

UNDERSTANDING CHANGE – SHAPING THE FUTURE

IMPULSES FOR THE FUTURE OF INNOVATION



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PREFACE

The accelerating pace at which new topics and technologies are appearing in our globalized and digitized world is posing major challenges for the German innovation system. As a medium of progressive digitization, the Internet has become a breeding ground for revolutionary innovations with far-reaching impacts on the market and on competitive structures, not to mention on all areas of public and private life. The connectivity of the Internet means that innovations are increasingly occurring at interfaces between disciplines or through combinations of previously unrelated topics or technologies. This calls for effective cooperation and an efficient exchange of knowledge extending across the boundaries between institutions and systems.

Although the German innovation system is already of a very high quality, it should become even more dynamic in order to maintain the international competitiveness of the German economy and to take a leading position both in system-relevant innovations and in providing support for social transformations. The challenge is to find ways to break down traditional path dependencies, to develop cross-sectoral application contexts and to conceptualize new business models from the demand side. The task for business, politics, science and society, therefore, is to shape the content, quality and intensity of the relationships between all actors in the innovation system in targeted ways.

In view of these challenges, the Fraunhofer-Gesellschaft has founded the Fraunhofer Group for Innovation Research. Its founding members are the five Fraunhofer Institutes that have already made substantial contributions to innovation research in the past: Fraunhofer Institute for Industrial Engineering IAO, Fraunhofer Institute for Systems and Innovation Research ISI, Fraunhofer Center for International Management and Knowledge Economy IMW, Fraunhofer Institute for Technological Trend Analysis INT and Fraunhofer Information Center for Planning and Building IRB. As the first non-technological Fraunhofer group, it focuses on socio-economic and socio-technical research. The foundation of this group marks a special way for the Fraunhofer-Gesellschaft to fulfill its public mandate to act as a central player within the German innovation system in applied research and in knowledge and technology transfer.

With the aim of combining excellence in applied research with the transfer of knowledge and technology to industry, expanding regional strengths and combining complementary competencies in ways responsive to demand, the Fraunhofer-Gesellschaft is dedicated to fostering cooperation and institutional networking between science and industry. In order to fulfill this function in an optimal way and to leverage synergies along the innovation chain, Fraunhofer is working intensively on realizing formats for results-oriented, interdisciplinary cooperation.



In this way, Fraunhofer is promoting advances in key areas such as public safety, micro- and nanoelectronics, translational medicine, programmable materials and quantum technology through targeted and coordinated cooperative arrangements. For example, in 2017 the Federal Ministry of Education and Research (BMBF) approved extensive investments in equipment for the Research Fab Microelectronics Germany, a new cooperation project involving the 11 Fraunhofer Institutes of the Fraunhofer Group for Microelectronics and two Leibniz Institutes.

A central structural component of Fraunhofer technology transfer are the 17 high performance centers that have been established since 2015 in cooperation with university and non-university partners and partners from industry. Their goal is to expand the established forms of cooperation with industry and to develop new, agile forms that can then be used by all players in the research and innovation system to facilitate successful transfer.

Because many of these technologies are deeply embedded in the world of work and in the lifeworld, the Fraunhofer-Gesellschaft and the Group for Innovation Research see it as their responsibility to provide active support for the resulting reconfiguration of the relationship between human beings, technology and society. This reconfiguration involves an enormous potential for innovation. Accordingly, the research activities of the five institutes comprising the group rest on a profound understanding of innovation systems – at the macro level as well as in the operational context. Based on a broad empirical foundation, the Fraunhofer Group for Innovation Research is thus well placed to offer policymakers, ministries and industry with guidance when it comes to competent, forward-looking and effective action.

In this spirit, the present paper provides food for thought for the future of innovation.

A handwritten signature in black ink, appearing to read 'R. Neugebauer', with a long horizontal flourish extending to the right.

Prof. Reimund Neugebauer
President of the Fraunhofer-Gesellschaft

INTRODUCTION

The unprecedented acceleration in the dynamics of economic development and its dependence on global interactions makes predicting the future especially difficult. Nevertheless, an examination of long-term trends provides an opportunity to begin a discussion about what reality could await us tomorrow and how we want to deal with it.

With this food-for-thought paper, the member institutes of the Fraunhofer Group for Innovation Research wish to present a selection of the trends that are destined to have a significant impact on innovation systems in the period leading up to 2030. Based on these trends, the paper derives theses for innovation in the year 2030 and describes the resulting tasks for business, politics, science and society.

The Fraunhofer Group for Innovation Research understands innovation in a way that includes technical, organizational and social innovations. An innovation is in this sense the successful implementation of an idea, where implementing an innovative idea can take the form of new technologies, products, services, business models or integrated solutions in markets, in organizations or in society. Innovation systems are conceived as a combination of all actors and all factors that drive innovation throughout its life cycle.

Relevant trends for innovation systems

This paper is centrally concerned with the trends that influence or lead to the transformation of innovation systems and thereby shape how innovation will occur in business, politics, science and society in the future. The essential developments in this respect are the following:

The **digital transformation** is opening up groundbreaking new perspectives for innovation systems. The specific forces driving this transformation are new digital technologies that complement a large number of other technologies, intelligent digital networking, digital platforms and the resulting increase in intelligent networking between people and objects (Bauer et al. 2015; acatech/BDI 2017). The rapid advance in the development of big data technologies and artificial intelligence will link things, data, components of knowledge and opinions closely with the living space of individuals. As a result, new ways of interpreting and evaluating information will become possible – a significant advantage in decision-making situations. The density of networks will continue to increase and with it the opportunities for orientation generated by the programmed filtering and sorting of information, by artificial intelligence and by learning systems.

This transformation is being accompanied by an **increase in complexity** of innovation systems. This is even more the case when, as within the European Union, nationally or regionally diverse values and patterns of thought and culture have to be integrated into overarching innovation processes and developed further in ways that foster global competitiveness. With the help of digital platforms, the research and development departments (R&D departments) of companies will increasingly be able to pursue open innovation approaches and integrate highly diverse external groups into the innovation process. Among these groups are, for example, suppliers and customers, but also startups, representatives of the maker movement and technically adept problem solvers in the crowd. As a result, the research and development departments, as currently the sole center of innovation in industry, will be supplemented by a continuously **expanding stakeholder base**, especially when it comes to developing solutions for concrete needs or urgent social challenges (Hightech Forum 2017b; Warnke et al. 2016). Whether in the fields of mobility, energy, raw and finished materials, or medicine, there are already numerous examples of cross-disciplinary innovation systems with a broad stakeholder base.

Moreover, the further dissemination of Open Science approaches will lead to a rapid increase in the **availability of knowledge** in the form of publications, research findings and software. In future, therefore, access to knowledge will no longer be the decisive factor in the success of the innovation process, but instead the ability to identify relevant knowledge, to analyze it and to promote its utility (Stifterverband 2018; Stuart et al. 2018).

Innovation processes are also being transformed by the emergence of new forms of value creation oriented primarily to the utility of an innovation that embed innovation from the outset in customers' workflows and environments. This increasingly situates **holistic and systemic solutions** at the center of innovation (Tombeil et al. 2013; EC 2018).

Apart from these five selected trends, which form the basis of the opportunity-oriented theses of this paper, there are further important trends that must be taken into account when analyzing the future development of innovation systems. In addition to the diverse aspects of globalization, including the possible trend toward national isolation and protectionism, these include first and foremost the consequences of demographic change and the necessary alignment of global innovation processes with the objective of sustainable development. Other factors include the increasing scope for shaping biological processes in the convergence of biotechnology and information technology processes, the rapid development of artificial intelligence technologies and the effects of changes in the global distribution of work and power. Extensive current analyses of these trends are included in the Innovation Indicator 2017 of the National Academy of Science and Engineering (acatech) and the Federation of German Industries (BDI) (acatech/BDI 2017), in the Report on Research, Innovation and Technological

INTRODUCTION

Performance in Germany published by the Commission of Experts for Research and Innovation (EFI) (EFI 2018) and in the innovation policy guidelines of the Hightech Forum (Hightech-Forum 2017b). Complementing these analyzes, the member institutes of the Fraunhofer Group for Innovation Research see the theses presented below specifically as a contribution to raising the awareness of actors from business, politics, science and society for the challenges of a not-so-distant future.

THESES ON INNOVATION IN 2030

The following five theses can be derived from the above-mentioned trends. They formulate structural features that the Fraunhofer Group for Innovation Research believes will be the hallmarks of innovation in 2030.

Innovation beyond R&D departments

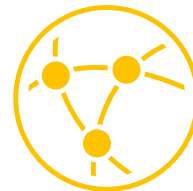
Due to the interdisciplinary linkages between innovation systems, individual innovations in isolated disciplines will be the exception in 2030. Changes will take place in comprehensive ways. They will concern a variety of social, technological and economic domains. Moreover, they will often occur at the global level. As a result, the task of initiating, coordinating and maintaining complex innovation and transformation processes will become increasingly demanding.

Thesis 1

"In 2030, openness, the ability to learn and cooperation will be the guiding principles of innovation."

Impelled by the need to adapt in increasingly faster and more efficiently ways to new condition, by 2030 the paradigm of open and flexible innovation has prevailed in business, politics, science and society. The basis of this paradigm is now the ability of all individual actors, as well as the entire system, to remain continuously adaptive. As a result, learning has taken on a whole new significance for all stakeholders. It has become the standard not only in the entire innovation process, but also in the value creation process. This orientation to learning is now the indispensable prerequisite for the stability of the system as a whole in which changes represent the normal situation even more so than they do today. As a result, agile processes and organizational structures are used in targeted ways geared to solutions.

How will openness, the ability to learn and cooperation affect your innovation system in the future?



Integrated solutions and value creation systems

Economically successful innovations call for combining technical and economic knowledge along the path leading from the idea to the market in order to conceptualize and implement appropriate business models. The path from the invention of the mp3 technology via the mp3 player to platform-based music streaming is a prime example of integrated value creation. Such comprehensive forms of value creation will also determine the short and medium-term innovation strategies of business in 2030. Producers of material goods will have developed for the most part into providers of solutions in which products and services are not simply integrated, but are tailored to customers' everyday workflows and can be accessed individually.

Thesis 2

"In 2030, integrated solutions will be the focus of innovation activities."



By 2030, the usefulness of new offers has become the central point of orientation for innovation activities. As a result, creativity and the organizational ability to act in a value creation system geared to value in use now represent the essential foundation for successful innovation. Based on accurately identifying actual user needs, technology and user functions are coordinated in the early phases of innovation and are integrated into the value creation networks of suppliers, customers and further actors. Fewer and fewer companies are able to achieve this entirely on their own, but are instead dependent on a diversified network of partners. Traditional business models have to be adapted or completely rethought.

Which solutions will your customers require in the future?



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Fully digitized innovation processes

The expectation is that in 2020 it will be possible to initiate and implement innovations in fully digitized ways. The development in this direction can already be seen, for example, in the increasing importance of digital twins in production technology. Digital twins make it possible to apply usage data for continuous improvement through defined interfaces, thereby enabling solutions to be produced, commissioned and tested virtually before they are actually realized. Based on real-time data and accurate algorithms, even complex validations or tests can be replaced by simulations.

Thesis 3

“In 2030, innovation processes will be fully digitized.”

By 2030, capabilities of artificial intelligence have developed far beyond current levels. Intelligent machines now learn complex interrelationships from more extensive sets of data without having to be programmed specifically for this purpose, thereby increasing their robustness against errors and anomalies. On the other hand, they now possess a greatly enhanced ability to anticipate and take into account possible developments in business, politics, science and society (Hecker et al. 2017).

The best brains are no longer the exclusive determining factor for the further development of products, services, processes and business models, but also the best machine integration of market requirements and of social and technological developments. In this way, incremental innovations in which existing solutions undergo gradual further development are now propelled primarily by algorithms that ensure an optimal match between the requirements identified and their conditions of fulfillment. By contrast, human creativity will continue to be the focus in the future for radical innovations leading to leaps in performance and based on making connections between solutions beyond the established paths of innovation. However, in 2030 this creativity also derives essential benefits from digital support: The risk of radical innovations failing because of a lack of customer acceptance or competitiveness is now reduced because, for example, it is possible to simulate and make better assessments of technological and application-specific properties at an early stage of development.



By 2030, R&D departments have become integrative control centers for digital innovation processes. The coordination of complex innovation networks has now become the focus of their external activities. Within their companies, their role is to coordinate different functional areas and disciplines that accompany innovations during their complete life cycle. Because of this high level of integration, the digital innovation process is geared primarily to complex solutions rather than to individually delimitable products. Data management and data security play an outstanding role in the innovation process in view of the enormous flood of data.

Where are the potentials of digitization in your innovation process?.....



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Application of knowledge across disciplines

By 2030, science, business and society have undergone a cultural transformation. The ivory towers of science have opened their doors: “Open Science” is now the order of the day. This is a result of the increased complexity and interdisciplinarity of scientific questions, combined with the claim of scientific findings to reproducibility. Both how scientific findings are produced, and the knowledge generated itself have become transparent. With a few exceptions, publications, research data and software in 2030 are freely accessible. This makes it possible for all stakeholders in innovation systems to utilize knowledge across disciplinary boundaries, thereby reducing the costs of creating knowledge, on the one hand, and accelerating scientific progress, on the other. Decisive for success in innovation is now the ability to find relevant knowledge in targeted ways. The involvement of groups of actors who did not traditionally exhibit an affinity for science in innovation processes has acquired special importance, for example through the active citizen participation in identifying, utilizing and assessing relevant knowledge.

Thesis 4

“In 2030, knowledge will be open to all – the challenge will be to apply it profitably.”



The knowledge that has become freely accessible will also be used by industry. By 2030, therefore, innovation processes in companies will be designed in flexible and open ways. Only in this way is it possible to meet the increasingly complex requirements that customers place on interdisciplinary solutions – and this in spite of shorter product and service life cycles in global competition. Open, interdisciplinary knowledge is now applied via “Open Innovation,” resulting in holistic solutions that are embedded successfully in social systems and interactions.

By 2030, cross-disciplinary knowledge and experts can be identified quickly and in targeted ways, thus making it easier to find integrated solutions to the major social challenges. The innovative capabilities of companies and social prosperity have increased thanks to the broad base of actors actively involved in innovation.

Which actors will you collaborate with in the future?.....



European digital ecosystem

By 2030, the digital transformation will already have led to far-reaching structural changes in science, business and society: The production, distribution and application of knowledge are now shaped by artificial intelligence and autonomous systems. Open Online Courses have become an integral part of the education system. Economic transactions are conducted on online platforms, leading to the dissolution of classical boundaries between industries and sectors. Now that social media have become the predominant platform of social discourse, the mobile availability and usability of data has become a matter of course. Data-based services play an essential role in value creation processes for which data is a valuable raw material. Europe has seized the opportunities offered by this transformation to become the world leader in data security and sovereignty. It also enjoys global competitive advantages due to the fact that production capacities have relocated back to Europe from emerging countries as a result of digital technologies such as 3D printing.

Thesis 5

“In 2030, Europe will enjoy unique global competitive advantages in terms of data security and sovereignty.”



In developing its digital ecosystem, by 2030 Europe will have benefited from the productive and value-creating power of its cultural diversity, on the one hand, and from its shared values, on the other. Thus, national standardization initiatives such as the “Industrial Data Space” (Otto et al. 2016) have developed into a European control and regulation system to meet the requirements that many non-European companies, institutions and private individuals also place on data sovereignty, protection and governance. This has a positive effect on digital value creation in Europe.

What benefits can you derive from the digital ecosystem in Europe in future?



TASKS FOR BUSINESS, POLITICS, SCIENCE AND SOCIETY

These five theses imply challenges and tasks for business, politics, science and society that must be addressed in order to ensure that innovation as a key competitive factor in Germany and the European Union is promoted in the best way possible.

Digital framework for action in business and society

Until now, the growth markets of digitization – for example, in the area of artificial intelligence – have been dominated mainly by American and Chinese technology companies. It is imperative that companies should derive greater benefits from the innovation potential of digital applications. However, securing the competitiveness of the German and European digital space in a sustainable way is a comprehensive political task: To achieve corresponding economies of scale and become competitive with major rivals such as the United States and China, Europe needs a “Digital Single Market Plus” which, as a Europe-wide digital space, is more ambitious than the framework conditions for a “Digital Single Market” published in 2015. Open standards, free markets, open and transparent government action and civil society participation feature centrally in these enhanced framework conditions in addition to free access to knowledge.

Above all, Europe should play a leading role in regulation and standardization. While regulation often still takes place at the national level and with a national focus, digital spaces and digital value creation are inherently “international.” Therefore, there is a need for further adaptation and harmonization in this area: The German and European innovation landscape needs a common digital framework for action that is investment-friendly, flexible, unbureaucratic and legally secure in terms of competition, as has already been proposed in the white paper on digital platforms issued by the Federal Ministry of Economics and Energy (BMWi) (BMWi 2017b) and in the digital agenda for Europe of the European Commission (EC) (EC 2014). Since the impact of the digital transformation on innovation systems is not the focus of these two publications, here we would like to highlight issues relating to authorship and ownership of data, which constitute one of the most important levers for the future strength of German and European innovation.

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Open Science as an integral part of the digital innovation process

The collection and use of data represents a major opportunity for companies. How the political framework conditions regulate the handling of data is already influencing the competitive factors of tomorrow. This includes aspects of the collection of data, their availability according to the situation and the development of competences for their curation, storage, evaluation and use. With the "Industrial Data Space" (Otto et al. 2016), the Fraunhofer-Gesellschaft has launched an exemplary initiative to ensure the data sovereignty of various interest groups in coordinated ways. Furthermore, in addition to its potentials, the use of artificial intelligence in the innovation process and in developed solutions also involves new dangers that must be assessed at an early stage.

Your tasks:



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Cross-disciplinary, user-centered value creation systems

The importance of the capacity for innovation as a competitive factor will be even greater in 2030 than it is today. On the path leading to future value creation systems, industrial research and development, which currently is still often oriented to technology, will have to become demand and user oriented. By 2030, the methodological knowledge required for this will have to be firmly anchored as an integral part of education policy in the curricula of all educational institutions, so that the economy can maintain its capacity for innovation and its interdisciplinary creative power. Permanent professional development at all levels and in companies of all sizes will also be indispensable, because this alone will enable companies to recognize cross-disciplinary and user-oriented innovation opportunities faster, absorb them sufficiently and implement them effectively.

Toward an open, learning-oriented and cooperative culture of innovation

By 2030 it will be necessary to orchestrate innovation processes on a broad basis, that is, to involve all potential participants in goal-oriented and differentiated ways. This calls for a variety of changes in business, politics, science and society in addition to the targeted selection of diffusion- or mission-oriented approaches to innovation. To be welcomed in this context is the announcement by the Federal Ministry of Economics of its intention to examine the establishment of a strategic center for innovation in Germany that could promote the development of key technologies in a concerted manner (BMW 2017a).

Critical and constructive social participation in innovation processes should be intensified, because it is already apparent that collaboration on the major social challenges, as these are set out especially in the UN sustainability goals, is driving technical, organizational and social innovations devoted to solving them (Hightech Forum 2017a; EC 2018). The aim should be to test new participation formats that go beyond proven practices such as citizen dialogues and whose goal is to promote the active, systematic and representative involvement of citizens. It will also be a question of shaping the co-productive and interactive cooperation of the actors involved from business, politics, science and society within the framework of an open and democratized culture of innovation.

Your tasks:



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FRAUNHOFER GROUP FOR INNOVATION RESEARCH

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 72 institutes and research units at locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of more than 25,000, who work with an annual research budget totaling 2.3 billion euros. Of this sum, almost 2 billion euros is generated through contract research. Around 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

With the foundation of the first non-technological Fraunhofer Group on July 1, 2017, the Fraunhofer-Gesellschaft will consolidate and expand its position as one of the leading players in innovation.

This new Fraunhofer Group for Innovation Research is the result of connecting those institutes which have already made substantial contributions to socio-economic and socio-technical research in the past:

- Fraunhofer Institute for Industrial Engineering IAO, Stuttgart
- Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe
- Fraunhofer Center for International Management and Knowledge Economy IMW, Leipzig
- Fraunhofer Institute for Technological Trend Analysis INT, Euskirchen
- Fraunhofer Information Center for Planning and Building IRB, Stuttgart

The Fraunhofer Group for Innovation Research sees itself as the Fraunhofer-Gesellschaft's platform for addressing system-relevant technological issues in the future. As one of its first tasks, the group supports the Research Fab Microelectronics Germany, recently launched with funding from the Federal Ministry of Education and Research, with socioeconomic and socio-technical expertise in the fields of future, organizational, innovation and impact research. Furthermore, the group strengthens the role of the Fraunhofer-Gesellschaft in the dialogue on research, technology and innovation policy with business, politics, science and society. It aims at making it easier for decisionmakers to orient themselves, position themselves and shape their future in the innovation system. Based on a broad empirical foundation, the Fraunhofer Group for Innovation Research thereby provides policymakers and ministries with a basis for informed, forward-looking and effective action. In addition, the group advises the Executive Board and the Presidential Council of the Fraunhofer-Gesellschaft on strategic decisions and initiates socially relevant subject areas and lines of research for Fraunhofer.

The following fields of research are at the forefront of a joint strategic orientation of the group under the guiding principle "Understanding change, shaping the future":

Understanding change

Understanding innovation systems is a precondition for designing them in targeted ways. This includes in particular:

- the identification, analysis and development of innovation systems
- futurology and technology forecasting
- socioeconomic and sociotechnical research

Shaping the future

Supporting the design of innovation systems includes in particular:

- strategic innovation, R&D and technology planning
- providing support for product, service and solution development
- corporate, sector and organizational development
- accompanying transformation processes

For over 45 years, the Fraunhofer-Gesellschaft has explored the thematic area of innovation research through scientific and application-oriented work – currently conducted by a total of 1300 employees at five Fraunhofer Institutes. The foundation of the Fraunhofer Group for Innovation Research is intended to further strengthen this competence accumulated for over four and a half decades.

Fraunhofer Institute for Industrial Engineering IAO

How will people work and live in the future? Researchers at Fraunhofer Institute for Industrial Engineering IAO in Stuttgart are studying these and similar questions. With its 618 employees, the institute accompanies companies and institutions along their path to new solutions, efficient processes and economic success. Its goal is to develop systematic solutions for optimizing interactions between people, organizations and technology.

- With a profound understanding of innovation methods and processes, as well as for markets and technologies, the research teams in technology and innovation management achieve the transfer of applied research into practice. Integrated into international networks, the institute studies and shapes topic of relevance for Germany's future as a location for business.
- At Fraunhofer IAO, researchers from different disciplines – from business studies and economics, computer science, engineering and social sciences, as well as natural science – collaborate in interdisciplinary teams. They analyze socioeconomic and sociotechnical questions from a holistic perspective with the aim of finding practical and practicable solutions.
- Among the clients of Fraunhofer IAO are both large companies and SMEs, as well as public institutions and bodies. The institute offers a unique knowledge head start and presents ways in which this knowledge can be adapted quickly to individual needs and used profitably. The institute places people at the center of its research.
- Fraunhofer IAO cooperates closely with the Institute for Human Factors and Technology Management IAT at the University of Stuttgart as well as with the Technische Universität Berlin and a range of other universities. Fraunhofer IAO has a total of 15,000 m² of office space, demonstration centers and development and test laboratories, including the "Future Work Lab – Innovation Lab for Work, People and Technology," which opened in February 2017.



*Prof. Wilhelm Bauer
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Fraunhofer Institute for Systems and Innovation Research ISI

As a scientific research institute with an interdisciplinary structure and a transdisciplinary modus operandi, Fraunhofer ISI views technological developments and social needs from a system-oriented perspective. Thus, it supports its clients from business, politics and science in finding holistic solutions. With its 288 employees, it offers recommendations for action and develops perspectives for important decisions. Fraunhofer ISI is acutely aware of socio-technical and socio-economic problem situations and challenges. What sets it apart is above all that its researchers consistently adopt the system perspective, anchor their technical findings in the social sciences, and thereby lend support to the practical application of these findings. Its empirically founded understanding of innovation systems and its mastery of multidimensional analysis procedures enable the Fraunhofer ISI to develop integrative assessments of complex issues.

- The researchers at Fraunhofer ISI analyze technological, sectoral, regional and national innovation systems, provide orientation and decision-making expertise, support systemic transformation and strategic processes and develop organizational and service-oriented innovations and new business models. Further research focuses are acceptance research, the conceptualization, organization and moderation of stakeholder processes, future dialogues and participation procedures, social scientific research designed to support the development of new technologies, and foresight processes such as scenario development and roadmapping, as well as technology forecasting and assessment and analyses of potentials.
- The knowledge gained through these methods enables Fraunhofer ISI to provide strategic advice to political and economic actors on the subject of innovation and to support the development and application of innovative technical and non-technical solutions. In this way, it contributes to mastering comprehensive social, environmental and economic challenges and to maintaining the sustainability of the economy and society.
- Fraunhofer ISI cooperates closely with the Chair for Innovation and Technology Management (iTM) at the Karlsruhe Institute of Technology (KIT). As an international leader in innovation research, Fraunhofer ISI maintains an intensive scientific dialogue with the USA, Japan and the BRICS countries, for example, through visiting researcher exchanges. Fraunhofer ISI works closely with its partners, the Karlsruhe Institute of Technology (KIT), the University of Kassel, the University of Strasbourg, ETH Zurich, Virginia Tech in the USA and the CAS Institute of Science and Development (CASISD) in Beijing.



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Fraunhofer Center for International Management and Knowledge Economy IMW

The 169 employees at Fraunhofer Center for International Management and Knowledge Economy IMW in Leipzig are engaged in the research and development of strategies, structures, processes and instruments for transferring knowledge and technologies between organizations, translating knowledge into innovation and the understanding and designing of the associated framework conditions – with a strong international focus.

- Fraunhofer IMW generates scientifically well-founded solutions and results for the long-term success of its clients and partners from business, politics, science and society. It compiles facts, information, research, analyses and studies concerning the challenges of globalization, digitization, disruptive developments and the economic and social changes that arise as a result.
- Its employees, who are anchored in research and teaching, concentrate their activities at the institute on the competence fields of innovation management and innovation economics in the knowledge economy, international management, international knowledge and know-how transfer, innovation financing, technology and competition analysis, development cooperation, socio-economic future analyses, innovation policy, business models, price and service management, quantifying and competence management, organizational development, stakeholder dialogues and social acceptance and digital transformation. In all of these areas, their primary focus is on questions of future value creation processes and networks and on interactions between technology and social systems.
- As partners to industry, politics and science, the Fraunhofer experts from Leipzig work as specialists within a wide-ranging national and international network. In their research, they use a Big Data Center to bring the latest empirical findings, data analyses, simulations, real-time forecasts and visualizations to bear on the development of innovative solutions for customers and research partners.
- Working in interdisciplinary research teams, Fraunhofer IMW researchers support companies, SMEs, ministries, federal and state commissions, the European Union and national and international institutions and organizations in anticipating, designing and implementing innovative solutions and strategies. Fraunhofer IMW cooperates with Leipzig University, the Leipzig Graduate School of Management, the Friedrich Schiller University Jena and a variety of scientific and professional organizations in Germany and abroad.



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Management and Knowledge
Economy IMW*

www.imw.fraunhofer.de/en/

Fraunhofer Institute for Technological Trend Analysis INT

The Fraunhofer Institute for Technological Trend Analysis INT with its 117 employees and its department of Technological Analyses and Strategic Planning (TASP) conducts research on technology and innovation management for a variety of customer groups – predominantly, but not exclusively, in the field of security and defense.

- The methods of the INT in this area cover all phases of innovation planning: requirements analysis, analysis of the current state of research and technology and analysis of the innovation environment and of the framework conditions, as well as the preparation of concrete recommendations for action. One of the outstanding features of its methods is that they often bring together a variety of social actors. Demand, research and innovation potential are situated within a time horizon of five to 25 years.
- With over 40 years of experience in the field of technology foresight for the German Federal Ministry of Defense, in which the institute provides support for analysis and evaluation capability with regard to technological developments and their impact on the German Federal Armed Forces, Fraunhofer INT has unique experience and expertise in the evaluation of emerging technologies and their development potential. Moreover, with the expertise in non-military research and innovation processes it has developed over the past decade, Fraunhofer INT is in a position to accompany and support cross-border innovation processes involving many highly heterogeneous groups.
- In addition to a unique holistic (360°) view on technological developments, Fraunhofer INT offers particular competencies in the areas of technology forecasting, technology scouting and civil protection and disaster control, as well as social resilience (resilience management). This professional competence framework is underpinned by expertise in the areas of bibliometrics, IT-supported data analysis, futurology and methods of participative and creative knowledge generation.



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www.int.fraunhofer.de/en/

Fraunhofer Information Center for Planning and Building IRB

With 98 employees, the Fraunhofer Information Center for Planning and Building IRB is the central institution for the national and international transfer of expertise in the field of construction and building. As a specialist information center with an integrated publishing house, it makes information and knowledge from research and practice accessible to a broad specialist public. Its main priority in the preparation and transfer of information is the accurate, reliable, neutral and objective evaluation of information.

As a specialist in dealing with knowledge, Fraunhofer IRB is an important service provider for the transfer of knowledge among different target groups from research, business and politics. In this way, it makes an important contribution as a multiplier for research findings in promoting innovation activities not only for the construction industry, but also for all disciplines within the entire Fraunhofer research community.

From this experience accumulated over many years, Fraunhofer IRB has developed competencies that have been brought together in the Competence Center "Research Services & Open Science" and have been translated into a comprehensive service portfolio in the area of Open Science and technology transfer. Within this field, the Competence Center develops strategies and concepts for the effective implementation of knowledge generation processes of the management, transfer and exploitation of research findings. It aims to make this knowledge available in a timely manner so that it can be integrated into (open) innovation processes, thereby shortening innovation cycles. The portfolio includes consulting services and technical infrastructures that enable project partners to effectively transfer and implement processes of the generation and dissemination of technological knowledge (from idea to exploitation).

The five core competencies of Fraunhofer IRB include:

- Development and transfer of (construction) knowledge from research and practice for a broad specialist public.
- Consulting on Open Science in the context of research and development projects (with priorities on Open Access, Open Data, Open Source and Citizen Science), which also takes into account the requirements of the digitization of science, business and society.
- Development of dissemination strategies for the transfer of technological knowledge in science, business and society with the target of increasing impact.
- Development and provision of infrastructure for the collection and publication of reports and research data (and research software).
- Consultation on the use of technological knowledge in (open) innovation processes and in general in the field of tension between scientific and economic utilization.



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