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FIR Research Framework Plan 2018 – 2023

fir at RWTH Aachen University

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Making use of research. Adding value.

1 Initial Situation and Positioning of FIR

FIR was founded over 60 years ago with the aim to establish and intensify research in the area of business organization. Since then it has produced significant results in form of reference models and frameworks for the organizational design of manufacturing, logistics, and services companies. In enterprises, the interplay between organization and information systems has always played a significant role. The ability to structure information, to distribute it, and to use it to solve corporate design and decision problems, has been the focus of numerous research studies.

The Institute for Industrial Management FIR is a non-profit, intersectoral research and educational institution at RWTH Aachen University concerned with business organization and corporate IT with the aim to establish the organizational basis for the digitally conntected company of the future. By developing and transferring innovative solutions, FIR contributes to enhancing the competitiveness of companies. This is achieved within an infrastructure that is ideally suited for experimental organizational research – methodologically sound, scientifically rigorous, and conducted in close collaboration with experts from business and industry.

The institute supports companies and provides research, qualification programs and lectures in the fields of production management, services management, information management, and business transformation.

As a Johannes Rau Research Institute, FIR supports the research strategy of the Federal State of North-Rhine Westphalia (NRW) and participates in research clusters to strengthen NRW as a hub of research and innovation. In this role, FIR is committed to pursuing research in the following key topics:

- **Industry and Environment** – How can we make production, logistics and mobility environmentally and economically sustainable in the long term?
- **Cities and Infrastructures** – In the face of demographic change and ever changing requirements, how can we create 'liveable' cities and adequate infrastructures?
- **Society and Digitalization** – What opportunities and risks does the digitalization of all areas of our lives present and how can we shape this development for the benefit of the individual and society?
- **Globalization and Integration** – How can we shape the impacts of globalization at the local and regional levels in different locations of the world in a humane and responsible way?

2 Objectives

FIR is seeking to take on a leadership position in the field of organizational research. This is to be achieved by focusing on questions in **organizational research for the company of tomorrow**. To a large extent, even if not fully, the company of the future is to be understood as an **information-processing system**. Thus, a strong emphasis will be placed on the preparation of data and their targeted use, following an **information logistics** approach. Based on this, answers to questions concerning the design of new value creation logics will be developed. To meet the requirements of a consistent organizational design, the fit between information-processing systems, overall organization, resources, and corporate culture will be taken into account.

The research framework plan of FIR e.V. at RWTH Aachen University describes the measures designed to achieve the above objectives. It specifies the strategic research aims and the corresponding objects of research for a period of five years. Concerning specific objects of research, it is a medium-term plan that defines the direction and content of research proposals, doctoral theses, studies, and major research initiatives.

3 Perspectives

Today, both the economy and society are undergoing a dramatic change, both nationally and internationally. This change is characterized by increasing digital interconnection, which results in significant leaps in productivity and completely new business models. The concept of digital transformation, which is used in this context, is strongly marked by four developments:

1. The **omnipresent social connectedness of individuals**, which has led to an unforeseen level of information exchange and a vast accumulation of knowledge in communities and forums.
2. The **exponentially increasing interconnection of physical objects** subsumed under the concept of the Internet of Things. This interconnectedness is making available a massive amount of data on the states of technical objects and systems, whose analysis and interpretation also results in a massive increase in knowledge and provides a completely new basis for predictions and decisions.
3. The emergence of **new software and IT architectures** can be seen as the third major development. The turn away from local, monolithic systems to distributed, but fully integrated systems (e.g. in the cloud or based on blockchain technology) facilitates the implementation of the concept of an explicitly unambiguous data pool which is free of redundancies and prevents version conflicts. New database architectures and in-memory processing techniques make it possible to perform database operations and analytics in near real-time.
4. The forth decisive development is due to technological progress in the areas of **data transmission and networking technologies**. New transmission techniques and standards such as 5G make it possible to achieve unprecedented bandwidth efficiency and thus high transmission speeds and more efficient use of available bandwidths

These four trends describe, in particular, developments in the area of information and communication technology that make it possible to interconnect people as well as machines, integrate software systems, process data in real-time, and transmit data and content of any kind with – in the near future – basically unlimited bandwidth and speed.

The four developments outlined above will be supplemented by **data analysis techniques** as well as **artificial intelligence and machine learning methods to process Big Data**. With the help of analytics options such as descriptive analytics, diagnostic analytics, predictive analytics, and prescriptive analytics, **corporate decision-making is supported and possible alternatives for action are generated**. Using augmented reality techniques, for example, decision-relevant information will be integrated into the work process. Moreover, data analysis and machine learning capabilities provide the **basis for new data-based services and business models. Technologies such as blockchain and additive manufacturing are considered to have, in addition,**

Digital, agile companies outperform traditional companies due to reduced latencies

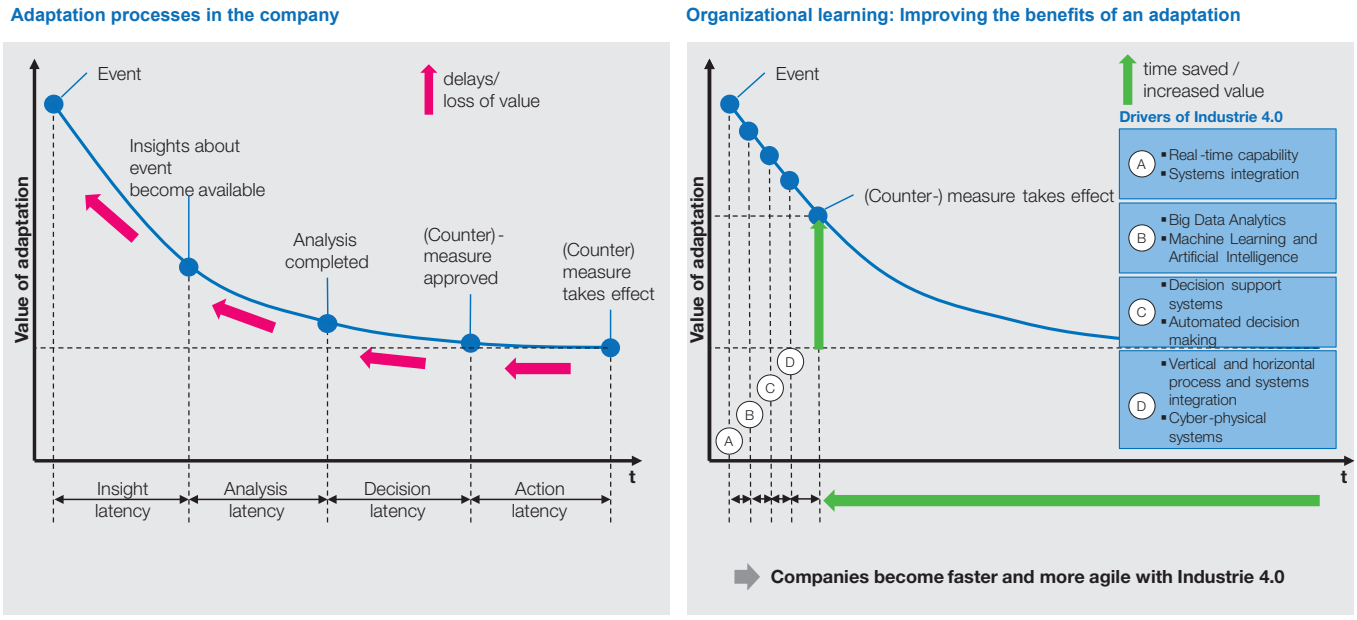


Figure 1: The digital, learning company

The Internet of Production provides the overarching vision for the implementation of Industrie 4.0

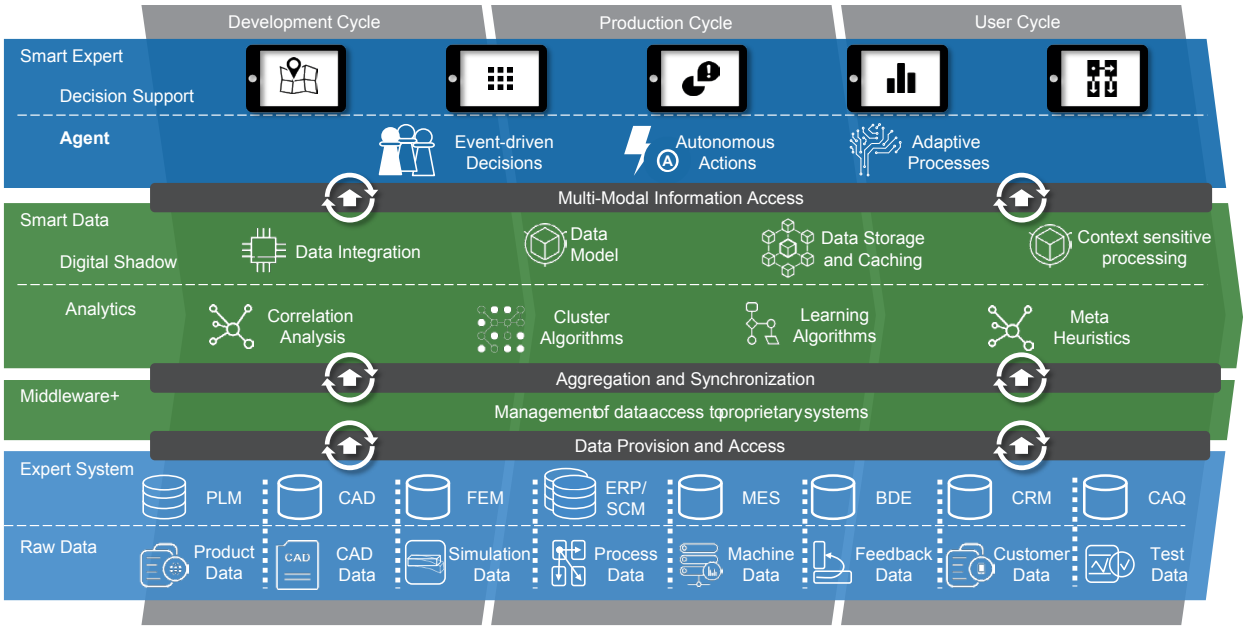


Figure 2: Infrastructure of the Internet of Production – IoP

a transformative potential – it is expected that these technologies will result in a variety of changes in our economy, some of which will be disruptive.

The interplay of the outlined developments and technology trends not only begs the question of what innovative services and offerings will be offered in the future and how they are developed, but also of what types of enterprise and organizational structures are emerging in the process. Moreover, new roles and job requirements are emerging as part of the development of new o**rganization and information architectures**. Both the significance and the concept of work will change and result in new forms of work organization.

The overarching goal of the digital transformation of companies is to create a learning, agile enterprise which, based on suitable IT-based technologies and the capability of organizational learning, is able to adapt to changing market framework conditions.

From a results-oriented perspective, new services and structures can be understood to result from digital transformation. When developing and implementing new offerings, speed is a key factor for competitiveness. Aside from the results-oriented dimension, the question of what **organizational forms** – in interplay with **information systems** – will be able to achieve speed and agility is of central importance. The ability to control and reduce latency times will become an important component of competitiveness (see Figure 1).

The ability to process and interpret data offers entirely new perspectives on the design of business models as well as production and logistics systems. The traditional understanding of a product as a tangible good at the center of the market offering is replaced by a perspective which understands the product as a platform for services. This trend is already visible in the automotive industry.

In this context, the Aachen approach of the **Internet of Production (IoP)** (see Figure 2) plays a decisive role. The IoP is the central enabler of an increase in agility of manufacturing companies. Agility is the strategic ability to open up new markets proactively. Apart from developing the requisite market offering, i.e. products and services, it is necessary to build up the necessary manufacturing capacity. This requires the introduction of highly iterative development processes in the **development cycle** and the establishment of proactive, adaptive production systems in the **production cycle**. The **user cycle** makes it possible to upgrade products already on the market based on customer feedback.

The IoP enables companies to make decisions requiring data and information from different domains faster and on a more well-informed basis. In future, the infrastructure of the IoP will allow the easy development of application-specific apps. Thus, interdisciplinary questions and problems can be resolved at an entirely new level of quality.

The **smart expert layer** consists of intuitive, mobile apps. By accessing generically prepared, application-specific information from different domains – aggregated from different expert systems – apps can be created extremely rapidly. These apps offer decision support when complex decisions need to be made. Starting with decisions made by humans, these agents, based on artificial intelligence, learn to identify decision options for future decisions. In case of well-defined problems, the agent is able to recognize recurring decision situations and automatically suggest – or even initiate – actions.

The **smart data layer** enables multimodal access to aggregated and thus refined data from different domains which are turned into information.

The **digital shadow** provides a realtime-capable representation of the relevant relationships between all processes. The digital shadow is generated through the cross-domain integration of aggregated and refined data from proprietary expert systems and becomes part of the smart data layer.

As a result of the integration of data, data models that describe cross-domain relationships are created. The correlation of product features from CAD drawings with quality data from the CAQ system can serve as an example. The models and the data are stored in a way that they can be rapidly made available, prepared to match the requirements of the specific case under analysis, to the smart expert layer.

The latency times for the provision and analysis of data can thus be significantly reduced. **The digital shadow** is generated through the preparation and refinement of raw data with the help of analytics methods. The methods provided at the smart data level make use of the knowledge already acquired from the relevant domains. **Raw data** from proprietary **expert systems** provide the input for the smart-data level. Access to these data is enabled through **Middleware+**.

In view of the various developments and challenges, it can be concluded that in future, the research-methodological approach to FIR's key research areas must, even more so than before,

1. have an even stronger interdisciplinary scope,
2. be more experimental in character
3. build on real-world use cases of the "large" demonstrator type, so-called Verticals.

In future, the focus will be placed on the following industrial verticals as use cases: S**mart Mobility, Future Logistics, Smart Maintenance, Smart Services, and Smart Commercial Buildings** (see Figure 3).

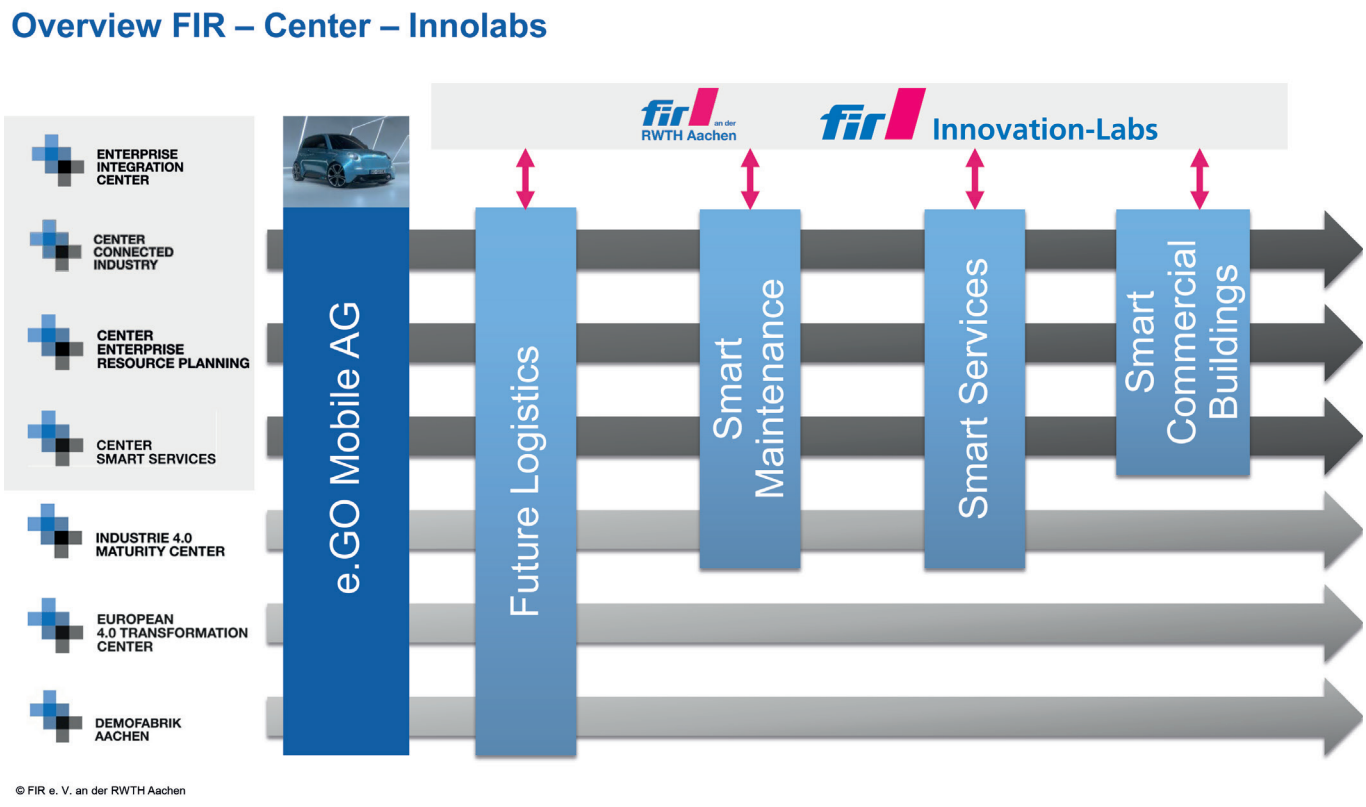


Figure 3: The five relevant Verticals

4 Vision and Mission of FIR as a "Research Clinic"

For many years, FIR's mission has been to help create the company of the future. In future, this will take a more concrete shape in the form of the "Smart Enterprise":

"The company of the future is a learning company. It bases its decisions on data and facts and has the capacity to anticipate future states and conditions. It identifies data-based patterns which provide a sound basis for decision-making.

The company of the future possesses a digital representation of all relevant aspects of reality and uses data management, analytics, and artificial intelligence methods to re-design business processes at the strategic and operational levels.

It shares its knowledge within the organization with partners and within ecosystems by using intelligent assistance systems.

Its performance is focused on creating value for customers, and, due to its agility, it is fast and efficient in its operations. The transformation of the company of the future into a "Smart Enterprise" takes place at the levels of organizational structure, information systems, (human) resources, and corporate culture."

Based on application-oriented fundamental research, the overall objective of FIR is to develop the methods and techniques that are required to turn this vision into reality.

In order to achieve this ambitious goal, new forms and ways of conducting research on and designing businesses and their subsystems are required: many research methods prevalent in organizational research today observe reality from outside – approaches that in future will no longer suffice to gain a systemic understanding at the required speed and depth.

Following an experimental research approach, the goal must be to build the required transformational knowledge by combining insights from the lab with experience from real-world companies. This is reflected in FIR's business model, which is to provide solutions to relevant questions and problems from industry in innovative research projects.

To this purpose, it is essential to build the bridge between experimental research in the lab and generalizable knowledge for industrial enterprises. The concept of the "Research Clinic" provides a strategy of how to achieve this (see Figure 4):

In this, FIR and other research entities at RWTH Aachen University benefit from the establishment and expansion of the various RWTH clusters and centers on RWTH Aachen Campus and

Disruptive change requires agile adaptation in real-time:
The Innovation Clinic as a new approach to research.

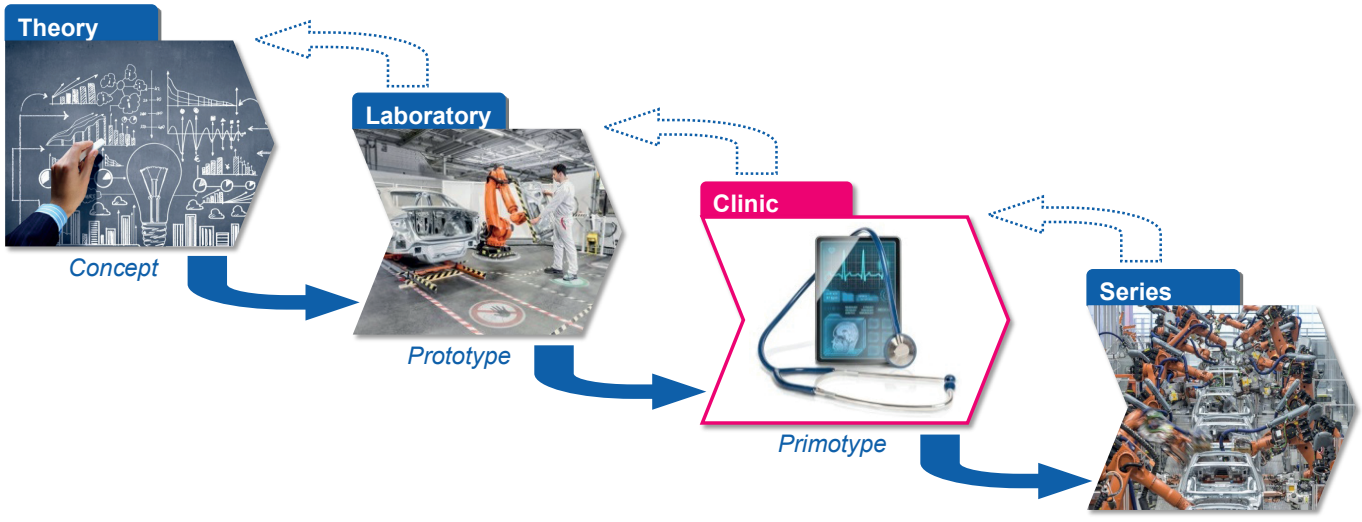
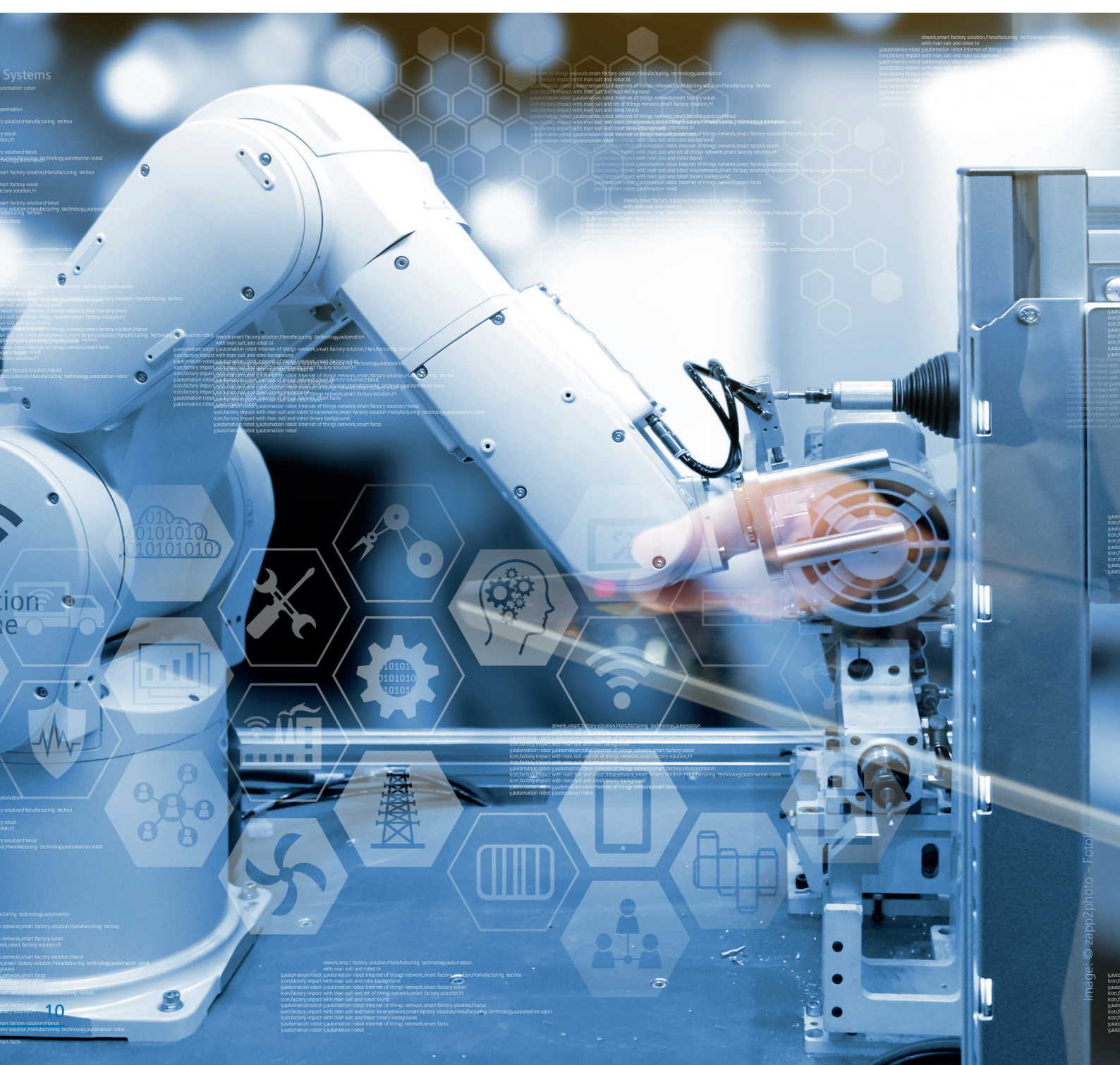


Figure 4: Disruptive uncertainty demand agile change in real- time: This requires the Research Clinic as a new approach to research.

contribute to its further development. Jointly with its partners, FIR will continue to pursue an approach of application-oriented research that places particular emphasis on the creation of digital representations as well as the visualization and simulation of complex organizational relationships in FIR's areas of research. Furthermore, this approach complements the scientific activities of FIR with extensive experimental research in Innovation Labs and in a production site operated under real-world conditions, the Demonstration Factory (DFA).

Going beyond the experimental approach to organizational research, there is a possibility to take one more decisive step towards acquiring conceptual knowledge on how to design future organizational forms: By establishing one's own entities on Campus, it becomes possible to gain profound insights into the various design options and identify factors for success. In this way, unique knowledge is being built, an approach which in this form is only available at FIR's facilities on RWTH Aachen Campus.



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5 Future Thematic Priorities

FIR has identified the following research priorities:

1. Concerning the design of future organizational forms, the focus will be on how companies, in accordance with the concept of the platform economy, can come closer to achieving the ideal of zero marginal costs; how control points for customer relationships and/or the generation of information can be occupied; what types of enterprise will have access to resources and data; and how these resources and data will be distributed.
2. Concerning the design of future forms of work and work systems, central questions include the measurement and assessment of work results and the coordination of self-organized work, as future organizational forms may require more flexible, multiple employment relationships replacing, to some extent, regular employment. The future organization of work will be characterized by boundless mobility and the automation of routine work activities. The mobility of labour will, among other things, pose new challenges for leadership and the creation of appropriate corporate cultural conditions. The significance of artificial intelligence technologies to support work and decision-making processes will continue to increase. Work will more and more evolve into 'decision work', which is responsible for assessing the alternatives proposed by technological systems.
3. As part of the emergence of a new understanding of production, the significance of the physical aspects of a product will continue to decrease, as the utility of the product will no longer be solely derived from the basic technical functions of the product. The physical system of the product is increasingly understood as a platform for services, and the product's major benefits will be defined by software components. New product offerings will become possible, promising new and enhanced performance capabilities on a continual basis through the flexible provision of upgrades.

Against the backdrop of the above named drivers of digital transformation, it becomes clear that due to the interplay of the four development trends summarized in Chapter 3 on "Perspectives," completely new forms of exchange of products and services, value creation; and organization are emerging. This takes place at the level of the company as a whole, the level of operational processes, and at the level of work organization.

The objective of digital transformation is to develop a learning, agile company which is capable of adapting to changing framework conditions with the help of suitable technologies and organizational learning.

In order to meet the above named requirements, it is essential to explore new ways in the research and integrated design of complex, highly interdependent value creation systems and organizational forms – this applies to both theoretical knowledge and application-oriented basic research. The currently dominant research paradigms in organizational research, which are based on the observation of already implemented concepts, will no longer suffice.

FIR will continue and further develop its approach to design-oriented organizational research using the infrastructure and platform provided by RWTH Aachen Campus. The infrastructures, Innovation Labs and Centers of the Smart Logistics Cluster located on RWTH Aachen Campus enable an explicitly experimental approach to organizational research. Moreover, RWTH Aachen Campus offers a platform for the establishment of new companies which, following the model of e.Go Mobile AG, allow to generate new insights that can only be gained through the direct, immediate experience of building and running one's own companies.

- Production Management
- Service Management
- Information Management
- Business Transformation

6 Thematic Research Fields at FIR

The four key research areas addressed by FIR in the long term are:

- **Production Management**
- **Service Management**
- **Information Management**
- **Business Transformation**

The specific topics and directions of research within the four areas are aligned with the overarching objectives of FIR as outlined in Chapter 3. Against this backdrop, the focus on these four areas of research is motivated by two important factors.

First, two areas that are particularly important for the German economy and its development are examined in detail, the **production and logistics economy and the services economy**. Both areas are represented by the two research fields of production management and service management, which are independent and have been established in the long term. FIR has long-standing experience and is well-established in both fields of research.

Second, these two research fields are complemented by those of **information management and business transformation**. Considered individually, these are independent, more recent fields of research. The effective use of information and the implementation of digital transformation in the company are significant success factors for the economy; by its expertise in these fields, FIR underscores its ambition to play an active role in shaping future economic structures. From the perspectives of production management and services management, strong research links with the fields of information management and business transformation will result in synergies.

6.1 Thematic Field „Production Management“

From the thematic priorities outlined in Sections 3 to 5, four target scenarios can be derived for production management. In this thematic field, these will constitute the key drivers for our research activities:

- Value creation structures are highly dynamic and flexible. The development of products and services takes place platform-based and in parallel. Taking the underlying level of uncertainty into account, all decisions are made in a highly automated fashion, almost without human intervention
- Any demand for physical products and services is triggered by pull principle: The focus is no longer on the speed of performance, but on the quality of performance and on uniqueness. Fully automated performance delivery systems are strictly built in accordance with these restrictions.
- Production planning is highly automated and controlled based on humanly defined and weighted targets. Resources are allocated efficiently and sustainably. Human labor and resources are optimally managed.
- Production is context-sensitively controlled and visually supported. Facilities and equipment continuously exchange information via the Internet of Things, which makes it possible to monitor production globally across systems at the desired level of detail. IN addition, production systems become capable of learning by using artificial intelligence methods.

6.1.1 Guiding Hypothesis and Key Research Question for the Thematic Field

Integral components of production planning and control, logistics, and supply chain management include, apart from the operational implementation level, the planning, coordination and control of material, information, and value flows in value creation networks, systems, and processes. As part of the increasing digitalization in accordance with the **Internet of Production (IoP)** paradigm, all data along the horizontal and vertical supply chain can be made available in real-time. With the help of appropriate methods of analysis, these data can be aggregated to provide information and lead to recommendations for action.

Thus, the objective of this thematic field leads to the following guiding hypothesis:
Decisions in production management are exclusively made on the basis of data. This leads to quicker and better decisions which help adequately to react to deviations. Here, potential solution scenarios in the solution space are subject to system-inherent endogeneous and exogeneous uncertainties. These result in specific

degrees of automation in decision making. Scenarios with a high degree of uncertainty require the implicit knowledge of humans in order to increase the quality of potential decisions. By taking prior decisions into account, the solution space is continually broadened and the degree of automation of future decision increased. In summary, the role of human individuals in production and logistics systems is currently undergoing a significant change, from an executing to a decision-making entity.

Research Question:
How is a data-based, IT-supported and thus intelligent organizational structure to be designed for an agile, learning company which secures adaptability of dynamic production and logistics systems?

Thus, essential principles of the thematic field "Production Management" include agility and adaptability (proactive change of adaptable structures and processes); integration and interoperability of close-to-production IT systems; network connectivity (cross-domain exchange of data and knowledge in production and logistics networks and with supply chain partners); and real-time capability (ad-hoc availability of relevant planning and control information without delay).

6.1.2 Key Research Focus "Intelligent, Data-driven Production Control"

The vision of an intelligent, data-driven production control outlines the real-time-capable provision and processing of data as well as decision-making based on the **digital shadow** for in-house production scheduling and control. The digital shadow provides a **sufficiently accurate, real-time-capable representation of all relevant data**. The application of pattern recognition and prognostic methods to these data provides decision support and enables mastery of complexity in production. Taking the results of the analysis and the chosen solution scenario into account, **learning from data** opens up a significant value creation potential. The objective of the key research area Intelligent, Data-driven Production Control is based on the hypothesis that the access to high-resolution data and their processing can **increase the efficiency of in-house production planning and control**. Accurate predictions of the future production system which **take the impact of confounding factors into account** become possible. Prerequisites for the use of data analysis methods include the identification of **relevant slices of reality in form of data models** and the integration of suitable data processing approaches in operational processes as well as in-house production planning and control.

Research Question:
How can the efficiency of processes and decisions within in-house production planning and control be systematically improved with the help of data-driven approaches? The main focus is on gaining knowledge and insights through experimental research with the help data-based models and real-world company data.

6.1.3 Key Research Focus "High-frequency Agile Production Planning"

High-frequency, agile production planning leverages existing data for the planning process and focuses on the orchestration of the **production- and logistics-related IT systems architecture** and the attendant business processes alongside the processing of orders.

Here, the integral use of **Advanced Data Analytics** to achieve automated decision-making and implementation in production planning and control is essential. The **aim** is to process high-resolution movement data in real-time analytically and in a goal-driven manner (keyword: digital shadow), in order to achieve a **high-frequency, flexible planning and control of production**. In the process, planning data is continually updated through the technology-driven collection of actual data (e.g. through automated feedback), with the aim of increasing the quality of future planning targets (e.g. through self-learning work plans).

One of the key success factors is an **information logistics** which makes use of available company-internal and company-external data in real-time, constituting a well-aligned **IT systems architecture**. In future, **real-time data** are aggregated into **real-time information** and made available in a form that is tailored to the respective target audience. These data are made available in a decentralized fashion to the right locations and at the right frequency, either as a decision support or as a basis for automated decision-making. Agile companies analyze such information in an automated fashion in order to derive and implement measures from solution scenarios for production planning purposes. The basis for this is largely provided by the paradigms and methods of **Advanced Data Analytics**.

Research Question:
Taking a production planning perspective, how must the IT system architecture for an agile company be orchestrated, combined, and calibrated? How does the support of production planning and control, based on Advanced Data Analytics, look like for a company on a path towards becoming a learning, agile enterprise?

6.1.4 Key Research Focus "Supply Chain Data Management"

Currently, completely new forms of **multilateral collaboration in dynamic value creation structures** are emerging. In this context, central entities claiming sovereignty over data and controlling the exchange of data are becoming obsolete. Through **cross-domain and cross-company data exchange, supply chain management** is being transformed into supply chain data management.

To secure **cross-company, end-to-end data availability**, organizational structures and technologies for the inter-organizational use of data are to be developed and tested. The **platform-driven centralization** of data use is diametrically opposed to approaches which seek to **gain sovereignty over decentralized data silos**. Concerning cross-company communication, a transaction-based corporate reality requires **much more than the mere bilateral exchange of data**. Data and information must be made available and usable to all potential partners in value creation. To achieve this, it is essential to use suitable technologies (such as blockchain) and reference architectures (such as Industrial Data Space).

Research Question:
How can cross-company data availability, which increases transparency in dynamic value creation structures, be realized? What potential does technology-secured data management offer to facilitate collaboration in value creation networks?

6.2 Thematic Field "Service Management"

6.2.1 Guiding Hypothesis and Key Research Question for the Thematic Field

The industrial services sector, in particular, has become more and more important both in research and industrial practice. Companies have expanded their portfolio to include product-related services and are now seeking opportunities to professionalize their service business in an increasingly competitive environment. **Many companies are already transforming themselves from manufacturers to service and solution providers.**

The complex field of data-based services, in particular against the backdrop of digital interconnection, is to be seen as a major future challenge. Companies are looking for opportunities to enhance and complement their offerings – or even to develop entirely new offerings and business models – with the help of data-based digital technologies. Following the Service-Dominant Logic paradigm, particular emphasis is placed on the alignment of activities to maximize customer value. In future, only those companies will be successful that are capable of quickly and effectively aligning their offerings with changing customer needs and demands (core skill: agility). Central in this context are digital business models that combine smart products with physical and digital offerings.

Key challenges for companies include:

- Developing an understanding of digital, platform-based business models within interlinked ecosystems; subsequent development and implementation of such business models.
- Development of a digital shadow for service and maintenance functions; mastery of modern data analysis and artificial intelligence methods.

Orchestrating the distribution of information and knowledge within the company to build agility. By focusing on the operation of machines and facilities, service functions are of central importance for companies in the manufacturing sector. Service and maintenance functions must be interconnected with other functions within the company as well.

It can be assumed that digital interconnection has the potential to call today's organizational forms into question. This applies to the differentiation between functions in the company (separation of functions such as services, development, production, distribution, IT, etc.) as well as to organizational forms of value creation chains. In the reorganization of companies and value creation chains, the question of gaining sovereignty over control points will be of major importance, i.e. the technical and contractually defined access to data.

Research Question:
For the above reasons, in its research, FIR will be concerned with the design of service and maintenance organizations. This will be done against the backdrop of the development and design of data-based services, the data-based management of service organizations, and the design of the collaboration between individuals in organization with the goal of achieving agility.

6.2.2 Key Research Focus "Design of Data-based Service Systems"

This research focus is concerned with the **development and innovation process for data-based services**. At its heart lie the further development of the approach and the methods of Service Engineering. While in the past, the focus in Service Engineering was placed, as far as possible, on a structured, complete, and

step-wise process, now the goal must be to create an agile development approach. Today and in future, **development speed is a crucial**. New offerings are to be brought to market as quickly as possible, in order to occupy control points and learn from the performance of the offerings on the market.

Research Question:
*Emphasis is placed on new, agile development principles for data-based services (e.g. Minimum Viable Services) as well as special distribution concepts for such services. The mechanisms and design elements of data-based digital offerings and business models are to be included in the development approach, as is an **orientation towards the ecosystem** (in contrast to bilateral customer-provider relationships).*

6.2.3 Key Research Focus "Industrialization of Services According to Lean Principles"

At the heart of lean management is the design of an efficient, continually learning – and thus continually evolving – company that is oriented towards customer value. For this reason, the principles of lean management are fundamental for digitally connected organizations as well.

The key research focus is centrally concerned with the **further development of the lean service approach for digitally interconnected, agile organizations**. A core task is the **design and application of the so-called digital shadow**.

Agile, digitally connected organizations make data-based decisions more often and faster.

Research Question:
*In future, the active, **deliberate examination of decision processes** and the mastery of **decision management** are among the core competencies of successful companies. Furthermore, in future, the lean service approach has to take account of value creation in ecosystems and platform approaches.*

6.2.4 Key Research Focus "Smart Collaboration Management"

This research focus is concerned with the d**esign of collaboration** in agile, learning, digitally connected enterprises. Particular emphasis is placed on elements of the knowledge culture, the design of interconnected organizations with the help of social software, and corporate learning. A major challenge is posed by the **necessity of a more frequent modification and adaptation of organizational structures, at least in some areas of the company**.

Research Question:
To achieve this, it is necessary to develop management methods for such organizations and provide answers to the question how information and knowledge can be effectively and efficiently made available to the right people and at the right locations (e.g. by identifying experts or using artificial intelligence methods to support service personnel). Moreover, questions concerning corporate culture and the development of competencies in the long term are to be addressed.

6.3 Thematic Field "Information Management"

6.3.1 Guiding Hypothesis and Key Research Question for the Thematic Field

The overarching objective of the outlined transformation into an agile, learning enterprise is to become capable of continuously adapting the organization in a dynamically changing environment with the help of digital and information technologies (IT). Such corporate adaptability is largely based on the company's ability to learn and to effectively make decisions, which in turn depends on how the company manages its informational resources. IT makes it possible to establish the broad informational basis required to successfully develop this capability. Another decisive factor is the organizational design of the use of information as a resource within the company.

In this context, the concept of **information logistics** provides the key to success – information must be delivered at the right time to the right location and in the right quality to reach the right recipient and thus form the basis for important decisions in the company. Information management, a responsibility of **corporate management for the planning of information and communications and sustained by an effective and efficient IT infrastructure**, plays a decisive role in meeting these requirements. So far, information management as a corporate task has been typically driven by IT organizations. However, due to the digital interconnection of the economy and society, information management has evolved into an **interdisciplinary endeavor** to be addressed by several actors, such as different corporate functions and external service providers, in order to create added value for the company. To be successful in this endeavor, it is required to foster interdisciplinary collaboration following a Business/IT alignment approach.

Due to the changed framework conditions outlined above, companies need to define new approaches for the organization of information management. Through the implementation of innovative concepts and the hands-on demonstration of the principles and uses of information management, FIR's Information Management section enables companies successfully to implement digital transformation. The task domain of information management can be defined as **the modeling, evaluation, design and optimization of corporate IT for the provision of informational resources**. Current and future focuses of research in this context are:

- Optimization of information provision within company-internal and cross-company business processes
- Management of innovative information technology solutions for the optimization of business processes, products, and offerings.
- Strategic alignment of corporate IT.
- Guiding Hypothesis

The goal is to optimally support the digitalization of business processes and models using information technology to increase the competitiveness and efficiency of an enterprise. In order to secure a long-term competitive advantage, currently unused IT potentials and future trends in IT are to be utilized. Using effective IT solutions, companies have the opportunity to develop into agile, learning companies and to identify new applications and business ideas.

Research Question:
How can enterprises utilize IT in the best possible way, and how can IT optimally support enterprises in realizing their business strategies?

6.3.2 Key Research Focus "Optimization of Information Provision in Business Processes"

Due to the increasing amount of data produced within companies, decisions which require their interpretation become increasingly difficult to make. As there are numerous and constantly changing decision variants, many companies draw on their implicit experiential knowledge when trying to make the best possible decision. Thus, companies miss the opportunity to make more optimal decisions based on a systematic analysis of the available data. The reason for this is that companies are facing the major challenge of building capabilities to manage information as a resource and design the overarching information logistics infrastructure. The purpose of information logistics is to plan and optimize the utilization of informational resources along their life cycle by integrating IT and processes.

Information logistics assists companies in solving questions and problems along the entire data value creation chain. The goal is to develop concepts and methods to make information flows manageable – from the source to the point of delivery. To achieve this goal, the provision of data through suitable data, IT, and organizational structures plays a major role – starting with the aggregation of data through quality validation through to analytics and finally the user-friendly delivery of information.

Research Question:
How is the information logistics infrastructure in companies to be designed to secure an efficient and effective use of informational resources along their entire life cycle?

6.3.3 Key Research Focus "Management of Information Technologies"

As outlined above, due to increasing digital interconnection, the adaptability of companies has become a major competitive factor. This capability can be developed and enhanced through the use of appropriate IT solutions. However, due to the changing requirements of the company's functions and the dynamics of innovation in information technology, the optimal deployment of IT solutions becomes increasingly difficult. This requires constant modification of application environments, and information technologies take on an increasingly important role in shaping business processes, product offerings, and business models, which must be planned and controlled. For these reasons, information technology management plays an important role in the design of agile, learning enterprises. Information technology management is concerned with the early detection of IT application scenarios in corporate contexts, value-oriented IT concept development, the evaluation and planning of IT applications, and the assessment of the contribution of these factors to decision-making processes in the company.

FIR's Information Technology Management section has expertise on the relevant information technologies for the design of agile, learning companies and their 'intelligent' goods and products; moreover, it is capable of assessing these technologies with regard to their application-specific potential and technical feasibility. This makes it possible for FIR's Information Technology Management systematically to develop novel IT solutions for process, business, product, and service innovations, and implement and validate them in prototype form.

Research Question:
How can digital technologies be expediently selected and utilized to increase the efficiency and effectiveness of business processes as well as product and business model development?

6.3.4 Key Research Focus "Strategic Alignment of Corporate IT"

An optimal business-IT alignment can only be achieved if corporate IT is oriented towards the company's strategic goals and its design strives to achieve a sufficient degree of complexity. Furthermore, there is a demand for corporate IT to contribute to the development and implementation of IT-driven digitalization strategies. To this purpose, concepts, methods and models must be developed which enable the corporate IT to align itself strategically not only to facilitate company-internal digitalization but also to open up digital potentials for customers and partners along the value creation chain. This includes methods with which simultaneously to monitor, evaluate and control the complexity of corporate IT. Furthermore, research needs to clarify what capabilities corporate IT must possess as part of the strategic process and how it can position itself strategically to achieve such capabilities.

IT complexity management seeks to **support companies in the strategic alignment of corporate IT** in order to implement digital transformation at an appropriate level of complexity.

Research Question:
How must corporate IT be designed and aligned so that long-term added value can be secured for the company at an appropriate level of complexity?

6.4 Thematic Field "Business Transformation"

6.4.1 Guiding Hypothesis and Key Research Question for the Thematic Field

The Business Transformation section understands transformation as a significant, strategically motivated paradigm shift affecting central value creation processes and basic business activities of an enterprise. As a result, these are newly aligned and designed in a fundamentally different way.

The central hypothesis is that the digital technologies outlined above, such as data analytics, the interconnection of individuals and things, and blockchain, not only lead to new services and business models as part of a strategic realignment, but also to a fundamental transformation of the structures, processes, and behavioral patterns of companies. This provides the opportunity for a strategically motivated redefinition of entrepreneurial activities and objectives. This understanding emphasizes a complete redefinition of business activities and thus distinguishes itself from approaches seeking to increase the productivity of existing systems and processes without questioning their importance.

Against this backdrop, the Business Transformation section is concerned with the phenomena, processes, and methods that are part of the transformation of businesses in a digitally interconnected economy. It seeks to answer the question of what methodological foundations need to be created in order to clarify the issue of digital transformation for companies and implement it successfully.

In various thematic fields, FIR's Business Transformation section addresses this question in concrete terms. It creates strategies for the development of platform-based business models and their integration in ecosystems. Furthermore, its activities include the design of purely data-based business models as well as building the required analytics capabilities as a core competency.

The business model, including processes, structures, as well as the behavior and the culture of the organization and its employees, is to be comprehensively transformed and redesigned in order to fulfill the company's purpose and mission. Another relevant thematic field is how to best manage the transformation process, a field which, unlike the other fields, takes a process perspective on the transformation. The process, starting with the transformation strategy and the formulation of a vision and progressing through to the development of a roadmap for implementation, is understood as a comprehensive change process that places high demands on management capabilities and leadership behavior.

Research Question:
How can the transformation, which results from a significant, strategically motivated paradigm shift, be managed and systematically implemented? What new forms of value creation are emerging through the use of digital technologies, and how are the institutional framework conditions to be designed?

Since its establishment three years ago, the Business Transformation section has developed a framework which subdivides the transformation process into a series of major steps, outlining the most important fields of action which must be addressed as part of a successful strategic transformation process. This framework has been further fleshed out in form of a Business Transformation Canvas and now provides structured framework for action for the management of comprehensive transformation processes. The process perspective underlying this framework is now being complemented by research in three key areas explicitly geared towards the design of future companies in a digitally connected economy: Ecosystem Design, Strategic Business Analytics, and Digital Leadership.

6.4.2 Key Research Focus "Ecosystem Design"

In the process of digital transformation, the models and logics of value creation are undergoing significant paradigmatic shifts. Increasingly, platform-based business models and ecosystems are emerging, in which value creation is being reorganized, going beyond existing value chain logics. We are concerned with the development and selection of appropriate strategies to implement these paradigmatic changes and to reduce uncertainties resulting from the entry into a platform-based economy and the requirements of ecosystem design. In our activities, we address questions of monetization as well as questions of institutionalization, for example; other issues to be addressed include questions of openness and accessibility; governance and regulation; and measurability and scalability within ecosystems and platforms.

Research Question:
What types and patterns of organizational form are being created in the process of digital transformation of companies in the platform economy and towards ecosystems? What paths do companies have to take to successfully reposition themselves, and what institutional framework conditions have to be created?

6.4.3 Key Research Focus "Strategic Business Analytics"

The potential of artificial intelligence and machine learning methods go far beyond just providing a significant increase in productivity of existing organizational systems. It is to be clarified how the application of advanced business analytics approaches can open up entirely new competitive positions that redefine the company's purpose and business model. Today, mastery of these diametrically opposed objectives – on the one hand, increasing the productivity of existing value creation models; on the other, creating completely new ones – is being discussed under the heading of Management Ambidexterity and considered to pose one of the biggest challenges in strategic management research. FIR's emphasis in this context is to be placed on investigating the role of modern business analytics approaches as a core competency for the repositioning of companies and on how business analytics must be developed and designed as a strategically relevant capability.

Research Question:
How are advanced business analytics methods to be applied within companies as part of a successful repositioning process, and how are the new organizational structures required in this process to be developed to result in new entrepreneurial capabilities?

6.4.4 Key Research Focus "Digital Leadership"

This key research area is concerned with how the transformation process as such is to be managed, placing a special emphasis on the design of the leadership system. The process, starting with a transformation strategy and a general vision through to the development of a roadmap to realization, is understood as a comprehensive change process that places high demands on leadership skills and behavior. Influencing and shaping the behavior of employees is of particular interest in this context.

Aside from strategic paradigm shifts, which accompany the design of platform-based business models, ecosystems, and the use of business analytics as strategically relevant capabilities, fundamental assumptions and perspectives, leadership structures and styles, as well as forms of communication play decisive roles in the transformation of companies.

With the help of methodologies such as design thinking, shifts in perspective can be initiated. Particular focus is placed on behavioral changes of executives and employees. Thus, the thematic field "Digital Leadership" is concerned with the development and application of suitable models and instruments that help adjust the behavior of individuals and of the organization as a system. Applying methods such as Transformation Readiness Assessment and tools such as the Transformation Canvas, concrete plans for the effective implementation of change processes can be developed.

Research Question:
How can the behavior of individuals and of the entire organization be changed in the digital transformation process to adapt to new organizational patterns and processes in order to accomplish the company's new purpose? What role do the company's management team and their behavior play in this process?

7 Conclusion and Outlook

In accordance with the present Research Framework Plan, FIR has formulated the following mission statement:

„By 2023, FIR will be a recognized opinion leader field of organizational research, providing expertise in the design of future forms of business and work organization. FIR has created the theoretical and structural foundations to achieve this objective. We have invested in new forms of generating knowledge through experiments in the lab and in real-world settings."

In all its activities, FIR will become significantly more internationally oriented and continually benchmark its performance and orientation against international top-class research institutions. At a moment where a massive transformation of the industrial landscape worldwide is expected to take place, FIR will only be able to assess its competitive position by comparing its output and performance against that of other high-profile research institutions. Through careful analysis, the top five to ten institutions in the field are to be identified, with the aim of getting to know and learn from their capabilities and expertise. FIR will seek to initiative collaborations with these institutions, in particular in the following thematic fields:

- Data management and information logistics
- Data analytics – from descriptive to prescriptive analytics
- Pattern development and organizational learning
- Development of new organizational forms which meet the requirements of agility
- Planning and control methods for the smart, agile company
- Decision support systems to assist with decision making in complex planning and design activities

Our mission is to prove our theses through experimental research ("Campus") and to provide solutions to otherwise unsolvable problems ("Clinic").

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8 Appendix: Public Funding Reference Frameworks

Future thematic priorities in research:
In its new High-Tech Strategy, Germany's federal government has defined priorities for research and innovation in areas exhibiting particular innovative dynamism: The Digital Economy and Society; Sustainable Economy and Energy; Innovation at the Workplace, Healthy Living, Intelligent Mobility, and Civil Security.

The Digital Economy and Society
With innovative solutions, we are addressing the challenges inherent in digital technologies, and we are seeking to use opportunities for value creation and prosperity in Germany.

Healthy Living
We are strengthening research aimed at helping people live healthy, active and independent lives.

Sustainable Economy and Energy
The manner in which we produce and consume needs to become more resource-efficient, environmentally friendly and socially compatible. In short, it needs to become more sustainable.

Intelligent Mobility
We are pursuing research in support of integrated transport policies that optimize the different modes of transport in terms of their efficiency, capability and interactions.

Innovation at the Workplace
We are focusing on the profound changes taking place in the modern workplace, since good jobs are an important basis for creative ideas and economic innovation.

Civil Security
Complex systems and infrastructures – for example, for energy supply, communications, mobility and logistics – need to work properly in the every day lives of people.

Figure 8.1: Future thematic priorities as defined in the federal government's High-Tech Strategy

Both the High-Tech Strategy of the German federal government and the European Union's Framework Program for Research and Innovation ("Horizon 2020") constitute the most important research policy frameworks for FIR, defining important key topics for future research projects.

Both programs emphasize their objective to promote innovation in specific application domains. By contrast with earlier programs, they do not consider themselves so much as research funding instruments; rather, with their stronger orientation towards application to address defined future challenges, they place particular emphasis on societal and, in particular, industrial demands.

The future challenges as identified in the European Union's research program are complementary, or even identical, to those of Germany's High-Tech Strategy.

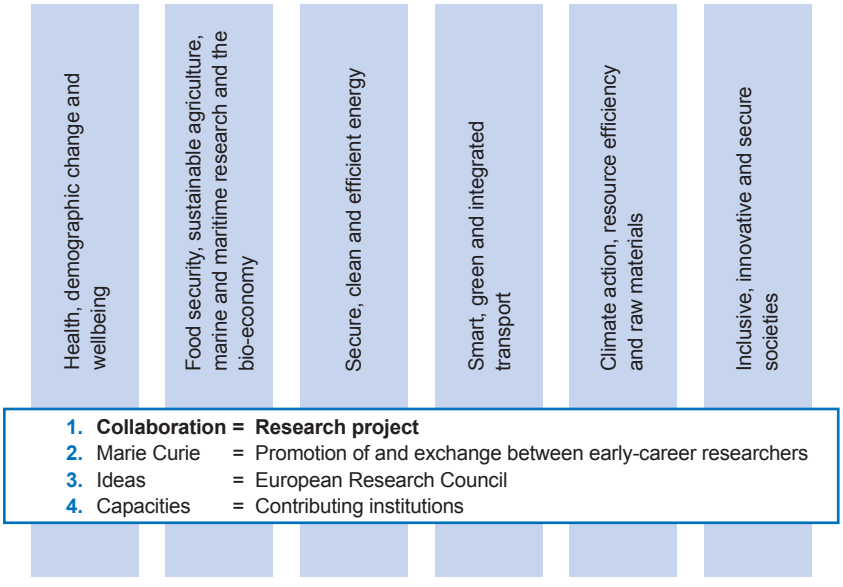

Figure 8.2: The European Union's "HORZION 2020" research and innovation program sets out to address societal and economic challenges

The High-Tech Strategy of the federal government defines central priorities for research and innovation in Germany (BMBF 2015). In its activities, FIR addresses most of the research priorities of the High-Tech Strategy (BMBF 2010) as well as the resulting priority tasks – this is particularly fitting as FIR's approach of application-oriented basic research is well-suited to answering questions across sectors. In particular, the priority task "Digital economy and society" is being addressed as a cross-sectional task within FIR's present and future areas of research (BMBF 2015) and thus plays a shaping role for FIR's future activities in research.

Key topics and issues as defined in the Strategy's central areas of action "Industrie 4.0" and "Smart Services" play a major role in defining FIR's activities. In addition to other key concepts within these two areas of action, the concept of software-defined platforms represents one important foundation for research at FIR.

Digital infrastructures for the basis for new business models

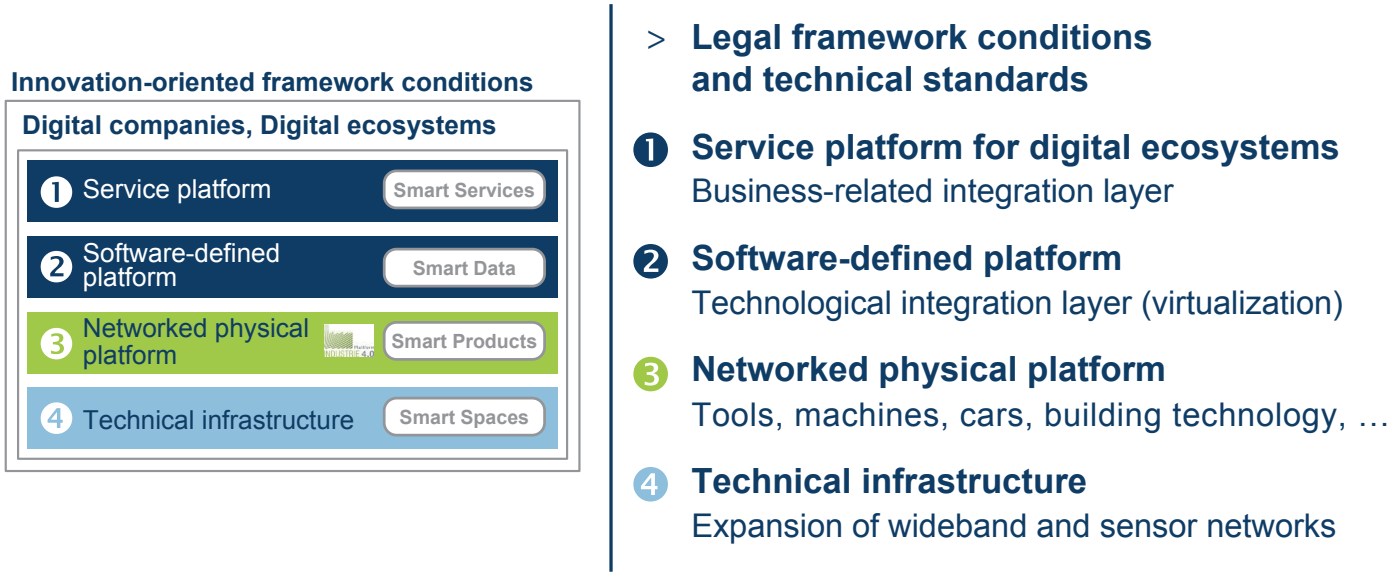

Figure 8.3 Concept and architecture of software-defined platforms in the world of smart services (Source: acatech)

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