AGC Inc.

Online Briefing on Research and Development

October 19, 2021

Self-introduction

Director, Senior Executive Officer, CTO
Hideyuki Kurata

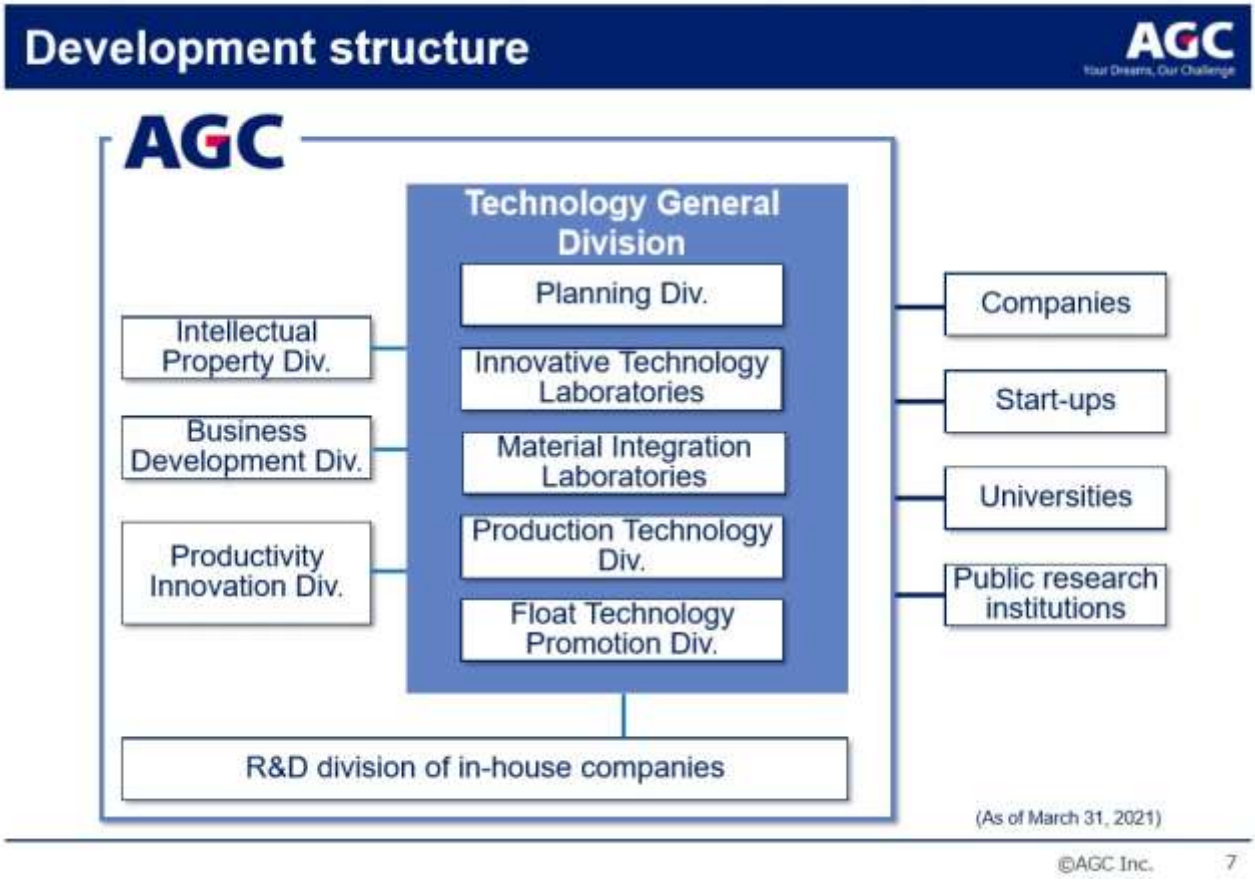
1987	Joined Asahi Glass (present AGC), assigned to Chiba Plant
2004	General Manager, New Business Promotion Department, Chemicals Company
2008	President, AGC Chemicals Americas, Inc.
2014	General Manager, Business Development Office
2015	General Manager, Strategic Planning Office, Chemicals Company
2017	General Manager, Life Science General Division, Chemicals Company
2018	Executive Officer, General Manager, Life Science General Division, Chemicals Company
2019	Senior Executive Officer, General Manager, Technology General Division
2021	Director, Senior Executive Officer, CTO, and General Manager, Technology General Division

Thank you for joining us today. I will be speaking on the topic of accelerating development activities through open innovation and DX. I have been appointed as the General Manager, Technology General Division in 2019, and I have been looking after all aspects of technology. Since 2021, I have been appointed as the CTO and am responsible for the overall activities of the Corporation.

The long-term management strategy was announced by the new organization, and Vision 2030 was set. By providing differentiated materials and solutions, AGC strives to help realize a sustainable society and become an excellent company that grows and evolves continuously.

Strategies under AGC plus-2023, we will accelerate our strategies toward Vision 2030. The first is pursuing ambidextrous management, the second is to promotion of sustainability management, and the third is gaining competitiveness by accelerating digital transformation. With these 3 pillars, we will achieve Vision 2030.

Today, I would like to talk about the overall view to the development structure, ambidextrous development, open innovation, and DX.

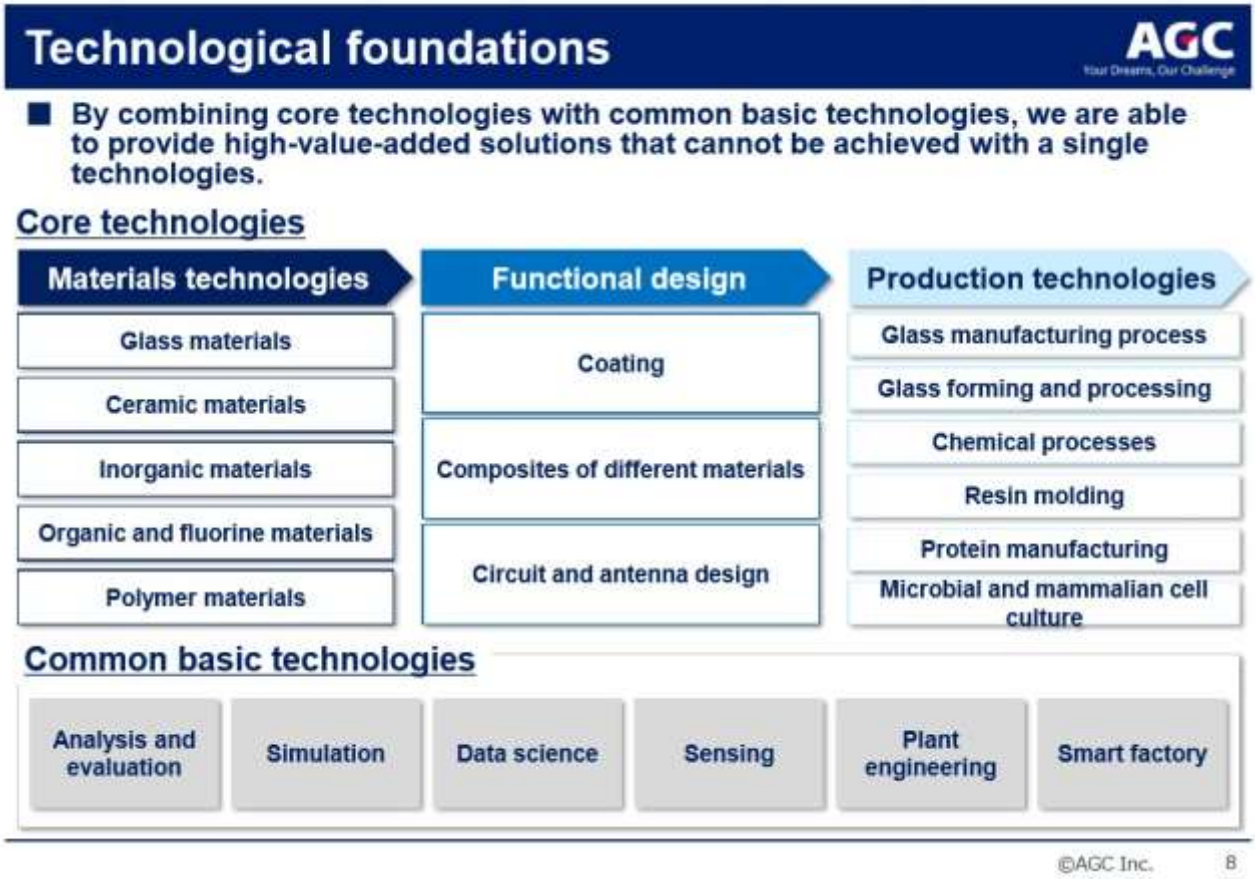


First, I would like to explain our development structure, development structure, technological foundations, and strategy.

This will be the development structure.

As I mentioned earlier, the Technology General Division plays a central role in the development of the corporate technology. This is supported by the Intellectual Property Division, and the Business Development Division, and they are in charge of new businesses. In addition, the Productivity Innovation Division will work closely with R&D division of in-house companies, as shown at the bottom of this page.

On the right will be the characters involved in open innovation.

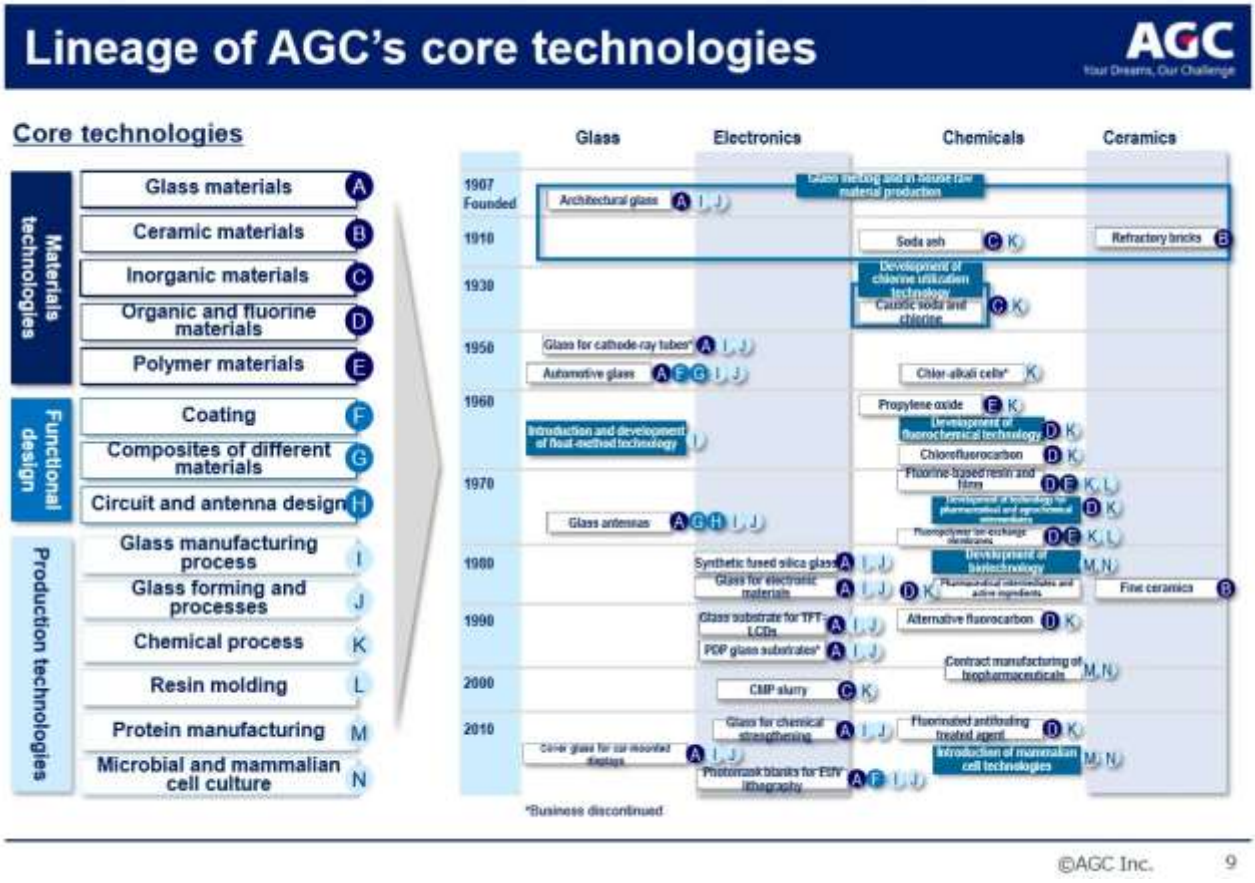


AGC's technological foundation is shown here.

In the core technologies, the left-most column is materials technologies, functional design, and production technologies. We have a wide range of materials, including glass, ceramic, inorganic, and organic, as well as a combination of functions in the form of coating, composites of different materials, and circuit and antenna design.

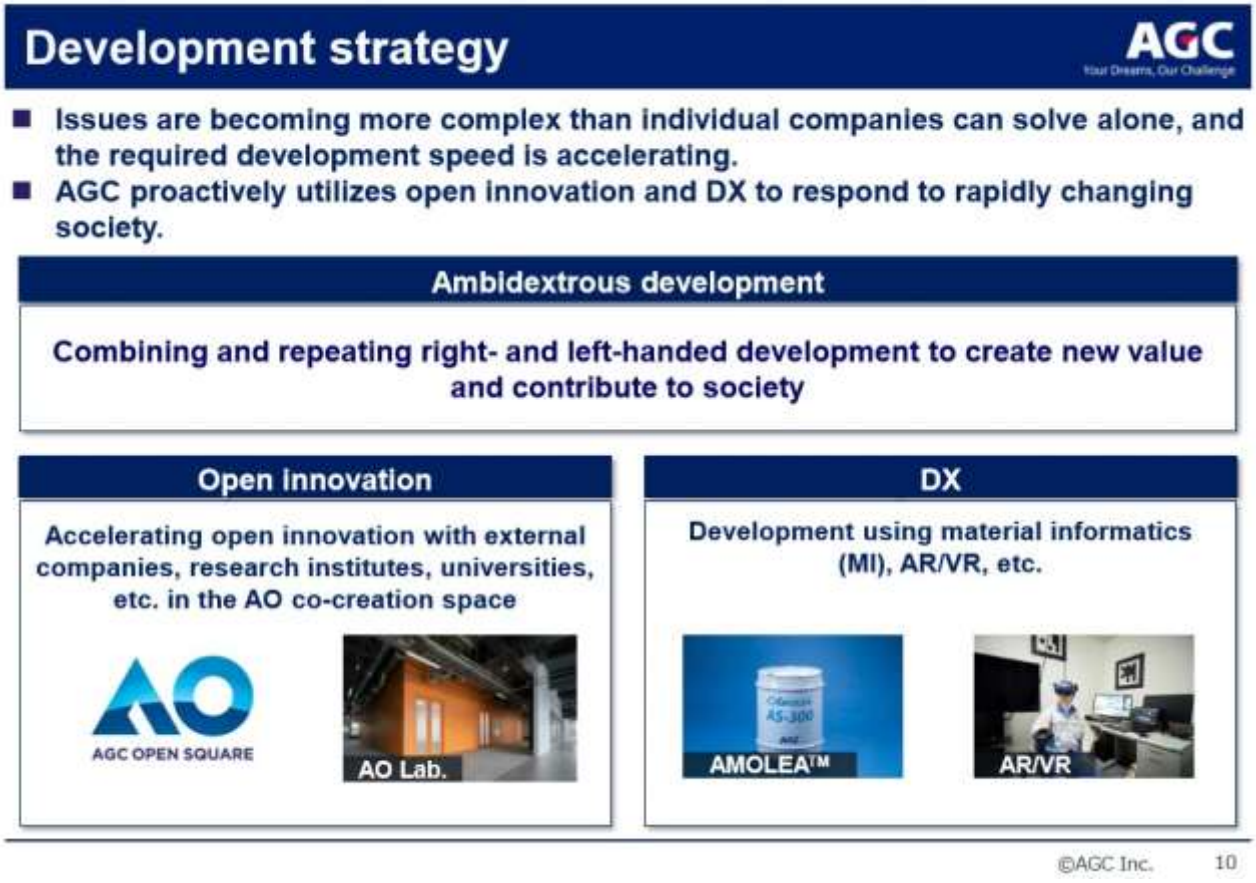
As a manufacturing company, we have a mission to commercialize our products by incorporating them into our production technology, so we continue to evolve our technology including equipment design.

Common basic technologies, for example, analysis and evaluation, data science, simulation, and plant engineering are the basic technologies that will evolve with the times and will be used in accordance with the applications above.



This will be a history of combining core technologies to provide products that the times require.

On the left are our core technologies, and on the right are the fields of glass, electronics, chemicals, ceramics, et cetera. Vertically, we have been providing a wide range of products since our establishment in 1907, starting with flat glass.



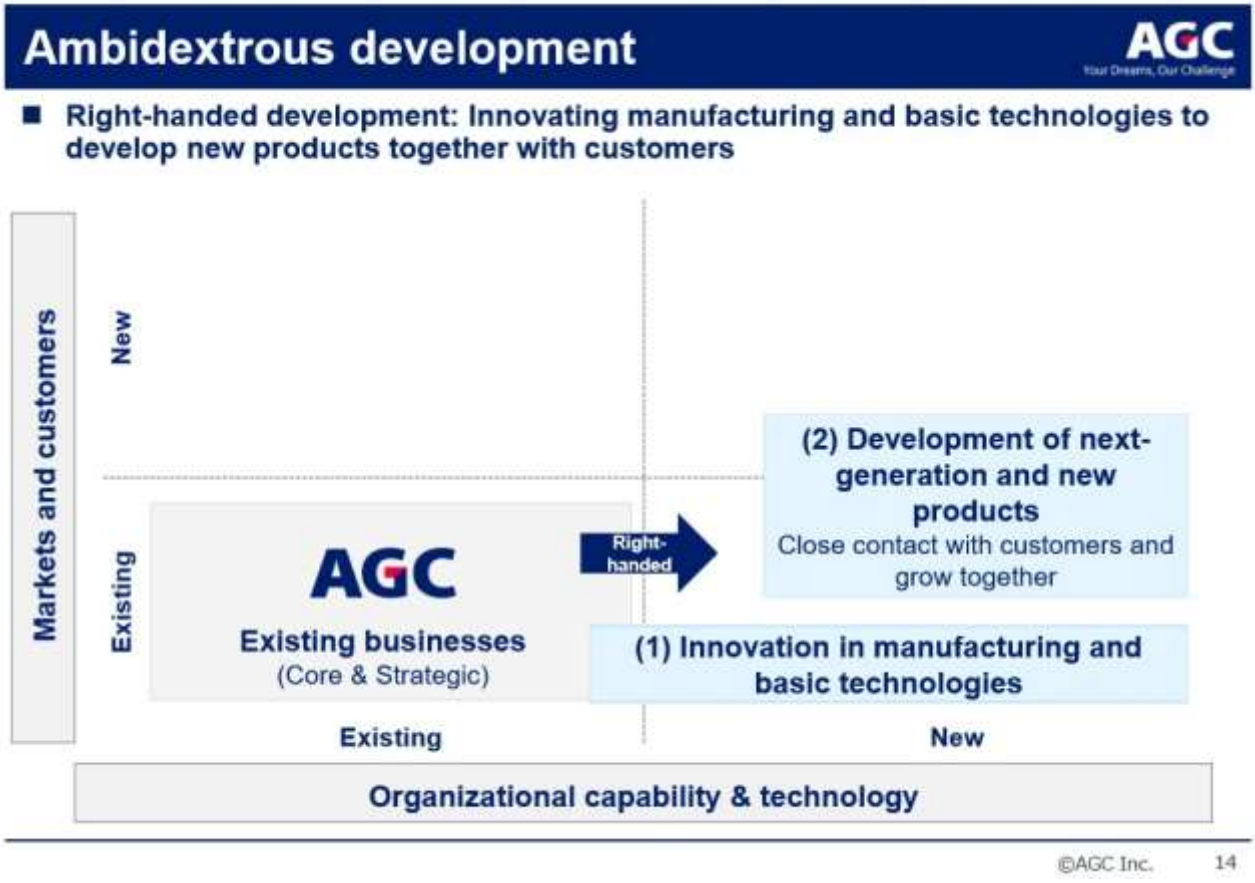
In terms of development strategy to support such product development and ambidextrous management, the world has become quite complex. The products that are in demand are coming out one after another, and the development speed is accelerating. So open innovation is the first thing that is needed. And if we don't develop with a combination of DX, we will be a delay in development in terms of speed and versatility.

In this way, we have 3 pillars: first is ambidextrous development, the second is open innovation, and the third is DX. With these 3 pillars, we will accelerate our development and contribute to society.

First, let me explain about ambidextrous development.

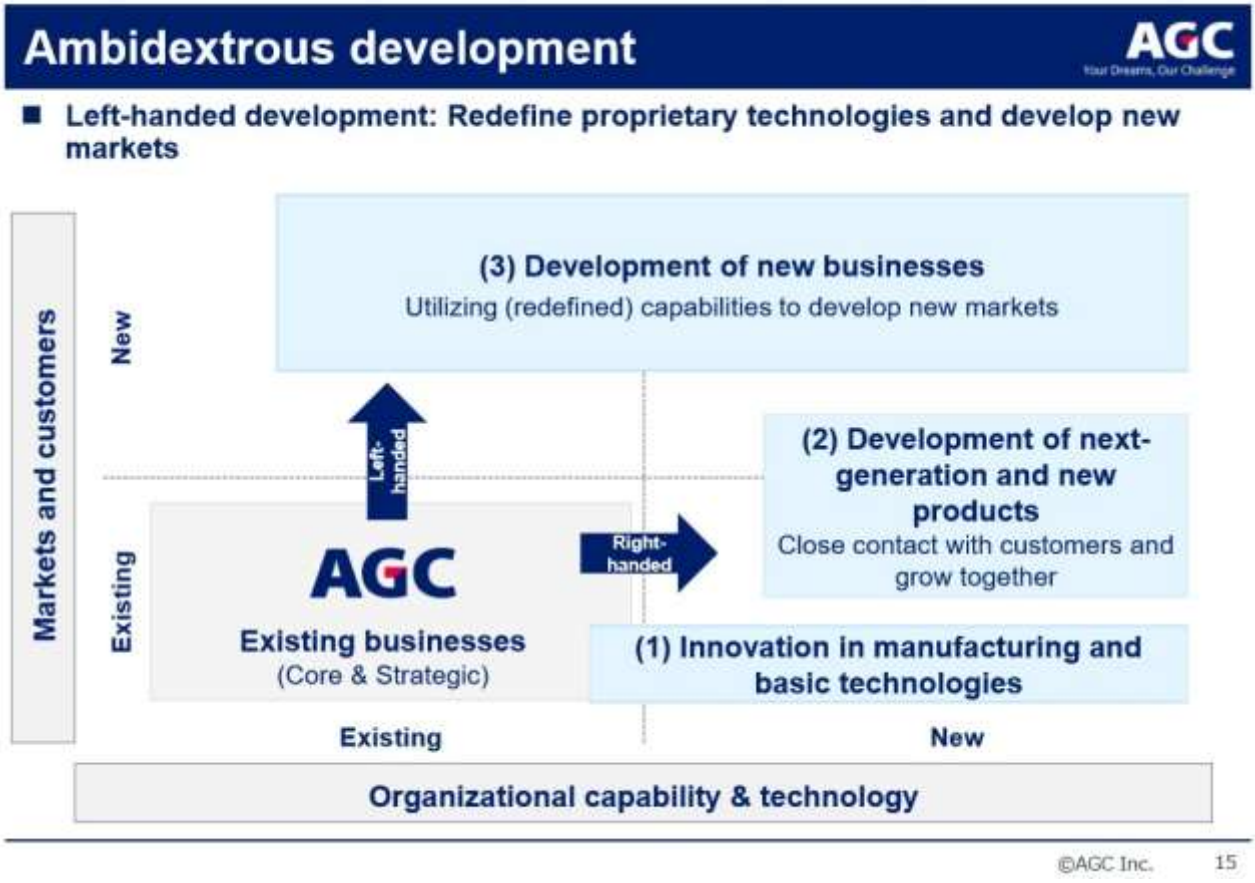
It's about how we should approach supporting ambidextrous management. The horizontal axis on the right is organizational capability and technology, and the vertical axis is existing and new market customers. The core and strategic technologies live on the left.

For ambidextrous management, we are wondering how we are going to do this. This is the technology on the lower left, and what I would like to talk about is how to develop it in the future.



The first is innovation in Innovation in manufacturing and basic technologies. This is about core technologies that come first in the list of technologies mentioned earlier. The most important thing is to constantly innovate and improve the competitiveness of manufacturing and basic technologies.

The second is to develop next-generation and new products that will grow together with our customers and grow in close contact with them. We are trying to evaluate this second point first.



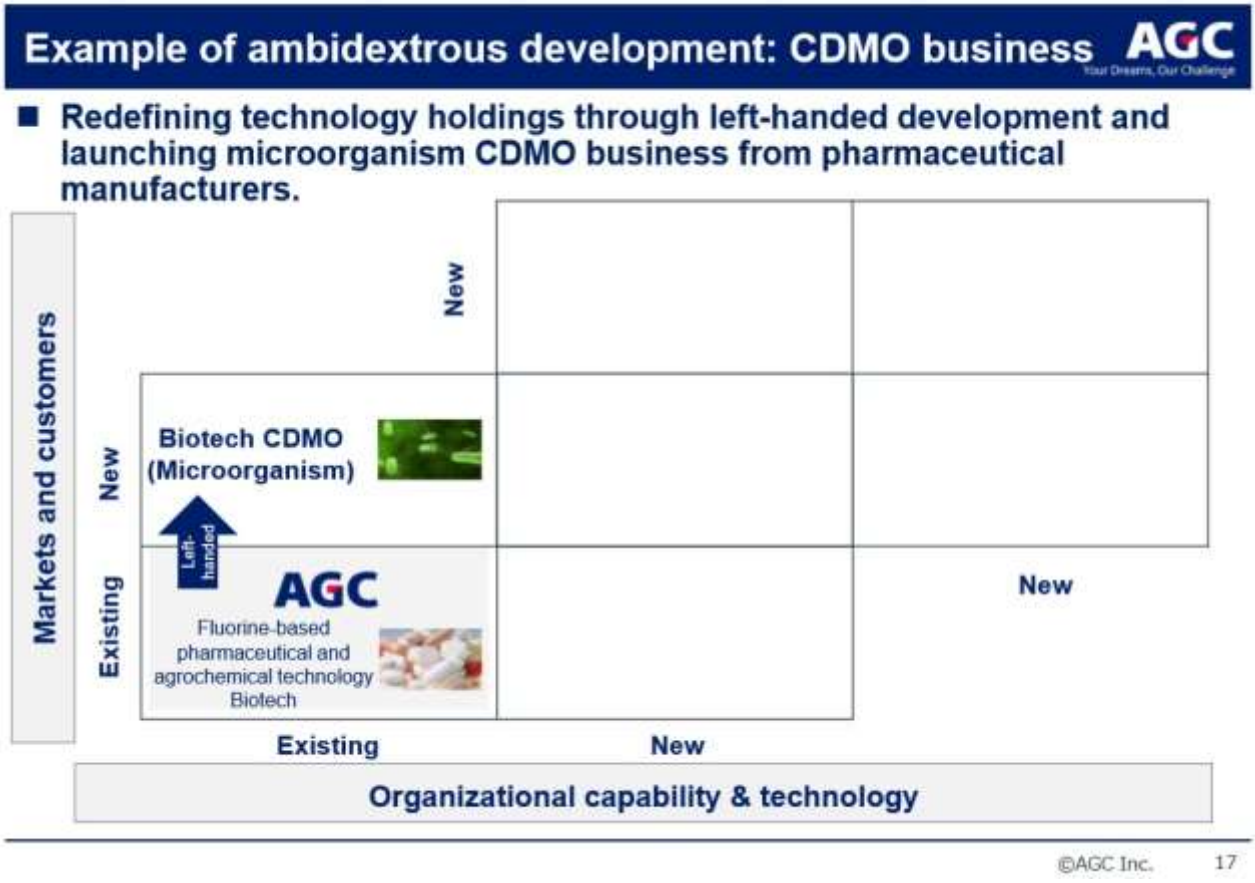
The important thing is that although we call them right-handed in the position shown above, they are what we call left-handed. Left-handed is a form of redefining and applying existing core technologies or core organizational capabilities to new markets, and seizing growth opportunities that overcome the changing times while backcasting in the future.

Example of ambidextrous development: CDMO business

- **Existing technologies include pharmaceutical and agrochemical intermediates and active ingredients, and biotechnology**

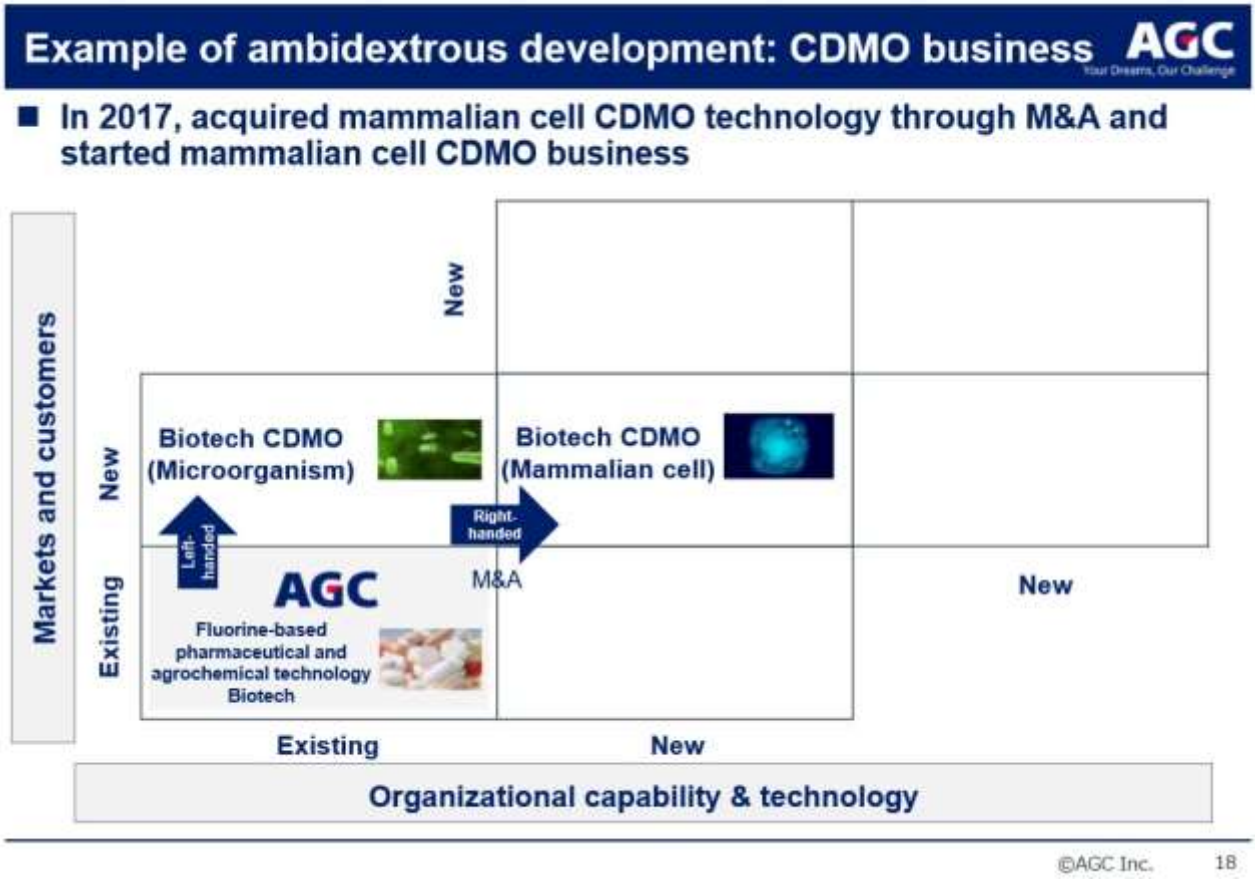
We will develop our business by combining these 2 while building our portfolio.

As an example, we are now developing a CDMO business in pharmaceuticals and biotechnology, and at the bottom left, we have had fluorine-based pharmaceutical and agrochemical technology for a long time. It was GMP compliant in terms of pharmaceuticals and agrochemicals and had a very high level of quality control technology. At the same time, AGC had also developed and possessed biotechnology.

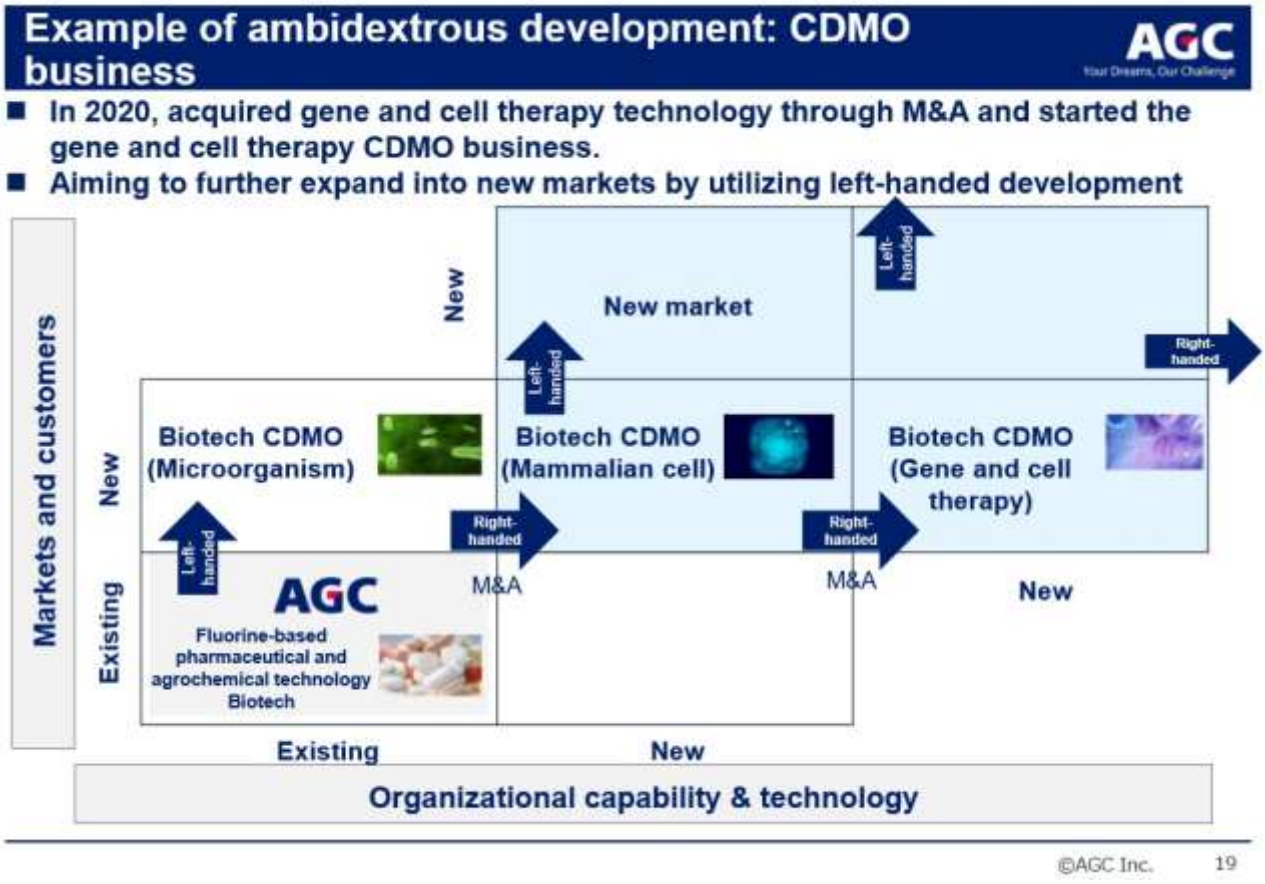


The era is changing from chemically synthesized drugs to today's antibody drugs and biopharmaceuticals.

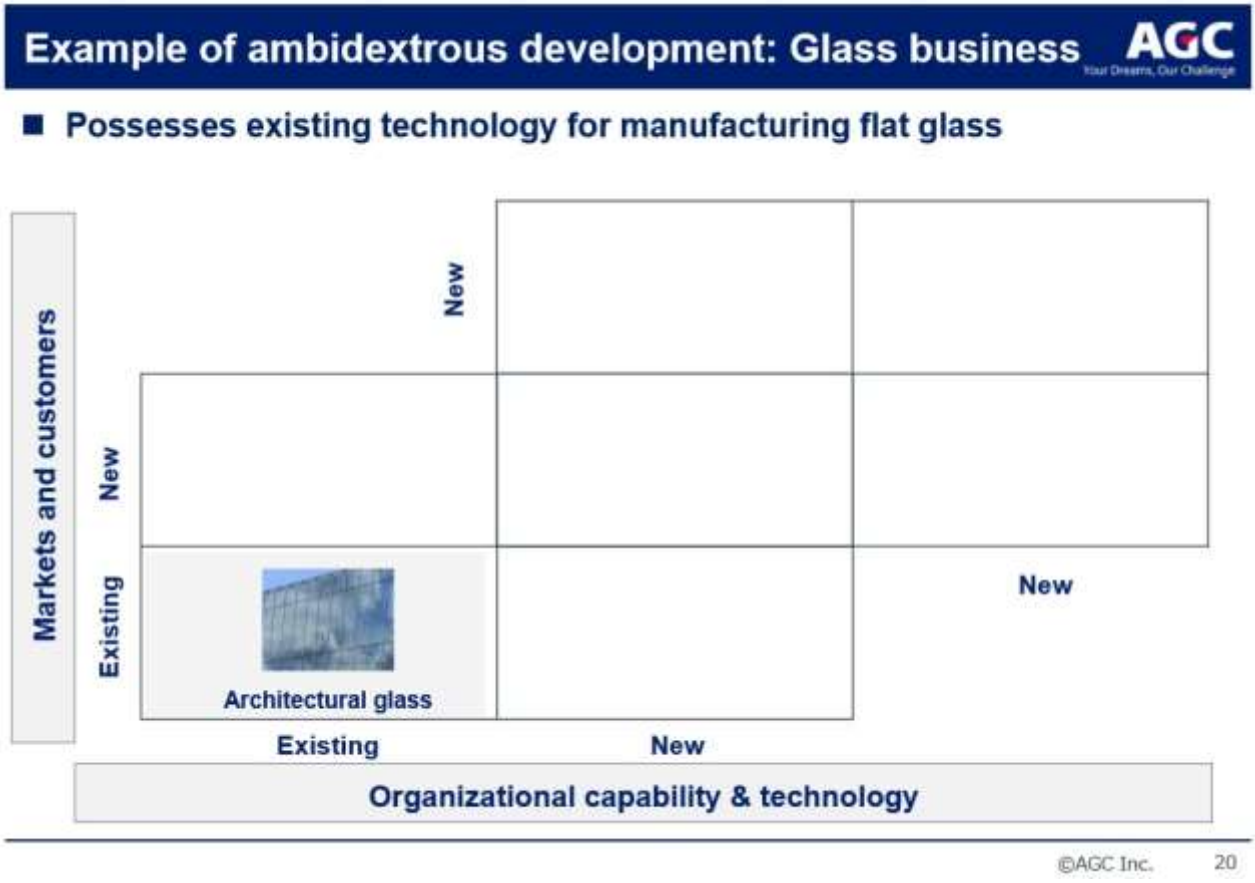
In anticipation of this future, we have entered the bio-CDMO business with a left-handed approach based on the technology we have.



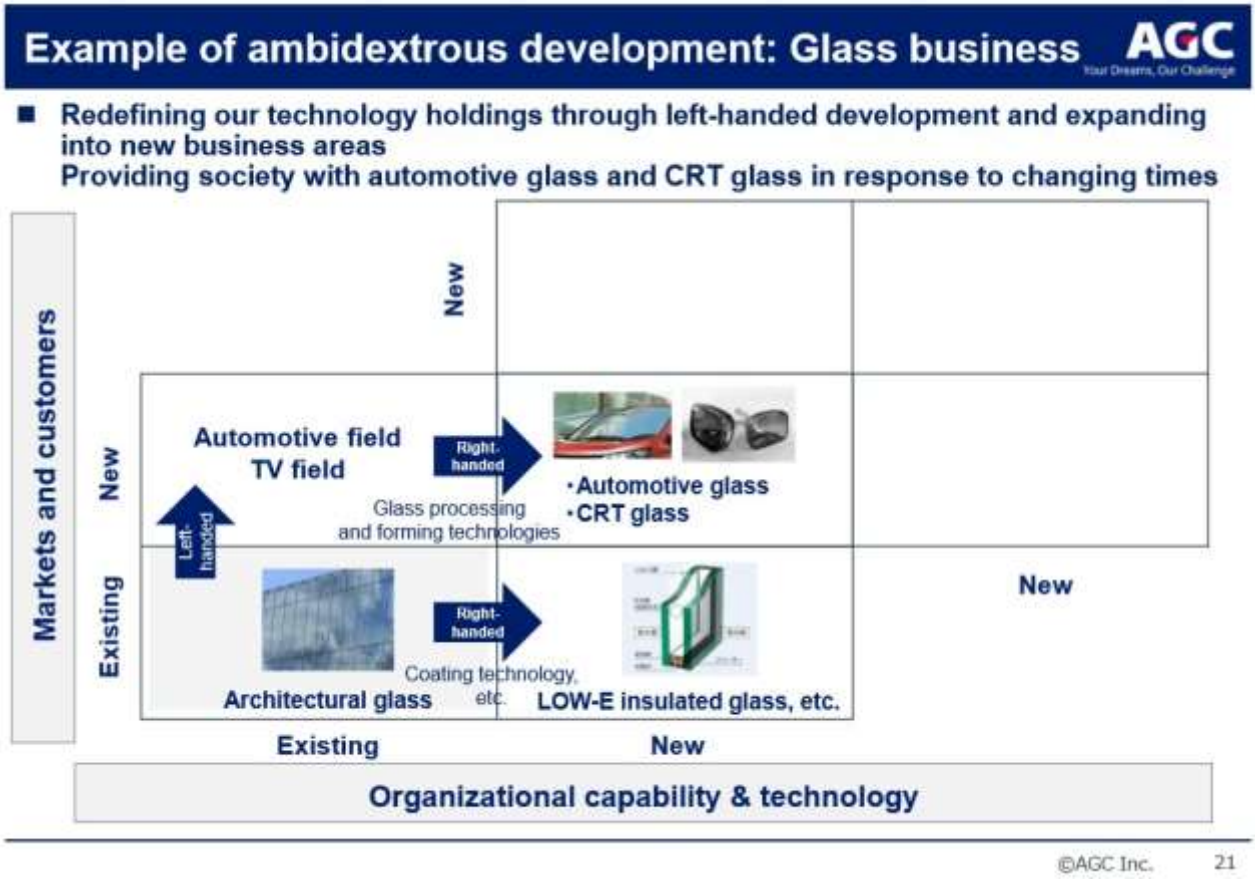
From microorganism proteins to antibody drugs, and from protein drugs to antibody drugs, mammalian cells have become necessary. We call this right-handedness, and we are adding new technologies through mergers and acquisitions.



Furthermore, in the future, as it is now, the fields of gene and cell therapy will expand. We are expanding our CDMO business by providing appropriate technologies to meet the changing needs of modalities, which we call modalities in the pharmaceutical world. This kind of biotechnology will again become a core and existing technology here, and I think that there will move to upper side through left-hand development in the future.

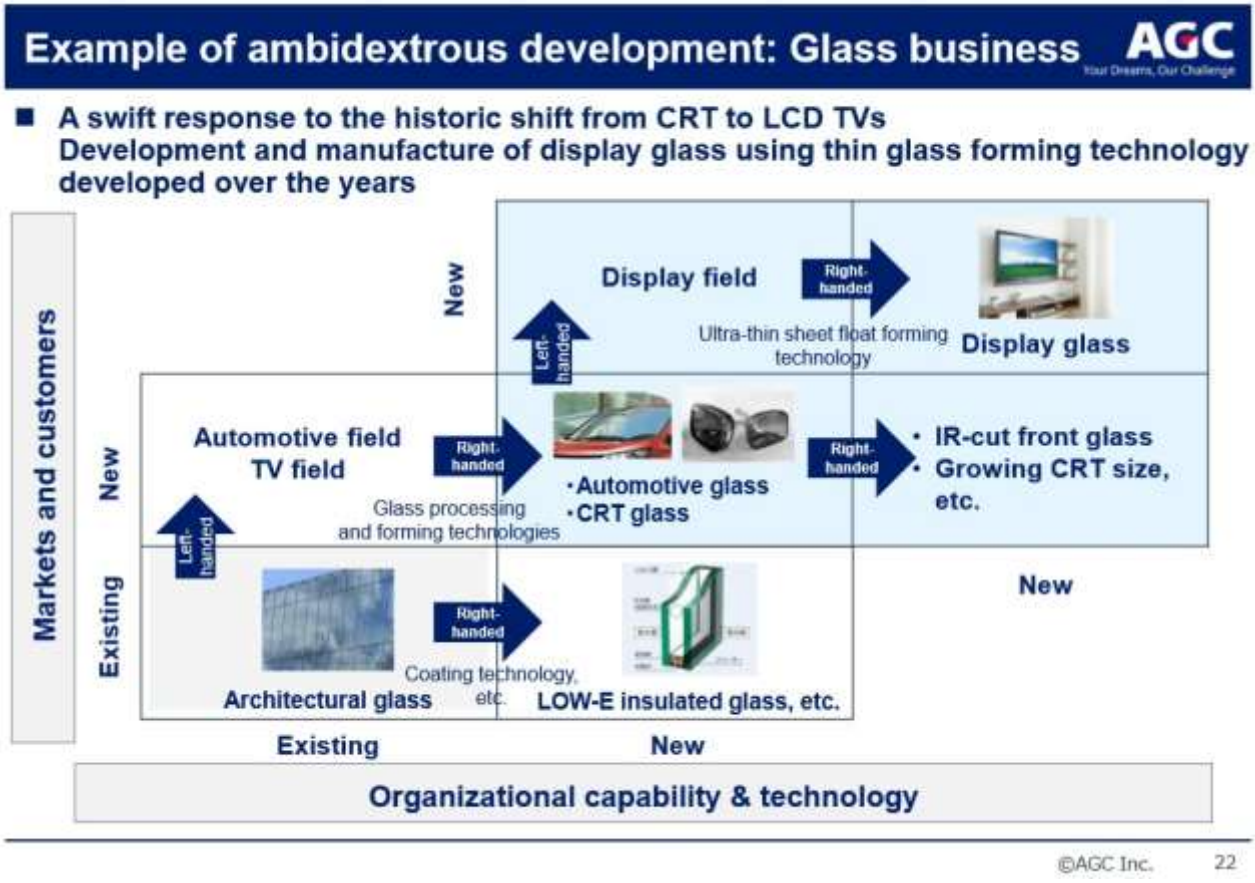


To use a simple example, we started with architectural glass in 1907. Architectural glass technology encompasses glass composition, melting, molding, and processing technologies.



While focusing on the molding and processing technology of this glass, this technology is the lowest side. For example, go to this top. The automotive field developed. The TV field emerged. We will approach the world in these areas by making full use of our processing, composition, and molding technologies. Among the products that emerged were automotive glass and CRT glass.

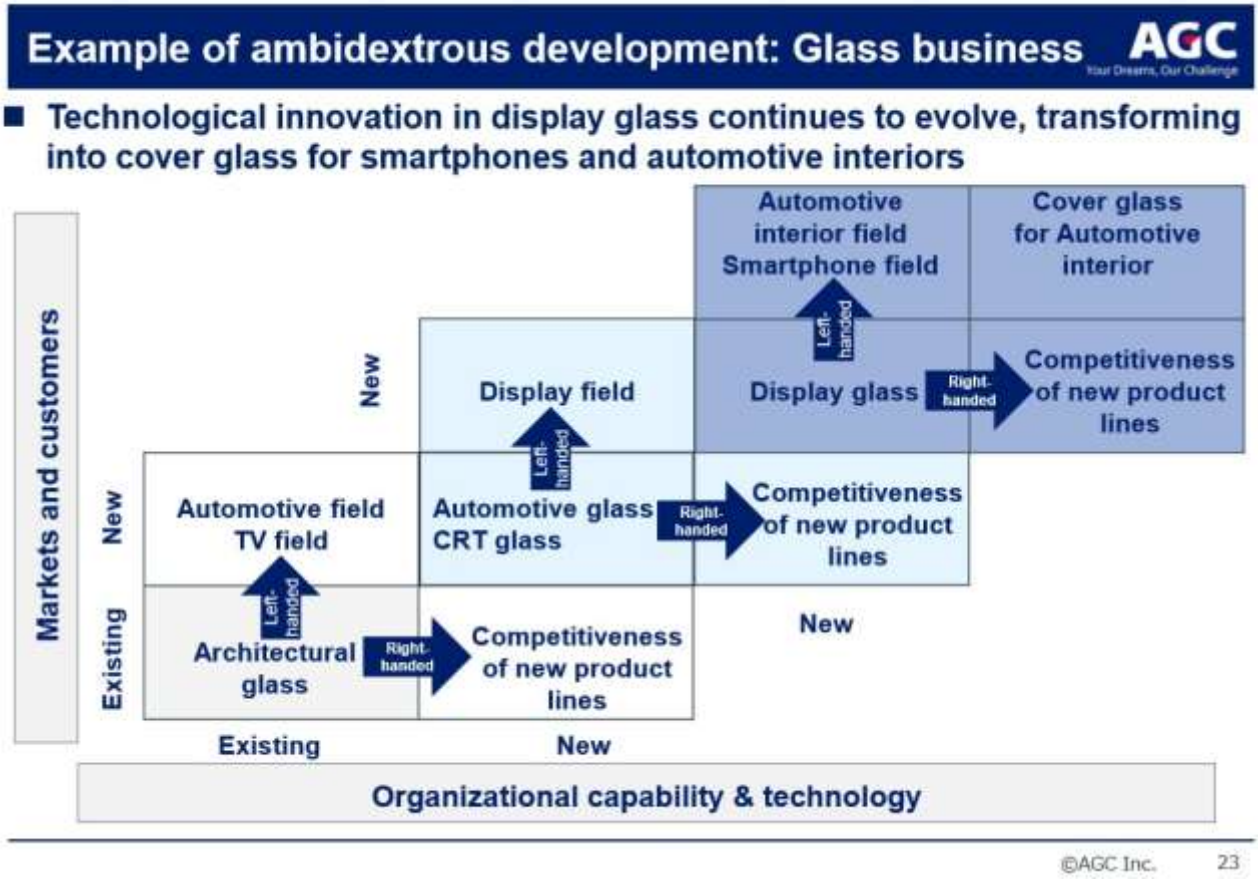
On the other hand, architectural glass is still evolving, and we are proposing various types of glass, including double-glazing and Low-E.



The next step for us is where to go from here. Some have moved on to flat CRTs and PDPs.

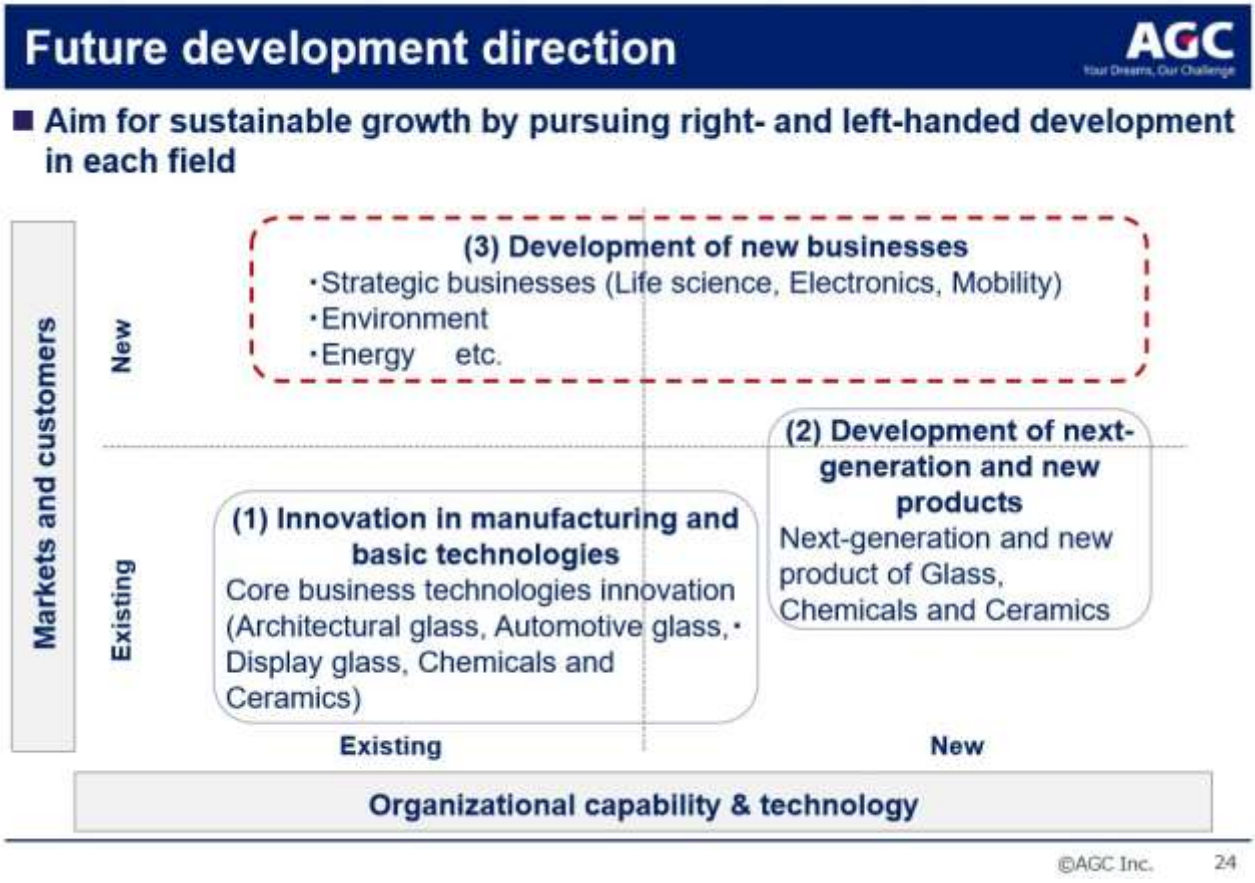
However, right-handed development was not possible, and a new technology called liquid crystal displays emerged.

displays and LCDs. In this way, we took on the challenge of the display field. By establishing the technology for float molding of ultra-thin sheets in the display field, we were able to develop the technology for display glass. From the bottom left like this, we have been creating innovative products one after another to meet the needs of the world with the times.



The current final stage was in the display field, but the display glass has now become an existing technology, and it is still evolving.

Looking at the top, what will happen is that the in-vehicle interior will become the key in the smartphone field and also in cars with CASE. From this point of view, we are also developing cover glass for automotive interiors, which is another result of our ambidextrous development.



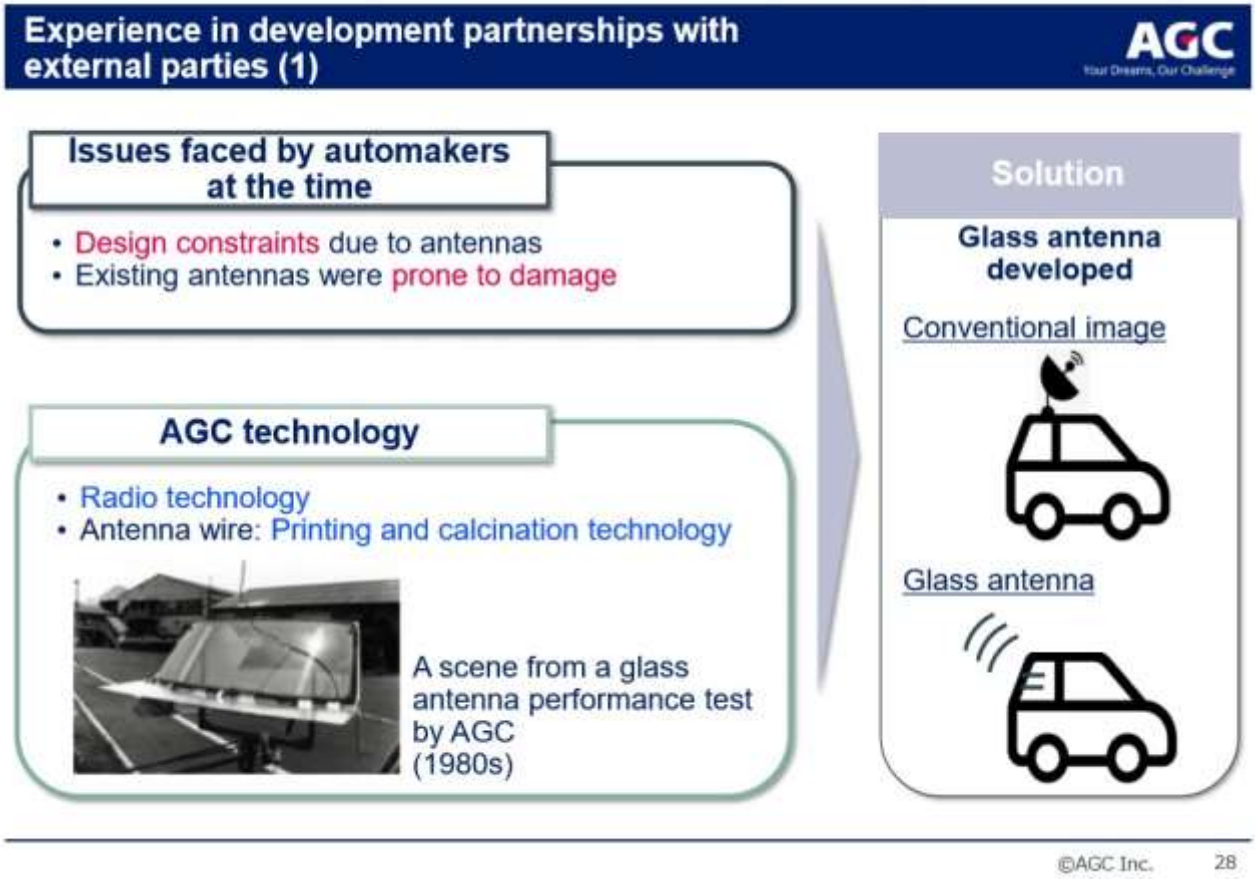
This is how development is done. We are trying to find a balance between those right-handed and left-handed in order to decide where to incorporate our development portfolio and where to focus our efforts.

In particular, the first is innovation in manufacturing and basic technologies. This is a weapon of differentiation for us, as we are making our core technology into a product. In addition to the above, we will use our basic technologies to move to the right in the area of next-generation, new products and core businesses. In addition, there are 3 strategic businesses, the environment and energy in the future. In terms of sustainability, new technologies will also be needed. We will redefine such technologies to create new business (3). We will develop a balance between these 3 elements.

The next step is open innovation. I would like to explain one of the 3 pillars, open innovation.

When we talk about open innovation, as I mentioned earlier, society is becoming more complex, and we don't have all the technology we need. In such a case, it is necessary to collaborate with customers, academia, venture companies, and external partners.

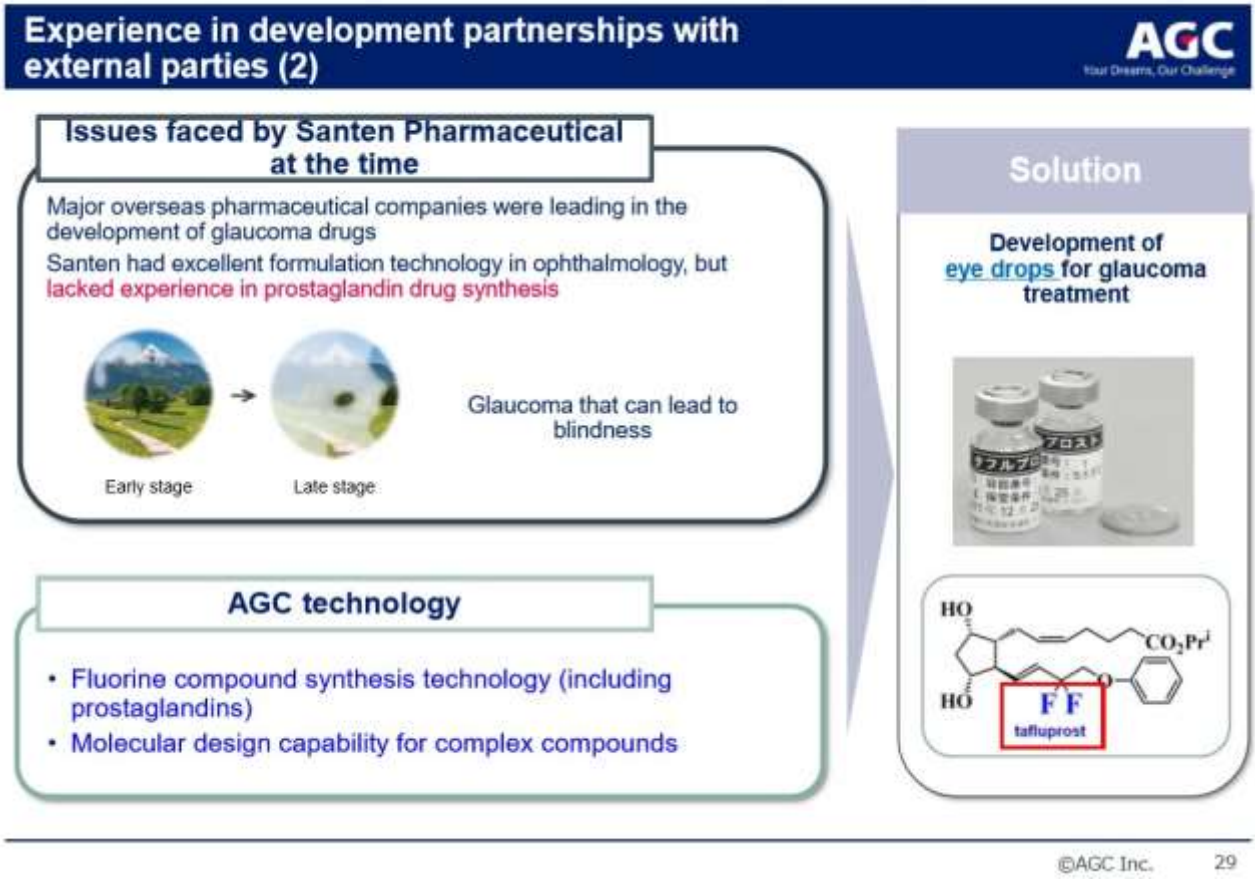
In the middle, we need to figure out how to convert our materials, processes, and equipment development into unique materials that can be used in final products. We are always promoting such complementary relationships as open innovation, which is our current development system.



This shows experience in development partnerships with external parties.

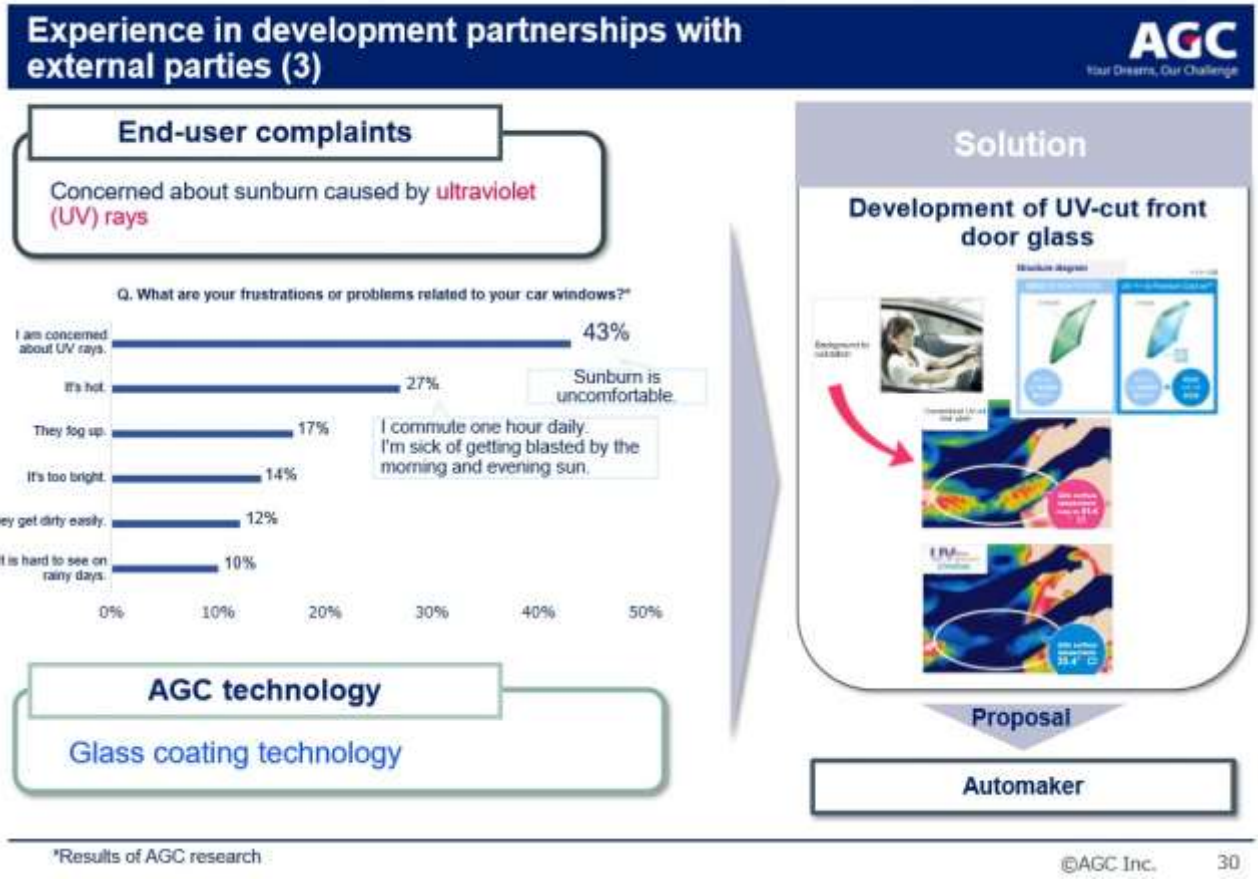
For example, in an automobile, it's the antenna. As you can see in this picture, in the 1970s, there were even stick-shaped antennas, and even in our youth, there were quite a few broken and troublesome antennas.

In the 1970s, a new era began to emerge in which traditional images were incorporated into glass. In such a situation, I think that glass, which has good electricity-receiving properties and is not damaged by printing and calcination while storing our radio wave technology, can be an open innovation in cooperation with customers.



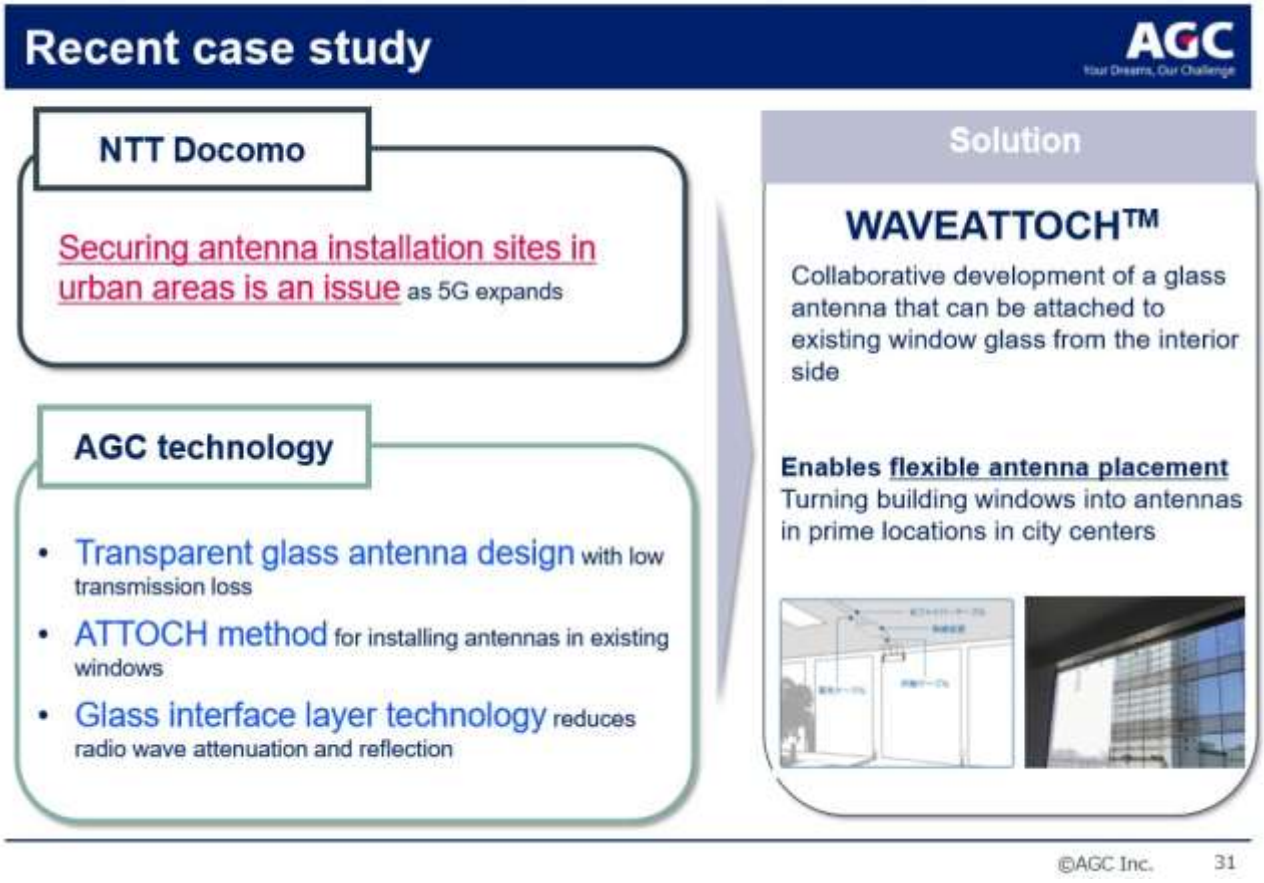
This is in the field of chemicals, and we have developed a solution with Santen Pharmaceutical Co., Ltd. for eye drops for glaucoma, shown on the right.

At the time, Santen was the leading glaucoma company in the world. However, Santen had formulation technology and high technology, but we had a longer history of synthesizing prostaglandin drugs, so we were able to collaborate with each other using our analytical capabilities for these complex compounds, and we were the first to release eye drops for glaucoma.



This is a slightly different type of open innovation, in which female employees find out the market needs of end users and try to commercialize products for sunburn caused by ultraviolet rays through repeated direct interviews and market surveys.

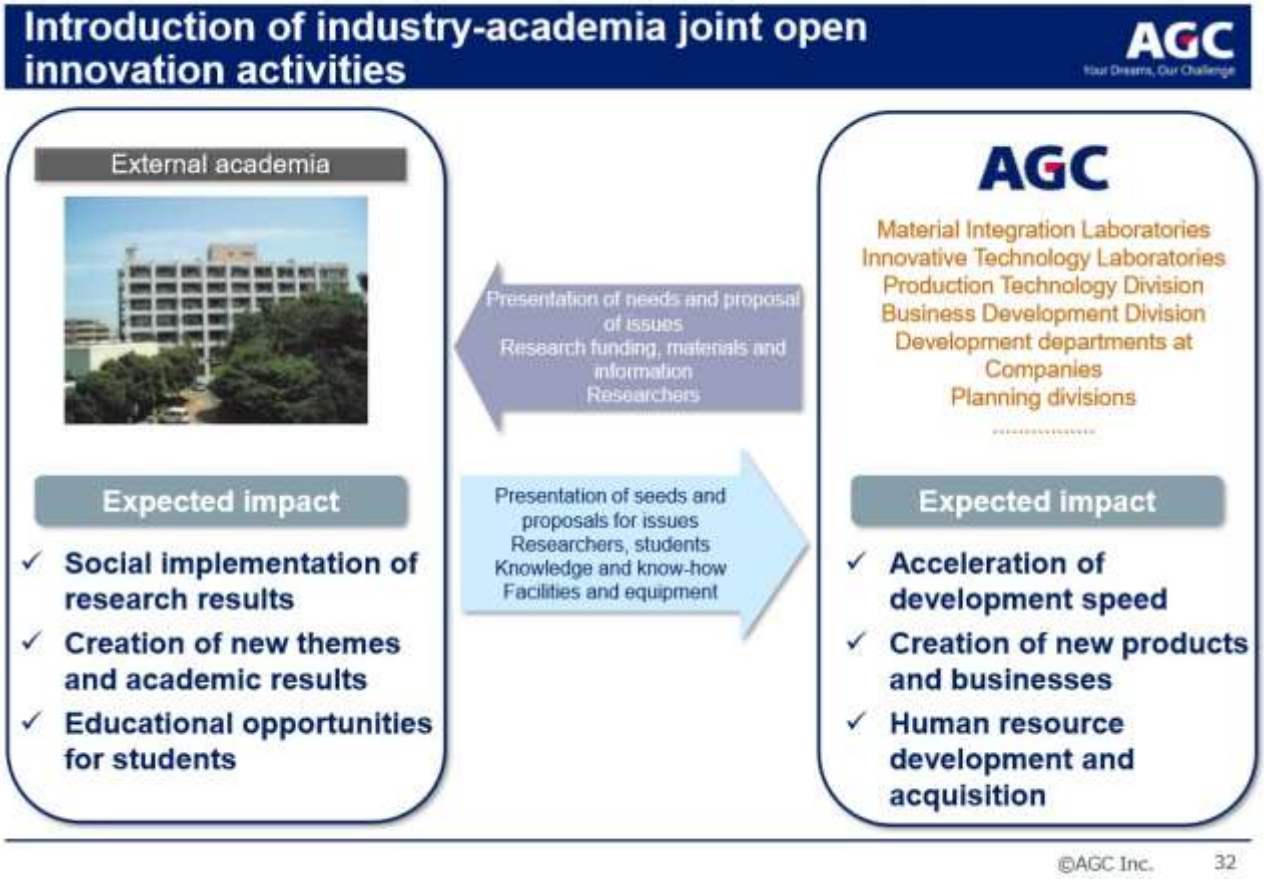
In terms of collaboration with end users, I think this will be open innovation in a different way. As a result, we have been able to develop a UV-cut glass product called UV Beeru Premium, which we sell to automakers.



In terms of the most recent example, there is a lot of information flying around about 5G and 6G in the future. Mobile communications will also increase. In such a situation, the location of the antenna is also limited. That's what I'm thinking.

NTT DOCOMO, INC., in particular, had a challenge in securing a place to install the antenna. They had the idea that if they could send the signal from inside the building it would reach pedestrians and cars alike by transmitting from inside the building, or rather, from a glass antenna.

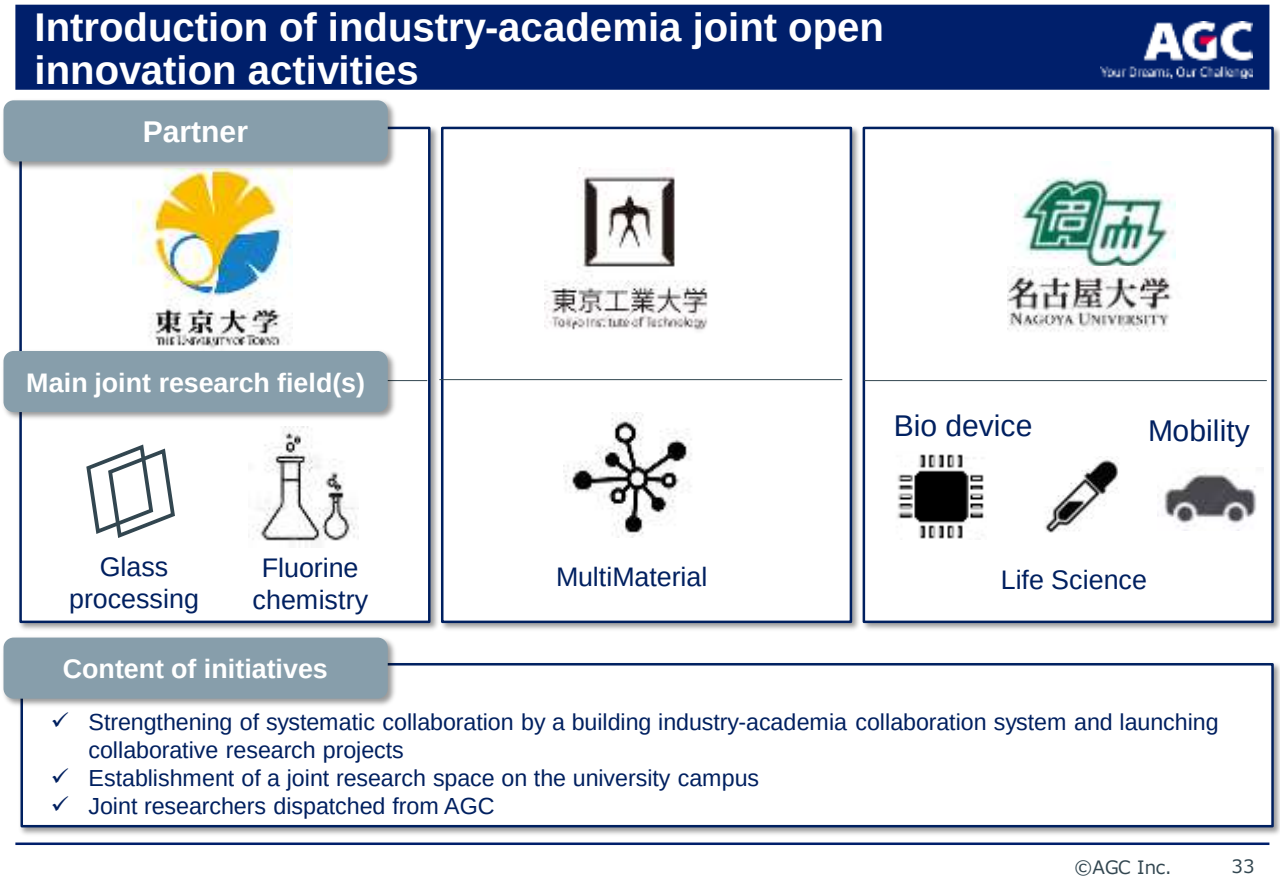
By collaborating with us, we have been able to create glass antennas that can be passed through glass, and the glass contains Low-E, which blocks various radio waves. We proposed a combination of these technologies, and together with DOCOMO, we came up with the final product, WAVEATTOCH. For this glass, what we call prime locations, but we believe it will require a variety of uses in buildings and automobiles in the future.



This is the basic flow of open innovation.

On the left is external academia, and the expected effect is the social implementation of research results. There are many universities that have made this their mission. There is also a need for educational opportunities for students who will support society in the future.

We are looking for technologies that AGC does not have, and chemical analysis that cannot be elucidated by AGC. There are also new products that are created through chemical clarification based on principles. In addition, collaboration with universities, including human resource development, will be very important, and I think it will be a very important key to improving Japan's development capabilities. We are currently focusing industry-academia joint open collaboration.



This is a diagram of a large-scale collaboration with a university. The left-most one is the University of Tokyo, the middle one is Tokyo Institute of Technology, and the right-most one is Nagoya University.

Each university has its own characteristics. We are currently conducting advanced research with the University of Tokyo on what kind of research is needed in the future based on glass and fluorine technologies. In addition, Tokyo Institute of Technology has established a joint research center for materials, and we are currently collaborating with Tokyo Institute of Technology, focusing on multi-materials. Nagoya University is strong in life sciences and mobility. We have set up themes including such biodevices and are promoting joint research.

The ultimate goal will be commercialization. While taking a multifaceted view of these businesses, we are working on open innovation with universities, including redefining the next new technology.

New research building established at AGC's Yokohama Technical Center

- **Establishing a new research wing as a place to "connect" inside and outside the Company**

Site: On the premises of the AGC Yokohama Technical Center (Tsurumi Ward, Yokohama)
Total construction cost: ¥20 billion
Total floor area: approx. 45,000m2 (Including existing researching building area: approx.70,000m2)
Completion: Completion in 2020, fully opened in 2021

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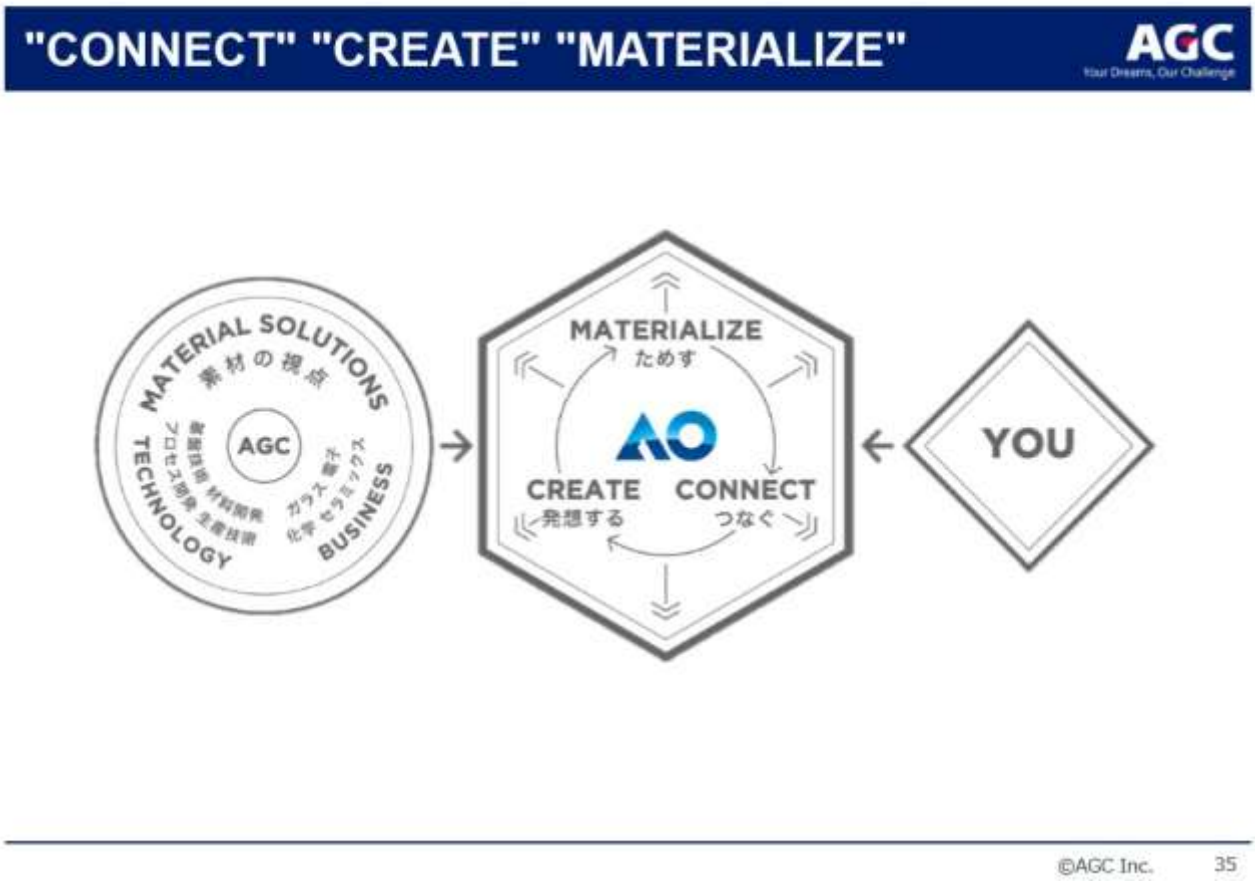
The Central Research Laboratory, which had been in use for 56 years, was consolidated into a single location and a new research building was established at the AGC Yokohama Technical Center. The grand opening was held in June this year.

As you can see in the photo on the right, we will be conducting research in the existing and new research buildings, which together cover 70,000 square meters, and will be fully utilized as a place for new open innovation as well as a place to create new innovations.



This is our idea of AO for open innovation.

It says to connect, create, and materialize. The first step is to connect with customers, and also to connect within the company. It's this speed and cycle that allows us to come up with rich ideas, and then experiment with them. Our goal is to create something new based on this.

First of all, we have prepared a video for you to watch.

[Video Plays]

The main purpose of the OPEN SQUARE is to encourage customers and academics who visit us to enrich their ideas and lead to the next step by running a cycle of looking at samples and products, touching them, feeling them, and coming up with ideas.

Utilization of VR

- Implement virtual prototyping with VR
  - Accurately identify customer needs and provide products that meet them
  - Accelerate the speed of product development

Development of architectural glass

Development of automotive glass

I would like to explain the third point about DX.

As I mentioned earlier, VR. It is very important to increase the development speed by alternately looking at the reality and the simulation.

Here are a few examples. One is the development of architectural glass, and the other is the development of automotive glass. As you saw in the video earlier, the purpose of this project is to accelerate the speed of product development by accurately grasping the needs of customers, delivering them quickly, and having them make decisions quickly.

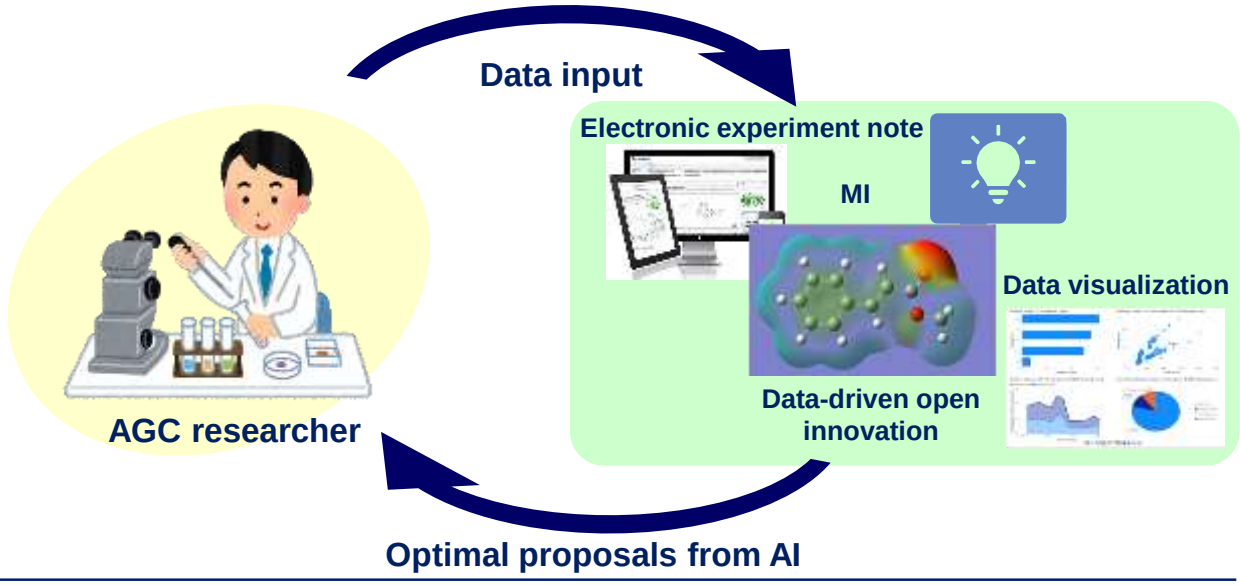
Examples of using VR for development

I think this will be another video, and this will be an example of architectural glass.

It's moving. There is a large piece of glass on one side of the room. This is the new research building. For example, the customer will need to know what kind of glass to fit into this glass surface. Naturally, the color scheme will also change when thermal insulation performance is added. And the coating will change this way. In the past, it was difficult to understand because of the small samples, but now we can see this in real life, virtually, and accelerate the speed at which we can make decisions on the spot.

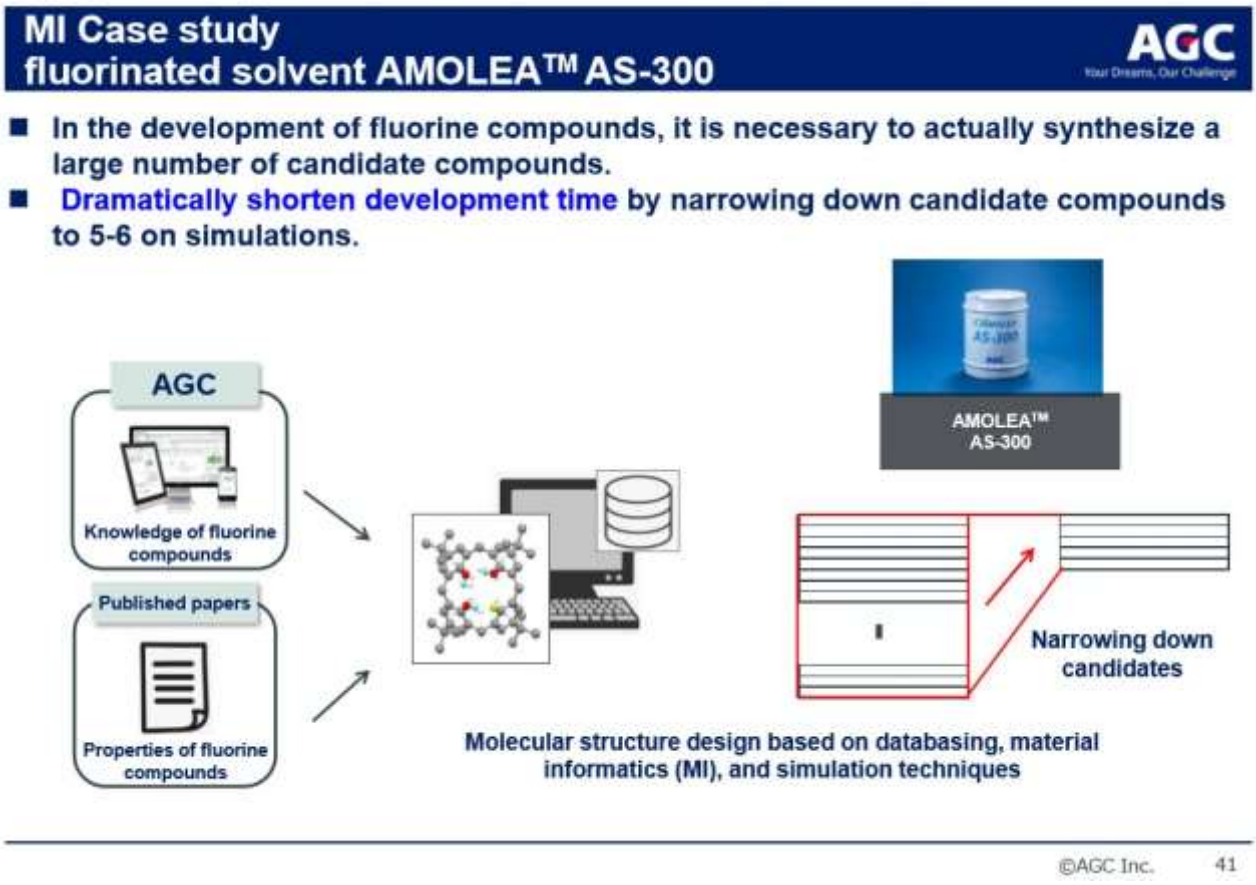
Materials development and composition development by MI (material informatics)

■ Utilizing MI for material and composition development, aiming to enhance R&D competitiveness and speed up development.
In addition, researchers who receive proposals for AI will be able to strengthen their creativity.



In addition to these VR projects, we are also speeding up our research and development using material informatics and AI.

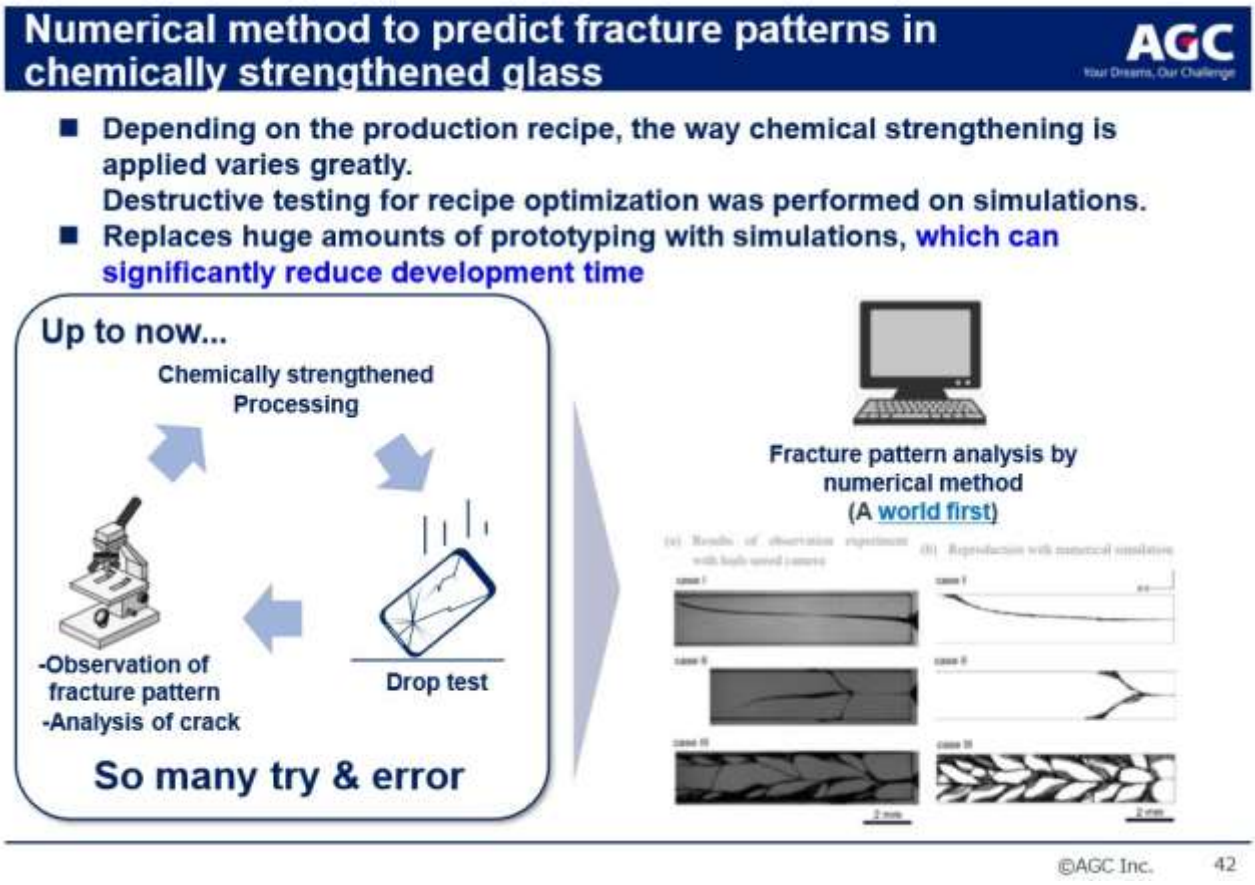
One is to visualize the accumulated data using experimental notes and so on. Data driven is speeding up research and development by making optimal proposals from AI based on the data lake. In addition to speed, we will also be able to find answers that we cannot conceive of on our own. This will be explained in a case study.



For example, one of MI's examples is AMOLEA, a fluorinated solvent, which is listed as AS-300. In order to produce the final product, our company needs to be environmentally friendly, have safety features, and enhance cleaning power.

Then, the data on the left side, the data that AGC has accumulated in the past on fluorine compounds, and the huge amount of data collected from published papers in the world, will be made into a database. And then the structure of the molecular design and the synthetic route, using AI and MI, we call the whole thing MI. Using AI, using machine learning, and simulation calculations. We use it to find the solution.

In this way, the solutions are narrowed down to 5 types or 6 types, as I mentioned, and then experiments are conducted from there. Naturally, some of these are imagined by the researchers and some are not, and then the real experiments begin and the products can be made. By doing so, we are able to reduce the speed of the process and at the same time produce better products.



The other is the fracture pattern of chemically strengthened glass.

Up until now, we had actually conducted drop tests many times, varying the height and analyzing the cracks to observe the shallow patterns. That alone would still take an enormous amount of time and experimental error. We used the accumulated data as a basis for simulations, and although I think this involves machine learning, we have made considerable progress in such data lake, and have created simulation algorithms that have enabled us to prove fracture patterns through analysis for the first time in the world.

This is an example of how we are accelerating the development of new products by combining the real and virtual worlds and seeing how the composition of the glass changes in the drop test and how the structure develops.

Finally, to summarize again, I have mentioned examples of development using DX, but in combination with open innovation, we can further decide on a development portfolio for medical device development and contribute to society by creating new value.

We will continue to grow sustainably through the provision of our unique materials and solutions and aim to be an excellent company that can contribute to society.

Thank you very much for listening.