Fraunhofer

FRAUNHOFER NETWORK "SCIENCE, ART AND DESIGN"

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FRAUNHOFER NETWORK “SCIENCE, ART AND DESIGN“

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FOREWORD

DR. GABRIELE NEUGEBAUER, PATRON OF THE FRAUNHOFER NETWORK “SCIENCE, ART AND DESIGN“

Why not draw inspiration from the collision of different worlds of thought? The founding members of the Fraunhofer Network “Science, Art and Design“ were thinking along those lines when they joined ranks in 2017 to create an engaging platform to spark a spirited dialog between the arts and science at Fraunhofer.

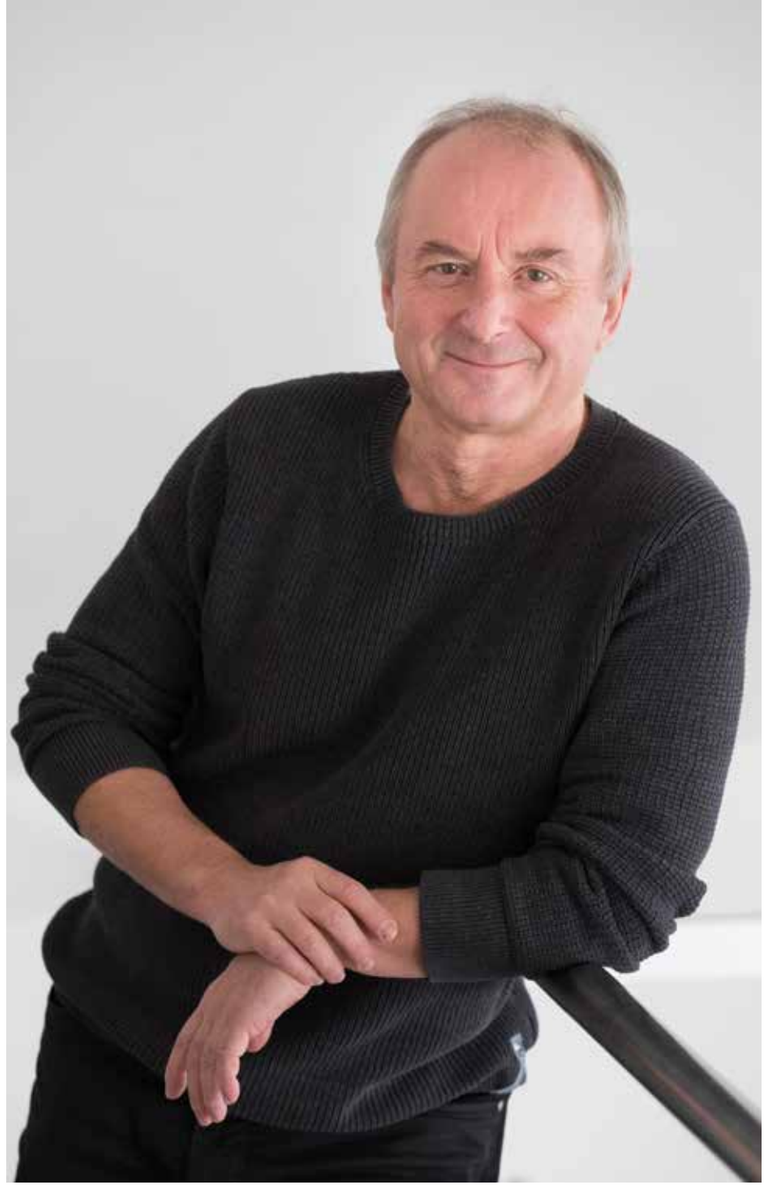
Those who enthusiastically heed their creative calling in the arts even if their education and careers in engineering and science have very different priorities, have good cause to wonder if the worlds of thought in the liberal and fine arts are really so far apart.

Scientists and artists alike are seekers in search of that spontaneous idea that defies conventional wisdom, breaks the mold of old thought patterns, and gives rise to new insights. And while the complex web of content in science may lead to the occasional entanglement, art often overwhelms with its diverse shapes and colors. Bringing the two together to break down these barriers is a compelling proposition. I hope with all my heart that it succeeds and finds broad support across the Fraunhofer-Gesellschaft.

In keeping with their charter, Fraunhofer Institutes devote their time and efforts more to the practical arts that were less esteemed in the Middle Ages. But as this brochure attests, these institutes indeed attach great importance to aesthetic forms, functional design and stylish creation.

Inventive product and communication design has often proven to be a powerful factor in the success of their project acquisition and marketing efforts. Sophisticated design is a fact of working life at Fraunhofer Institutes, as are joint art projects, public dialogs and creative workshops.

Given these auspicious conditions, the Network “Science, Art and Design“ will surely do its part for Fraunhofer. To quote the phrase “panta rhei,“ everything flows. With that in mind, I am very much looking forward to exciting discussions and enlightening ideas that are, literally, inspirational.



PREFACE

PROF. DR. MATTHIAS KLINGNER, SPOKESMAN FOR THE FIELD OF DESIGN IN THE NETWORK “SCIENCE, ART AND DESIGN“ AND DIRECTOR OF FRAUNHOFER IVI

An appreciation for simplicity, permanence and practicality seems to be fading amid the garish colors and frenzied pace of our times. This is perhaps less true in science, where what we know about complicated relationships can be brilliantly abstracted in a formula. Aesthetics – that is, perceptions of beauty and style – take on different shades in science, art and day-to-day life.

Still, science and art remain vital to our culture today, even if the canon of education and values is changing much faster than ever before. Educational attainment in the age of digitalization is geared primarily towards keeping pace with rapid advances in the sciences.

Knowledge doubled every hundred years or so in the 18th and 19th centuries; today it is doing so in the space of five to ten years.

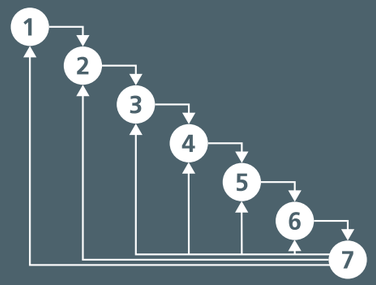
The Fraunhofer Network “Science, Art and Design“ does not wish to confine the dialog to education and science. A broader discourse is far more befitting for a prestigious research institution that explores a range of topics affecting all areas of life. These days, the mere prospect of an outstanding academic career is not enough to recruit excellent personnel. It takes creativity to invigorate and enrich the working environment and the labors of science with unconventional new ideas. Art and culture have much to contribute to that end.

Very much in the spirit of Kant’s “Critique of Pure Reason,” rational insight is not the sole wellspring of all our knowledge. We also owe what we know to our sensory perceptions. To put it simply, merely demonstrating the viability of an idea with some random prototype is not enough. What makes a presentation truly impressive is the convergence of form and function in a unified whole. This symbiosis of technology skills and design proficiency can be tremendously inspiring, as we occasionally experience when designers, architects and artists at the various Fraunhofer Institutes collaborate. You will find shining examples of their efforts in this brochure, the purpose of which is to encourage art and design to take deeper root at Fraunhofer in the years ahead.

The four basic types of design processes

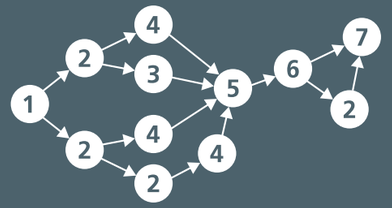
Type 1 – Linear

Type 2 – Feedback



Type 3 – Cyclical

Type 4 – Branching



DESIGN PROCESSES

An excerpt from "Designprozesse – eine Einführung" [Design Processes – an Introduction] by Petra Kellner

Every design project is based on design processes, an outline of which at the beginning of the project facilitates general project planning and time and resource management.

The selection of methods and techniques to be applied is not a matter of choice between right and wrong. Instead, this depends largely on the context and problem at hand. The decision in favor of the process best suited for the overall project is made based on these criteria.

There are four basic types of models for the design process.

Linear models | This design process is a sequence of successive steps, each of which is self-contained.

Feedback models | Feedback on the initial problem and between all stages of the process helps recognize wrong decisions.

Cyclical models | This circular perspective implies that a problem solved is always the point of departure for addressing a new problem.

Branching models | A description of microprocesses at the individual levels of the design process points out a number of possibilities. A decision has to be made at those junctures.

All design processes follow a basic pattern that emerges for each problem-solving effort. It is layered in various levels, starting with problem recognition, analysis, and broad and condensed research into potential approaches to solutions.

Efforts to develop general concepts for solving the problem can commence once all information and data have been selected and assessed, and the design problem has been precisely formulated. Alternative solutions are reviewed, weighed and evaluated to determine the design that will be put into practice.

This phase of refining, detailing and documenting the design concludes the process.

Product design
Vehicle design
Interior & exterior design
Interface & interaction design

DESIGNED BY FRAUNHOFER

Design is much more than a mere add-on for successful enterprises in many lines of business. They see it as an integral part of their efforts to promote innovation and gain a competitive edge on the market.

The design factor is also one of the great selling points. A well thought out product and industrial design is therefore key to long-term market success.

Industrial and product designers create the look and feel of capital equipment, which includes production plants, vehicles, machines, devices and tools used by mechanical and medical engineering companies, industry enterprises, retailers, skilled trades, labs and many others.

But design is not just skin deep, and the designer's brief extends beyond shaping outward appearances of objects to creating recognizable brand affiliations for this capital equipment.

Of course, the designer has to deliver the necessary functional units and safe human-machine interfaces ergonomically engineered to expedite workflows, but they also have to come up with big-picture concepts that factor modularity or scalability into the equation.

This is why design is becoming an ever more important aspect of R&D projects pursued to develop innovative products and services.

Industrial and communication designers have mastered a wide range of skills that can give Fraunhofer and its industry partners considerable advantages over their competitors.

The examples of best practices at the various Fraunhofer Institutes certainly attest to that.

This brochure is part of a push to impel the momentum of this trend.

Product design
Vehicle design
Interior & exterior design
Interface & interaction design

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PRODUCT DESIGN

Product and industrial design is rooted in the English Arts and Crafts movement and the Deutscher Werkbund. The Bauhaus founded in 1919 greatly influenced the evolutionary advance of industrial design. This school is a cornerstone of modern design in general.

Product design deals in the currency of mass-manufactured consumer goods – that is, all products for people's everyday needs. These are mostly objects for domestic use such as electrical appliances, household goods, furniture and clothing.

Consumer goods are often produced in vast quantities, so designers need to be familiar with manufacturing and market concerns. A holisitic view of the manufacturing process and the prospective product's use therefore includes functional, sensory, ecological and economic factors. Of course, there are technical and ergonomic requirements and economic factors that shape a product, but its aesthetics are no less important. Its look and feel has to appeal to the target group, deliver value to the customer and manifest the company's brand values for all to see.

The owners of consumer goods often attach great emotional value to these possessions. This is why design is one of the biggest selling points for B2C products. It also serves to set the product apart so it stands out among the crowd of competitors. The design strategy is thus extremely vital to the design process.

Product design also has to keep in step with social and economic trends. And in this day and age, designers must also consider a product's sustainability alongside its affordability.

1 *What the KiTS2.0 looks like.*

2 *And how it works.*

KiTS

A THERAPY DEVICE SUITABLE FOR CHILDREN AND A SIMULATION PLATFORM FOR TREATING SCOLIOSIS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

Premise & objectives | "KiTS – Child-oriented therapy device and simulation platform for scoliosis treatment" was a research venture launched to address shortcomings in FED (fixation, elongation, derotation) therapy and current practices for fitting spinal braces. This project's brief was to develop a state-of-the-art device to serve the needs of both therapists and patients.

Its two primary objectives were to improve scoliosis treatment and develop a method for fitting spine braces.

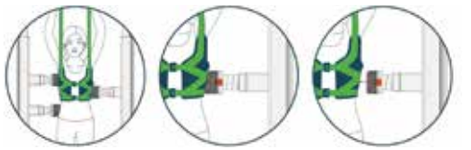
Results & added value | Patient feedback now helps improve the therapy. This feedback system motivates patients to play a more active role and it documents their performance. The system is not tied to any one device and may be used independently of the FED system for physiotherapy exercises.

Demonstrators confirmed that the device's design, patient feedback and the compact sensor-actuator system work well. The project's objectives were achieved with an improved device, a design better suited to children and a more effective therapy.

KiTS

A THERAPY DEVICE SUITABLE FOR CHILDREN AND A SIMULATION PLATFORM FOR TREATING SCOLIOSIS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden



2

Design | Jessica Rietze (Fraunhofer IWU)

Specialty field | Product design

Development time | 36 months

Completion date | 2015

Partners | Diers International GmbH; DIGALOG GmbH; KMS Kunststoff-Metall-Schubert; KUPFER.ROT GbR; Modellbau GmbH; MRC Systems GmbH; Orthopädie- und Rehatechnik Dresden GmbH; OrthoSax GmbH & Co. KG; Deutscher Verband für Physiotherapie (ZVK) e.V.; Praxis für Physiotherapie Beatrice Wenzel-Paegelow; Rehabilitationsklinik Zgozelec; Transfer- und Profilsysteme GmbH; Uniklinik Jena; Velomat Messelektronik GmbH; TU Dresden

Funding | BMWi

Material & methods | This project produced a cutting-edge ergonomics concept and a therapy and diagnostic device featuring a design tailored to the needs of children and adolescents. Its benefits are several, two being a simpler, more streamlined therapy and greater safety for the patient.

With a state-of-the-art sensor-actuator system to extend its application range, the FED device also provides a platform for simulating spinal orthoses. Custom-designed mechanical guides reduce costs and facilitate handling. The actuators in the new generation of devices may be fully automated.

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Cumulino

AN ACTIVE POSITIONING CUSHION TO CURE AND PREVENT CRANIAL ASYMMETRIES IN INFANTS AND TODDLERS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

1

Premise & objectives | This project's brief was to develop a concept and functional model for an active positioning aid for a baby's head – a pillow to prevent and rectify cranial asymmetries. Researchers were operating on the premise that the targeted properties, choice of materials, and the structural, formal and functional design of this positioning aid could also reduce the risk of sudden infant death syndrome (SIDS).

To achieve these goals, the project team designed a cushion that moves the child's head from left to right and vice versa.

Results & added value | This research venture demonstrated that this type of positioning cushion is indeed a viable product. The pillow repositions the baby's head precisely to specifications.

The results were presented to medical professionals and select national experts on neonatal cranial malformation to assess and consider as part of an acquisition strategy. The feedback was very positive indeed, prompting plans to set up a spin-off to transfer these research results from the design lab to medical practices.

1 *Cumulino – an active positioning cushion for babies.*

2 *An exploded view of the system.*

Cumulino

AN ACTIVE POSITIONING CUSHION TO CURE AND PREVENT CRANIAL ASYMMETRIES IN INFANTS AND TODDLERS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

2

Design | Lukas Boxberger

Specialty field | Product design

Development time | 18 months

Completion date | 2017

Partners | DIGALOG Industrie-Mikroelektronik GmbH; Schicktanz GmbH Sohland/Spree; WarmX GmbH

Funding | BMBF

Material & methods | The cushion steadily but slowly changes shape to move the head. This action can be made to address various points of contact on the skull without disrupting the child's sleep to prevent constant pressure from being exerted on any particular position. This pillow serves to prevent and rectify malformations. It features silent shape-memory actuators embedded in a flexible plastic matrix. The cushion repositions the head at electronically controlled time intervals set by the operator. The designers went to great lengths to factor infant anatomy and the degree of head movement into the equation. As the human-machine interface, the cushion had to have an ultra ergonomic design. This is vital to the child's comfort and the product's acceptance on the part of potential operators.

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EFORMIN

SHAPE MEMORY ACTUATORS IN MINIMALLY INVASIVE SURGICAL INSTRUMENTS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

1

1 *What this minimally invasive surgical instrument looks like.*

2 *How the modular instrument system works.*

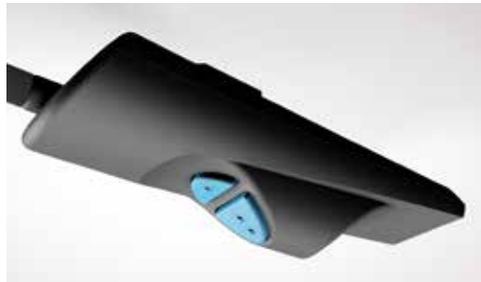
Premise & objectives | More and more medical fields are adopting minimally invasive procedures for their advantages over open surgery. Patients benefit from more benign procedures that hasten recovery. On the downside, access is limited to small incisions and natural orifices, which hampers flexibility and can pose ergonomic challenges for surgeons. Manually operated instruments generate mechanical friction and provide limited tactile feedback, both of which can elevate the risk of tissue injuries. The designers in this project set out to negate these drawbacks by developing an instrument based on a modular concept and equipped with shape-memory alloys (SMA) to provide actuator, sensor and force feedback.

Results & added value | SMA-based actuators and sensors have significantly improved this minimally invasive surgical instrument and made it far more precise. The angulation function and an electrical control unit for the end effector have enhanced the instrument's performance and extended its application range for several more use cases such as ENT surgery. Surgeons have tested the instruments' handling on medical dummies in an initial pre-clinical assessment. Their feedback on its ergonomics, use and functions was very positive.

EFORMIN

SHAPE MEMORY ACTUATORS IN MINIMALLY INVASIVE SURGICAL INSTRUMENTS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden



2

Design | Sophia Elsner

Specialty field | Product design

Development time | 24 months

Completion date | 2019

Partners | Asklepios Orthopädische Klinik Hohwald; endocon GmbH; joimax GmbH; Karl Storz SE & Co. KG; Krankenhaus Dresden Friedrichstadt; LAKUMED; Newkon GmbH KMU; Olympus Surgical Technologies Europe; radimed GmbH; Richard Wolf GmbH; Söring GmbH

Funding | BMWi

Material & methods | Shape-memory alloys (SMAs) have two advantages: They are multifunctional, so they can serve as sensor and actuator. And they have the high specific energy density required for this application, which calls for considerable force to be exerted in limited space. The object here was to enhance functionality and improve handling.

An electrical interface connects the individual modules – that is, the control unit, shaft, bending section and effector. The thermal shape-memory effect generates the actuating force that acts directly on the effector. This combination of SMA-based sensors and actuators could also accommodate a programmable transfer function.

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SMA suction and irrigation system

MISSION: DEVELOP A SURGICAL SUCTION AND IRRIGATION SYSTEM MADE OF SHAPE-MEMORY MATERIALS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

1

1 *Rendering of a functional model of the surgical suction/ irrigation system.*

2 *The head of the suction/ irrigation system.*

Premise & objectives | Rigid suction devices that bend only at predetermined angles figure prominently in many types of surgery. It is unusual for the two functions of suction and irrigation to be integrated in one system. Having to put one instrument down to pick up another tool exacerbates the risk of complications and prolongs the time in surgery.

Shape-memory alloys enable companies to make shape-shifting suction and irrigation pipes that bend to almost any angle. This BMBF-funded research project explored the possibility of developing a functional model for a shape-shifting combination suction/ irrigation system made of SMAs.

Results & added value | An assessment was conducted using phantom models under operating room conditions. The two functional models were found to be an improvement over a conventional rigid suction device with a rigid working end.

Better access to hard-to-reach target areas is likely to enhance patient safety. The instruments' optimized ergonomics and their combined suction and irrigating action proved far more beneficial for the surgical procedures conducted for these trials.

SMA suction and irrigation system

MISSION: DEVELOP A SURGICAL SUCTION AND IRRIGATION SYSTEM MADE OF SHAPE-MEMORY MATERIALS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

2

Design | Fraunhofer IWU

Specialty field | Product design

Development time | 21 months

Completion date | 2018

Partners | Institute for Machine Tools and Production Processes (IWP) of Chemnitz University of Technology; Asklepios Klinik Hohwald; Zahntechnik Leipzig

Funding | BMBF

Material & methods | The designers devised two concepts for the instrument's bending mechanism using a virtual twin, which they then put into practice. One variant consists of an SMA tube activated by the tempered water used for irrigation. The other, also made of SMA, features a pull wire for very small bend radii. It is activated via resistance heating. Both versions provide suction and irrigation in one instrument.

Produced with a 3D printer the ergonomic handles were then optimized with user feedback in mind.

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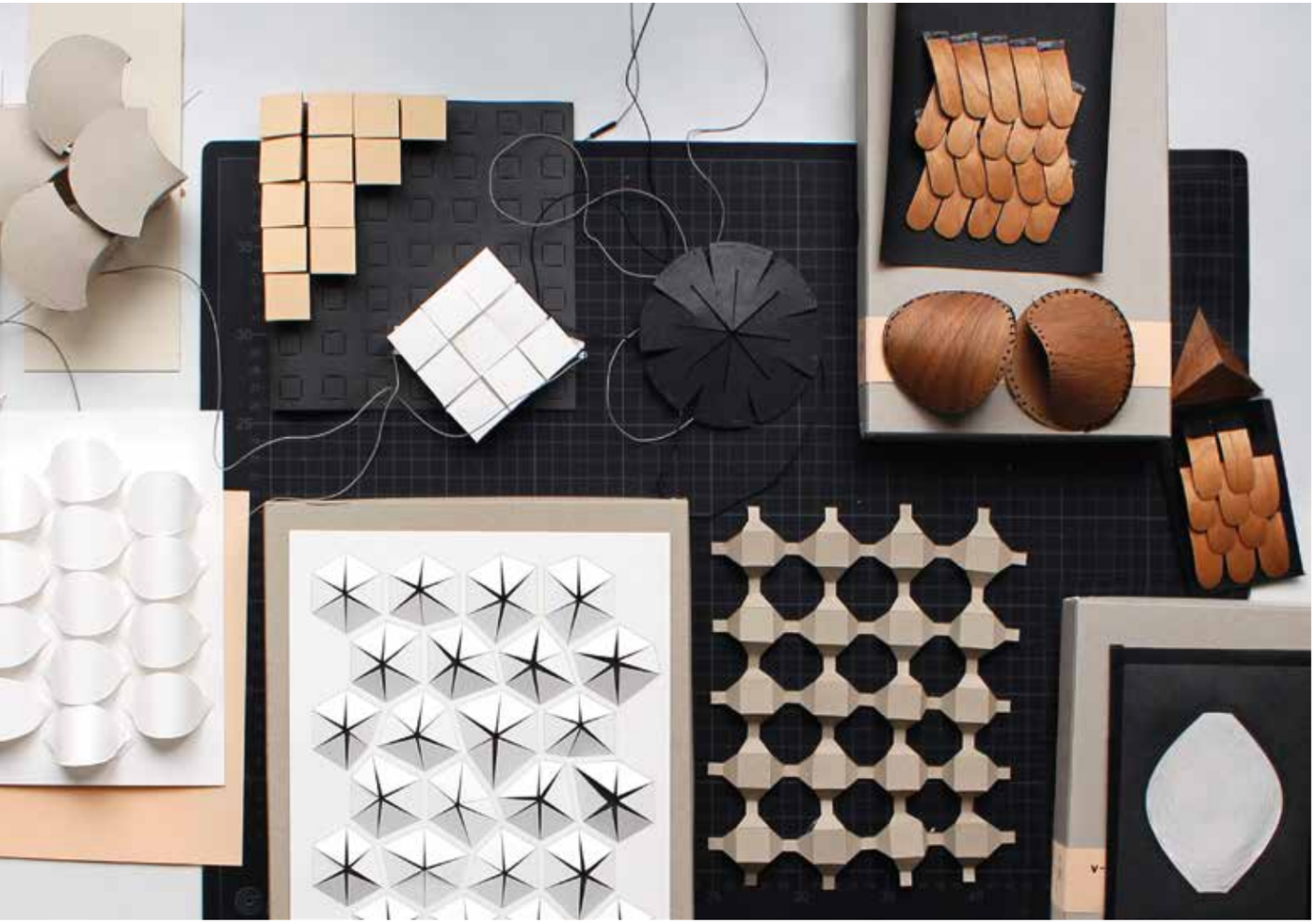


1

1 *Experimental design studies for the development of SMA-controlled adaptive surface systems.*

2 *A closed and open surface structure.*

SOUNDADAPT

SURFACE MODULES FOR OPTIMIZING THE ACOUSTICS OF ROOMS FOR SPECIFIC APPLICATIONS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

Premise & objectives | Every room sounds different. The acoustics of few, if any, are ideal. The architecture of rehearsal rooms often demands acoustical compromises that come at the expense of all musicians in the venue.

This project aimed to use smart materials – that is, shape-memory alloys – to devise a sophisticated technical design for acoustically adaptive room surfaces. The brief was to find a way to adapt the acoustics of rehearsal rooms specifically to the needs of the given musicians.

Results & added value | The SoundAdapt project confirmed the premise that professional musicians need adaptive acoustics for their practice sessions. At the time of writing, research engineers were busy simulating variable acoustic scenarios for select rehearsal rooms.

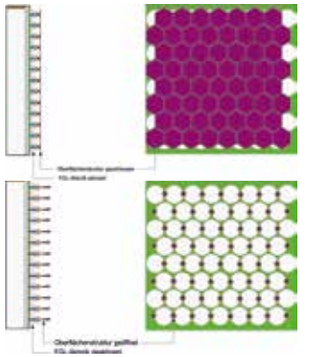
Scientists and designers were also developing functional models for technical design purposes and functional models of actuators that can be combined for different purposes.

This technology can be brought to market if the variable acoustic effect in rehearsal rooms demonstrably benefits musicians.

SOUNDADAPT

SURFACE MODULES FOR OPTIMIZING THE ACOUSTICS OF ROOMS FOR SPECIFIC APPLICATIONS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden



2

Design | Paula van Brummelen

Specialty field | Product design

Development time | 36 months
(an extension is planned)

Completion date | 2021

Partners | ADA Acoustics & Media Consultants GmbH; DIGALOG Industrie-Mikroelektronik GmbH; SBS Bühnentechnik GmbH; Schirmer GmbH – Beratende Ingenieure; weißensee academy of art berlin

Funding | BMBF

Material & methods | A user survey identified subjective acoustic parameters that can be translated into objective benchmarks and then measured in various rooms. The researchers are applying this information to develop various concepts for adaptive and acoustically effective surface modules, select actuator principles and a control unit to meet specifications. They aim to combine various subsystems – the surface, actuators and control unit – in a functional model and then experiment with it. Their next step will be to develop a prototype composed of adaptive acoustic elements that can be used for testing in various rehearsal rooms. Researchers will then measure room acoustics and conduct subjective interviews to assess its effectiveness.

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Smart Frame +

GREATER SAFETY FOR LIGHTWEIGHT LOCOMOTION

Fraunhofer Institute for Machine Tools and Forming Technology IWU Chemnitz

1

Premise & objectives | Fraunhofer IWU's primary objective in this project was to develop and deliver a lightweight structure made of a functionally integrated fiber composite. The brief was to investigate technologies to integrate piezoceramic elements into fiber composites and assess their suitability for use as sensors or actuators.

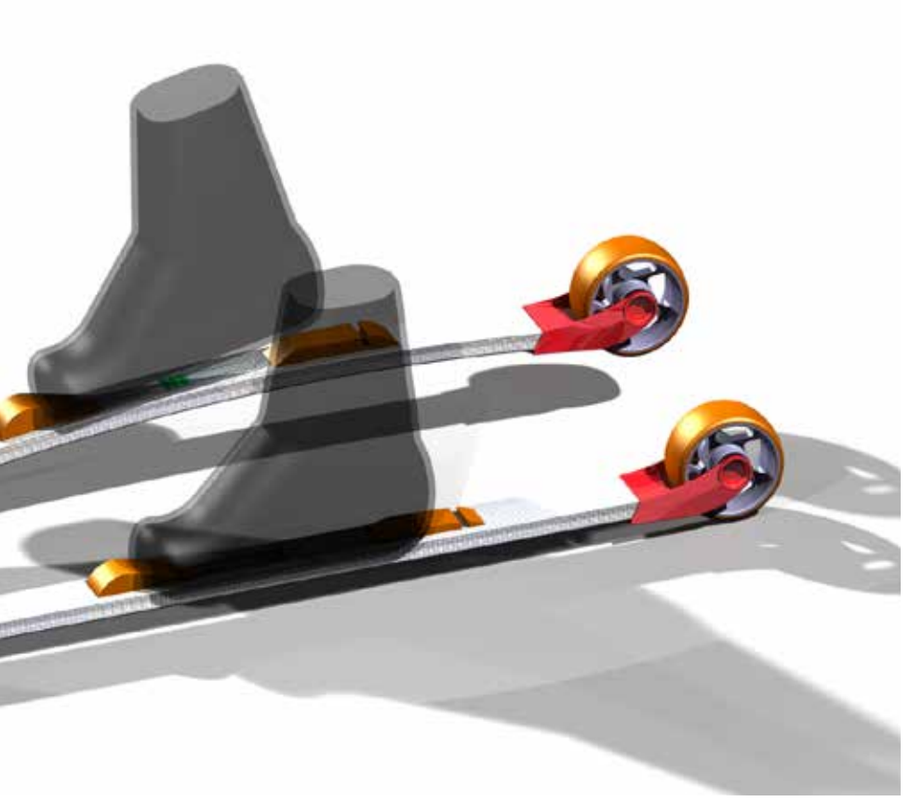
A roller ski manufactured using pultrusion technology served as the reference component.

Results & added value | The arching profile elevates the summer ski, treating the user to a far more authentic skiing experience. It feels more like the real thing than conventional aluminum ski rollers.

This roller ski features an innovative core with a piezo sensor that can be integrated as the section is pultruded. The sensor takes readings, measuring all applied forces during training, and sends this information to an app via a wireless link. This feedback enables users to fine-tune their training in pursuit of their goals.

1 *Sensorized roller skis.*

2 *Pultrusion of fiber-reinforced plastic sections.*



Smart Frame +

GREATER SAFETY FOR LIGHTWEIGHT LOCOMOTION

Fraunhofer Institute for Machine Tools and Forming Technology IWU Chemnitz

2

Design | Carsten Lies

Specialty field | Product design

Development time | 36 months

Completion date | 2019

Partners | Burg Giebichenstein University of Art and Design Halle; Ziegler Instruments GmbH; GERMINA Sportwelt GmbH; Schicktanz GmbH Sohland/Spree; DIGALOG Industrie-Mikroelektronik GmbH; Fraunhofer IKTS

Funding | BMBF

Material & methods | The roller ski's chassis was made with the radius pultrusion method. This process produces very affordable parts by pulling the dry semi-finished fiber products off the bobbins and through an impregnator with the heated die curing them in a matter of seconds.

The ski roller was designed with the help of computer simulation tools. They incorporated costly carbon fibers only at particularly high load-bearing points. Unidirectional (UD) rovings made of glass and carbon as well as quadraxial layers of glass and braided bands of carbon absorb the load applied to the skis.

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RF-KombiSCAN

A SCANNER TO ASSURE THE QUALITY OF FOOD

Fraunhofer Institute for Reliability and Microintegration IZM

Premise & objectives | Many foods are susceptible to rapid biochemical, physical and microbiological changes, particularly meat products. This project's objective was to develop an RF combination scanner to serve as day-to-day quality assurance tool in the food industry. The standard practice today is to send random samples to labs. This research venture set out to change that with an optical contamination scanner to determine right away if the food is edible.

To obtain more reliable results, the researchers decided to combine two different optical phenomena, Raman and fluorescence, and analyze the wavelengths.

Results & added value | This combined analysis proved able to detect both extrinsic and intrinsic changes in the chemical composition at an early stage. This way, inspectors can assess quality indicators such as freshness. Tests are non-invasive, so they can even be conducted through the packaging, leaving the wrapper intact.

RF-KombiSCAN can significantly improve quality assurance in the food industry in a cost-effective way. Able to test many more samples than the conventional lab method, it also presents the analyzed results straightaway for that specific product. Food vendors can then take immediate remedial action.

1 *The RF-KombiSCAN tablet and laser.* **2** *A close-up of its fastener.*

RF-KombiSCAN

A SCANNER TO ASSURE THE QUALITY OF FOOD

Fraunhofer Institute for Reliability and Microintegration IZM

2

Design | Johannes Rojahn (Fraunhofer IZM)

Specialty field | Product design

Development time | 18 months

Completion date | 2014

Partners | Technische Universität Berlin; Gries & Co. KG; COSINUS Computer Messtechnik GmbH; RGB Photonics GmbH (vorher RGB Lasersysteme GmbH); Lacon Electronic GmbH

Funding | BMWi

Material & methods | The partners in this consortium collaborated closely to define the technical requirements for the RF-Kombiscan's design.

Digital prototypes provided platforms for experimenting with various arrangements of interior components. This enabled researchers to create the smallest viable product – a device that operates smoothly and handles well.

The food industry's rigorous demands for hygiene and cleaning were factored into the housing's design.

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ArtGuardian

A VIRTUAL SENTINEL TO WATCH OVER ARTWORKS

Fraunhofer Institute for Reliability and Microintegration IZM

Premise & objectives | Private collector or public museum, every owner of valuable works of art wishes to preserve those prized possessions. Of course, this is best done under ideal climatic conditions, but not every exhibition room and mode of transport provides the perfect environment for artworks.

Three Fraunhofer Institutes and their partners combined state-of-the-art microelectronics, structural engineering and information technologies to create ArtGuardian, a solution that helps owners protect their art.

Results & added value | ArtGuardian technology consists of three components. A sensor system continuously monitors microclimatic conditions. A software platform forwards information and handles communication. And a steadily growing set of rules sets limits and provides instructions that may be amended to suit the given artwork.

ArtGuardian is the first system of its kind to fully monitor and document the microclimate in warehouses, vehicles and rooms that store, transport and exhibit valuable paintings. In this case, surveillance translates into protection: for example, museums could use ArtGuardian to prove that all their exhibition rooms are equipped with optimum air-conditioning to obtain a climate certificate.

1 *Winner of the 2015 iF DESIGN AWARD.*

2 *Exploded view of the ArtGuardian sensor.*

DESIGN AWARD 2015

ArtGuardian

A VIRTUAL SENTINEL TO WATCH OVER ARTWORKS

Fraunhofer Institute for Reliability and Microintegration IZM

2

Design | Johannes Rojahn (Fraunhofer IZM)

Specialty field | Product design

Development time | 24 months

Completion date | 2014

Partners | Fraunhofer ISST; Fraunhofer IBP; Fraunhofer IAP; Fraunhofer WKI; Rathgen-Forschungslabor

Funding | Fraunhofer

Material & methods | The researchers painstakingly pinpointed functional requirements, customer needs, component interaction, layout and design of the ArtGuardian sensor system in an iterative process.

Nothing was left to chance. The designers of the ArtGuardian sensor system interviewed users about their needs, tailored control features to use cases to facilitate handling and produced several different functional prototypes to develop the mounting system.

The sensor won the 2015 iF Design Award, taking top honors in the product category. A patent application has been filed for the innovative mounting system.

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Mission: Develop characteristic design elements for the institute's products

THE LAWAVE LASER ACOUSTIC TEST SYSTEM AND LISEC POWDER NOZZLE MEASURING SYSTEM

Fraunhofer Institute for Material and Beam Technology IWS Dresden

Premise & objectives | A leader in material and laser technology, Fraunhofer IWS develops innovative systems for tomorrow's industry that set quality standards. The brief for this project calls for the development of a product design that backs up this claim to leadership and underscores the institute's values and capabilities.

This is to be a sophisticated design that lends products featuring innovative technologies a professional and uniform look and feel. Fraunhofer IWS delivers on its performance promise with designs that manifest sustainable quality for all to experience.

Results & added value | Fraunhofer IWS solutions and products are applied in industrial environments where the design factor figures ever more prominently. Fraunhofer IWS is collaborating with the Chair of Industrial Design Engineering at TU Dresden to develop a product design that lends the institute's solutions a highly recognizable, professional look that speaks to their advanced technology and quality. This effort has given rise to a newfound awareness for the mindful design of user experiences. It also provides a reference framework to strengthen the dialog between workgroups, create synergies and enable standardization.

1 *Institute-wide benchmarks for product design: COAX14, LIsec and LAwave.*

2 *LIsec – the first incarnation of the 2019 IWS design principles.*

Mission: Develop characteristic design elements for the institute's products

THE LAWAVE LASER ACOUSTIC TEST SYSTEM AND LISEC POWDER NOZZLE MEASURING SYSTEM

Fraunhofer Institute for Material and Beam Technology IWS Dresden

Design | Frank Drechsel, Thomas Theling (TU Dresden)

Specialty field | Product design

Development time | 24 months

Completion date | Underway

Partners | TU Dresden, Chair of Industrial Design Engineering

Funding | In-house resources

Material & methods | Initial design studies have been created for the LAwave laser acoustic test system and LIsec powder nozzle measuring system. Specific design elements have been developed based on these two products and, in the next step, will be applied to the broad portfolio of Fraunhofer IWS. The resulting designs will create an unmistakable identity, yet be malleable enough to adapt to Fraunhofer IWS's various products and the partners' individual requirements.

2

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1

1 *Simulation of sandwich interior panels with a textile design.*

2 *Edge of a sandwich panel for aircraft interiors.*

PROTEG A1.2

TECHNOLOGY TO OPTIMIZE THE PRODUCTION OF AIRCRAFT CABINS FEATURING COMPONENTS BASED ON NATURAL FIBERS

Fraunhofer Institute for Microstructure of Materials and Systems IMWS

Premise & objectives | The Klima-Panel [Climate Panel] subproject explored the feasibility of textile-patterned natural fiber composites to serve as a covering for aircraft interiors. The aim was to replace the standard patterned foils that provide the outer skin for sandwich panels in aircraft interiors. This would reduce the weight of the side panels by around 400 g/m². The reassuringly robust look of the fiber composite could also enhance the perceived safety of passenger aircraft.

Results & added value | The researchers established the feasibility of using natural fiber composites to this end, proving their mechanical properties to be suitable for interiors as required by the ASTM standards for aerospace materials.

However, the researchers were unable to confirm the composites' compliance with fire, smoke and toxicity (FST) requirements in this project. Demonstrator components were included in Green Vision, a mockup at Airbus Operations in Finkenwerder catering to airlines that want to promote the use of natural fiber reinforced plastics (NFRP) in aircraft interiors. A German automaker uses visible NFRP laminates in the interiors of one of its lines. This OEM also uses fiber composites in body components.

PROTEG A1.2

TECHNOLOGY TO OPTIMIZE THE PRODUCTION OF AIRCRAFT CABINS FEATURING COMPONENTS BASED ON NATURAL FIBERS

Fraunhofer Institute for Microstructure of Materials and Systems IMWS

2

Design | Sven Wüstenhagen

Specialty field | Industriedesign

Development time | 36 Monate

Completion date | 2012

Partners | Fraunhofer PYCO (Teltow); FIBRE (Faserinstitut Bremen); Airbus Operations GmbH (Finkenwerder)

Funding | BMBF

Material & methods | A general concept spelled out the design options, which included textile fiber-composite surface layers with added functional yarns. This provided the blueprint for producing sample laminates under conditions much like those in an actual factory.

The partners characterized the mechanical properties of the fiber-composite structures and optimized their layout and design accordingly. The joint project also served to investigate and optimize the FST properties and the surface resistance of the fiber composites to mechanical and chemical stimuli.

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1

Mission: develop a sled made of three plastic components

A TOUGHENED ORGANIC COMPOSITE FOR WINTER SPORTS GEAR

Fraunhofer Institute for Microstructure of Materials and Systems IMWS

Premise & objectives | Plastic toboggans are fairly sophisticated injection-molded components. The state of the art in this technology is conducive to developing plastic sleds with new features beyond the boundaries of conventional use cases. Given their mechanical and tribological properties, wood-plastic composites (WPCs) looked to be very promising candidates for this application.

In this case, the material was to be used for a kit sled with components made of two injection molds. Assembling its individual parts, flat-packed for convenient shipping, is left to the customer.

Results & added value | The researchers investigated and defined the processing and application windows for WPCs with the climatic conditions for sledding in mind. Their findings enabled them to develop the sled further, beyond the conventional use case.

They identified the critical points of component designs from a technology perspective and adjusted the injection molding process to modify these aspects. The resulting workflow was very efficient with forming and technology specialists working well together. Their efforts succeeded, yielding insights and solutions in materials engineering and creating new winter sports applications for plastic articles.

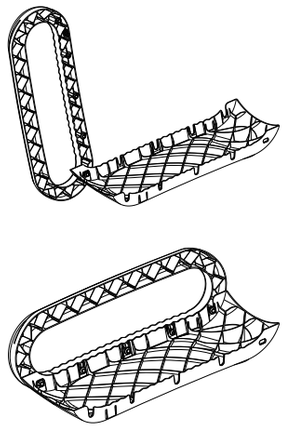
1 *A rendering of the WPC & polyethylene combination.*

2 *A diagram of components designed for tool-free assembly.*

Mission: develop a sled made of three plastic components

A TOUGHENED ORGANIC COMPOSITE FOR WINTER SPORTS GEAR

Fraunhofer Institute for Microstructure of Materials and Systems IMWS



2

Design | Prof. Frithjof Meinel, Stephan Schulz

Specialty field | Industrial design

Development time | 36 months

Completion date | 2018

Partners | KHW GmbH; Burg Giebichenstein University of Art and Design Halle

Funding | BMBF

Material & methods | The project kicked off with interdisciplinary workshops. All participants were on hand to define processing methods and determine the degree of freedom the designers would have for the layout of mechanical components. Applying design-specific methods, they devised a systematic approach to be used by all disciplines involved in the project.

The designers proposed a draft for a sled based on the properties of the toughened WPC, which the team then optimized with user acceptance, market potential and technical feasibility in mind. The CAD rendering of the sled was dimensioned for utmost material efficiency using finite element analysis and flow modeling techniques.

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Product design
Vehicle design
Interior & exterior design
Interface & interaction design

DESIGNED BY FRAUNHOFER
VEHICLE DESIGN

Vehicle design is a classic application that merits special mention for two reasons. For one, a great deal of industrial development effort is devoted to this pursuit. For the other, our culture traditionally attaches great emotional value to the look and feel of vehicles.

The designer's brief is to give shape to the vehicle's exterior, interior and brand affiliation, while factoring all the technical, aesthetic and ergonomic requirements into the design equation.

A distinction can be made between automotive design and transportation design. The former deals with cars and motorcycles destined mainly for private use; the latter with commercial, agricultural, construction and logistics vehicles for B2B customers and public means of transport, including rail cars.

Iconic designs that appeal to the emotions figure prominently in the automotive industry, where vehicles are supposed to express the automaker's brand values and persuade a prospect to buy.

Design is one of the biggest selling points; the customer's decision often hinges on the vehicle's look and feel. Well aware of their great responsibility, automakers bring designers on board the R&D process at the earliest opportunity.

Transportation design is very similar to the design of capital equipment. However, the lower production numbers and the vehicles' often unique technical specifications do present challenges.

1

Kids bikes crafted of alternative materials

RESOURCE EFFICIENCY IN BICYCLE MANUFACTURING

Fraunhofer Institute for Microstructure of Materials and Systems IMWS

Premise & objectives | Students majoring in industrial design are taught interdisciplinary skills, which includes designing and engineering with the appropriate materials to arrive at a sustainable product.

This design school semester project challenged students to reinvent the bicycle with an optimized look and mechanical design. This would be the subject of an investigation into a renewable materials suitable for a product that has to hold up to the rigors of heavy use.

Results & added value | Taking a multilateral approach, the workgroup pursued several solutions in parallel to arrive at a "rideable result". This proved to be a rich and rewarding learning experience for all participants. It yielded innovative materials and a compelling design.

Although this was a student project, the outcome has real business potential. All those involved are now aware of the challenges of radically reinterpreting a product and know what it will take to rise to this sort of occasion in the professional world.

1 *Lightweight, heavy duty – a bike that grows.*

2 *A bike frame made of sewn kraft paper.*

Kids bikes crafted of alternative materials

RESOURCE EFFICIENCY IN BICYCLE MANUFACTURING

Fraunhofer Institute for Microstructure of Materials and Systems IMWS

2

Design | Burg Giebichenstein University of Art and Design Halle; DLR Braunschweig

Specialty field | Product design

Development time | 3 months

Completion date | 2015

Partners | Burg Giebichenstein University of Art and Design Halle; Mifa Mitteldeutsche Fahrrad AG; DLR Standort Braunschweig (Jörg Nickel)

Projektform | Design school semester project at Burg Giebichenstein University of Art and Design Halle

Material & methods | Workshops first familiarized the students with various renewable fiber composites. They learned a great deal about the process chain for manufacturing semi-finished products, mechanical properties of components subject to climatic forces, and processing methods. This briefing prepared students for research they were to conduct into material systems and acquainted them with the industry along the process chain.

Expert consultants were brought in from time to time to hold presentations and clarify questions, with all sides benefiting from the knowledge gained.

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1

1 *The vehicle prototype, ready for action.*

2 *A muscle-powered electric drive.*

e_synergy

A LIGHT ELECTRIC VEHICLE (LEV) FOR DELIVERING CARGO IN METROPOLITAN AREAS

Fraunhofer Institute for Microstructure of Materials and Systems IMWS

Premise & objectives | This project's main objective was to develop a novel muscle-powered hybrid electric vehicle to provide last-mile delivery service. The driver compartment was to be a well-protected passive safety cell.

The overall system comprises an innovative battery unit with liquid temperature control at an optimum power-to-weight ratio, a natural fiber composite (NFC) in form of a semi-finished product for energy-efficient low-pressure processing, and a glass fiber-reinforced polymer (GFRP) suspension. This was to be a cargo carrier, but a platform that could also accommodate a passenger vehicle looked to be a good idea, so safety belts were also installed.

Results & added value | The designers drew on the experience of seasoned cargo service providers to build a very practical utility vehicle. The partners developed the materials with industrial applications in mind. This way, that could rapidly ramp up prototypes, transforming them into standard models suitable for industrial mass manufacturing.

Participants are sharing their insights into material development and component design, speaking at events catering to specialists in lightweight fiber composites and publishing technical papers. Members of the project's advisory board reviewed the overall result and found it to be viable proposition.

e_synergy

A LIGHT ELECTRIC VEHICLE (LEV) FOR DELIVERING CARGO IN METROPOLITAN AREAS

Fraunhofer Institute for Microstructure of Materials and Systems IMWS

Design | Sven Wüstenhagen

Specialty field | Vehicle design

Development time | 35 months

Completion date | 2017

Partners | IFC-Composite GmbH, Haldensleben; Olaf Lange Dreiradbau, Berlin

Funding | BMWi

Material & methods | A specification sheet set out the requirements for the semi-finished natural fiber product and the component properties. This provided the blueprint for developing the material, an effort that benefited from IFC Composite GmbH's support. As this effort was underway, the design of the sandwich structures and development of a low-pressure manufacturing process also made strides. The vehicle structure, based on a chassis developed by Olaf Lange Dreiradbau Berlin, was finalized to the point of optimizing components. A working prototype developed to demonstrate a new type of temperature control system for prismatic Li-ion cells was tested for function and safety by a subcontractor and installed in the vehicle prototype.

2

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1

1 *The AutoTram® high-tech demonstrator.*

2 *AutoTram® up close.*

AutoTram®

A TEST PLATFORM FOR DEVELOPING INTERMEDIATE VEHICLE TECHNOLOGIES

Fraunhofer Institute for Transportation and Infrastructure Systems IVI

Premise & objectives | Developed at Fraunhofer IVI in Dresden, the concept behind AutoTram® was born of an idea of engineering a high-tech demonstrator for emerging public transport technologies. A new breed of intermediate transport system, the AutoTram® pairs the benefits of a bus – maneuverability, simple infrastructure and moderate life cycle costs – with the high passenger capacity, comfort and ecofriendly drives of trams.

The aim was to offer municipal authorities, transportation companies and private operators an attractive, cost-effective alternative to the prevailing people-mover systems and conventional means of transport such as buses, trams and light rails.

Results & added value | The institute demonstrated its capabilities when it presented the AutoTram®, the product of a skill set encompassing various intermediate transport technologies. The first version of the vehicle dates back to 2005. This universal test platform provided the launch pad for many other developments at Fraunhofer IVI. Featuring a complex array of integrated components, the modular design lends itself to many other public transport applications. Based on the original concept, the AutoTram® Extra Grand was developed in a follow-up project. Able to accommodate more than 250 passengers in its 30+ meter chassis, this pilot vehicle has come to be known as the world's longest bus. It has attracted a great attention at home and abroad for innovative intermediate vehicle concepts.

AutoTram®

A TEST PLATFORM FOR DEVELOPING INTERMEDIATE VEHICLE TECHNOLOGIES

Fraunhofer Institute for Transportation and Infrastructure Systems IVI

Design | Sergio Stanisci (CWA Constructions SA/Corp); Fraunhofer IVI

Specialty field | Vehicle design

Development time | 9 months

Completion date | 2003

Partners | CWA Constructions SA/Corp.; Derap AG; Frey AG Stans

Funding | Fraunhofer IVI initial funding

Material & methods | The basic structure of the AutoTram® is that of a standard hybrid vehicle with a drive configured to accommodate various alternative energy storage systems. This technology marks a major stride on the path to a fully electric drive. A precision multi-axle steering system was developed to provide lane stability for this train-like bus. It has also been deployed in commercial vehicles. The AutoTram®'s modular structure was a top design priority. The vehicle can be operated in bidirectional mode and uncoupled for use as two identical vehicles. With its variable capacity and the maneuverability of a vehicle that is not tied to catenaries, it can satisfy the demands of many passenger transport applications.

2

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Product design
Vehicle design
Interior & exterior design
Interface & interaction design

DESIGNED BY FRAUNHOFER
INTERIOR & EXTERIOR DESIGN

Interior & exterior design is all about planning buildings, rooms and components with a holistic outlook. Alternative lifestyles, changing work practices and innovative technologies to boost energy efficiency, enable connectivity and the like pose unprecedented challenges. However, they also present fresh opportunities in interior and exterior design.

The boundaries between architecture and design are blurring at the crossroads of aesthetics and function, an intersection where the signs to ecological and economic sustainability often point in different directions.

Interior and exterior design deals with all levels of architectural design. The design brief may call for state-of-the-art structures that are ultra compact and modular for easy extensibility, for mobile or floating buildings, for imaginative interior living and working spaces, or for the develoment and integration of custom functional elements or furniture into the building's structure.

The planning and design of rooms and buildings goes hand in glove with the experience of the people who occupy and bring these spaces to life.

Well-being is, of course, essential. It depends on many factors. The general appearance, the choice of materials, the fittings and furnishing, the lighting and color scheme – all these variables influence the feel-good factor.

Today's design is all about pursuing innovative ideas that facilitate flexible use – one example being portable furniture – and championing sustainable materials and construction methods. That is unlikely to change tomorrow. Smart tech that makes life easier and more comfortable is also finding its way into our homes and habitats.

1

1 *Contract development for the Bombardier low-floor and high-floor Citytram.*

2 *FEM calculations for an aluminum section.*

Lightweight seating system

AN ULTRALIGHTWEIGHT VEHICLE INTERIOR FOR SEGMENTED TRAMS

Fraunhofer Institute for Transportation and Infrastructure Systems IVI

Premise & objectives | This project challenged Fraunhofer IVI to develop a concept for ultralightweight segmented trams with integrated structural design elements. In the course of this research venture, the partners also investigated how to optimize the structure of seats with lightweight design principles and reduce production effort and costs.

The goal was to reduce the seat's weight by 25 percent and the cost of a self-made seat to 20 percent below the price of a comparable benchmark seat. The seat shell would also have to meet a tangled web of statutory requirements for product function, safety and stability, and live up to great expectations for ergonomics, comfort, aesthetics and cost-effectiveness.

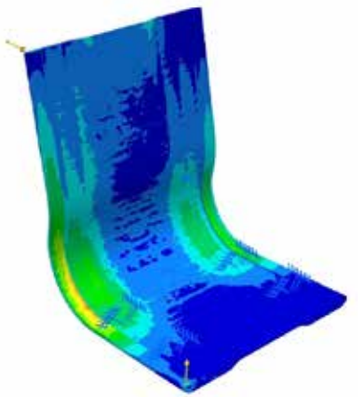
Results & added value | The design process culminated in five concepts that called for different manufacturing methods. A seat-back panel flanked by aluminum sections emerged as the preferred variant. The great advantages of this design are simplicity and savings. It consists of relatively few parts, so producing and assembling one of these seats costs around 15 percent less than buying a comparable aluminum seat.

The designers complied with the fire prevention code by opting for a non-combustible metal. The flat appearance of the design and the considerable savings potential of mass per individual seat were additional factors that contributed to its acceptance.

Lightweight seating system

AN ULTRALIGHTWEIGHT VEHICLE INTERIOR FOR SEGMENTED TRAMS

Fraunhofer Institute for Transportation and Infrastructure Systems IVI



2

Design | Ernst-Eckart Schulze; büro+staubach gmbh

Specialty field | Interior design

Development time | 30 months

Completion date | 2014

Partners | Bombardier Transportation, Bautzen; Fraunhofer IWU, Chemnitz; Fraunhofer IWS, Dresden

Funding | Sächsische Aufbaubank – Förderbank – SAB

Material & methods | The initial proposals emerged from an iterative process that had designers conceptualizing the product with design studies, analyzing its ergonomics, conducting FEM (finite element method) calculations and estimating manufacturing costs. The industry partner was very much a part of this process.

The team then assessed and compared steel, stainless steel, aluminum and magnesium's potential for fabricating seat structures before designing a product with manufacturing methods specific to the chosen metal in mind. Studies were sketched by hand and rendered as 3D models in CATIA to visualize proposals. FEM simulations also helped with the decision-making during the conceptual phase.

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1

1 *autartec® building, lake view.*

2 *Interior view of the autartec® house.*

autartec®

STRUCTURAL COMPONENTS FOR BUILDINGS AND SETTLEMENTS WITH LARGELY SELF-SUFFICIENT ELECTRICITY, HEAT AND WATER SUPPLIES

Fraunhofer Institute for Transportation and Infrastructure Systems IVI

Premise & objectives | The autartec® research project brought partners from southern Brandenburg and eastern Saxony on board to develop diverse technologies for self-sufficient settlements and floating buildings.

The project's brief was to further develop established processes for capturing solar power, generating heat and storing energy in distributed ways, as well as microfiltration and disinfection techniques so that all these systems could be integrated into the building's shell. The goal was to to find a way of installing these complex building services without encroaching on living space. The team built the individual autartec® components into a floating building – the autartec® house – that would serve as a test platform and public showcase for these technologies.

Results & added value | The partners drew on a broad set of skills in designing and building energy-efficient, highly functional products and floating houses to create a self-sufficient dwelling that supplies its own energy and provides an elegant space for people to live in style. With its futuristic look, renewable energy supply and built-in environmental technologies, the autartec® house stands as a symbol of a dawning new era.

This floating house could well be the seed from which new ways of living on water and land grow. Located on the lake Bergheide, a flooded former coal pit in the Lusatia region of eastern Germany, it also points the way to a brighter future for landscapes denuded by mining.

autartec®

STRUCTURAL COMPONENTS FOR BUILDINGS AND SETTLEMENTS WITH LARGELY SELF-SUFFICIENT ELECTRICITY, HEAT AND WATER SUPPLIES

Fraunhofer Institute for Transportation and Infrastructure Systems IVI

Design | Fraunhofer IVI; AIB GmbH; Wilde Metallbau GmbH

Specialty field | Interior & exterior design

Development time | 60 months

Completion date | 2019

Partners | Fraunhofer IKTS; AIB GmbH; AWAS GmbH Dresden; bendl HTS GmbH & Co. KG Sebnitz; Beratungsgesellschaft für Wirtschaftliches Bauen (BWB); Brandenburg University of Technology Cottbus-Senftenberg; GEDES e. V.; Heliatek GmbH; ifn Anwenderzentrum GmbH; INNIUS DÖ GmbH; Rupp Betonerzeugnisse GmbH; TU Dresden; TUDAG – Deutsches Zentrum Textilbeton; Wilde Metallbau GmbH

Funding | BMBF

Material & methods | The floating house embodies the autartec® concept of cultured living in an independent and self-sufficient abode. This use case is based on the energy and space requirements of a four-person household. A 175 m² pontoon serves as the platform for a two-story building with a wrap-around porch. The building's structure mirrors the three self-sufficient electricity, heat and water treatment plants in a triad of intersecting cubes with surfaces aligned to maximize the yield for each form of energy.

Efficient organic materials such as textile-reinforced concrete and wood pay tribute to the renatured surroundings and attest to the building's ecological and architectural independence.

2

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1

1 *Room for ideas – Fraunhofer IVI library.*

2 *On-site Internet research.*

A library for a new age

A PLACE FOR INSPIRATION – MORE ROOM FOR IDEAS

Fraunhofer Institute for Transportation and Infrastructure Systems IVI

Premise & objectives | As the digital transformation picked up momentum over the past few decades, it made deep inroads into every frontier of science and has changed the role of academic libraries. Researchers who once haunted reading rooms now often log into databases and e-book portals via the Internet. Readers who regularly pored over printed journals today keep up to date by clicking and swiping through e-journals and newsletters.

Modern libraries are no longer mere repositories for books and periodicals; they are hubs of knowledge and forums for exchange. This insight gave rise to the idea of revitalizing the Fraunhofer IVI and IIS/EAS library, which evolved over time, growing organically rather than by design.

Results & added value | Today, the institute library is no longer a temple of silence brimming with dark bookshelves. It has become something else altogether – a generously dimensioned, open space that extends an invitation for people to research, linger, collaborate and inspire one another. Catering to visitors and staff alike, it is a comfortable venue for study and communication and a fertile creative space where new ideas and stimulating discussions can flourish.

Additionally, it serves as a stylish setting for the main attraction – the actual books. It houses the extensive collections of both Fraunhofer Institutes.

A library for a new age

A PLACE FOR INSPIRATION – MORE ROOM FOR IDEAS

Fraunhofer Institute for Transportation and Infrastructure Systems IVI

2

Design | Elke Sähn, Architekturbüro Michaela Hoppe, Dresden

Specialty field | Interior design

Development time | 12 months

Completion date | 2014

Funding | In-house resources

Material & methods | A warm, welcoming atmosphere now suffuses a spacious, bright room once dominated by dusky shelves. Elegant upholstered furniture provides a relaxing retreat from researchers' often hectic working life. Sleek lamps and softly flowing curtains accentuate the urbane design. A filigree spiral staircase catches the eye and connects the lower level with the gallery. State-of-the-art presentation equipment and a workstation designated for research add a charming touch of utility.

In-built equipment in the shelves and strategically situated monitors, a photocopier, a CD archive and a wardrobe conjure a very tidy overall impression. The two librarians' workspaces, separated by a glass wall, harmonize well with the rest of the ensemble.

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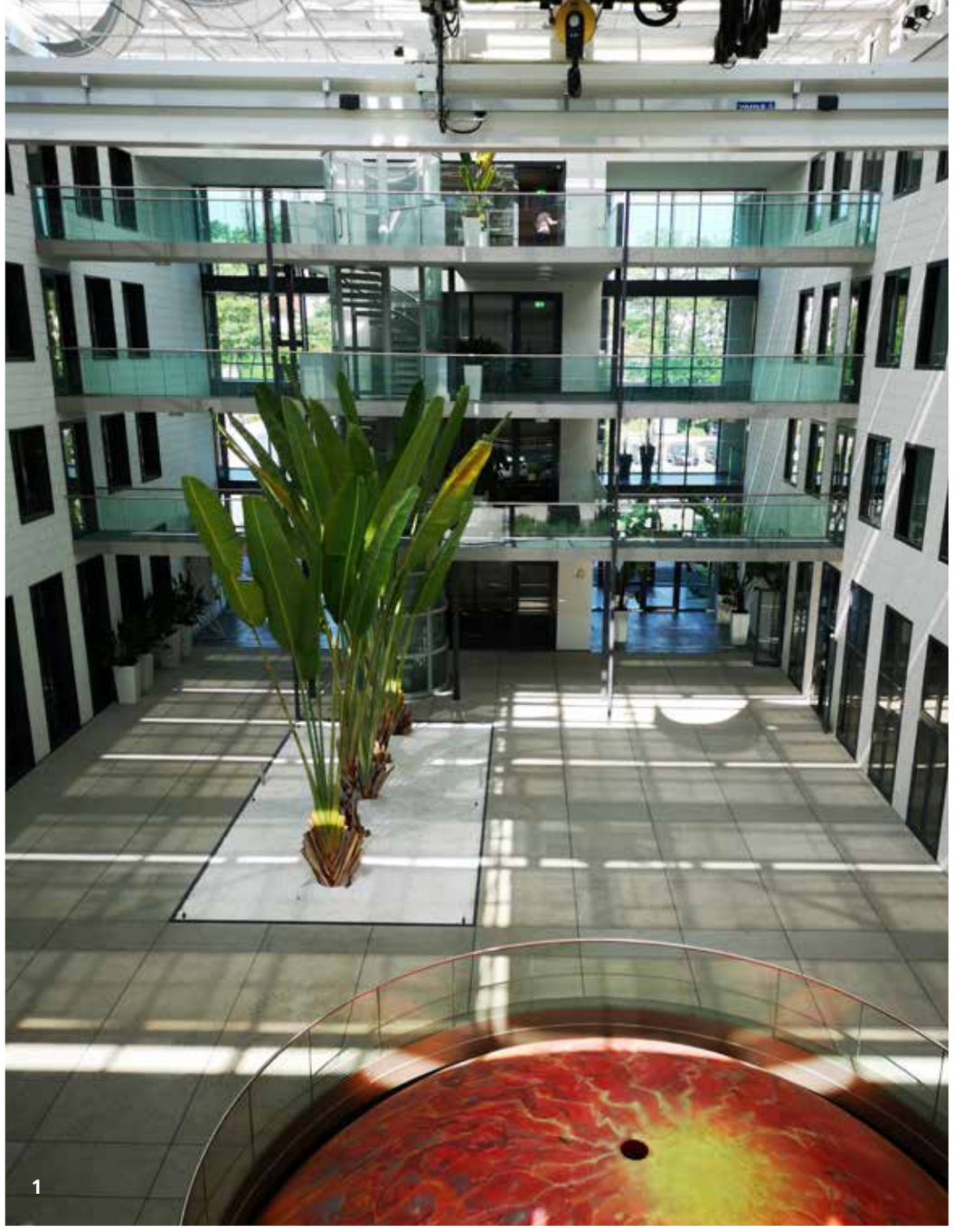

1

1 *RHODOS® in the ITWM atrium.*

2 *Play of light.*

Planning and designing workspaces

LAYING OUT RESEARCH FACILITIES WITH FUNCTIONAL AND AESTHETIC ASPECTS IN MIND

Fraunhofer Institute for Industrial Mathematics ITWM

Premise & objectives | Fraunhofer ITWM's mission is to meet challenging technological, economic and societal demands by applying state-of-the-art mathematical methods, pursuing innovative ideas to advance applied mathematics, and delivering results in a joint effort with industry partners.

It takes an innovative research design for the institute's staff to excel at this task – a collection of ideas and planning methods to create working environments that promote communication, collaboration and creativity to benefit research efforts. This project's brief was to design interior and exterior architecture with a transparent layout, open pathways and connecting spaces to support the institute's mission.

Results & added value | Architects and designers succeeded in joining beauty and utility in a sublime marriage of form and function. This building provides many glimpses of the shape of things to come. Its elegant, transparent architecture welcomes – perhaps even insists on – communication. This hub at the TU Kaiserslautern graces its host city with a setting that celebrates the joy of research, the fun of exploration. Staff clearly feels at home in these environs.

The eye-catching synchronized light installations in all atriums put the finishing touch on this impressive complex. Even passersby enjoy the light shows that draw their attention to the flamboyantly colorful outer shell of the recently installed RHODOS® driving simulator.

Planning and designing workspaces

LAYING OUT RESEARCH FACILITIES WITH FUNCTIONAL AND AESTHETIC ASPECTS IN MIND

Fraunhofer Institute for Industrial Mathematics ITWM

2

Design | H. Ermel, L. Horinek, L. Weber (ASPLAN); I. Bracke (Atelier Bracke)

Specialty field | Research design (Exterior, interior & audiovisual design)

Development time | 2004-2005, 2011-2014

Completion date | 2005, 2014

Partners | ASPLAN; Atelier Bracke

Funding | Fraunhofer; BMBF; Rhineland-Palatinate; European Regional Development Fund (EFRE)

Material & methods | Real models are giving way to virtual models. Mathematics is the stuff of which these models are made. It is math that emulates the real world on computers and provides the foundation for the bridge built to cross over to this other world of simulations. Many architectural features of the ITWM building are a nod to this metaphorical bridge. It is manifested in the wide yet delicate walkways that connect the building's blocks and sections. Conference rooms and cafeterias take up exalted positions much like the bridge of a ship. Even the spare staircase at the back of the building looks to be a mix of bridges and Escher's Penrose stairs. Three generously dimensioned four-story spiral staircases, interactively illuminated in the evening hours, are the vertical complement to these horizontal bridges.

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Product design
Vehicle design
Interior & exterior design
Interface & interaction design

DESIGNED BY FRAUNHOFER
INTERFACE & INTERACTION DESIGN

Interface and interaction design is all about conceptualizing and designing the touchpoints between humans and devices, machines and systems. It is part visual art, part engineering science.

Interaction design is more concerned with developing scenarios and concepts for the user experience. Interface design is more about engineering the actual interfaces. However, this distinction often blurs in the real world, where it is practically impossible to pinpoint where one discipline ends and the other begins.

Physical objects and processes are part of this, but the focus today is very much on the interaction with digital user interfaces. The sensory input and output by which information is conveyed can be visual, tactile or auditory.

The object is always the same regardless of type of sensory signal – for the user's interaction to trigger easily understood, timely feedback that result in the desired outcome. This requires an interface tailored to the target audience that intuitively provides excellent orientation and treats users to a safe, ergonomic experience on par with the users' abilities.

Interface and interaction designers often collaborate with computer scientists, cognitive researchers and psychologists or follow the latest developments in these fields to put new insights into practice.

1

SmartBEAT

SMARTPHONE-BASED REMOTE MONITORING FOR HEART FAILURE PATIENTS

Fraunhofer Center for Assistive Information and Communication Solutions AICOS

Premise & objectives | SmartBEAT is a smartphone-based kit that uses communication technologies and sensors to remotely monitor several clinical variables of heart failure (HF) patients. It monitors vital signs deemed essential by expert cardiologists such as physical activity levels, weight, blood pressure, heart rate and therapeutic compliance.

This data is processed, stored and later transmitted to caregivers so they can track changes in the patient's condition. An algorithm analyzes the readings taken by the devices and the condition reported by the patient to identify any decompensation.

Results & added value | This system was designed to assist patients with their routines for monitoring symptoms. A longitudinal pilot study conducted over three months tested SmartBEAT on a group of 54 HF patients. Clinicians remotely monitored its readings, contacting patients when the data prompted an intervention, for example, by indicating a failure to comply with the therapeutic regimen.

The compliance rate with SmartBEAT was 97 percent.

1 *Measuring blood pressure.*
2 *Readings, notifications and weight.*

SmartBEAT

SMARTPHONE-BASED REMOTE MONITORING FOR HEART FAILURE PATIENTS

Fraunhofer Center for Assistive Information and Communication Solutions AICOS

2

Design | Catarina Correia

Specialty field | Interface & interaction design

Development time | 48 months

Completion date | 2019

Partners | Centro Hospitalar São João; Verhaert – New Products & Services NV; Remedus BVBA; Seniornett Norge; LifeOn-Key Inc; Vigisense SA; KempenLIFE; Smart Homes – Nationaal Kenniscentrum voor Domotica & Slim Wonen

Funding | AAL JP (H2020 & Portuguese Foundation for Science and Technology)

Material & methods | The vital signs system (VSS) uses Bluetooth low energy (BLE) technology and sensors to monitor some of the aforementioned variables in HF patients. VSS records all physiological measurements necessary to monitor the status of these patients' health.

A survey of cardiologists, nurses and general practitioners indicated the following devices are needed to take these readings: scales, a blood pressure gauge, a pulse oximeter and a fitness bracelet. SmartBEAT's user prompting guides patients through the daily data collection routine using VSS, and helps them complete questionnaires and document the medications they take.

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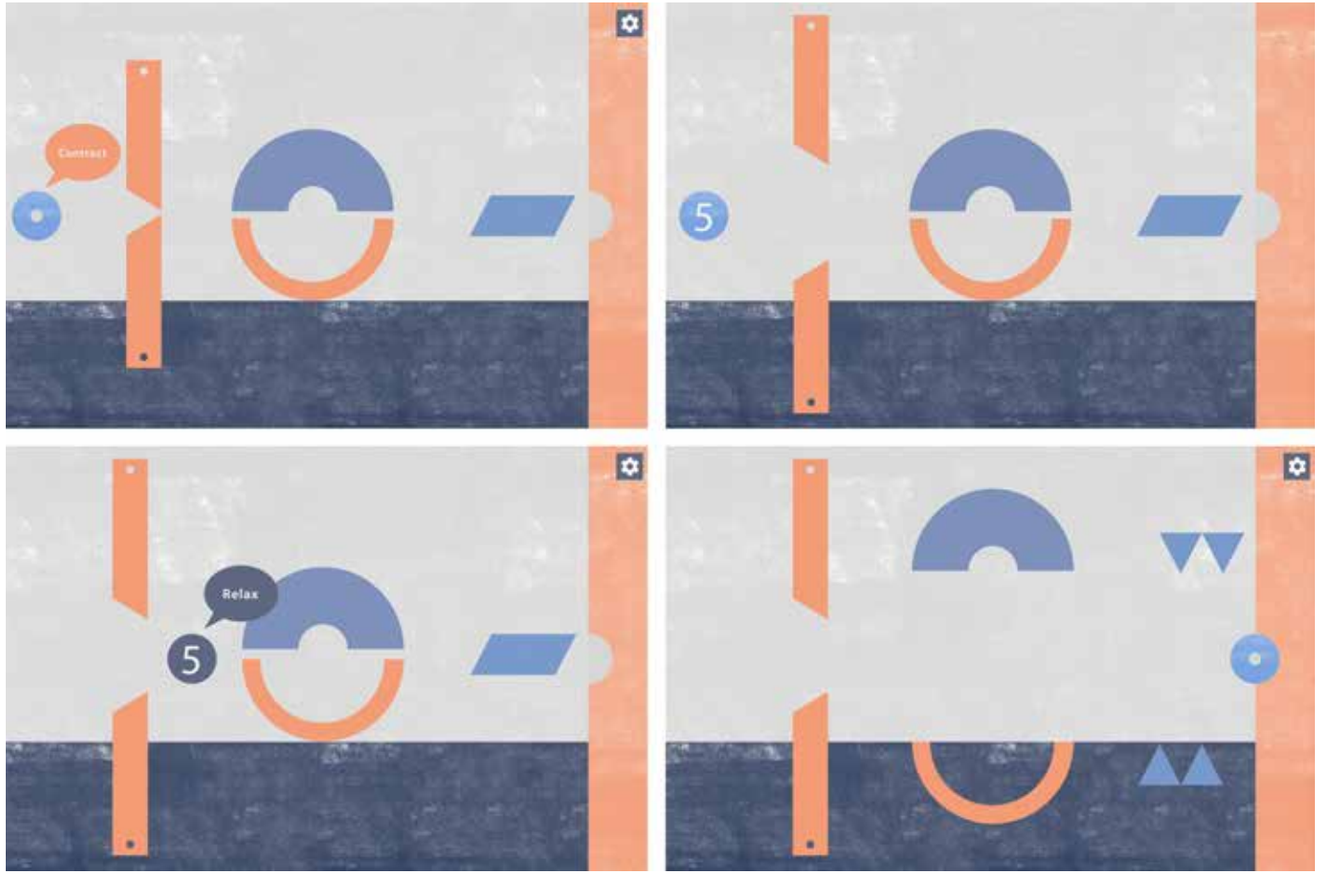
Physio@Home

INTERACTIVE APPLICATIONS FOR HOME USE TO AUGMENT PHYSIOTHERAPY

Fraunhofer Center for Assistive Information and Communication Solutions AICOS



1

1 *A whole new ball game – open the gates to let the circle pass.*

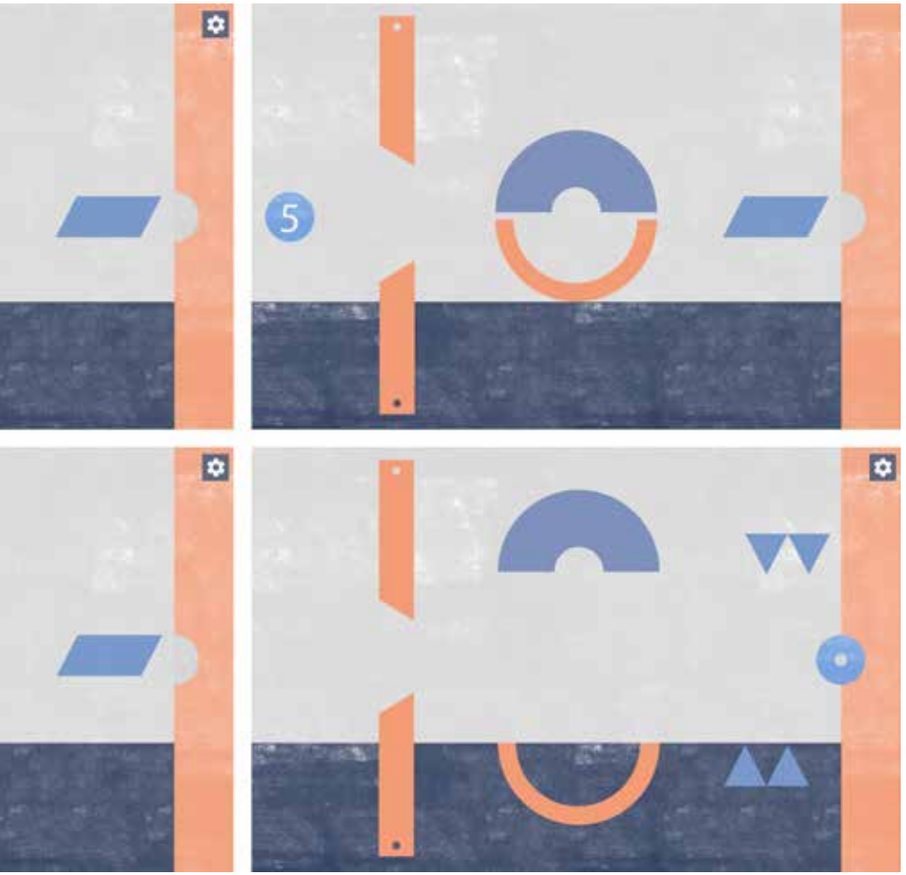
2 *Physio@Home in action.*

Premise & objectives | This project pursued the goal of developing a solution for use in the home to supplement the physiotherapy sessions in a medical practice or rehab clinic. Smartphones or tablets and wearables equipped with inertial and electromyography sensors (EMG) serve to monitor proper form and execution of exercises. These devices also furnish biofeedback to the user.

Physio@Home is modular, mobile, cost-effective and easy to use. Interactive games and biofeedback assist the patient with these exercises to encourage compliance with the therapeutic regimen.

Results & added value | The games developed in this project are modular by design and tailored to slot in perfectly with rehab programs of physiotherapists. Safe in the knowledge that these games adapt to the characteristics they have defined for the given patient, physiotherapists can use the underlying platform to determine the number of sets, repetitions, and muscle tension and release times – conveniently, without having to leave their practice.

The system forwards relevant data when a session ends for the therapist to monitor the patient's progress and, if necessary, adjust the exercise regimen.



Physio@Home

INTERACTIVE APPLICATIONS FOR HOME USE TO AUGMENT PHYSIOTHERAPY

Fraunhofer Center for Assistive Information and Communication Solutions AICOS

2

Design | Catarina Correia (Fraunhofer AICOS)

Specialty field | Interface & interaction design

Development time | 24 months

Completion date | 2019

Partners | Company Plux – Wireless Biosignals SA

Funding | PT2020

Material & methods | An EMG sensor connected to the end device via Bluetooth serves to control the games. Patients can move an object in the game and progress to the next level when the readings taken by the sensor exceed a threshold value set by the physiotherapist. In other words, they have to flex the muscle hard enough to achieve the targeted tension.

If the contraction falls short of the threshold value or the patient relaxes the muscle before it is achieved, the object will not move. This is a tensioning exercise, but other situations in the game require and encourage the user to relax the given muscle.

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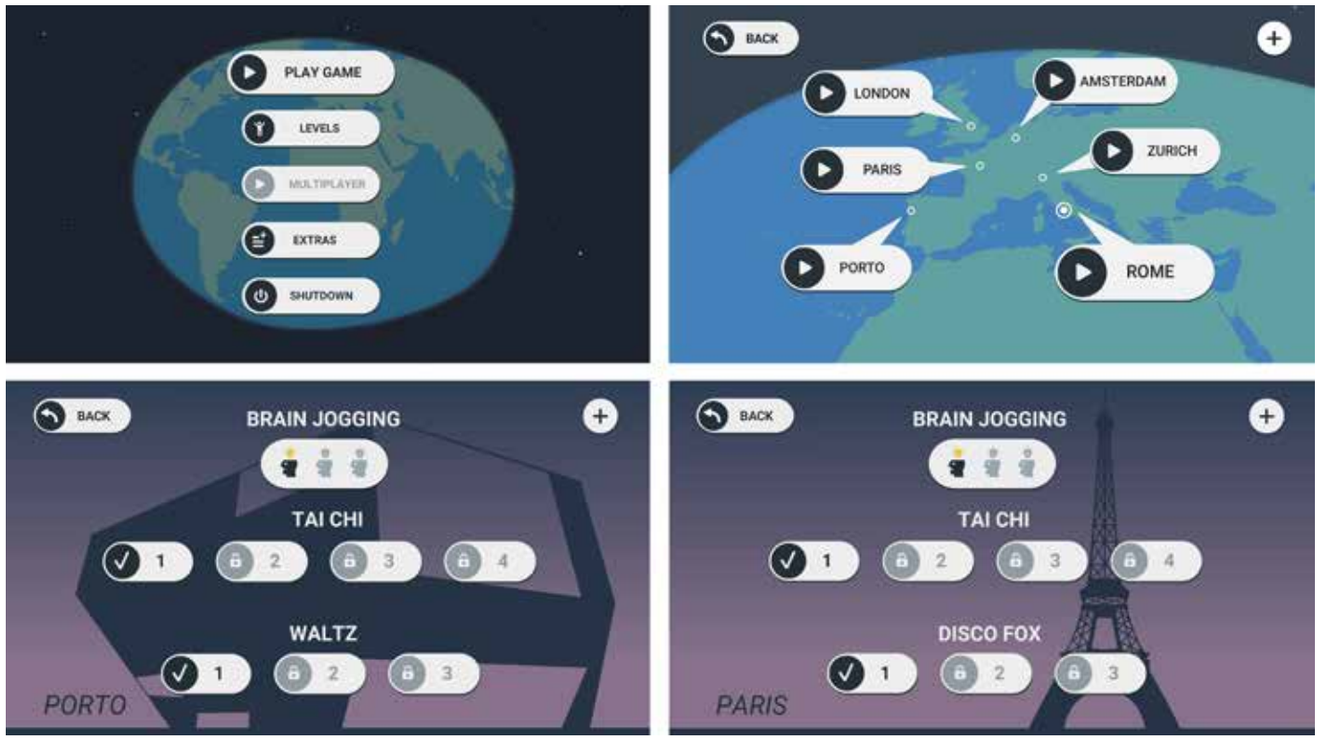
Active@Home

SOCIAL EXERGAMING, DANCE AND TAI CHI TO PROMOTE HEALTH AND PREVENT FALLS

Fraunhofer Center for Assistive Information and Communication Solutions AICOS



1

1 *Examples of the game's navigational UI.*

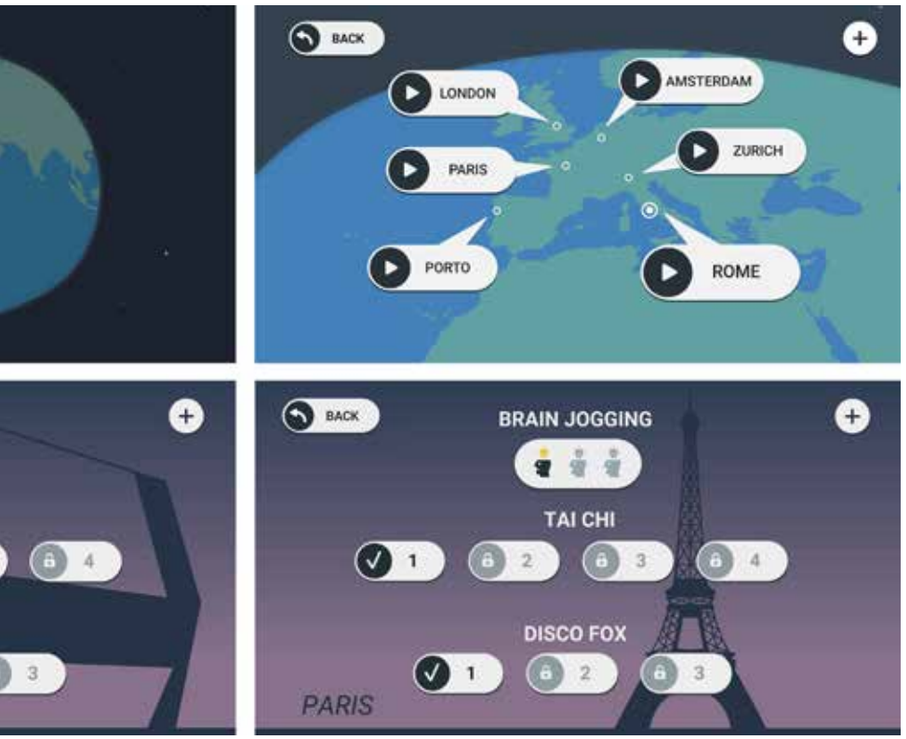
2 *A user interacting with a TV and portable sensors practicing tai chi.*

Premise & objectives | The solution encourages physical activity and promotes fall prevention through a home entertainment exergame system that incorporates Tai-Chi-based strength training, dance-based balance training and cognitive training explicitly targeted at attentional and executive functions for older adults.

Wearable motion sensors on wrists and ankles track the player's movements. The sensor on the right wrist also serves as a cursor for navigating the game. The system runs on an HDMI flash drive connected to the television.

Results & added value | The specifications for the user interface were all about simplicity and clarity. They called for easy-to-read text with an appropriate font and font size, readily recognizable shapes, the proper dimensions for display on a TV screen, straightforward instructions that would be simple to follow, and unequivocal visual and audio feedback on the exercises' performance.

Players had to come to terms with unfamiliar ways of interacting, but they gradually adapted and found the handling easier over time. Now that the overall system has been tested for user-friendliness, studies are to be conducted to learn more about the user experience.



Active@Home

SOCIAL EXERGAMING, DANCE AND TAI CHI TO PROMOTE HEALTH AND PREVENT FALLS

Fraunhofer Center for Assistive Information and Communication Solutions AICOS

2

Design | Elsa Oliveira, Ricardo Peixoto

Specialty field | Interface & interaction design

Development time | 36 months

Completion date | 2019

Partners | Unie van Katholieke Bonden van Ouderen KBO; Comfort Keepers Portugal – Conforto em Casa, Lda; Swiss Federal Institute of Technology Zurich ETH, Department of Health Sciences and Technology; MIRALab SARL; Dividat GmbH

Funding | Portuguese Foundation for Science and Technology

Material & methods | To enhance immersion and stimulate the player to move through several challenges, the solution proposes a background narrative: traveling the world through several cities. In each city, the player is able to perform a dance style, practice Tai Chi exercises, and play games to exercise their brain. Dance and Tai Chi exercises have a specific scenario and a friendly trainer character (3D avatar) that the player has to mimic. The quiz and brain-exercising games are played using steps in different directions to answer the prompts. The TV user interface has to be quite intuitive in order to visually explain a) the goal of each game, b) how the user can interact with the game, and c) which are the actionable elements in the interface. Likewise, the wearable device is easy to place and remove to prevent users from checking a user manual for placement.

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FallSensing

A TECHNICAL SOLUTION TO IDENTIFY FALL RISK FACTORS EARLY ON AND PREVENT FALLS

Fraunhofer Center for Assistive Information and Communication Solutions AICOS

1

1 *User interfaces from registration to navigation.*

2 *Users performing an exercise.*

Premise & objectives | This project aimed to develop a technical solution for the elderly to identify potential fall risk factors early on and prevent falls. The system includes response plans for interventions in various areas, including physiotherapy practices, in and around residences and retirement homes.

These efforts produced FallSensing games for use in nursing homes to promote group exercises that further the cause of fall prevention and encourage social interaction among residents. These include four brief games in which two alternating teams of up to three players each compete. The game is set in an Antarctic landscape; the characters are penguins.

Results & added value | The interface spells out the game's goal very clearly. Even so, it was found that some of the graphical elements, one being the characters that demonstrate exercises, would have to be larger. Players felt the game was entertaining; they especially liked the penguin characters. Some of the older users found the exertions required by the game to be too strenuous.

Observations indicate that extrinsic motivators such as caregivers play a key role in the gaming experience.

FallSensing

A TECHNICAL SOLUTION TO IDENTIFY FALL RISK FACTORS EARLY ON AND PREVENT FALLS

Fraunhofer Center for Assistive Information and Communication Solutions AICOS

Design | Elsa Oliveira

Specialty field | Interface & interaction design

Development time | 36 months

Completion date | 2018

Partners | Sensing Future Technologies, Lda; ESTeSC – Coimbra Health School

Funding | Portugal 2020; COMPETE 2020; ERDF-EU

Material & methods | The system has two types of users: players and the game administrator. Players wear one sensor each on their bodies, attached either to the thigh, ankle or back of a foot. It tracks the player's motions for the system to monitor and evaluate exercise form and animate the avatar. Penguins seemed a logical choice of character. Animated to perform the exercises, these delightful creatures up the fun factor for players.

Each game has its own rules and treats player to a different experience by varying the number of repetitions of a given movement. The game administrator, generally a caregiver at the senior citizens center, launches the system on a computer and picks the players for the teams.

2

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1

1 *GoLivePhone app and GoLiveClip.*

2 *Home screen and weekly activity.*

GoLivePhone

EMPOWERING LESS TECH-SAVVY SENIORS TO USE A SMARTPHONE INDEPENDENTLY

Fraunhofer Center for Assistive Information and Communication Solutions AICOS

Premise & objectives | The main premise of the project was to enable novice technology users, including older adults, to use an Android smartphone on their own. The default Android Launcher was replaced by an Android application that was specially designed to address seniors' goals and needs. It can be installed in any Android smartphone and it can be configured and personalized to fit each user's requirements. It aims to be a permanently available companion to support older adults in their daily activities and bring them closer to their relatives or caregivers, by including functions related to communication, emergency support, medication, activity monitoring, fall detection, navigation and symptom tracking through questionnaires.

Results & added value | The project started life as an internal initiative at Fraunhofer AICOS Portugal. Gociety, a business enterprise, later acquired the license to market this technology under the name of GoLivePhone. Researchers set out to gain a deeper understanding of aging to help meet older people's expectations for a fulfilled life. The GoLivePhone is the product of this quest. They brought senior citizens on board for future users to help design technology to meet their needs. The idea was to empower rather than patronize – to enable the elderly to live independently yet in safety and to manage their social, personal and health affairs on their own.

GoLivePhone

EMPOWERING LESS TECH-SAVVY SENIORS TO USE A SMARTPHONE INDEPENDENTLY

Fraunhofer Center for Assistive Information and Communication Solutions AICOS

2

Design | Catarina Correia

Specialty field | Interface & interaction design

Completion date | 2019

Partners | Gociety BV (client)

Material & methods | The GoLivePhone uses a Bluetooth link to interoperate seamlessly with the GoLiveClip, a wearable device that monitors movements and detects falls. This clip sends all its data to the GoLivePhone app, which can translate this information into notifications. For example, it can trigger a call for help in the event of a fall.

The researchers took a user-centric approach to developing this technology, applying participatory design methods and engaging in interactive value creation with older people. The team also pursued the lofty goal of designing an exceptionally user-friendly and readily accessible solution.

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1

HMI Design for Machine tools

INTERACTION DESIGN AND USER INTERFACE DESIGN FOR TOOLING MACHINES

Fraunhofer Institute for Industrial Engineering IAO

Premise & objectives | The design brief for this project was to develop an HMI (human-machine interface) to facilitate programming and control of machining processes.

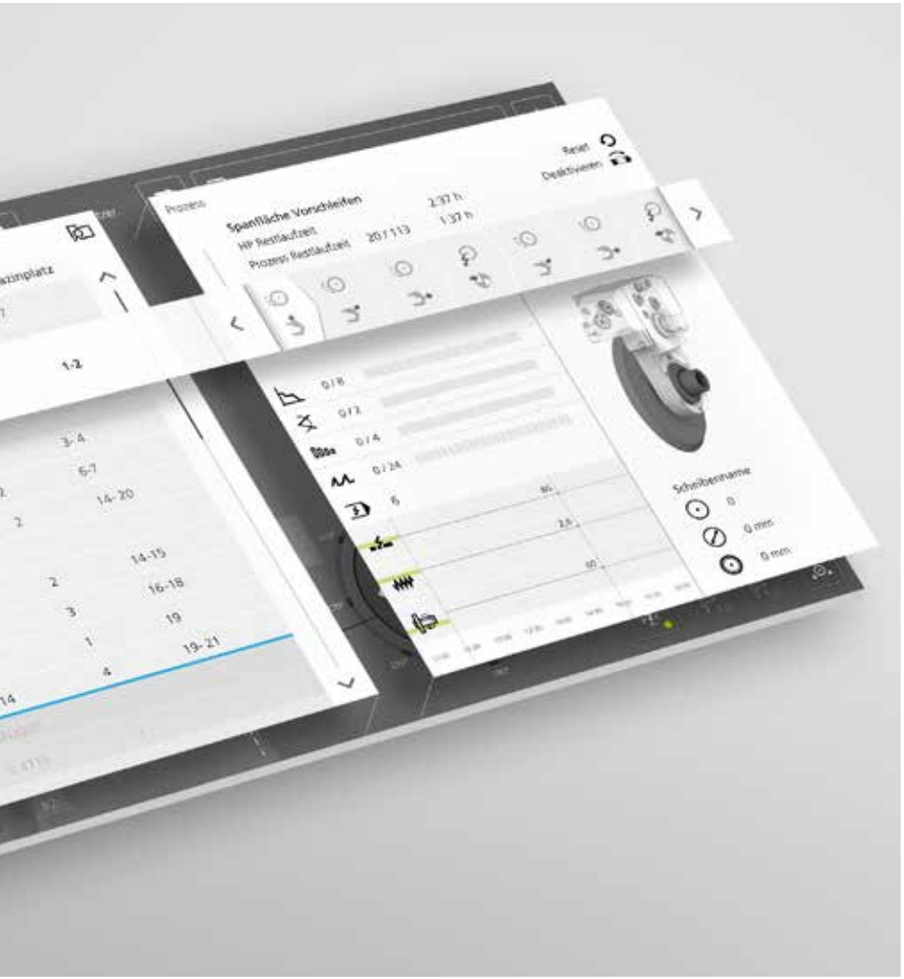
The HMI is to be used both on workstations for preparing work and directly on Vollmer machine operating panels; it has a visually appealing design but is also highly functional, thus making it very user-friendly to operate and manage.

Results & added value | This design journey arrived at its destination with an intuitive, clearly structured user interface featuring a custom set of icons. Subtle but sophisticated refinements of the visuals and handling put at operators' fingertips the power to make the machine serve the user's needs.

All HMI control features – the touchpad, mouse and remote control – are adaptive to provide precisely the support the user needs. The design is clear and simple enough for users to easily add functions and modify features.

1 *Intuitive HMI design to match the machine.*

2 *Simple, direct access to machine functions.*



HMI Design for Machine tools

INTERACTION DESIGN AND USER INTERFACE DESIGN FOR TOOLING MACHINES

Fraunhofer Institute for Industrial Engineering IAO

2

Design | David Blank

Specialty field | Interaction design

Development time | 12 months

Completion date | 2013

Partners | VOLLMER WERKE Maschinenfabrik GmbH (client)

Material & methods | The client had analyzed the situation and specified the user requirements, providing the touchstones for the future HMI's design.

The researchers referenced select use cases to develop the principles for interaction, to lay out the interface, and to design its visuals.

A style guide and many open design elements support the development of the HMI.

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1

1 *That's nonsense! Task cards.*

2 *What-would-you-do, hex situation cards.*

BG ETEM

MISSION: DEVELOP A SCIENCE-BASED TOOL TO ASSESS THE CULTURE OF PREVENTION

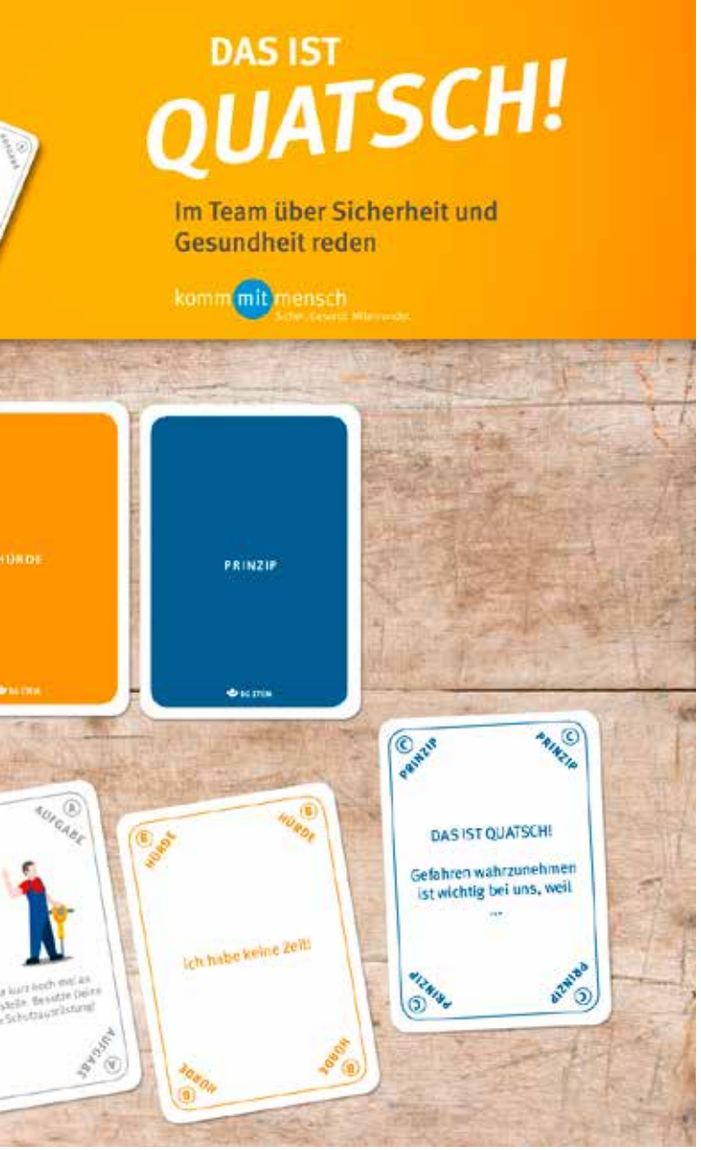
Fraunhofer Institute for Industrial Engineering IAO

Premise & objectives | Applied to occupational health and safety, Edgar Schein's theory of corporate culture implies that health-related behaviors have developed over time and employees have been socialized accordingly. If so, then what does a corporate culture of prevention mean to a company and how can it be fostered and nurtured?

Following on the heels of kommmitmensch, an awareness campaign promoted by the DGUV, the German social accident insurance association, this project set out to develop tools to support the member companies of the BG ETEM, an employer's liability insurance association. These tools were to help companies develop cultures of prevention in which employees live by the twinned values of safety and health.

Results & added value | The designers produced interactive tools to address specific target groups and raise employees' awareness of prevention. They also enable the workforce to reflect on their company's culture of prevention.

The researchers applied participatory design methods, bringing the companies and their workforces on board in the run-up to tool development in a bid to boost target group acceptance and adoption. Called "Das ist Quatsch!" [That's nonsense] and "PrinzipienFest" [a word that means principled, but is spelled to imply a celebration of principles], these two tools complement one another. Each supports the other's goals, and both are all the more effective for it.



BG ETEM

MISSION: DEVELOP A SCIENCE-BASED TOOL TO ASSESS THE CULTURE OF PREVENTION

Fraunhofer Institute for Industrial Engineering IAO

2

Design | Florian Paschke, Vivien Iffländer, Fabian Bitter

Specialty field | Interaction design

Development time | 12 months

Completion date | 2019

Funding | Berufsgenossenschaft Energie Textil Elektro Medienerzeugnisse BG ETEM, an employer's liability insurance association for the power, textiles, electrical and media product sectors

Material & methods | The developers applied a combination of socio-scientific tools and design methods: Qualitative surveys are known to be effective tools for mapping aspects of the corporate culture, so the researchers conducted 40 interviews at five medium-sized enterprises and analyzed the responses. They also held a specifications workshop for future tool users to pinpoint the requirements for the prospective tools. These users were apprised of the insights gained in the interviews, which were then put into practice with the help of creative design methods. A focus group discussion with stunt persons then served to mirror and enrich the results. An iterative process then translated the results of the survey into two tools.

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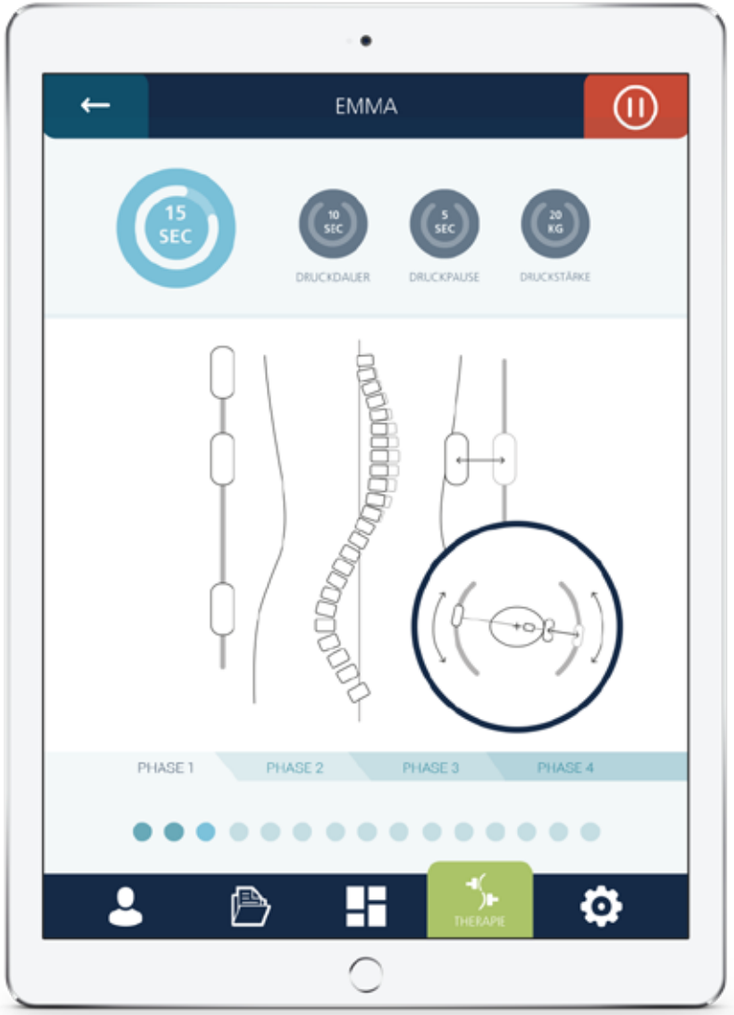

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KiTS 2.0

DIGITALLY ASSISTED THERAPY FOR ACTIVE POSTURE CORRECTION IN PATIENTS WITH IDIOPATHIC SCOLIOSIS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

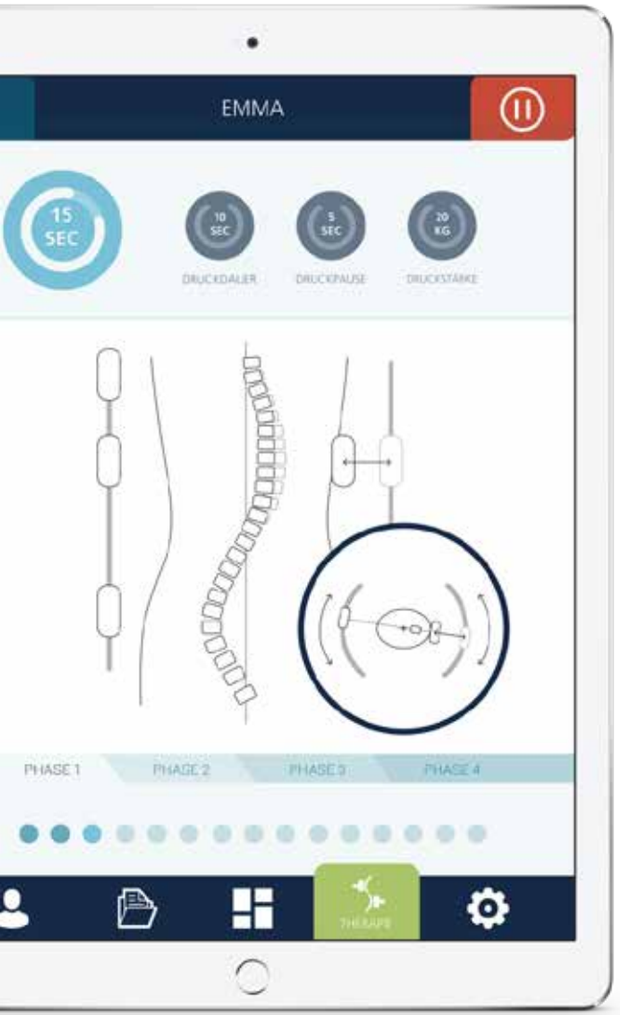
Premise & objectives | This research was launched to design an interactive concept and an interface to improve FED (fixation, elongation, derotation) therapies. The premise was that a digital assistant integrated into the existing therapeutic system would encourage patients to participate more actively in the FED regimen. This assistant could incorporate features to improve therapy results, for example, posture autocorrection that could promote the regression of idiopathic scoliosis.

Results & added value | This smart device consists of an ultrasound sensor to track the patients' body movements in the FED device, paired with a user interface.

At the core of the application is an ergonomic navigation system that provides easily understood instructions to guide the user through the therapy. The application not only brings greater transparency to the regimen, it does the same for the patient journey by enabling people to track the progress of their therapy. That is a first in this field. It also automatically documents captured data. That and the improved patient monitoring lightens the therapist's workload.

1 *FED device interface in action during therapy.*

2 *A game played during FED therapy.*



KiTS 2.0

DIGITALLY ASSISTED THERAPY FOR ACTIVE POSTURE CORRECTION IN PATIENTS WITH IDIOPATHIC SCOLIOSIS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

2

Design | Sophia Elsner

Specialty field | Interface & interaction design

Development time | 24 months

Completion date | 2018

Partners | TU Dresden; Uniklinik Jena; DIERS International GmbH; T&T medilogic GmbH; DIGALOG GmbH; KUPFER.ROT GbR; Scheinpflug Gesundheitsdienste; ORD GmbH; MRC Systems GmbH; Praxis für Physiotherapie Beatrice Wenzel-Paegelow; Centro de Rehabilitación y Medicina Física Sastre Roca S.L./ES; Rehabilitationsklinik Zgorzelec; Sana Kliniken Sommerfeld

Funding | BMWi

Material & methods | A survey of patients and therapists found that the human-machine interface and the therapy itself could be improved. The researchers felt a gamified approach would make it easier for the patient to engage in a more active and complex regimen. The application now features a game that challenges patients to control their posture by tracking and monitoring their movements in the FED device. The input from the ultrasonic sensors serves as the reference parameter.

Typical gaming mechanisms such as varying levels of difficulty and a points and reward system motivate the patient to play a more active part in the therapy and engage more dynamically in posture correction exercises.

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1

Smart Tools for Smart Design

EARLY INTEGRATION OF DESIGN TO DRIVE INNOVATIONS IN PRODUCTS AND MATERIALS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

Premise & objectives | Teams setting out to develop products with new distinguishing features based on smart materials could benefit from integrating design in the inception phase of the innovation cycle.

Smart materials are responsive – that is, they can react autonomously to environmental stimuli. This project tasked designers to outline visions of how smart materials could shape our day-to-day lives and explore these new possibilities.

Results & added value | These efforts culminated in a collection of tools that works with the designers' visual and verbal language and translates engineers' sophisticated technical know-how into tangible assets. The tools are intended to bring both sides closer together by bridging the divide between the two disciplines. This is about encouraging engineers to share the bounty of their knowledge and experience with designers, and vice versa.

The tool collection includes a material database designed for intuitive handling, material cards, use-case cards, descriptive function clips/videos and function demonstrators. These assets can help interested parties in science and industry better understand and intuitively use smart materials.

1 *Smart tools (function demonstrators, material cards and use-case cards).*

2 *An excerpt from the functions clip.*

Smart Tools for Smart Design

EARLY INTEGRATION OF DESIGN TO DRIVE INNOVATIONS IN PRODUCTS AND MATERIALS

Fraunhofer Institute for Machine Tools and Forming Technology IWU Dresden

2

Design | weißensee academy of art berlin

Specialty field | Product design

Development time | 18 months

Completion date | 2016

Partners | Fraunhofer IKTS; Fraunhofer IAP; weißensee academy of art berlin

Funding | BMBF

Material & methods | Engineers and designers pooled their expertise to define the relevant design parameters and create a database of piezoceramics, shape memory alloys and electroactive polymers for designers to draw on.

The Textile and Surface Design department adopted these tools and practices. It pursued further projects, holding workshops and conducting a series of trials to dig deeper with this research and spark a spirited dialog between researchers, material experts and design students.

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1

Digital Villages

DIGITAL SOLUTIONS FOR RURAL AREAS

Fraunhofer Institute for Experimental Software Engineering IESE

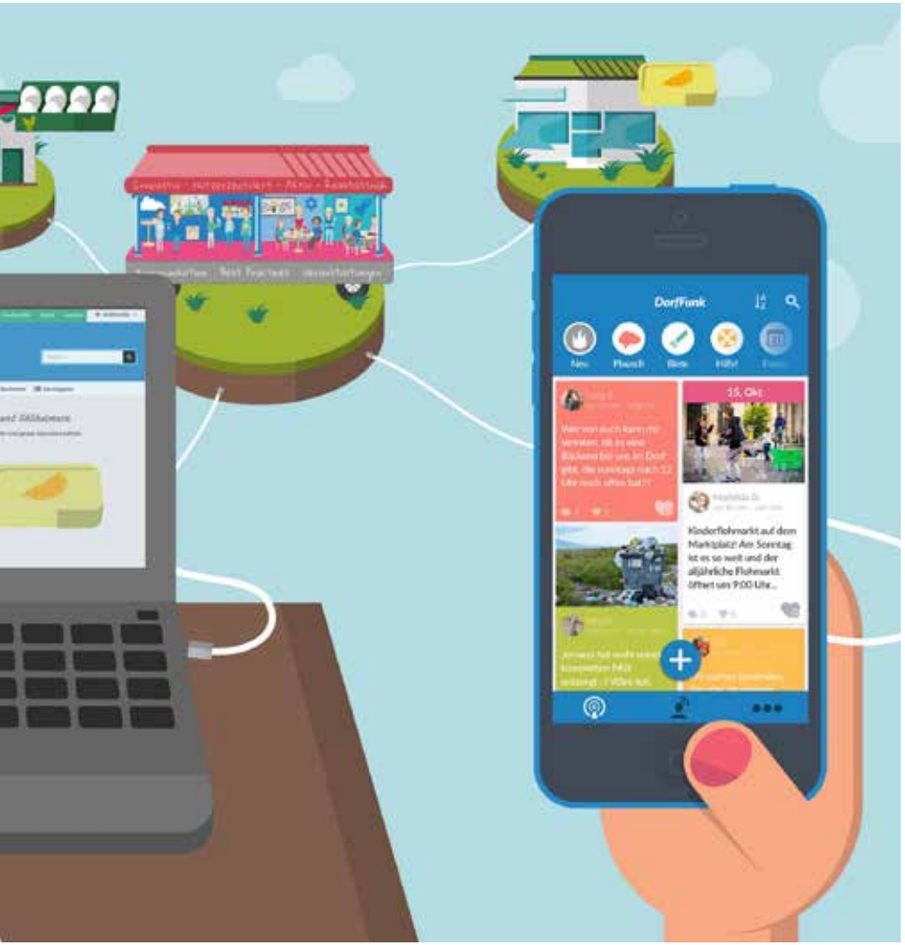
Premise & objectives | Yesteryear's rural population took it for granted that all the locals know and support one another. Every village had a general store; most people worked nearby. Today, public and private services are getting harder to come by in the country. Villagers are having to travel greater distances even for basic amenities, which is prompting many to move to big cities.

The Digital Villages project demonstrates how digital transformation can help tackle these challenges and give rural communities a new lease on life. It aimed to connect village life with the digital world and empower the populace to collectively support their region.

Results & added value | The solutions address various issues such as local amenities, communication and public services. Local vendors offer their goods in a collective online shop. Home delivery is part of the offer – a pickup notice goes to a neighbor's smartphone, who then drops the package off. The receiver can send a thank-you note via the DorfFunk [Village Grapevine] app that serves as the local communications hub. This is a forum for citizens to chat about village life, offer help or get in touch with the town hall. For example, if a citizen reports a pothole, the message goes straight to the clerk in charge of roadworks. All this is done via a common open platform that third parties may also access.

1 *The Digital Villages platform – a hub to connect diverse services.*

2 *Creating solutions as a collective in workshops.*



Digital Villages

DIGITAL SOLUTIONS FOR RURAL AREAS

Fraunhofer Institute for Experimental Software Engineering IESE

Design | Jill Tamanini, Christian Tamanini (Fraunhofer IESE)

Specialty field | Interface & interaction design

Development time | 54 months

Completion date | 2019

Partners | Rhineland-Palatinate Ministry of the Interior and for Sport; Entwicklungsagentur Rheinland-Pfalz; the associations of the municipalities of Betzdorf-Gebhardshain, Göllheim and Eisenberg

Funding | Rhineland-Palatinate Ministry of the Interior and for Sport

Material & methods | Nobody knows a village better than its residents. Hence the researchers opted for a user-centric design process, recruiting locals so they can help shape these services from the start. Requirements were identified on-site through surveys conducted at local events and residents taking part in a living lab. Villagers attended creative workshops, playing with ideas and putting the best to paper in a prototyping process that felt more like fun than work. Residents tested the resulting digital solutions at an early stage to cycle their feedback right back into the development effort.

2

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A CHAT WITH THE EXPERTS

The Fraunhofer Network "Science, Art and Design" set out to promoting interdisciplinary collaboration and investigating artistic practices to introduce fresh, new perspectives to research processes.

Some of the more than 20 member institutes are well-versed in design, an aspect that is integral to their work. They have recognized its power to create and add value to projects and product marketing. Others still have a way to go yet, but are beginning to see smart product and industrial design as the key to enduring success.

Institutes that lack these design skills or find that the rewards of acquiring these proficiencies do not justify the effort and costs are fortunate to be able to draw on the knowledge of other institutes and the expertise of outside partners. These are often universities and technical colleges with many years' experience teaching design methods. Their researchers have applied and refined these practices in real-world projects.

The design experts interviewed here were quick to stress how important creative and design skills are to standing up to competitors and standing out from the crowd on the market. And they see companies showing a keener interest in putting design methods to work to benefit their business.

This topic is a focal point of activities at Fraunhofer IAO in Berlin. In the following interview, the head of the competence team for Design-based Strategies talks about the role of design research for society, industry and Fraunhofer, and shares her views on collaboration with universities and colleges.

Of course, the Network's stakeholders are also interested in learning how others see the situation. That question was also explored in chats with representatives of design programs at institutes of higher education in Dresden. They had a lot to say about how design processes have changed over time, what design schools mean to society and the economy, and how these university programs can be combined with research, for example, at Fraunhofer.

Dr. Marie Lena Heidingsfelder heads up the competence team for Design-based Strategies at the Fraunhofer Center for Responsible Research and Innovation. Her projects focus on developing new formats for participatory research and innovation processes, and on design-based methods for transformational processes. A media and communication scientist, she studied at Weimar, Lyon and Berlin, earning a doctorate in design fiction and science communication from the latter city's University of the Arts.

INTERVIEW

"DESIGN CAN BE A TRANSLATOR BETWEEN DIFFERENT SYSTEMS."

A chat with Dr. Marie Lena Heidingsfelder, head of the Design-based Strategies team at the Fraunhofer Institute for Industrial Engineering IAO

Dr. Heidingsfelder, can you briefly explain to us what design research is all about?
Design research or design science is a comparatively new discipline that encompasses a wide range of different research approaches to reflexively explore design theories, techniques and methods alongside actual design practices. The researchers in this field borrow research problems and methods from other sciences such as ethnology, empirical social science and innovation research to develop approaches and methods of their own. But this is not just about researching the nature of design; it is also about generating new knowledge through design – that is, research through design.

What role does design research play today and what role will it play tomorrow for society, businesses and, ultimately, for Fraunhofer?
Design thinking, especially, is a buzzword that has sparked great interest in design approaches and methods on the part of business, science, society and government. Although design thinking is a matter of some controversy even among design researchers, today is still a great time for all those who see and tap the potential of design processes and methods. In fact, exploiting the potential of design for social, business and political processes has never been so easy. There are many promising touchpoints for design research at the Fraunhofer-Gesellschaft. This applies to concrete projects to develop technologies for people. For example, interaction design or participatory design methods can be used to bring these people on board at an early stage. It also applies to the ways in which research findings are conveyed to the public. Visual communication methods, design prototypes or even narratives can serve this purpose. And it applies to the success of efforts to design interdisciplinary or multi-stakeholder processes.

How important is design to research and why is it important?
Researchers – particularly at Fraunhofer – can use design methods to do inclusive things like incorporating different perspectives and co-creating by collaborating with other disciplines, customers or users. What's more, design also works as a translator between disciplines or different systems such as business, science, government and society.

It helps people see and discuss research results and potential development paths. It can serve to turn research into something tangible such as prototypes or narrative visions of the future, and generate knowledge using processes and methods. And iterative, fault-tolerant design methods can inspire new ideas for procedures and processes.

As the head of the Design-based Strategies team, you see design-based methods and strategies as the key to innovation. Your team members bring to the table skills in various creative disciplines.

What skills do you think a person in the design field needs to have to work successfully in the research field?
First, let me point out that my team is very diverse in its educational backgrounds and skills. It includes colleagues trained in interaction design, visual communication, product design and creative direction, as well as a dramaturge and a copywriter. The backgrounds don't fit into a cookie-cutter profile, as it is precisely this diversity that benefits us so greatly. Aside from a good education in their chosen fields, what they all need is an open mind for interdisciplinary collaboration. They have to enjoy developing new processes and methods, and be keen to constantly expand and reflect their knowledge – academically, as well. Then there are challenges associated specifically with Fraunhofer. You have to be able to handle the mix of project work, acquisition and science, get your mind around new topics, and work within varying time frames. I believe this all about the combination of a good education, self-reflection, open-mindedness, the joy of broadening horizons, having fun in interdisciplinary collaboration, and Fraunhofer competence. And humor is always good when people with different backgrounds work together.

"It's important to think in terms of alternatives and to see the future as a shapeable space of possibilities."

What advantages or opportunities do you see in employing people from the design sector at Fraunhofer? Where are the drawbacks?
I see nothing but advantages. As I said before, there is great potential at the boundaries between disciplines. Two things are important, though: For one, the job has to be on equal footing. Designers should not be hired merely as translators or beautifiers. They have to be involved in the various steps of the project from inception to the application or offer. Only then can interdisciplinary collaboration truly succeed. For the other, friction is likely when different disciplines collide with their different time horizons, approaches, methods, processes and, in some cases, values. This teamwork requires good mediators – bridge-builders working from both sides – and it takes time.

Which design principles do you find indispensable these days?
I believe it's important to think in terms of alternatives and to see the future as a shapeable space of possibilities.

The Shaping Future research project funded by the German Federal Ministry of Education and Research (BMBF) shared the same objective as your dissertation – to develop and test methods for the participatory design of research agendas. This project was pursued at Fraunhofer IAO and the methods developed in close collaboration with the Berlin University of the Arts. What role did UdK students play in this collaboration?
Several students worked as research assistants in our department and on the project. They helped wherever help was needed, creating and assessing workshops, developing infrastructure for the exhibition, writing up results.

How would you promote collaboration with colleges and universities? Does this require further action? What should these measures look like?
What proved very successful in our case was to formalize the relationship via jobs for research assistants. Joint project applications would also be a possibility, and a good one at that. The bottom line is that goodwill alone is not enough to sustain long-term collaboration. It also requires support in the form of time and resources.

The scientific work is the most important tool for research. In this respect, what role should the teaching of these skills play beyond what is taught now in university programs?
I'd like to see more offers along these lines in design programs. Not everyone has to learn how to write academic papers – and let's not forget the reading. But even basic knowledge would be beneficial, and those interested should be able to deepen it. It's not that I would want to prevent anyone from becoming "just a practitioner." But the path to the theory should not be a rocky road less taken. I had a research stay at the TU Delft while working on my dissertation. There's a lot to be learned from their blend of theoretical foundation and great practical projects.

Prof. Jens Krzywinski has been head of the Chair of Industrial Design Engineering at the Institute of Machine Elements and Machine Design of TU Dresden since 2012. Combining the teachings of general mechanical engineering and industrial design, this program covers design basics such as graphics and sculpture as well as methods-based product design. Jens Krzywinski studied engineering design at the TU Dresden and completed an exchange student program at the Design Burg Giebichenstein University of Art and Design Halle and at the Friedrich Schiller University Jena. During his time as a research fellow at the TU Dresden, he investigated design processes as well as transfer via design, successfully completing his dissertation project on transportation design in 2011.

INTERVIEW

"DESIGNERS NEED THE COURAGE TO GRAPPLE WITH AN IDEA EVEN IN UNCERTAIN SPACES."

A conversation with Prof. Jens Krzywinski, professor for Industrial Design Engineering at the Institute of Machine Elements and Machine Design of the TU Dresden

The TU Dresden was one of the first universities in Germany to teach design. How have design processes in general and how has teaching developed over time?
A great deal has happened over the past fifty years. There is a lot more content of relevance to the design process and greater dependency between disciplines. The design process itself has changed in this respect, and there are many more people involved. Everything has become faster and more agile; there are far more methods. Of course, the teaching has changed accordingly. There is still room for some fundamentals, but we are much more disposed towards projects and place significantly greater emphasis on interactive, interdisciplinary formats than was the case fifty years ago.

Which design principles do you find indispensable these days?
There are quite a few. Dieter Rams' ten principles for good design are general enough to still apply. According to those rules, good design is as functional as it is human-centered and aesthetic. I believe that holds true to this day. If we look at the three facets of sustainability – social, economic and ecological – it too still applies to design. This gives us two paradigms that are extensive enough for a framework to emerge. There is a third point we can add to that – the transition from the actual product to the experience of how it is used. The importance of designing a good user experience has certainly increased.

What kind of potential for development does the Chair of Industrial Design Engineering have for the future and what challenges is it facing?
It has great potential for development because the truly exciting issues to explore are increasingly to be found between the disciplines. Design brings a lot of helpful things to the table here. It will take a great deal of mediation effort to encourage acceptance of new technologies. Design can contribute significantly to that end.
As to the challenges, I believe there are two: For one, design has to show a real interest in related disciplines and come to an agreement, and we have get out of that artsy corner we have been painted into. For the other, the standard by which design will eventually have to be measured is its impact on societal transformation and its power as a positive force for change.

Your chair is in the Mechanical Engineering department. What goal are you pursuing with your teaching and what sets your program apart from an independent design program, perhaps for product design?
For one, we want to create a strong connection to design engineering and product development. This is important because we need to pick up students where they are now, and it's necessary because technology is growing more and more complex. The second goal is to embrace user-centric product development: What do users want? How are they expressing their wishes? How can I see what they want if they can't tell me exactly what it is? We also want a very fast, quite agile way of working when creating potential solutions, always bearing in mind there is not just one good solution. In the best case, a larger team will choose or jointly develop the best option from a variety of good solutions. What distinguishes our curriculum apart from that of other design programs is its extensive coverage of mathematical and scientific fundamentals and the deeper immersion in machine design. In terms of content, I also believe our program overlaps even more with the actual project work. Without exception, I draw on at least the basics of machine design in every subject. What also sets us apart is the fact that we can afford the luxury of seven design projects in our degree course – all for a specific interested stakeholder, researcher, start-up or developer – and that we pursue these projects jointly with this partner.

What are the benefits of being affiliated with an engineering faculty and where are the boundaries of machine design?
One of the great benefits is that whenever you start pushing at the limits of your own skills, you can always find someone with a complementary skill set to fill the gap. There is great demand and appreciation from other disciplines who say, "You can do things in terms of both content and methodology that we can't, at least not to that extent." As far as boundaries go, at the moment I see a clear limitation in that it's impossible for us to accept design students with an interest in engineering. We also come up short on socially provocative super-conceptual or visionary designs. The curriculum's chosen orientation just doesn't leave enough room for that.

How can design help visualize the results of research and development efforts in other disciplines?
I think it helps in many ways by conveying things in a different way than scientists usually do. This could be the visualization of an object that can be grasped by people who do not have a background in science. It could be a scenario that transforms abstract research into a product and use case. Or it could be an animation that puts the facts of the situation and the technologies together so people understand the bigger picture. But the most exciting thing for us is working together on boundary objects – these can be objects, demonstrators and prototypes occupying for example the space between disciplines – and discussing and developing them further in a joint effort. Iteration is a continuing process that starts with, "Here's my proposal." You turn that into a prototype and then to go on to ask, "Any suggestions for improvement?" That's the cue for the next prototype. This sort of free-spirited agility has been the go-to approach in design for a hundred years now. It can also serve the research of many other disciplines well.

What are the benefits of design research?
For many years, we've been working with the best practices that have been shown to deliver good results. Very few of these methods have been properly assessed. Design research can help with that. We're pretty good at taking things from other disciplines and continuing to work on them, but we're often not quite sure about the details of what is actually happening in a given application. The user experience is a hot topic, but I still get the impression that very few people know what exactly this means. We often apply user experience tools or elements from the consumer sector to explain a B2B application. This often falls far short of the mark because the players and contexts are very different in these two situations. Design research can also help clear that up.

"The standard by which we will be measured is our impact on societal transformation."

Is there such a thing as "design literacy" – that is, can design even be taught and what role does talent play in this?
That's the big question – and a tough one to answer. My doctoral advisor always said, "You have to be curious," and "You have to learn to love uncertainty." There's a lot of truth in both statements. For me, design literacy has a lot to do with observation, with seeing and perceiving. This seeing and perceiving requires some training, so the basic interest is necessary. It is important to take an interest in things and people to learn what they're all about. The second part – and I don't know if this can be called talent – is to approach things that are not fixed with a free and easy attitude. Whenever I say, "That could well be," I have to have the courage to let those words stand as a hypothesis as I grapple with it, perhaps only to find out that I may be wrong after all. Design is not going to work without the awareness of being in an uncertain space and the willingness to continue working despite this uncertainty.

As far as I'm concerned, the creative, aesthetic impression – that is, the question of will I find a suitable look for a product and its use case – is only the third or fourth most important concern.

You rely heavily on collaboration with partners in industry and science. What are the advantages of these projects?
These ventures are far more motivating for students. It really is a big deal if I know that my project is being supported and has been commissioned by someone who is actually planning to do something with it. This also ensures that what students are learning is in demand and has been proven. We have an outstanding success rate for a design school. Although we have relatively few students, each finds a job in the design field of their choice within a very short time – some even before they earn their degree.

How would you combine a design program with research, for example, at a Fraunhofer Institute?
We have done very different things for many of the Fraunhofer Institutes in Dresden, so this combination already exists. It usually starts with a project within the framework of a research paper. The next step is to create concepts or concrete product designs. We have prepared drafts outlining three examples of a technology's application to create an awareness of the possibilities and describe the leeway and latitudes within the given boundaries. By the same token, we have also designed prototypes in student projects that were fully functional, such as the data glasses for the Fraunhofer FEP. We are working with Fraunhofer IVI on the future of agricultural machine engineering in a project called Feldschwarm. These are just two recent examples, and we are looking forward to more exciting projects and challenges in collaboration with Fraunhofer institutes.

Prof. Diana Simon has been Professor of Communication Design at the HTW Dresden – University of Applied Sciences since 2014. Her teaching focuses on user-centered communication design in the context of digital product innovation. Diana Simon studied Design at the Anhalt University of Applied Sciences in Dessau, and Electronic Business at the Berlin University of the Arts (UdK). After setting up the Interface Design department at Deutsche Welle in Berlin and serving as its creative lead for ten years, she has been responsible for the brand experience at Lofelt, a Berlin-based tech start-up, since 2015.

INTERVIEW

"THE NEED TO INVOLVE DESIGN AND DESIGNERS AT AN EARLY STAGE IS ALREADY UNDERSTOOD."

A chat with Prof. Diana Simon, Professor of Communication Design and Dean of the Faculty of Design at the HTW Dresden – University of Applied Sciences.

Education is not just the acquisition of knowledge. Developing students' individuality, personality and talents also plays a major role. How would you define design literacy?
Design is a flexible and evolving process often inspired by doing as well as a creative approach with the material. It can be a series of progressive, interdependent steps in which the result is achieved – sometimes advancing carefully and sometimes in associative leaps of sudden inspiration. From my point of view, this makes design education very special. This goes beyond factual knowledge; it is about implicit knowledge related to the process of designing. Talent is definitely an important part. Design has to be taught as a creative practice that includes working in teams and with requests from different stakeholders. These skills are an important part of today's job descriptions. In my teaching practice, I don't convey final design solutions; I encourage a mindset that enables students to grow by setting goals for themselves and finding their own ideas that may extend beyond my input.

What role does design education play today for society as well as for business?
Designers' skills are becoming increasingly important in an economic system geared toward innovation. In my experience, designers have the skills and methods to trigger and accompany development processes in the long run, from the first sketch to the release of an innovative product. Nowadays, designers should position themselves within this complex field and know whom they are collaborating with in each area. Therefore, an education in design should enable people to develop creative solutions at the intersection of technological possibilities and societal value, in part using artistic means. This requires both empathy and a holistic way of thinking beyond the boundaries of one's own discipline. Essential skills include the ability and the willingness to perceive, understand, translate and process the requests of a wide variety of people.

What does the Faculty of Design aim to accomplish with its curriculum?
Our aim is to educate creative, critically thinking designers who are familiar with both the cultural and technological factors as well as the impact of design. We educate designers so they can work in applied contexts and in interdisciplinary teams. This program empowers our students to develop concepts and solutions of

their own and, once they complete their studies, to navigate and assert themselves confidently in an extremely dynamic field. We give them a compass to guide them on their path – social values, critical thinking and specialized knowledge of fundamental, design principles and methods.

Which principles do you find essential these days?
Design is ubiquitous in day-to-day consumerism as well as in the long-term strategies of powerful global corporations. This is why the idea of grappling with the social implications of one's actions as a designer is such an important principle for me. Design is to some extent inherently political. As a future-oriented discipline, it is about what should be done, and this is something that has to be negotiated among the various stakeholders. Even if the ethical issues in product and communication design are not the same, it is the nature of designers to make countless decisions for future users of their products. This is why designers should deal with this responsibility in a transparent way and an eye to future consequences.

The Faculty of Design at the HTW Dresden has been collaborating with organizations of various sizes for many years now, including Fraunhofer institutes in Stuttgart, Dresden and Berlin.
We are committed to the idea of a practice-oriented program. With that in mind, we collaborate with external partners, usually research institutions and companies, in different formats. The prerequisite is that the partner on the practical end has a real need for design. These collaborations are always project-based and temporary contracts. The terms for the usage of results must be specified within a partnership agreement.

"Design is to some extent inherently political. As a future-oriented discipline, it is about what should be done, and this is something that has to be negotiated among the various stakeholders."

How is the teaching at the Faculty of Design structured and what role does collaboration with partners play in this?
Most of the program consists of project-based design modules to explore and experiment with design methods, materials and aesthetic strategies based on real-world design needs. Particularly students in the advanced semesters work closely with companies and scientific institutes in applied research projects, further developing their findings with the help of design. Beyond that, we also offer seminars on theory where students learn how to work with scientific sources and humanities research to reflect on their own design practice.

Which design methodology do you apply and teach?
We see design methods as a continuously developing plurality of techniques and practices that generate ideas, forms, solutions and concepts.

Prototyping is done at an early stage and in iterative loops to test designs for their viability and impact with the relevant stakeholders taking part. The methods used in each case depends on the context, the designer's specialization and individual profile. With this understanding of methods, we position ourselves in the field of application-oriented design to distinguish our approach from a more theoretical approach of design processes and the purely methodological concept of design thinking.

Certain circles still harbor biases towards designers. Some question their usefulness. Have you been in situations where design is met with skepticism?
My personal experience is different, but I believe this may still be the perception in some lines of business. However, this is currently undergoing change. The need to involve design and designers at an early stage and to make them an integral part of the product development process is already understood. This is now common practice in most organizations and we live by that rule in our Berlin-based tech start-up, Lofelt.

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EDITORIAL NOTES

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