THE CANON FRONTIER

Focus on Technology and R&D

Shaping the future through innovation to meet the changing times

Since its foundation in 1937 as a camera manufacturer, Canon has continued to diversify its business operations based on the optical technology accumulated through camera development, and today operates in four industry-oriented groups.

With the power of technology, which is the driving force of value creation, we will produce attractive products and services that contribute to social progress and the well-being of people.

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Innovating for a better society and continued growth

Empowering future innovators to explore the unknown

Toshio Homma
Executive Vice President & CTO, Canon Inc.

Toshio Homma

Evolving with the changing times

The world is entering a future society in which all industries will be incorporating innovative technologies such as AI, the IoT, robots, and big data to solve various social issues. Canon, which started out as a camera manufacturer, has promoted the diversification of its business in line with the needs of the times, centered on optical technology, and has expanded its business fields to include office equipment and optical products. Today, Canon operates in four industry-oriented groups: Printing, Medical, Imaging, and Industrial. During this period, management and R&D have been working together to develop technology management and build an optimal R&D system.

The technology behind Canon > Page 4

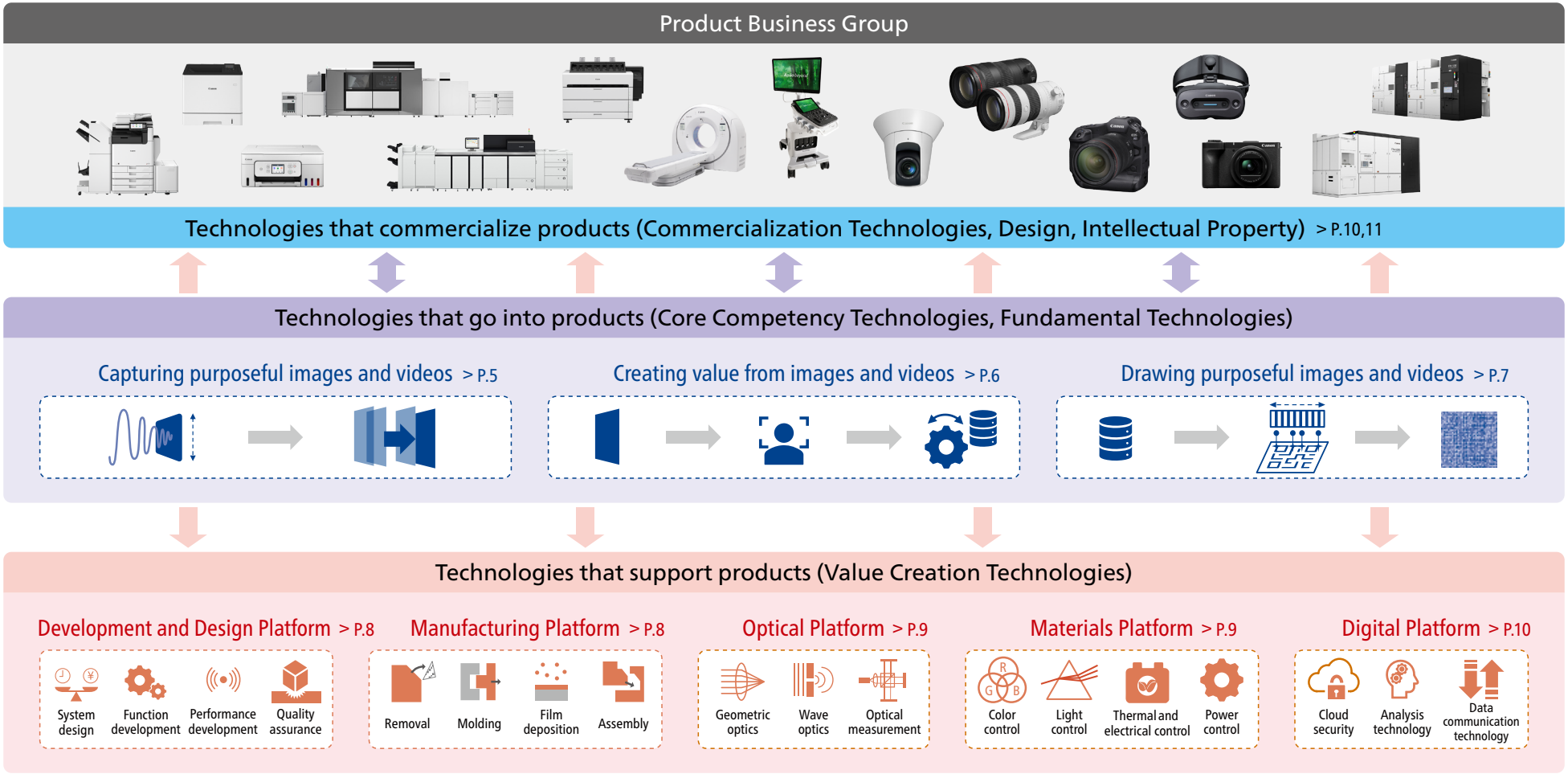
Although Canon is composed of various businesses, we continue to grow as one unified company thanks to a system that enables us to make use of our accumulated technologies across the entire Group. The Canon Group's technologies are classified into Technologies that go into products (Core Competency Technologies and Fundamental Technologies), Technologies that support products (Value Creation Technologies), and Technologies that commercialize products. The Technologies that go into products do not exist independently. Through their use in product design in close combination with the platform of the technologies that support the product, they contribute to creation of competitive products that are difficult to be imitated by competitors. This development environment, in which we are able to combine technologies to create synergies, is also effective in integrating newly acquired technologies and those of companies acquired through M&A, serving as a driving force for Canon's continuing evolution and creation of new value.

Looking ahead

It goes without saying that these technological capabilities are one of Canon's strengths. And what gives us that strength is the presence of engineers who have a sense of responsibility and a sense of purpose.
Canon has established a development environment where these engineers join forces to demonstrate their capabilities. In addition, we provide opportunities for joint research with universities and research institutions in Japan and overseas, study abroad programs, and other initiatives so we can absorb the latest technologies in fields that need to be strengthened. By further reinforcing these fields, we will refine and enhance our technology.

Social contributions and growth through innovation are what made Canon into the company it is today. The Canon of the future will continue to further evolve and grow by developing human resources who will take on challenges in uncharted fields.

Technology platforms that support our businesses



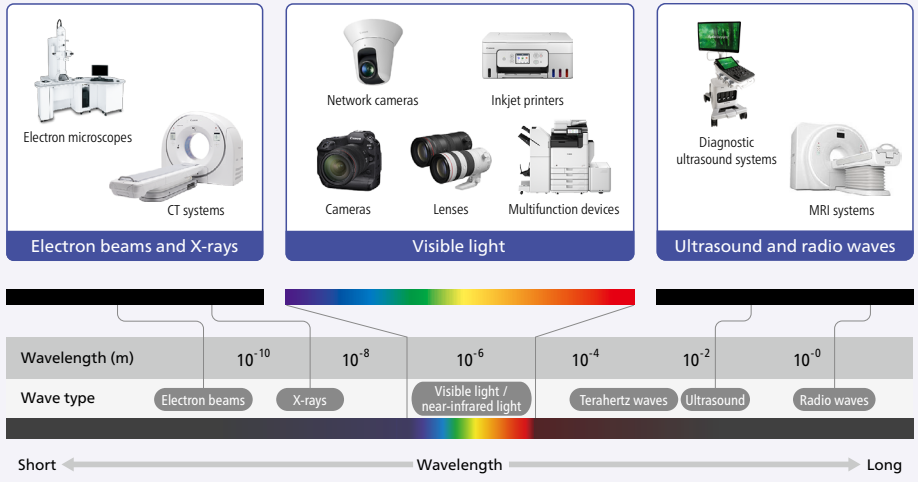
Surpassing the human eye in every aspect

Capturing purposeful images and videos

The light that we can perceive with our eyes is limited to wavelengths between 400 and 800 nm*. Technologies that capture purposeful images and videos refer to Canon's distinctive technologies that enable the visualization of microorganisms, the interior of animate and inanimate objects, materials, and even darkness. To accomplish this, both visible light and light not visible to the human eye, such as electron beams, X-rays, ultrasound, and terahertz waves, are used.
Electron microscopes, cameras, CT systems, MRI systems, and other devices make use of the properties of specific waves to capture them, thereby realizing technologies that capture images true to their purpose. These technologies, which meet a wide variety of needs from both the microscopic and macroscopic worlds, are one of Canon's signature strengths. Our capture technologies are also well regarded for their low noise performance, which has led to more collaborations with other companies.

*Nanometer = one billionth of a meter

Scan for more information

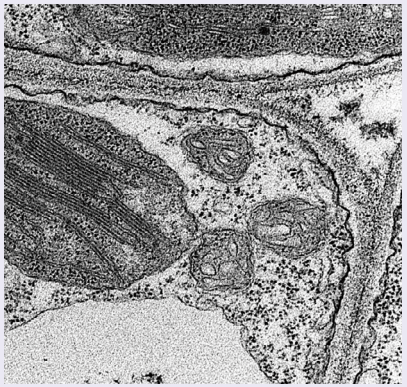


Canon's technologies that capture a wide range of wavelengths

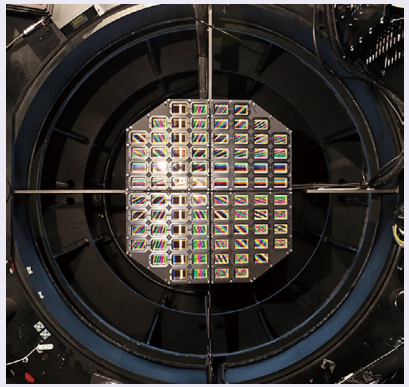
Application case study

CMOS sensors

Canon's CMOS sensors, which incorporate our best capture technologies, are used in a wide range of applications, from examining microscopic specimens (substances used in experiments or analyses) to observing celestial bodies.
CCD sensors, which have been used in electron microscopes and astronomical observation systems, have several drawbacks. They require long electron-beam exposure time to form images, which can damage specimens, and they require special cooling devices to suppress noise caused by heat, making them difficult to miniaturize. Consequently, there are hopes to replace CCD sensors with CMOS sensors, which offer high-speed readouts and noise reduction capabilities. Canon's CMOS sensors achieve high-speed readouts and offer high sensitivity, high image quality, and low noise. Because of these advantages, they have been used in electron microscopes manufactured at JEOL Ltd. and at the Tomo-e Gozen astronomical observation system at the University of Tokyo's Kiso Observatory. In this way, Canon's CMOS sensors are addressing demand to capture images true to their purpose in many different fields.



A carrot leaf scanned with the electron microscope equipped with CMOS sensors



Tomo-e Gozen's camera equipped with 84 ultra-high-sensitivity CMOS sensors

Creating immediate value using information extracted from images

Creating value from images and videos

The world around us is inundated with images and videos including ads and posters, videos from network cameras, and CT and MRI images. Technologies that create value from images and videos are those technologies that convert images and videos into higher added value. These include image quality quantification technology that accurately measures aspects like hues and clarity, which were previously judged by the subjective sense of human vision; image sharpening technology that improves the quality of images to increase the value of images; and image recognition technology that accurately extracts information from images and adds value to the extracted information. For example, in the medical field, Canon's unique technology that adds value to information both improves the quality of MRI images and shortens examination times, thereby reducing stress on patients and medical staff. In addition to the three technologies, we also have standardization technology, which enables the bidirectional transfer of information between various devices and services. By using the right combination of technologies for the specific application, we boost the value of our products.

Scan for more information

Canon's technologies that increase the value of our products

Application case study

Super Color Management

Image quality quantification technology that measures accurately what people visually perceive is needed on the printing frontlines.
Even when printing the same image data, differences in printer models and paper types can cause color mismatches. As a result, color variations occur when printing the same image data on multiple printers. There are international color management standards that manage the colors on printed matter numerically. However, the human eye may perceive different colors from two items even if the colors of the two items are measured to be the same based on the standard. For that reason, Canon developed a scale to measure colors as perceived by the human eye. We use this color scale to map colors that have nearly the same visual impressions when viewed. The system also analyzes the image data to be printed, compares the desired colors with those that the printer can reproduce, and processes the image so it gives nearly the same visual impression as the intended color. This improvement in color consistency is expected to radically change workflows when deploying different printers across multiple locations.

Bespoke goods created on different printers all have visually consistent colors

Quick, accurate, and precise. Making drawing technologies possible.

Drawing purposeful images and videos

Printed matter like labels and packages, and semiconductors essential to control electronic devices, can fulfill their role of transmitting information only when the information has been drawn in the form of images or electronic circuits. Technologies that draw purposeful images and videos refer to technologies that draw information quickly, accurately, and precisely on paper, semiconductors, and other objects.

As Canon has diversified its business from printers and cameras to lithography equipment and other devices, it has developed various image-drawing technologies for different types and sizes of objects where drawing takes place. The core technologies are material technology that gives substance to information; device technology that outputs information; optical and precision mechanical technology that drives mechanisms quickly and accurately; and image processing technology that compensates information accurately. These technologies, in isolation, cannot produce competitive products. We deliver competitive products by combining and matching technologies.

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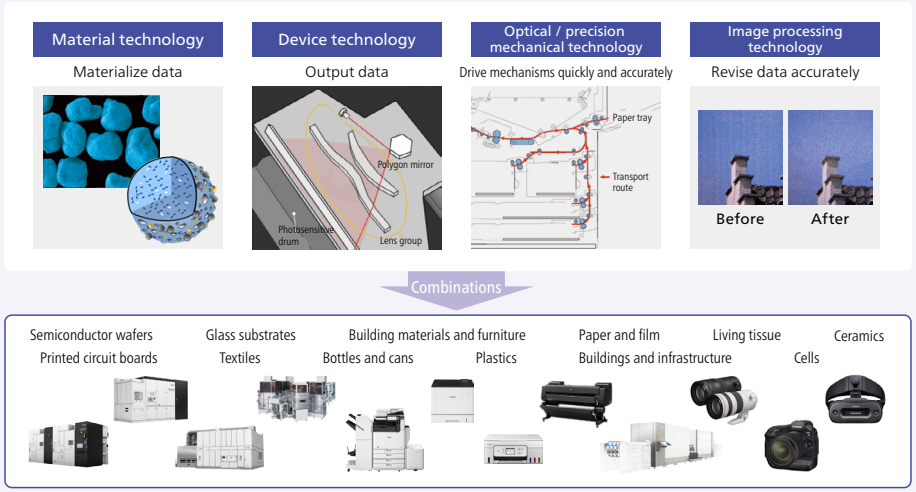


Canon's technologies that make all kinds of drawing possible

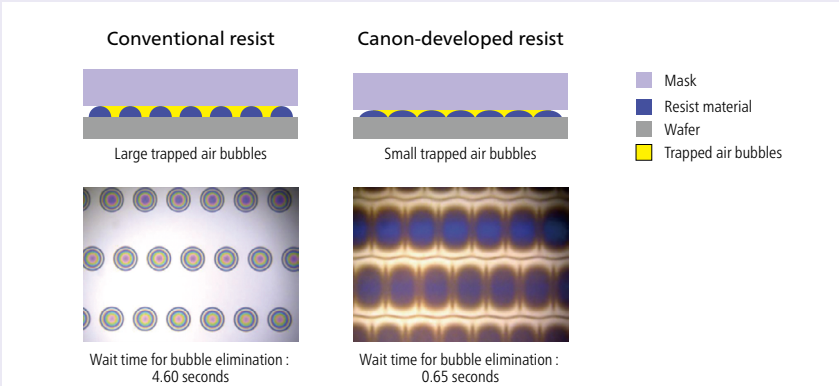
Application case study

Resist for nanoimprint lithography semiconductor manufacturing equipment

An example of a drawing technology that was realized by combining technologies is the development of a resist used in nanoimprint lithography (NIL) semiconductor manufacturing equipment.

NIL renders semiconductor circuits with nanometer-level trace widths by dispensing droplets of liquid resist on the silicon wafer to match the circuit pattern and then pressing and removing a mask etched with the circuit pattern onto the resist. The compatibility of the resist and the device is extremely important, because the formed circuit pattern can be damaged while removing the mask. Canon successfully developed a resist optimized for NIL equipment through the collaboration of domestic and overseas Group companies that have advanced technologies in NIL research and material development.

The newly developed resist droplets spread over the wafer surface at a faster speed, greatly reducing the wait time to eliminate air bubbles trapped in the droplets. This has led to a three-fold increase in processing speed.



Behavior of resist droplets on a wafer

Shortening development time through virtual prototyping

Development and Design Platform

In conventional product development, tangible prototypes are produced based on drawings designed in CAD and then used for repeated experiments and testing. This method placed a burden on product development in terms of cost and duration of prototyping because many pieces of different prototypes had to be built for each stage of development.
At Canon, we have built a platform that can be used for all products throughout the company, accumulating simulations for reproducing and testing physical phenomena from the micro to the macro scale, such as warping or undulation of paper, melting of individual toner grains, or the impact on a camera when the camera is dropped. We can now check accuracy and solve problems in the product design stage, for development in a shorter time and at a lower cost. The simulation technology is used in the development of office multifunction devices, flat panel display lithography equipment, mirrorless cameras, CT systems, and the like, promoting prototype-free manufacturing in many divisions and providing high-quality products to customers in a timely manner.

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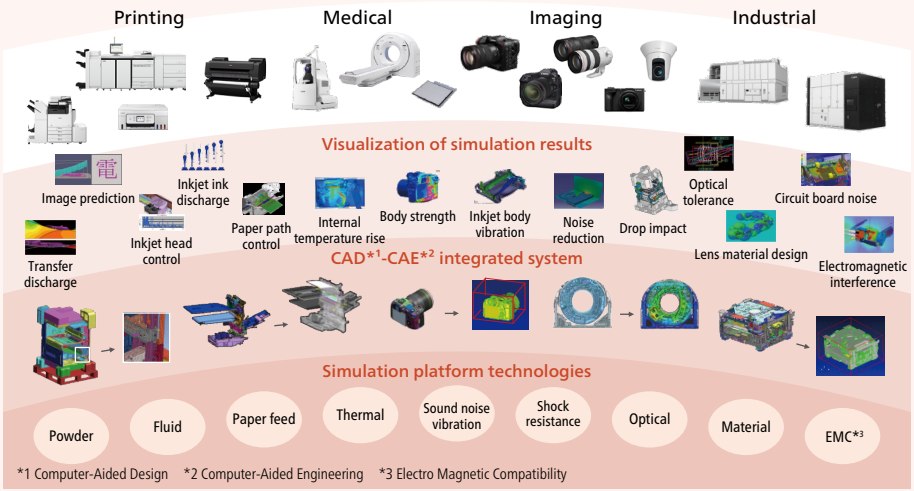

Development and Design Platform applicable to a wide range of products

Creating manufacturing methods

Manufacturing Platform

Advanced manufacturing technologies are essential to delivering attractive products to the world. At Canon, in the course of pursuing optimized manufacturing methods for respective products, we have acquired and enhanced technologies for advanced manufacturing in four areas: removal, molding, film deposition, and assembly. We have systematically categorized this stockpile of technologies into a technological foundation composed of three areas: process design technologies for developing manufacturing methods for components, elemental equipment technologies for controlling the operation of equipment, and systemization technologies for implementing these technologies into actual manufacturing systems. We utilize this platform to manufacture precision fabrication equipment and automated assembly systems in house and use them to produce key parts and units. This enables us to produce a wide range of products at a high level of productivity and precision: for example, everything from camera lenses that require stable quality at mass volumes to lenses for semiconductor lithography equipment that demand precision on the order of nanometers. This manufacturing capability underpins the competitiveness of our products.

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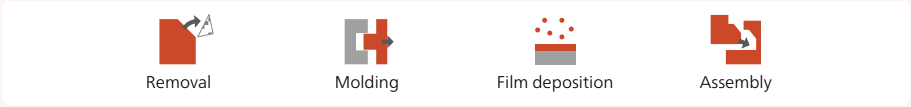
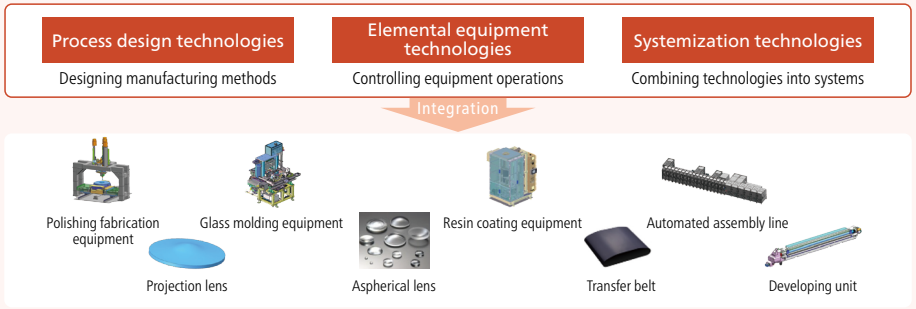


Technologies for advanced manufacturing in four areas



Conceptual image of Manufacturing Platform applications

Expanding the possibilities of light

Optical Platform

Optical technology, a mainstay of Canon's diversification, has always been advanced as a core competitive technology. Over time, the range of light handled by our optical technology has broadened beyond the wavelength of visible light: on the shorter wavelength side to X-rays and on the longer side to infrared rays, and even to terahertz waves. The products that rely on our optical technology have also expanded from interchangeable camera lenses to printers and semiconductor lithography equipment. Our optical technology used to utilize the properties of ordinary rays of light, but as the technology progressed, it came to incorporate wave optics, which deals with the properties of light as waves, and now even utilizes the properties of light as particles.

We have also developed the capability to design and manufacture lenses used in our products, which have progressed from simple spherical shapes to complex aspherical shapes. We have even developed diffractive optical (DO) elements — minute structures that control light — which is a technology that is found in our interchangeable lenses for mirrorless cameras. Canon systemizes the outcomes of these series of advances in optical technology as fundamental technologies.

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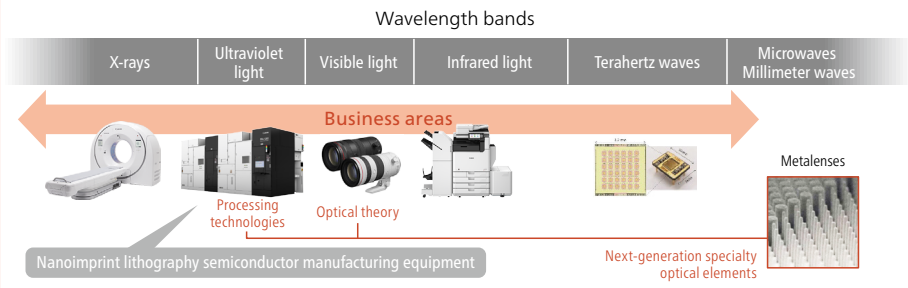


Canon's main optical products and relevant wavelength bands

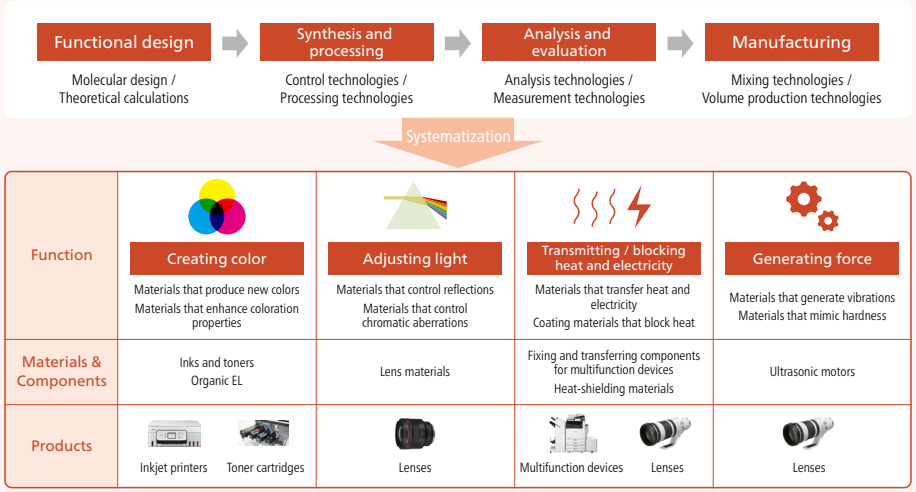
Improving product performance and competitiveness

Materials Platform

Materials are a key element that impacts product performance. Canon identifies materials whose improved functionality will offer highly competitiveness, and strategically develops such materials entirely in-house. It has also acquired and enhanced technologies necessary for each stage of developing materials — namely, functional design, synthesis and processing, analysis and evaluation, and manufacturing.

Canon divided these accumulated material technologies by function into four categories: technologies for creating color, technologies for adjusting light, technologies for transmitting / blocking heat and electricity, and force-generating technologies, and systemized these technologies as a Materials Platform accessible companywide. The Materials Platform is a source of competitiveness as it facilitates the extension of technologies to other products, such as applying a light-adjustment material technology originally developed for interchangeable camera lenses to network cameras.

Scan for more information



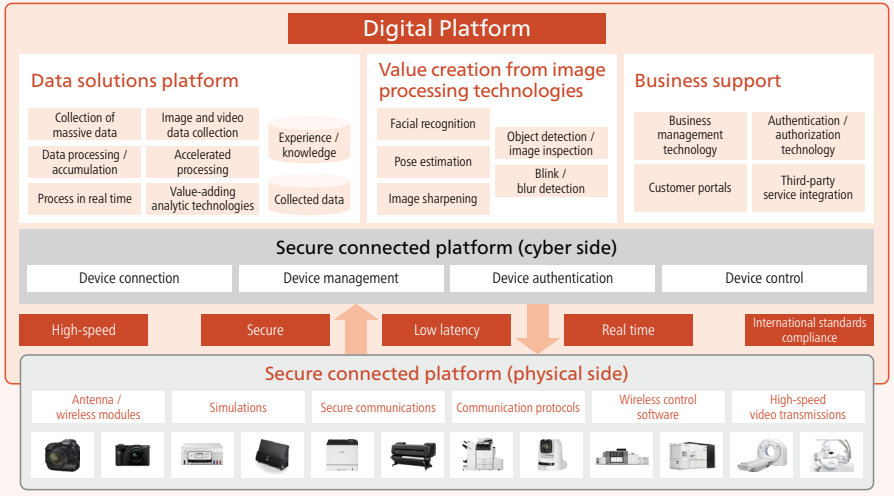
Conceptual image of Materials Platform applications

Amplifying product value through enhanced functionality and ease of use

Digital Platform

Most of the value of products used to be built into the hardware. However, in recent years, most products have been connected to a network. There is a growing demand for systems that increase products' added value by linking them with the cloud, such as various functions and services using cloud and digital technologies, and data analysis solutions.
Through the development of cameras, office multifunction devices, and other products, Canon has developed Digital Platform technologies that link hardware with cyberspace. A specific example is the development of a data solutions platform that collects and analyzes massive amounts of operational data from printers, semiconductor lithography equipment, and other devices and uses this data to extend services to customers. Another example is a secure connected platform that links devices to the cloud quickly, simply, stably, and securely. These platforms are used in a broad range of Canon products and services.

Scan for more information



Conceptual diagram of Digital Platform

Bringing together quality, cost, and delivery in a single product

Commercialization Technologies

Even if products or services have amazing technologies or features, customers will not accept them if the quality, cost, and delivery (QCD) are not in line with expectations. Striving for the optimal QCD balance in mass production is where a manufacturer's true prowess shines and is directly linked to its competitiveness.
Commercialization Technologies are what integrate technologies, ideas, and functions into a product. Transforming a manufactured finished product into a commercial product that reaches customers involves several key elements, especially usability and safety assurance.
To achieve these objectives, our development and production departments collaborate as one while making extensive use of systemization technologies that bring together design technologies and other individual technologies.

Pursuing usability and aesthetic beauty

Design

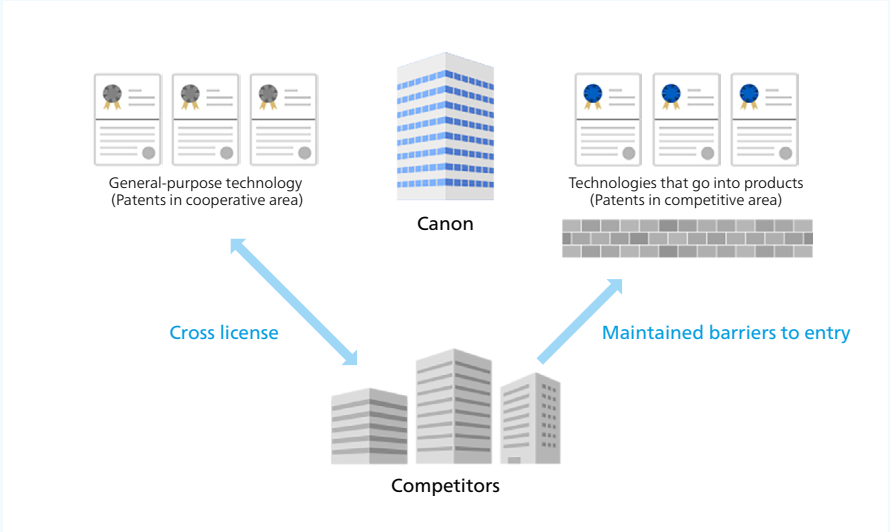
No matter how well a product performs, it is not a good product if using it creates stress. As Canon expands into more business domains, the role of design has also expanded. Its scope has widened from the physical design of individual products and graphical user interfaces (GUI) to the design of spaces surrounding products. In the case of large equipment, it is increasingly important to construct a space design that takes into consideration the operators' movement flow and efficiency of their work in the place where the equipment operates. Despite the changing role of design, Canon consistently values pursuing designs for the users. Through interviews with customers and studies of actual usage environments, we repeatedly examine and verify from multiple perspectives in pursuit of designs that blend usability and aesthetic beauty.

A control panel accessible from a seated position

Balancing competitiveness and freedom

Intellectual Property

To address a variety of societal challenges, technologies are now being intricately combined, leading to situations where existing proprietary technologies are applied in fields different from their original intentions.
Canon's intellectual property activities are based on its Open & Closed Strategy, which aims to strike a balance between securing competitiveness and ensuring freedom, tailored to each technological field from the perspective of business development.
Inventions that form the foundation of a product's competitiveness are either not licensed to other companies or not filed for patent protection, with priority given to maintaining competitive advantage. In technological fields with high versatility, where the use of other companies' technologies is unavoidable, freedom is ensured through cross-license agreements among patent holders.
Through this strategy, Canon not only ensures an advantage for its own products but also removes barriers to expanding its business and technological domains, thereby driving the advancement of its operations.

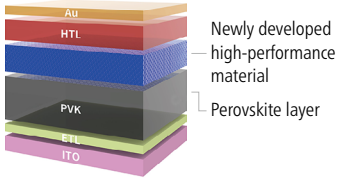


Conceptual diagram of Open & Closed Strategy

New applications in a growing number of fields

High-performance material

Canon's Materials Platform is creating value in a variety of applications, beyond the scope of our current four industry-oriented groups. One example is a high-performance material developed by applying technical expertise to materials originally developed for photosensitive drums, which are key components of office multifunction devices and laser printers. Thanks to their conversion efficiency and ease of installation, perovskite solar cells are expected to become the next generation of solar cells. However, there are still barriers to their widespread use, such as durability improvement, and stable mass production. The high-performance material developed by Canon has the potential to solve these issues and be a game-changer in global energy.



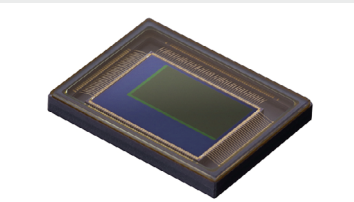
Layer structure of a perovskite solar cell

A key device for the "eyes" of future society

SPAD sensor

Image sensors convert light into electrical signals to generate images. Growing needs for advanced surveillance and autonomous driving are propelling demand for advanced sensor technologies that can clearly capture subjects and measure distances to target objects quickly and accurately even on dark roads or environments with strong contrast conditions. Canon has developed a SPAD sensor with approximately 2.1 megapixels that achieves a high dynamic range. By using a newly proposed light detection method, the SPAD sensor can detect a pedestrian at a distance of 120 meters in low-light conditions of 0.1 lux*1 while reducing the power consumption per pixel by about 75% in comparison to our previous sensor*2. Because of these advantages, the SPAD sensor is expected to be used in many applications, such as surveillance, automotive, and industrial fields.

*1 For reference, a full moon night measures about 0.2 lux
*2 The SPAD sensor announced by Canon in 2022

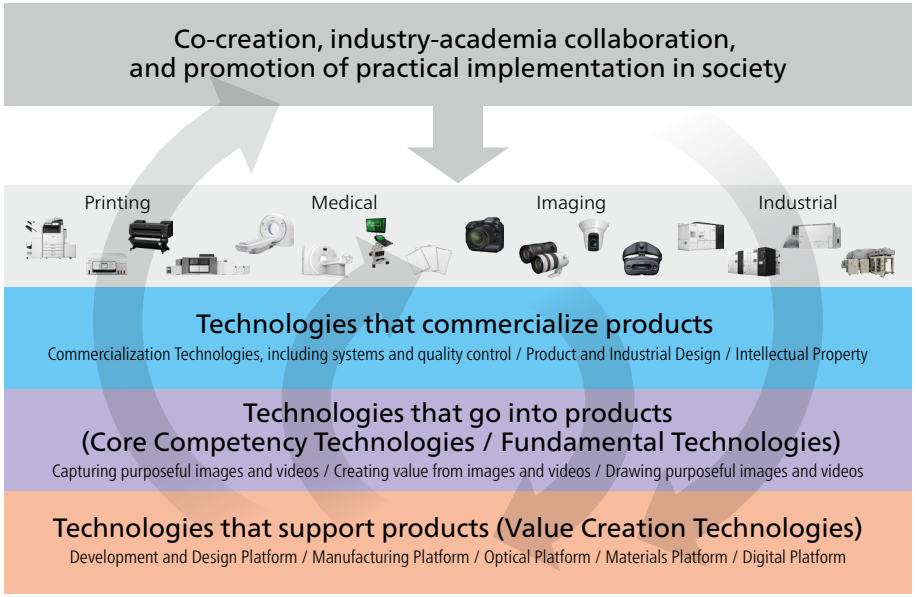


The newly developed SPAD sensor (prototype)

Open Innovation

Scan for more information

Canon's technology platform, which consists of three technological foundations, is not just a collection of individual technologies, but a systemized environment that is utilized throughout the company and across the business boundaries.
This unique technology platform is what makes it possible for the company to grow across its four industry-oriented groups. This same environment also supports new ventures—whether they join through mergers and acquisitions or through partnerships with universities and research institutions. By making it easy to apply Canon's core technologies, it helps these new projects move forward quickly and reach their goals sooner.
As new products are developed and produced within this environment, the technologies gained and refined in the process are fed back into core technological foundations. Through this ongoing cycle of innovation and improvement, Canon's technologies continue to grow stronger and evolve—paving the way toward the future.



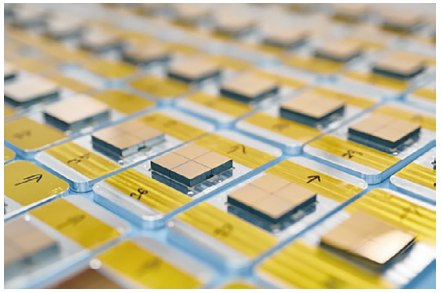
Conceptual image of three technological foundations utilized in Canon's Open Innovation

Driving real-world applications
— Supporting the early stage technologies for the future

Through the Canon Foundation, Canon supports scientific research aimed at solving social challenges and driving innovation for the future. The Foundation provides grants to researchers who envision new forms of value for society and boldly explore the unknown frontiers of science and technology needed to realize that vision. To help turn as many of these ideas as possible into real-world solutions, Canon actively engages with researchers and explores how its core technologies can support their efforts.

Co-creation
— Accelerating the development of photon-counting CT

As populations age, the need for early disease detection through diagnostic imaging is growing. Computed tomography (CT) is an effective diagnostic imaging method, but since it uses X-rays, patient exposure risks must be taken into account.
Photon-counting CT (PCCT) is a next-generation CT that is expected to provide high-definition images with less X-ray exposure dose than conventional CT and to allow accurate determination of tumor malignancy. In 2021, Canon welcomed semiconductor manufacturer Redlen Technologies Inc. to its group of companies, and by leveraging their core device technology, has established mass production technology for specialized semiconductors that improves X-ray detection efficiency and enables noise reduction. Canon is currently engaged in joint research with leading medical institutions in Japan, the US, and the Netherlands for practical application of PCCT. Through early practical application of PCCT, Canon aims to reduce the burden on patients and provide accurate diagnosis.



Manufacturing process of detector modules

Joint research with Radboud University, the Netherlands

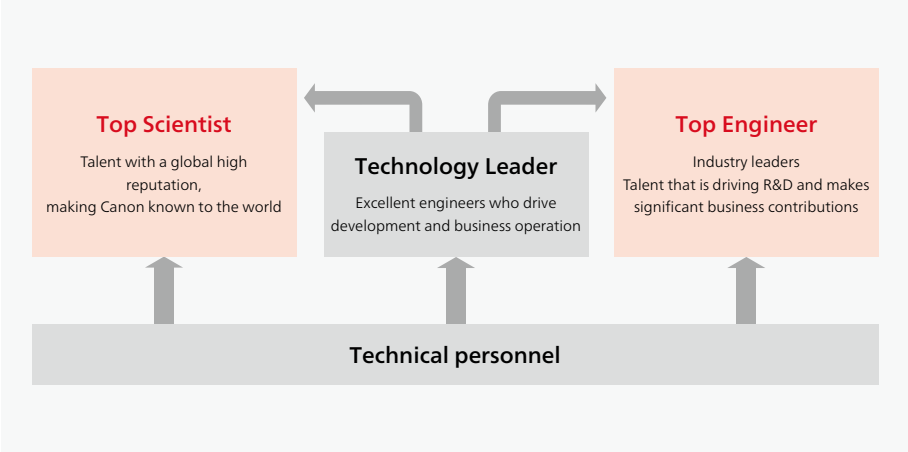
Opportunities for technical personnel

Scan for more information

Offering platforms of deep technical expertise across businesses and products, Canon's unique development environment allows the entire company to utilize the technologies and even make further technological advancements. These efforts are led by the engineers who serve as our technical leaders. Canon has an environment that encourages them to take on challenges, thus creating innovation.

An environment that nurtures and brings out the talents of engineers

Canon has established the Advanced Engineer Recognition System to find and support employees who lead R&D, with the aim of contributing to existing businesses and fostering seeds for new business. Under this system, top-class engineers involved in the development of technologies that are decisive for the success of existing business or the creation of new business, and key technologies expected to contribute to profits over the medium to long term, are recognized as Advanced Engineers. Recognized engineers are offered compensation aligned with their contributions to the company, such as a certain amount added to their salaries as an incentive. In addition, they have more opportunities to contribute to the development of science and technology through participation in academic societies and industry organizations as individuals responsible for the core of Canon's technology.



Types of Advanced Engineers

Image of career development

The career paths for Advanced Engineers are mainly divided into two types: In-depth type and Technology Deployment type. On the In-depth path, engineers will deepen their expertise in recording, sensor, and other core technologies through overseas study and collaboration with external partners. They also develop peripheral technologies required for commercialization and standardization (integration into platforms) to achieve a broader scope.
Meanwhile, on the Technology Deployment path, engineers will develop their careers while refining base technologies such as optical technology and automation technology through system design and implementation. Through multiple internal rotations across different departments, they will help to deploy technologies in various products and areas using abstractions and models.
In both cases, each individual is expected to grow from a single outstanding engineer to a future member of management, leading engineers and various technologies to drive Canon's growth.

Overseas Study Program

Since 1984, Canon has been offering an overseas study program to acquire core technologies and to broaden horizons and build personal connections with outside researchers through R&D activities on a global level. To date, more than 100 engineers have studied at Stanford University, Imperial College London, and other institutions through this program. After their return to Japan, they have been active in positions supporting Canon's technical core, for example, as the heads of R&D divisions or managers in charge of overseas R&D bases.


Stanford University (USA)


Imperial College London (U.K.)

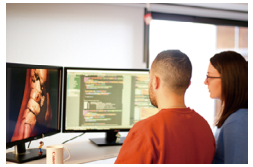

Carnegie Mellon University (USA)


University of British Columbia (Canada)

Global R&D

Scan for more information

1 Canon Medical Research Europe Ltd.



Edinburgh, U.K.

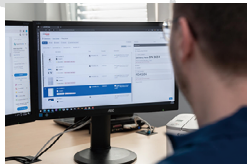
2 Canon Research Centre France S.A.S.

Rennes, France

3 Canon Production Printing Netherlands B.V.

Venlo, the Netherlands

4 NT-ware Systemprogrammierungs-GmbH



Bad Iburg, Germany

5 Milestone Systems A/S

Copenhagen, Denmark

6 Axis Communications AB

Lund, Sweden

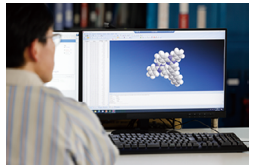
7 Canon (Suzhou) System Software Inc.

Suzhou, China

8 Canon Medical Diagnostics Corporation

Nagaizumi (Shizuoka), Japan

9 Canon Inc.



Ota (Tokyo), Japan

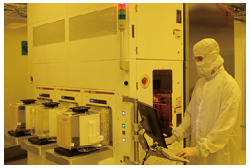
10 Canon Medical Systems Corporation

Otawara (Tochigi), Japan

11 Redlen Technologies Inc.

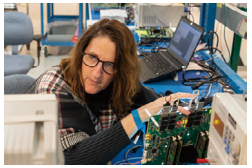
British Columbia, Canada

12 Canon Nanotechnologies, Inc.



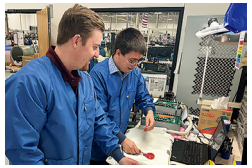
Texas, USA

13 Canon Medical Research USA, Inc.



Illinois, USA

14 Quality Electrodynamics, LLC



Ohio, USA

Canon

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CANON INC.
30-2, Shimomaruko 3-chome, Ohta-ku, Tokyo 146-8501, Japan