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# Digital Transformation Case Study: BASF

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*“We haven’t set an end point to the journey because we recognize this is a space where there is constant updates and acceleration. We want to figure out how to adopt capabilities over time and constantly develop new offerings. It is constant and ever evolving.”*

– Richard Trethewey  
Vice President,  
Digitalization of R&D

*“We live in an exponential world and cannot say ‘today we are digital.’ It is ever evolving and requires continual adaptation.”*

– Brian Standen  
Head of Digitalization in Materials  
and Chemicals R&D,  
North America

## Executive Summary

Digital transformation has the power to disrupt traditional ways of working and unlock new capabilities and opportunities in practically any industry sector. In this case study, we examine the digital transformation journey of BASF, one of the world's largest chemistry companies.

Research and development (R&D) has been a key growth driver of BASF's more than 150-year history. This case study focuses on the digital transformation within BASF's R&D organization, rather than the entire corporation. BASF's purpose is to create chemistry for a sustainable future. Products and solutions are designed to make the best use of available resources and help overcome challenges. BASF has turned these challenges into opportunities by leveraging innovation competency and building a digital framework.

This case study highlights several factors, many of which are still ongoing, that have contributed to BASF's digital transformation successes thus far:

- **Digitalization within R&D:** The central tenet of BASF's digitalization journey is the effectiveness of applying digital capabilities within R&D. At BASF, prioritizing digitalization in everyday R&D operations improves effectiveness of research, increases efficiency, and opens up new innovation opportunities.
- **Collaboration with External Partners:** Academic partners and startups have helped drive digitalization of R&D by improving efficiency in better decision-making, increasing accessibility, reducing cost, and providing access to new capabilities and expertise.
- **New Business Opportunities:** Tapping into digital technologies in R&D enabled the development of new solutions more quickly, complementing existing business and unlocking new opportunities for growth.

**Acknowledgements:** RTI greatly appreciates the time and insights provided by BASF's R&D digitalization leadership. Many thanks to Toralf Senger, Brian Standen, and Richard Trethewey.

## Context for the Reader

This case study is one of a series of case studies IRI is developing to examine successful digital transformation within legacy companies. To evaluate each digital transformation, RTI Innovation Advisors developed a series of perspectives or “lenses” to explore different aspects of the case study company in a systematic and comprehensive fashion. In this and future case studies, we apply these lenses to understand how the company’s digital transformation manifested itself and how the company has changed as a result. Each case study will be documented in the context of the following digital transformation lenses:

- **Strategy** - the corporate, product, and digital strategies and how they inform the business and how or if corporate vision and strategy have changed as an intentional part of the digital transformation
- **Structures** (organizational structures and hierarchies) - how structures, teams, and leadership have influenced the digital transformation work and how the purpose, design, governance, and activities of the organization and teams have evolved as part of the digital transformation
- **Resources** (people, time, funding, etc.) - how resources and their allocations are influenced by digital transformation initiatives and how these have changed digital investments, talent and expertise, and capabilities
- **Culture and Change Management** - how existing beliefs and norms influenced digital transformation and how culture, communication, collaboration, incentives, and training changed in the face of digital transformation
- **Technology and Data** - how information technology, digital systems, and data environments are shaped and evolved as a result of digital transformation. As part of the digital transformation, what changes to technology infrastructure, systems integrations, data management (access, quality, etc.), capabilities, and new applications have occurred?
- **Opportunities and Offerings** - how existing business opportunities and business models influence digital transformation and how in turn business opportunities are changed or are introduced as digital transformation evolves. Customer centricity is often a key aspect of new digital efforts and offerings and will be considered in detail.

If digital transformation explores or affects some or all of the aspects via these evaluative “lenses,” we will include the learning from those changes in our analysis.

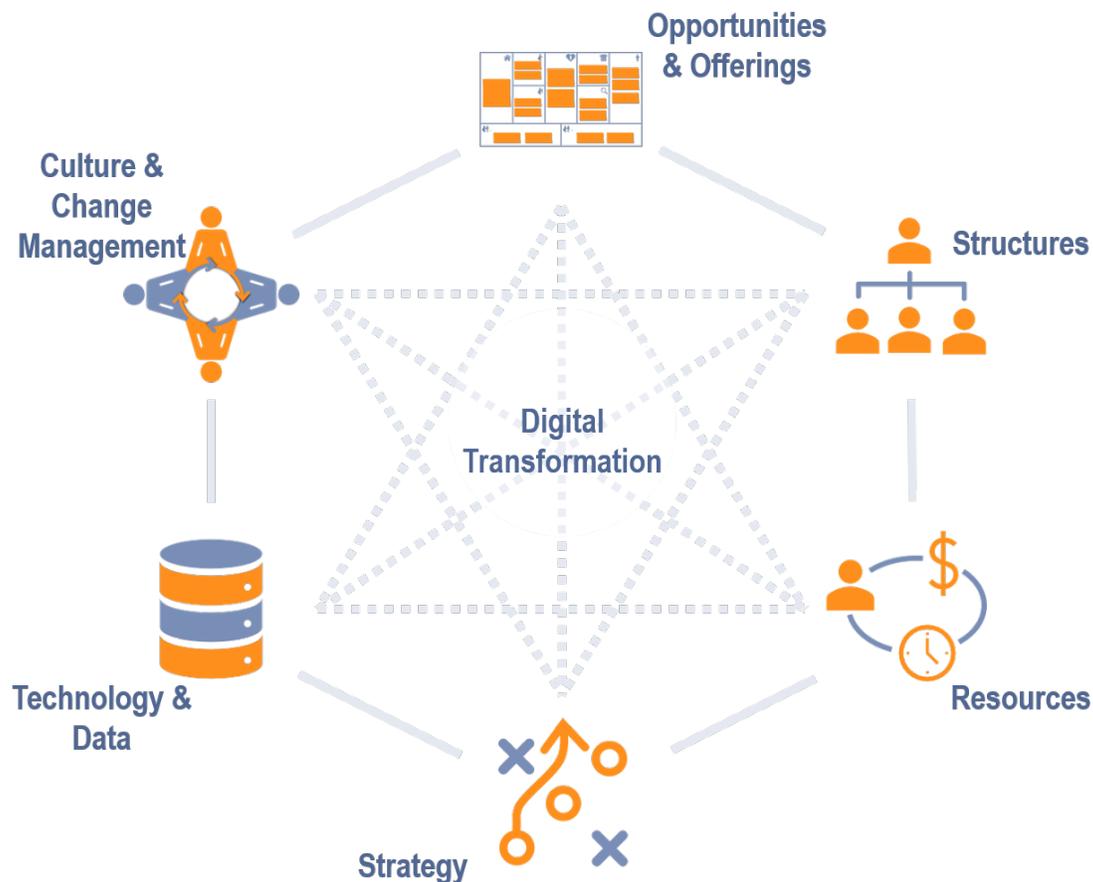


Figure 1 – Six Lenses of Digital Transformation

Each case study will follow a basic organizational transformation construct, examining:

- **Impetus** - Change drivers that led a company to contemplate and pursue digital transformation
- **Preparation** - The specific initial steps taken to set the stage for and embark on the digital transformation
- **Action** - The kinds of actions taken across the key aspects or “lenses” as the company’s digital transformation progressed
- **Maintenance** - Lessons learned and continuing actions to sustain the transformation

## Company History and Digital Opportunity

### BASF—The Company and its History

BASF was founded in 1865 to produce dyes and inorganic chemicals. Today, BASF is a world leader in the chemical industry. More than 117,000 employees in the BASF Group work on contributing to the success of customers in nearly all sectors and almost every country in the world. The portfolio is organized into six segments: Chemicals, Materials, Industrial Solutions, Surface Technologies, Nutrition & Care, and Agricultural Solutions. In 2019, BASF posted sales of \$69.9 billion and earnings before adjustments of about \$5.3 billion.

The BASF case study differs from others in the IRI Digital Transformation series in that we focus on BASF's digital strategy specifically related to its R&D organization. BASF's R&D operation is a key growth driver to the overall company. Approximately 11,000 employees were involved in BASF's R&D in 2019. In 2019, R&D expenses amounted to about \$2.2 billion. In 2019, BASF filed approximately 1,000 new patents worldwide. Also, in 2019, BASF once again ranked among the leading companies in the Patent Asset Index, a method that compares patent portfolios industry-wide.

### The Impetus for Digital Transformation

*Success with Industry 4.0 initiatives, plus other external stimuli, prompted BASF to embark on an R&D-led digitalization journey.*

BASF's digitalization of its R&D journey was reshaped in 2016 to create critical mass behind its years of experience in the field. Capitalizing on the momentum of efforts such as Industry 4.0, BASF determined the time was right for digitalizing R&D efforts to join the company's wider digital transformation. The motivation for digitalizing R&D was catalyzed by both internal and external drivers.

Externally, in 2015 and 2016, there was intense discussion throughout BASF's home country of Germany on how rapid technological progress (including digital technologies) could affect the country's economy. For centuries,

Germany has been a leading global economic force with a vital industrial core. There were considerable concerns that digitalization capabilities would leave the country's automobile manufacturing industry behind. To ensure Germany would play a role in the new digital world, the government created a ministerial role to monitor digitalization, commissioned several studies on modernizing the digital economy, and adopted a number of policy initiatives and regulatory measures to support fair and simple rules for digitalization.

Internally, driven by the conversations happening in Germany, cross-divisional teams at BASF had explored the opportunities for the intelligent use of data and digital technologies and tested them in pilot projects since 2015, as part of the company's wider BASF Industry 4.0 initiative. Following the initial exploration of Industry 4.0 as the first big digitalization push by BASF, the R&D organization became a very specific case for digitalization. BASF recognized a compelling business-

based argument for investing in and leveraging a new digitalization strategy for R&D because innovations developed through their R&D operations are a key driver of the company's growth. A digitalization strategy in R&D was advantageous because R&D expenditures at BASF were seen as a company priority and the strategy positioned R&D as the growth engine of BASF. Thus, linking R&D opportunities, growth, and competitiveness to developing new digital technologies became a priority among BASF leadership.

One of these new digital technologies was the BASF supercomputer, named Quiriosity, which the company purchased in 2017. The supercomputer served as an essential investment in the digitalization of R&D.

### **Why R&D?**

*"There was recognition of the breadth of applications for digitalization and that R&D needed to be one. Our ability to innovate and drive growth would depend critically on adopting technology."*

— Richard Trethewey  
Vice President, Digitalization of R&D

## The Preparation for Digital Transformation

*A group of leaders across R&D's three research divisions collaborated to design a strategic focus and prioritize initiatives to help drive digitalization of R&D.*

To support an agile response to the rapid changes happening in the world, BASF needed to leverage digitalization throughout its R&D organization. To drive digitalization, BASF formed a specific organization within R&D. Staffed by individuals from across R&D's three research divisions, this group further raised awareness of the importance of digitalization in R&D, formulated digitalization priorities, and developed strategic initiatives.

Members of this group remained co-located with their research organizations to enable cross-functional collaboration across research units. The initial digitalization effort of the newly formed department focused on three key opportunity spaces where digitalization could benefit R&D:

- Data Science: Facilitate quick accessibility of integrated data.
- Scientific Modeling: Accelerate modeling and experimentation with simulation and supercomputing.
- Knowledge: Leverage existing data and scientific literature to drive the process of creating and assessing hypotheses.

## The Actions of Digital Transformation

*Merging digitalization and information technology (IT), driving digitalization as one of the action areas of the corporate strategy, and collaborating with external partners were key enablers of BASF's digital journey.*

With a new digitalization team forming, BASF's R&D digitalization strategy began to take shape. Some overarching themes emerge from the story:

- Driving Digitalization as an Action Area of the Corporate Strategy: When Martin Brudermüller, Chief Technology Officer (CTO) and one of the foundational leaders in the digitalization journey, transitioned to his new role as Chief Executive Officer (CEO) in addition to his role as CTO, a new corporate strategy was developed. Digitalization and innovation

were at the forefront of BASF's new strategy, thus becoming important drivers in determining the organization's future endeavors.

- Collaborating with External Partners: External resources are essential to BASF's success as a company, and digitalization has been no different. BASF has collaborated with partners in academia and start-ups who bring deep knowledge in emerging technologies, bridge the knowledge to R&D to enable new digital solutions, and build internal capability.
- Merging Digitalization and IT: BASF recognized the importance of IT's role in transforming digital capabilities. In 2019, BASF merged its corporate IT and digitalization functions into one unit.

The following six lenses highlight key aspects of BASF's actions and progress in their digital journey.

### Strategy Lens



The focus on digitalization within the R&D organization was a fundamental component of BASF's digitalization strategy. At the onset of their journey, digitalization was seen as advanced IT. Since then, BASF's digital leaders in the R&D organization have come to understand digitalization as a new way of working to drive innovation. This change in understanding underpinned the digital R&D strategy linkages to BASF's corporate strategy.

At an organizational level, BASF's strategic goal is to leverage the opportunities digitalization offers along the entire value chain. In doing so, R&D plays a key role in increasing innovative strength and competitiveness by using new technologies. Integrating digital technologies directly into the daily work of R&D enables effective problem-solving and opens up new business opportunities.

Historically, chemical companies, including BASF, have generated enormous amounts of data related to R&D. Thus, developing a digital strategy within the R&D organization

#### **How is digitalization in R&D defined at BASF?**

"We are embracing and adopting a range of capabilities under digitalization and bringing them under the core in how we do R&D. Digitalization helps support and make existing work more efficient and more effective."

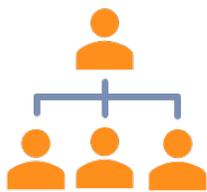
— Richard Trethewey  
Vice President, Digitalization of R&D

was prudent and advantageous to the company. The decision to develop an R&D digital strategy was rooted in the vision to drive economic value, including the ability to leverage digital technologies and enable better and faster decision-making throughout the entire innovation funnel. BASF's R&D management views digitalization as an integral part of the R&D strategy. Digitalization is an enabler and can be used to leverage other parts of the strategy.

As a key leader in bringing digitalization to the forefront of R&D in 2017, CEO and CTO Martin Brudermüller recognized the importance of aligning the corporate strategy with digitalization. Coupling the digital infrastructure with the corporate strategy gives BASF the ability to adapt rapidly to the dynamic requirements of the digital marketplace. Today, digitalization anchors BASF's corporate strategy.

To drive their R&D strategy, BASF uses digital roadmaps as a tool to detail and implement the R&D digital strategy. The roadmaps help set future digital investment priorities by identifying emerging trends and pinpointing the types of digital technologies that will be needed to advance research in the future.

### Structures Lens



BASF's digitalization organizational structure is unique compared with the structures of the other companies RTI has profiled in this case study series. BASF adopted a hybrid digitalization structure. Instead of bringing in people to form a central team, they formed a specific unit within the R&D structure staffed by individuals from the three research divisions. These individuals remained co-located in their research divisions to fully embed staff in their projects and not disrupt interactions with R&D colleagues.

As the new corporate strategy was being developed in 2018, the company had a key realization: IT is critical to transforming digital capabilities; thus, the IT team was central to the strategy. In 2019, BASF established a new Digitalization & Information Services functional division to fold together experts from digitalization and IT into one division. The goal of bringing the two entities together was to drive digital activities more quickly through collaboration with the different business units, functions, and R&D units. This

thinking is not new for BASF. It is a central theme of BASF's "Verbund" principle, emphasizing intelligent integration, not just of production plants, logistics flows, and infrastructure, but also of expertise and demand. It has proven to be a strong foundation for the launch of their digitalization strategy.

### Resources Lens



BASF's commitment to talent and organizational structure has been at the forefront of digitalizing the R&D strategy. This commitment has prioritized investment and provided a critical foundation for growing digitalization efforts. Additionally, BASF has relied heavily on outside resources as a key facilitator to enhancing knowledge of emerging opportunities and growing internal capabilities. Resources, including people, funding, and expertise garnered by external partnerships, have bolstered BASF's digital capabilities.

BASF's strong scientific tradition and extensive experience with different forms of modeling laid the foundation for a strong digitalization R&D team. However, the company experienced challenges at the beginning of the journey to finding talent working at the intersection of chemicals and digital. Thus, BASF leaned on external partnerships to strengthen capabilities.

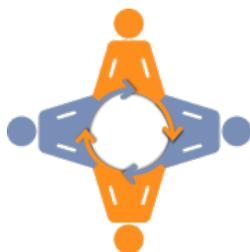
External collaborations have been essential to building a foundation in R&D digitalization. BASF has already had an extensive global network of partners, including universities, research institutes, and companies. This network of partners has been essential to enabling the digital journey in the R&D organization. University partnerships have traditionally been the backbone of BASF's R&D partnerships. BASF's digitalization leaders highlighted two key partnerships as exemplars of how they accelerated learning on digital opportunities:

In 2017, BASF announced its membership in Systems That Learn (STL), a research initiative within the Massachusetts Institute of Technology (MIT) Computer Science and Artificial Intelligence Laboratory. STL aims to accelerate the development and deployment of next-generation technology, including artificial intelligence and machine learning (ML).

In 2019, BASF joined forces with Technische Universität Berlin (TU Berlin) to launch a Berlin-based Joint Lab for Machine Learning (BASLEARN). BASLEARN seeks to foster research collaborations and develop novel ML algorithms for challenges derived from chemistry and chemical engineering fields.

Although BASF continues to leverage academic collaborations, they are also finding strong partnerships with start-ups as R&D shifts its focus to new digital business models. R&D is strengthening partnerships with start-ups to support new insights, enable participation in the ecosystem, and drive commercial viability.

## Culture and Change Management Lens



BASF leaders interviewed for this case study generally felt that because of the enormity of BASF's R&D organization, multiple cultures across R&D are intersecting at different divisions, topics, and domains. To carry out this massive operation and orient around a common identity, the R&D digital team relied on the corporate culture as a guide.

Although some companies may need to sell the idea of digital transformation to enable cultural changes and secure buy-in, BASF found that the nature of locating a digitalization effort within R&D tapped into the inherent curiosity of scientists. Scientists are often early adopters of emerging technologies and thus do not need a lot of convincing before instituting digital transformation initiatives. These scientists were among the biggest advocates for digitalization at BASF and led the call for several initiatives.

One such initiative is the creation of an internal applications store. First, a small group of scientists began experimenting with hackathons, which soon expanded to interest in coding and tools to support app development. As the number of apps grew, several scientists realized that the R&D community within BASF needed a centralized system to easily search for and locate apps. The app store fueled a change in the BASF R&D culture by fostering an openness to create, share, and leverage apps in R&D.

### BASF Hackathon

BASF hosted a 24-hour hackathon that sought to answer the question: *“How can you put all the relevant information together for our crop protection discovery work?”* Scientists from across the organization in several different parts of the globe came together to develop an app that draws together information on a particular molecule. The hackathon was a stimulus to the development of the BASF internal app store.

## Technology and Data Lens



BASF’s investment in a supercomputer proved to be a valuable investment in BASF’s R&D digitalization journey. The supercomputer was the biggest technological infrastructure added to R&D’s repertoire thus far and has enabled creation of a host of digital products and solutions. The supercomputer, named *Quriosity* following an employee online voting, has facilitated the discovery of new chemical compounds and products and been a pillar in enabling the success of BASF’s R&D digitalization journey.

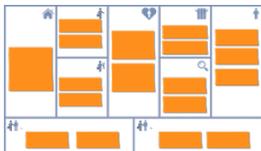
In addition to *Quriosity*, one of the most visible successes of BASF’s digitalization of R&D has been the development of hundreds of apps to support R&D. BASF created the R&D app store to enable scientists to share their information with all BASF colleagues and access new data analysis tools. Now scientists across BASF’s R&D organization are developing hundreds of apps to expand research capabilities.

The extent of BASF’s technological infrastructure has facilitated great success in creating digital products and solutions, but the journey has not been without a number of challenges.

Reflecting on their digitalization journey, employees noted that one of the biggest lessons learned happened in the early days. When BASF embarked on their digitalization journey and brought people together from across the R&D organization, they were challenged by data silos. Because of the vastness of the R&D operations, it was inevitable that bringing people to a central digitalization team would invoke change management issues given that each person comes with different language and platform preferences.

Because BASF is such a large organization, the struggle with data silos was not surprising and stemmed from a hierarchy organized around many different business units and research centers. Although many organizations would probably struggle with change management issues so early in the journey, BASF was able to capitalize on the challenges. The digitalization group was forced to unite and accept that the heterogeneity of data required to carry out this digitalization journey would be limitless. With data science at the forefront of BASF's digitalization strategy, a flexible and agile data pipeline was needed to address rapidly evolving data science techniques.

## Opportunities and Offerings Lens



By incorporating digital technologies and data into R&D operations, BASF has developed several new solutions enabling existing business and attracting new customers. Implementation of BASF's strategy to date has highlighted several new opportunities to operate differently and engage with customers, business units, employees, and partners in enhanced ways.

Digitalization leaders categorized opportunities and offerings into two categories:

- Optimizing efficiency and increasing chances of creating the best product
- Enabling customer-facing digitalization efforts

R&D's role in optimizing efficiency is best illustrated through BASF's industry-leading position in agriculture. Their R&D and innovation strength is

demonstrated through strong pipeline projects in crop systems, including growing of crops, seed development, and weed management. R&D is leveraging digital capabilities to enhance modeling and simulation, improve field data collection, and develop new active ingredients.

**Molecular Modeling:** Using the latest developments in molecular modeling technologies, BASF developed Revysol<sup>®</sup>, a new active ingredient and the first and only isopropanol-azole of its kind on the market. Revysol's unique structural composition enables flexibility by allowing the molecule to undertake different conformations. Revysol binds to the target site up to 100 times more powerfully than conventional triazole fungicides, even when target site mutations have developed. Revysol solutions can be leveraged across several different crop types. In the United States, farmers can use Veltyma, which is powered by Revysol and provides disease control, strengthens plant health, and increases yield response in corn.



Revysol performance



Untreated control

Source: <https://agriculture.basf.com/global/en/innovations-for-agriculture/innovation-for-fungicides/revysol/revysol-in-corn.html>

**Visual ML:** BASF is leveraging ML via image analysis to enhance decision-making across R&D. In one example, BASF leveraged visual ML for herbicide discovery to enable the prioritization of candidates, which was previously accomplished using visual assessments.

**Digital Imaging:** In BASF's Seed and Traits business, digital R&D capabilities are enabling scientists to determine plants' genomic features that are driving phenotypic behavior by introducing drones for field collection. The drones are equipped with multispectral sensors to help automate and optimize field data collection.

**Mode of Action (MoA):** *MoA* is a term used to understand why a certain molecule provides a specific outcome. Identifying the outcome (e.g., stops a weed from growing) is not sufficient knowledge for scaling up a new product. The reasons why the molecule provides said outcome must also be completely understood. This knowledge is essential for BASF's agricultural business. BASF employs novel MoA analysis tools to confirm how new products work before scaling for production. For example, MoA analyses supported the development of a new active ingredient, Inscalis™ insecticide. Inscalis controls insect pests in a variety of row and specialty crops, including soybeans, cotton, and citrus.

**Analyzing Learned Molecular Representations for Property Prediction:** In collaboration with MIT as part of the Machine Learning for Pharmaceutical Discovery and Synthesis Consortium, BASF applied neural networks to discover a wide range of solutions for molecular property prediction. Through this, the Consortium was able to design an algorithm for property prediction that outperforms existing baselines.

## The Maintenance of Digital Transformation

*BASF's digitalization of R&D journey has been a growth driver for the company and served as a catalyst for a company-wide digitalization effort.*

### Timeline



BASF's digitalization of R&D journey was reshaped in 2016, driven, in part, by external conversations happening in Germany. In 2017, BASF purchased Quiriosity, a supercomputer. The purchase of the supercomputer helped accelerate digitalization in the R&D organization and facilitated the discovery of new chemical compounds and products using more efficient modeling. In 2019, the digitalization R&D team went through some structural changes when the IT and Digitalization teams merged into a single division to accelerate digitalization and increase capacity.

BASF leaders characterized their digitalization journey as exponential—digitalization is infinite and ever-evolving. It will develop and change over time as new capabilities and technologies continue to emerge. Thus, when asked to comment on progress in their journey, BASF digitalization leaders reinforced the notion that digitalization has no timeline. Creating artificial timelines restricts innovation potential. They foresee digitalization as a lifetime journey, reinforced by BASF's new corporate strategy.

#### How far are you on your overall journey?

“As we look back, there has been substantial progress, but there is more progress to be made. This is not something that has a beginning and end. It is continual growth and development.”

— Brian Standen  
Head of Digitalization in Materials and  
Chemicals R&D, North America

### Measures and Metrics

*The R&D digitalization team prefers to be very cautious in the use of metrics in such a rapidly emerging field, despite regular use of metrics in other parts of the company.*

This case study highlighted several examples of the impact of digital activities on BASF products and research activities:

- Molecular Modeling
  - Revysol: Increases crop efficiency by maximizing yield, quality, and profit.
- Visual ML
  - Enhances decision-making, ensures accuracy, and drives cost savings.
- Inscalis Insecticide
  - Quickly stops insect pests' feeding, reducing nutrient loss and vectoring of harmful viral/bacterial pathogens, resulting in healthier plants and optimal yields with higher quality.
- Molecular Representation for Property Prediction
  - Improves R&D workflows by enhancing current evaluation protocols.

The R&D teams gauge progress by setting priorities and milestones on their digital roadmaps. Digital roadmaps are the key vehicle to steer progress based on charting and measuring desired outcomes. Digital roadmaps allow the R&D team to make an economic case for digitalization efforts and help track progress.

The digitalization team is still determining how best to measure success. Although many of the other case study companies profiled prefer to use the traditional metrics of revenue, costs, and customer satisfaction, BASF R&D leaders are hesitant to translate the potential value of new digital capabilities and approaches into quantitative measures. They pointed out that traditional metrics, such as return on investment, can sometimes do more harm than good, potentially killing early-stage promising or emerging concepts. The digitalization team often thinks in terms of efficiency gains such as hours saved in the lab or reduced costs of experiments. Additionally, improving the effectiveness of R&D through digital technologies is a key measure of success, like the examples Revysol and Inscalis, which demonstrate impact on products.

As a leader in the chemical industry, BASF uses metrics to drive the company forward. However, with support from corporate leaders, R&D digitalization efforts have not conformed to the traditional BASF focus on metrics. Instead of

focusing on traditional metrics, digitalization leaders spoke about the importance of facilitating teamwork throughout the organization.

## Learnings and Lessons

When asked to share the top success factors that influence a digital transformation journey, BASF leaders provided the following insights from their experiences:

- **Embrace Diversity:** New ideas are created when people with diverse backgrounds work together. Collaboration enables employees to see the bigger picture and consider the entire experience of both internal business units and external customers.
- **Embrace the External World:** External collaboration is essential to growing digital capabilities and advancing in the journey. Collaboration is critical to innovation and digital success.
- **Start Small:** Digital transformations do not start with an organization-wide plan of change, but rather with a series of micro-revolutions. Although large-scale digitalization projects may result in broader adoption, they carry significantly more risk. Instead, efforts aimed at “low-hanging fruit” can help an organization see measurable benefits to gain leadership and researcher support.
- **Garner Support from Leadership:** From developing budgets to promoting organizational buy-in, leaders are key multipliers in developing and enabling a digital culture.
- **Ensure Appropriate Resourcing:** An essential part of R&D is being able to recreate things. Without proper funding and recurring investment, digitalization efforts would fail.

## Conclusions

This case study highlights several factors that have contributed to BASF’s digital transformation successes thus far:

- Recognition by a research-centric company that digital transformation within the R&D organization could unlock new capabilities that drive growth.
- Collaboration with external partners, which creates new knowledge and enables new capabilities.

- Acknowledgement from leadership that digitalization and innovation are essential to driving value in the future.
- Recognition that IT is essential to driving digitalization efforts.
- Commitment from leadership to align the corporate strategy with digitalization.
- Creation of an internal app store, which helped foster an openness to create and share within BASF's scientific community.

These factors can also help other organizations that are earlier in their digital journey.