VIRTUAL PRODUCT CREATION
Modern product development and manufacturing engineering is no longer just a matter of technical activity, but a strategic technological challenge that takes into consideration the entire lifecycle of products and services. Digital techniques, processes and methods define the core of engineering, because they enable successful planning and controlling of development time, product quality and associated costs. In the Virtual Product Creation division, we realize the vision of a fully digitized product creation process. In addition to solutions for the initial stage until the start of production we also work on digital engineering solutions that enable subsequent stages of the product lifecycle such as production, the use of products and associated services up to maintenance, end of life and reuse.

Our two specialist departments »Information and Process Control« and »Model-based Engineering« support industrial companies and public institutions in their quest for ever-improving standards of excellence in their solutions. Our portfolio of consultancy and development services ranges from independent technology surveys and optimization of digital applications (e.g. CAD, CAE, Digital Mock-Up (DMU), Digital Factory, immersive engineering with augmented and virtual reality, PDM/PLM and engineering data analytics with big/smart data) through to optimization of information standards and IT integration architectures. Our fund of proven experience is targeted to improve your company situation with an agile approach: starting with a state-of-the-art analysis of the currently existing solution followed by the development of the future capabilities for engineering. We can help you make the successful switch to a modern, fully digitized organization operating with high efficiency and maximum effectiveness.

In this brochure we cordially invite you to browse through our division and become acquainted with what we do. You will get insight into the kind of work undertaken by our two departments and find out which methods they develop in cross-departmental collaborative research. You will gain an overview of the technologies and applications which you can establish in your own company with our support, learn about the range of laboratories and facilities which we put at your disposal, and see how you too can benefit from our research.
The aim of the IPC department is to create a consistent end-to-end information flow across the entire product lifecycle that:

1. Enables feedback of information to the early stages of the lifecycle,
2. Supports cross-disciplinary, as well as cross-enterprise collaboration,
3. Ensures consistency in distributed information.

With these aims in mind, we develop and optimize innovative technologies for product lifecycle management (PLM). Furthermore, we create intuitive methods and tools that support knowledge-based decision-making.

Product data and product lifecycle management

Media gaps, lack of data integration and opaque processes are the three greatest obstacles to efficient product development. Solutions are presented by technologies of product data management (PDM) and product lifecycle management (PLM), which offer access to product-related data across the complete lifecycle of a product so that relevant information from the initial development stages is still available for the subsequent stages of manufacturing, sales and customer service. Even so, there is no one-size-fits-all PLM solution that can be applied to all kinds of companies. We help you to identify the right kind of technology for your company and produce concepts of use and PLM rollout strategies.

Next Generation PLM – on the way to information factories

Smart products and their digital networks are revolutionizing our world and the field of product creation. Intelligent products merge into complex systems that can interact with their environment, as well as generate and process data. Solutions from the field of Next Generation PLM support engineers and companies in extrapolating innovative development methods and business models from trends such as smart data and Industrie 4.0. In this context the information factory uses »living« models to provide timely digital security for networks of cyber-physical systems. As a result, the information factory is an ideal approach to the step-by-step transformation of developing and manufacturing companies on the road to Industrie 4.0.

Product development process

Core processes, management processes and support processes all guarantee manufacturers a fast product creation and high product quality. However, product creation is never a process with final closure – product details need to be changed or new suppliers have to be brought in. All such changes mean that existing processes have to be correspondingly modified so that they can continue to operate smoothly. We use methods of process modeling and management to analyze and optimize operational processes. And where standard methods do not kick in, we develop new ones.

Sustainability – responsible product development

Modern products and services no longer have to fulfill only economic criteria; ecological and social aspects are steadily gaining in importance and need to be factored into early product development stages. We support companies in creating the conditions on the levels of processes, methods and system landscapes to plan and develop products with resource-efficient and socially sustainable lifecycles. Furthermore, we also work together with you to ensure that your development processes and systems environments produce products which are ecologically compatible.

Product-Service Systems (PSS)

PSS unite products and their companion services developed to be in perfect harmony with one another. The service component is offered across the entire product lifecycle and raises the benefits of the product for the customer. This level of integration of goods and services means that the product is endowed with a unique selling point which will enable companies to differentiate themselves from their competitors. At the same time, PSS enable customers to be offered solutions specially customized to fit their needs. We develop methods and tools for PSS which ensure broad coverage of development activities.

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Model-based development draws on description, abstract notation or visual representation. The MBE department develops applications for all three forms of modeling. Our portfolio includes intuitive virtual tools, digital functional models and digital manufacturing processes.

**Model-based systems engineering**

When experts from different disciplines come together to develop a product, they use highly heterogeneous development tools. To ensure that the development process still goes forward, across-the-board integration of all acting systems is of the very essence. We develop methods and tools that support the collaborative work of a variety of disciplines right from the beginning – to make sure that you succeed in your switch to systems engineering that integrates multi-disciplinary development projects in one single unified process. Our methods use cross-domain functional modeling for early-stage simulation and verification of complex systems, while creating consistent traceability to expose interdependencies.

**Digital factory processes and their validation**

It is not just products that can be planned and developed more rapidly and efficiently using digital and virtual technologies. This applies to production facilities and processes as well. And if the product development processes are closely coupled with production planning processes, products become more economical and sustainable. Against this background, we optimize tools and methods for digital production planning. Our focus here is on the coupling of product and factory lifecycle management, design for X (DFX), smart hybrid process planning (SHPP), virtual commissioning, and Industrie 4.0.

**Immersive physics-based product modeling**

First and foremost, product development is creative collaborative work facilitated by user-friendly tools. These should be simple, understandable and give access to all relevant data and models so that a team of experts from a range of disciplines can work together to build a common understanding of the product while developing it from its first drafts through to the service stage. Our immersive virtual development environment allows product developers to use ergonomic digital instruments to intuitively model objects, coat them with material and modify them. To this end we bring modern 3D interaction techniques – such as haptic interaction, 3D manipulation, 3D modeling and sketching – together with 3D visualization technologies, including interfaces to PLM systems.

**Smart hybrid prototyping (SHP)**

Different actors in the product creation process (PCP) – developers, decision-makers, stakeholders, users – have very different perceptions of the product being developed. To date, functional validation that makes a product perceptible is employed mostly in the later stages of the creation process, using physical prototypes – which means that improvement loops are costly and time-consuming. Moreover, target users and customers are only rudimentarily involved. We develop technologies that allow the early validation of a product which take account of all actors involved and thus significantly shorten the PCP and improve its quality. With the help of SHP, products can be validated early in the development process in a multimodal approach, which realistically simulates their mechanical, electrical and control functionalities.

**3D inspection and re-engineering**

If a real-world system is mirrored in virtual reality, then its actual status and the possibilities it holds for optimization can be analyzed in the simulation. A real system, on the other hand, and particularly one up and running, would hardly allow for such fine analysis. Our research aims to create three-dimensional product models with optical measuring systems and to automatically analyze them using intelligent 3D image processing technology, as well as to design interfaces to PLM systems and manufacturing techniques. This enables the generation of product models, even if no digital product data is available.
with the product under development. Designing tools for intuitive use plays a key role in user acceptance, which is absolutely critical for the seamless integration of virtual development tools in the development flow.

Information Management for Product Creation

Successful management of all development-relevant information is the basis on which competitive product creation is built. In collaborative processes such information needs both to be aligned to each respective development activity in a context-sensitive manner and to be consistently spread across the whole range of acting disciplines and participating companies. At the same time, data generated from customers and users, as well as from product use and maintenance is playing an increasingly important role in product creation. The research focus of the Information Management for Product Creation research field is to facilitate the transformation to Industrie 4.0 with intelligent solutions for product lifecycle management (PLM) and to provide solutions to ensure that the rising complexity of information is kept at a manageable level. In this context, consistent networking of information across all stages of the product lifecycle opens up decisive opportunities for optimizing the innovations under development in terms of quality, costs, time, and sustainability.

Product Development Methods and Processes

Societal developments, innovative technologies and the transformation of the global economy all call for a rethinking of processes and methods of product creation. Modern users want to be actively involved in the creation of products, while customers are no longer content with the product itself but want it to be accompanied by an extensive range of services. Companies develop products across a variety of different sites. Development of application-related solutions to meet the challenges posed by product-service systems, sustainable products and lifecycle engineering is the focus of the Product Development Methods and Processes field of research.

Product Design and Functional Validation

Virtual prototyping is an important tool to master the increasing complexity of the product creation cycle. Visual analytics, immersive design reviews, multitouch systems, tangible user interfaces, haptic interaction, immersive sketching, and user centered design are no longer just concepts in forward-looking research proposals, but hands-on technologies for innovative solutions in industry. The research field Intuitive Interaction with Virtual Prototypes puts the spotlight on the way developers interact with virtual development tools and on how prospective users interact with the product under development. Designing tools for intuitive use plays a key role in user acceptance, which is absolutely critical for the seamless integration of virtual development tools in the development flow.

Intuitive Interaction with Virtual Prototypes

Early digital modeling and realistic depiction of mechatronic products in virtual prototypes with tangible functions enable investigation and improvement of a product’s functionality at an early stage of the development process. This research field aims to establish simulation and modeling in the conceptual phase and to integrate them seamlessly from multidisciplinary system design to functional validation and approval for use. Digital models are generated at each stage of the product creation cycle, while new methods of traceability enable consistent end-to-end linkage of information and visualization of interrelationships in system development. Yet this is by no means limited to virtual design – the combination of digital and real models to form smart hybrid prototypes enables quicker and more cost-effective changes to be made, and thus accelerates the pace of the design process.

Methods for Digital Production and Factory Processes

In future, more and more manufacturing plants will have virtual counterparts. The real-world factory will be precisely reflected in a continuously updated virtual representation accessible by production planners, product developers and other actors. The digital factory is a highly realistic tangible model that simulates not merely correct geometric appearance, but also the actual behavior of all component parts. This means that they can all be evaluated and optimized on the virtual level before being altered in real life. A full simulation also factors in the entire value creation network playing a part in production with all its resources and planning and production domains. At the same time all adjustments that need to be made to value creation networks can be derived automatically. Thus, planning results cover not just the actual manufacturing process but also include a reliable forecast of product characteristics after run-through of a technical production process chain in a value creation network.
Use of virtual techniques in plant construction

Virtual techniques are now well-established technologies in the automotive, aeronautics and consumer goods industries. Yet techniques like virtual reality (VR) and virtual commissioning are largely unknown in medium-sized enterprises specialized in building industrial assembly systems. This is why the investigation and evaluation of the potential of virtual techniques for the construction of industrial plant equipment is one of the prime focal points of our research.

This project targets the integration of a PLM solution with a VR environment to enable visualization of development statuses without prior preparation of CAD models. Through real-time coupling with a simulation of the system’s behavior, the kinematic and control behavior of the components used can be visualized in a VR environment.

Furthermore, the use of smart hybrid prototyping technology renders a tactile experience of the assembly process in the context of the virtual assembly prototypes. With this, we are making a contribution to Industrie 4.0 as the application of virtual techniques in plant construction is one of the prime focal points of our research.

3D data analysis: Non-destructive identification of components and conductor track structures

Maintenance and overhaul of electronic components in durable assets comes with high cost and intensive effort. Working together with partners from industry, we developed the prototype of an integrated analysis and testing process for the non-destructive and largely automated production of circuit diagrams.

The results serve to produce testing plans and enabling targeted repair. New optical and improved electronic test procedures were developed to capture the necessary network data.

The VPC division has developed a software prototype that uses computed tomography, 3D scans and 2D image data for the optical analysis of pads, conductor track traces, layers, and component data. The data is automatically combined, visualized and output as a netlist. Furthermore, the technology is also being tested for recognition of single parts in 3D scans of machine assemblies. Using the CAD reference data thus identified, the whole assembly can be automatically reconstructed and used for re-engineering.

PDM/PLM: Full evaluation of a PDM project

The challenges and risks in the selection and introduction of a PDM/PLM system can cause the introductory project to go way beyond the time horizons and costs initially planned. Against this backdrop, a global player in the automotive industry sought our support in the cross-company roll-out of a new PDM/PLM system and the cross-site harmonization of the PDM-ERP landscape.

Project modules were identification and evaluation of future trends in digital tools, analysis of requirements from the viewpoint of specialist departments, definition of evaluation criteria and use cases in conjunction with management, and analysis of available IT solutions with account taken of customer-specific development processes.

The result comprised a proposal for action with strategic measures that not only factored in evaluation of available IT solutions, but also took full account of data structures, the IT system structure, data generation processes, and the development exchange with, and amongst, the customer’s OEM suppliers.

Industry-related training as a professional in product lifecycle management

Efficient handling of product data and development knowledge is one of the key challenges of modern product development. This is why, when it comes to product lifecycle management (PLM), companies are highly concerned with procedures and tools for the control and administration of all product-related information across the whole product lifecycle. However, as companies also suffer from the lack of specialist personnel with the necessary know-how and practical experience, there is currently a huge need for professional training in these areas.

The three week in-service training »PLM Professional« addresses this pressing demand. The syllabus for the course was designed jointly by the Fraunhofer Institutes IPK, IAO and IPT in cooperation with the Bremen Institute for Mechanical Engineering (BIME) and participation of leading companies. It has been evolved, harmonized and evaluated especially to address the needs of industry. Dedicated experts from research and development teach both the interdisciplinary theoretical basic principles and the practical skills and know-how – which also include insights into the workings of relevant IT systems.

For more information, visit: www.plm-professional.de
Virtual Reality Solution Center (VRSC)
Over the past few years, virtual reality has established itself as an important technology for product development and presentation. The Virtual Reality Lab was opened in 2001 to tap the potential of this technology, open up new fields of application, and drive forward development of existing technologies. Today, the lab is a competence center in which innovative technologies – such as projection-based 3D visualization, 3D interaction technologies, and haptic interaction solutions – are continually being refined and developed. Drawing on these technologies, applications for computer aided design (CAD) and computer aided styling (CAS) are developed and new opportunities for use opened up in the fields of fly-and-walk-through for technology and architecture, assembly/disassembly tests, training platforms, information-enhanced design reviews, and prototype development.

PDM/PLM – Competence Center
One of our best known facilities is a virtual space – the PDM/PLM Competence Center. Given that sharper market competition is forcing companies to cut product development time, media gaps, inadequate product data integration and non-transparent workflows pose major obstacles. All these impediments can be largely avoided through use of PDM/PLM technologies which offer a uniform way of managing product data, while also integrating application systems. The PDM/PLM Competence Center develops solutions that exploit the full potential of PDM systems and PLM solutions on the company level. The PDM/PLM Competence Center supports both companies in the small and medium-sized enterprise sector as well as major industrial players and OEMs in the development, planning and roll-out of customized PLM strategies. Furthermore, it also assists in holistic evaluation, selection and adoption of PDM systems and PLM solutions for enterprises.

Virtual Engineering Learning Center (VELC)*
The Virtual Engineering Learning Center uses digitally supported methods of teaching and training engineering activities. Its state-of-the-art syllabus and infrastructure are a response to the needs of industry and prospective engineers. Training at individual computer workstations with loose software integration has given way here to training in integrated system landscapes which take full account of the technologies and concepts of present-day and future information systems. To meet the requirements of a broad spectrum of teaching and training methods, the VELC employs flexible furniture and an IT environment with plug-and-play capability: 22 mobile workplaces and mobile dividing walls support work in a wide array of workplace constellations, including short-term study groups, subject-graded learning islands and long-term project work. Its amenities – projection walls, a 52-inch display, a high-end audio system and a professional speaker’s stand – also enable presentation of high-end industrial applications, while novel and innovative methods of collaborative work can be realized with cutting-edge technologies such as its 3D active stereo projectors with shutter glasses, its multi-touch display and its integrated SMART Board.

iLab*
The Innovation Lab offers both teams and individuals an ideal environment for the creative and pioneering search for new ideas. The iLab answers the need for purposeful creativity in the workplace as called for by modern enterprise culture. Technologies and methods for the systematic search for new ideas foster creative thinking and enhance innovation capability. The results obtained are evaluated in discussion groups which the iLab supports with a broad array of communication and presentation options.

Digital Cube Test Center (DCTC)*
The DCTC is a multifunctional center for virtual product creation that unites product and process development, verification and research on the basis of virtual prototypes combined with real components. To this end it offers three core structures. Its functional drive simulator enables evaluation of single components and even entire vehicles in the early stages of the development cycle. Its smart hybrid prototyping (SHP) technology is a rapid and efficient solution for evaluating mechatronic products during their initial development phase. And in the context of the digital factory smart hybrid process planning enables timely verification of production and assembly procedures.

Center for Innovative Product Creation (CIP)
The Center for Innovative Product Creation (CIP) creates solutions for the engineering workplace of tomorrow’s world. With its formal meeting and conference areas, including a lounge corner, state-of-the-art workplaces, informal creative areas, and a showcase for the simulation of activity with physical objects, the CIP caters for the testing of the whole spectrum of typical engineering types of work. Its infrastructure of cutting-edge technology enables the flexible wiring and joining of individual areas so that the lab can be used both to demonstrate virtual product creation research results and to support researchers and industry partners in the development and testing of the latest innovative solutions.

Engineering Collaboration and Control Center (EC3)*
The Engineering Collaboration and Control Center realizes a multifunctional concept of space that can be used for both current and future engineering usage scenarios. It offers three large work surfaces ideal for digital and analog modes of collaboration. Its 84 inch multi-touch display enables collective viewing and editing of digital product models. Furthermore, the EC3 also boasts a movable mounted multifunctional work surface that can serve as an additional projection screen. A whiteboard wall approximately four square meters in size awaits the notes of creative minds. And connectivity with other labs such as the Digital Cube Test Center (DCTC) and CIP means that novel collaboration scenarios can also be researched and tested. This pioneering use of space concept is completed by an innovative building services concept and a flexible lighting system.
We offer you a broad bespoke range of services from consulting and planning through to realization and roll-out. We have a rich record of proven expertise especially in the automobile and automotive supplier industry, aerospace technology, machine tool and plant construction, and energy and medical technology.

**Our Services**

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**Technology and method consulting**

Our focused technology consulting services help you to identify and make the right choice of future technologies. What is more, we also support you in the planning, development, introduction and application of novel virtual development methods and technologies.

**Potential analyses and surveys**

We use product and technology-oriented feasibility studies, market monitoring and trend analyses to investigate and evaluate the inherent potential of technologies and products. This approach enables us to identify early emerging trends (such as digital transformation) – and is the ground rock on which we advise companies on how their product development should be shaped to respond to current trends so as to secure a long-term competitive edge.

**Optimizing product creation processes**

We investigate technological feasibility and implement on-track process and technology optimization that gives greater economic efficiency to your own product creation processes. When it comes to improving product development in your own company, we are not satisfied with a selected approach that takes a partial view. Instead, we embrace a holistic approach that takes as much account of engineering activities, data and information as it does of the company’s organization and processes, its tools and the overall relevant IT structure.

**Networking**

We have an extensive network of partners in science, industry, public authorities and government. This rich network of contacts facilitates the constitution of strategic research and development collaborations for our customers.

**Cooperation in the context of national and international research and development projects**

We cooperate with you within the framework of publicly funded research and development projects. And together with our proven technical expertise, we also bring in our rich trove of experience in contract research and project coordination.

**Professional training**

We offer our customers an extensive range of seminars. Our portfolio of further training measures teach much more than theoretical know-how. With us you will learn about technologies and methods by engaging hands-on with real-world use cases and you will be given direct examples of how they can be successfully applied. This means that the skills and know-how you gain will be of immediate benefit to you when you return to your company.

**Our Customers Benefit from the Following Service Portfolio**
When it comes to innovation, we both pull together. Because innovation is vital for a company's success. Innovation is what can turn a company into a technology leader on the global market. With our distinguished track record of proven expertise we develop innovative products, technologies and methods and support you in mastering the challenges of tomorrow's world.

**WE OFFER A BROAD SPECTRUM OF TYPES OF PARTNERSHIPS AND ALLIANCES**

**Industry projects**
Research and development projects are an efficient means of driving forward innovation in a company. We develop economically viable solutions on your behalf.

**Strategic preliminary research**
New and further development of technologies and markets for the future is what independent, publicly financed preliminary research is all about. Our business partners benefit from the insights gained in such preliminary research.

**Regional cooperation**
The Berlin Center for Digital Transformation develops technologies and solutions for networking processes, objects, people and systems. It also offers networked technologies and services for digital transformation. The Center is a cooperation of the Berlin Fraunhofer Institutes with research focus on Internet of Things, Cyber Physical Systems, Industry 4.0 and 5G technologies. Its transfer centers and laboratories offer the opportunity to quickly achieve specific innovation results.

**OUR COOPERATION NETWORK WITH INSTITUTES AND ASSOCIATIONS**
To ensure that our customers really do have fully comprehensive expertise brought to bear on finding solutions to their specific problems, we cooperate with a variety of other institutes and associations. We are affiliated with:

- The Fraunhofer Big Data Alliance
- The Fraunhofer AutoMOBILE Production Alliance
- The European Manufacturing and Innovation Research Association
- The Innovation Alliance for Virtual Technologies
- The Virtual Dimension Center (VDC Fellbach)
- The Prostep iViP Association

**VISIT OUR ESTABLISHED INDUSTRY WORKSHOPS**
Our industry workshops are a forum for the exchange of views and experience between scientists, engineers and product users. They offer a place where you can talk directly about matters of theory and practice to our own experts and the representatives of major companies and small and medium sized enterprises. The set of objectives such gatherings subscribe to ranges from honing expertise and building cooperation networks to the initiation of joint application-oriented research projects and transfer of research results to the enterprise sector.

The key themes and issues addressed in our industry workshops are:

- Putting PDM/PLM into practice!
- Product-Service-Systems – the future of business
- 3D-measuring technology and software for reverse engineering and inspection
- Successfully integrating virtual reality in development processes
If you have any questions on research and development in the Virtual Product Creation division or require further information on a particular research area, please contact one of our experts listed below. They will be happy to assist you!

**HEAD OF BUSINESS DIVISION**

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**INFORMATION AND PROCESS CONTROL**

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**FRAUNHOFER IPK – YOUR PARTNER**

The Fraunhofer Institute for Production Systems and Design Technology IPK and its business divisions Corporate Management, Virtual Product Creation, Production Systems, Joining and Coating Technology, and Automation Technology are dedicated to applied research and development for industrial production. We develop methods and technologies for corporate management, product development, production processes and the design of industrial plants and facilities. Our research centers on processes that enhance productivity in terms of the development and realization of products and their integration in systems solutions. This includes such challenges as the design and realization of intelligent production equipment, its integration in complex manufacturing environments, and its operational optimization. On top of this, we also develop novel applications in cutting-edge fields such as security and mobility.

**Interdisciplinary cooperation of the business divisions:**
- Corporate Management
- Virtual Product Creation
- Production Systems
- Joining and Coating Technology
- Automation Technology

For over 30 years our international, interdisciplinary team of scientists, engineers and student assistants has driven application-oriented research and development for the benefit of our partners and customers. Along with our own in-house applied research, we also develop new solutions in close collaboration with national and international companies. We work together with our industry partners in turning our basic innovations into fully fledged functional applications. Our approach covers the entire product lifecycle – from the initial product idea and its development, layout and manufacturing through to product recycling and disposal. The processes and methods we develop are the hallmark of an all-embracing holistic approach. Our work combines sound economic principles and sophisticated technology with ecological benchmarks such as sustainability and environmental friendliness. We are aware that our achievements rest in large part on the innovativeness and dedication of our team players. This is why we attach great importance to the coming generation of creative scientists by promoting long-term training for specific know-how for our core competencies in management, product creation, production processes and the design of industrial plants.