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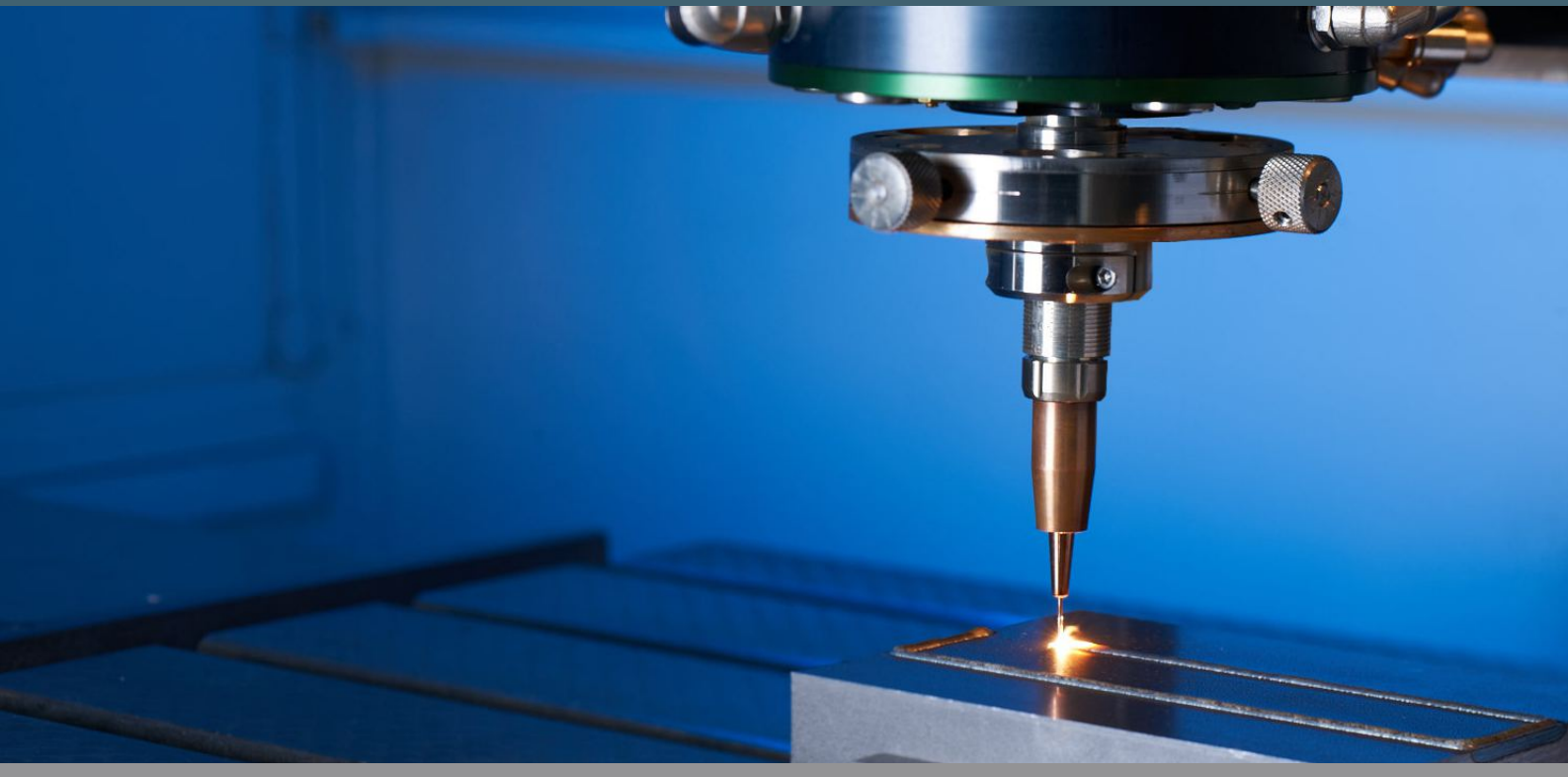


FRAUNHOFER - TECHNOLOGY RESOURCE PARTNER IN MANUFACTURING FOR THE INDIAN GOVERNMENT

Content

FOREWORD

Dear Friends

The SMART word is increasingly being used in many aspects of our lives. Smart cities, smart phones, smart mobility, smart meters, smart manufacturing, smart grids….. What does "Smart Technologies" really embody? Are there a set of critical factors that define "smart" or is merely jargon that gives the subject an exalted status and meaning?

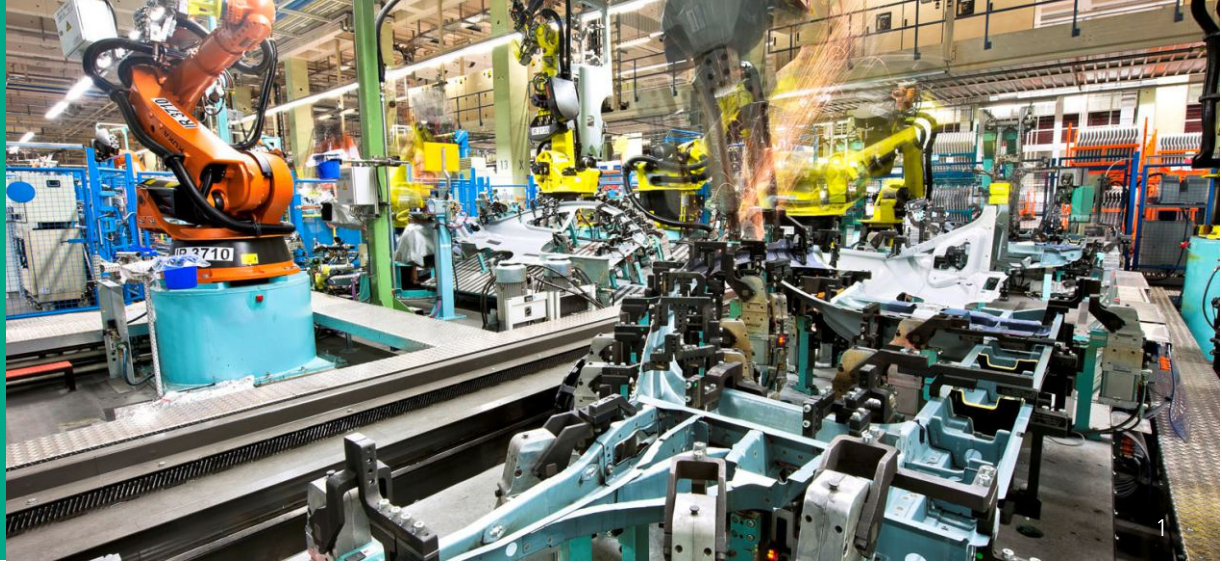
The technology pioneer Alan Kay said "The best way to change the future is to invent it". Innovation is a great game changer, and the grand challenges of this century have generated solutions which are connected, replicable, intelligent, transformational and most times even disruptive. In fact, smart nations are revving up their innovation potential to drive their advantage in a globally competitive world. Start-ups worldwide are changing the way people think, act, buy and live. Large organisations are rallying around their researchers and field personnel to understand exactly what the customer needs, and how to reach them in the fastest and cheapest way. Not all are smart technologies though, quite a few are merely marketing gimmicks, riding on the term "smart" and thereby gaining momentum.

Fraunhofer has been at the forefront of smart technologies and enriching lives. Our research aims to integrate solutions across industries, in a cross functional and efficient manner, and result in technologies and innovations that are path breaking, often well ahead of its time. Since our 66 institutes and the various centres around the world are application oriented and industry agnostic, we are able to harness the immense capabilities from our global ecosystem and develop strategies, technologies and solutions that are finely tuned to the various markets and client requirements. Global approaches and local solutions.

In this issue of our Newsletter we have focussed on Smart technologies, across the broadest spectrum, bringing to you some concrete examples and case studies of smart manufacturing, smart energy and smart cities. Of course this is a precursor to our Flagship event, the 4th Fraunhofer Innovation and Technology Platform on "Smart Technologies for a Smarter Planet", being held in New Delhi on 1st & 2nd September 2016. We look forward to your participation and dialogue with us, to make this event more meaningful and productive. Watch this space for more info on this exciting event!

Enjoy Reading and do give us your feedback!

Anandi Iyer



Defining the future of Production Processes - Smart Manufacturing

By: Prof Boris Otto, Director of the Fraunhofer Innovation Center for Logistics and IT

The fourth industrial revolution is affecting all industrial enterprises across the globe. The proliferation of innovative information technology within value creation systems brings about new business opportunities. But on the flip-side, challenges must be overcome to be able to take these opportunities. Smart manufacturing is a capability to use digital technologies for more efficient, more effective and ecologically more sustainable value creation systems. One of the cornerstones of smart manufacturing addresses the question how companies leverage the value of data—both from internal sources, but increasingly of those of the entire ecosystem.

Digitizing the Industrial Enterprise

The digitization of the industrial enterprise is among the issues of outmost importance for many economies across the globe.

The emergence of smart services brings about new challenges, but also great opportunities. Customer value creation is not depending any longer solely on physical product offerings, but materializes as hybrid product-service bundles. Competitive advantage in the long-run will increasingly be determined by a company's ability to offer digital services around their traditional service and product offerings. Successful examples can be found at tool machine manufacturer TRUMPF, for example. The company is offering an App Store around sheet metal processing on top of their tool machinery product portfolio. Furthermore, the automotive sector is planning autonomous driving of trucks in Germany, but also elsewhere in the world.

The business logic of smart services follows four common principles. First, smart services address a comprehensive customer demand, they support an end-to-end customer process. As a consequence of that, they second tend to be highly individualized, lot-size "one" like. Third, as no player in traditional value chains is able to orchestrate all capabilities needed to do so, smart services require an ecosystem. Finally, many smart services are ubiquitous, i.e. they can be consumed anywhere at anytime.

So-called digital native companies such as Uber and AirBnB have mastered the business logic of smart services. However, many enterprises in countries with strong manufacturing sectors want to leverage their traditional asset, i.e. the physical product. They do not want to rely on the "digital" aspect of smart services only. In particular in Germany, for example, they have been successful by offering world-class products and through excellence in managing supply chains. However, the trend towards individualized, lot size one like hybrid products—in line

"Smart manufacturing can be defined as an enterprise capability to leverage digital technologies for better, i.e. more efficient, more effective, more resilient and more eco-friendly value creation processes"

- Prof Boris Otto, Director of the Fraunhofer Innovation Center for Logistics and IT)

1: Photo credit : © Photo Daimler AG

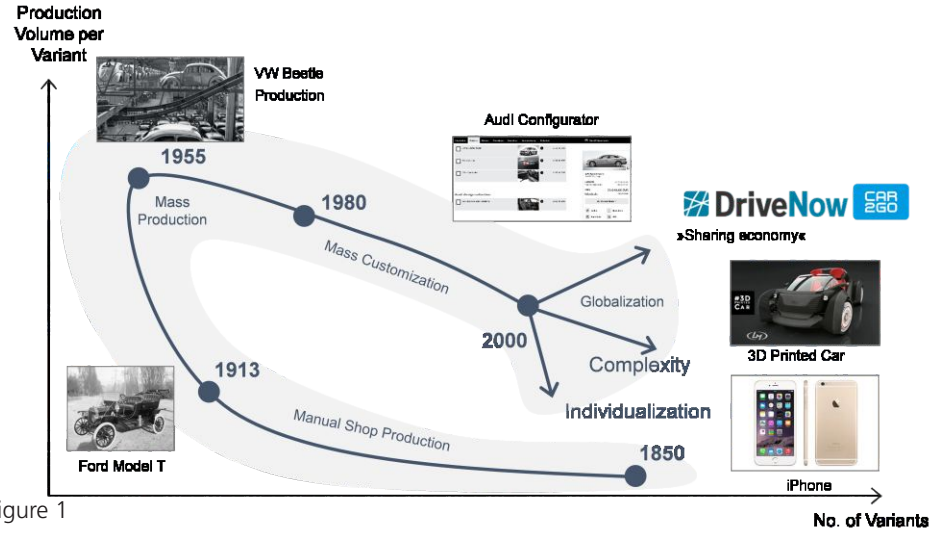


Figure 1

with parallel developments towards more regional products, for example—results in dramatically increasing complexity of our value creation processes (see Figure 1). To cope with this complexity industrial enterprises deploy cyber-physical products, manufacturing analytics and autonomous devices and machinery in their factories; short: smart manufacturing approaches.

The Convergence of Manufacturing and Information Technology

In brief terms, smart manufacturing is about making use of the convergence of manufacturing and information technology. But this convergence is not an end in itself, of course. It is rather a requirement of the design of innovative hybrid products that follow different business logics as the ones we used to produce over decades.

Figure 2 shows the architectural layers of hybrid products in their context of the digital economy. As can be seen on the left hand side, hybrid products materialize as bundles of smart services based on smart data on the one hand side and smart (physical) products based on smart infrastructure spaces on the other. Many digital native companies make use of the fact that these architectural layers can be decoupled. For example, Uber does not own taxis and AirBnB does not own hotel rooms. Instead these companies concentrate on offering smart services to the end customer. The physical product itself is threatened to be commoditized.

Mastering the entire architecture stack, though, has the potential to offer maximum value to the customer in a one-stop shopping mode, i.e. delivering the hybrid product bundle consisting of both physical components and digital services from one hand. TRUMPF, to come back to the aforementioned example, offers digital services to their customers that are able to

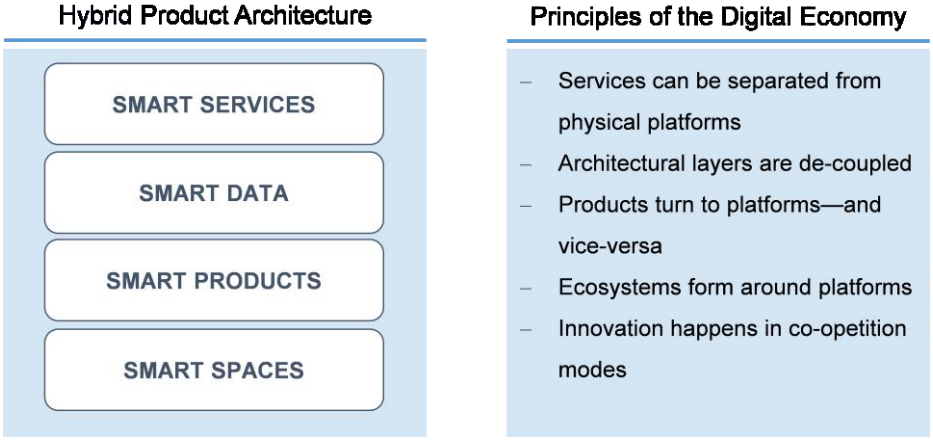


Figure 1: Complexity in Value Creation Systems

Figure 2: Hybrid Products and the Digital Economy

analyze production noise emitted by their machines for malfunction or maintenance needs and in doing so ensuring maximum equipment efficiency. And Tesla is building their electric cars according to platform strategies as we know them from smart phones. New functionality such as the intelligent side mirror is made available through software updates. Offering hybrid products such as these requires industrial enterprises to build up smart manufacturing capabilities, in short: to think manufacturing and information technology as one.

India and Germany: Complementary Strengths

Smart manufacturing is key to developing the manufacturing sector in Germany. As the country is highly industrialized with high labor costs, the adoption and proliferation of cyber-physical systems in value creation systems is a prerequisite to stay competitive. Furthermore, the German manufacturing sector is highly developed with regard to embedded systems used in industrial machinery, for example. The country, though, has high demand of skills and competencies in the fields of information and digital technology and it may be doubted whether it can meet this demand from internally only. The Indian information technology sector is highly developed, the three companies Tata, Cognizant and Infosys alone employ more than 600,000 people. More importantly, these companies are able to offer consulting and integration services in highly innovative fields such as cloud computing and digital technologies. Thus, the Indian information technology sector offers capabilities that are needed by many German industrial enterprises.

Vice-versa the German manufacturing sector is leading in production engineering and technology as well as related information technology fields such as embedded systems (see above). Both industrial information technology as well as digital, often consumer-driven technologies and competencies are needed to build fully-fletched hybrid digital products as outlined in Figure 2. Obviously, Germany and India bring complementary strengths to the table. Joint endeavors would allow German and Indian companies to offer hybrid products needed on a large scale.

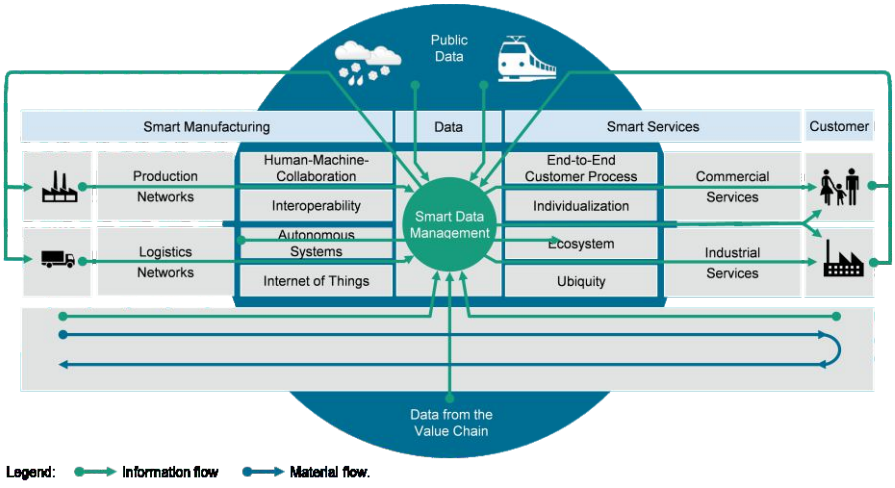
Another question is related to internal adoption of smart manufacturing approaches in India. Opponents of the idea argue that the Indian manufacturing sector is characterized by low labor costs and limited automation and, thus, smart manufacturing approaches would not add any value. While that is true, of course, smart manufacturing is not only an end in itself. As outlined above, smart manufacturing is a prerequisite to be able to offer smart services. Consequently, adopting smart manufacturing approaches might be a path of innovation for many industrial enterprises in India to address new business opportunities.

The Role of Information and Data

Data is the key resource to link smart services on the one hand side and smart manufacturing on the other (see Figure 3). Smart data management allow the industrial enterprises to

What makes the Industrial Data Space unique are the design principles that were articulated by the user companies such as:

- Digital sovereignty over data assets
- Secure data supply chains from the "cradle to grave" of data assets
- Collaborative governance and common rules of the game
- Trusted network of data, i.e. of data providers/owners and data users
- Trustworthiness through certified endpoints
- Scalability and network effects through inter-cloud integration, for example
- Open and participative design and development process



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leverage the assets of the past and at the same time take the digital opportunities that lay ahead of them. Smart data management is about managing data flows from the customer to the customer covering all internal and external players in the ecosystem. It requires the capability to exchange and link own data assets with those of partners in the value chain as well as those of public data sources.

Towards an Industrial Data Space

In this context, the Industrial Data Space aims at a virtual data space which facilitates the secure exchange and the easy linking of data assets within industrial ecosystems. In doing so, the Industrial Data Space provides a means designed by all users to embark on the digital transformation while at the same time always keeping control over one's data assets, thus, at all times keeping digital sovereignty. The Industrial Data Space does not necessarily require a central data vault (such as Data Lakes, for example), but it rather materializes as the entirety of Industrial Data Space endpoints, i.e. instances of a trusted, certified piece of software that we call the Industrial Data Space connector.

The Industrial Data Space initiative is an excellent opportunity for Germany and India to work together to enable smart manufacturing solutions in the two of both countries.
At present the initiative is organized in two ways:

- On October 1st 2015, we were able to kick-off a Fraunhofer research project to develop the precompetitive components of the Industrial Data Space. The activities are funded by the German Federal Ministry of Education and Research.
- In parallel we worked together with our industrial partners—of which many are today in this room as well such as ATOS, SICK, thyssenkrupp—to create a chartered association to bundle the user requirements and to funnel the industrial expertise around the Industrial Data Space architecture. On January 26th, 2016, we reached our first milestone and were able to found the Industrial Data Space association. The chartered association is open for contributions and also members from all countries around the world.

There are many opportunities for Germany and India to collaborate in order to make smart manufacturing happen. The time is now to do so and many joint activities have already been launched such as the "Make in India" campaign at the 2015 Hannover Trade Fair.

Figure 3: Smart Data Management

Fraunhofer Office India - Proud to welcome H.E Dr. Angela Merkel, Chancellor of Germany & The Prime Minister, Shri Narendra Modi

The Federal Chancellor of Germany Dr. Angela Merkel visited India on 5th and 6th October for the Inter-Governmental Consultations. She held political and economic meetings in New Delhi and Bangalore. Fraunhofer accompanied the Chancellor throughout her journey in India. In Delhi Fraunhofer was mentioned several times, and was also part of the official Indo German Governmental Consultations through the signing of the MoU. In Bangalore, the Federal Chancellor and Prime Minister Modi attended the Indo German Business Forum on "Digitizing the Future Together", which was conceptualised and co-organised by Fraunhofer Office in India.

Fraunhofer signed MoUs with the Ministry of Heavy Industries & Public Enterprises and Hindustan Machine Tools limited (HMT) on 05th October, 2015 and exchanged the same in the presence of the two dignitaries, Hon'ble Angela Merkel, Chancellor of Germany, and Hon'ble Narendra Modi, Prime Minister of India in Delhi. The MoUs signed underlines the cooperation on technology between the two countries.

Ministry of Heavy Industries & Public Enterprises, and Fraunhofer-Gesellschaft collaborated with Fraunhofer in the field of manufacturing and have announced Fraunhofer as their Technology Resource Partner to support and augment the Make in India programme by increasing the innovation and technology prowess of Indian industry. The activities include creating a roadmap for technological development for Indian industry, identifying and plugging technology gaps, implementation of identified projects in manufacturing, working with various stakeholders in Government, Industry & Academia for increasing cooperation in applied research.

Hindustan Machine Tools limited (HMT) and Fraunhofer-Gesellschaft wish to focus on the Development of new features in existing products, New Product Development, Analysis of Design for Improvement and New Technology Development. HMT seeks to engage in an exercise to focus on its core competencies and upgrade its technology.

Industry event "Digitising Tomorrow Together – An Indo-German Summit" focusing on Technology & Innovation.

06th October, 2015 – Bengaluru, India:

Chancellor Merkel mentions Fraunhofer in her speech

"…India needs quality jobs, and Germany needs highly skilled workers. Even so, the presence of German institutes and organizations - such as Fraunhofer, the German Academic Exchange Service or the Chamber of Commerce - has become significantly stronger in India. "

1: The Prime Minister, Shri Narendra Modi in meeting with the German Chancellor, Dr. Angela Merkel, at Hyderabad House, in New Delhi on October 05, 2015.
Pic courtesy—German Embassy, Delhi

2. L to R — Shri. Vishvajit Sahay - Joint Secratary, Dept of Heavy Industry (DHI), Ms. Anandi Iyer, Director Fraunhofer India, Mr. Frank Treppe -Director Corporate Strategy and International Affairs, Fraunhofer, Shri Dr. Rajan Katoch, Secretary DHI

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Chancellor Merkel mentions Fraunhofer in her speech

"One lays great emphasis on a fruitful cooperation between Industry and Research not only in Germany but also here in India. Therefore it is no surprise that renowned institutions from Germany have established themselves here in India. One such shining example is the Fraunhofer Representative office , an exemplary institution in the field of applied research. We could convince ourselves just last evening that particularly the cooperation between Industry and applied research works really well in Bangalore, even though this is not a very old tradition in India. Bangalore therefore is a shining example of the cooperation between our two countries, in the field of research as well as development".

3: Prime Minister and Chancellor of Federal Republic of Germany, H.E. Dr. Angela Merkel witnessing the Exchange of MOUs at the Indo-German Summit in Bangalore. Fraunhofer represented by Mr. Frank Treppe, Director Corporate Strategy and International Affairs, Fraunhofer & HMT represented by Mr. Girish Kumar Managing Director - HMT

4: Professor Boris Otto at the concluding session of the event in the presence of the premiers.

The two dignitaries also addressed at an event organised by Fraunhofer and NASSCOM **"Digitising Tomorrow Together – An Indo-German Summit"** in Bangalore on 06th October 2015. Mr. Frank Treppe, Director Corporate Strategy and International Affairs, Fraunhofer-Gesellschaft along with the head of NASSCOM welcomed the two dignitaries at the event. With promoting 'Industrie 4.0' being one of the agenda at the event, Professor Boris Otto Director of the Fraunhofer Innovation Center for Logistics and IT was one of the panellist at the panel discussion along with other prominent Indian & German CEO's like Mr. Baba Kalyani - CMD of Bharat Forge, Mr. Gerd Hoefner - Managing Director and CEO at Siemens Technology India, Mr. BVR Mohan Reddy - Chairman NASSCOM, Mr. Hubert Reilard - Managing Director at EFD Induction Limited & Mr. G.V. Prasad - CEO of Dr. Reddy's Laboratories.

The event was a huge success where Fraunhofer was mentioned in several occasions at the event. The need of a 'Fraunhofer like ecosystem' was found as the recurring theme of the panel discussion. The emphasis of the applied research carried out by Fraunhofer India was highly complimented by all the dignitaries as well as by Chancellor Dr. Merkel. In the end, the event was concluded by Professor Boris Otto who highlighted the need of Fraunhofer and its partners in India to work in collaboration with the industry and bridge the technology gaps in Indian industry. The senior ministers in Chancellors Merkel's cabinet who visited India along with her included Foreign Minister Frank-Walter Steinmeier and a number of corporate honchos such as Siemens head Joe Kaeser, Airbus chief executive Thomas Enders, and Deutsche Bank's Jürgen Fitschen. The powerhouse delegation of 20 is the largest to have come from Germany and emphasises the predominant economic orientation of the visit and the influential business interests behind it.

Media highlights post signing MOU's with HMT & Ministry of Heavy Industries

- HMT enters into MoU with Fraunhofer for technology upgradation
  October 08th, 2015 Live Mint
- Germany's Fraunhofer institute to assist Make in India initiative
  October 06th, 2015 Business Standard
- HMT inks pact with Fraunhofer for technology upgradation
  October 06th, 2015 Economic Times
- HMT shares zoom 18 per cent on pact with German firm Fraunhofer
  October 07th 2015, India.com
- HMT zooms over 40% in two days on signing MoU with Fraunhofer
  October 07th , 2015 Business Standard
- HMT spurts after signing MoU with German firm
  October 07th 2015, Business Standard
- DHI Fraunhofer Framework MoU
  October 05th 2015, Business Standard
- Fraunhofer-Gesellschaft signs MoUs with govt, HMT Ltd
  October 05th The Hindu Business Line

The future of Smart Manufacturing in India

In conversation with Shri Vishvajit Sahay, Joint Secretary - Dept of Heavy Industries, Govt of India.

Initiatives taken by the Department of Heavy Industries in strengthening the Manufacturing sector in India?

Indian Manufacturing Policy aims at raising contribution of manufacturing to 25% of GDP by 2022 from current 16%. The major output apart from turnover is substantial growth of SME sector, so that maximum employment is created by adding 100 million additional jobs by 2022. This increase is possible from increase in domestic value addition and technological depth in manufacturing towards global competitiveness. Thus, further integration of Indian economy with the rest of the world is necessary.

The Department of Heavy Industry, Government of India is responsible for development and growth of the Capital Goods sector, Automotive & Auto component sector and 31 Public Sector Enterprises. Put together, these represent about 10% of GDP or more than 50% of Indian Manufacturing.

The Department deploys major tools of development as ambitious & integrated policies supported by Schemes/ projects, technical support infrastructure and facilitation & motivation. The Government, through the Department of Heavy Industry, has announced the first ever National Policy for Capital Goods in February 2016 for Capital goods industries like machine tools, heavy electrical equipment, earthmoving & mining equipment, textile machinery etc. The policy sets ambitious targets for the growth of the sector in terms of enhancement of production, generation of employment and growth of exports. Suitable strategies are being charted out to accomplish the ambitious targets for the industry. In the automotive sector, the National Electric Mobility Mission Plan 2020 is already under implementation and the Automotive Mission Plan 2016-2026 has just been approved. All these have emanated from the National Manufacturing Policy.

Under the scheme for Enhancement of the Competiveness of the Capital Goods Sector, some very important projects inter alia engendering industry-academia-government collaboration have been approved. Some of these are Creation of Centre of Excellence (COE) at Indian Institute of Technology, Madras for development of 11 Machine tool Technologies. These technologies are required to be developed for making "Make in India" vision a success. Another key initiative is the support to Machine Tool Park at Tumkur along with the Government of Karnataka. Under this project, 500 acres of integrated machine tools park will be set up .The Government support will enable raising quality of industrial infrastructure to global level and when fully implemented, the park is expected to double Indian turnover of machine tools to Rs.9000 crore apart from creating additional employment opportunities. Another important project approved is the Creation of Centre of Excellence (COE) at PSG College of Technology, Coimbatore for development of welding Technologies.It is expected that hundreds of high -tech welding jobs will be created as a result of the centre. Following the MoU signed in November 2015 between

Shri Vishvajit Sahay is an officer belonging to the 1990 batch of Indian Defence Accounts Service (IDAS) and serving presently as Joint Secretary in the Department of Heavy Industry (DHI), Ministry of Heavy Industries & Public Enterprises. An alumnus of the prestigious St. Stephens College, Delhi.

25 years of diverse experience in the Government of India ranging from Security Sector to Entertainment Sector to Industrial Development. As Joint Secretary in DHI handles the Heavy Engineering and Machine Tools Sector, apart from being on the Board of Directors of several CPSE's under DHI.

Held additional charge of the post of Chairman and Managing Director, Heavy Engineering Corporation Limited, Ranchi, a critical player in the Capital Goods Sector. Also held additional charge of the post of Chief Executive Officer in the National Automotive Testing and R&D Infrastructure Project (NATRiP) a project, which when fully implemented will provide a major fillip to the Auto Sector.

Steering the first ever attempt at framing a National Policy for the Capital Goods Sector under the 'Make in India" programme of the Government. Earlier served in the Acquisition Wing, Ministry of Defence at a senior level and handled the procurement process for modernization of the weapons and equipment of the Indian Army.

Was the Nodal Officer from the Indian side for financial management of the Foreign Military Sales(FMS) Programme of the US Government with the Government of India. Also served in the Ministry of Information & Broadcasting dealing with the film industry and various film export and marketing initiatives.

Has experience of negotiations on Government to Government basis on film co-production agreements with countries such as Italy, Britain, China and Canada. Also handled sensitive issues such as certification of films for public exhibitions, exhibition of films in film festivals and through the broadcast media. Has been a part of Inter-Government negotiations on matters pertaining to the Audio Visual Sector in General Agreement in Trade in Services (GATS).

"The Government support will enable raising quality of industrial infrastructure to global level and when fully implemented, the park is expected to double Indian turnover of machine tools to Rs.9000 crore apart from creating additional employment opportunities."

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the DHI and Fraunhofer, Technology cooperation between HMT Machine Tools Limited from M/s Fraunhofer under Technology Acquisition Fund Programme has materialized. Many other such important and far reaching impact projects have been approved or are under consideration.

2. Please highlight the key innovative technologies that DHI is looking for to integrate Smart Manufacturing?

The solutions that we look for today are joint production, JVs, overseas investments and Transfer of technologies to India. For capital goods sector , India requires advanced high technologies such as NC / CNC systems, high precision manufacturing, smart instrumentation & control, new materials, advanced metallurgy, heavy engineering technologies, green technologies, Internet of Things, Nanotechnologies, Additive Manufacturing etc. A complete listing is available on the Department's website dhi.nic.in in the Working Group Report on Capital Goods Sector as well as in the policy document of the National Policy on Capital Goods. Some countries need to review their stringent policies regarding dual use of technology because with Make in India assuming shape in Defence manufacturing in India, a large number of technologies would have dual use applications and if countries remain reticent in transferring such technologies then the competitor countries would leave them behind in investing in India.

3. What are the opportunities for public-private partnerships?

India is looking for long term partnerships. 25 sectors of "Make in India" (http://www.makeinindia.com) are considered to be most prominent for development and growth. These include Capital Goods, Machine Tools, Earthmoving, Road Construction and Mining Machineries, Automobiles, Drugs & Pharmaceuticals, aerospace, shipping, IT hardware & electronics, telecommunication equipment, defence equipment , solar energy, textiles and garments, leather and footwear, gems and jewellery and food processing industries. Today , India has put in place very attractive sector policies in Automobiles, Capital Goods, Biotechnologies, Electronics hardware, skills & training, infrastructure services, energy particularly solar and other non –conventional renewable sectors, roads & highways etc. Defence sector is also gradually opening up and there are boundless opportunities available there. Thus, it can be said that most opportunities for Public Private partnerships are in new projects in the areas of energy, transport, roads & highways, infrastructure, smart cities and industrial corridors. The machineries to manufacture all this, which is the remit of DHI, continues to offer opportunities for investment and technology infusion. Surplus land resources of CPSEs are being freed up to provide investment/JV opportunities to foreign as well as Indian corporates. The PPP India database (Department of Economic Affairs, Ministry of Finance) indicates that 758 PPP projects costing INR 3,833 billion (US $ 57 billion) is reflected as having

Image Source: scaleup-india.com

awarded/underway status (i.e., in operational, constructional or in stages wherein at least construction/implementation is imminent). There exists significant untapped potential for the use of the PPP model in e-governance, health and education sectors. Karnataka, Andhra Pradesh and Madhya Pradesh are the leading states in terms of number and value of PPP projects. At the central level, the National Highway Authority of India (NHAI) is the leading user of the PPP model.

4. What are your visions for the future of Manufacturing in India?

Indian Manufacturing Policy seeks to almost treble the current manufacturing from US 350 billion (not including mining, construction and other services) to US one trillion by 2022. This creates opportunities for 12- 16% p.a. growth. India would be needing FDI and foreign capital to achieve the targets. As already mentioned, DHI has launched the first ever National Capital Goods Policy. The policy addresses a host of issues of this sector and recommends appropriate measures to allow the sector to grow in a free flowing manner. The Policy seeks to enhance production of capital goods by 3 times over the next decade - from Rs 2,30,000 Crore to Rs. 7,50,000 crore. It also aims to generate additional 22 Million jobs, both direct and indirect (from 8.4 Million to 30 Million) and to enhance India's share to global exports from 0.8 % to 2.5%. Major work to facilitate Indian manufacturing is going on through creation of quality industrial infrastructure, emphasis on green manufacturing, reducing burden of compliance and incentivising the manufacturing sector. Support to SMEs, Indian branding and firing competition amongst states to attract industry are other focus areas. The idea is to make India a global hub of tech manufacturing in high precision, aeronautics, energy, telecom, electronics , biotech and such other knowledge based sectors.

5. What role can Fraunhofer play as a 'Technology Resource Partner' according to you ?

India looks towards Fraunhofer as an important knowledge partner. The GoI gives due importance to its relationship with Fraunhofer, which is why the MoU with them was signed in the presence of both the heads of Government in New Delh last year. In fact, the MoU with HMT was also similarly signed. We look forward to setting up Fraunhofer like institutes in India in some kind of collaboration with Fraunhofer. We also look towards Fraunhofer as a major technology solution provider to Indian PSUs and also Capital Goods Sector. Of late, Fraunhofer has enhanced its presence and visibility in India and we had a very purposeful visit to one of their laboratories in the last edition of Hannover Messe.
We hope that the forthcoming visit of our Secretary to Hannover Messe in April 2016 and the Fraunhofer lab will bring the joint agenda into sharp focus and some kind of action plan will be outlined for follow up.

"We look forward to setting up Fraunhofer like institutes in India in some kind of collaboration with Fraunhofer. We also look towards Fraunhofer as a major technology solution provider to Indian PSUs and also Capital Goods Sector."

Secure production in Industry 4.0

Source: Fraunhofer Magazine, Text: Britta Widmann

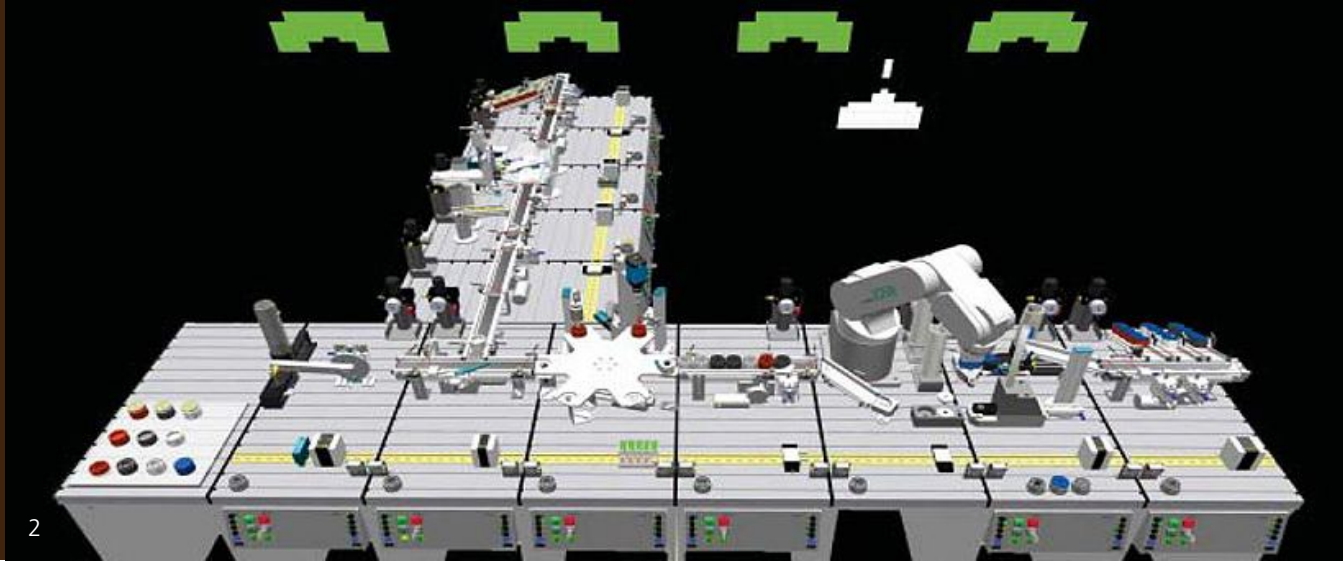
Industry 4.0 production facilities and components are connected to each other and linked via the Internet. The digitalization of production opens up new opportunities, yet also renders these systems vulnerable to attacks from outside. Fraunhofer researchers offer an IT security laboratory as a test environment in which to simulate attacks and detect any gaps

A wonderful new world of production sees machines, robots, system components, mini computers in components, and sensors all networked with each other to deliver the multi-site value chains of industry 4.0. These various devices exchange data, carry out condition monitoring, forecast and calculate the optimum sequence of process steps, plan equipment usage and much, much more. Yet as communication via Internet technologies makes its way into factories, it pushes up the security risks. In addition to known viruses, networked production facilities must face new threats in the form of customized malware. These programs are able to collect information on system parameters, remotely control machinery, manipulate controls or paralyze production processes. This means industry 4.0 networks require special protective measures, sophisticated network technology and effective testing methods to uncover vulnerabilities in the system and reliably eliminate them. The IT security laboratory at the Fraunhofer Institute for Optronics, System Technologies and Image Exploitation IOSB in Karlsruhe is specially equipped for production and automation technology. This lab serves as a secure test environment in which to simulate potential attacks on production networks, examine the implications of such attacks and develop suitable countermeasures and strategies. It also enables the researchers to assess the security features of the current communication standards and protocols for industrial automation systems. Among other things, these cover data encryption against product piracy, industrial espionage and sabotage.

Different than office IT

"IT security in industrial production has a very different set of conditions to deal with – it's just not the same as office IT," says Birger Krägelin, a computer scientist and project manager of the IT security laboratory at the IOSB. Control of production facilities requires the kind of real-time interventions that make it difficult to apply changes to the systems. The very act of installing available software patches, monitoring software, malware scanners and antivirus programs affects the stability of the carefully coordinated processes. Conversely, the production processes themselves determine when updates are feasible. Any firewalls present on the network and any encrypted connections between

1. Source: Fraunhofer IGD



systems can affect the real-time requirements. "If we incorporate known security measures from the normal office environment between machines, for example, this could delay the sending of messages. This in turn might cause conveyor belts to run slower, valves to delay their closing, photoelectric sensors to falsely trigger, motors to run faster, or control components to fail," explains Krägelin. Another major difference between production and other IT environments is the comparatively long period that hardware and software remain in use.

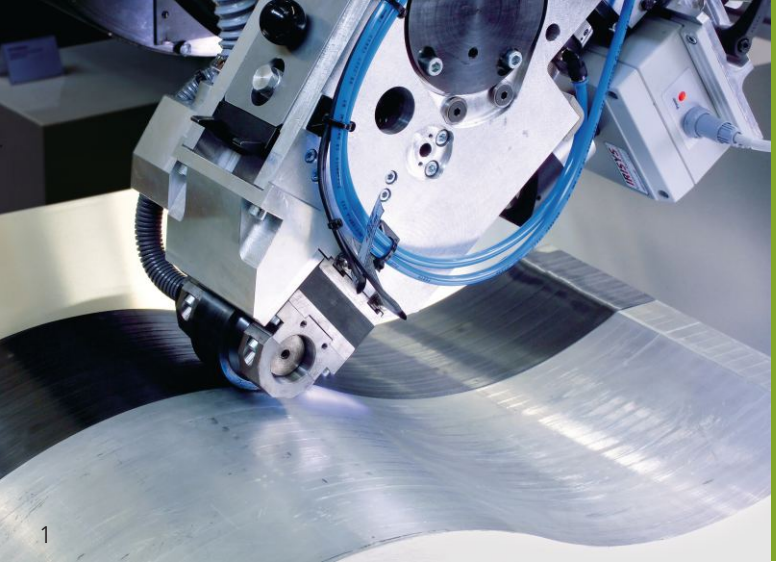
In order to come up with and set up IT protection mechanisms that are adapted to production environments, the research team comprising automation technology and IT security specialists made sure the lab has the equipment it needs: It has its own model factory with real automation components that control a simulated production facility featuring conveyor belts, electric motors, robots and lifting equipment. All a factory's network levels are present with typical components including firewalls, circuits and components for wireless units. With their own private cloud, the IOSB experts can install different customizable configurations and set the model factory to run various scenarios.

"Thanks to the cloud, we can patch in virtual firewalls, PCs, or client computers and change entire network structures with the click of a mouse. This enables us to install a virtual firewall or analysis systems between two components, for example a machine and a higher-level manufacturing execution system MES. Then we can launch malware detection from the cloud to check controls and plant visualization for infections," says Krägelin. "We can create new factory environments and simulate cyberattacks with no need to purchase any components or lay any cables."

Companies can use the IT security lab to obtain advice on the planning and commissioning of secure industrial network structures. In addition, they can benefit from the know-how of the IOSB experts when it comes to the analysis of their existing networks and components. In the future, the researchers also want to showcase the lab as a training and learning platform. "One thing engineers often lack is the knowledge of how to deal with cyber threats," explains Krägelin.

Caption:
The Internet and modern technology are increasingly shaping manufacturing industry. The digitalization of manufacturing also harbors new risks. Industry 4.0 networks require extra protection.

2. Source: Fraunhofer IOSB



Making it lighter

Source: Fraunhofer Magazine, Text: Ms. Birgit Niesing

Lower carbon dioxide emission is one of the significant goals of the future. Not only for Germany, but also for the EU and all industrialized nations. Trimming down the weight of cars, planes and trains offers a potential solution for saving energy and raw material.

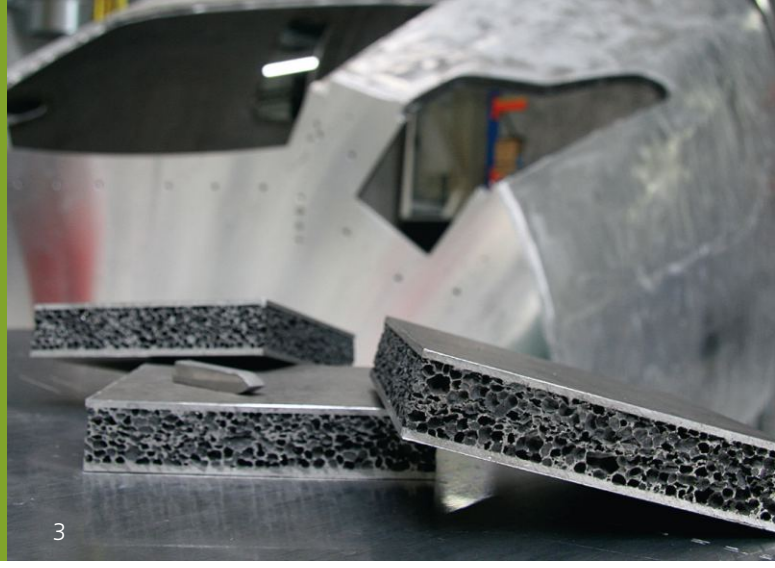
"In times of dwindling resources and growing environmental awareness, lightweight construction is one of the key technologies," emphasizes Professor Andreas Büter, spokesman of the Fraunhofer Lightweight Design Alliance (see box). Yet while engineers have many years of experience in working with steel, manufacturing with alloys, metal foams and composite materials is still in an early stage. More research and development is needed in this area. "It is important to find a good compromise between weight reduction on the one hand and sufficient rigidity, stability and durability on the other," states Büter. "The challenge is to use the right material in the right place."

Parking assistance systems, airbags, anti-lock braking systems, heated seats – as cars gain in comfort and safety, they also gain in weight. The popular sport utility vehicles (SUVs) tip the scales at 2 metric tons or more. But even small and medium-sized cars usually weigh in at over 1.2 metric tons. Now is the time to start trimming it down, though: as of 2020, Europe will apply more stringent limits for vehicle emissions of carbon dioxide. From then on, new cars are to emit an average of no more than 95 grams of CO2 per kilometer; the current limit is still 130 grams.

To meet this requirement, cars have to get lighter. Reducing a car's weight by 100 kilograms cuts its fuel consumption by 0.4 liters per 100 kilometers and its carbon dioxide emissions by up to 10 grams. The car body offers one way to save weight. Car manufacturers still make it using steel, but this is set to change according to a study by Berylls Strategy Advisors entitled "Lightweight Body Design – Coming Out Of The Niche". In the future, lightweight materials – such as high-strength steel, aluminum, magnesium or composite materials – will be used more frequently. In fact, the global market for lightweight body construction is expected to grow by an average of 15 percent per year, reaching 100 billion euros by 2025. But lightweight construction offers opportunities to more than just automakers: manufacturers of aircraft, trains, wind power plants, machinery and systems want to reduce the weight of their products too. The McKinsey study "Lightweight, heavy impact" predicts that the global market for lightweight materials will grow by 8 percent annually to more than 300 billion euros in 2030.

Fiber-reinforced plastics FRP – in which fibers made of glass, carbon, or other materials are embedded in a plastic matrix – are especially light yet still stable. Depending on the requirements, the fibers can be arranged in multiple layers oriented in different directions. This way, the properties of the component can be optimally tailored to where it will be used. For example, carbon-fiber-reinforced plastics CFRP have great potential for use in lightweight construction. These components, also commonly referred to as carbon components, are often only half as heavy as steel but equally as impact-resistant. Formula 1 race cars have been using this ultralight material for years. CFRP is also slowly beginning

1. Components made of fiber-reinforced straps are bonded with Laser
Source: Fraunhofer IPT



to replace metal as a material in commercial aircraft; it already comprises more than half of the weight of the material in the new Boeing 787 and Airbus A350 airplanes. It's a different story for automotive applications, as this lightweight material is rarely used in production vehicles. There are a couple of reasons for this: CFRP components are still significantly more expensive than the same components made of steel, and their production is complex. Nevertheless, a few automakers are also starting to use carbon fiber. Some luxury cars already contain CFRP components, and in the BMW I3 electric car, the passenger cell is made of carbon fiber.

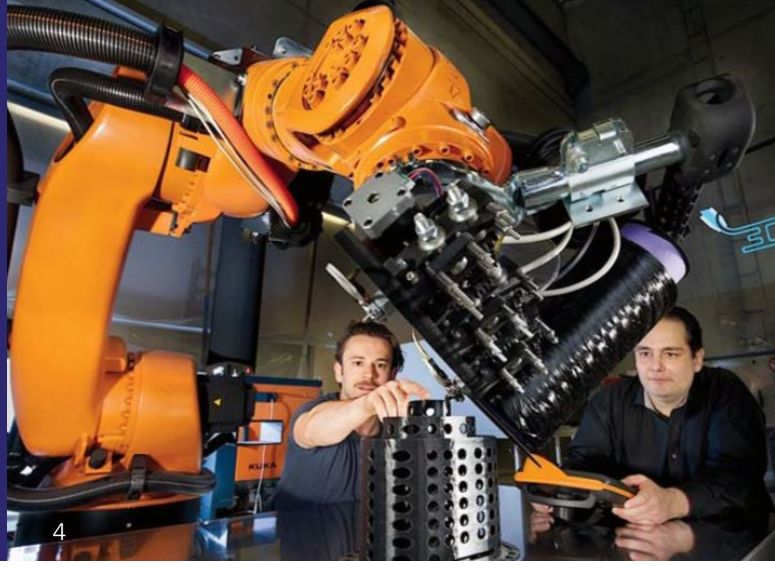
Fraunhofer researchers are working to see that even more vehicle components can be mass-produced using these materials in the future. Experts from the Fraunhofer Institute for Structural Durability and System Reliability LBF in Darmstadt have developed a transverse control arm made of carbon fibers, which is 35 percent lighter than one made of steel. In order to specifically deflect the forces acting on the component, the reinforcing fibers are arranged in the load direction. Integrated piezoelectric transducers prevent the lightweight component from vibrating. The researchers are already planning ahead: They want to continuously monitor the cross-member with fiber optic sensors and a fiber optic cable. Built into a vehicle, this "measurement transverse control arm" makes it possible to record and compare all loads with the design specifications. In an operationally stable design with verified load data, the weight of a component can be reduced by up to 40 percent. A load monitoring system such as this also makes it possible, by means of an online service life estimate, to warn the operator of potential operating damage and thus ensure the timely replacement of critical components.

The component can be manufactured in less than four minutes. First, fibers are woven together to create a blank. "Structures made using a weaving technique absorb a great deal of energy and ensure enormous resistance to damage," explains Michael Karcher, project manager at the ICT. Another plus: The highly automated robot-assisted process yields reproducible components and hardly any waste. The woven blank is then filled with resin and cured in a press under heat and pressure. "This high-pressure resin transfer molding (RTM) technology is suitable for the mass production of large and complex component geometries. The finished components have a good surface finish, a low cavity and pore content and have excellent material and component properties," emphasizes Karcher. The ICT scientists jointly developed the lightweight car seat cross-members in cooperation with partners from research and industry in the Technology Cluster Composites (TC^2) research cluster in Baden-Wuerttemberg. Also on board was the Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut EMI, and the Fraunhofer Institute for Manufacturing Engineering and Automation IPA. Carbon-reinforced components from the printer One method is particularly well suited for the

"Innovative lightweight construction solutions can do more than just reduce weight," stresses Professor Frank Henning, head of the Polymer Engineering department at the Fraunhofer Institute for Chemical Technology ICT in Pfinztal (near Karlsruhe, Germany). He also heads the Chair for Lightweight Construction at the Institute of Vehicle System Technology at the Karlsruhe Institute of Technology KIT. "Thanks to the new manufacturing methods, even complex components that unite various functions can be completely manufactured in one piece," enthuses Henning. ICT researchers combined two production methods in order to manufacture a crash-relevant car seat cross-member, including cable ducts and integrated seat mounts, using fiber-reinforced plastics in mass production.

2. Carbon Fibers
   © Bernd Müller
   Source: Fraunhofer Magazine

3. The innovative aluminium foam made it possible to reduce the weight by 20 percent compared to conventionally manufactured locomotives. Tooling costs are cut by 60 percent as well.
   Source: Fraunhofer IWU



4. The 3D fiber printer enables additive manufacturing of thermoplastic parts with integrated continuous carbon fibers. © Wolfram Scheible
Source: Fraunhofer Magazine

4

resource-efficient production of complex components: additive manufacturing. This entails building up components layer by layer directly from powders, liquids or extrusion material, based on data models. Experts at the Fraunhofer Institute for Laser Technology ILT in Aachen developed an additive laser process years ago for manufacturing metallic components – selective laser melting (SLM). It allows the manufacture of complex components that are much lighter than conventional metallic components and which are given, for example, a bionic structure that is unobtainable with conventional methods. Plastic components can also be manufactured with additive methods. However, the number of materials suitable for selective laser sintering is still limited. Experts from the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT in Oberhausen are working on new materials.

But are carbon fibers also suitable for additive manufacturing? IPA scientists in Stuttgart developed a 3D fiber printer with which thermoplastic components can be quickly and cost-effectively manufactured in top quality from fiber-reinforced plastic. Using a special printer jet, carbon fibers are injected directly into the molten plastic during the printing process – continuously and just exactly where needed. Even engines could be lighter in the future. Together with the Sumitomo Bakelite business unit SBHPP, researchers of the ICT Project Group New Drive Systems and the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg have joined forces to construct a research engine with a fiber composite cylinder block. This makes it possible to reduce the weight by up to 20 percent. Another plus: The component can be produced cost-effectively by injection molding. New tools for mass production. Despite all the advantages, complex components made of fiber-reinforced plastics are still rarely used in mass production. A major reason is that manufacturing costs are often too high – but this is about to change. Fraunhofer researchers are working on new manufacturing processes that are also suitable for high-volume production. One example is the EU's FibreChain project, "Integrative process chain for the automated and flexible production of components made of fiber-reinforced plastics". This project brought together partners from 18 European countries, including the Fraunhofer Institute for Production Technology IPT, which coordinating the work, and the ILT, to develop new systems technology and tools for the mass production of high-performance, recyclable lightweight components made of continuous fiber-reinforced thermoplastics.

Fraunhofer researchers are currently working on other approaches to automate the production of fiber composite components. For example, IPT engineers are driving development of a laser-assisted tape placement technique. The fiber-reinforced plastic bands, or tapes, are welded by laser by laser and formed into a compact structure. To make the method useful to small and medium-sized enterprises as well, the researchers

Fraunhofer Lightweight Design Alliance

In order to develop new materials, manufacturing and joining technologies, as well as test procedures for lightweight design, 15 Fraunhofer Institutes have joined forces in the Lightweight Design Alliance. The alliance addresses the entire development chain – from material and product development to mass production and certification, all the way through to recycling. Fraunhofer Institutes taking part include:

- Structural Durability and System Reliability LBF
- Chemical Technology ICT
- Manufacturing Technology and Advanced Materials IFAM
- Integrated Circuits IIS
- High-Speed Dynamics, Ernst-Mach-Institut, EMI
- Laser Technology ILT
- Production Technology IPT
- Silicate Research ISC
- Industrial Mathematics ITWM
- Environmental, Safety and Energy Technology UMSICHT
- Ceramic Technologies and Systems IKTS
- Mechanics of Materials IWM
- Material and Beam Technology IWS
- Machine Tools and Forming Technology IWU
- Nondestructive Testing IZFP

5. Robot controlled non-destructive ultrasonic testing of a CFRP component.
© Andreas Schlichter
Source: Fraunhofer Magazine

developed the multi-material-head (MMH), a novel tape placement head. This makes it possible to process different fiber materials – such as glass and carbon fibers or various matrix materials – in the same system, assisted by laser or other heat sources. This development earned the experts at the IPT.

If lightweight components are to prevail on the market in the future, they must not only be inexpensive to mass produce, but must also function safely and reliably. Fraunhofer scientists therefore calculate models that make it possible to ascertain the damage tolerance of the materials and, using special methods, they analyze the stability of the components with respect to the heavy, fluctuating mechanical and thermal stresses of day-to-day use. A further challenge for lightweight design is that the components and materials should not only help save energy during operation, but also be recyclable when no longer in use. "Innovative lightweight construction must be viewed in terms of the entire lifecycle – from the design through production, testing and usage on to recycling," emphasizes Prof. Büter.

Just how FRP can be designed to be more environmentally friendly is demonstrated by researchers at the Application Center for Wood Fiber Research HOFZET of the Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut, WKI. There they combine carbon fibers with different bio-based fibers made of hemp, flax, cotton or wood. The result: The components are inexpensive and very strong, have good acoustic properties, and are much more ecological than pure carbon-fiber components. High-strength steels, light metals and metal foams.

An increasing number of different materials will go into new products in the future. Creating robust bonds between components made of fiber composite materials, light metals or metal foams calls for optimized joining methods that are also economical to implement. Adhesive technology experts are pursuing this at the IFAM in Bremen. New laser processes, such as those being developed by researchers at the ILT, IPT and the Fraunhofer Institute for Material and Beam Technology IWS in Dresden, are also gaining in importance.Fraunhofer researchers are laying important groundwork so that cars, aircraft, machinery and plants can use less energy in the future. They also help make lightweight design feasible for mass production.

Fraunhofer Lightweight Design Alliance

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- Machine Tools and Forming Technology IWU
- Nondestructive Testing IZFP

Sustainable Smart Cities

Source: Fraunhofer Magazine Text - Chris Lower

What will life be like for tomorrow's city dwellers? In a major joint project funded by the EU, researchers are developing concepts for sustainable, livable and future-ready cities.

"Our goal is to find workable solutions to make cities smart and livable in the future. To this end, we first implemented pioneering concepts for sustainable energy supply, mobility and information technology in three selected cities," relates Alanus von Radecki of the IAO, who is coordinating the project. "An information and communications technology architecture forms the core of this in all three landmark cities."

"It provides the foundation for ensuring that the individual technologies are networked and coordinated with one another in each city," explains von Radecki. The scientists relied on a standardized architecture for information and communications technology developed by the Fraunhofer Institute for Open Communication Systems FOKUS. This way, the concepts can be adapted by other cities with relative ease – even if the conditions and concerns are different in each situation.

1. Source: Morgenstadt: Urban Innovators Summit (metropolitansolutions.de)

Cities have always set the pace of progress. As if under a magnifying glass, the central challenges of our coexistence as people are revealed here: from mobility to codetermination to modern energy supply. Today is when we must set the course for the sustainable, smart cities of tomorrow.

As for what the city of the future will look like, researchers in the Triangulum project intend not only to theorize but to also put theory into practice. Under the direction of the Fraunhofer Institute for Industrial Engineering IAO, innovative ideas for intelligent urban living areas are being implemented in Manchester, Eindhoven and Stavanger, to be later followed by Leipzig, Prague and Sabadell in Spain. The project originated from the Fraunhofer-Gesellschaft's Morgenstadt initiative and is supported by the Steinbeis-Europa-Zentrum SEZ. The European Commission has declared it to be a pilot project as part of the Smart Cities and Communities initiative. A broad base of 23 European partners – from municipalities, the scientific community and industry – are taking part in the project.

"This is made possible by the project's modular approach," says von Radecki. All of the employed technologies are implemented module by module, in order to establish a comparable information platform. "Essentially, all the key issues facing future-ready cities are rooted in information, communication, exchanging data and networking in real time," stresses von Radecki. What is important in this context is to converge existing separate communications infrastructures – whether sensor, information or mobile communications networks.

Information technology plays a decisive role

The plans for the Norwegian city of Stavanger illustrate why information technology plays such a key role. Here, the plan is to provide consistent links between companies, residents, research institutes and doctors through IT networks in order to plan better, more efficient use of energy and even to perform remote medical diagnoses. Thanks to an extensive fiber-optic network already in place, high-resolution videos and the like will soon be able to aid telemedicine professionals in their work, for example, or enable further innovative public services. The infrastructure is also set to be used to open up further channels for civic involvement. For example, when it comes to helping blaze the trail to the Smart City.

2. Source: Fraunhofer FIT

Stavanger has the most electric vehicles on the road

Stavanger is distinguished by another notable aspect: the city has the highest density of electric vehicles in Europe. "This and the existing high-speed information and communication technology ICT infrastructures form the basis for better networking of energy and mobility solutions," explains von Radecki. New solutions will also help to supply energy more efficiently. Thus, a combined heat and power plant is slated to provide public buildings with energy, with the municipal swimming pool serving as an energy storage unit. This means that during the day the pool temperature may rise several degrees Celsius over the temperature setting, and then cool down again over night.

The project partners also have ambitious plans for Manchester. Here the "Manchester Corridor" student district, home to some 72,000 students, will be transformed into a Smart City community. "Historical buildings are to be renovated as a part of this. Also, a self-sufficient energy network is to be built, to supply the entire city quarter with heat and electric power," reports von Radecki. The energy network will not only supply geothermal and long-distance heating, but will also include two separately operating electric power grids and a fuel cell that can store the excess energy. Through it, e-cars, e-cargo bikes and the Metrolink e-tram can be supplied with electric power – vehicles with internal-combustion engines will be completely banned from the district.

Eindhoven's future will also be electric. Urban transportation is to be provided by e-buses, and residents will be able to access to various parts of the infrastructure – such as booking electric car-sharing vehicles or utilizing intelligent parking concepts – by means of an ICT solution. Sensors – installed in street lamps, for example – will among other things capture motion data so that the street lighting, public transportation or car-sharing can be managed on an as-needed basis. All of this is initially planned for the former industrial site of the company Philips in the Strijp district. This is also where the innovative Sanergy concept for cleaning up contaminated soil will be implemented. It entails a closed system in which energy is gained by filtering and circulating contaminated groundwater. In addition, a biomass-fueled combined heat and power plant is to be built.

A further district, Eckhart Vaartbroek, will also join this leap into the future. It is dominated by older public housing projects, which are to be renovated to become more energy-efficient. "In order to calculate the energy savings, we use an IT-based tool that can reflect the expenditures and yield in a 3D visualization of the district," reports the project manager. The ambitious plans are to be achieved within three years. Afterward the concepts will be adapted to three other cities.

Triangulum

The Triangulum project is one of three Horizon 2020 landmark projects relating to the Smart City. For this research the European Commission is providing 25 million euros. The goal is to design and test concepts for sustainable, intelligent urban development. For this, innovative solutions will first be implemented in the cities of Manchester, Eindhoven and Stavanger. In the next step these concepts will then be adapted to three additional cities. The project was launched in February of 2015. Total project costs amount to more than 29 million euros. Under the scientific guidance of the IAO, the following cities have joined forces in the project consortium along with other research institutions and industrial companies.

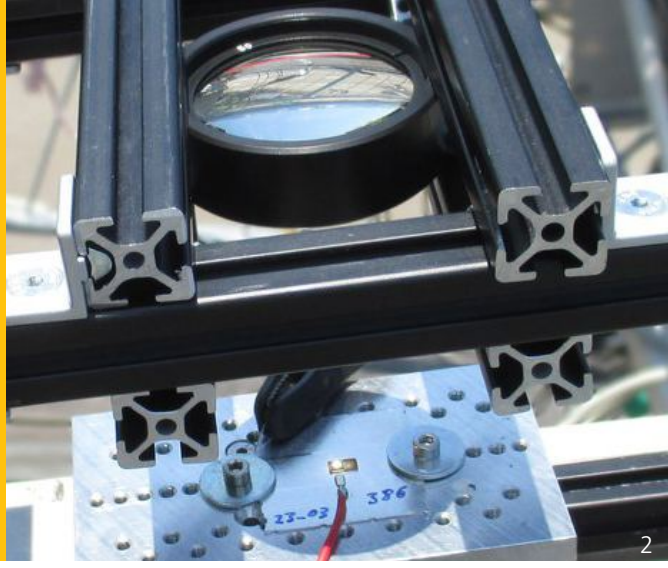
- Steinbeis-Europa-Zentrum
- The University of Stuttgart's Institute of Human Factors and Technology Management IAT
- Fraunhofer FOKUS

Participating partners in Manchester (UK) Manchester City Council | The University of Manchester | The Manchester Metropolitan University | Siemens plc | Clicks and Links LTD

Participating partners in Eindhoven (the Netherlands) Municipality of Eindhoven | Park Strijp Beheer B.V. | Stichting Woonbedrijf SWS.Hhvl | Technische Universiteit Eindhoven | Strijp S. Ontwikkeling B.V. | Koninklijke KPN N.V.

Participating partners in Stavanger (Norway) Stavanger Kommune | Greater Stavanger Economic Development AS | Rogaland Fylkeskommune | The University of Stavanger | Lyse Energi AS

Participating partners in the subsequent cities Prague Institute of Planning and Development (Czech Republic) | Ajuntament de Sabadell (Spain) | City of Leipzig (Germany) | TÜV SÜD AG (Germany)



Smart Energy: A Global Imperative

Source: Fraunhofer Embedded Systems Alliance

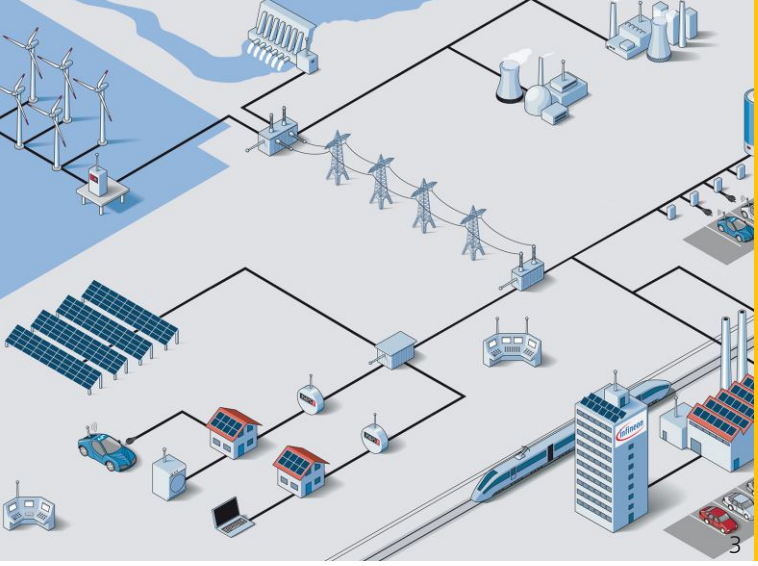
In the Fraunhofer Embedded Systems Alliance, various institutes have joined up to develop solutions for residential customers, industry customers, prosumers, generation facilities, storage systems, electric vehicles, distribution grids, etc. in accordance with customer-specific requirements.

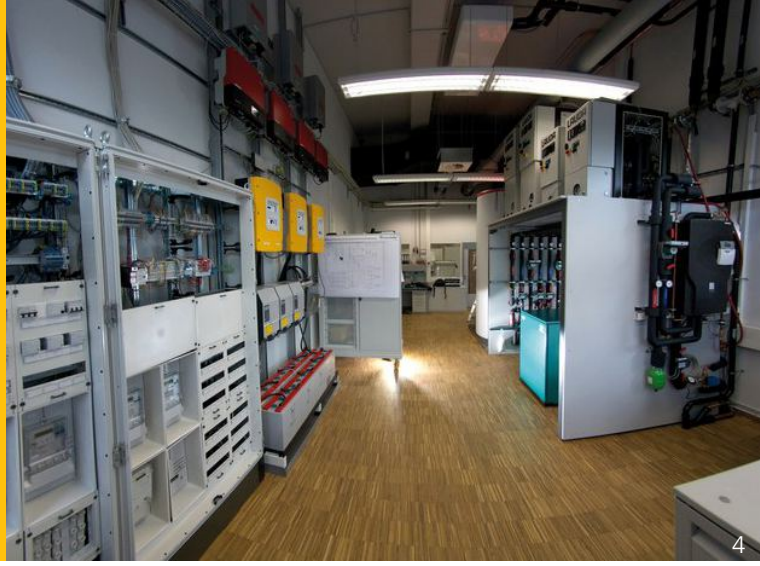
The energy industry currently finds itself in the middle of a major change. In the future, energy will be generated increasingly from renewable energies such as wind, solar, or hydropower at distributed sites. Due to the strong fluctuations to be expected in energy generation, new challenges arise in terms of ensuring supply security and network stability. For example, renewable energies must be stored temporarily and must be transported and billed according to demand in order to achieve efficient energy usage. This requires an ICT infrastructure for control and monitoring called a **Smart Grid**, which represents a critical infrastructure, just like the current energy supply infrastructure.

Major changes are expected to occur particularly in the distribution grids. Currently, the homes of residential customers are already being equipped with smart meters and corresponding communication gateways. They enable exact recording of the energy consumption, but other use cases, such as influencing the customer's energy consumption through variable prices, are also conceivable. Furthermore, customers can also generate energy on their own as so-called prosumers, e.g., with the help of a photovoltaics system, and feed this energy into the distribution grid's low-voltage network. On the level of medium-voltage networks, more generation facilities operating with renewable energies (e.g., wind parks, biogas plants) will also be connected in the future. To balance supply and demand, storage systems are needed, such as pumped-storage power plants or decentralized battery storage systems. In this context, there are currently broad discussions on whether electric vehicles might also be suitable as storage mediums for energy in the future. Energy consumption can also be adjusted to the supply by systematically controlling energy consumers. This can be done either indirectly, e.g., via the above-mentioned price incentives, or through direct controls. The distribution grid operator could, for example, directly control the refrigerated warehouses of industrial customers, which could be hypercooled if there is an oversupply of energy and could then do without energy for a certain amount of time if there is a shortage of energy. In addition to energy consumers, storage systems, and generators that are connected to the distribution grid, increased control and monitoring of the distribution grid facilities themselves, such as local transformer stations or substations, is also expected in the future. Embedded systems are used everywhere in the Smart Energy sector. They collect, process, store, and transmit a wide variety of different kinds of data in order to ensure reliable and safe operation and permanent supply security in terms of energy.

1. This laboratory building at Fraunhofer ISE is equipped with cold water storage and serves as a demonstrator for grid-supportive operation.
©Fraunhofer ISE

2. World record for concentrator photovoltaic technology: mini-module comprised of four-junction solar cells reached 43.4 percent efficiency.
©Fraunhofer ISE





Goals and Research Questions

Technologies and solutions are being developed to allow reliable and secure communication among embedded systems via technologies such as wireless and powerline. For use with wireless metering sensors, energy harvesting technologies are being investigated, which obtain energy from the surrounding area and are thus able to record energy consumption with low maintenance requirements and extreme flexibility. For energy management and to ensure supply security, development is under way regarding processes and models for load distribution, for charging electric vehicles, for the use of electric vehicles as energy storage mediums for load balancing, for the smart interconnection of all operating resources, etc. Aspects such as real-time capability, efficiency, IT security, etc. are also taken into consideration in this regard.

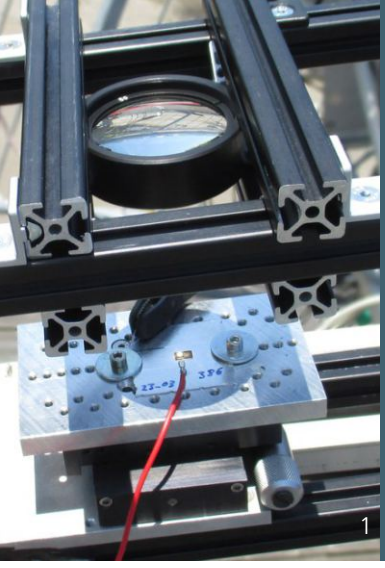
Smart operation of an energy supply system is only possible if there is a systematic exchange of information among its components and stakeholders. This requires suitable communication solutions that fulfill the respective functional requirements. Both performance and quality parameters play a crucial role in the selection of the communication solutions. The development of smart communication concepts, and the expansion and adaptation of communication standards and protocols are important tasks in this context. At the same time, it must be ensured that all components and stakeholders of the energy supply system can also communicate with each other seamlessly and transparently across domains.

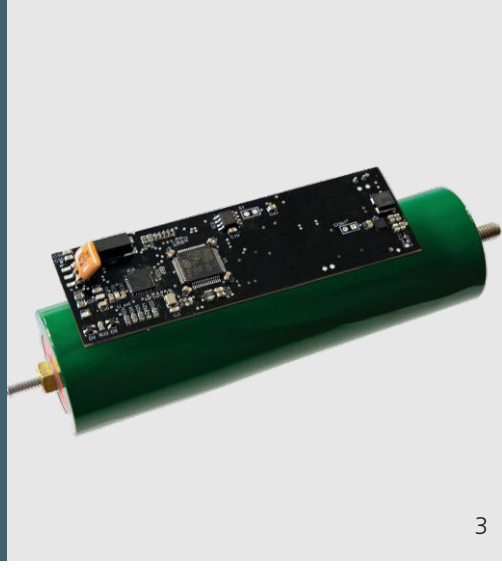
In the development of solutions, measures for ensuring IT security, i.e., protection against attacks, are considered right from the start (Security by Design). As shown by the Stuxnet worm in mid-2010, successful attacks on control networks such as SCADA systems constitute a major threat. Suitable protection measures must be integrated into the infrastructures in order to protect them from attacks and thus prevent manipulated ICT components in the Smart Grid from becoming "weapons". For instance, the smart meters and gateways installed at the consumer's site must be protected from manipulations in order to prevent, for example, the theft of electricity. The communication between the involved entities must also be protected from the injection of false data, just like the services for recording electricity consumption as well as those for accounting and billing. If personalized data are processed, the developed solutions must also consider privacy aspects, for example to preclude the creation of consumer profiles. All security and privacy measures must function throughout the entire lifecycle (Secure during Operation).

All appliances, devices, and components of the system involved in the Smart Energy production contain embedded systems that communicate with each other and enable the various use cases. Fraunhofer is performing research to find secure, privacy-protecting, robust, and cost-efficient solutions.

3. "Energy To Smart Grid" (E2SG) is a major European energy research project. Its aim is to reduce power losses occurring in energy distribution by 20 percent.
Source: presseagentur.com

4. The SmartEnergyLab of Fraunhofer ISE: The digital agents are located in the three yellow cabinets. ©Fraunhofer ISE





Recent Research News @ Fraunhofer

1. World record for concentrator photovoltaic technology: mini-module comprised of four-junction solar cells reached 43.4 percent efficiency. ©Fraunhofer ISE
2. The ROS-based software allows driverless transport systems to navigate autonomously in unstructured environments.
3. Intelligent cell of the Fraunhofer IPA: A microcontroller records physical parameters such as temperature and state of charge. If a cell is empty, it switches itself off automatically.

Concentrator Photovoltaic Technology Continues to Break New Records
Fraunhofer ISE's mini-module achieves new world record efficiency of 43.4 %

The highest efficiencies for the direct conversion of sunlight into electricity are reached with concentrator photovoltaic (CPV) systems, and the technology still promises room for improvement. After announcing its world record solar cell two years ago, Fraunhofer ISE announces its new highest efficiency on the module level. A mini-module comprised of four-junction solar cells reached a newly confirmed world record of 43.4 percent. "This value is a new milestone in the history of CPV technology and demonstrates the potential available for industrial implementation," says a pleased Dr. Andreas Bett, Deputy Director of the Institute and Division Director of Materials, Solar Cells and Technology at Fraunhofer ISE.

Adopting ROS to develop industrial applications

The open-source Robot Operating System ROS can be used to make the development and commissioning of robotics and automation systems more efficient. The ROS-Industrial initiative is committed to the diffusion of ROS in the industrial domain. Fraunhofer IPA heads the initiative's European Consortium, and acts as a technology partner for the developer community and industrial partners. A new member of the Consortium, contributing technically and financially to the initiative, is Robert Bosch GmbH.

Electric cars: batteries with brains

The battery is the heart of the electric car. Fraunhofer researchers have developed an energy storage device which is significantly more cost-effective over the entire life cycle in comparison with previous models. If one of the more than one hundred battery cells is defective, it can be replaced easily. Until now, the entire battery had to be replaced.

Researchers at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart have now created an alternative. The trick is: each battery cell has its own built-in microcontroller that records relevant physical parameters, such as the temperature and the state of charge of the cell. As a result, each cell knows what condition it is in. The cells "talk" to each other via the existing power wiring between battery cells. This is known as power-line communication. They can also communicate with other devices, such as the on-board computer, which uses the data from the cells to calculate how much remaining energy the entire battery still has, the so called state of charge.

Adjusting production processes in real time

Industry 4.0 requires comprehensive data collection in order to control highly automated process sequences in complex production environments. One example is the cultivation of living cells. But digitalizing and networking biotech production equipment is a huge challenge: relevant standards have yet to be established, and biology has a dynamic all its own. Using fully automated equipment for producing stem cells, Fraunhofer researchers have managed to adjust the process control to cell growth – delivering an adaptive system that is suitable for use in a number of sectors

Mass-produced underwater vehicles

Autonomous underwater vehicles are essential for tasks such as exploring the seabed in search of oil or minerals. Fraunhofer researchers have designed the first robust, lightweight and powerful vehicle intended for series production.
DEDAVE is the world's first autonomous underwater vehicle to be developed from the outset with a view to series production. It will be manufactured by a company to be specifically created for this purpose as a spin-off from the IOSB in the first half of 2016. The series production of a product of this type requires that every single manufacturing step is documented in detail. This is the only means of ensuring that the trained workers can build the vehicles as on an assembly line. For this part of the project, specialists from the auto industry have been engaged to contribute their expertise in industrial manufacturing and the qualification of subcontractors.

A long-term EKG for wind turbines

Offshore wind turbines have to take a lot of punishment, and this is particularly true for their foundations, which are anchored in the seabed. Divers periodically descend to inspect these structures for defects, but in the future, such checks will be faster and easier to carry out thanks to a new sensor ring. In the future, this arduous and sometimes dangerous task can be performed by a robot; more specifically, a box-shaped remote operating vehicle, or ROV for short. The groundwork for this technology has been laid by researchers at the Fraunhofer Institute for Ceramic Technologies and Systems IKTS in Dresden in cooperation with various industry partners.

This system offers a number of benefits. It is far more precise than other methods used to date, because for instance it can also analyze the dimensions and depth of cracks, which until now was impossible. Furthermore, this type of inspection is much faster than labor-intensive manual methods – the job is complete in just ten minutes.

Rapid and energy-efficient production of lightweight components

When consolidating carbon fiber reinforced plastics (CFRP), individual layers of fibers and plastic connect to each other under pressure and high temperatures to form a homogeneous plate. Fraunhofer researchers have developed a method which is fast and energy efficient, and which is also suitable for smaller quantities as well as high-temperature plastics: CFRP is directly irradiated in a vacuum by infrared radiation.

low-cost-wafers-for-solar-cells

Silicon wafers are the heart of solar cells. However, manufacturing them is not cheap. Over 50 percent of the pure silicon used is machined into dust. A new manufacturing technique developed by Fraunhofer researchers puts an end to these material losses, with raw material savings of 50 percent along with an 80 percent reduction in energy costs.

Solar vehicle charging at home

Owners of home photovoltaic systems will soon be able to make their households even more sustainable, because PV power is also suitable for charging personal electronic vehicles. A home energy management system created by Fraunhofer researchers incorporates electric vehicles into the household energy network and creates charging itineraries.

4. An inside view of the StemCellFactory.
5. Researchers fitted a test pipe knot with two sensor ring demonstrators for practical trials in the Baltic Sea.

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Recent Events @ Fraunhofer Office India

1: Panel discussion moderated by Ms. Anandi Iyer, Director Fraunhofer India.

2: Prime Minister and Chancellor of Federal Republic of Germany, H.E. Dr. Angela Merkel witnessing the Exchange of MOUs at Hyderabad House in New Delhi (October 05, 2015) Fraunhofer represented by Mr. Frank Treppe, Director Corporate Strategy and International Affairs, Fraunhofer & Mr. Vishvajit Sahay Joint Secretary of Department of Heavy Industries for Ministry of Heavy Industries and Public Enterprises.
Photo courtesy - Ministry of External Affairs, India

Sustainable Cities and Climate Change
23rd September, 2015 - Bengaluru

The Fraunhofer Office India, the Consulate General of Germany in Bengaluru, and The Energy and Resources Institute (TERI) had collaboratively organised a panel discussion & workshop on 'Sustainable Cities and Climate Change' on 23rd Sep, 2015. The event primarily concentrated on Sustainable Cities with special focus on Municipal Solid Waste Management, Deteriorating Air Quality and Clean Water. The meeting brought all the relevant stakeholders and experts from the respective areas on the same dais and facilitated a discussion on the need of the hour and proceeded further to combat the impacts of climate change coupled with already existing stresses on the urban centres like Bengaluru.

Fraunhofer participates in the 'Bosch Manufacturing Conclave 2015'
05th November - Mumbai

Fraunhofer participated as a 'Knowledge Partner' in an event hosted by Bosch India 'Smart Manufacturing Conclave' on the 05th November in Mumbai. It was a full day conference that aimed to highlight and bring together I4.0 leaders and practitioners from India and Europe and share the realities of industry 4.0, talk to and meet the people who are set to lead the smart manufacturing way. The sessions were set to clear the increasing ambiguity in the role of Information and Communications Technology (ICT) around real and virtual worlds of production, also known as the Cyber Physical Production Systems.

As a knowledge partner, Prof. Verl, Chairman of the Board Fraunhofer Future Foundation was the closing keynote speaker at the event highlighting the roadmap for Smart Manufacturing in India.

Fraunhofer @ IMTEX
20th January, 2016 Bengaluru
Fraunhofer Expert spoke on "Vehicle Light Weighting" at the 'International Seminar on Forming Technology'

Fraunhofer expert, Dr. Andreas Sterzing from Fraunhofer IWU was the 'Keynote Speaker" at the 'International Seminar on Forming Technology', a one day seminar that addressed the latest trends, developments and research in forming technology. The seminar focused on Design & Software, Equipment & Tools and Process and brought together the

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fraternity of forming technology users and manufacturers on a common platform to discuss related issues.

Fraunhofer in 'Auto Expo — Component '
04th — 07th February 2O16 - Delhi

The Auto Expo , over the last several year has grown tremendously in size & transformed itself into a global event. Fraunhofer office India was a part of the German Pavilion showcasing the automotive competencies of Fraunhofer.

Fraunhofer in 'Invest Karnataka'
03rd — 05th February 2O16 - Bengaluru

Invest Karnataka, organised by the State Government aimed to create a platform for the best minds to meet, exchange ideas and drive forward the state's vision of prosperity for all - by employing technology, innovation, inclusivity and sustainability as key factors for development. The event saw a conglomeration of industrialists, entrepreneurs, and government officials.

Fraunhofer was a part of the German Pavilion promoting Research & Innovation. Ms. Anandi Iyer was one of the keynote speaker at an Energy Workshop, and she highlighted the 'R&D Ecosystem in Karnataka: Fostering Innovation and Growth'.

Fraunhofer in 'MAKE IN INDIA WEEK'
13th-18th February 2016 - Mumbai

The 'Make in India Week' event held in Mumbai aimed to showcase the potential of design, innovation and sustainability across India's manufacturing sectors in the coming decade. The event sparked a renewed sense of pride in India's manufacturing – and took corporate and public participation to the next level. Fraunhofer office India participated in the event as the preferred 'Technology Resource Partner in Manufacturing for Indian Government'. Fraunhofer exhibited a variety of technologies mainly in the areas of Manufacturing, Food Technology, Renewable Energy, Automotive & Electronics. The event was a huge success for Fraunhofer that resulted in more than 60+ quality business inquiries.

3: Dr. Andreas Sterzing from Fraunhofer IWU

4: Ms. Anandi Iyer speaking on "R&D Ecosystem in Karnataka: Fostering Innovation and Growth"

Fraunhofer India: Recent Media Coverage

Experts call for a roadmap to develop smart cities

Bengaluru: Sep 24, 2015, DHNS

Experts in the field of environment, public health and urban development have called for a roadmap to make cities smarter in India, to make them energy efficient and ecologically sustainable. Cities should work together to beat climate change, the experts said.

Speaking at a workshop on Sustainable Cities and Climate Change organised by Consulate General of Federal Republic of Germany, Fraunhofer and the TERI here on Wednesday, the Consul General of Germany (Karnataka and Kerala) Jorn Rohde said there is urgent need for an international agreement between cities to handle global warming and climate change.

"Germany is striving hard on this. By 2020, we have targeted to be free of pollutants. A high percentage of our fuel is now from renewables, while 50 per cent is from solar and wind. We have to have similar targets in the world to reduce the pressure of climate change. There was a time, in 1967, when a Singapore team travelled to understand the development of a city, but now things have changed. There to be lost, we can begin even if we are late," Rohde said.

Pronab Dasgupta, Director of Southern Regional Centre, TERI, said the Delhi, Mumbai, Hyderabad and Bengaluru shared many features.

The carrying capacity of the cities have been deteriorating and depleting. map of how the cities should cope with global issues has to be drawn.

There is need to build an actionable road map around all these issues for B other cities and also to introduce pilot projects to understand how they wou area and whether they work in other areas too. Pilots are important f projects, Anandi Iyer, director of Fraunhofer India said.

D Satyamurthy, Additional Chief Secretary, Urban Development departmen is one of the major issues facing Karnataka.

"Decongesting Bengaluru has to be a major priority as traffic pile-ups a precious time. The other problem we face is water - we need clean and

HMT zooms over 40% in two days on signing MoU with Fraunhofer

In the past two-days, the stock zoomed 41% from Rs 41.70 to Rs 58.80 on back of heavy volumes.

DI Reporter | Mumbai
October 7, 2015 Last Updated at 12:49 IST

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India's NTPC collaborates with German institutes on solar research, Coal India tendering next 800MW

By Tom Kenning Feb 19, 2016 12:38 PM GMT

SMEs in industrial clusters will be main beneficiaries from DHI-Fraunhofer MoU

KNN Bureau | 05 10 2015 12:39:46 PM IST

Department of Heavy Industry
Ministry of Heavy Industries & Public Enterprises, Government of

New Delhi, Oct 5 (KNN) Small and medium enterprises (SMEs) in industrial clusters will be the main beneficiaries from the agreement between the Department of Heavy Industries with Fraunhofer, Germany, government said today that this will pay way for induction of latest technologies bital goods sector.

morandum of understanding (MoU) was signed in the nce of Secretary, Department of Heavy Ministry, R Katoch today.

bjective is to support and augment the "Make in India" amme through increasing the innovation and technology c Enterprises said in a release.

urveys with units and clusters and run a number of s with the help of Fraunhofer.

Germany's Fraunhofer institute to assist Make in India initiative

The Department of Heavy Industries (DHI) has appointed Fraunhofer as a technology resource partner to support and augment the Make in India programme

BS B2B Bureau | New Delhi
October 6, 2015 Last Updated at 12:19 IST

The Department of Heavy Industries (DHI), Government of India, and Fraunhofer, Germany, on October 5, 2015 signed a framework memorandum of understanding (MoU) making Fraunhofer as a technology resource partner to support and augment the Make in India programme by increasing the innovation and technology prowess of Indian industry.

The activities include creating a road-map for technolo development for Indian industry, identifying and pluggi technology gaps. Implementation identified projects in manufacturing, working with various stakeholders in

Department of Heavy Industry and Fraunhofer officials signing the MoU

'Power-starved B'luru should focus on renewable energy'

Rasheed Kappan, Bengaluru: September 25, 2015, DHNS

The City might have lost out in the Smart City race. But it could still benefit by learning the dynamics of how a Smart City works through a multi-stakeholder approach.

This, in essence, is the contention of Damian Wagner from the German Fraunhofer Institute for Industrial Engineering, as he emphasises on a collaborative effort that integrates the government, experts, engineers and the City agencies.

Wagner, in an interaction with the Deccan Herald on the sidelines of a conference on, "Sustainable cities and climate change," talks about capitalising on Europe's experience with Smart Cities. But he insists that this could work even better by exploiting India's strengths in Information and Communication Technologies (ICT).

"Politicians here should also understand the need for a roadmap. It is a long-term process that requires training," he explains.

Fraunhofer Institute's approach is essentially built around the six pillars of mobility, infrastructure, energy, ICT, security and governance. But this grid could be prioritised according to the local government's preference. The process, as Wagner

BMJ Univ, Frauenhofer sign MoU

DP CORRESPONDENT
Ludhiana

BML Munjal University, founded by The Hero Group, announced the signing of a Letter of Intent with Fraunhofer, Europe's larg- est applied research organisation.

Fraunhofer's researchers intend to work jointly with their Indian colleagues to advance ecological and

and Honorary Faculty of BML Munjal University lectured at these sessions on 'L

HMT inks pact with Fraunhofer for technology upgradation

By PTI | 6 Oct, 2015, 09.47PM IST

Post a Comment

READ MORE ON » technology upgradation | Narendra Modi | HMT | Fraunhofer | Angela Merkel

BENGALURU: State-run engineering firm HMT today signed an agreement with German firm Fraunhofer for technology upgradation.

'India, Germany Can Ensure Success of Industrie 4.0'

Express News Service

Bengaluru: India and Germany can together make a success of the next stage of industrialisation where products can be tailored to meet individual customer needs.

Dr Boris Otto from Fraunhofer Institute for Material Flow & Logistics, who was part of 'Digitising Tomorrow Together' — an Indo-German summit held here on Tuesday, called this stage Industrie 4.0. He spoke to *Express* on the importance of cyber-physical systems that will transform the industrial landscape of the future. The complementary

tems. We are trying to de- velop c with fi consid best in To a mechan machi job-ma not a c jobs wi "It is how we change there w new job ing the require speciali oversee 4.0 will

Fraunhofer to Propel 'Make in India' Programme

By IANS | Published: 05th October 2015 07:09 PM Last Updated: 05th October 2015 07:09 PM

Email 0

NEW DELHI: The department of heavy industries and leading German applied research fi Fraunhofer-Gesellschaft signed a pact on Monday to augment 'Make in India' programme, official statement said.

Fraunhofer will assume the role of 'Technology Resource Partner' for propelling innovation technology prowess of Indian industry.

The agreement's thrust will be to create a road map for technological development for Indi industry, identifying and plugging technology gaps, implementing identified projects in manufacturing, and working with stakeholders in the government, industry and academia t increase cooperation in applied research.

The pact is a result of the 12th Five Year Plan's mandate of augmenting Indian industrial technologies through collaborations with Fraunhofer-Gesellschaft like institutes.

Availability of latest technology to capital goods sector and small and medium enterprises

10 quick snippets on how Karnataka-Germany relations have achieved a new high

TARUSH BHALLA
5 FEBRUARY 2016

55

It is said that **Germany ranks eighth in the list of India's top import partners** with India **exporting $7**

Europe's seve countries car

Government approves 5 projects with grant of Rs 175 crore

Tweet 0 Recommend Submit

1, 2016, 08.21PM IST

MT | HEC | CNIITMASH

ELHI: Government today approved five projects with of Rs 175 crore related to the capital goods space for ies including HMT Machine Tools Ltd.

nment today approved five projects leading to further ement in the competitiveness of the Indian capital ector and giving impetus to the Make in India gn of the Prime Minister.

(Government today approved...)

Enhance investment by giving thrust on infrastructure

Germany and France bet big on Karnataka's competency

N V Vijayakumar

BENGALURU: German and French consul generals have expressed their wish to enhance the existing investment climate in Karnataka, by giving more thrust on the infrastructure front.

In an exclusive interaction with *Deccan Herald* ahead of the Invest Karnataka 2015, German Consul General Jörn Rohde and French Consul General François Gautier ex-

pressed their wish that the state government take up the infrastructure issue seriously to attract more investments.

Rohde said that at the German and Indian government levels, there is good relationship, and the bilateral relationship is growing at a fast pace.

"German Chancellor Angela Merkel came to Karnataka to understand what is happening at the ground level. We discussed commercial relationship and increasing trade. For this to happen, we need a good investment climate, good infrastructure, then ease of doing business and loosening of bureaucratic hurdles. We are working for Indian companies in Germany with that aim, as well," he said.

Rohde said there are 6,000 German companies in India, of which, 580 are present in Karnataka, and participate in 'Make in India' and 'Make in Karnataka'.

"Besides increasing the manufacturing base, many German companies are involved in R&D activities. Our companies are involved in skill development to help India compete globally. The Indian Chamber of Commerce and Fraunhofer Institute have been doing a phenomenal job in India, especially in Bengaluru," he said.

François Gautier

Jörn Rohde

"The meeting is an excellent opportunity for Karnataka to showcase its potential power. For the consulate, it is an opportunity to become ambassadors of Karnataka to showcase the opportunities to German companies," he said.

Road map to investors

He expressed his wish that in the investors meet, the Karnataka government will showcase the road map to investors, and address the existing shortcomings in infrastructure.

"Reliable investment parameters and infrastructure are the precondition for becoming competitive in a globalised economy," he said.

Meanwhile, French Consul General Gautier said his country is also looking at opportunities, and infrastructure is a big issue.

"We have already committed an investment of €20 billion in India. Over the next five year period, we plan to contribute €10 billion more investments. Along with research and development, IT, defence and aerospace will attract more investments," he said.

Gautier said that Karnataka is the most sought-after destination for investment as far as French companies are concerned. "We are very much acclimatised to its climate and talent pool. We have also begun tapping the startup ecosystem flourishing in Bengaluru," he said.

DH News Service

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UPCOMING EVENT

Fraunhofer Innovation Technology Platform 2016
1st & 2nd September 2016 – Delhi

The Fraunhofer Innovation Technology Platform, is an exciting initiative and an annual flagship event organised by Fraunhofer Office India. Each event focusses on different thematic fields and showcases cutting edge technologies innovations and solutions through the Fraunhofer Technology Platform and make Fraunhofer in India synonymous with Technology and Innovation. Also, FIT tries to connect Industry and Academia in India through the Platform as well as acquiring Industry and Government contracts.
The 1st and 2nd FIT Platform focussed on **'Mobility and Logistics'** and **'Sustainable Technologies for the City'** of the Future as thematic areas respectively. The 3rd FIT Platform focussed on **'Energy Efficiency and Renewable Energy'**.

The 4th FIT Platform 2016 focusses on **'Smart Technologies for Smarter Planet'** deals with the theme smart or connected technologies or Indutrie 4.0 and will begin with an "Inaugural Plenary Session" on "Smart Technologies the key differentiator". The event will kick off on 1st Sept 2016 with a high profile panel discussion followed by the launch of Smart Skills Fraunhofer Academy Workshop & the inauguration of Smart Technology Exhibition followed by a networking dinner. The second day, 2nd Sept will be devoted to parallel technical sessions on the sub-thematic areas of Smart Manufacturing, Smart Cities & Smart Energy. The event is expected to be attended by more than 200 Delegates from India and abroad, mostly by CEOs, CTOs, and Innovation experts from Industry and Research as well as Government.

The event is being held in Delhi as the thematic focus will warrant participation from senior policy makers & bureaucrats who are major stakeholders & decision makers in the implementation of various government programs.

1: Panel discussion in FIT Platform 1

2: Inaugral lamp ligting ceremony in FIT Platform 2

Cover page credit: Fraunhofer Institute for Integrated Circuits II: Effizienter High-Speed Physical Layer 10+ Gbps für die nächste Generation der Video-Übertragung.

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