

Feature: MGC Group Research Strategy

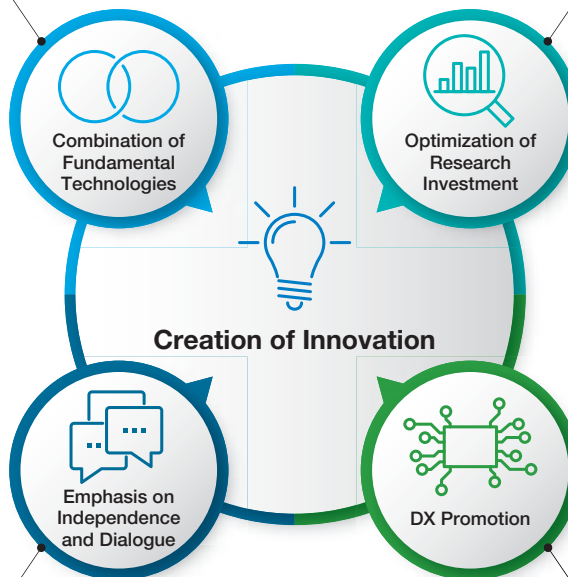
Characteristics of Research and Development

Key Point 1

Our diverse fundamental technologies not available to other companies are an important management resource giving us a competitive edge. Over 90 percent of MGC's products are created from technologies developed in-house. By combining these technologies, we will expand the potential of business without limit.

MGC's research organizations respect the ideas and independence of researchers, and encourage bottom-up research backed by a budget. Our welcoming organizational culture in which open discussion is exchanged on an everyday basis is a vital key for the creation of innovation.

Key Point 3



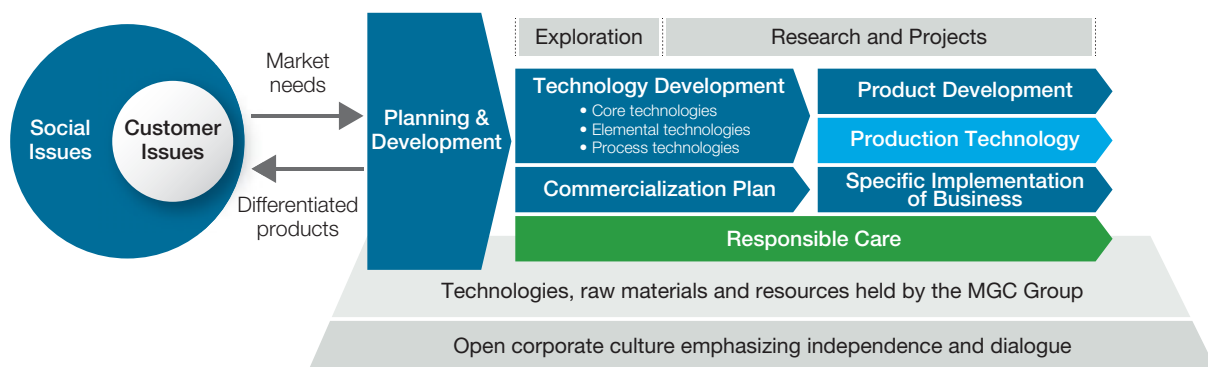
Key Point 2

We will introduce objective assessment indices assigning priority to research themes for maximizing cost effectiveness, or in other words, increasing investment efficiency in research activities. We will work to achieve transformation into a profit structure resilient to change in the external environment while obtaining results commensurate with investment.

We will utilize the latest AI (Artificial Intelligence) and MI (Materials Informatics) to promote the enhancement and increased efficiency of the research process. We will establish and revise organizations related to intellectual property, and transform how intellectual property management is carried out using DX (digital transformation) methods. We will create an IP landscape.

Key Point 4

Characteristics of the Research and Development Process



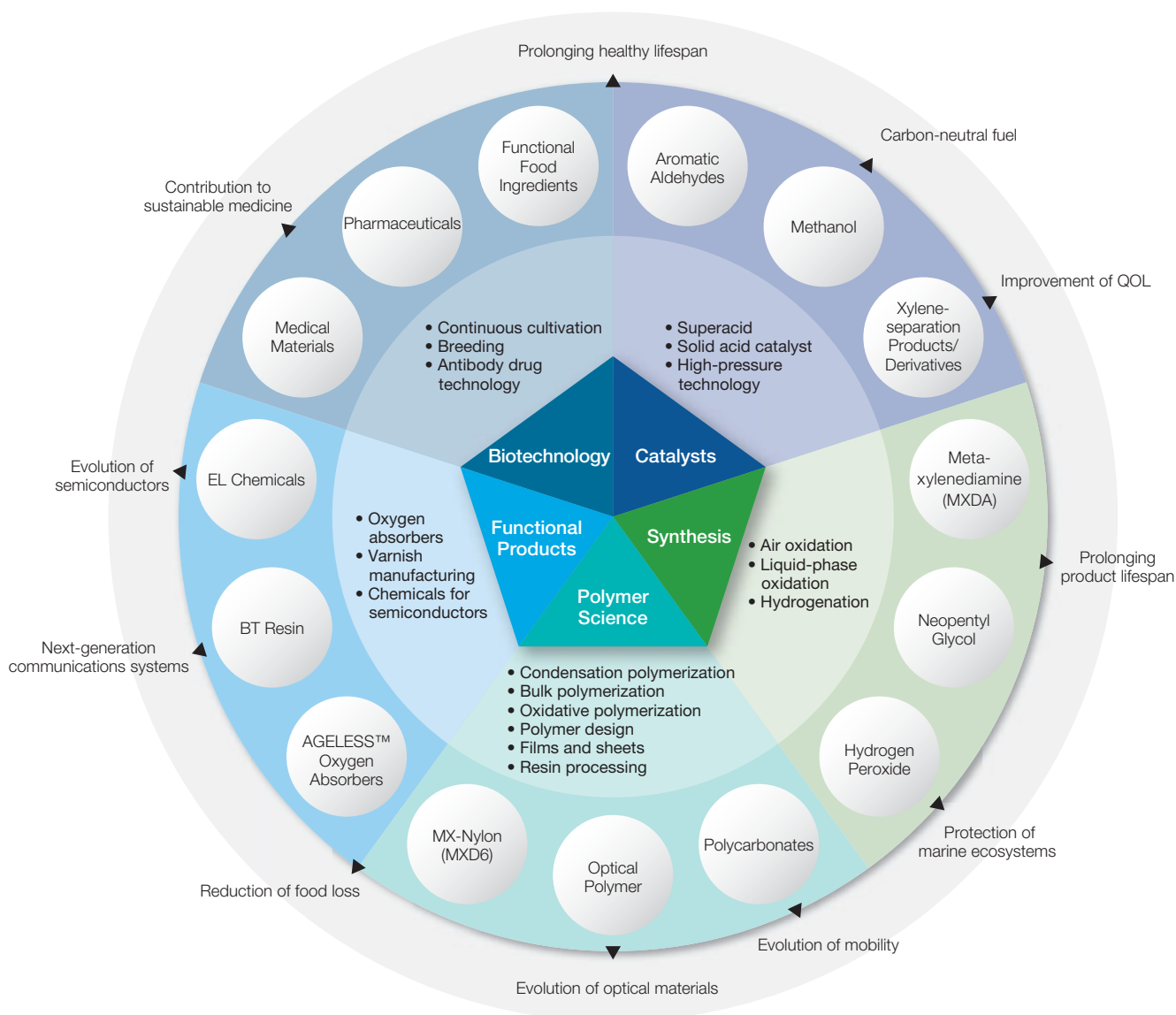
When implementing research strategy, we believe it is important to first strive to accurately ascertain social issues and customer issues, and then create differentiated products by matching the market's requirements (needs) with the Group's unique technologies and resources (seeds).

The research and development processes can be broadly categorized into "discovery" and "research and projects" aimed at commercialization and market entry as research themes. Planning & Development Divisions of business sectors will improve elemental technologies in existing business and develop new products and new grades. The Research & Development Division will explore areas such as new business and the long-term theme of climate change. Each organization encourages knowledge collaboration and free exploration within a corporate culture emphasizing independence of researchers and dialogue.

Among the mobility, medical and food, information and communication, energy, and infrastructure target areas specified in the newly-established Medium-Term Management Plan, in addition to CSR we established priority research areas by considering compatibility with the Company and growth. In each research area, we concentrate management resources on priority themes and confirm market value shortly after the launch of each project. We also aim for timely commercialization by strengthening ties with the Production Technology Division aimed at increasing development speed. At the same time, we are continuing to make improvements by applying the "Q-MGC" companywide quality assurance system to our research and development process as well, to ensure the safety and reliability of our products.

Please refer to "Production Management and Socially Responsible Sourcing" on page 51 for details on production technology.

Fundamental Technologies Supporting a Wide Range of Products



The Group has five core technologies: catalysts, synthesis, polymer science, functional products, and biotechnology. Catalyst technology began for the development of catalysts used in methanol synthesis, developing into synthesis technology based on this technology, which in turn produces numerous unique products. Meanwhile, we have also obtained polymerization technology for synthetic resin looking to downstream deployment. We develop the functional design of mechanical characteristics and optical

properties using applications from evaluation and molding technologies of plastics. In addition, we also develop functional products adding new functions through the use of technologies for combining multiple raw materials. The beginnings of our biotechnology are in microbial culture research using methanol as a source of nutrients. As described here, the MGC Group is characterized by having a wide range of technologies from upstream to downstream in the value chain.

[Glossary]

Catalyst:	A substance that promotes a chemical reaction without changing itself
Synthesis:	Creating a chemical compound using a chemical reaction
Polymer science:	Chemical reactions and processing technologies creating a type of macromolecules (polymers) by bonding many smaller repeating molecule units together
Functional products:	Products that employ added new functions through the use of technologies for combining multiple raw materials
Biotechnology:	Technology using biological functions to transform substances

Accelerating the creation of new technologies and new products through a research organization structure based on social change

Director, Managing Executive Officer
Responsible for
Research & Development
In charge of Intellectual
Infrastructure Center

Kenji Kato



Results obtained through unification of research organizations

Even before the onset of the COVID-19 pandemic, the chemical industry had been forced to respond to social change on a global scale. We view these changes to be “opportunities for business growth” for MGC. In April 2020, we made major changes to the structure of our research organization to create and foster new businesses and expand existing ones. In the new structure, researchers dispersed over four company divisions throughout the Company were placed under the Research & Development Sector. This is because, in an era buffeted by intense waves of change, it is important to view social issues from a perspective that is as broad as possible rather than just from the perspectives of individual business sectors.

Now that over a year has passed since the organizational reform, technology exchanges between our three research institutes in Tokyo, Niigata and Hiratsuka have become more active. As a result, they have been able to conduct a higher level of research activities using a top runner approach by sharing knowledge and results. Furthermore, the analysis of causes when business issues arise has been made easier by clearly separating the research division and the development division. We are also striving to further increase the precision of forecasting of expected returns from R&D investment. As a result, we feel that it has now become easier than ever to draft and implement long-term plans for commercialization of technology required five to ten years in the future.

In April 2021, partial organizational reform was implemented, such as integrating the existing R&D Promotion Division and Advanced Business Development Division into the Research & Development Division to further strengthen the entire company’s research structure. The Intellectual Infrastructure Center, which handles important measures related to intellectual property, was also established.

MGC’s innovation and the direction of research

As pressing social issues accumulate in the present, there are heightened expectations for the innovations created by chemical manufacturers. Innovation is none other than newly creating “value to share with society,” which is the mission of the MGC Group. Furthermore, we also believe maximizing the synergies created by combining the top-caliber functions of each Group company and sector is an essential element for the creation of innovation.

The new Medium-Term Management Plan establishes key research areas according to future social issues. I understand my role to be that of establishing the timeline for achieving the goals set for the Group and maximizing the return on investment. Research assessment indices based on scoring were established in fiscal 2020 to eliminate arbitrariness from the prioritization of management resource allocation. The indicators, comprised of more than ten items such as growth and CSR perspectives, are not for progress management, but rather for performing comprehensive evaluations of the research themes themselves. Ensuring that said evaluations are objective, fair and open, as well as encouraging voluntary course correction, are also important aims. Furthermore, we intend to increase the weighting of research and development at overseas sites in consideration of factors such as geopolitical risk.

Looking to the decade ahead, it will first be essential to develop innovative new materials in telecommunications and next-generation mobility. We also intend to work on new technologies that contribute to a sustainable society, such as environmentally-friendly plastics, green chemicals, and other innovations as our mission as a chemical manufacturer. We will steadily implement strategies ensuring a variety of research emerges ten years from now.

Key Point 1

Various fundamental technologies support a wide range of products.
Their combinations are unlimited

creation of new businesses.

In fiscal 2020, we reorganized the existing technology platform on the Intranet, establishing a system expediting innovation promotion by taking an overall view of a variety of fundamental technologies and combining them. Researchers at multiple sites bring together their respective strengths via the platform, and this is also expected to have effects such as facilitating medium- to long-term research and exploration activities.

Xylene Product Flow

The flowchart illustrates the Xylene Product Flow, starting with Mixed Xylene, Ammonia, and Hydrogen as primary inputs. Mixed Xylene enters the Superacid Technology (Xylene Separation & Isomerization) process. Ammonia and Hydrogen also feed into this process. The output of this process is Meta-xylene, which is used in Agrichemicals and Pigments, Etc. Meta-xylene also feeds into the Superacid Technology (Carbonylation) process, which also receives Carbon Monoxide as an input. The output of this process is Aromatic Aldehydes, used in Fragrances, Etc. Aromatic Aldehydes feed into the Oxidation Technology process, which also receives Ammonia as an input. The output of this process is Meta-xylenediamine (MXDA), used in Engineering Materials, Etc. Meta-xylenediamine (MXDA) feeds into the Polymerization Technology process, which also receives Hydrogen as an input. The output of this process is MX-Nylon (MXD6), used in Packaging Materials, Etc. MX-Nylon (MXD6) feeds into the Compounding Technology process, which also receives Hydrogen as an input. The output of this process is High Performance Polyamide Resin "Reny™", used in Automotive Parts, Etc. Hydrogen also feeds into the Hydrogenation Technology process, which also receives Ammonia as an input. The output of this process is 1,3-BAC, used in Paint and Composite Material. 1,3-BAC feeds into the Compounding Technology process. The legend indicates that blue rounded rectangles represent Technology, grey rectangles represent Raw Materials (External), and blue rectangles represent Products.

```

graph LR
    MX[Mixed Xylene] --> ST1[Superacid Technology  
(Xylene Separation & Isomerization)]
    A[Ammonia] --> ST1
    H[Hydrogen] --> ST1
    ST1 --> MY[Meta-xylene  
Agrichemicals and Pigments, Etc.]
    MY --> ST2[Superacid Technology  
(Carbonylation)]
    CO[Carbon Monoxide] --> ST2
    ST2 --> AA[Aromatic Aldehydes  
Fragrances, Etc.]
    AA --> OT[Oxidation Technology]
    A --> OT
    OT --> MXDA[Meta-xylenediamine  
(MXDA)  
Engineering Materials, Etc.]
    MXDA --> PT[Polymerization Technology]
    H --> PT
    PT --> MN[MX-Nylon (MXD6)  
Packaging Materials, Etc.]
    MN --> CT[Compounding Technology]
    H --> CT
    CT --> HPR[High Performance Polyamide Resin  
"Reny™"  
Automotive Parts, Etc.]
    H --> HT[Hydrogenation Technology]
    A --> HT
    HT --> BAC[1,3-BAC  
Paint and Composite Material]
    BAC --> CT
  
```

Key Point 2

Maximizing investment return based on goals set in the new Medium-Term Management Plan and future growth areas

Medium-Term Management Plan, we intend to concentrate management resources on high-priority themes according to these indicators. While working closely with business sectors responsible for product development, we aim to obtain results commensurate with investment within the period specified for each theme, and expand our differentiating businesses.

Furthermore, when all research organizations were unified in April 2020, the Research & Development Division took the lead to strategically establish new research themes based on our business portfolio and future growth areas.

	1. Business Portfolio Target Area	2. High Suitability to the Company	3. Future Growth Areas
Type A: Theme in Growth Area of Existing Business Priority injection of resources driving future growth			
Type B: Theme in Growth Area Outside Existing Business Development of new markets such as contributing to a sustainable society			
Type C: Theme with Commensurate Return on Investment in Existing Business Expansion of existing business through detailed response for each product			

Key Point 3

Emphasis on Independence and Dialogue

Open corporate culture emphasizing bottom-up research and dialogue

MGC's research organizations respect individual ideas and independence, and promote bottom-up research not constrained by stereotypes, in parallel with R&D conducted according to management measures. Research institutes have open exchanges of discussion on an everyday basis to find new angles such as forecasting unexposed needs and testing/evaluation methods. We consider this organizational culture to be a vital key for the creation of innovation.

One example of these bottom-up initiatives is the "Kompass Activity" run by the Tokyo Research Laboratory. This is a free-participation exploration activity in which researchers use 10% of their work hours to share research ideas in order to draw upon their knowledge as a group. All themes are published on the Intranet, and a system has been established to enable comments and voting, with some being promoted to official research themes. At present, this activity has also expanded to other research institutes. In addition, we have established numerous opportunities for stimulating researchers, such

as exchanges of opinions with other companies and collaboration with universities. While we have inherited the corporate DNA of the culture of a company founded on technology, we will aim for sustained growth as a research and development corporate group by incorporating new knowledge from outside.



Companywide poster presentation presenting each other's research results

Key Point 4

Promotion of DX (Digital Transformation)

Using AI and MI to enhance and increase efficiency of the research process

The use of computational chemistry has been taking root in the research organization of MGC in the past ten years, and has produced outstanding results such as the prediction of molecular structure and the analysis of synthesis reactions. Over the three-year span of the new Medium-Term Management Plan, we will use the latest AI and MI (materials informatics) to promote DX, and assist the enhancement and increased efficiency of the research process. For example, we will accelerate research speed while eliminating unnecessary processes by applying digital technology to molecular design and materials development, where an enormous volume of trial and error had previously been necessary, in order to predict test

results with a high level of accuracy.

In April 2021, we established a dedicated AI and MI promotion team within the Research & Development Division to strengthen the system for promoting DX. Eventually, we will establish a working environment in which all researchers are able to utilize the latest digital tools as needed. Furthermore, we will proceed to utilize strategic intellectual property based on the approach of exporting data processing knowledge that has been cultivated in the research division. We aim to transform from conventional basic-patent administration operations to data-driven intellectual property operations.

Intellectual Property Strategy

The importance of intellectual property (patents, technologies, knowledge and general know-how) is increasing as chemical manufacturers pursue sustained growth. In April 2021, MGC established a new organization called the Intellectual Infrastructure Center to utilize DX to strategically accumulate and establish rights for intellectual property, and moreover to deploy it throughout the Group. The Intellectual Property Department (new), which formulates and implements strategy on intellectual property, the Technical Intelligence Department (new), which handles the utilization of digital technology and technical studies pertaining to intellectual property, and the Chemical Analysis Department (relocated from the R&D Promotion Division) were established within the Center. The aims of these organizational reforms are to use DX to transform how intellectual property is managed and realize an IP landscape^{*2}. In particular, operations collecting and analyzing vast quantities of intellectual property data such as patent, literature and public releases of rival companies, are characterized by high compatibility with AI. We will combine existing tools and the analytical skills of researchers with AI to perform the transformation to data driven intellectual property operations. In the near future, we believe that AI will be able to provide powerful support for the formulation of research strategies by quantitatively indicating the suitability of our research fields and themes.

^{*2} Management strategy emphasizing intellectual property. It indicates an overview of current conditions and future prospects concerning the company's market position in light of research and development trends within the industry and technical information on individual patents.