this exact team constellation as a whole only arises in a particular emergency. This is a major challenge that must be taken into account in the ViTAWiN project.

Virtual training has many advantages

With VitAWiN, different professional groups repeatedly practice working together in such complex scenarios without any risk to real patients. This allows strengthening the confidence to act of all participants. Just like conventional training, VR training requires highly qualified instructors, but there is no need to block any medical products or medical devices, or real care units. Indeed, medical equipment such as ECG or ventilator units can be virtualized as Digital Twins. Another advantage is that VR training is more sustainable because there is no need to use disposable medical materials, such as bandages, cannulas, or ventilation tubes. Furthermore, this training method can contribute to pandemic resilience because participants can train together in separately assigned time slots from different locations.

And, of course, let's not forget: Younger people, in particular, are accustomed to virtual games and can be motivated by Serious Games to take part in training. After all, fun is the best prerequisite for learning!

vitawin

Related links:

ViTAWiN demo:
Interprofessional training session

ViTAWiN trailer:
Integration of emotions and haptics

ViTAWiN trailer:
Interdisciplinary cooperation

Fraunhofer Center for Digital Diagnostics: Telemedicine solutions to strengthen rural areas

The Fraunhofer Center for Digital Diagnostics, founded in 2021 in the Potsdam Science Park, focuses on the targeted development of digital diagnostics solutions. In the Brandenburg model region, new solutions and fields of application for digital diagnostics are being researched and developed in order to efficiently support patient care and realize value-added potential in the region.

For the development of digital diagnostics solutions, the effective combination of competencies for diagnostic instrumentation, data sciences, and medicine is critical to success.

Accordingly, the Center initially bundles the competencies of three core institutes on an institutional level: those of the Fraunhofer Institute for Cell Therapy and Immunology, Branch of Bioanalytics and Bioprocesses IZI-BB (instrumentation), the Fraunhofer Institute for Cell Therapy and Immunology IZI (medical needs), and the Fraunhofer Institute for Experimental Software Engineering IESE (digitalization).

Fighting pandemics with OPEN-POCT

Platform for secure transmission of mass PCR test results quickly brings clarity about the course of infections

In the current Corona pandemic, there is potential for optimization, for example in the performance of reliable and rapid testing of large numbers of people or in the administrative processing via the public health offices. This is why the project "OPEN-POCT" was launched to research and implement innovative solutions for these challenges. The Fraunhofer Institutes IESE and IMM (Institute for Microtechnology and Microsystems) have started with the goal of developing a holistic concept for rapid and widely available mass testing of the population for immediate containment of occurring outbreaks. The State of Rhineland-Palatinate is funding the research project in the context of the European Regional Development Fund (EFRE REACT-EU).

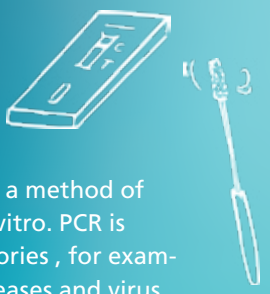
OPEN-POCT encompasses both the technical developments and the establishment of an administrative and regulatory ecosystem for a scalable, intelligent, and digitalized open-access rapid testing platform for the detection of infectious agents. The project results are intended to be transferable to other pandemics.

Rapid PCR-based testing for mass testing

Although antigen tests for rapid testing as well as for mass testing were available in sufficient quantity at some point in the current Corona pandemic, we still lack mass-suitable on-site rapid testing based on PCR (PCR = Polymerase Chain Reaction), which is much more reliable. What are the reasons for this? Essentially, it is because rapid PCR tests are up to 30 times more expensive per test than rapid antigen tests: While users can purchase rapid antigen tests for less than one euro, the wholesale prices for rapid PCR tests are over 30 euros. Furthermore, they are severely limited regarding the number of tests due to the high production costs and limited production volumes. In addition, operator systems are necessary, which means high investment costs of several thousand euros for the test centers or other users.

The challenge in OPEN-POCT is therefore to develop a concept for an on-site rapid PCR test – including short development times for the PCR test itself and cheaper test systems – in order to enable containment of a pandemic. The focus will be on new business models that can access highly scalable production capacities when needed and to which the broadest possible range of manufacturers and companies can contribute. Specifically, this will involve a division into generic and specific components in order to enable acceleration of regulatory approval steps and product development, as well as rapid adaptation to newly emerging pathogens at any time. In simple terms, this means that the testing system will consist of several standard components and that only one component needs to be adapted to the respective virus.
The core of the test system will be a Fraunhofer technology that makes it possible to easily detect infectious agents on site in a short time on the basis of PCR. With such sensitive POC-PCR rapid test systems (PoC = Point of Care), the project partners strive to contain the spread of infectious agents as quickly as possible, to protect lives, and to guarantee

Did you knowt?
PCR and PoCT briefly explained!



The polymerase chain reaction (PCR) is a method of multiplying genetic material (DNA) in vitro. PCR is used in biological and medical laboratories , for example for the detection of hereditary diseases and virus infections. The biochemist Kary Mullisdeveloped the method in 1983 and was awarded the Nobel Prize in Chemistry for it ten years later.

The term point-of-care testing, or PoCT for short, stands for »near-patient lab diagnostics« and in medicine refers to diagnostic tests that are not performed in a central laboratory, but rather directly in the hospital ward, in the office of a registered physician, or in a pharmacy, or by the patients themselves. Examples include rapid Corona tests, pregnancy tests, and blood glucose measurement. (cf. Wikipedia)

normality.

Transparency about the infection incidence

The platform will be complemented by the integration of automated transmission of positive test results, the reporting of which imposes a high bureaucratic burden on limited medical resources. In order to achieve holistic and rapid containment of a pandemic, it is therefore of the utmost interest to remove these bureaucratic obstacles in addition to technological obstacles.

The integration of an intelligent data transfer strategy into the OPEN-POCT rapid testing platform therefore represents a promising solution approach. This requires combining automated data transfer via secure data systems with data protection of individuals, general IT security, and data security. In order to achieve the highest possible acceptance of the platform, the data usage control framework "MY DATA Control Technologies" of Fraunhofer IESE will be integrated. This will allow individuals to determine which data they, as tested persons, want to share with which recipients and which not.

An expansion of digital data transfer solutions, such as linking them with the Corona warning app, reveals additional options for connecting the test system on the one hand and information or communication platforms on the other hand. This will relieve the burden on public health departments, as they can already reach their limits when tracking even a small number of newly infected persons per day.

In addition, the project partners aim to develop further concepts for containment by communicating with public authorities, companies, physicians, and other institutions during the course of OPEN-POCT in order to support the establishment of an administrative and regulatory ecosystem for mass testing.

More information on the project:
www.sofort-open-poct.de

Dispatching in Emergency Medicine

Nowadays, even in emergency medicine and in emergency medical services, nothing works without data and software. This is why the German Center for Emergency Medicine and Information Technology (DENIT), which is located at Fraunhofer IESE, has been providing the state government of Rhineland-Palatinate and the relevant authorities with competent consulting and support in the analysis and provision of data on emergency medicine and emergency medical service issues since 2008.

The aim of DENIT is to develop solutions for preclinical process optimization. Among other things, it aims to enable emergency medical services at any time to head for a nearby hospital that is ready to receive a patient, in order to ensure the fastest possible care for patients. For this purpose, authorized persons can use the web-based information system ZLB 2.0 (Central State-Wide Treatment Capacity Indicator in Rhineland-Palatinate).

In Rhineland-Palatinate, a total of about 100 hospitals, 2 ministries, 8 control centers, and 8 ÄLRD (medical directors of the emergency medical service) as well as the ADD (Supervisory and Service Directorate) are connected to the system.

How does the ZLB 2.0 work?

The ZLB 2.0 can be accessed via a web-based browser. Depending on a patient's existing primary diagnosis, users can view or search for currently available emergency capacities (e.g., for polytrauma), diagnosis-related intensive care beds (treatment, monitoring, ECMO), ward beds (e.g., internal medicine specialty), and other kinds of infrastructure. The ZLB 2.0 shows the respective duty and operating times and indicates the individual capacities as available, unavailable, or defective. Based on the input data, the program provides comprehensive status boards, state-wide situation views, and analyses depending on a rights and role system.

At the beginning of the Corona pandemic, the ZLB 2.0 was supplemented by additional reports on treatment capacities for COVID-19 cases. This includes registration of cardiopulmonary machines, which are so important in the case of COVID-19. With the ZLB 2.0, COVID-19 patients can thus be allocated more smoothly on the one hand and, on the other hand, the state government, the emergency medical service authorities, emergency control centers, and hospitals get the greatest possible transparency at the same time.

Digital therapy protocols for cancer treatment
3 questions for...

… Prof. Dr. med. Hartmut Link – former Head of the Clinic for Internal Medicine specializing in ontology at the Westpfalz-Klinikum Kaiserslautern

Chemotherapy with drugs is an important part of the treatment of most cancers. Every chemotherapy consists of combinations of several active agents, which are described in complex protocols. Until now, this was done in hospitals in handwritten form using protocol templates or electronic worksheets. In collaboration with Onkodin GmbH, Fraunhofer IESE has standardized these protocols for chemotherapy with drugs and thereby optimized their availability, up-to-dateness, and creation.

Thus Onkopti was born – a database with digitalized oncology therapy protocols.
The goal of Onkopti is to provide quality-assured protocols for the individual treatment of patients. Currently, the Onkopti database at Fraunhofer IESE comprises about 2,000 such protocols, which are used by oncologists in private practice, hospital networks, and pharmacies.

One person who knows all about this is Prof. Dr. med. Hartmut Link. Not only did he contribute his expertise to the development of the solution, but he also used the database himself in his former role as Head of the Department of Oncology, among other roles, at the Westpfalz-Klinikum Kaiserslautern. We asked him about the added value of Onkopti.

www.onkopti.de

»Digitalization in oncology opens up new perspectives and leads to a high increase in quality.«

Prof. Dr. med. Hartmut Link

1 What benefits do you expect from digitalization in hospitals, or specifically in medical oncology?

The very complex diagnostic, therapeutic, organizational, and communicative tasks of medicine in hospitals, and of medical oncology in particular, offer outstanding applications for digitalization. Digitalization in medical oncology opens up new perspectives and leads to a high increase in quality, for example in the areas of knowledge management, communication, process optimization, quality management, decision support, drug therapy safety, and personnel and resource allocation. One central task of medical oncology is the drug therapy of cancer and malignant blood diseases. The enormous ongoing gain in knowledge about molecular perturbations and defects of malignant cells enables the continuous and rapid development of new drugs. This huge amount of information combined with complex therapeutic guidelines can be excellently processed and implemented in patient therapy with digital methods.

2 What role does the Onkopti database with standardized therapy protocols play in this? And in which hospitals is Onkopti already being used?

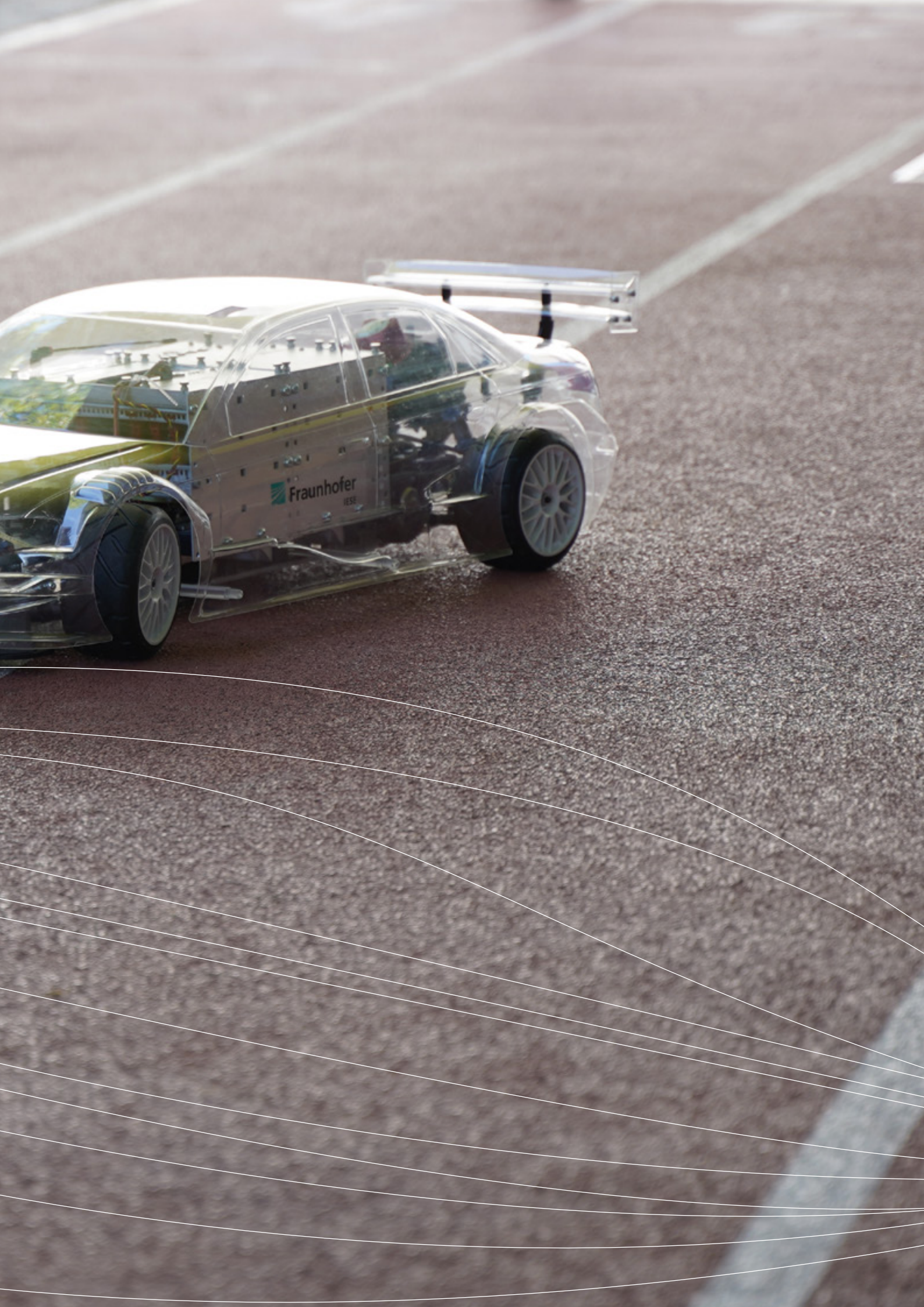
In principle, all curative chemotherapy consists of combinations of two or, as a rule, three or more active agents. In addition, there are essential drugs to prevent side effects. Such a therapy protocol is then administered in several cycles and at specific intervals. Only study protocols published in international journals with validated results and benefits for the patients can be adopted in routine therapy.

The translation of this knowledge and the concrete application of drug therapy are central tasks and challenges for internal medicine oncologists. With the Onkopti database, which has been generated and continuously developed further at Fraunhofer IESE since 2008, an essential tool with digitalized therapy protocols is available at a central location. Onkopti standardizes therapy protocols according to the basic idea that each protocol is composed of self-contained building blocks that can be defined in a standardized way. The more than 2,000 protocols currently available can be exported in a standardized format to application programs used in hospitals and medical practices, and can also be used as online publications. Onkopti is used, for example, at the Westpfalz-Klinikum Kaiserslautern, at the University Medical Center Mainz, in hospitals in Amberg, Bayreuth, Hof, in a large hospital group, and in many other hospitals and medical practices. The special variant onchemo.com, which is freely available as a progressive web app, was developed especially for mobile devices and is available in German and English.

3 What effect does Onkopti have in terms of increasing the quality of therapy for patients?

When an electronic prescription system is used in oncology, the time from prescription to application is very short. The therapy and the very important supportive and concomitant therapy are always up-to-date as well as guideline-compliant and meet the current standard. It has been scientifically proven that the error rate can be reduced significantly with an electronic prescription system. A high level of drug therapy safety can thus be achieved. If a change of the therapy plan is required, a great number of additional current therapy protocols are available. Thanks to the monthly updates, new drugs, approvals, and therapy protocols are available for patient therapy after only a short time.

IESE on Trend


Fraunhofer
IESE

Autonomous driving in local public transport

In the interview: Dr. Rasmus Adler, manager of the research program "Autonomous Systems" at Fraunhofer IESE

A lot of testing is already being done with regard to autonomous driving. But the test courses are manageable and well-defined, and the vehicles drive at a maximum of 25 km/h. However, 40 or 50 kilometers per hours would be the prerequisite for being able to drive in city traffic. Autonomous buses in local public transport – soon to be a reality or a dream of the future?

According to Rasmus Adler, it will be a long time before we can use nationwide autonomous public transport.

Many experts assume that it will not be possible for some time yet to realize autonomous driving at Level 5, i.e., without a driver. Do you agree, and if so, what are the reasons for this?

For me, there is absolutely no question that at the current state of the art, fully autonomous driving at Level 5 will not be possible without limiting the corresponding traffic situations in individual traffic. The more complex the operational environment, the more expensive sensor technology is required. In addition, one has to rely on methods from the field of Machine Learning, and the use of these methods in safety-critical contexts has not been researched sufficiently yet. So the complexity of the operational environment plays a crucial role. However, this is not reflected in the autonomy levels of the Society of Automotive Engineers. The ALFUS taxonomy for unmanned systems from the U.S. Institute of Standards and Technology is clearer on this, as the complexity of the operational environment is presented as an aspect that is orthogonal to independence from humans.

In the development steps toward autonomous driving, it is often predicted that the first step will be the so-called "platooning" for trucks on the highway, and that further development is also most likely to take place in non-urban areas. Autonomous driving in local public transport would be the last step. What is your opinion on this?

Platooning does, in fact, offer many incentives that make it lucrative to intensively promote autonomous driving. After all, it not only reduces the drivers' workload, but also saves fuel above all – and thus money. With platooning, vehicles automatically drive closely behind each other in the slipstream. It can therefore be considered more a kind of "virtual drawbar" than a highway pilot. In local public transport, the story is completely different. Here, it is not just about a "virtual drawbar", but about automated driving in a very complex

environment. In the long term, it will therefore be much longer before we can talk about nationwide autonomous local public transport.

Since July 2021, the law on autonomous driving has been in force, creating the framework conditions for Level 4 driving functions in local public transport. At the moment, the technology itself is still quite a way from achieving that. What are your predictions: When will it be possible to realize Level 5 in local public transport?

In local public transport, autonomous driving at Level 5 – i.e., completely independent of the traffic area – will not be realized either. What we will very likely see, however, is driverless driving on defined routes such as bus lanes. But even there, a question must be asked in advance: How can we reconcile safety, freedom from disruption, and the business case? In my view, so-called tele-operating is helpful in this context, as it allows one person to monitor an entire fleet of vehicles with the help of various monitors and thus to support the technology in difficult situations. This would make it possible, for example, to actively counter the shortage of skilled workers and increase reliability at the same time.

Mobility turnaround 2030: DB Regio commissions study on public mobility of the future

The mobility turnaround is urgently needed to achieve the existing climate protection targets. What public mobility may look like in the future was investigated by Fraunhofer IESE together with Fraunhofer IML in a study commissioned by DB Regio AG.

The study focused on the question of what an attractive, road-based local public transport system could look like in the future. The results of the study are based primarily on expert opinions gathered in a workshop and in individual interviews, as well as on the results of a survey among citizens living in rural areas.

One thing became particularly clear: Two things, above all, must be implemented so that road-based local public transport, in particular, i.e., classic buses, can contribute to the mobility turnaround and to climate protection: The bus must find its place in the mobility landscape and the users must be placed unconditionally at the center of all considerations and actions.

Curious about the results?
Follow this link to the detailed study:
https://s.fhg.de/mobilitaetswende

Bosch: Functional safety and iterative development in harmony

In the interview: Dr. Peter Munk, Dependable Cyber-Physical Systems Engineering, Robert Bosch GmbH

"Computers on wheels" – that is how we can already describe the vehicles on our roads today. Of course, we expect that the complex software integrated into the cars will also perform reliably, because after all, any failure could have dangerous consequences. One person who knows a lot about the topic of "Safety" is Dr. Peter Munk from Robert Bosch GmbH. He works on "model-based functional safety" and relies on cooperation with Fraunhofer IESE when it comes to the interplay of iterative development and functional safety.

What exactly do you see as a challenge in the SafeOps project at Bosch?

The challenge in the SafeOps project is the interplay of modern, iterative development on the one hand and functional safety standards on the other hand. Basically, the existing safety standards were written with the mindset that a system must be safe at the time it is deployed. This means that, according to ISO 26262 and other existing safety standards, I must have created a whole mountain of documents with which I can prove that I have done everything necessary and possible to make the product as safe as possible.

And what exactly does this now mean in terms of the iterative development you mentioned?

If we look at DevOps-driven iterative development on the other hand, which also wants to continue updating products after deployment – after the start of production – and which wants to provide additional features to end customers, then from the perspective of functional safety, this naturally means that we always have to continually generate these documents anew. And do so for every new feature, for everything that is added iteratively after the start of production.

How can Fraunhofer IESE provide support for this challenge?

The effort required to create these documents, the effort required to track in which document we have to make which changes for any modification – this is what we consider a great challenge. To solve it, we are cooperating with the experts of Fraunhofer IESE We are interested in ways to simplify and accelerate the creation of documents with more automation and more digitalization.

Which major advantages do you see in the collaboration with Fraunhofer IESE?

For us, Fraunhofer IESE is a very good sparring partner with whom we can drive complex concepts and issues. Of course, we also rate very positively that our partner contributes input from other industries that we as Bosch employees do not necessarily cover. In addition, we think it is great that we have the opportunity to have Fraunhofer IESE implement prototypes of the concepts we developed. Although this did not happen in our joint project last year, it is possible in principle and often very helpful.

BOSCH

Dr. Peter Munk, Dependable Cyber-Physical Systems Engineering, Robert Bosch GmbH

Listen to the detailed interview (in German) here!

MORGEN DENKER

Collaboration project to bring about paradigm shift in safety engineering

In the ICON research project "LOPAAS" (Layers of Protection Architecture for Autonomous Systems), Fraunhofer IESE is collaborating with Fraunhofer IKS and the University of York in England in the Assuring Autonomy International Programme (AAIP) to develop an approach to assuring the safety of autonomous systems and, in particular, autonomous vehicles. The internal Fraunhofer funding program "ICON – International Cooperation and Networking" supports bilateral cooperation projects with internationally renowned universities and non-university research institutions. In the three years of the project, 3 million euros are available for the collaboration to bring about the necessary paradigm shift in safety engineering of autonomous systems.

The market introduction of autonomous systems and automated driving, in particular, poses many challenges. One key challenge is how to assure safety without operating with such severe restrictions regarding speed and other factors that the added value disappears. This is precisely the challenge that has been underestimated in many forecasts to date, and pilot studies conducted by automotive manufacturers also confirm passengers' perception that autonomous vehicles are mostly slow and hesitant.

The Fraunhofer Institute for Experimental Software Engineering IESE, the Fraunhofer Institute for Cognitive Systems IKS, and the University of York have been researching this topic for years and are advancing the state of the art and the state of the practice. With the help of the ICON project, the partners are now bundling their research competencies to develop a reference safety architecture and safety argumentation for automated driving and autonomous systems. This includes, in particular, "dynamic risk management", which gives the vehicle a better "understanding" of the current risks of a driving situation. Dynamic risk management takes into account not only external influencing factors such as the driving behavior of other road users, but also internal factors such as uncertainties in the perception of the current situation. Taking uncertainties in the safety architecture into account offers new opportunities to use Artificial Intelligence (AI) for safety-critical tasks. It describes how external and internal influencing factors can be used to automatically determine and control risks during ongoing operation.

The long-term goal of the project is to enable autonomous vehicles to drive faster and less hesitantly, as they can assess risks more safely and accurately. To achieve technology transfer, the results of the project are subsequently to be incorporated into standardization and norming.

From Lab to Road

Automated driving is a prime example of how difficult it can be to bring autonomous systems into practical application. In this video, Program Manager Dr. Rasmus Adler explains which innovative safety concepts IESE is developing for this purpose.

Smart Energy: Autonomous systems for a smart energy transition

Challenges in the wake of "green" energy grids

If Germany is to become climate-neutral by 2045, it still has a long way to go. The expansion of renewable or "green" energies will play a key role in this – but they are not alone. The reason: Without autonomous control systems for the energy grid, the energy transition will not succeed. Fraunhofer IESE is conducting research on precisely such technologies.

Autonomous control systems and smart grids flexibly adapt to the needs of current energy supply.

There is no question about it – the switch to renewable energies is imperative and represents an important building block for the success of the energy transition. If alternative energy sources are promoted more, the transformation will hopefully also progress faster. What is given too little consideration, however, is the question of how energy supply and consumption can be regulated locally in such a way that coal, natural gas, and heating oil can even be dispensed with entirely in the future.

To answer this question, we need to take a brief look to the past: Whereas in the past, electricity used to be generated in a few large power plants, transported via the transmission grid, and passed on to individual consumers with the help of the distribution grid, the energy distribution of green sources of electricity is much more complex today. For example, it is not only important to have sufficient energy stored for days with little sunshine and calm wind conditions. The energy consumption of private households is also much more difficult to predict nowadays – and thus difficult to plan for.

In addition, the energy grid must be structured in such a way that it can handle the constantly changing levels of feed-in and consumption: from the electricity generated by private households using photovoltaic systems to large-scale systems such as wind farms or open-space solar plants. And: renewable energy must be available where it is needed; whether in the rather sparsely populated northeast of Germany or in the populous regions along the Rhine Valley.

Development of smart grids and autonomous grid control systems

In view of the large number of future generation plants and the dependence on non-controllable influencing factors such as sunshine and wind, it is clear that the control of regenerative energy systems cannot be performed by humans. They simply do not have the required overview and speed to react. This task must be taken over by autonomous grid control systems or smart grids. According to the BMWi (German Federal Ministry for Economic Affairs and Climate Protection), the term "smart grid" describes the communicative connection of the players in the energy system to the energy supply network – from generation to transport, storage, distribution, and consumption.

In contrast to merely automated solutions with firmly imprinted rules of behavior, autonomous or smart systems are capable of acting autonomously – including reacting to unforeseen situations. The problem is that, although it is useful to allow autonomous systems to act on their own responsibility, this factor is problematic with regard to their reliability. It is difficult to guarantee that the Machine Learning methods used in such autonomous systems will always react correctly. Fraunhofer IESE is taking on this challenge and is developing dependable autonomous systems that can be used in energy grids and thus will advance the energy transition.

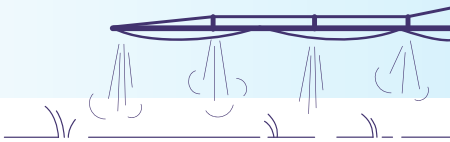
Contributions of Fraunhofer IESE – selected projects

In several of its research projects, Fraunhofer IESE is actively contributing to the success of the energy transition: In the project "Open District Hub at Jülich" (ODH@Jülich), IESE is cooperating with other project partners to develop a Digital Ecosystem for energy supply in urban districts. The energy transition is linking the infrastructures of the electricity and heating sectors ever more closely. In order for this sector coupling in buildings and neighborhoods to succeed, state-of-the-art tools are needed for the planning and operation of corresponding technical systems. In the project "ODH@Jülich", these software tools are being developed, and thus the foundation for cross-sector energy supply in urban districts is being laid.

To achieve the climate protection goals, the energy demand for private and public mobility must also be increasingly met from renewable energy sources. It is therefore to be expected that the energy distribution grids will be significantly strained not only by decentralized power generation plants, but also by the charging behavior of electric vehicles. Research into the effects of increasing electromobility on distribution grids and how these can be countered with the help of Digital Twins is the focus of the research project "MobiGrid", in which Fraunhofer IESE is also involved.

The goal of the already completed research project "DESIGNETZ" was to increase the share of renewable energies in electricity consumption and to create a smart energy supply of the future in the long term. Specifically, Fraunhofer IESE provided support in the design of the distributed system architecture of the integrated data and service platform for energy grid management as well as in the elicitation of data protection requirements and the development of data usage control components for the integrated platform. In the end, the energy system was viewed holistically across all players and energy sources: Finer control down to the distribution grids emerged and existing standalone solutions were unified in order to enable resource-efficient energy supply.

Smart Farming as an opportunity for agriculture



Digitalization reconciles economy and ecology

In the interview: Dr. Rasmus Adler, Program Manager Autonomous Systems, and Bernd Rauch, Project Manager of the Fraunhofer lighthouse project Cognitive Agriculture (COGNAC) and Head of the Department Architecture-centric Engineering at Fraunhofer IESE

Our agricultural products must be produced in a more environmentally friendly way – this goal is at the top of the political agenda. But how can farmers manage to run their farms ecologically and economically at the same time? This is precisely the question that Fraunhofer IESE is addressing with its research program Smart Farming. We asked our two experts about the role that autonomous systems play in this context and about the special challenges that have to be solved in agriculture in particular.

What are the major challenges in agriculture?

Adler: Basically, agriculture is about becoming more sustainable. However, there is an area of tension in the sustainability triangle of ecology, social and societal aspects, and economic goals that must be taken into account.

What support is Fraunhofer IESE providing to master this challenge?

Adler: We provide support in the sense that technology can help to take tension out of the triangle. Normally, if you improve one corner of the triangle, the other two corners will suffer. With good technology, it is possible to succeed in optimizing all three corners. At IESE, we help manufacturers develop new technologies and also bring them to market.

How should we imagine this support in concrete terms?

Adler: In principle, we at Fraunhofer IESE have three points that we address: The first is the dependability and safety of the technology as a prerequisite for being able to bring it to market at all. The second is user acceptance. And the third is interoperability between different systems from different manufacturers. And these are exactly the requirements we address when it comes to autonomous systems and autonomous agricultural machinery.

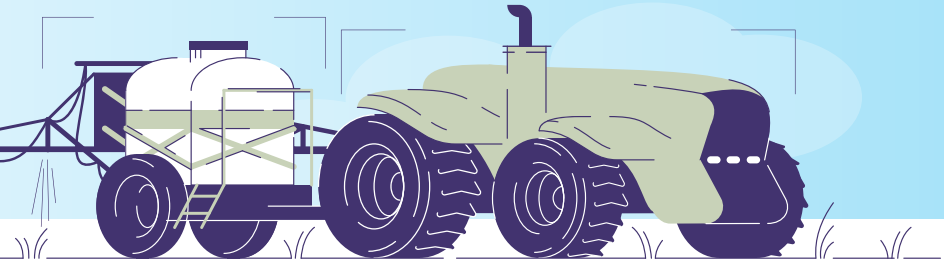
For what purposes are autonomous agricultural machines used?

Adler: For example, there are field robots that are used for weed management. They work mechanically by first using sensors to distinguish weeds from crops and then pulling the weeds out of the ground. This allows farmers to do without chemical weed killers and makes farming much more sustainable. In our major lighthouse project Cognitive Agriculture, COGNAC for short, we are also dealing with these very field robots.

COGNAC is a good keyword. How can you briefly describe the content and the goals of this project?

Rauch: Roughly speaking, we are researching three topic areas in COGNAC: automation of field work, novel sensor technology, and the agricultural data space. At Fraunhofer IESE, we are focusing in particular on the data space, the Agricultural Data Space (ADS). These three topic areas naturally overlap, and that is also the idea behind COGNAC: That is, we are not just taking one single aspect here and exploring it in depth; rather, we are looking at how different aspects of digital agriculture or this Digital Ecosystem can be brought together in one project.

»Digitalization offers many opportunities to combine the productivity and sustainability of agricultural processes.«



Bernd Rauch (left) and Dr. Rasmus Adler

This interplay sounds quite complex. What are the particular problems here?

Rauch: Agriculture is a very challenging domain: There are an enormous number of different production processes with sub-processes, technical systems, software solutions, apps, and independent players. All of this has to be considered, connected, and balanced in the Digital Ecosystem. In addition, there is a dynamic biosphere; i.e., as a production partner – if you want to call it that – you have a living environment that you have to deal with. Sometimes it rains, but sometimes it is dry, or there is frost; you always have to react to that.

What concerns do farmers have about digitalization and smart farming?

Rauch: Of course, farms are concerned with data protection and data sovereignty. After all, in a Digital Ecosystem, data needs to be shared in order to carry out processes. That is why we also consider our data usage control solution "MY DATA Control Technologies" in our smart farming projects. In addition, one of the greatest challenges farmers still face is a smooth production process, which is often hindered by a lack of interoperability.

And how can IESE help to ensure that nothing goes wrong in the production process?

Rauch: Well, as I said, agriculture is not a factory with controllable parameters, but takes place in the biosphere. If you have a narrow time window for a harvest, for example, and the machine simply does not start, you have a big problem and the harvest may be lost. This means a challenge for everyone offering solutions – whether it is hardware, software, or even a service. And this is what we are researching in COGNAC and for what we are developing solutions for our industry partners. Our goal is to improve interoperability between the systems involved and to ensure that the work processes run smoothly and that the machine can ultimately take off for the harvest.

Listen to the detailed interview (in German) here! MORGEN DENKER Podcast

Book recommendation

Handbook Digital Farming – Digital Transformation for Sustainable Agriculture

Ed. Prof. Dr. Jörg Dörr, Dr. Matthias Nachtmann *(Springer Verlag)*

Rural counties as Digital Ecosystems

In the model project Smarte.Land.Regionen, which is funded by the German Federal Ministry of Food and Agriculture (BMEL), Fraunhofer IESE and its partners are jointly developing solutions for improving the provision of public services in rural areas. The focus is on four topic areas: Education and Work, Healthcare and Care, Mobility, and Community and Volunteerism. The centerpiece is to be a Digital Ecosystem that brings together digital solutions in a marketplace for rural counties.

In the project Smarte.Land.Regionen, the focus is on several players: For example, counties perform tasks for their citizens. Digital solutions must be made available by corresponding solution providers. In addition to the technical aspect of operation, local support is usually needed to successfully implement digitalization projects in rural counties. A digital platform is to be created in the project in order to network all the players involved. It represents the central element for implementing the vision.

From Lab to Smart City

With Digital Ecosystems, Fraunhofer IESE is making cities and regions smart. In this video, Division Manager Steffen Hess illustrates how Fraunhofer IESE supports cities in implementing a sustainable Smart City with digital solutions.

Open solutions for more digitalization in rural areas

Through the platform, **rural counties** receive neutrally prepared information that provides insights into the most important types of digital solutions and relevant topics related to digitalization and digital public services. Furthermore, specific information on the offerings is provided so that counties can gain insights into functionalities, data usage, source code, and quality. Notes on how to use the solution in the county or references to other counties already using the solution are also available. Counties see all of this information as marketplace listings. These also contain offers to proceed with the operation of a solution with an appropriate provider.

The **citizens** are the actual users of the solutions offered by the solution providers on the digital platform. Until now, they were confronted with the challenges of having to create a solution-specific user account with an unfamiliar company every time they used a digital solution, and being forced to enter data over and over. The platform, by contrast, offers basic services, such as a uniform login for all digital solutions offered on it.

Solution providers can make their solutions available to counties nationwide via the platform. Counties benefit from this by being able to compare existing solutions with little effort. Ensuring that the solutions are legally correct is also made easier, as the platform offers functionalities that are important to counties. Thanks to the open-source approach, the solutions offered can be jointly developed further in accordance with the motto "Public Money, Public Code".

The core activity of **on-site support** is to provide (organizational) advice to the counties on solutions or topic areas. It is also possible to offer and find consulting services via the platform.

The next step is now to realize the vision of a unified digital platform. To do this, the project team must first clarify legal issues surrounding the platform as well as possible business models. A first version will go live in 2022 together with some counties.

Industrie 4.0: Digital twins in manufacturing

In the interview: Dr. Thomas Kuhn, Division Manager Embedded Systems at Fraunhofer IESE

It has been more than ten years since the term Industrie 4.0 was first brought to the attention of a broad, international audience at Hannover Messe 2011. Since then, research and industry have been working intensively on answering the question of how service-based manufacturing can become reality on a large scale. In the meantime, not only have the necessary standards been developed, but with the asset administration shell as a digital twin, research now has the central element of Industrie 4.0 ready. How much Industrie 4.0 has already been achieved in industrial manufacturing, and how can companies raise their production to this new level?

How far has the fourth industrial revolution progressed in Germany already?

Over the past few years, a great deal has happened in this country with regard to the digitalization and networking of productions. The necessary standardization of Industrie 4.0 solutions has gained massive momentum, in particular through the work of the Plattform Industrie 4.0 and the Industrial Digital Twin Association e.V. (IDTA); IESE is cooperating with both. This paves the way for a comprehensive digital transformation of industry, at least in theory.

What is currently the biggest challenge in the transformation?

Of course, there are still quite a few obstacles that are hampering Industrie 4.0. For example, the integration of legacy systems into the overall complex of systems is a common challenge. These systems must first speak a common "language", and a uniform digital interface is needed for all types of assets: from devices to processes and products to IT software and certificates. All this is provided, for example, by the Eclipse BaSyx middleware.

How exactly does this middleware work?

The middleware is basically built like a construction kit containing a collection of well-defined building blocks. These can be linked and integrated to form a centralized or decentralized system architecture. For example, to initially connect the shop floor with the office floor, cross-network and cross-protocol peer-to-peer communication between the production machines and the IT can be used. Ultimately, every company can then choose for itself which components it needs for a particular use case and then deploy them.

Dr. Thomas Kuhn, Division Manager Embedded Systems, supports companies on their way to Industrie 4.0.

What is the role of the asset administration shell in this?

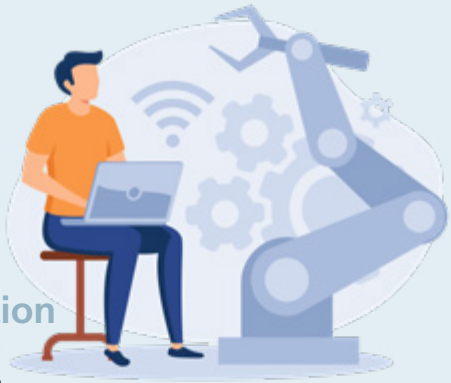
In order to prepare all data models and protocols in such a way that they are interoperable, a uniform "language" is needed, as I mentioned above. This is precisely what BaSyx provides for with the principle of asset administration shells. These are standardized digital twins that are set up in a uniform structure. Each asset administration shell contains submodels that both represent the state of a real asset virtually and provide live data about it as needed. What makes this so special: The asset administration shells can not only be passed on to other companies; above all, the standard is open and can be accessed at any time.

How does IESE support the companies?

First, we examine the respective manufacturing processes very comprehensively and, on this basis, develop a strategy together with the companies on how they can best benefit from Industrie 4.0. Currently, we are collaborating with a wide variety of companies in the context of so-called satellite projects. These include companies from the automotive and pharmaceutical industries as well as companies from the software sector. Together, we identify the individual Industrie 4.0 use case and ultimately bring service-based manufacturing into practical implementation.

Listen to the podcast on Production (in German) here! MORGEN DENKER

Industrie 4.0 in practice



Providing optimal support for employees with digitalization

In the interview: Kai Ellenberger, Managing Director of Ellenberger GmbH & Co. KG

The company Ellenberger GmbH & Co. KG from Kaiserslautern is also feeling the increasing cost pressure of the global market. However, rather than laying off staff to cut costs, managing director Kai Ellenberger is focusing on automation and digitalization. In this way, the industrial engineer supports his 25 employees while increasing his company's productivity at the same time. Over the years, the company, which was founded in 1983, has evolved from a service provider for the machining of cast iron, aluminum, and steel to an automation manufacturer and series producer for the commercial vehicle industry, for plant and vehicle construction, and for the construction machinery sector. Together with Fraunhofer IESE, Ellenberger has optimized the workflow of the tool change process in its production with the help of a digital database.

What are the greatest challenges in your industry where Industrie 4.0 could help?

The demands on the number of units and the variety of products have risen sharply in recent years. At the same time, customers' quality demands are also increasing noticeably, and globalization is creating a certain cost pressure. This means that we have to be permanently innovative in order to remain competitive. To do so, we have opted for mechanical automation on the one hand, while the topic of digitalization and Industrie 4.0 naturally also plays an important role on the other hand.

What drives me above all in all these measures are our employees. In my family-run company, the focus is on people. My goal is to support them optimally in their everyday work with automation and digital solutions.

What tool are used to support employees at Ellenberger?

We must distinguish two levels here. One is mechanical aids in the form of automation that literally take loads off the employees. For example, we have our own robotics department, where we design and build robots ourselves to make our employees' work easier.

This means that where we used to invest a lot of muscle power, we now have more freedom for creativity. The effect is that employees come up with great ideas about what else we could improve with the help of automation. And on balance, this has resulted in a cost advantage, which, of course, also has a positive effect on the competitiveness of the whole company.

And what is the second level of tools?

Now we come to digitalization and Industrie 4.0. We have many ideas in this area as well, but we cannot implement these without external support. One of the service providers we are working with is Fraunhofer IESE with the project BaSys and the middleware Eclipse BaSyx. IESE has provided exactly the know-how that we do not cover internally.

How has Fraunhofer IESE accompanied your company on its way towards Industrie 4.0?

In very concrete terms, we repeatedly had a problem with feedback from the machine tools: When is a tool change necessary? At what point does a tool wear out? When does it need to be turned or replaced?
This is exactly where the experts of Fraunhofer IESE, together with the other project partners, have done a really great job. They have developed a simple digital solution that is used to provide feedback to a digital database in order to optimize tool changes.

Can you be a little more specific?

Yes, sure! Of course, this sounds very complex, but I will give you an example: We have twelve machines; each machine contains between 30 and 50 tools. These tools wear out in a wide variety of ways. During the time when we have to change the tools, the machines are at a standstill. So there is a downtime involved in any tool change during which no production can take place. Accordingly, the goal is to choose the time in such a way that the downtime is as short as possible while changing as many tools as possible.

Now, many different data and parameters of the machines and

»The employees are any company's most valuable asset. That is why we should support them optimally with the help of digital tools.«

Kai Ellenberger, Managing Director of Ellenberger GmbH & Co. KG from Kaiserslautern

tools go into a digital database, which specifies a calculated "change window". This means, for example, that from 11 to 11:30 a.m., 22 of the 50 tools are ready for change. You can compare this to a pit stop in Formula 1 racing. Based on the data we receive from this tool change system, our tool changer can recognize exactly when which tool must be made available so that it can be changed at the right time on the right machine.

In summary – what is the added value for you?

The new solution gives us a huge advantage because we no longer have search times or downtimes, which saves us an enormous amount of time and optimizes production. The new system has given us a simple recipe for optimal tool change.

What are future Industrie 4.0 plans at Ellenberger?

The next step is the digitalization of our machine tools themselves. By this I mean digital twins and asset administration shells – in other words, ways to create things in the digital world via BaSyx in order to better understand the real world. This will enable us to improve our processes even further.

Or it would also be conceivable for us to use digital assistance systems to support our employees in maintenance tasks: With up-to-date maintenance videos or documentations, they could be guided via digital glasses or a smartphone.

My vision is that together with IESE, we will develop a standardized connector that can be used by any small or medium-sized company – whether it is a chipper or a bakery. An interface that you can plug into an old machine, so to speak, and then have direct access to the new, digital technology. As I understand it, BaSyx could provide the solution for this.

As a final tip – what advice would you give your colleagues from small and medium-sized companies with regard to digitalization?

There is no room for discussion from my side. That boat has actually been missed already. Anyone who is still thinking about whether to even do it or not is, in my opinion, just like the man who once said: "The Internet? That won't catch on anyway."

Digitalization in manufacturing only has advantages if you do it right. Digitalization should not be done for the sake of digitalization. You should have a goal in mind of what you want to achieve with digitalization. Anyone in the same industry as us should really be thinking about digitalization – and do so in every area. We have only talked about manufacturing and production now. However, topics such as employee management, personnel matrix, training also offer a lot of potential for digital solutions.

Listen to the detailed interview (in German) here! MORGEN DENKER

Infra-Bau 4.0: More efficiency for complex construction projects

Meta-platform ensures transparency and better networking of players

Large construction projects are usually associated with enormous coordination effort and in practice, the exchange between individual construction stakeholders often requires many steps and is inconsistent. A consortium project under the technical and scientific leadership of Fraunhofer IESE has developed a digital solution for this: The platform of Infra-Bau 4.0 networks all participants of an infrastructure construction project with each other, enables the digital mapping of resources and processes, and thus facilitates planning and re-planning in construction.

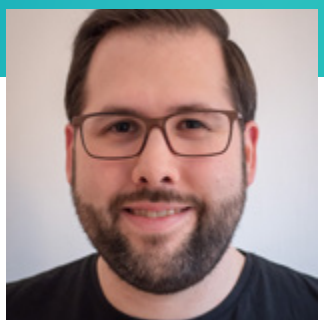
There is a lot of construction going on in Germany, but the opportunities offered by digitalization are far from being fully exploited in the construction industry. Newer working methods such as "Building Information Modeling" (BIM) can provide digital planning data, but are not yet used across the board. In addition, they reach their limits in the area of networking as well as in short-term re-planning, which is a common occurrence in construction. Many steps are therefore still initiated separately and manually. Automated, coordinated, transparent processes and uniform standards in communication and planning are lacking.

The goal of the project Infra-Bau 4.0 was to close this gap. Funded by the German Federal Ministry of Digital Affairs and Transport, a large number of consortium partners from research and industry collaborated in the development of a digital communication platform that is intended to enable infrastructure projects to be designed more efficiently and thus reduce workload, time, and costs. With the internationally active construction and real estate consultancy Drees & Sommer, the consortium had strong leadership with extensive industry knowledge. Fraunhofer IESE was responsible for the technical-scientific leadership, contributing years of expertise in the field of Digital Ecosystems to the project. "We understand a Digital Ecosystem as a socio-technical network in which companies, technology, and people cooperate with each other via a digital platform, with each player benefiting individually from participation", explains Denis Feth, "Security and Privacy Technologies" expert at Fraunhofer IESE and technical-scientific manager of the project. "Within the framework of this project, our institute considered the topic in its entire breadth: How must such a platform for the construction industry be structured? What can be incentives for participation? How can we enable secure data exchange?"

Not a competitor to existing tools, but a meta-platform

The Infra-Bau 4.0 platform is the result of all these considerations. As a Digital Ecosystem, it networks all construction players, from the site manager to the planner to the individual construction worker. Even construction machines can be integrated. In this way, a digital project hierarchy is mapped that corresponds to the real situation at the

> With our meta-platform, we keep the threads together in the background and enable exchange.«



At Fraunhofer IESE, Denis Feth is the technical-scientific manager of the project Infra-Bau 4.0.

construction site. Each person has their own account, which they can use to interact with other players. The exchange of information is thus clearly structured and remains traceable.

"What was and is important for us is that using our platform will not mean any additional effort for those involved and that there are no obstacles in its use", Feth emphasizes. "We also do not want to compete with existing solutions at all. Quite the opposite: All stakeholders continue to interact with their familiar tools. We keep the threads together in the background with our meta-platform and enable exchange." Well-known construction site tools such as the BIM software "Revit" or the project management solution "Powerproject" have already been connected to the platform, for example. With "LCM Digital", "Cranebee", "Digitale Baustelle", and "Smart Site One", several applications from consortium partners are also integrated into the platform.

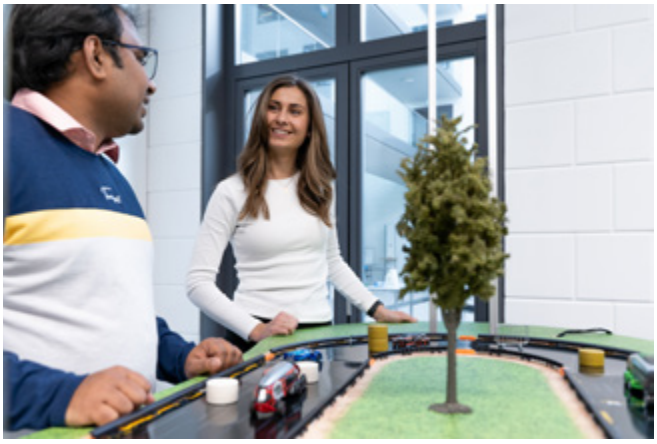
The platform not only allows data to be exchanged, but also to be cleverly reused with the help of Artificial Intelligence methods, explains Feth: "Currently, when unplanned changes occur in the process at the construction site, planners have to deal with this problem largely manually. Our platform, on the other hand, can provide well-founded decision proposals based on the collected data that are optimized in terms of parameters such as costs and time, thus providing planners with valuable assistance."

A communication platform with potential

The Infra-Bau 4.0 project started in the summer of 2020 and focused on the construction execution phase. In a first step, the requirements for the platform were elicited with the help of realistic case studies. This was followed by the technical design and detailing of the platform, before actual implementation began. Finally, there was a rough first evaluation of the functionalities by the project partners and a closing event. The project officially ended at the turn of the year.

Denis Feth is very satisfied with what has been achieved so far: "Within a year and a half, we have accomplished a great deal and have been able to show that our communication platform is technically feasible and can be used in a variety of ways."

Making research tangible



IESE on Tour

Hannover Messe 2022: Making networked production easy with asset administration shells!

#WeKnowSolutions – this was the motto of the presentation of the Fraunhofer-Gesellschaft at Hannover Messe 2022 from 30 May to 2 June 2022 in Hall 5.

Digitalized manufacturing processes enable fast responses to changing markets and sustainably secure the competitiveness of companies. For the implementation of Industrie 4.0, the asset administration shell plays a central role. It realizes digital twins and connects ERP and PLM systems with production, calculates KPIs, and indicates optimization potential. Visitors to the Fraunhofer booth were able to experience the advantages and added value that Industrie 4.0 offers companies and how easy digitalization in production is with the open-source middleware Eclipse BaSyx.

Project partners from the BaSys 4.2 satellite projects demonstrated that BaSyx also enables small and medium-sized companies to move in the direction of Industrie 4.0. The project partners were available to answer visitors' questions at the booth of the German Federal Ministry of Education and Research (BMBF) – in Hall 2. A special highlight was the Corona test robot of the IESE partner objective partner. The robot demonstrated how the use of the middleware makes all processes from testing to billing easy to perform and how Industrie 4.0 can change business models – data-driven and digitally.

A special feature this year: Hannover Messe was dedicated to the 10th anniversary of Industrie 4.0, which due to the cancellation of the trade fair in 2021 took place this year. To mark the occasion, a panel discussion among the "founding fathers" of Industrie 4.0 was held on the Research Stage in Hall 2: Prof. Henning Kagermann, acatech, Prof. Wolf-Dieter Lukas, former BMBF state secretary, and Prof. Wolfgang Wahlster, DFKI. The keynote speech for the panel discussion was given by Prof. Peter Liggesmeyer, Institute Director of Fraunhofer IESE and scientific spokesperson of the Plattform Industrie 4.0.

Prof. Liggesmeyer brings Industrie 4.0 to life for State Secretary-Judith Pirscher: Industrie 4.0 at the BMBF booth.

Our esperts are now on the road again with their topics and projects.

BaSys networking meeting: Successful series continued in Berlin

In mid-May 2022, representatives from research and industry exchanged their experiences around the BaSys satellite projects and in the handling of the Eclipse BaSyx middleware when they met at the Fraunhofer Forum Berlin. The hybrid format of the event was already introduced by Fraunhofer IESE in the fall of 2021 and was very well received by the companies involved in the projects. Therefore, the workshop series was continued this year – approx. 120 participantes attended the exchange of experiences virtually or in person.

At the three-day workshop, the BaSys project partners presented the current developments from the core projects BaSys 4.2 and BaSys überProd as well as from the satellite projects and discussed the results achieved to date. Particularly exciting were the experiences made with Eclipse BaSyx in the implementation of demonstrators, the asset administration shell, and the customer solutions. The participants left the event with numerous ideas, suggestions, and visions, which they can now incorporate into their practical applications.

Background: In the context of the research project BaSys 4.2, there are more than 20 application projects, so-called satellites, that implement specific applications from the field of Industrie 4.0. The aim of the BaSys research projects is to develop solutions that will enable the transition to digitalized, flexible Industrie 4.0 production. In this context, the project teams – with the participation of Fraunhofer IESE – realized numerous asset administration shells in order to digitalize very different usage contexts. The asset administration shell as a standardized digital twin creates digital images of products, devices, services, and other assets in production.

hub.berlin 2022

Fraunhofer IESE was also part of the "Business Festival for Digital Designers and Doers", the hub in Berlin, from 22 to 23 June 2022. In their talk, Department Head Dr. Marcus Trapp and Senior Requirements Engineer Matthias Koch took their audience on a journey to the world of Digital Ecosystems and platforms. They encouraged the audience to engage with the topic and the opportunities, while at the same time realizing that a lot of patience and courage is required here.

In the context of the Cube Class at the Fraunhofer Booth, the two IESE researchers showed in their talk how Digital Ecosystems are made tangible with Playmobil® – using the method "Tangible Ecosystem Design".

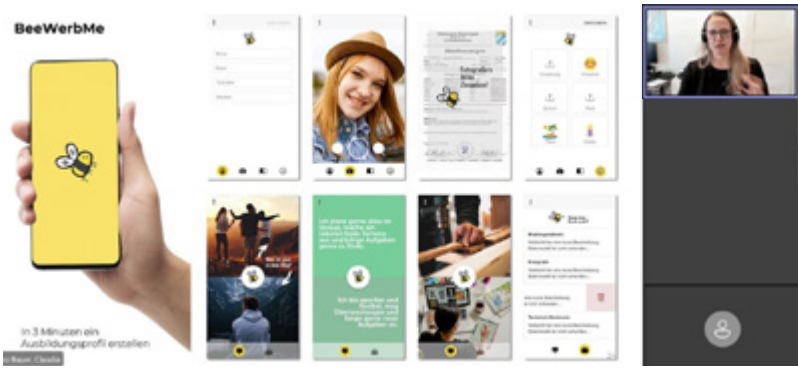
E-World energy & water

At E-World 2022 in Essen, Fraunhofer IESE presented "Smart Energy Ecosystems with Digital Twins" from 21 to 23 June 2022. The experts showed a Digital Ecosystem based on digital twins of an urban district and how this enables sector-coupled energy management of urban districts.

Girls' Day 2022: Research inspires!

At the end of April 2022, numerous girls were able to experience computer science and mathematics in a wide variety of facets at the virtual Girls' Day organized by the Fraunhofer ICT Group.

At the beginning, the influencer and YouTuber MathemaTrick and a student doing her cooperative studies at Fraunhofer IESE provided exciting insights into the world of research. They also provided interesting background information on what made them choose their fields of study. The program continued with a virtual talk by IESE expert and Professor of Design Strategy Prof. Claudia Nass. Via video talk, she demonstrated to more than 80 female students what software design and app development are all about and why a lot of creativity is needed here in particular.



Prof. Claudia Nass sparks curiosity for software design and app development in the schoolgirls.

There was also a lot to explore in the virtual research lab of Fraunhofer IESE. From "insights into the exciting world of software engineering" to information on various job profiles and internship opportunities at IESE to challenging quiz questions, there was something for each of the approx. 140 lab visitors.

Minister Schweitzer experiences research up close

At the beginning of May 2022, Alexander Schweitzer, Minister for Labor, Social Affairs, Transformation and Digitalization of the State of Rhineland-Palatinate, visited the Fraunhofer Institute for Experimental Software Engineering IESE in Kaiserslautern. Institute Director Prof. Peter Liggesmeyer and the Fraunhofer experts not only took him into the world of applied research mentally, but also allowed him to immerse himself in digital worlds with VR glasses and handheld controllers. "Particularly against the backdrop of the transformation, it is hard to imagine our working world and our private lives without intelligent digital solutions. It is exciting to see how the team of experts from Fraunhofer IESE is turning visions into reality", said Minister of Digitalization Schweitzer about his visit to IESE.

The model project Smarte.Land.Regionen with the focus on "Education and Work" was on the agenda, as were the many digital healthcare projects, for example on medical care in rural areas or the smart production of cancer therapeutics. In the live demo on the project ViTAWiN, Minister Schweitzer was able to try out for himself how virtually augmented training can optimize continuing education and training in interprofessional emergency care. In addition, the Minister gained many other insights into the research projects and topics of IESE.

In the subsequent interview with the radio station Antenne Kaiserslautern, Minister Schweitzer indicated that he was impressed: "What fascinates me in particular is the application orientation of IESE. In other words, that it is about solutions that benefit people, especially in rural areas. This is something that, as Minister of Digitalization, I find particularly exciting, of course."

Minister Schweitzer (2nd from right) learns about the IESE projects on Smart City and Smart Region.

COMING SOON!

Summer camp of the Fraunhofer network "Research, Art and Design"

Between 28 August and 2 September 2022, the two Fraunhofer Institutes IESE and ITWM in Kaiserslautern will host a special kind of creative bootcamp: Students from the fields of Design, Civil Engineering, Architecture, and similar degree programs from all over Germany can apply for the 3rd Summer Camp of the Fraunhofer Network WKD (Research, Art and Design). In three small teams, they will then work intensively on a topic together with Fraunhofer researchers – this year the motto for everything is "Innovative use of regional resources".

Kaiserslautern as the location of the Summer Camp offers the participants two exciting sources of inspiration: on the one hand, the revitalization of old industrial areas on the former Pfaff site in the city center and, on the other hand, the natural extraction and processing of sandstone in the wildly romantic Schweinstal. For the future residential district on the former Pfaff site, the team "LIVING" will, with the support of the IESE experts, work on the design and implementation of a central outdoor meeting place. This place will serve as an anchor to unite analog and virtual community-building formats.

After the one-week workshop, the teams' work will be presented to and receive awards from a jury of experts from the Network.

Students from the fields of urban development, architecture, or landscape architecture, but also UX or communication design are the primary target groups for the IESE team to develop an interactive concept together with the IESE researchers. In the process, they can gain exciting insights into the projects and the work at Fraunhofer IESE and learn about their career prospects in research.

Upcoming IESE events

13-15 Sep 2022
7th International Commercial Vehicle Technology Symposium – Kaiserslautern

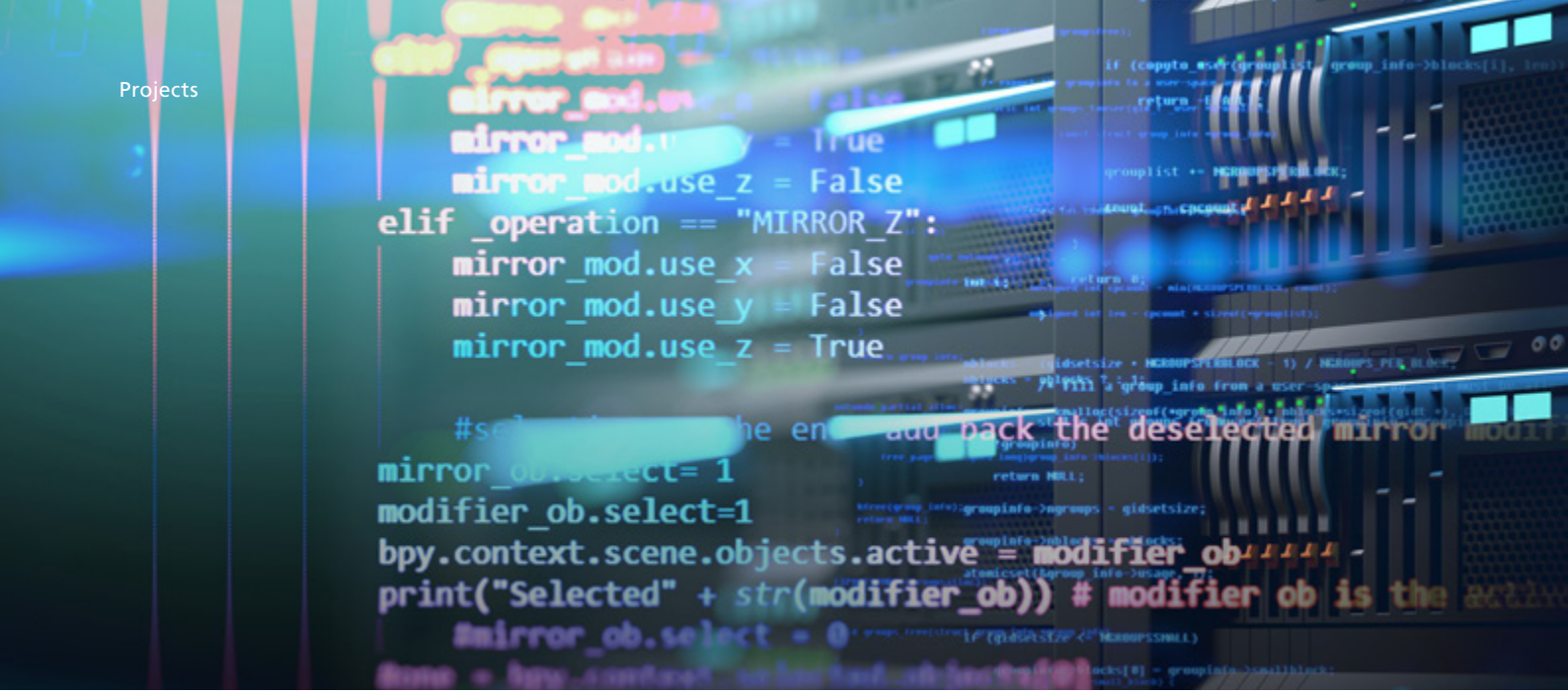
29 Sep 2022
Closing event COGNAC – Dresden

18-20 Oct 2022
Smart Country Convention – Berlin

FURTHER INFORMATION ON ALL IESE EVENTS

iese.fhg.de/de/veranstaltungen_messen.html

Projects



Deutsche Telekom AG

Secure data marketplace with MY DATA Control Technologies

About Deutsche Telekom AG

Headquarters: Bonn, Germany
Number of employees: 226,300 (31 Dec 2020)
Industry: Telecommunications

Deutsche Telekom AG secures its digital data marketplace with Fraunhofer IESE's "MY DATA Control Technologies". With its Data Intelligence Hub (DIH), Deutsche Telekom AG is laying the foundation for a secure and trustworthy data economy. The online platform offers a marketplace for trading data as well as tools for analyzing and refining this data. The vision of the Data Intelligence Hub is to enable innovative data-driven service, using Machine Learning and Artificial Intelligence to add value.

The challenge: Sharing digital data while preserving data sovereignty

New information can be obtained through data refinement, such as aggregation of different data or large volumes of data. One difficulty in this regard is that companies are reluctant to share their data with third parties. This is often due to the loss of control over their own data once it has been shared. The concepts of the International Data Spaces (IDS), which were developed by the neutral user association "International Data Spaces Association" (IDSA), overcome exactly this challenge.

In the joint project between Deutsche Telekom, Fraunhofer IESE, and other project partners, the lessons learned from the International Data Spaces approach were transferred to Deutsche Telekom's Data Intelligence Hub and certification according to IDSA was prepared. The core component of the certification is the technical implementation of data sovereignty through the IDS Connector. The IDS Connector is the central technological component in the IDS that enables stakeholders to exchange, share, and process digital content while preserving data sovereignty.

A particular focus is on preserving data sovereignty for all stakeholders involved. This is why Deutsche Telekom has opted for MY DATA Control Technologies, a technology for the technical implementation of data usage control developed by Fraunhofer IESE.

Creation of data economy and data sovereignty in the Data Intelligence Hub

With MY DATA Control Technologies, the data sovereignty of various players in the Data Intelligence Hub is preserved through a technical implementation of data usage control in combination with the IDS Connector. The IDS Connector enables the integration of so-called "data apps", which can intervene in the data flow in terms of content. This is where MY DATA Control Technologies can unleash their full potential. MY DATA Control Technologies are a powerful framework for controlling

> "Fraunhofer IESE's MY DATA Control Technologies are an efficient and flexible solution; perfect for putting data sovereignty into practice in a digital platform like the Data Intelligence Hub. We look forward to further collaboration."

Sebastian Wiemann, Product Manager, Portfolio Unit IoT, Deutsche Telekom AG

data usage by intervening in data flows. It is based on open standards such as the ODRL language.

Fraunhofer IESE has developed a MY DATA data app for the IDS Connector that can implement data modifications to preserve data sovereignty, such as anonymization or deletion of sensitive information. In addition, data can now be released on a temporary basis, without losing control of it. The data sovereignty realized by MY DATA Control Technologies makes it possible to take the next step towards a self-determined future in the context of the digital transformation.

With the Data Intelligence Hub in combination with MY DATA Control Technologies, Fraunhofer IESE has contributed an essential aspect towards informational self-determination and transparency in the data economy. Together, the two technologies enable digital sovereignty in data-driven business models.

ARE YOU FACING A SIMILAR CHALLENGE?
Talk to us! Our IESE experts will be happy to support you.

With Fraunhofer IESE's MY DATA Control Technologies, Deutsche Telekom offers the players of the digital marketplace sovereignty of their data.

HÄFNER Präzisionsteile Oberrot GmbH

System modernization as the first step towards Industrie 4.0

About HÄFNER Präzisionsteile Oberrot GmbH

Headquarters: Oberrot, Germany
Number of employees: 16
Industry: Tool and Fixture Construction

HÄFNER Präzisionsteile Oberrot GmbH is a producer of high-precision weights in single to small lot productions, partly highly individualized. In addition, HÄFNER Präzisionsteile Oberrot produces precision parts (e.g., for transmissions), where various kinds of data are recorded in a CAQ (Computer-Aided Quality) system during quality assurance. In both cases, data must be exchanged across company boundaries. The aim of the joint BaSys satellite project with Fraunhofer IESE is to use digital twins at precisely this point as the basis for a service platform for exchanging data with customers and thereby modernize the legacy system of HÄFNER Präzisionsteile Oberrot.

Use of digital twins across company boundaries

In the form of the asset administration shell, the digital twin is a central element of Industrie 4.0. At the beginning of the project, the biggest challenges were dealing with digital twins and connecting them to the existing infrastructure. On the one hand, the technology is very new and was still in the active development process at the start of the project. Specifications and tools for the asset administration shell were used in practice with industry partners for the first time in the satellite projects. On the other hand, the concept of digital twins is interpreted differently by different parties; i.e., a uniform understanding had to be created first.

Fraunhofer IESE provides support in updating the legacy system

The collaboration between Fraunhofer IESE and HÄFNER Präzisionsteile Oberrot started at the beginning of 2020 and is expected to continue for several more years. After the successful completion of the current satellite project "BaSys4SupplyQ", a follow-up project is being planned for two more years.

The first step was to establish a common understanding of the BaSys world and also to become better acquainted with the AS-IS status of the existing software systems and processes at the company. Based on this,

concrete requirements could be elicited, which were implemented in the course of the project. The project partners collaborated closely in every step – from data inventory and data modeling via the architecture documentation to the implementation and integration of the resulting system.

For the exchange of calibration data of HÄFNER precision weights, the project team developed a platform that is already available as a prototype. System modernization at HÄFNER Präzisionsteile Oberrot will continue to be actively pursued in the coming years.

Creation of a platform for cross-company data exchange

In addition to the quality of manufactured components, the customer portal that was developed can also provide supplementary information from production. This represents a differentiating feature compared to other companies on the market. In addition, the results of the project can be used to create an extended service platform for the customers. Work on this will be continued as part of the follow-up project "BaSys4ServiceNet".

In the new project, the focus will be especially on the changeability of the system. The new project will also investigate to what extent BaSys will enable new digital business models for HÄFNER Präzisionsteile Oberrot.

"Through the collaboration with Fraunhofer IESE, we have successfully completed a very important milestone for our company in the context of our digitalization strategy. The outstanding expertise and excellent project management of Fraunhofer IESE elevated the project to a very professional level."

Martin Häfner, Managing Director
HÄFNER Präzisionsteile Oberrot GmbH

ARE YOU FACING A SIMILAR CHALLENGE?
Talk to us! Our IESE experts will be happy to support you.

Sartorius Lab Instruments GmbH & Co. KG

Fraunhofer IESE supports Sartorius Lab Instruments GmbH & Co. KG in designing and building up modular and flexible production. The Sartorius corporation is a leading international partner to biopharmaceutical industry and research that contributes to ensuring that biopharmaceutical drugs and vaccines are developed and manufactured safely and efficiently. As an innovative company with a broad product range, Sartorius recognized the opportunities offered by modular and flexible production early on.

In close cooperation with Fraunhofer IESE, a modern system architecture with digital twins is being developed, and the digital twins are being modeled as asset administration shells.

In addition, Fraunhofer IESE provides support in issues related to the software engineering of the emerging Industrie 4.0 system. By using the Industrie 4.0 solution Eclipse BaSyx developed at Fraunhofer IESE, rapid successes could be achieved and a modular, versioned, and flexible production could be developed in an efficient and standardized approach.

As a result, a novel solution for addressing flexible production requirements and the constantly growing number of variants is being developed together with Fraunhofer IESE.

Robert Bosch GmbH

Process innovations in automotive software engineering

About Robert Bosch GmbH

Headquarters: Abstatt near Stuttgart, Germany
Number of employees: 395,000 (2021)
Industry: Elektronics and Information Technology, Automotive

Since 2016, Fraunhofer IESE and Bosch Chassis Systems Control (CC) have been collaborating successfully in various fields of software process innovation in the context of the development of embedded automotive systems. The spectrum of topics considered is very broad: It ranges from identifying the potential of agile methods and practices to the use of innovative knowledge transfer concepts and the influence of the digital transformation on the engineering process. The aim is to identify current trends and approaches from applied research, adapt them to the needs of Bosch CC, and implement them hands-on in projects.

Integrating current trends and process innovations into the engineering process

In recent years, the role and significance of software in the automotive sector has changed dramatically. More and more functionality is being implemented in software and is only made possible by software (e.g., automated driving functions). The way software is developed has also changed – from standardized architectures such as AUTOSAR to the generation of code from models. In addition, the speeds at which new functionality must be delivered and at which new approaches and technologies are emerging has also increased dramatically. This has major implications for the requirements on an efficient software engineering process and how it must be changed.

By collaborating with Fraunhofer IESE, Bosch CC has learned about current trends and approaches in the area of process innovation from the perspective of applied research and has been able to assess their added value and improvement potential better. The results were used to integrate new methods and processes into the engineering process of Bosch CC in a targeted manner and transfer them to their employees.

"The cooperation with Fraunhofer IESE always helps us to identify new trends and topics for improving our engineering processes and to take a look at current developments in the area of applied research. IESE's experimental approach assists us in quickly evaluating new approaches in terms of their benefits for Bosch CC and in adapting them for us."

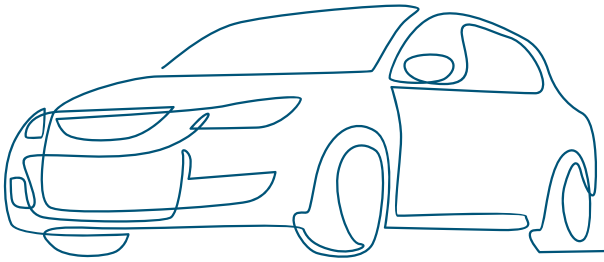
Peter Fröhlich, Director Engineering Methods, Tools and Licenses, Chassis Systems Control (CC), Robert Bosch GmbH

Specific outcomes from collaboration in the past include, for example:

- Collection of agile knowledge building blocks and their impact on business goals
- Pocket Guide of agile practices and knowledge transfer methods
- Overview of agile scaling approaches and their advantages and disadvantage
- Agile maturity level models for self-assessment of development projects
- Design of the "agile test manager" role
- Overview of knowledge transfer concepts and how they fit into a learning continuum
- Knowledge transfer concepts for teaching about "Continuous Integration"
- Concepts for the management and lifecycle of Big Data in the engineering process (data management)

Currently, Fraunhofer IESE and Bosch CC are working on the influence of the digital transformation on the engineering process and on how data obtained in the process can be harnessed (e.g., using Artificial Intelligence methods) to increase the efficiency of the process and to better communicate the process in the company.

ARE YOU FACING A SIMILAR CHALLENGE?
Talk to us! Our IESE experts will be happy to support you.



More industry projects

ZF Friedrichshafen

ZF Friedrichshafen AG is the world's third-largest automotive supplier and one of the world's leading companies in the field of driveline and chassis technology. In the course of implementing the shift-left approach, which extends the established V-model for continuous and test-driven product development in practice, ZF Friedrichshafen AG is cooperating closely with Fraunhofer IESE to exploit the potentials of this innovative approach in the best possible way. For this purpose, the existing test environments of the various corporate divisions are currently being evaluated jointly within the framework of this collaboration, based on data collected on the applied test methodology and tool support as well as an accompanying market analysis. A consolidation of the established development practices based on this and accompanied by Fraunhofer IESE will enable the creation of effective synergies between software- and hardware-focused test benches on the part of ZF Friedrichshafen AG and pave the way toward a uniform development platform for continuous quality assurance of software-based automotive system components.

TTTech Auto

TTTech Auto AG is developing the secure software vehicle platform MotionWise in Vienna and at various locations in Europe and Asia. MotionWise is used to orchestrate software functions in highly automated automobiles. Orchestration is a mechanism for coordinating software functions so that they are executed reliably, in the correct order, and on time with respect to deadlines.

As this is a highly safety-relevant software platform, a rigorous development process is necessary to continuously meet the requirements of relevant standards such as ISO 26262. In the area of documentation, TTTech Auto wants to further optimize their architecture-centric development processes together with Fraunhofer IESE.

Based on Fraunhofer IESE's extensive experience in designing and documenting software architectures, a new method is currently being developed jointly that will allow the MotionWise architecture to be developed and documented in a way that meets the specific requirements of TTTech Auto. This will form the basis for the planned future collaboration on the further design and expansion of TTTech Auto's own agile and architecture-centric process.

Bertelsmann Stiftung

With the support of Fraunhofer IESE, the **Bertelsmann Stiftung** is currently developing a concept for the "Trusted Health Ecosystem", a Digital Ecosystem for healthcare systems in Germany and Europe. Patients should receive the best possible information and support during the course of their illness. To this end, they should be able to easily access high-quality health information that they can easily understand and that is tailored to their specific situation. In addition, they should have easy access to integrated services such as appointment booking, telemedicine, and many others. In this conceptualization, the focus of consideration is the selection and interaction of potential healthcare partners. It is important that both health tech startups and established companies – from physicians to corporations – can get involved and can contribute and cooperate for the benefit of the patients. To do so, well-trodden paths must be left behind so as not that restrict the solution space unnecessarily. Instead, solutions must be designed that fully exploit the possibilities of the digital world and create real added value for patients, rather than just marginal improvements. In this ambitious project, the Bertelsmann Stiftung is relying on Fraunhofer IESE's many years of experience in designing and building Digital Ecosystems in a wide variety of industries. In this context, Fraunhofer IESE is using selected methods from its ecosystem portfolio, which ranges from initial positioning to conception and market launch all the way to growth and scaling.

Hitachi

The cooperation between **Hitachi Ltd.** and Fraunhofer IESE addressed the research question of how the runtime assurance methods developed at IESE can be used for dynamic risk assessment and conditional safety certificates in order to increase the efficiency and flexibility of autonomous mobile robots in Smart Logistics applications. To this end, the dynamics and variability of the logistics use case were first analyzed systematically in terms of risks and system capabilities, and then transferred into models. These models can be used by runtime monitors to resolve the variabilities in a fully automated way and thus achieve a gain in efficiency compared to classical safety mechanisms, which are typically designed for worst-case assumptions regarding risks and capabilities. The overall concept consisting of a model-based safety engineering method and suitable runtime components was evaluated by way of example in a simulation environment. The result showed that the speed of the robots and thus the efficiency can be increased, on average, with dynamic safety mechanisms.

Siemens Schweiz

Siemens Schweiz AG, Smart Infrastructure division, is a global provider of sustainable infrastructure and covers the entire value chain in the areas of buildings and electrification. To this end, Smart Infrastructure connects the real world with the digital world across energy systems, buildings, and industries. In doing so, Smart Infrastructure follows the Siemens philosophy of thinking in holistic ecosystems and therefore establishes Digital Ecosystems in order to optimally connect partners and customers and be able to offer the best possible integrated solutions. To this end, the business area Building Products of Siemens is closely cooperating with Fraunhofer IESE. To explore a wide variety of design possibilities for a Digital Ecosystem for smart buildings, the Fraunhofer Ecosystem Shaping Method was used. In this process, business, technical, and contractual aspects were considered and their interrelationships were identified. On this solid basis, IESE and Siemens are jointly working on the design and development of this ecosystem and on its integration into the platform landscape of Siemens.

MBCC Group

The **MBCC Group** based in Mannheim, Germany, is one of the world's leading suppliers of construction chemical products and solutions. Its main brands include Master Builders Solutions, PCI, Thermotek, Wolman, Fire Protectors, Colorbiotics, Watson Bowman Acme, TPH Bausysteme, Bluey Technologies, and Nautec. The MBCC Group employs approximately 7,500 people worldwide at operating facilities in more than 60 countries. The global headquarters in Mannheim houses several global functions, including Global IT Security. In order to implement a holistic IT security strategy and review individual units and facilities, the Group's Global IT Security commissioned Fraunhofer IESE to perform IT security audits and penetration tests. Following the first projects in 2021, further projects were started in 2022 to actively support the MBCC Group's Global IT Security with experts from Fraunhofer IESE.

Rambus

DRAMSys4.0 is a fast and flexible open-source simulation framework for Dynamic Random Access Memory (DRAM). The framework is being developed together with the Technical University of Kaiserslautern (Chair for Microelectronic Systems Design) and Fraunhofer IESE. As a technology leader in memory systems, U.S. technology company **Rambus** understands and appreciates the critical importance of using virtual prototypes and models for the development of innovations, and licensed the Fraunhofer framework for their internal memory systems research projects.

Rambus gets access to the research branch of the DRAMSys tool, which enables the simulation of state-of-the-art memory technology. For the academic partners, the collaboration with Rambus provides valuable feedback on market demands and will thus lead to further enhancement of the DRAMSys infrastructure in terms of broader applicability in industry. In 2021, the European research network HiPEAC bestowed the prestigious Tech Transfer Award on the DRAMSys team led by Dr. Matthias Jung for their work on DRAMSys4.0 as well as the resulting technology transfer.

Research projects

FMIS

The objective of the feasibility study **"Farm Data Management and Farm Management Information System (FMIS)"** was the preliminary conception of a software system that can be used to map complex processes and their workflows in the management of agricultural enterprises. Farmers are using more and more digital systems for a wide range of operational tasks, most of which can only be used as standalone solutions. Agricultural work and production processes extend across system boundaries; however, there is a lack of comprehensive data management with the possibility of consolidating and evaluating operational data in one place. Together with the Technical University of Dresden and the Association for Technology and Structures in Agriculture (*Kuratorium für Technik und Bauwesen in der Landwirtschaft,* KTBL), production processes as well as existing systems in the Digital Ecosystem were analyzed and basic approaches for the creation of a common data management solution were presented. In addition, a prototype operational FMIS was designed for a selection of typical operational KPIs. The study is one building block in the comprehensive activities of the Saxony State Office for the Environment, Agriculture and Geology (LfULG) aimed at improving farm data management and FMIS for agricultural enterprises in Saxony.

Green Economy

The **Green Economy** model is aimed at an environmentally compatible economy in which ecology and economy are positively linked with each other to increase social welfare. In the context of the project "Interactions between the Process of Digitalization and the Transition to a Green Economy", interfaces between Germany's necessary evolution toward a Green Economy and the increasing digitalization are being addressed and analyzed. These interfaces will then form the basis for the development of recommendations for action regarding framework conditions related to environmental protection.

With its expertise, Fraunhofer IESE is particularly involved in identifying the potentials of digital technologies for strengthening environmental protection and rural areas. To do so, interfaces between the topics of equal living conditions, digitalization, and environmental protection are being identified. Based on an analysis of good practices, possible implementation measures are being identified and subjected to an obstacle analysis. Finally, proposals of instruments for strengthening rural areas and environmental protection will be developed, with special consideration of the potential of digitalization.

Working creatively on projects at IESE!

ReCo

As part of the **ReCo** funding program (Strengthening and promoting the resilience of continuing education programs and mastering the consequences of the Corona crisis), Fraunhofer IESE is expanding a one-day seminar on SafeAI into a four-day certified advanced training course **"Data Scientist specialized in Assuring Safety"** in order to complement the existing training offered by the Fraunhofer Academy in the area of the successful Data Scientist program co-designed by IESE. The topic of Artificial Intelligence (AI) in safety-critical applications is attracting growing interest in practice, an interest that is expected to increase in the coming years. The training offers interested parties an overview of the state of the art at the interface between functional safety and AI, including relevant standards and standardization initiatives. In addition, it creates an awareness for the challenges of using AI in safety-critical solutions by highlighting typical problems from this challenging area. Participants learn about possible strategies for the safe use of AI solutions and try out a selection of approaches that help them address specific challenges and derive custom-tailored safety concepts. The training, which can be conducted either online or as a hybrid event, includes a large proportion of exercises and interaction in order to convey the content in a practice-oriented manner and facilitate transfer to everyday professional life.

Fraunhofer SOC

The implementation, monitoring, and evaluation of a holistic IT security strategy of the 76 Fraunhofer Institutes is performed by the central information security coordination body. Fraunhofer IESE has been working for this central body since 2002 already. In addition to the regular performance of IT security audits and consulting services, the institute also accompanies the introduction and evaluation of the Information Security Management System (ISMS). Fraunhofer IESE started its activities in the distributed **Security Operation Center (SOC)** of the Fraunhofer-Gesellschaft in 2021. In the so-called Red Team, typical tasks among its core activities include proactive vulnerability detection and tracking.

digital.vital

In the project **digital.vital,** Fraunhofer IESE is developing a software solution intended to help elderly people live a self-determined, healthy, and richly varied life. The portal digital.vital developed as part of the project is to be made known nationwide through network meetings already during the course of the project and will be made available to all interested municipalities as an open-source solution for use after the completion of the project. The portal is being implemented under the leadership of the Amt Hüttener Berge in cooperation with the partner municipalities of Germersheim and Püttlingen.

Smart Wendeler Land

Together with the county, its eight municipalities, the economic development agency Sankt Wendeler Land, the Digital Competence Center, and the citizens, Fraunhofer IESE is developing an integrated Smart City strategy in the project "**Smart Wendeler Land**" that is intended to support this rural area by providing profitable digital solutions. The strategy focuses on four defined ecosystems: citizen services, services of general interest, co-creation, and mobility. Within these ecosystems, individual measures and projects are proposed, tested, and realized. In conjunction with this strategy development, Fraunhofer IESE is realizing the conceptual design of a data platform that is to link the individual digital measures in the county in an inter-municipality manner. With the extensive support of the partner Zebralog, concepts for participation as well as communication processes are being developed. This will ensure successful development and implementation processes of the Smart City strategy in the county of St. Wendel with a focus on co-creation and citizen participation. The project partners aim to jointly develop the county in the sense of a public-welfare-oriented Smart Wendeler Land.

Smart Cities Made in Germany

Since 2019, the German Federal Ministry of Housing, Urban Development and Construction (BMWSB) and the KfW (Kreditanstalt für Wiederaufbau) have been funding 73 "**Smart Cities Model Projects**" in three rounds. In total, the federal government is investing 820 million euros in the development and testing of practice-oriented digital solution approaches for the design of sustainable urban and municipal development oriented toward public welfare. To support the nationwide network of model projects, the BMWSB commissioned a consortium of renowned institutions to act as the Smart City Coordination and Transfer Office (KTS). In addition to overall project management, the tasks of the KTS include expert support, evaluation, and coordination of the knowledge transfer within the funded projects. In addition, the practical and specialized knowledge gained is to be transferred to the wider municipal sector.

Fraunhofer IESE supervises the Smart Cities model projects from Rhineland-Palatinate and Saarland as a consultant of KTS. Furthermore, it is involved in various knowledge transfer formats, especially on innovative and technically driven topics such as urban data platforms, digital twins, open source, or smart city ecosystems. These topics are additionally the focus of its scientific support. In this context, five studies are currently being conducted with the goal of formulating innovative digitally supported concepts and thus recommendations for action for the model projects. In addition, Fraunhofer IESE is advising 18 model projects on their individual needs in order to support them in strategy and project development, efficient project management, and sustainable persistence of measures.

SATURN

The development and establishment of a **Smart Physicians' Portal for Patients with Unclear Disease (SATURN)** supports the diagnosis of patients based on Artificial Intelligence (AI) and provides a traceable and transparent tentative diagnosis. Different AI approaches based on expert knowledge or clinical case data are used. The diagnosis support based on rule-based approaches is based on medical expertise extracted by experts from available knowledge sources, such as guidelines and specialist literature. AI experts at Fraunhofer IESE then develop rule-based models based on this knowledge. In contrast, diagnosis support by means of Machine Learning and case-based reasoning uses real clinical data from university hospitals, taking into account data protection and patient privacy. The challenge here is that the amount of data is sometimes small. For this reason, hybrid approaches are also being investigated, where models are developed and refined both on the basis of expertise and on the basis of data. In all developed methods, special attention is paid to transparency and traceability for the users. Therefore, approaches from the areas of Explainable AI and uncertainty assessment are being used. The goal is to strengthen users' trust in the AI-based solution. If the tentative diagnosis indicates a rare disease, SATURN enables referral to experts from university hospitals. With the help of guideline-oriented standards of care, specific recommendations are given for common diseases.

TrUSD

The increasing digitalization in the world of work opens up the possibility for companies to collect and evaluate extensive data on various work processes. On the one hand, this development forms the basis for process optimizations; on the other hand, it presents companies with new challenges in terms of employee data protection and data security. The collection, transfer, storage, and evaluation of personal data in a company, in particular, entails the risk of inadmissible monitoring and touches on issues of employees' informational self-determination and the associated legal regulations (e.g., the European General Data Protection Regulation). Currently, however, employees generally have neither the knowledge nor the possibility to understand the collected data, its processing, and the associated consequences for their privacy (transparency), let alone to control it (self-determination).

In the project **"TrUSD – Transparent and self-determined design of data usage in companies"**, a practice-oriented and legally compliant approach for technology-supported employee data protection was therefore developed: Privacy dashboards enable companies to provide their employees with both transparency about company data processing procedures and self-determination possibilities regarding data processing. In addition, companies are supported by a participatory process model developed in TrUSD. This enables them to strengthen the organization-wide trust and work culture and at the same time allows them to benefit from business-enhancing analyses with personal data released by employees in a self-determined manner. The project builds a bridge between the potential of comprehensive data analytics in organizations and the employees' right to privacy. The requirements of employees, employee representatives (e.g., works councils, staff councils, trade unions) and employers with regard to employee privacy are reconciled better so that a fair balance of interests is achieved.

IESE at a Glance

Mission

Applied research on innovative solutions for the design of dependable Digital Ecosystems

Vision

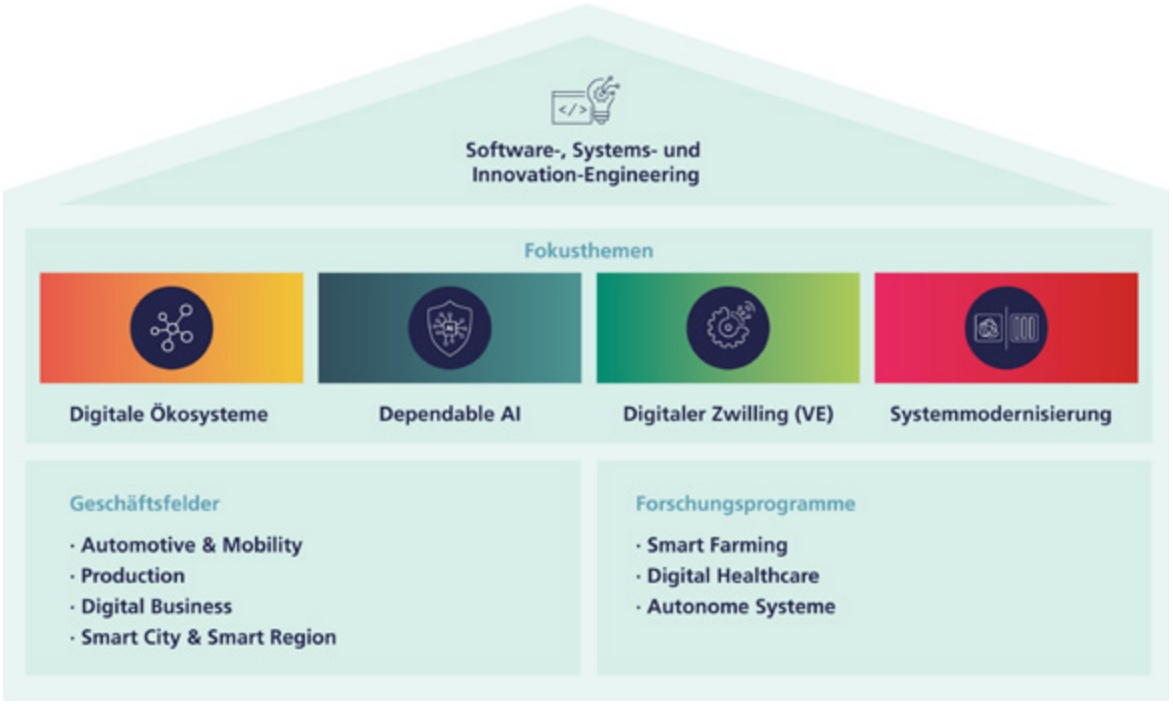
A better life, sustainability, and economic success through dependable Digital Ecosystems

About the Fraunhofer Institute for Experimental Software Engineering IESE

The Fraunhofer Institute for Experimental Software Engineering IESE in Kaiserslautern has been one of the leading research institutes in the area of software and systems engineering as well as innovation engineering for more than 25 years. With its applied research, the institute develops innovative solutions for the design of dependable digital ecosystems, thereby accelerating the economic and social benefits for its customers.

Fraunhofer IESE provides support in mastering challenges in a wide variety of application areas, with particular expertise in the areas of "Automotive & Mobility", "Production", "Digital Business", "Smart City & Smart Region", as well as "Smart Farming" and "Digital Healthcare". In over 2,000 customer projects, the institute has transferred cutting-edge research into sustainable business practices and innovative products, with the current focus topics being "Digital Ecosystems", "Dependable AI", "Digital Twin / Virtual Engineering", and "System Modernization".

Fraunhofer IESE is one of 76 Institutes and research units of the Fraunhofer-Gesellschaft. Together they have a major impact on shaping applied research in Europe and worldwide, and contribute to Germany's competitiveness in international markets.



Everything under one roof – with software, systems and innovation engineering, IESE is driving the digital transformation in all areas of application!

Fraunhofer IESE makes companies fit for the digital future!

With its research approaches, solutions, and competencies, Fraunhofer IESE supports commercial enterprises from all industries. The IESE experts research new technologies and methods for them and together with them. After all, software is the key to innovation and business success.

For some applications, Fraunhofer IESE has special domain competencies and experience. The institute therefore bundles its offerings and research competencies into corresponding business areas and research programs.

Business Areas of Fraunhofer IESE

Automotive & Mobility

In recent years, vehicles have increasingly become "computers on wheels", with complex software on board. Trends towards higher levels of automation and digital networking with services in the automotive industry continue to drive this development. But how do companies from this domain ensure that their software is highly dependable?

Fraunhofer IESE develops innovative software and systems engineering solutions for the automotive and commercial vehicle industry that can be depended on in every respect. Its experts support companies in the implementation of safety concepts, the development of new architectures, virtual integration and qualification, and the design of innovative products. Measurability, transparency, and quality are always at the forefront in all these endeavors.

Production

Automation in production, coupled with dependable and high-precision plants, has guaranteed the success of the German economy for many years. Digitalization in this industry (Industrie 4.0) and the resulting innovation impulses are continuing this trend. Digital twins enable easy and flexible access to data and services and open up new possibilities for optimization and flexibilization, all the way to completely new business models.

At Fraunhofer IESE, an important building block for the future has been created with the reference implementation of the open-source middleware BaSyx, which makes it possible to support companies in an easy way to exploit the potential of digitalization and enable participation in Digital Ecosystems. Application examples include virtual commissioning, flexibilization of processes, or AI applications for process monitoring, product quality assessments, and plant optimization.

Digital Business

The key to solving many problems and optimizing existing structures lies in the cross-sectional networking of value chains in Digital Ecosystems. This is the only way to make information

available in a quantity, speed, and quality that will enable not only new business models but also solutions to problems.

Digital Ecosystems and the platform economy will change every industry in many ways. Platform business differs significantly from traditional business and may require companies to completely rethink their own positioning and their own business model.

This is why Fraunhofer IESE has developed methods that provide companies with customized solutions and support them on their way from the business idea to implementation in the context of existing systems.

Smart City & Smart Region

Digitalization in rural and urban areas is important in order to benefit from the possibilities of networked data and services in these areas of life as well. Digital platforms make it possible to make services easily and quickly accessible to millions of citizens.

The "Digital Villages Platform" developed at Fraunhofer IESE is characterized by the fact that it is tailored particularly to the needs in rural areas. For communication, trade, and mobility, customized solutions exist that already have many tens of thousands of users.

In cities and municipalities, however, there are many other opportunities to offer improved infrastructures and services with IoT (Internet of Things) devices – examples are smart street lamps or parking services.

Research Programs of Fraunhofer IESE

Smart Farming

Due to the growing demands regarding environmental protection and sustainability with limited land areas and fossile resources, agricultural technology is facing ever greater challenges, also in Germany. To master these successfully, optimized processes with high efficiency are indispensable. As in many other areas, software is a key technology in the agricultural domain as well. In modern Farm Management Information Systems (FMIS), but also in tractors and implements, software-based innovations bring crucial competitive advantages. Data and its intelligent interpretation for the purpose of automating, optimizing, and simplifying agricultural processes is an essential element of the digital transformation.

With its research program "Smart Farming", Fraunhofer IESE supports companies in this process and conducts research into innovative technologies and solutions for Smart Farming.

Digital Healthcare

The healthcare sector is in a state of upheaval and is facing complex challenges. The shortage of public funds coupled with rising demand for healthcare services from a steadily aging population and the rapidly advancing digitalization in the healthcare industry are important drivers in this context.

The research program "Digital Healthcare" at Fraunhofer IESE supports all stakeholders in the healthcare sector on their way to shaping the future of healthcare through digitalization. With the help of Artificial Intelligence and digital innovations, we contribute to increasing the efficiency of the system and improving patient care, while at the same time reducing or streamlining the costs in healthcare and the healthcare industry.

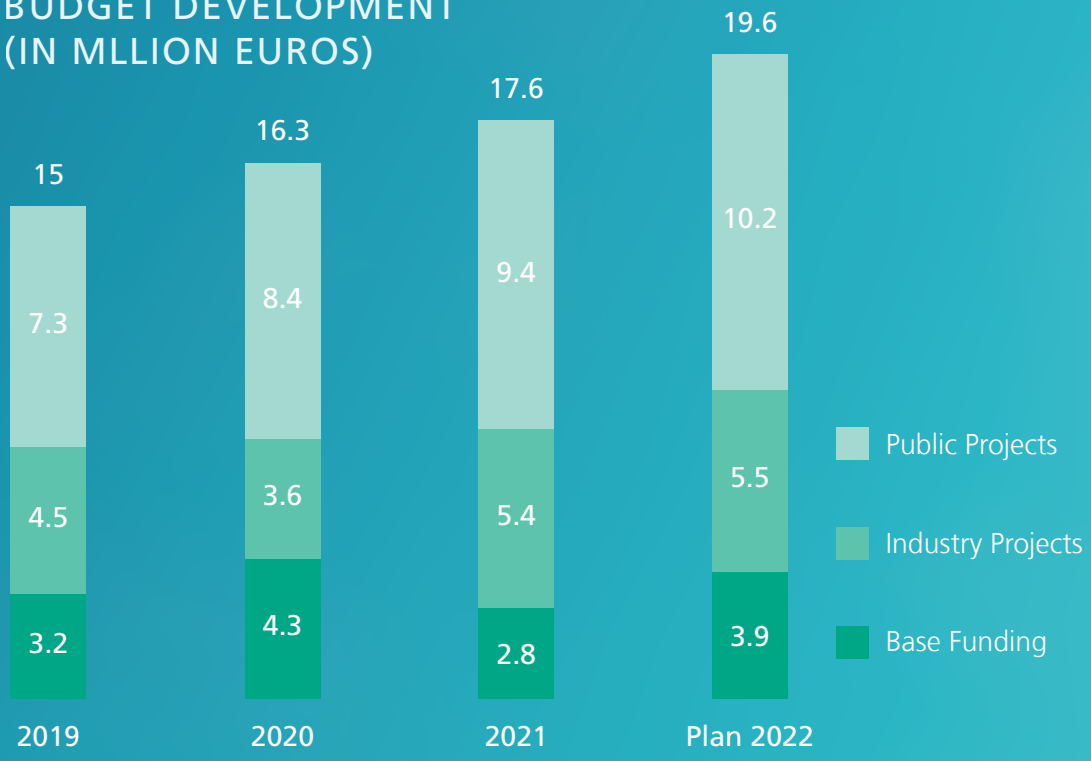
Autonomous Systems

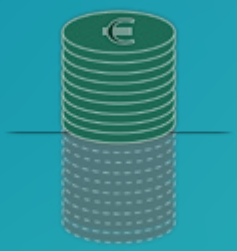
Autonomous systems offer enormous potential to solve acute ecological, social, and economic challenges. For example, field robots can reduce the use of herbicides through mechanical weed management. Cobots and autonomous mobile robots (AMRs) can be used in a variety of ways in production and healthcare to increase efficiency and counteract the shortage of skilled workers. Robotaxies and drones that fly autonomously are further examples of the potential and diversity of use cases.

With its competencies and its network, the research program "Autonomous Systems" of Fraunhofer IESE helps suppliers, manufacturers, and operators to move from prototypes and application ideas to market-ready autonomous products, dependable applications/services, and innovative business models.

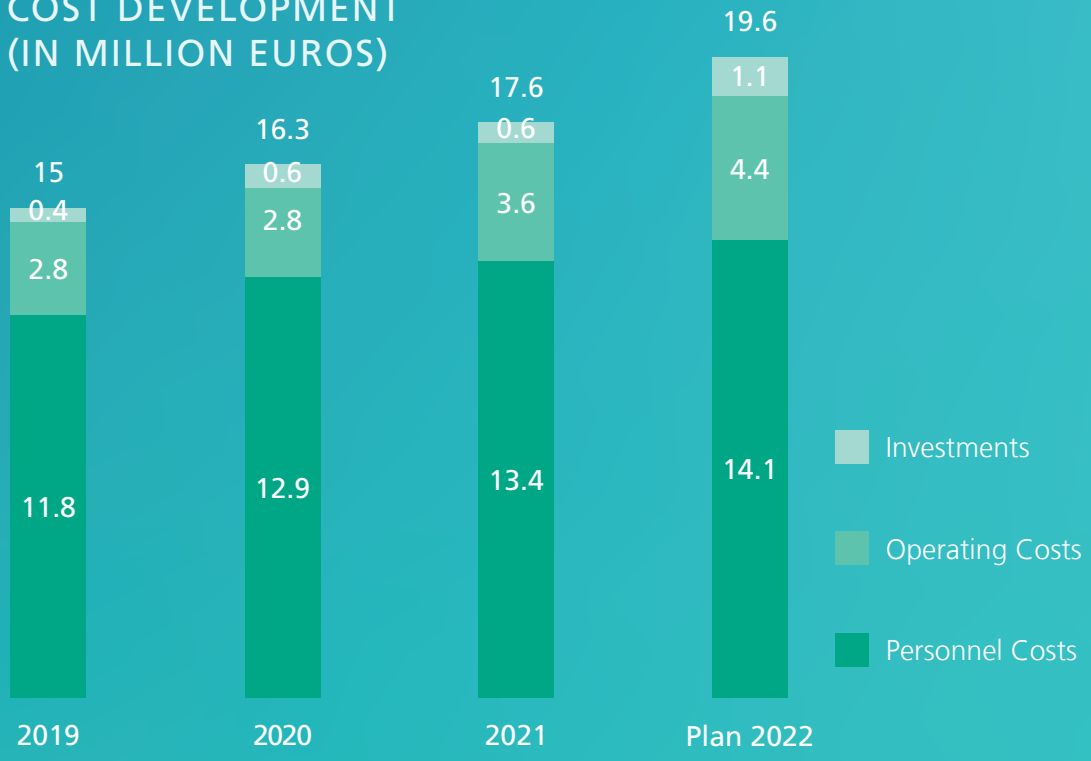
Budget & Cost Development

BUDGET DEVELOPMENT (IN MLLION EUROS)



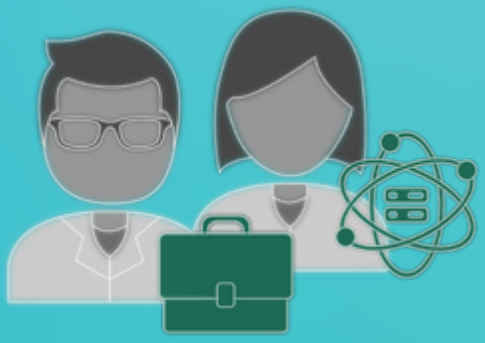


COST DEVELOPMENT (IN MILLION EUROS)



Personnel

PERSONNEL IN NUMBER OF HEADS

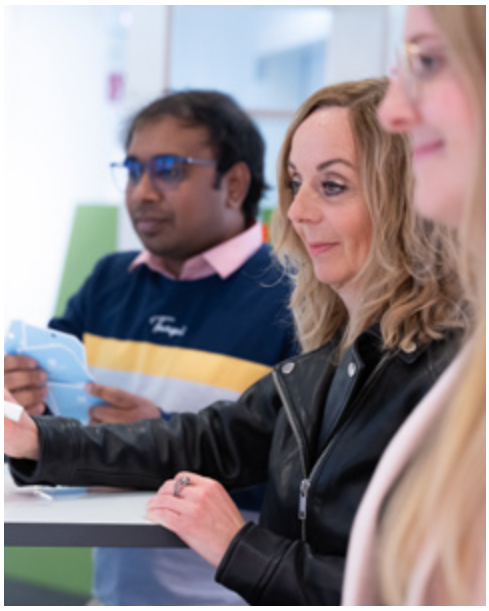


184
CORE STAFF

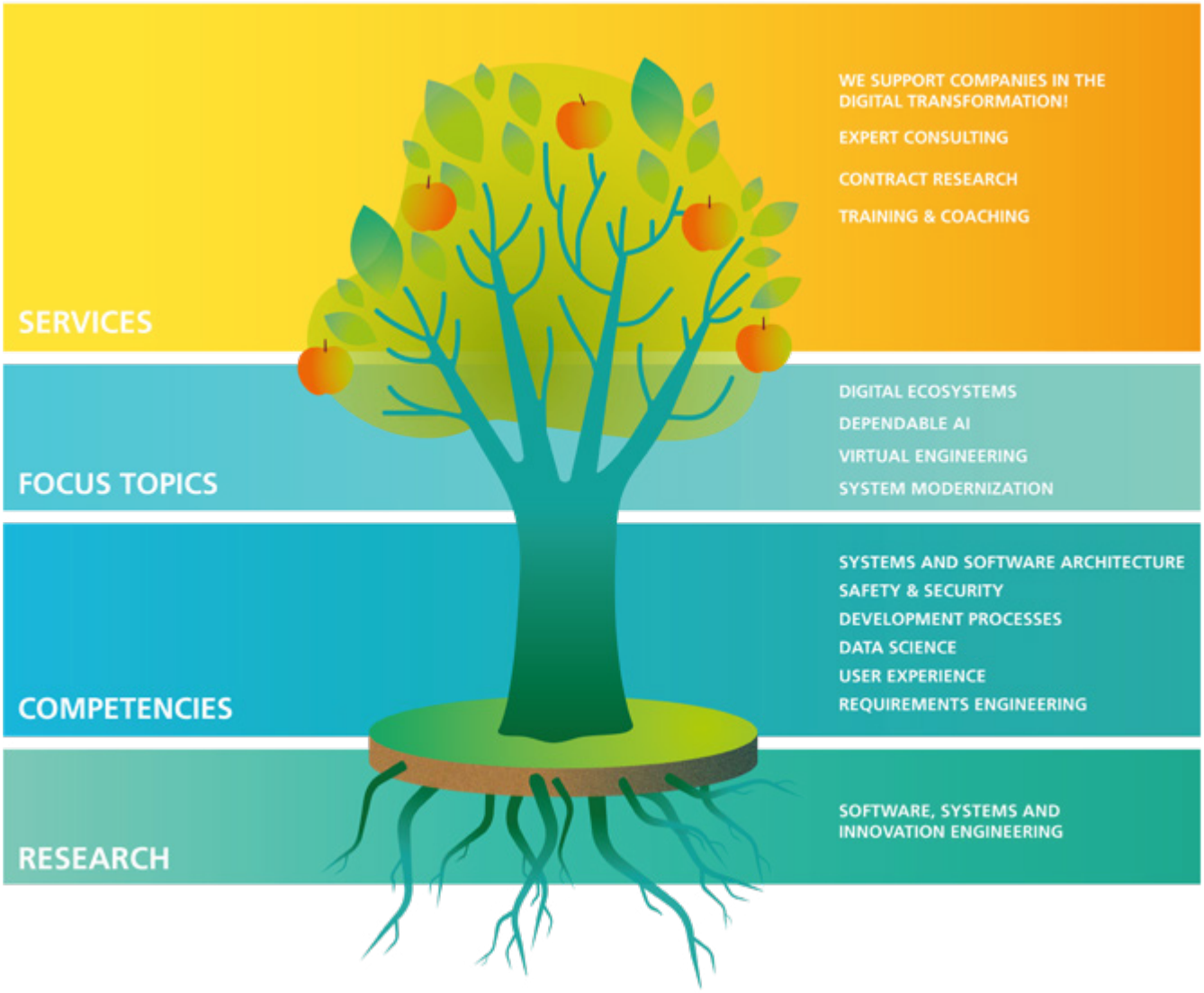
10
APPRENTICES & COOPERATIVE DEGREE STUDENTS

62
STUDENT RESEARCH ASSISTANTS

Research live



Research as the root of success...
...so that your projects will bear fruit!



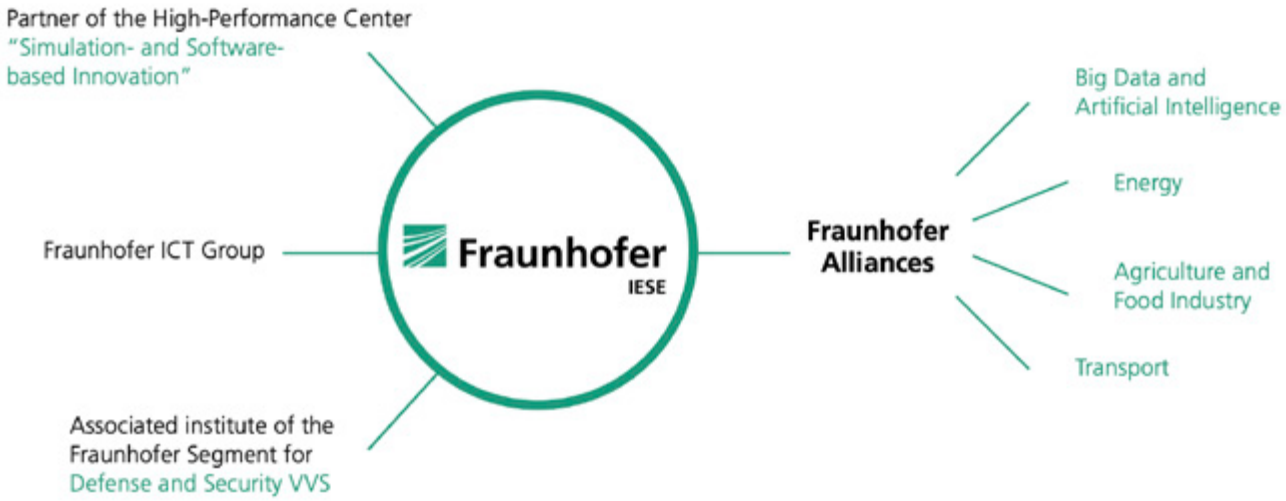
Our research in the areas of software, systems, and innovation engineering is the root of your success, because our research results flow directly into our service offerings and customer projects – for a better life, sustainability, and economic success.

In both research and industry projects, we apply our competencies to continuously help our customers move forward. Our competencies thus form the solid trunk on which the success of Fraunhofer IESE and its customers is based. The competencies of IESE in turn form four main branches, namely our focus topics. We have tailored these topics specifically to the requirements of our customers and are offering numerous services in this area, such as expert consulting, contract research, or training as a partner for companies.

We support you as our customer in a wide range of industries and conduct research for you on trend-setting key technologies so that your projects will continue to bear fruit in the future!

Alliances & Networks

Fraunhofer networks



Other selected networks

bitkom e.V.
Working groups: Arbeit 4.0, Projektmanagement, Qualitäts-management, Plattformen, Smart City/Smart Region, Digitale Landwirtschaft, Digital Design, Open Data/Open API
www.bitkom.org

Commercial Vehicle Cluster Südwest (CVC)
www.cvc-suedwest.com

Deutsches Institut für Normung e. V.
Standardization committee: DIN/DKE NA 043-01-42 GA "Künstliche Intelligenz" | www.din.de

DLG e.V. (Deutsche Landwirtschafts-Gesellschaft)
www.dlg.org

Gesellschaft für Systems Engineering e.V. (GfSE)
Arbeitsgruppe System Architecture Framework | www.gfse.de

GI e.V. – Gesellschaft für Informatik
Different groups, incl. Board Task Force "Data Science / Data Literacy", Fachgruppe Software-Messung und -Bewertung | www.gi.de

ISERN – International Software Engineering Research Network | isern.iese.de

Industrial Digital Twin Association e.V. (IDTA)
www.industrialdigitaltwin.org

Plattform Industrie 4.0 | www.plattform-i40.de

ProSTEP ivip e.V. | www.prostep.org

SIAK – Science & Innovation Alliance Kaiserslautern
www.science-alliance.de

Softwareforen Leipzig | User Group Requirements Engineering | www.softwareforen.de

VDI – Verein Deutscher Ingenieure e.V. | www.vdi.de

ZD.B (Zentrum Digitalisierung Bayern) – Plattform Digitales Landmanagement | www.zentrum-digitalisierung.bayern

Institute and Administrative Management

Prof. Dr.-Ing. Peter Liggesmeyer
Director

Prof. Dr. Frank Bomarius
Deputy Director

Prof. Dr.-Ing. Jörg Dörr
Extended Institute Management

Nicole Spanier-Baro
Administrative Director

Organizational Chart

As of August 2022

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Linda M. Northrop | SEI Fellow – Software Engineering Institute, Pittsburgh, USA

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Government

RDin Stefanie Nauel | Ministry of Economic Affairs, Transport, Agriculture and Viticulture of the State of Rhineland-Palatinate, Mainz

Dr. Carola Zimmermann | Ministry of Science and Health of the State of Rhineland-Palatinate, Mainz

Private Member

Renate Radon | Landau

Guest

Christine Regitz | SAP SE, Walldorf

At the last meeting, Prof. Liggesmeyer welcomed the members of the Advisory Board at a hybird event.

Project Grant Numbers

BaSys 4.2
01IS19022A (BMBF)

Denit/ZLB
29311-3:357 (MdI RLP)

DESIGNETZ
03SIN231 (BMWK)

Digital Green Economy
3719 16 1020 (UBA)

Digital.vital
031.48 / 048.00 / AD/103 (Amt Hüttener Berge)

Infra-Bau 4.0
DG 25 - 836.7/12 (BMVI)

MobiGrid
03EI4016C (BMWK)

ODH@Jülich
03SF0608 (BMBi)

OPEN-POCT
724-0001#2021/0004-1501 154 84009429 (MWG RLP)

SATURN
ZMI1-2520DAT02D (BVA)

Smarte.Land.Regionen
2818SL001 (BLE)

S(mar)t. Wendeler Land
LKWND-2021-09 (Landkreis St. Wendel)

SPELL
01MK21005B (BMWK)

TrUSD
16KIS0898 (BMBF)

ViTAWiN
01PV18006B (BMBF)

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berlin@iese.fraunhofer.de

The Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft based in Germany is the world's leading applied research organization. Prioritizing key future-relevant technologies and commercializing its findings in business and industry, it plays a major role in the innovation process. It is a trailblazer and trendsetter in innovative developments and research excellence. The Fraunhofer-Gesellschaft supports research and industry with inspiring ideas and sustainable scientific and technological solutions and is helping shape our society and our future.

The Fraunhofer-Gesellschaft's interdisciplinary research teams turn original ideas into innovations together with contracting industry and public sector partners, coordinate and complete essential key research policy projects and strengthen the German and European economy with ethical value creation. International collaborative partnerships with outstanding research partners and businesses all over the world provide for direct dialogue with the most prominent scientific communities and most dominant economic regions.

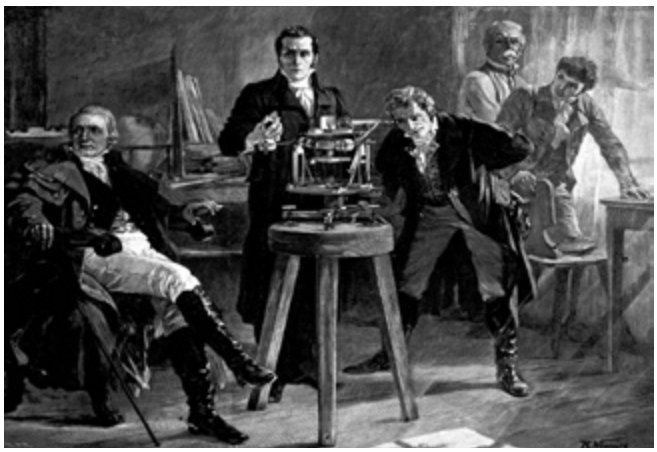
Founded in 1949, the Fraunhofer-Gesellschaft currently operates 76 institutes and research units throughout Germany. Over 30,000 employees, predominantly scientists and engineers, work with an annual research budget of €2.9 billion. Fraunhofer generates €2.5 billion of this from contract research. Industry contracts and publicly funded research projects account for around two thirds of that. The federal and state governments contribute around another third as base funding, enabling institutes to develop solutions now to problems that will become crucial to industry and society in the near future.

The impact of applied research goes far beyond its direct benefits to clients: Fraunhofer institutes enhance businesses' performance, improve social acceptance of advanced technology and educate and train the urgently needed next generation of research scientists and engineers.

Highly motivated employees up on cutting-edge research constitute the most important success factor for us as a research organization. Fraunhofer consequently provides opportunities for independent, creative and goal-driven work and thus for professional and personal development, qualifying individuals for challenging positions at our institutes, at higher education institutions, in industry and in society. Practical training and early contacts with clients open outstanding opportunities for students to find jobs and experience growth in business and industry.

The prestigious nonprofit Fraunhofer-Gesellschaft's namesake is Munich scholar Joseph von Fraunhofer (1787–1826). He enjoyed equal success as a researcher, inventor and entrepreneur.

Figures as of: January 2022.



The man behind the name: Joseph von Fraunhofer

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Printed by
Nino Druck GmbH, Neustadt / Weinstraße

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