THE CANON FRONTIER 2023/2024

Focus on Technology and R&D

Create the Future by Creating Innovations through Systematic Integration of Technologies

Canon's technology, with its origins in camera development, is now expanding its possibilities and being applied to four business areas of printing, imaging, medical, and industrial.
All in order to solve diverse social challenges and enrich lives.
By creating competitive products through a development environment that enables systematic technology integration, while leveraging open innovation structure, Canon is leading the way into the future.

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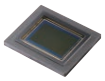

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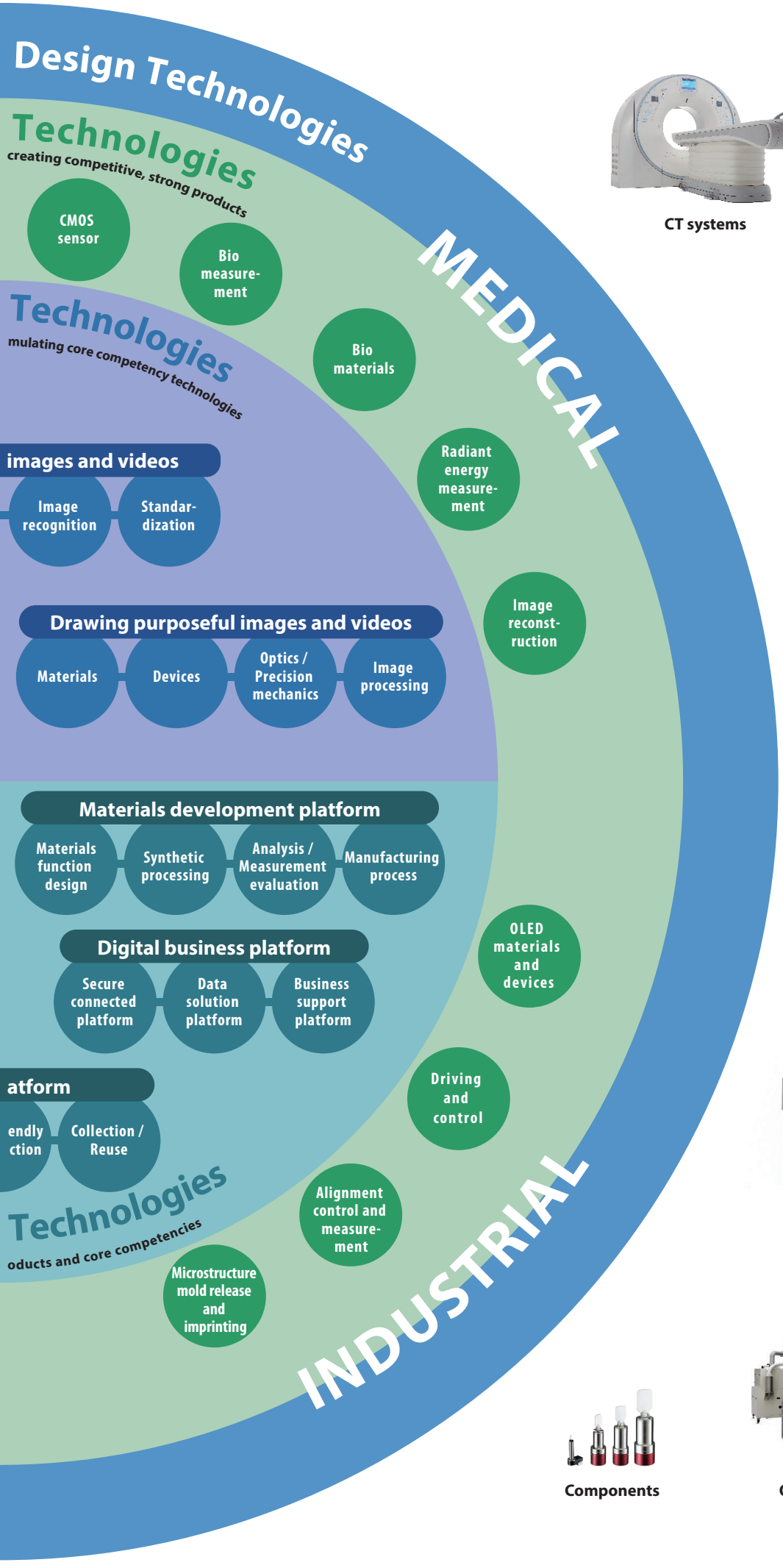

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CTO Message

Looking to Solve Social Problems through Innovation

The post-COVID19 society is in a period of transformation. Amid these developments, how will Canon develop new technologies and carve out a new future?
Toshio Homma, Executive Vice President and Chief Technology Officer (CTO), talks about research and development at Canon.

Toshio Homma
Executive Vice President & CTO, Canon Inc.

Social Changes and Canon

As society undergoes significant changes thanks to striking technological progress in the forms of digital transformation (DX) and artificial intelligence (AI), Canon is also approaching a major turning point. Alongside the continued contraction of markets for cameras and other products that once constituted our core businesses, significant changes are affecting the office multifunction device and printer markets as well. We are taking on the challenge of great transformation in order to reach the next stage of growth.

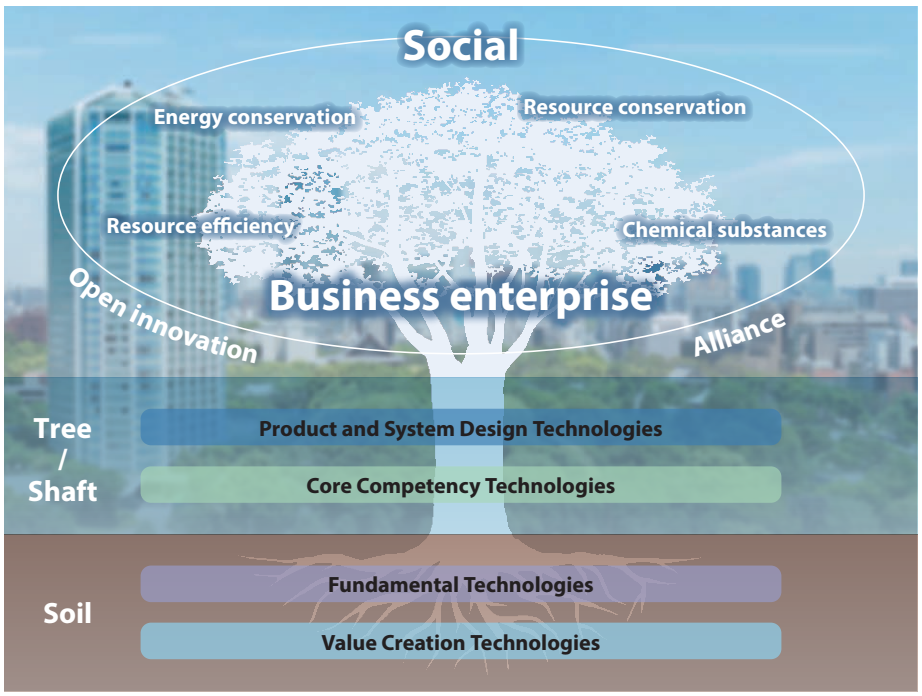
In the future society we are about to step into, research and development undergoes a paradigm shift, where an innovation-focused approach to solving society problems is being added to the prior invention-focused approach. We are in an era where a variety of social issues such as environmental concerns are coming forth and technologies solve them. Social issues come to define technologies in need. Relying solely on inventions after spending much time to nurture the seeds for the future is no longer possible. There is an even greater need for innovation-focused R&D that can address social issues in timely manner. Canon's R&D units are also engaged in self-transformation for that purpose.

Research and Development at Canon

Since Canon's foundation, we have been promoting diversification of our business through development of core competency management, which combines core competency technologies (core technologies), which create industry-leading core products, with fundamental technologies that form the basis of our technology accumulation, and value creation technologies that form the basis of our product commercialization technologies.

We have transformed several of these core technologies into fundamental technologies through repeated R&D efforts. For example, the core technology behind camera people detection has been further developed as a fundamental technology for detection AI/statistics analysis and is now being incorporated into healthcare IT systems helping to enhance our business unit.

Core competency management is put into practice in the research and development process through the "matrix R&D structure." The head office's research departments and the product development divisions of the business units of various products have established a matrix-style system and created a structure that will make it possible to use company-wide technologies. The development divisions of our business units are the main



players when it comes to the core technologies that make our products competitive. Meanwhile, the head office's research departments handle research into forthcoming trends and the development of fundamental technologies. This can lead to the advance development of core technologies at the business departments.

Furthermore, the most distinctive feature of Canon's R&D is that a holistic environment (one where technologies can be joined in complex ways) has been developed where it is possible to use and deploy together throughout the company the "technologies that go into products" like core technologies/fundamental technologies and the "technologies that support products" such as value creation technologies. With this, by simultaneously leveraging the technologies included in products and those that support products in product development, we will create competitive products that are hard to mimic for other companies.

Aiming for New Heights

At Canon, the three groups of core technologies and fundamental technologies, both of which are employed in products, respectively related to capturing, value deriving, and outputting of video/image, have strongly supported the four businesses of Printing, Imaging, Medical, and Industrial, while at the same time having promoted business diversification. This structure has been the main source of Canon's current strongpoints. Going forward, Canon will use open innovation through industry-academia collaborations and collaborations with partner companies to further strengthen our businesses and expand their scope. Canon's value creation technologies for our products are very advantageous in such efforts.

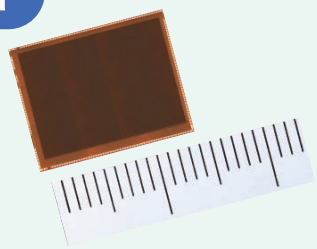
For example, in the XR field we are creating new value by collaborating with partner companies which have cyber (software etc.) technologies as their core competencies, making use of the physical (product) technologies for capturing and depicting videos and images that are Canon's strengths. In the fields of such materials technologies as inks and toner, we are working through collaborations with our partners in the fields in questions to expand their uses beyond printing. In addition, we will work on a wide range of alliances in the field of environmental technology to realize a sustainable society.

Canon needs young, vital people to make these changes. In order to maintain the R&D system that meets the demands of the times, we actively provide opportunities for them to demonstrate their power in both the research department of our headquarters, which develops cutting-edge fundamental technologies, and the development department of business units, which develops world-class core technologies. In addition, for new areas of technology that need to be strengthened, we provide opportunities for education to acquire the technology. Canon hopes to continue its corporate culture by developing human resources who have a distinctive insight into both technological fields and social issues, which is essential for innovation, and who are willing to take on uncharted territory.

For more information about
Research and Development at Canon

SPAD Sensor / Ultra-high-sensitivity Camera

Canon Successfully Develops Key Devices for Future Society



One of the key components that we expect to further enrich our society in the future, beyond what we see today is the sensor that converts light into electric signals. Canon has successfully developed an ultra-small (13.2mm x 9.9mm) SPAD sensor capable of capturing the world's highest*1 resolution 3.2-megapixel color photography—a higher resolution than full HD (approximately 2.07 megapixels), even in low-light environments.

*1 SPAD sensors for video photography use. As of July 31, 2023. Based on Canon research.

For more information about SPAD Sensor

Measuring the Number of Photons, not the Amount

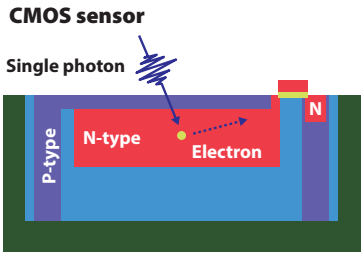
Single Photon Avalanche Diode (SPAD) sensor is a type of an image sensor. The term "image sensor" may brings to mind the CMOS sensors typically used in digital cameras, but SPAD sensors operate on different principles.

Both SPAD and CMOS sensors take advantage of the fact that light possesses the property of particles. While in CMOS sensors, each pixel measures the amount of light that reaches to the pixel within a given time, SPAD sensors on the other hand measure each individual light particle (i.e, photon) that reaches to the pixel. Each photon that enters the pixel immediately get converted into an electric charge, and the generated electrons are eventually multiplied as an avalanche, allowing one photon to be extracted as one electrical signal.

CMOS sensors read light as electric signals by measuring the volume of light that accumulates in a pixel within a certain time frame. This also counts the noise that enter the pixel along with the light particles (photons), hence contaminating the information received. Meanwhile, SPAD sensors digitally count individual photon particles, preventing from any analog noise to enter. This makes it possible to obtain a clear image even in dark places when there is little light, and vividly capture subjects in the darkness.

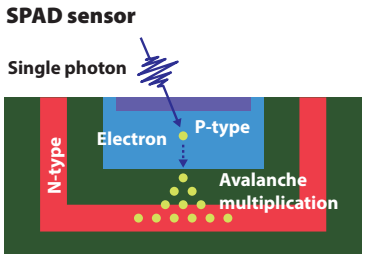
approx. 1X multiplication

Due to the impact of noise, may not be able to detect a single photon, leading to degraded accuracy.



approx. 1000000X multiplication

Correctly detect an incident of single photon. Detection of an individual photon without noise increases the accuracy of infomation.



Low-light Scenes as if It Were in Bright Areas

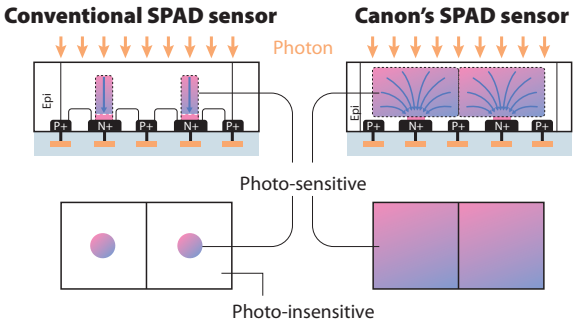
The SPAD sensor developed by Canon employs a proprietary pixel architecture that reflects photons inside the pixel in order to effectively detect photons across the entire region of effective pixels. Under equivalent light conditions, the SPAD sensor can capture the same images as a conventional CMOS sensor while requiring only 1/10 of imaging area. This realizes an ultra-small design that can be installed even in small devices and can greatly increase sensitivity. Both static images and video images can be performed in low-light environments, including dark night conditions. By equipping cameras designed for low-light environments and other monitoring applications to this SPAD sensor, even video footage of low-light environments can be viewed as if it were recorded in bright areas, enabling identification of subject movement as though viewing with the naked eye in well-lit environments.

Achieving High Pixel Density and High-sensitivity

In conventional SPAD sensors, only photons that travel through the region covered by high electrical field (sensitivity field) can be detected, leading to a challenge which require pixel size to be shrunk and as a result, sensitivity to be lowered.

With the proprietary architecture of Canon's SPAD sensor, the space within the sensitivity field covers the entire pixel area, allowing it to efficiently capture the charge (quantity of electricity) generated from incident photons. This makes it possible to achieve 100% fill factor, realizing both miniaturization and high sensitivity.

As a result, clear images with the world's highest resolution of 3.2 megapixels can be captured under environments darker than starless night skies.



Conventional SPAD array (left) and Canon's SPAD array (right).

Unprecedented High-speed and High-precision Distance Measurements

Canon's SPAD sensor has a time resolution as precise as 100 picoseconds (1/10 billion seconds), which enables extremely fast information processing. This makes possible to capture the movement of objects that move extremely fast, such as light particles. In addition to high-resolution and high-sensitivity, it is also capable of capturing light trails moving at a speed of approximately 300,000 km (7.5 times the earth's circumference) per second.

Taking advantage of those characteristics, it is expected to be used as a sensor for driverless vehicles and medical diagnostic imaging equipment, etc.

An Ultra-high-sensitivity Camera Created from a Combination of the Latest Technologies

Captured image of the night approx. 5km away (Lens: CJ45eX13.6B IASE-V H)

World's first ultra-high-sensitivity interchangeable-lens camera for color photography, equipped with a SPAD sensor

Canon has launched the MS-500, the world's first*2 ultra-high-sensitivity camera for color photography use, equipped with a SPAD sensor. When combined with an ultra-telephoto broadcast lens, it is possible to capture clear color videos of vessels several kilometers away, even at night. Not only can you discover the vessel, you can also determine what type of vessel it is.

Canon develops and produces sensors, lenses, camera imaging engines, and the like, and deeply understands their characteristics. Because the structure of the SPAD sensor differs from that of ordinary sensors, it called for new ideas to take advantage of its unique characteristics and to achieve its maximum performance regarding things like electrical circuits and image processing. For this reason, we took a fresh look at everything from sensor controls to color and gradation processing, contour enhancement, noise reduction, and other functions. Completing such improvements through cooperation among the various departments involved resulted in developing this product.

*2 As a color camera equipped with a SPAD sensor. As of July 31, 2023. Based on Canon research.

For more information about Ultra-high-sensitivity Camera

Photon Counting CT

Next-generation CT That Allows Materials in the Body to be Accurately Identified

Interest in the early detection and prompt treatment of diseases has increased over the years. CT systems, which feature short examination times and widespread availability at many hospitals, are therefore attracting a great deal of attention. In particular, there are high expectations for photon counting CT, which promises to improve CT performance in many ways.

Canon and the National Cancer Center Japan have been conducting joint clinical research on photon counting CT since April 2023.

Growing Expectations for CT Systems

With the rapid aging of society, the demand for health promotion and disease prevention is greater than ever.

Computed tomography (CT) has been introduced in many hospitals because of its advantages such as shorter examination times, a wider range of applications (including head, heart, and tumors), and clearer images as compared to magnetic resonance imaging (MRI). On the other hand, because CT systems employ X-rays, the risks of radiation exposure must be kept in mind.

For these reasons, the introduction of photon counting CT (PCCT), which can provide higher-resolution images while reducing exposure dose, is eagerly anticipated.

PCCT can even Identify Materials in the Body While Minimizing the Exposure Dose

Canon is currently conducting clinical research on PCCT, which generates diagnostic images by counting individual photons, the smallest quanta of light. Conventional CT and PCCT can be compared using the

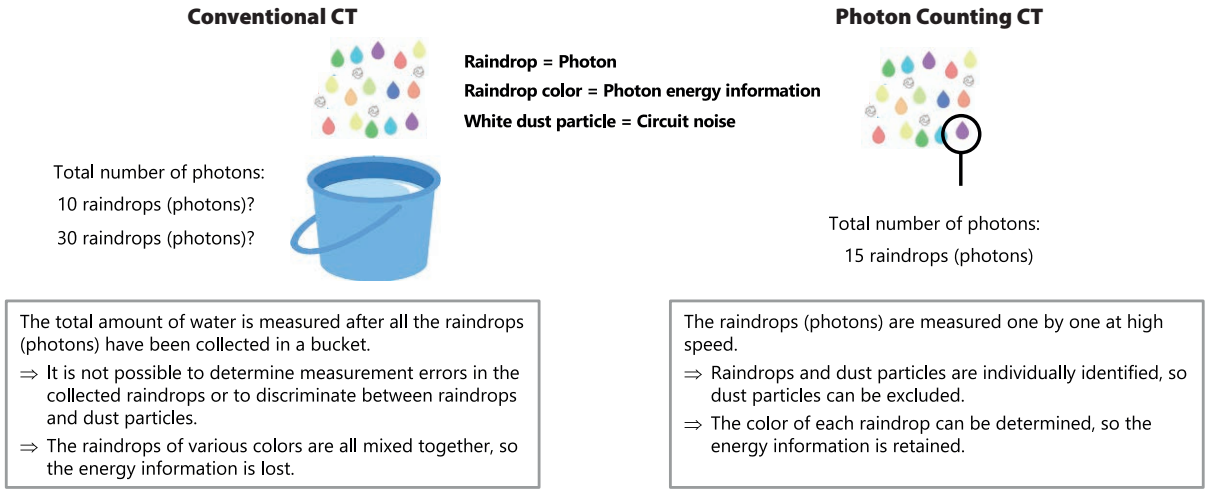
analogy of collecting raindrops in a bucket. Conventional CT measures the total amount of water after collecting all the raindrops (photons) of various colors in the bucket (Figure 1). In this measurement method, the photons cannot be counted directly and only approximate numbers are obtained, which leads to measurement errors in determining the number of photons.

The colors of the raindrops represent the energy information of the photons, which differ from one other. But the raindrops of various colors are all mixed together in the bucket, so the energy information of the individual photons cannot be evaluated.

PCCT, on the other hand, measures the raindrops (photons) one by one at high speed. By measuring the raindrops individually, it is possible to discriminate between raindrops and dust particles (which represent circuit noise). This allows image noise to be reduced, resulting in clearer images with lower exposure. In addition, the color of each raindrop can be identified, so the energy information for each photon can be determined. Every material has unique energy response characteristics in terms of the degree of attenuation of the photons passing through the material (a gradual decrease due to photon absorption, dispersion, etc.). Precise information concerning the materials in the body can therefore be obtained from the acquired energy information.

PCCT employing this photon counting approach can be useful for identifying whether a mass is a high-grade tumor or for determining the amount of residual contrast medium. By improving diagnostic efficiency, we aim to reduce the burden on patients and to ensure more effective treatment planning.

Mechanism of photon counting (Figure1)



Promoting Patient-centric Healthcare from Prevention to Long-term Prognosis

It is also expected that PCCT, which has the advantage of low exposure dose, will gain widespread acceptance in preventive care. Its higher diagnostic accuracy and its ability to accurately identify materials in the body can lead to quicker decision-making and more effective treatment planning. With regard to prognosis, PCCT can be very helpful in deciding whether or not further treatment is necessary, such as in patients with cancer. PCCT is also expected to contribute to health maintenance and promotion thanks to its wide range of applications from prevention to long-term prognosis.

Canon and the National Cancer Center Japan began joint clinical research on PCCT in April 2023 to assess its effectiveness and safety in actual medical equipment. By conducting advanced clinical research, developing new diagnostic methods, and verifying their clinical usefulness, we are working to promote the rapid practical application of PCCT.

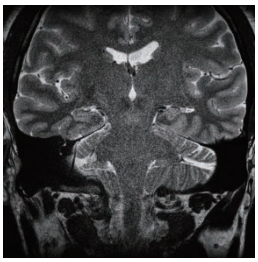
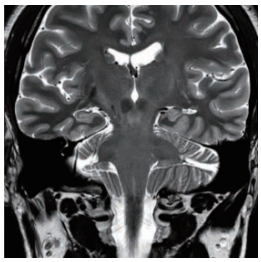
Image acquired by PCCT

For more information about Photon Counting CT

Image Analysis

Reducing the Burden on the Patients and Medical Staff

Canon will contribute to reducing the burden on patients and healthcare professionals by developing technologies that aim to solve the incompatible problems of obtaining high-resolution images and reducing the time required for examinations.

	Conventional examination	Examination with PIQE
Image		
Number of pixels	960×960	960×960
Examination time	11 minutes 40 seconds	3 minutes 56 seconds

PIQE's noise reduction and high-definition scanning technologies improve image quality.

MRI system with PIQE technology

Trade-off in MRI

A Magnetic Resonance Imaging (MRI) scanner, which is a type of diagnostic imaging system, uses a strong magnetic field to obtain images of the organs and blood vessels in the body. Because MRI does not involve radiation exposure, demand for MRI is growing in a wide range of fields, including diagnosis, treatment, and research. However, compared to computed tomography (CT), which can acquire images in a relatively short scan time, MRI requires a longer scan time of around 30 minutes to acquire images of various scan planes in the body. The longer the scan time, the more likely the patient is to move during the examination, making it difficult to obtain high-resolution images. In MRI examinations, there is a trade-off between high-resolution imaging and a short scan time. Canon has been actively developing new technologies to address this issue.

Continuously Evolving Technologies for Achieving Higher Image Quality

In 2019, Canon developed Advanced intelligent Clear-IQ Engine (AiCE), a noise reduction and reconstruction technology for MRI based on deep learning*. And in 2023, Canon introduced an MRI system equipped with Precise IQ Engine (PIQE) which is a further evolution of AiCE.

While AiCE employs deep learning specifically for noise reduction, PIQE focuses on further improving image quality by adding high-definition imaging functions to the technologies developed for AiCE. In addition, PIQE minimizes the artifacts (differences from the actual image) that arise during digital image processing.

PIQE therefore helps to avoid the trade-off between high-resolution imaging and a short scan time.

Canon will continue to listen closely to the voices of our customers in the medical community and work hard to respond to their needs. We are committed to employing our image processing and manufacturing technologies which have been developed since our founding to further promote patient-centric healthcare.

* Deep learning is used only during the design stage. The diagnostic imaging system itself does not have self-learning capabilities.

For more information about PIQE

Responding to Social Issues with Our Technology to Obtain High-quality Images

Canon uses the latest image processing technology to sharpen images taken with network cameras and other devices, thereby transforming them into valuable information.

① An image shot with ISO sensitivity of 51200 at moonlit night brightness (0.05lux)

② The same subject shot with ISO 4000000

③ An image obtained by applying the latest noise reduction technology to the image ②

Making Invisible Things with Human Eyes Visible

Canon has been researching various image processing technologies that utilize deep learning, and is working to develop technologies that can transform images captured with network cameras into value-added images so that changes in objects can be clearly seen even in the dark or at a distance.

For example, if a network camera located outside in a dark, it will record a noisy, grainy image when the ISO is increased for shooting. Therefore, Canon has developed an image processing technology that uses deep learning to predict noise and remove it.

What is needed for image processing using deep learning is a number of shooting cases in which the image you want to see is degraded by shooting under bad conditions. Canon has been developing and producing cameras for many years and is fully aware of the characteristics of lenses and sensors. Canon has accumulated numerous appropriate examples needed in the development of noise reduction method that process degraded images into "images you want to see." These examples enable objective image processing without relying on human experience or intuition, making it possible to sharpen images taken under adverse conditions.

Also, Canon has developed technologies to eliminate the effects of fog and haze for monitoring in difficult shooting environments. Fog and haze reduce the difference between light and dark. Thus, the resulting image loses contrast. The contrast depends on the distance to the subject. Canon has developed a technology to correct image data appropriately by calculating the distance to the object to be photographed and the amount of fog and haze in the distance. Thanks to this technology, now we can reliably visualize what we want to see even at night, in bad weather, or in other situations where it is difficult for the human eye to see.

Canon will continue to contribute to solving various social issues, by creating clear images beyond human vision, using image processing technology, which takes advantage of our own development and production of key devices such as lenses and sensors.

Images with reduced sharpness due to fog or haze (left) and images with sharpening processing (right)

For more information about Image Processing Technology

Super Color Management Technology

Reproducing the Colors That People Perceive

One of the most important technologies for video, photography and printing is the management of colors. Canon—which has been uncompromising when it comes to color reproducibility throughout its work of developing cameras, displays, and printers—is developing the next generation of color management technology.

Color Management That Achieves the Colors Intended

Technological innovations have brought about various changes in society. The field of printing is one such example. A shift is underway from conventional offset printing which uses a printing plate to digital printing, where digital data are printed directly onto paper.

Because the range of colors that a printer can produce depends on its specification and the type of paper used for output, generally speaking, the colors of the final products will not match if those conditions vary. With digital printing, color management plays the crucial role of uniformly managing the colors among devices.

Diversification of Printed Matter Makes Color Matching All the More Important

Conventional color management has focused on minimizing the difference of values that measured the color of the printed images. To wit, when matching colors among several items of printed matter, the items would be measured using a colorimeter with the goal of getting those values as close to one another as possible. However, as printed matter has diversified, we have learned that even if the physically measured values are the same, the colors appear different in some cases when seen by the human eye. After many years of research at our R&D department into how humans recognize colors, Canon created a "color scale" that shows numerically the colors and gradations (shades) that humans sense and developed a measuring method using it. Based on this technology, Canon is moving forward rapidly on development to respond to the heightened demand for color matching.

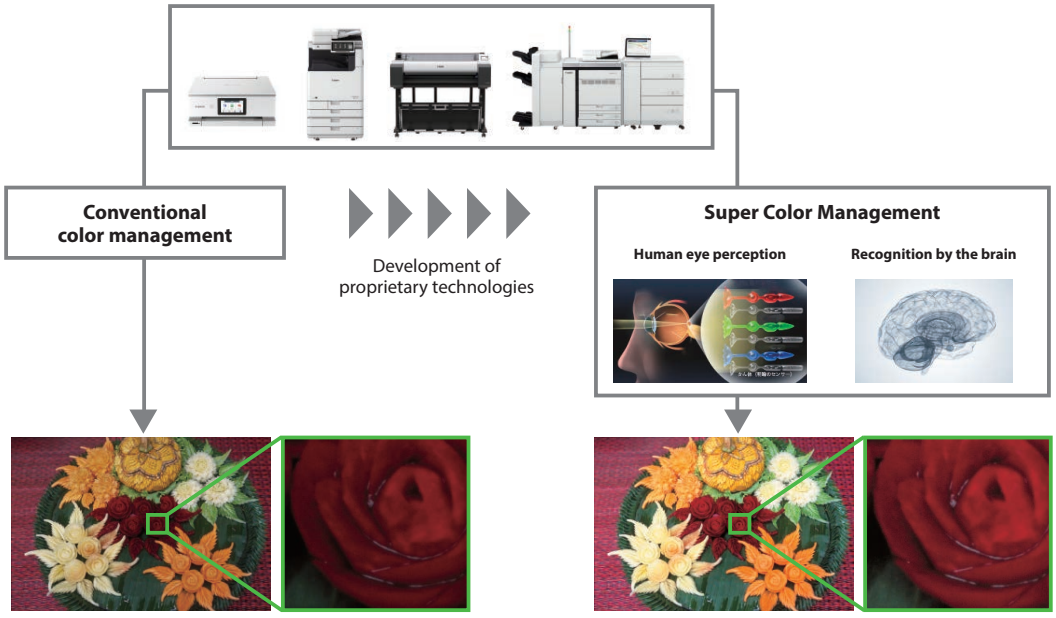
Automatic Adjustment to "Colors That People Perceive" with Canon's Proprietary Algorithm

With conventional color management, sometimes the printed results look unnatural to human eye, because the original range of colors in the to-be-printed image is squeezed into the color gamut of the printer.

Canon is striving to reproduce colors perceived by the human eye by developing Super Color Management (SCM) that can appropriately process colors even when there is a big difference in the color gamut between the to-be-printed image and the printer that prints it.

As part of SCM, Canon has developed a "mapping" technology that assigns colors based on a proprietary algorithm so that, even if the color gamut of the image you want to print extends beyond the printer's representable color gamut, the colors you perceive when viewing the printed image are closer to the colors that the print data originally have. Canon has also enabled dynamic color mapping for each printed image. As a result, It achieved the effect that the color perceived by the human eye from the printed image comes closest to the original color.

Automatic assignment of "colors that people perceive"



It performs uniform mapping processing on all kinds of images. In some cases, the human eye feels the expression is flat with less shading than the original color.

It automatically compares the colors that the printer can express with the colors of the image data to be printed, and converts the colors outside of the printer's gamut into colors that are close to the original colors when viewed by human eyes.

Changing Corporate Marketing Workflow for Improved Productivity

With the spread of digital printing presses, there is a growing trend of printing original goods within companies and using them for marketing activities. In such a case, it is common to print posters on a large-format printer, flyers on an office multifunction printer, shop cards on a small inkjet printer, and so on, using different printers depending on the intended use of the printed material. In cases where the output paper and printer models are different, or where the output has to be checked at multiple sites, how to unify the colors has been a problem. With the introduction of SCM, however, there is no need to spend time and effort to check the quality of print repeatedly. Even if no one has specialized skills, printing of original goods that require matching colors can be made in-house, changing the workflow of corporate marketing.

For more information about Super Color Management Technology

Commercial Printing

Next-generation Inkjet Technologies to Meet Needs in Commercial Printing

To meet diversifying customer needs in the field of commercial printing, Canon has developed compact commercial digital presses with excellent print media compatibility by combining three technologies—ink circulation print head, high-concentration latex ink, and the closed heater process.

Compact Commercial Digital Presses with High Productivity Demanded by the Market

Analog offset printing is suitable for high-volume printing and was once the mainstay for commercial printing presses producing catalogs and other printed materials. In recent years, however, the industry has been transitioning to digital printing, to meet the needs such as variable printing in which contents change from one printed piece to the next, and on-demand printing, suitable for high-variety small-lot production. High-quality commercial digital presses, which are comparable to offset printing, have also emerged.

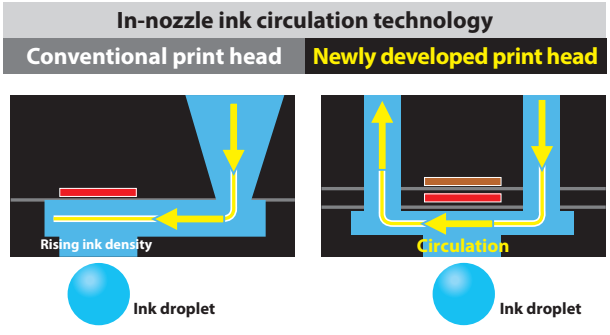
Digital commercial printing can be divided into two main types—electrophotographic printing, in which toner is fixed to paper such as in copiers, and inkjet printing, which jets ink droplets from fine nozzles. Electrophotographic commercial digital presses have the advantage of being compact and low-cost to install, but they do not easily print materials larger than A3+ size(329×483mm) or print at high speeds. Although inkjet commercial degital presses are fast and can produce results comparable to offset printing for such items as photo books and product catalogs, the equipment tends to be larger and more expensive. As customers' needs diversify and the demand for digital printing increases, the market is looking for presses that are superior to offset printing. That demand can be fulfilled by Canon's compact, high-speed, high-quality digital presses.

A New Concept in Print Heads—Ink Circulation

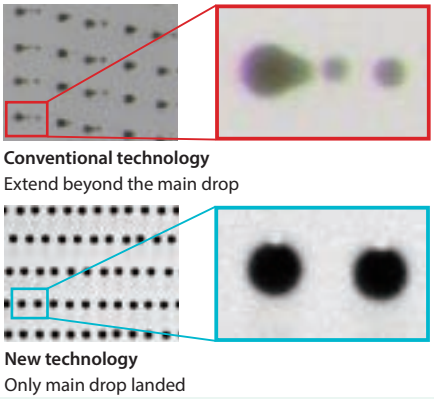
In the print heads used for inkjet printing, moisture tends to evaporate from the nozzles when exposed to the air, causing ink viscosity to increase. Especially with high-concentration latex inks*1, which can reproduce text and colors clearly, the print heads are more prone to dispensing failures. To prevent ink viscosity from rising, we introduced a structure for ink circulation. This allows the jetting velocity to be lowered to the point where the main droplet of ink fired*2 is a few pl (picoliters)*3 in size so that only clean main drops are dispensed from each print nozzle.

*1 Polymer particles dispersed in water
*2 Normal jetting creates multiple droplets, which interferes with image quality
*3 1 pl (picoliter) = billionths of a milliliter

Suppress viscosity rise by ink circulation



Landed dots



Conventional technology
Extend beyond the main drop

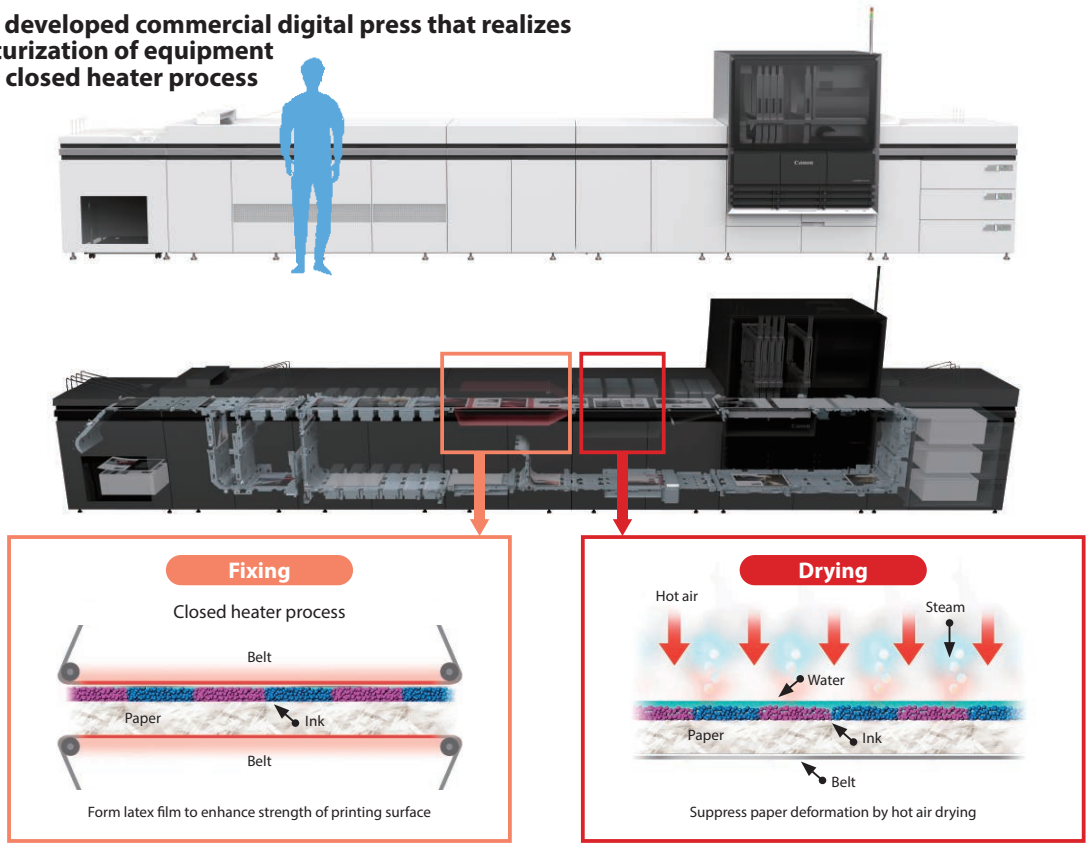
New technology
Only main drop landed

Achieved Miniaturization by Developing a New Heater That Significantly Improved the Fixing Processes

When fixing ink on paper, two issues are at play—controlling paper deformation due to moisture and using moisture to get additives to penetrate the paper. These conventional processes required a large drying equipment to instantly evaporate moisture upon printing. Then, once the paper deformation had been prevented, the paper would be steamed to fix the ink. This resulted in commercial digital presses tending to be very large pieces of machinery.

The innovation that solved this problem of contradictory processes is Canon's closed heater process, whose design is based on technology developed for electrophotography, applied to inkjet printing for the first time. In this system, the paper printed with high-density ink is semi-dried using non-contact hot-air drying. The paper is then heated in a sealed space sandwiched between the upper and lower belts, allowing the additives to permeate the paper, coating the ink pigments with a latex film, and strengthening the bonding to the printed surface. This new design cuts out more than half the paper transport distance needed conventionally for drying and fixing, thereby reducing the size of the equipment.

Newly developed commercial digital press that realizes miniaturization of equipment by the closed heater process



Continuing to Create New Printing Technologies by Combining Technologies

Canon's proprietary value creation technology, simulation technologies are being fully leveraged to verify things like the ink density distribution inside nozzles in ink circulation and the behavior of ink droplets affected by dispensing speed. Canon's chip fabrication and mounting technologies cultivated over our long history have also led to the creation of a high-density array of nozzles that makes high-speed, high-resolution printing possible.

In this way, Canon incorporate some of our fundamental technologies in materials, devices, precision mechanisms, and image processing. These technologies give rise to products that are valuable to our customers and that only Canon can deliver. We will continue to flexibly respond to the needs of the times by refining our various technologies.

For more information about Commercial Printing

Nanoimprint Lithography

An Innovator Drastically Changing Convention in the Semiconductor Industry

Technology fields responsible for the manufacture of semiconductor chips over half a century are about to be joined by an innovative technology.

Nanoimprint semiconductor-manufacturing system is currently being studied mass production at KIOXIA Corporation Yokkaichi plant, Japan.

New Technology That Achieves Miniaturization with Low Power Consumption and at Low Cost

The evolution of semiconductor chips relates directly to the history of circuit miniaturization. The key to this miniaturization has been the shortening of light-source wavelengths and advances in lithography technologies that support miniaturization. In the early 1990s, 350nm patterns (nm: nanometer = one-billionth of a meter) were realized with i-line lithography systems. That miniaturization has since continued, with KrF/ArF lithography systems, and, in recent years, with EUV lithography systems.

Advances in lithography technology have contributed significantly to miniaturization and cost reduction of semiconductor chips. However, it has become increasingly difficult to achieve further miniaturization and manufacture complex semiconductor chips at low cost only through extensions of current technology.

Canon has achieved miniaturization at lower power consumption and lower cost with nanoimprint lithography (NIL), a new technology that is an alternative to conventional lithography technology. By enabling inexpensive production of patterns of 15nm or smaller, NIL is poised to revolutionize the semiconductor industry.

Confronting the Frequent Issues That Arise from a Simple Principle

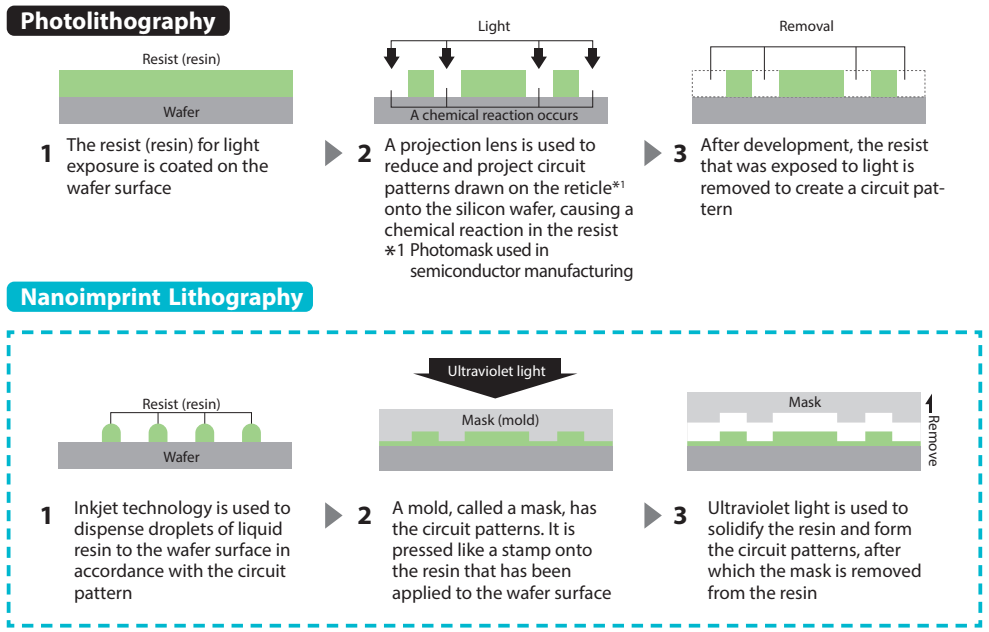
Unlike conventional lithography technology that uses light to expose circuit patterns, NIL does not require a light source. Circuits are formed using a simple principle that involves transferring a circuit pattern mask (mold) onto the coated resist (resin) on the surface of the wafer (a thin silicone plate).

However, because of the system's simplicity, there are numerous issues, and for a long time it has been said that practical application would be a challenge. To overcome a number of these issues, Canon began by working on technology to control the amount and positioning of the resin applied to the wafer surface. This technology precisely controls how much and where the resin is applied to prevent it from being squeezed out when the mask is pressed into the resin, while also ensuring the formation of a resin layer with a uniform thickness regardless of the size or number of indentations on the mask being used.

Next, Canon developed a nanometer-level control technology to prevent the deformation of the convex circuit patterns formed in the resin, making it possible to cleanly remove the mask from the wafer.

Furthermore, through the comprehensive development of hardware, software and materials technologies, along with environmental control technologies to keep microscopic particles in check and prevent contamination, Canon successfully overcame numerous obstacles on the way to practical application.

Comparison of Photolithography (conventional lithography technology) and Nanoimprint Lithography manufacturing processes



Energy-saving Processing Technology and Expanding Applicable Devices

Recently, NIL's energy-saving processing technology has also attracted attention. With existing lithography systems, complex circuit patterns are formed through repeated etching, but the overall manufacturing process is time-consuming and costly as a result. NIL, on the other hand, is able to form complex two- and three-dimensional circuit patterns in a single pass, power consumption can be reduced by about one-tenth compared to advanced logic exposure technology.

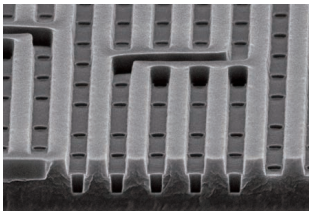
Furthermore, Canon, Dai Nippon Printing Co., Ltd., and KIOXIA Corporation together succeeded in pattern formation using NIL at the most advanced semiconductor manufacturing level (minimum line width of 15nm). At the Environmental Awards*2 held in 2022, the efforts by these three companies received an Award of Excellence and they were recognized with their contribution for reducing power consumption during semiconductor manufacturing and for the technology which will support the rapid expansion of an IoT society going forward.

The range of possibilities for semiconductors that can be manufactured using NIL is expanding to include DRAM which is memory for storing data, logic for processing data and controlling equipment, and even micro-optical elements other than semiconductors.

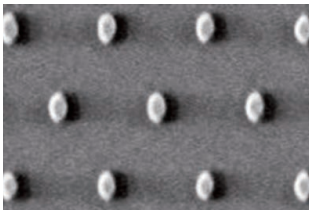
*2 Awards sponsored by the National Institute for Environmental Studies, Japan and the Nikkan Kogyo Shimbun, Ltd. and supported by the Ministry of the Environment

Patterning performance

Three-dimensional circuit pattern



Two-dimensional circuit pattern



Two- and three-dimensional circuit patterns formed by NIL
Source: KIOXIA Corporation

For more information about Nanoimprint Lithography

Development and Design Platform

Virtual Prototyping Technology Applied to Various Products

Virtual prototyping is a simulation technology that runs the prototyping process in a virtual environment inside computers without actually building a prototype.

Canon has expanded the scope of virtual prototyping technology to be applied to all of our businesses to improve quality and shorten development lead times.

Issues of Simulation Technology to be Addressed

In conventional product development, a number of tangible prototypes were produced based on drawings designed in Computer Aided Design (CAD) in order to confirm the adequacy of design, discover new issues through repeated experiments, and share images among developers. This method placed a burden on product development in terms of cost and duration of prototyping because we had to build many pieces of different prototypes for each stage of development. Therefore, in recent years, we have come to build models that act as prototypes in the virtual environment in computers and use them to evaluate performance and quality.

That method, in turn, had other issues. For simulation in virtual space, product design data created using CAD must be converted to Computer Aided Engineering (CAE) models. This took a lot of time and effort. In addition, general-purpose simulation software did not provide accurate simulations that were optimized for verification of specific product designs.

The Pursuit of High-precision Virtual Prototyping Technology

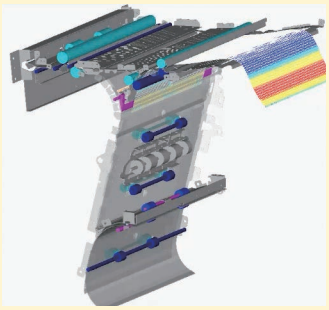
Canon has been developing virtual prototyping technology to check how a product will function and complete the design process on a computer, without producing any physical prototypes when possible. Efforts began in earnest at Canon in the early 2000s through a group-wide project to create a virtual prototyping environment. With these efforts, Canon developed a technology for automatic conversion of 3D CAD data into CAE models and original in-house software.

We now have the virtual prototyping technology in place for all of Canon's products and have built a proprietary development and design platform that enables the design process to be completed in a virtual environment alone. Using virtual prototyping technology that faithfully reproduces the various malfunctions that may occur to a product, it is possible to evaluate virtually the design accuracy and solve problems without creating a physical before producing the product. As a result, we can develop products in a shorter period than before.

In the development of a multifunction device, for example, a simulation model is automatically generated in a computer to simulate movement in the paper feeding unit. In this virtual environment, the paper movement in the feeding unit can be checked in detail without building a physical prototype. A product of higher quality can therefore be developed in a shorter period of time.

In simulations, publicly available values are often used to specify material properties, but Canon uses actual and analyzed values measured in-house to improve the accuracy of simulations, even going so far as to manufacture in-house dedicated equipment for that purpose to ensure accuracy in the measurement and analysis of such values.

Using this virtual prototyping technology, a variety of tasks are now possible on the computer. It is now possible to verify parts that would have been too small or hidden to see if they had been verified using a physical prototype. In addition, since almost all of the verification which could not have been covered by a single physical prototype can now be carried out, the design quality can surely be improved.

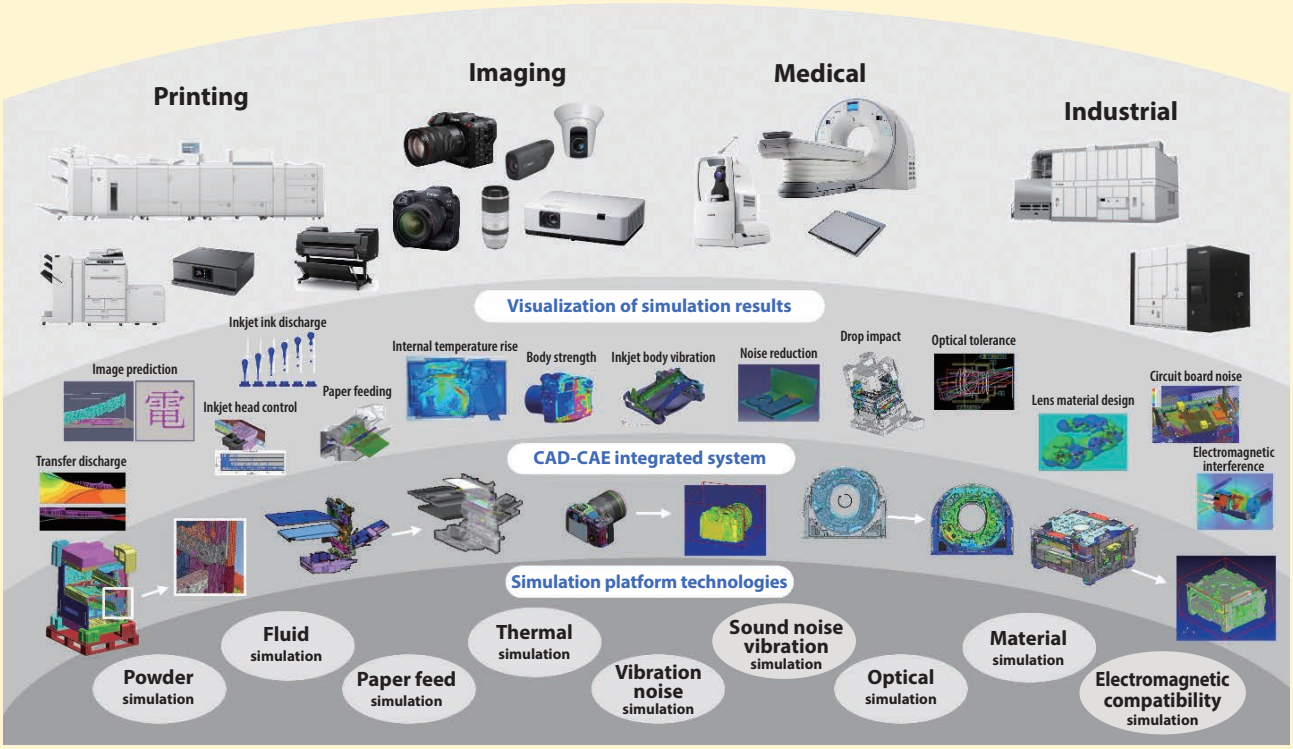


Simulation of paper feeding process inside a printer

Virtual Prototyping Technology for Group-wide Use across Businesses

Canon has developed a library of virtual prototyping technologies for a full range of phenomena involved in product development, such as drop impact, vibration, and heat generation. The library is made available to developers to conduct virtual prototyping, which allows simulations to be performed with high accuracy in the early phases of new product development across a wide range of businesses.

Heat flow virtual prototyping technologies used for multifunction devices are a good example. The same type of simulation is applied to the development and manufacture of the internal parts of equipment used to produce high-definition displays used in smartphones and TVs. In this way, virtual prototyping technology is being used throughout the company beyond the scope of businesses.



Virtual prototyping technologies applicable to a wide range of products

Virtual Prototyping Technology Makes a Big Contribution to EQCD

The virtual prototyping technology thus shortens development time and allows Canon to create high-quality products. It also contributes significantly to achieving carbon neutrality by reducing physical prototypes and enhances Canon's pursuit of improvements in terms of the environment, quality, cost, and delivery (EQCD).

Canon's virtual prototyping technology allows it to deliver high-quality products to customers in a timely manner leveraging its unique technology and know-how accumulated over many years, while also taking the environment into consideration.

For more information about Development and Design Platform

Manufacturing Platform

Evolution of Automated Assembly to Achieve the Previously Impossible

Once responsible for only simple assembly, automated assembly has evolved to include delicate and complex assembly processes that require sophisticated skill. Automated assembly technology enables rapid and stable precision assembly and even contributes to quality improvement. By linking automated assembly with product design, many of Canon's businesses aim to reach unexplored territories.

Automation of Difficult Processes That Requires Sophisticated Skill

Delivering attractive products to the world requires a foundation of extremely delicate and highly precise assembly technology. Canon now produces lenses for cameras by automated assembly. Canon has also succeeded in automating exceptionally difficult production processes such as assembling components into tiny space surrounded by delicate and complex structures or inserting components into connectors on electrical boards.

By realizing a system that is constantly in operation to steadily produce high-quality products, Canon goes beyond rationalization to the stage which could not be reached with conventional assembly.

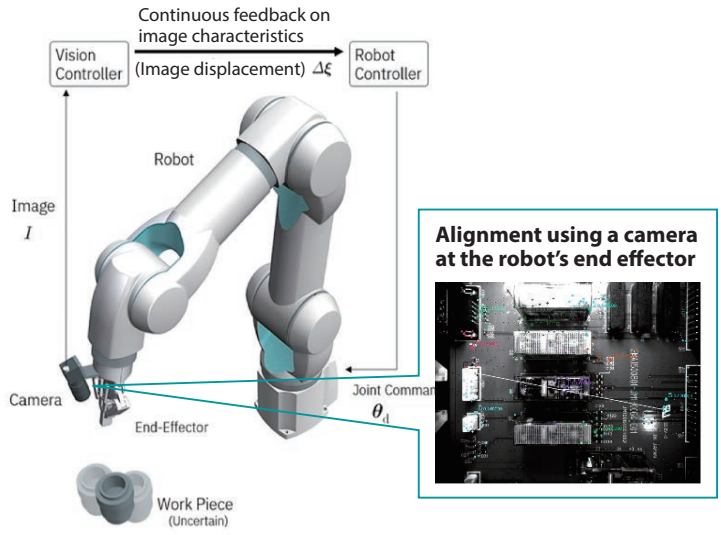
In-house Development of Basic Technology for Automated Production

Canon's automated production robots have been developed as a unique technology to shape new ideas generated within the company to enable the assembly of precision optical equipment that requires high quality.

For example, Canon has achieved precise part alignment with "Visual Servo," applying high-definition and small cameras, that analyzes video information from the camera attached to a robot arm.

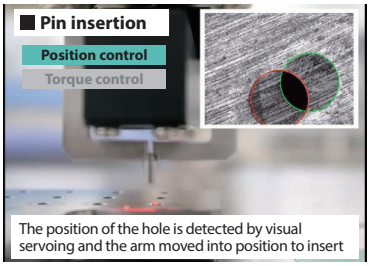
An example to show the excellence of Canon's comprehensive production technology is an automated production robot called a "multi-skilled automated assembly machine." Moving multiple robotic arms at the same time, the machine executes complex parts assembly processes while accurately picking up parts of various shapes and properties from the randomly stacked pile of parts.

The creation of the automated production robot that can work quickly, reliably, and stably, regardless of the number of processes or the sensitivity of the work, is the result of accumulation of experiences developing various automated production technologies.



Position adjustment with images from the camera

The multi-skilled robot identifies parts of different shapes and properties

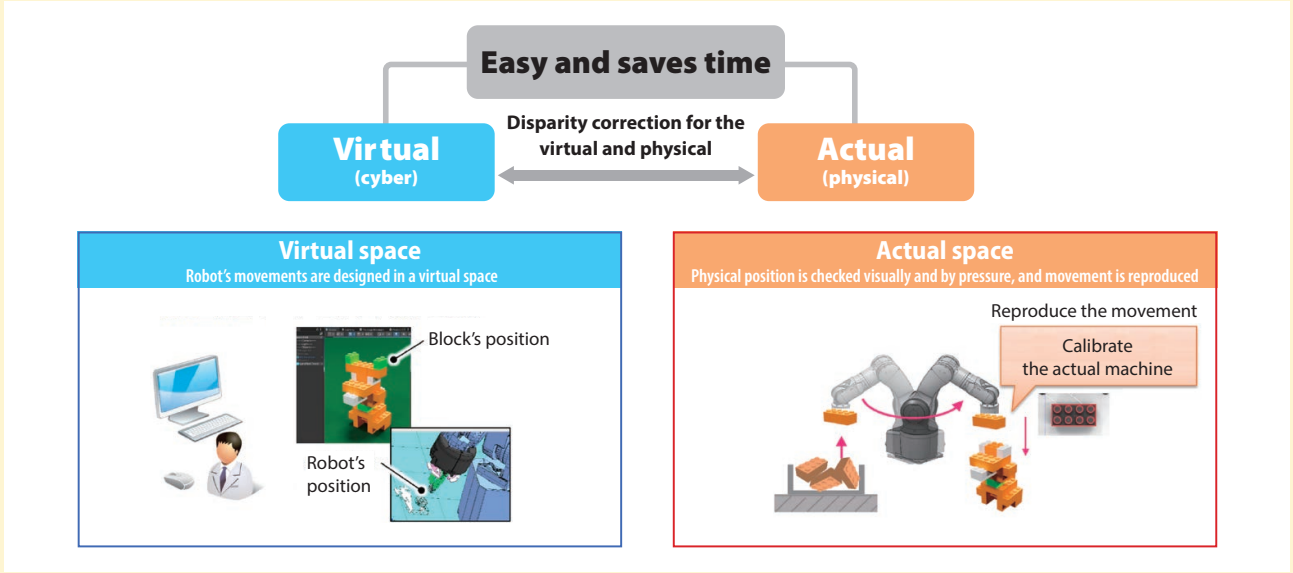


Visual Servo performs precise alignment

Opening Up a New World of Manufacturing through Cyber-physical Cooperation

Canon has developed its own simulation software that reproduces robot movements in cyberspace.

The proprietary simulation software, which has reflected experience in all the businesses across the company, can design a motion of a robot in just a few tens of minutes. This preparation work to apply the robots in production lines used to take days. This system greatly shortened the time needed. In addition, the robot's high-precision sensors enable it to achieve the delicate movements set in the simulation.



A Solid Foundation of Production Technology Produces Cutting-edge Products

Canon's automation technology originally started for the production of consumable products including toner cartridges. The technology has contributed to customer value in terms of rapid supply and stable quality. Now, Canon's production technology, which was primarily a source of its price competitiveness, has been evolving to become a technology for providing customers with high-quality products, at the same time.

For example, automated assembly greatly increases assembly accuracy to levels that were previously impossible, allowing for complex designs that could not be adopted due to lack of accuracy.

Starting from consumable products such as toner cartridge, in all areas of Canon's business, including cameras, semiconductor manufacturing equipment, and medical equipment, the product development and production technology divisions have joined forces to realize this evolution, which allows the company to create higher value-added products in each business.

Canon continues to develop a new future by developing technologies to create new values of its products through production technology and deliver them to the customers.

For more information about Manutucturing Platform

Materials Development Platform

Technological Infrastructure to Improve Product Performance and Boost Competitiveness

Canon has built up materials technology through the development of a wide range of products. We have systematized these technologies into a proprietary materials development platform which serves as a company-wide technological infrastructure for improving product performance and boosting competitiveness.

Our Materials Development Platform Supports Product Evolution and the Creation of New Businesses

Materials are an important element that impacts product performance. When classified according to the functions performed by materials, the material technologies that Canon has accumulated through the development of interchangeable lenses, printers, etc. are divided into four categories. These are (1) technology for creating color, (2) technology for adjusting light, (3) technology for transmitting and blocking heat and electricity, and (4) technology for creating force.

For each material, which fulfills one of these four functions, Canon has built up a set of technologies that combines "design of the material that provide high functionality," "synthesis and processing" that realize the functional design of the material, "manufacturing" that enable its production in the quantity and quality enough to be used in products, and "analysis, measurement, and evaluation" to confirm that the material is produced as intended.

Canon has systematized these technologies to establish a "materials development platform" as a technological foundation across the Group, and uses it to further improve its products and to launch new businesses earlier to provide customers with high value-added products in a timely manner.

Four features that enhance product performance

Function	**Creating color** Materials to create new colors Materials to enhance coloration properties	**Adjusting light** Materials to control reflection Materials to suppress chromatic aberration	**Transmitting and blocking heat and electricity** Materials that transfer heat and electricity Coating materials that block heat	**Creating force** Materials to create vibration Materials to mimic hardness
Materials & Components	Inks / Toners Organic EL	Lens materials	Heat-shield coatings Fixing and transferring components for office multifunction devices	Ultrasonic motors
Products	 Inkjet printers  Toner Cartridges	 Camera lenses	 Office multifunction devices  Camera lenses	 Camera lenses

Streamlining Development with Our Own Materials Database

Materials development once took years, relying on the knowledge and experience of engineers in an iterative process of prototyping, evaluation, and verification. Canon has now consolidated into a database all of the information on material characteristics and experimental data from R&D processes to serve as a material bank. This system, which utilizes the knowledge accumulated by engineers with the help of AI, contributes to identifying new materials with the necessary functions. It improves our developmental efficiency and allows us to find new materials that will boost the competitiveness of Canon's businesses, utilized in development of light-emitting materials for displays, and other areas of material development.

Using Materials Technology Developed In-house for Better Performance and High Value-added Products

Components and materials that add value to products are positioned as "key parts" at Canon. We accumulated and refined technologies related to them by developing them in-house. Particularly in interchangeable camera lenses, our advances in materials technology have improved the products' performance and given us an enormous competitive edge.

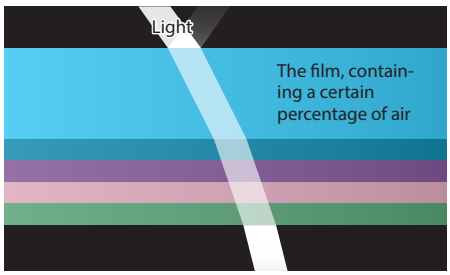
Chromatic aberration is one thing that directly impacts the performance of interchangeable lenses. Because common optical materials have different refractive indices for the red, green, and blue lights that make up natural light, ordinary lenses cannot collect light into a single point to create a sharp image. In order to eliminate image blur and color shift, blue light control was a particular problem. Commonly available materials do not offer the optical performance that Canon requires in terms of blue light control, so we synthesized our own optical material, starting from the basic molecular design. By combining this new optical material with glass materials, we succeeded in dramatically reducing chromatic aberration. The result was Canon's Blue Spectrum Refractive Optics (BR) Lens, an optic element that has made superior imaging performance possible and is winning accolades from camera users.

Materials Technology of Current Businesses Leading to New Businesses

To improve the performance of interchangeable lenses, more than our BR Lens is needed. We also developed in-house surface processing technologies for lenses that all but eliminate reflection.

These are Subwavelength Structure Coating (SWC), a technology for forming nano-scaled structures on a surface and Air Sphere Coating (ASC), a technology that allows the coating to contain a certain percentage of air, which has a lower refractive index than optical glass. Both coating technologies provide superior anti-reflective performance. These coating technologies are being used in other businesses, such as films that clear the field of view of network cameras. In addition, they are also being applied in new fields, such as in paints that suppress the reflection of display surface. Thus, these technologies are expected to contribute to strengthening the competitiveness of Canon's businesses.

Air Sphere Coating (ASC)



The film, containing a certain percentage of air with lower refractive index than optical glass, forms an ultra-low refractive index layer

Application to anti-reflective paint

Due to lack of light reflection, the depth of objects is hard to recognize
(Photo: anti-reflective paint on a flask)

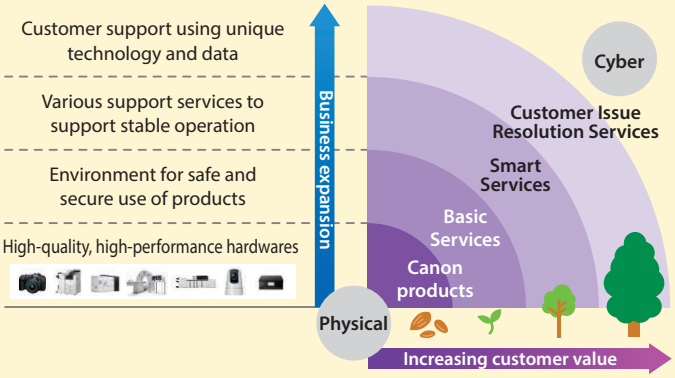
For more information about Materials Development Platform

Digital Business Platform

The Canon Digital Platform Technologies That Provide Our Customers with New Value

Canon's Digital Business Platform—which increases product value through coordination (Cyber-Physical Systems) of the cloud (cyber) with hardware products (physical)—to provide new value that anticipates customers' expectations and demands.

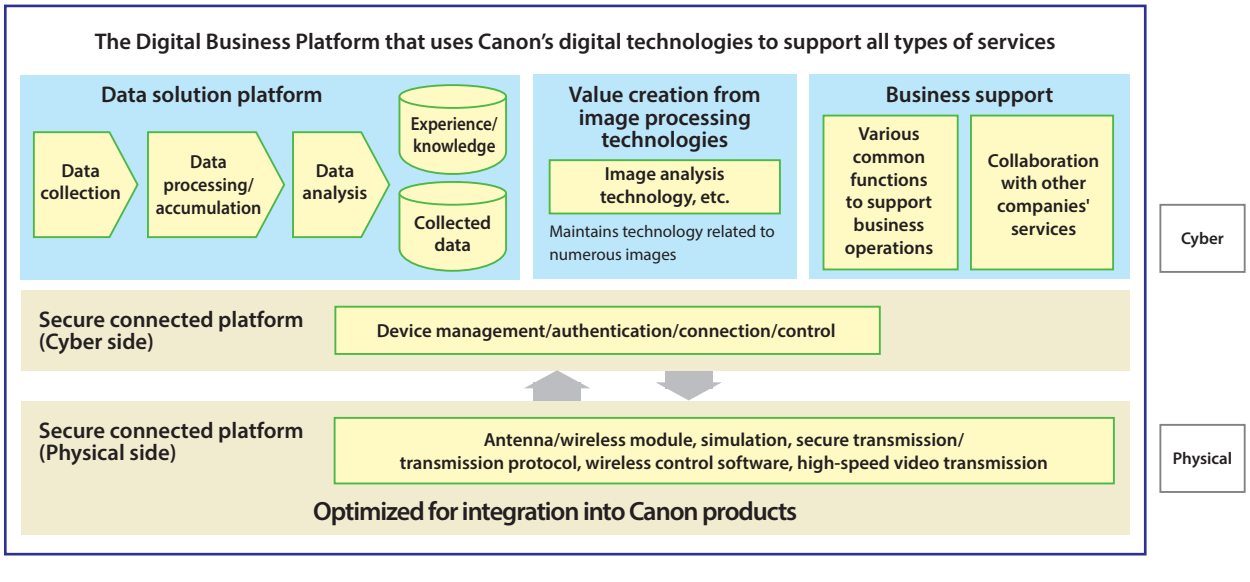
Canon's Cyber-Physical Systems concept (Figure1)



Digital Business Platform That Connects Canon Products to Virtual Spaces to Provide Value

With Canon's own products serving as the core, we are further developing the basic services that provide the environment that makes it possible to use products securely and safely in the cloud, as well as the smart services that support stable operation of those products. We are also providing services for solving customer issues that provide those customers with new value. What serves as the technological infrastructure that supports these three services is our Digital Business Platform. (Figure1)

In other words, our Digital Business Platform is the collection of fundamental technologies that deliver value by linking the hardware (physical = products) that Canon maintains with the cloud (virtual space). We define this as Canon's Cyber-Physical Systems. We are working to expand our lineup of products and services in ways that will make it possible for them to be safely connected to virtual space, adopt constantly running monitoring and defect prediction features, allowing them to be used with peace of mind, and being able to anticipate future expectations and demands of customers.



Equipping Products with Basic Services That Connect Securely, Quickly and Stably

To maximize experience value for our customers, it is crucial that Canon's input and output devices with their excellent video and imaging technology be linked to cyber space and connected securely and stably. Canon takes an active part in planning with international standards bodies for such standards as Wi-Fi and 5G communications, and makes proposals for specifications. With these international standards providing the base, we develop technologies for transmitting data at high speeds, simply, stably, and securely depending on how they are being used and the data involved. This work includes, for example, the development of communication control technologies that upload large volumes of high-quality images to the cloud at high speeds and boosting device security through the use of secure chips.

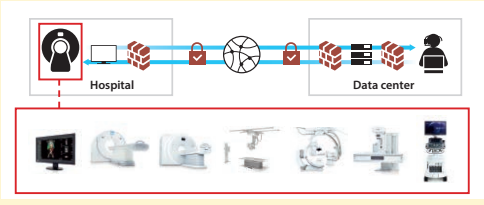
The hardware and software for telecommunications such as antennas and wireless modules are developed internally at Canon so they can be used in products across all of Canon's businesses, including printers and cameras.

Improving Value for Customers by Utilizing Data

Canon is making significant progress in the use of data to improve customer value. In the printing field, we can not only automatically have toner sent based on the remaining toner information of our networked office multifunction devices use, but also collect and analyze data on how much a variety of consumable products such as the drum have been consumed. We can detect a component's life expectancy based on use and minimize downtime for customers by systematically replacing parts so we provide services that enable customers can use their products with peace of mind.

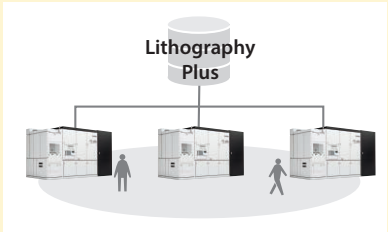
Online support service to monitor the status of the customer's printer

In the medical field, Canon Medical Systems' Remote Diagnostic System constantly monitors the status of customers' CT and other equipment, and even when a problem occurs, it remotely analyzes the status of the equipment and provides support, thereby resolving problems in a timely reasonable manner.



Remote Diagnostic System monitors the status of equipment

In the semiconductor field, we provide our "Lithography Plus" service. This service analyzes the vast amounts of operating data generated by Canon lithography equipment around the world so it can optimize equipment operating at customers' facilities. On the other hand, the "anomaly detection" function —which observes data in real-time to detect abnormalities and signs of potential trouble during production—it prevents malfunctions in semiconductor lithography equipment that generally operate throughout the year and realizes superior operating rates for those devices.



Lithography Plus detects equipment problems and their warning signs

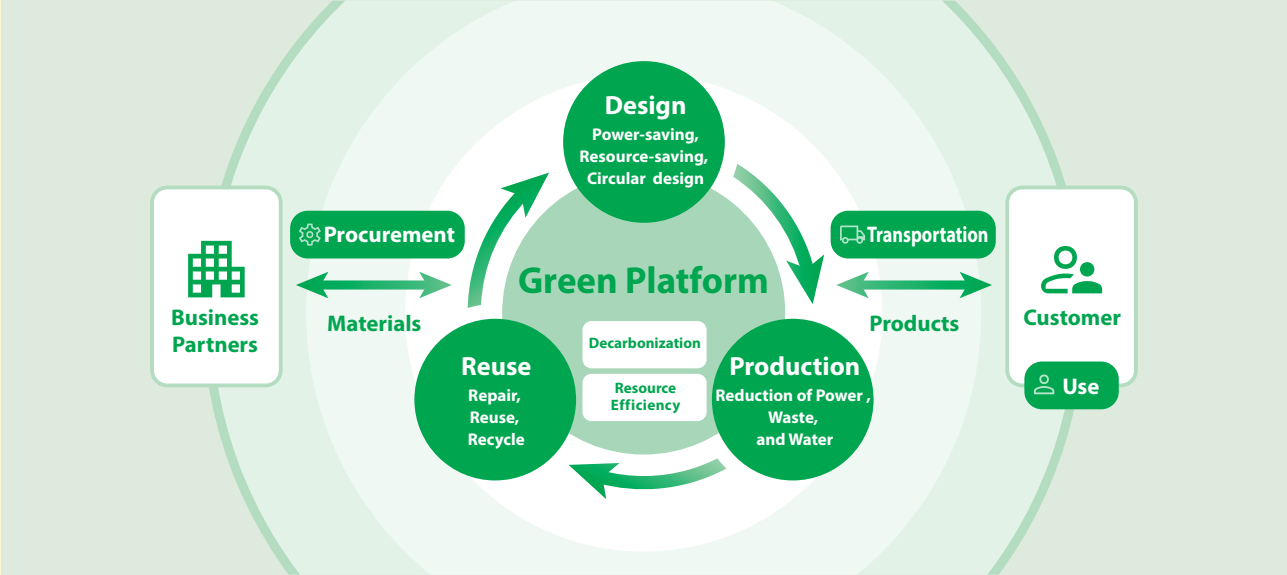
We are working to further develop the use of such data so we can deliver new value to our customers.

For more information about Digital Business Platform

Green Platform

A Technology Infrastructure That Helps Reduce the Environmental Impact of All Our Products and Corporate Activities

Canon has been ahead of its time in creating environmentally conscious products. We have been involved in efforts across the entire product lifecycle, not only to conserve resources and power, but also to reuse and recycle products. In response to changes in society surrounding environmental issues, we have organized these technologies and knowledge into a company-wide technology infrastructure called the Green Platform to strengthen our activities.



Canon's Green Platform

Organized as a Technology Infrastructure Based on the Environmentally Conscious Systems and Technologies That Canon Has Accumulated

In recent years, more attention has been paid to sustainable corporate activity. Since its founding, Canon has remained ahead of its time in working to consider the environment. In 1993, we established the Canon Group Environmental Charter. Under this charter based on the concept of EQCD (Environment, Quality, Cost, Delivery), we position the Environment as a matter of priority over Quality, Cost, and Delivery. We have conducted business under the EQCD concept and belief that, "Companies are not qualified to manufacture goods if they are incapable of environmental assurance."

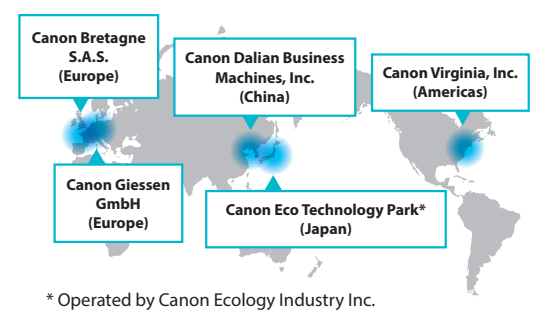
The Green Platform is a technology infrastructure that comprehensively helps all of Canon's business activities, based on the environmentally conscious systems and technologies that Canon has accumulated over the years. Canon contributes to minimizing environmental impact, including decarbonization and improvement of resource efficiency , by combining and utilizing a variety of proprietary technologies at each stage of the product life cycle such as design, production, and reuse.

Canon Eco Technology Park, communications base for sustainability activities

Promoting Reuse Initiatives Ahead of the Circular Economy

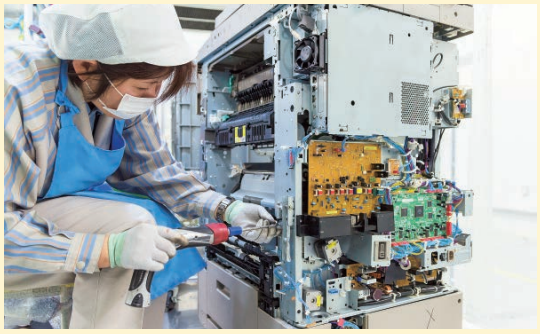
Canon has established five recycling sites around the world, and has created to improve resource efficiency. We began collecting used toner cartridges recycle programs in 1990. If you were to lay end-to-end all of the recycled toner cartridges we've recycled to date, they would circle the Earth four times.

At Canon Eco Technology Park, opened in 2018, state-of-the-art automated recycling lines have been implemented. Used toner cartridges are crushed and the materials automatically separated for recycling of the main component, high-impact polystyrene (HIPS). The sorting purity of the recycled plastic reaches 99% or greater with the intensive use of various separation technologies.



Canon's global recycling sites

Since 1992, Canon has also undertaken the "remanufacturing" of used multifunction devices. We collect used devices and break them down into parts, which are washed, cleaned and replaced any parts that show wear or deterioration. When a remanufactured device is shipped, it is guaranteed to offer the same level of quality as a new product. Furthermore, Canon has designed a new stain-resistant toner bottle that minimizes toner adhesion and messy leaks for consumables. We are also working on toner bottle refill production, taking into account ease of collection for customers and ease of recycling at Canon after product use. In addition, from inkjet printers for home use to cameras that meet professional needs, we are equipped to handle repairs.

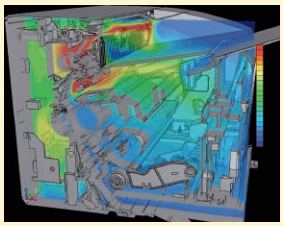


Remanufacturing of a multifunction devices

Reduce Environmental Impact through Resource-saving and Power-saving Product Design

Using our proprietary simulation technologies, Canon develops to conserve resources and power in the product life cycle in product design. We reduce environmental impact by reducing resources used in products and improving transport efficiency during delivery.

For example, in the development of laser printers, it was difficult to downsize the product due to the need for components to cool the heat during toner fixing and the path (space) for printing paper. Canon accurately simulates the flow of heat, wind, and paper during product design. Thermal updrafts create air flow inside the product, eliminating the need for cooling fans. In addition, the structure (shape) and arrangement of the members were optimized by minimizing the curve of the paper path. As a result of these efforts, we are realizing products that are miniaturized (power-saving).



Simulation of heat flow contributing to the miniaturization of laser printers

Challenging Power Waste "Zero" during Production

In order to further reduce the amount of power consumed during production, Canon are developing a system that enables detailed visualization and analysis of the state of power consumption for each process in the factory. By disaggregating factory power not only by location but also by operation of production facilities, we can thoroughly identify hidden "power waste." We will accelerate the decarbonization of our production sites by deploying this system throughout the company to efficiently reduce power consumption.

The Green Platform is the technology infrastructure for adapting to the coming age of dramatically increasing social demand for reducing environmental impact, and it is the source of Canon's competitiveness in creating strong products. Canon advances its Green Platform and contribute to the decarbonization and improvement of resource efficiency.

For more information about Green Platform

EOS R3

A Mirrorless Camera for Snapping the Moments You Want to Capture

EOS R3

The "EOS R3" full-size mirrorless camera with superb high-speed and autofocus performance. In the pursuit of unprecedented visual expression, this camera is equipped with cutting-edge technologies. With a development approach that always targets future needs, and reliability obtained through strict evaluations of quality, we satisfy photographers' wishes.

Our Unique Autofocus Technology Delivers Moments Beyond Ideal

As digital cameras have evolved, and their ability to handle subjects and settings that are difficult to capture has increased. However, there is no end to the desires of photographers who want to "take the photo that is more like what I had in mind." Canon has been giving thought to what sorts of functions would lead users to expand their photographic horizons and coming up with one new technology after another.

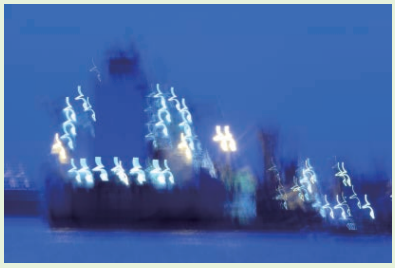
The "EOS R3" is equipped with an "eye control function" that precisely focuses on the spot that the photographer sees with their eyes. To detect the line of sight of the photographer requires that pupils be detected with great precision. We have improved quality through trial and error, such as by studying the eyes of a variety of people in order to reduce the impact on the precision of pupil detection due to eyelids, eyelashes, the use of glasses, and so forth.

With regard to the "subject detection function" that can detect the subject, the camera makes use of deep learning technology that uses an enormous amount of data to train its AI. Detectable subjects and conditions have also been enhanced. This is the most advanced technology in Canon's camera development, and we are seeking further advances.

Possibility of Handheld Photography Widened by Image Stabilization Achieved with Cooperative Control

What you want to avoid when taking photos is "camera shake." With our "EOS R5" (released July 2020), Canon has achieved the high level of image stabilization that significantly outperforms DSLR EOS systems with 8.0 Stops*1. Canon achieved this by developing a "cooperative control" in the image stabilizer for both the lens and camera body. This system can eliminate all five types of camera shake.*2

Cooperative control optimizes the correction effect by changing the amount of correction between the lens and body according to the photographing operation. In this system, a lot of information needs to be exchanged at high speeds. One of the elements that made cooperative control possible is high-speed communication between the lens and the body. Canon has long been refining its mirrorless camera "RF mount" communication technology in anticipation of the system evolution. The entire EOS R system supports photographers so they can take photos that satisfy them even with a single, handheld camera regardless of how bright or dark conditions may be.


Without image stabilizer


With image stabilizer

*1 When using RF24-105mm F4 L IS USM, f=105mm Yaw (up and down axis rotation)/Pitch (left and right axis rotation) direction, CIPA standard compliant
*2 5 axes of shift shake (up, down, left, and right), angle shake (up, down, left, and right), and rotation shake

The subject detection function can also detect animals, and other subjects that are moving quickly

Using Simulation Technology and Uncompromising Quality Assessments

At Canon, by employing simulation technology in a variety of projects, the precision and speed of development have been improved and manufacturing is being made more efficient. Previously, we had to use prototypes to, for example, carry out droppage tests and measure heat generation in the body, but now these things can be simulated at the design stage. Furthermore, when it comes to camera design know-how, we have a vast accumulation of past technologies and we make use of knowledge from when we developed film single-lens reflex cameras.

At the prototyping stage, the quality control and development departments join together to make repeated evaluations and take countermeasures. In particular, quality evaluations for picture quality and autofocus are rigorous, and if those high hurdles are not overcome then the product cannot move to the next step. Development continues ceaselessly to the very end under the policy that we will not release a product until the target specifications have been achieved.

Sealing materials for preventing intrusion of water and dust

Making the Most of the Accumulation of Technologies, and Continuing to Create Cameras That Satisfy Demands

Component technologies from a variety of departments were combined for the EOS R3. Canon's component technologies—which are developed and turned into systems after thinking about what might lie years down the road—cover a broad range, resulting in an environment where it is easy to realize ideas. The R&D departments are closely tied together, and the very fact that we have these component technologies and simulation technologies means we can develop the advanced cameras we do.

Expanded uses are foreseen for cameras in such fields as medicine, space, and agriculture. With our goal of creating cameras that capture images that previously were impossible to get, Canon will continue to expand the possibilities of visual expression sustained by the accumulation of technologies developed throughout the company and feedback from a wide range of users.

For more information about EOS R3

Inkjet Ink Technology

Advanced Ink Technology for High Image Quality

Digital printing technology continues to evolve to meet diversifying printing needs. Canon develops ink for its products in-house, as it is an important element that determines image quality to provide new value to customers by making vivid colors and a wide range of color expression possible.

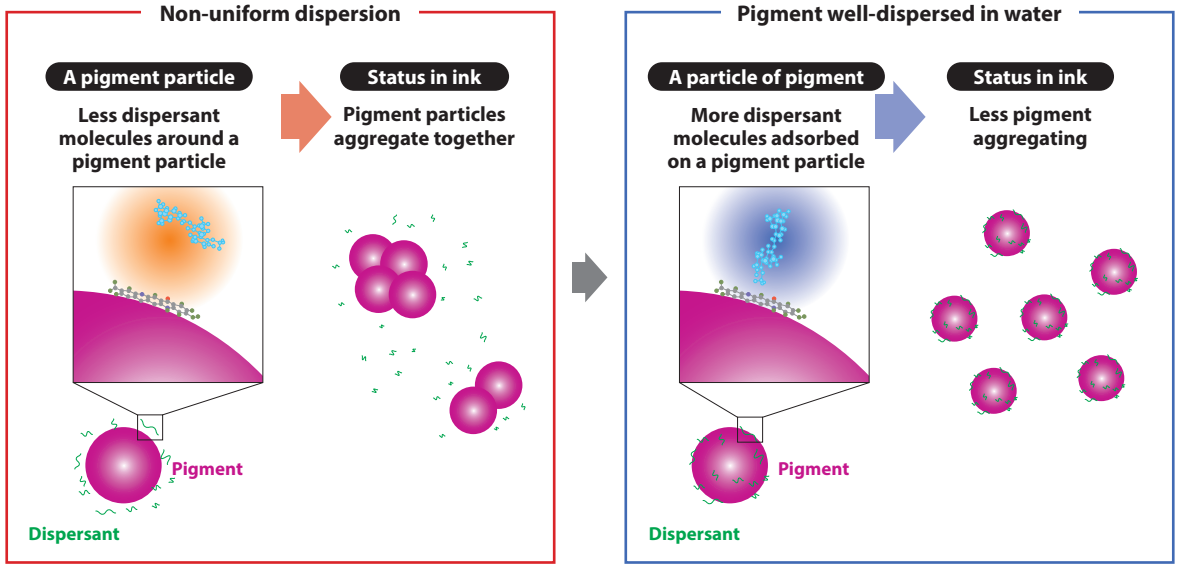
Evolving Technology Expands the Role of Pigment-based Ink

Inkjet technology is expanding its applications from home-use printers to the field known as commercial printing, which includes printing of catalogs and direct mail, and also to the field of industrial printing, which involves printing on a variety of media, such as labels and packages. Color materials used in ink include dye-based ink, in which the colorant penetrates into the medium to show its color, and pigment-based ink, in which the colorant is fixed to the surface of the medium. Pigment-based ink is the mainstream in commercial printing which may involve printing on water-resistant papers, and in industrial printing which may involve printing on non-absorbent materials such as plastic sheets or other materials.

Advanced Ink Technology for Vivid Colors

Improvements in pigment particle size and dispersion technology have helped achieve higher quality images, expanding the role of pigment-based ink. In ink, pigment is dispersed, instead of being dissolved, in water. If pigment is not well dispersed in water, pigment particles will aggregate together, causing poor coloration and affecting image quality. Therefore, it is necessary to find good dispersant that achieve uniform dispersion, though that requires ingenuity. In addition, smaller pigment particles generally achieve better colors with less pigment, and broader color gamut. Thus, creating extremely small, nanometer*-size grains of pigment, to be put into ideal dispersant, is also crucial in creating good ink.

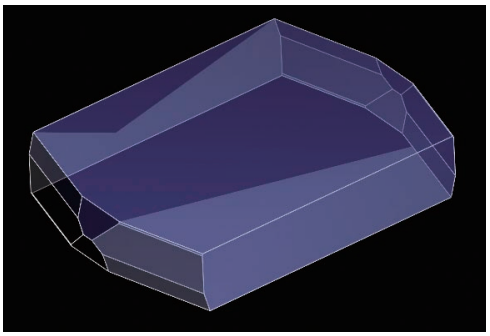
* One-billionth of a mater



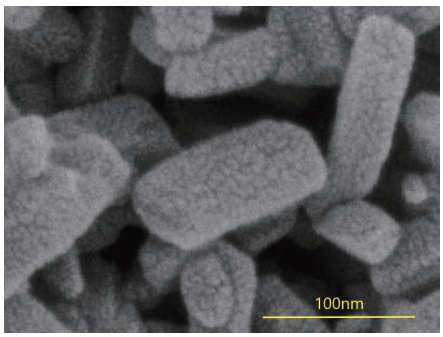
Finding optimal molecular structure of pigment and dispersant to secure uniform dispersion

The product development divisions of printer business and headquarter R&D divisions in charge of basic material research work together utilizing advanced simulation technologies to identify the optimal molecular structure, including dispersion material and pigment particle arrangement and shape of crystal for good coloration and dispersion. Canon designs the ink, develops the production technology necessary to produce the ink as designed, and mass-produces the ink at its own factory. By exercising all these processes in house, Canon is producing highly functional pigment inks. This arrangement reduces development effort to one-third, and provides customers with high-quality ink in a timely manner.

Pigment crystal structure given by computer simulation



Electron microscopic image of pigment crystals



Accelerating high-quality ink development with computer simulation

Broader Color Gamut with Newly Developed Ink

The needs for printed materials change with the times. Prior to new ink development, we research what colors are currently in demand. For example, posters require strong impression. To address this requirement, large-format printers are now equipped with fluorescent pink to express positive and light impression as well as bright, soft luminescence in orange. These days, there is an increasing demand for the vivid color showcase composition with printed materials. Canon has expanded its color range for high brightness and high saturation with newly developed red, orange, green, and violet. The eye-catching coloration has been well-received.

Basic inks **Newly developed inks**

High-impact bright color printing with newly developed inks

Evolving Ink Technologies for Higher Image Quality

Canon has kept up with diversifying printing needs with a wide range of printers. These include home-use printers for documents and photos, continuous feed printers for books and high-quality catalogs, large-format printers suitable for posters and drawings, and label printers that can print on labels and packages of various textures. In order to continuously produce attractive products, Canon leverages its accumulated expertise, ink technologies and other core technologies.

Digital printing, which does not require a large number of people or special skills, will solve the social problems of labor shortage and lack of business successors in the printing industry. Canon is committed to helping customers solve their problems through the advancement of printers and ink.

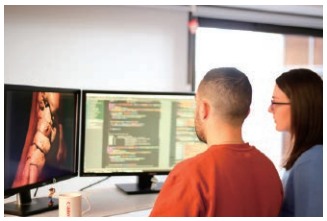
For more information about Inkjet Ink Technology

Global R&D

R&D of New Technologies Around the World

The Canon group conducts business around the world. Today, sales outside of Japan account for approximately 80% of Canon's consolidated net sales.
To ensure that the research work from Canon's global R&D locations expands into businesses, Canon's developers activity collaborate and engage in exchanges with research institutes.

1 Canon Medical Research Europe Ltd.



Edinburgh, U.K.

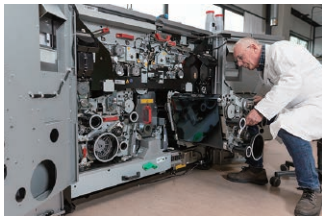
R&D of clinical decision support systems AI automation.

2 Canon Research Centre France S.A.S.

Rennes, France

R&D of next-generation networking and imaging technologies and its standardization activities.

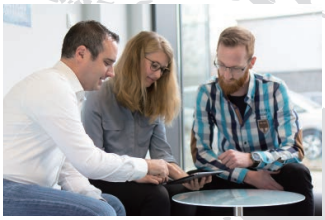
3 Canon Production Printing Netherlands B.V.



Venlo, Netherlands

R&D of commercial and industrial printers, consumables, etc.

4 NT-ware Systemprogrammierungs-GmbH



Bad Iburg, Germany

R&D, sales, and support of print and scan management solutions and document process management systems.

5 Milestone Systems A/S

Copenhagen, Denmark

R&D of video management solutions.

6 Axis Communications AB

Lund, Sweden

R&D for network video and analytics, access control, intercom and audio systems.

7 BriefCam Ltd.

Modi'in, Israel

R&D of video management software.

8 Canon (Suzhou) System Software Inc.

Suzhou, China

Digital printing business related software.

9 Canon Medical Systems Corporation

Otawara (Tochigi), Japan

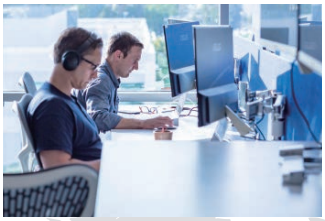
R&D of medical devices and systems.

10 Redlen Technologies Inc.

British Columbia, Canada

R&D and manufacturing of semiconductor detectors modules used in photon counting CT and other advanced imaging applications.

11 Arcules Inc.



California, USA

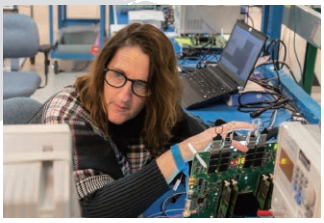
Video surveillance-as-a-service.

12 Canon Nanotechnologies, Inc.

Texas, USA

R&D of nanoimprint lithography systems.

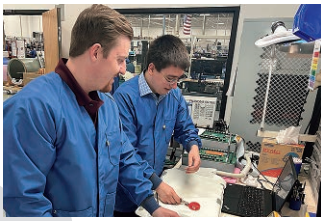
13 Canon Medical Research USA, Inc.



Illinois, USA

R&D of core system physics, data acquisition, and image reconstruction hardware and software for medical devices and systems.

14 Quality Electrodynamics, LLC



Ohio, USA

R&D, manufacturing and service for innovative, high-performance RF-coils used to obtain detailed MRI images of the human body.

Canon Inc.

Headquarters ..... R&D areas, development of digital cameras, etc.
Yako Office ..... Development of inkjet printers, large-format printers, inkjet chemical products.
Kawasaki Office ..... R&D areas, R&D of production equipment and dies, R&D of semiconductor devices, etc., and R&D of network cameras.
Tamagawa Office ..... Development of quality management technologies.
Kosugi Office ..... Development of medical devices.
Hiratsuka Plant ..... Development of displays and next-generation devices.
Ayase Plant ..... Development of semiconductor devices.
Fuji-Susono Research Park ... R&D of electrophotographic technologies.
Utsunomiya Office
Utsunomiya Optical Products Plant
..... R&D of semiconductor lithography equipment and FPD lithography equipment.
Optics R&D center ..... R&D of optical technologies.
Toride Plant ..... R&D of electrophotographic technologies, etc.

* The 14 sites listed above are selected to have a certain size. It introduces businesses that are expected to synergize with Canon Inc., as well as some of its affiliates that conduct research and development to promote global diversification.

For more information about Global R&D

CANON TECHNOLOGY

The site presents a wide range of
Canon technologies from various angles,
providing easy access to the technology
you want to learn about.

https://global.canon/en/technology/

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