THE CANON FRONTIER 2016/2017

Focus on Technology and R&D

THE CANON FRONTIER 2016/2017

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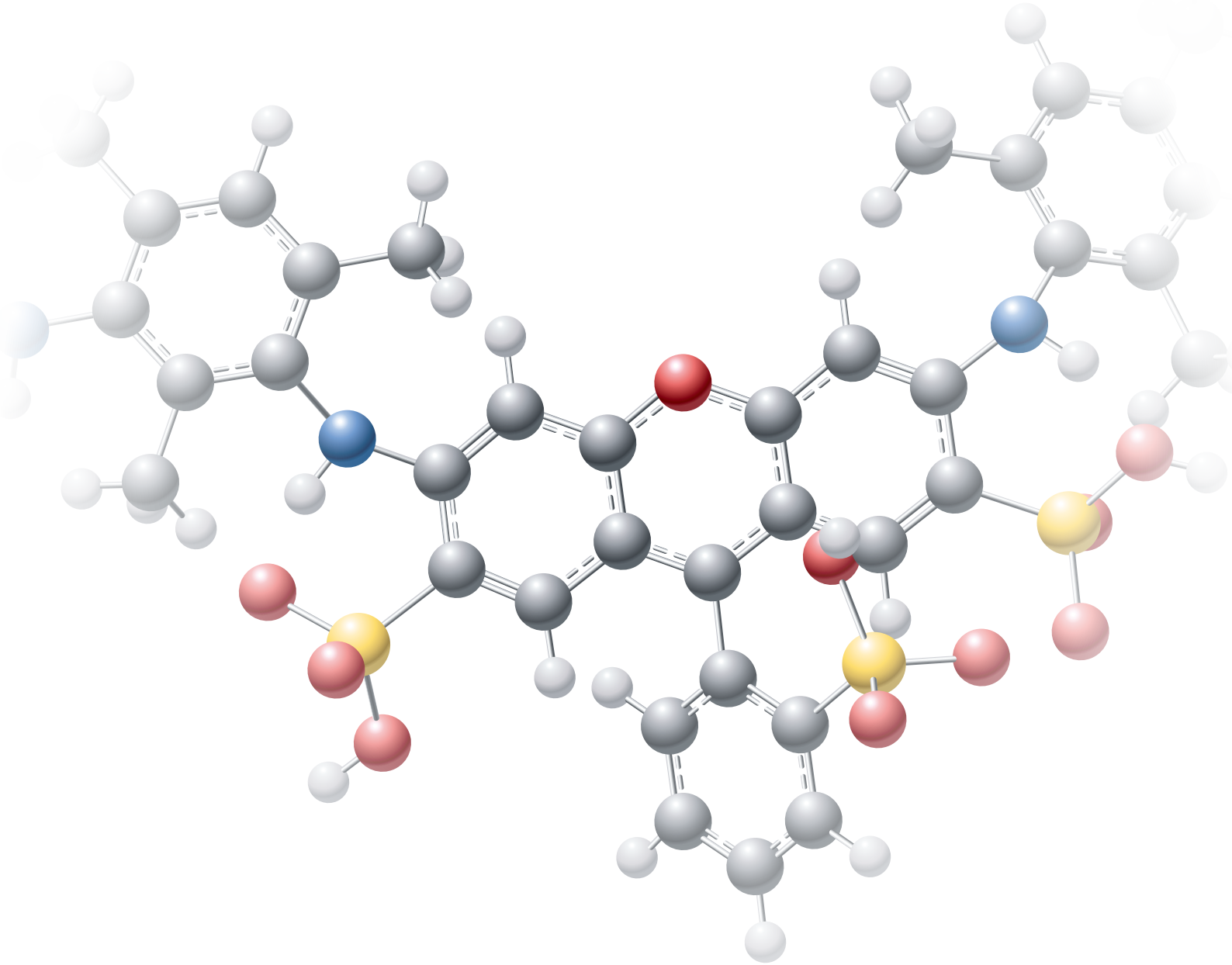
About the cover
The cover features a high-resolution reproduction of Johannes Vermeer's "Girl with a Pearl Earring" (The Royal Picture Gallery Mauritshuis, The Hague). Thanks to Canon's material appearance acquisition/image processing technology and Océ's raised printing technology for UV curable type printer; the asperity, gloss, and even the color of the original is faithfully reproduced.

Creating Something New Giving Birth to Innovation

New dreams are realized through new technologies. Canon, through its corporate DNA with an emphasis on technology, has created unprecedented value by merging a diverse range of ideas and technologies. The source of these amazing and impressive technologies derives from the passion and vision of the company's engineers, who embrace seemingly impossible challenges. By venturing into unexplored fields and creating technological innovation, Canon aims to contribute to enriching the lives of people around the world.



Technologies Supporting Canon

Innovative Technologies that Support Lifestyles, Business and Industry

Professional digital SLR cameras

Ophthalmic equipment

Digital cinema cameras

Professional

Digital radiography systems

Broadcast equipment

Professional digital video camcorders

Professional displays

Interchangeable lenses

Professional inkjet printers

Digital compact cameras

Image scanners

Compact photo printers

Connect station

Home

Digital SLR cameras

Inkjet printers

Compact-system cameras

Digital camcorders

Production systems
Assembly technologies
Measuring and inspection technologies
Processing technologies
Process and production equipment technologies
Automation

Optical materials
Toners and inks
Electronic materials
Medical and bio materials
High-functional materials
Nano materials

Operating systems and middleware
IP
Controllers
Cloud computing
LSI and PKG
Substrates
Communication technologies

Imaging elements
Display elements
Miniaturization
MEMS technology

Production engineering technologies
Material technologies
Software and hardware engineering
Device technologies

Over the course of Canon's more than 70 year history, prioritizing technology has been a part of the company's corporate DNA and represents the source of Canon's innovative technologies. The unique core technologies that the company has cultivated over the years have led to the creation of eight fields of R&D, which include optical technologies and image communication technologies. The company is engaged in business activities for products and services in four major areas of use: Professional, Home, Office and Industry. With the aim of developing new, one-of-a-kind technologies and products, Canon combines the creativity of its engineers with the company's core technologies to create never-before-seen value.

Large-format inkjet printers

Small-office/Home-office inkjet printers

Cloud-based document services

Office multifunction devices

Calculators

Document scanners

Office

Solution software

Toner cartridges

Network cameras

Facsimile machines

Laser printers

Laser multifunction printers

Multimedia projectors

Die bonders

3-D machine vision systems

Commercial photo printers

High-speed continuous-feed printers

Semiconductor lithography equipment

Industrial cameras

Multi-purpose cameras

Organic LED (OLED) panel manufacturing equipment

Components

Color label/ Color card printers

Mixed reality (MR) systems

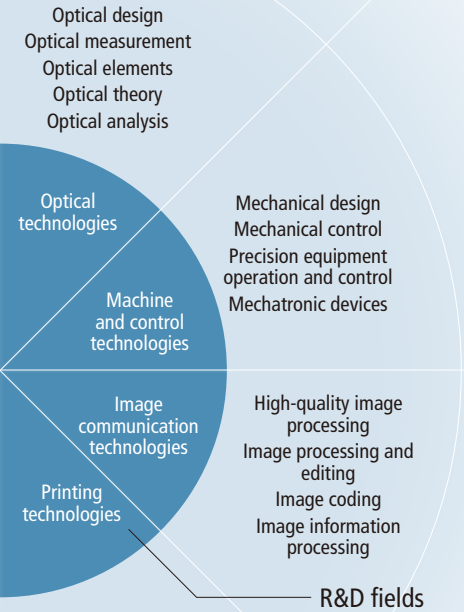
Industry

Flat panel display lithography equipment

Digital production printing systems

Handy terminals

Vacuum thin-film deposition equipment



Special Feature 1

Network Cameras Protect One of the World's Largest Libraries

Home to more than 150 million collection items, the British Library welcomes more than 1.6 million visitors every year. The Library is now renewing its security system to protect books and other items from potential damage or theft. Canon, which boasts cutting-edge products and technologies within the global network camera market, is providing full support to the British Library's efforts for this major renovation.

Valuable Collections Offer Link for Future Generations

The British Library's vast collections of more than 150 million items range from newspapers and magazines to paintings, maps, manuscripts and musical scores.

To protect these valuable assets, the collections are subject to strict control. While it goes without saying that food and drink are prohibited in the reading rooms, the use of pens is also forbidden, with only pencils permitted. In 1997, the Library installed surveillance cameras, not only to protect the collections, but also to maintain security and prevent crime in its restaurants, shops and public areas, and since that time has worked to enhance its security system.

Initially, 250 analog cameras were installed. Having been in use for many years, however, a number of these cameras have exceeded their service life. It was for this reason that the British Library decided to look into the latest security systems, focusing on the advanced security functions offered by digital network cameras and video recording systems.

Security System Renovation

Simply changing from an analog recording system to a digital one was not a feasible way to assure safety and security over the long term. In 2012, the Library established a five-year plan to upgrade its entire security system, including integration with the access control and intruder alarm systems. The plan began with the replacement of all of the Library's network cameras. The decision was made to convert the system over a five year period to minimize interruptions to the Library's operations.

The most important aspect of this renovation is the performance of the network cameras. The selection of Canon Full HD (high definition) network cameras was based on a thorough survey and evaluation of products from other manufacturers worldwide. By switching to Canon high-quality security cameras, the Library was able to reduce the total number of cameras required, thus lowering operating costs, which was another of the objectives of the upgrade. Accordingly, Canon's role goes beyond just providing products. The company is also working with the Library as a project partner to achieve this objective.

Left and top right: Canon network cameras survey the British Library. The King's Library that contains the book collection of King George III
Center right: Magna Carta (the Great Charter) on display at the British Library Bottom right: The Maps Reading Room

About the British Library

The British Library is the national library of the United Kingdom and one of the world's greatest research libraries. It provides world class information services to the academic, business, research and scientific communities and offers unparalleled access to the world's largest and most comprehensive research collection. The Library's collection has developed over 250 years and exceeds 150 million separate items representing every age of written civilization and includes books, journals, manuscripts, maps, stamps, music, patents, photographs, newspapers and sound recordings in all written and spoken languages. Up to 10 million people visit the British Library website (www.bl.uk) every year, where they can view up to 4 million digitized collection items and more than 40 million pages.

Canon network cameras oversee a reading room

Satisfying the Many Demands of the British Library

Posing one of the greatest challenges in upgrading the British Library's security system was its environment, because the St. Pancras building was granted Grade I status in 2015 for its architectural excellence, quality of materials and design ethic. Although it was not possible to mount cameras on the Library's walls, the Canon network cameras enable the capture of clear, high-resolution images from the building's high ceilings. In addition to high image quality, the Library required exceptional video-compression capabilities to support efficient data transmission, as well as pan/tilt/zoom (PTZ) functions, an ultra wide field of view and Power over Ethernet (PoE) compatibility.

Canon's VB-H610D fixed dome network camera is capable of capturing images in Full HD (1920 x 1080 video resolution) across an ultra-wide 112° field of view. These high-resolution, ultra-wide field-of-view cameras not only allow fewer cameras to be needed in each room, they also contribute to reduced maintenance costs in terms of data storage, installation and cabling.

Canon VB-H41 PTZ cameras were put to work in the Library's reading rooms. Featuring 20x optical zoom, full HD resolution and PTZ functionality, these cameras are capable of capturing images in color even in dimly lit environments. They also support special detection functions that let users pre-define the motion of objects within a specified range. Should something out of the ordinary occur, the system can initiate data recording to facilitate the prompt confirmation of threats to prevent theft or damage.

Canon network cameras installed in the British Library
From left: the VB-H610D and the VB-H41

Ensuring the Safety of Visitors and Cultural Heritage

The British Library needs to continuously record video data from multiple cameras and store the resulting images for extended periods. Should a major incident occur, all of the data must be made available to the police without delay so that they can act swiftly. Canon network cameras, featuring high-performance image sensors with exceptional noise reduction, not only produce clear images, but also help users save on bandwidth and data storage. Their low power needs and low-cost operation also contribute to long-term storage of video data.

Within a year of the launch of the Library's security system renovation plan, more than 50 cameras were replaced with Canon cameras. In 2016, this number will be increased to approximately 400, all of which will be network cameras.

The upgraded security system positions the British Library at the cutting edge of security technology among libraries today. And Canon's network camera technology is supporting the Library in its mission to pass on its treasured collections to future generations.

The Sir John Ritblat Treasures Gallery, which displays historical items including Magna Carta

In the Library's Paccar Gallery space, exhibits relating to West Africa are displayed

British Library Interview

Canon Provided Excellent Products and Advanced Technologies that Allowed Us to Implement a Highly Capable and Flexible Security System

"The British Library is frequented by readers, tourists and visitors of all ages. Like all major public spaces in London, there are security issues to be addressed and our network cameras help us ensure the safety of visitors to the Library.

We evaluated cameras from several market leaders, but selected Canon because they offered the quality and capabilities that we were looking for at a competitive price. When we first saw the images from Canon's network cameras, we were very impressed by the clear definition. And there was no drop in image quality even when HD images were compressed to 6 Mbps (megabits per second, a measure of data transfer speed). Overall, the image quality was exceptional, and the cameras performed particularly well in the demanding low-light environment of the exhibition spaces.

For this system upgrade, we needed to integrate the Canon cameras with a video recording system from Tecton. Fortunately, Canon's technical support team provided prompt and efficient service. They quickly addressed and took care of any issue that arose during the process, no matter how small. We were very pleased with the level of support we received.

Whilst the British Library is a very safe venue that suffers very low levels of crime, the constantly evolving nature of security threats means that we need our security system to be both highly flexible and easily adaptable. In future, we are keen to embrace the capabilities offered by a fully digitalized security system incorporating Canon products, including making increased use of video analytics."

From the left
Bhanu Goud, Security Systems Manager
Rick Meyer, Head of Security
The British Library

An entrance hall with a spacious open ceiling

A shop in the library that is open to the public is popular with tourists

In the monitoring room, the safety and security of the Library are under close observation

The Boston Spa Reading Room in the Midlands in England

Solutions Business Based on Optics and Imaging Technology

Increasing worldwide interest in crime prevention and heightened demand for replacing analog cameras have fueled dramatic growth in the world's digital network camera market. Canon is expanding this business through its lineup of network cameras that are ideally suited for a wide variety of applications that support safety and security.

Expanding Applications for Network Cameras on the Strength of High Image Quality

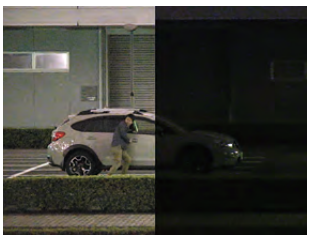
At Canon, NVS (network visual solutions) refers the total system that combines cloud services and image analysis with network cameras at the core. In addition to the core camera technologies, such as the optics, CMOS sensors, imaging processors and image-analysis software that the company has honed over the years, Canon is leveraging its strengths in the areas of network control and cloud services, areas the company has developed for its office equipment systems. The goal is to achieve a solutions business that uses big imaging data for more than just crime prevention and monitoring.

For instance, network cameras equipped with multi-person tracking technology make it possible to understand congestion conditions by detecting pedestrian numbers and traffic flows while estimating genders and ages. The application of advanced image analysis offers expanded opportunities as a marketing tool for tourism and distribution industries.

Development of High-Sensitivity Network Cameras that Deliver Exceptional Visibility, Even at Night and Over Long Distances

Canon is developing a compact, high-sensitivity network camera that can clearly capture subjects in color under conditions that would prove challenging to the naked eye, such as at night, as well as across long distances. Equipped with a large-aperture ratio lens, high-sensitivity sensor and high-performance image processor, the model makes possible the identification of a subject's face in color at a distance of 100 meters, even in dark environments with a mere 0.08 lux of illumination, roughly equivalent to the illuminance of moonlight. Canon released the VB-M50B in 2016.

VB-M50B



Comparison of scene viewed with the naked eye (right) and image captured by the network camera (left)

Partnering with the Industry's Top Companies Endeavoring to Become the Global Leader by Creating Innovative Products

Amid rapid market growth, Canon, viewing the network camera segment as a new business sector offering great promise, has welcomed into the Canon Group both Axis Communications*, the global leader in network cameras, and Milestone Systems*, the industry leader in video management software (see glossary at bottom of page for additional information).

Canon provides innovative and high-performance network visual solutions through its superior imaging technology and technological partnerships with the industry's top companies.

VB-R11

VB-M741LE/
VB-M740E

VB-M641VE/
VB-M640VE

Glossary

Axis Communications (Sweden)
The global leader in the security camera business. Also boasts exceptional network video processing technologies.

Milestone Systems (Denmark)
The world leader in IP video management software and surveillance solutions. Milestone Systems provides high-speed video coding and related management technologies.

IK
A code that specifies the degree of protection provided by enclosures for electronic equipment against external impacts, as defined in the European standard EN 50102.

The Story Behind the Development of the New VB-R11VE Network Camera

A Canon First: Achieving 360° Continuous Rotation

The VB-R11VE is an outdoor-model network camera that can withstand extreme conditions, including wind, rain and temperature changes. Enabling flexible range of motion, it offers wide-area coverage with a single camera. Below are some of the technologies that the Canon engineers poured their passions into in pursuit of the highest levels of performance.

VB-R11VE

The engineers involved in the development of the VB-R11VE

High Hurdles to Overcome: Smooth Acceleration/ Deceleration and Endless Panning

In addition to the high image quality and low-light image capabilities that customers have come to expect from Canon, the development team strived to realize the highest levels of rotational precision, durability and installation ease.

The first development hurdle that needed to be cleared was the camera's 360° continuous rotation mechanism. The signal line that connects the lens to the body utilizes a mechanism called a slip ring. This mechanism ensures that no twisting occurs, even during complete rotations. The engineers verified the camera's performance by rotating the imaging components more than twice the target durability frequency, testing the durability to ensure that the signal would be transmitted correctly, even if rotational friction should occur.

The Birth of a Camera Capable of Withstanding Extreme Conditions and Strong Impacts

For all-weather network cameras intended for outdoor use, high weather resistance and high durability are essential characteristics. The VB-R11VE is designed to operate across an exceptionally broad temperature range, from -50°C to 55°C. But creating a product capable of withstanding such temperature changes was unprecedented for Canon, posing a significant challenge for the company.

Shock resistance test (IK10*, see glossary)
The IK10 rating denotes resistance to the impact of a 5 kg weight dropped from a height of 40 cm.

During the development of the camera, a survey of U.S. system integrators revealed strong demand in the U.S. market for impact resistance against mischief and vandalism to the cameras. The design structure was promptly changed to enable the camera to absorb shocks. In order to improve impact resistance, a five kg iron ball was dropped on the camera from every conceivable angle.

The Ultimate in Image Quality Through Enhanced Lens, Sensor and Image-Processing Technologies

While the VB-R11VE delivers exceptional low-light imaging performance, the key lies in its lens, CMOS sensor and image processing technologies. The camera features a fast lens with an f-number of f/1.4. Because a lens's diameter must increase to let in more light, a special lens configuration was employed that realizes high performance with a large aperture ratio in a compact lens design.

Additionally, the camera's 1.3 megapixel high-sensitivity CMOS sensor, which has exceptional noise characteristics, compensates for subjects with different levels of illumination to maintain brightness during image capture. Furthermore, with regard to image processing, the camera targets the highest levels of imaging performance for a network camera through the application of technologies cultivated in the development of digital video camcorders aimed at achieving a balance between contrast and noise.

The Future of Network Cameras Reveals the Evolution of Technology

The VB-R11VE is equipped with various intelligent functions that assist monitoring. The camera newly incorporates an auto tracking function that enables continuous tracking despite its high-magnification 30x optical zoom. To ensure smooth tracking performance, the engineers worked to achieve a balance between when the camera should move based on how much the subject moves, and preventing it from moving too much so as not to cause discomfort.

The VB-R11VE is also equipped with a number of new technologies. And thanks to the ideas and technological strengths of Canon engineers, including the merging of network camera systems with the company's multifunction office systems and the pursuit of 4K imaging, we can look forward to seeing further advances in the network cameras segment in the future. Through its ongoing development efforts, Canon aims to contribute to realizing a safe and vibrant society.

● **Example of auto tracking function**

Moving object detection **Auto tracking**

Note: For detailed information, visit the Canon website at canon.com/technology

Special Feature 2

Capturing and Preserving the World's Heritage in 4K

Special Feature Presentation of TBS's "The World Heritage" in 4K: Residences of the Royal House of Savoy in the First Capital of the Kingdom of Italy.

Canon's ultra-high-definition 4K cameras made it possible for the first time ever to shoot the terrestrial broadcast program entirely in 4K. What are the possibilities afforded for video expression by shooting with 4K cameras? We investigate the future of television imagery on location.

A Passion for High-Resolution Images Twenty Years after the Program's First Broadcast

"The World Heritage," a popular television program produced by TBS (Tokyo Broadcasting System Television, Inc.), was first broadcast in April 1996 and will soon celebrate its 20th year. Striving to record natural and cultural heritage sites from around the world in the highest quality video possible, the program began making use of 4K production equipment in 2012.

During production of the episode on the Residences of the Royal House of Savoy World Heritage Site in Turin, Italy (aired on June 28, 2015), the production team brought the highest quality camera equipment from Japan to produce the program's first episode for terrestrial broadcast to be shot entirely in 4K. Although the episode was converted to HD (high definition) when it was broadcast because terrestrial digital broadcasting did not yet support 4K, the overwhelming beauty of the images drew a huge response after the program aired.

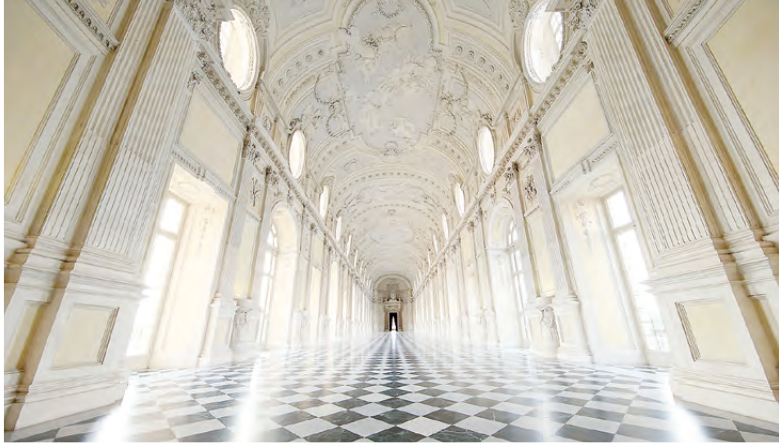
世界遺産 THE WORLD HERITAGE

TBS's "The World Heritage"
Broadcast on TBS every Sunday at 6:00 p.m. (Japan)

Capturing the Finest Details of the Palace's Luxurious Glory

One of the site's highlights is the Royal House of Savoy's collection of weapons and armor, housed in the glorious armory's gallery. This magnificent space is festooned from wall to wall. The footage presenting this area captured the sense of the decorations and the visceral dimensionality of the weapons as though they were headed directly toward the viewer. In the 4K footage of this gallery, we can clearly see a higher level of image quality than that offered by Full HD because the subjects appear with a level of definition beyond what the human eye can perceive. Canon's 4K cameras were able to capture all the details of the armor and weapons along with the true ambiance of the gallery.

The ability to capture both the entirety and the fine details of this gallery is one of the special features of 4K cameras. For example, if you were to use a conventional camera to shoot mosaic artwork made from an assemblage of small pieces of glass or other colorful materials, you would not be able to capture the fine details without drawing close to the artwork. But when you enlarge the field of view, the lack of imaging detail makes it difficult for viewers to perceive that what is being displayed is a mosaic. With Canon's 4K cameras, however, you can get the best of both worlds. This greatly broadens the possibilities for new approaches to imaging expression.



Left: Ceiling of the Palazzina di Caccia di Stupinigi, captured in 4K. Even the texture of each and every decorative element in the designs was scrupulously recorded in 4K

Top: The delicate hues of the creams and light blues adorning the grand gallery of the Venaria Reale

Middle: The grand gallery of the royal armory is the crowning achievement of the 4K images

Bottom: Self portrait of Leonardo da Vinci, captured with ambient light only

Canon's 4K Cameras Capture Collections of Treasures

The highlights of the program were the Shroud of Turin, which has been publicly displayed only one time over a period of several decades, and the self portrait of Leonardo da Vinci from the Royal House of Savoy's collection. Both images were captured in dark rooms without lighting, conditions that pose significant shooting challenges. But the combination of Canon's EOS-1D C top-of-the-line digital SLR camera and EF lenses made it possible to capture these tremendously high resolution images despite the low-light environment. As a result, the program was able to record the beautiful subtleties of these subjects in 4K.

From World Heritage to "Image Heritage" 4K Images Bring History to Future Generations

The episode was shot using Canon Log, a proprietary recording method that saves unprocessed RAW data. During post-shooting editing, hues and tones are dynamically adjusted and colors are graded to bring to life the world within the footage. This process leverages Canon Log capabilities to their maximum, producing finished images that are unlike anything ever seen before.

The production concept of "The World Heritage" is based on using the latest imaging technologies to record video legacies of the world's heritage sites and to pass them on for posterity. Among the World Heritage Sites that have previously been presented, some have been destroyed by the ravages of war and can never be filmed again. The technical power of Canon's cameras and lenses elucidates the intrinsic value of the beauty within nature and humanity.

Residences of the Royal House of Savoy: Palaces of the Savoy, Italy's first royal family, in the first capital upon the unification of Italy in the 19th century. The palaces of the Royal House of Savoy, which contain numerous valuable collections, were inscribed as a World Heritage Site in 1997.

4K broadcasting: An ultra-high-definition next-generation video format that, with a screen resolution measuring approximately 4000 x 2000 pixels for a total of approximately 8.29 million pixels, offers four times the resolution of Full HD (high definition) video, which has a screen resolution of 1920 x 1080 pixels for a total of approximately 2.07 million pixels. According to the road map established by the Ministry of Internal Affairs and Communications, 4K broadcasting is expected to expand gradually from the opening of the Tokyo Olympics and Paralympics in 2020, then to CS broadcasting, BS broadcasting, cable TV and eventually IPTV.

Photos That Come to Life! The Wonder of 4K Video

From left: Naohiko Ogawa, Exective Producer
Masahiko Soma, Technical Director

4K Cameras That Fulfill the Demands of the Pros

Ogawa We took four Canon cameras to Turin for our 4K shoot to ensure the very highest image quality possible. This was the greatest number of cameras we've ever used. After Turin, we went on to film Hallstatt, a World Heritage Site in Austria. Our equipment weighed a total of 700 kg and included 40 hard disks, all packed into 30 cases.

Our main camera was the Cinema EOS C500. Next was the XC10; we made use of its compact body and integrated lens to capture scenes with motion. We mounted an ultra-wide-angle lens on the EOS-1D C, which is a digital SLR camera that can record in 4K, thinking that we could use it to create time lapse sequences that would look like high-image-quality photos come alive.

The C500 provided major fire power. Special permission was granted to bring in a large crane for filming

Soma I think if we hadn't had these cameras, we would have had a hard time shooting this program. Of these, the high-performance C500 cinema camera has a 60p (60 frames per second) frame rate, which is twice the normal rate, and it can record RAW data. I think it was the performance of the C500 that allowed us to capture every decorative detail of the armory, and it was thanks to the performance of Canon lenses that we were able to capture the large spaces with a wide angle of view and in great clarity. I think the EF11-24mm f/4L USM zoom lens is an excellent lens. With an 11 mm focal length, there's no lens distortion (warping of images due to lens aberration) despite the ultra wide angle of view it offers and it realizes high resolution in all four corners of the image.

Cinema EOS C500

XC10

EOS-1D C

The XC10 for Mobility, and the EOS-1D C for Low-Light Shooting

Ogawa We used the XC10, which had just hit the market, to capture scenes of people in motion, mounting it on a gimbal for smooth hand-held shooting. When mounted on the gimbal, we couldn't reach the focus control, so we had to rely entirely on the autofocus. But, the autofocus performed so smoothly that the effect was imperceptible, and we were able to shoot everything without any problems. Even when we moved from indoors to outdoors, the auto white balance ensured excellent color reproduction.

Soma The use of lighting is often prohibited when shooting at World Heritage Sites. We were lucky in that the da Vinci self portrait and Christ's shroud were on exhibit while we were shooting, neither of which is on public display except once every few decades. Lighting was not allowed, of course, so we shot with ambient light only. The locations were very dark, but we paired the EOS-1D C with the EF50mm f/1.2L USM, a bright lens, and I think we got some very impressive images.

Advanced Technology and Reliable Support for Professionals

Soma Using Canon products, one of the things that we were really impressed by was the level of comprehensive support that Canon provides. They really understand the conditions on the ground. While we were shooting we called them up and they helped us many times (laughs).

Ogawa Of all the Canon products I've used, the one that really made an impression on me was the EOS 5D Mark II, the first digital SLR camera equipped with a Full HD video capture function. I could sense Canon's dedication to movies, and I think this commitment will continue through the company's current development of 8K cameras.

Soma In the future, as ultra-high-definition 4K video becomes the norm, I think we'll see greater demand for stabilization to suppress slight tremors and vibrations during camera focusing. Although I've already experienced Canon's focusing performance with the XC10, I'm looking forward to further advances in the technology that will make the instant that an image comes into focus even more dramatic. Canon products never cease to amaze us, so I'm pretty sure that they'll be able to make it happen.

Interview with the Head of Imaging Equipment

Inquisitive Minds Guide the Future of Next Generation Imaging Equipment

Hiroo Edakubo, Deputy Chief Executive
Imaging Communication Products Operations, Canon Inc.

Canon made its formal entry into the cinema and television production market in 2011 with the launch of the Cinema EOS System lineup of cinema cameras and lenses. Since that time, we launched digital cinema cameras capable of shooting 4K video and, at our Canon EXPO 2015 (see page 17), we introduced an 8K camera, which achieves four times the resolution of 4K. In response to the question "Do we really need video resolution as high as 8K?" Canon has provided a glimpse of the potential of next-generation imaging equipment through the astonishing ultra-high-definition that such technology can achieve.

The Choice of Professionals: Cinema Cameras That Expand the Boundaries of Imaging Expression

Canon's digital cinema cameras transcend the divide between broadcasting and cinema to support both industries. Our engineers thoroughly investigated cinema and television sets and locations to create the Cinema EOS C500, a product designed to satisfy the needs of professionals despite its compact body design. Its unique shape allows close-to-the-ground shooting and facilitates convenient mobile shooting. Also, instead of a fan to cool its circuit boards, the C500 uses air ducts to disperse heat. This structure prevents malfunctions due to heat, even if the camera were subject to 24-hour use in the desert.

In terms of ruggedness and durability, it offers the same level of performance as other Canon products. The knowhow that we've cultivated through our professional digital video camcorders and SLR cameras support the tremendous reliability that these products deliver.

From Input to Output, Imaging Technology with a Focus on the Future

A display capable of outputting high-definition images is needed to confirm and edit high-definition video content shot on digital cinema cameras. In addition to professional-use 4K reference displays, Canon is also developing an ultra-high-definition 8K display. The highly detailed and realistic imaging performance achieved through our proprietary image processing technologies, when combined with an 8K camera, makes possible a truly impressive realm of imaging expression.

At Canon, our strength lies in our in-house development capabilities that run the gamut from input to output. Our lenses and image sensors, the most important components during the image-capture process, are produced in-house. The integration of these into the camera facilitates exceptional imaging performance on the display. Amid the rapid advances we're seeing in next-generation imaging devices, the cinema and television production markets are livelier than ever. Our engineers, in their pursuit of the ultimate in imaging performance, will continue working with users around the world to create the best products possible.

Cinema EOS System 8K prototype camera

8K products featured at the Canon EXPO 2015 Tokyo exhibit

Professionals shooting on-location with a 4K camera capable of capturing exceptional levels of image quality

Pushing the Limits of Ultra-High Resolution and Ultra-High Sensitivity

CMOS sensors* (see glossary at bottom of opposing page for additional information) optically receive image information from the subject and convert it into digital image signals. These sensors are a key component in cameras for high-definition 4K, which is on its way to becoming mainstream, as well as in 8K cameras. Based on the technologies the company has cultivated through its digital SLR cameras, Canon is targeting new levels of advancement in terms of ultra-high-resolution and ultra-high-sensitivity imaging performance.

Ultra-High-Resolution 250 Megapixel CMOS Sensor

Five Years since 120 Megapixels Targeting the World's Highest Pixel Count*

Canon, quick to recognize the potential of CMOS sensors, launched related research and development efforts in the 1990s. In 2010, the company produced a CMOS sensor with 120 megapixels, achieving a level of resolution equivalent to that of the human eye, a feat that garnered considerable industry attention. Some five years have passed since the announcement of this technological achievement. Since that time, Canon successfully developed an APS-H-size CMOS sensor with approximately 250 megapixels (19580 x 12600 pixels), the world's highest pixel count for its size. This ultra-high-pixel-count CMOS sensor achieves a level of resolution that is approximately 125 times that of Full HD (1920 x 1080 pixels) video and approximately 30 times that of 4K (3840 x 2160 pixels) video.

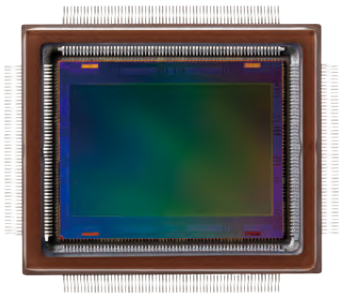
Compared with the 120 megapixel sensor, each of the 250 megapixel sensor's light-receiving photo diodes has less than one-half of the surface area. Despite the small pixel dimensions, declines in sensitivity were suppressed through the development of a structure that maximizes the amount of light that is captured. Additionally, although increases in pixel counts result in increased signal volume, which can cause such problems as signal delays and slight discrepancies in timing, an ultra-high signal readout speed of 1.25 billion pixels per second was made possible through such advancements as circuit miniaturization and enhanced signal-processing technology. Accordingly, the sensor enables the capture of ultra-high-pixel-count video at a speed of five frames per second.

* As of September 7, 2015. Based on a Canon survey

The Processing Technology Behind the Realization of the Ultra-High-Pixel-Count CMOS Sensor

The key to developing an ultra-high-pixel-count CMOS sensor lies in semiconductor processing technology. This technology facilitates the optimal fabrication of the various components incorporated in CMOS sensors, such as the photodiodes and peripheral circuitry. To realize the 250-megapixel CMOS sensor, a variety of new technologies for semiconductor processing were employed, which made possible the achievement of an extraordinary pixel count and a signal-readout speed of 1.25 billion pixels per second. Through the ongoing evolution of processing technology, Canon's CMOS sensor fabrication technology continues advancing to all-new levels.

A camera prototype equipped with the 250-megapixel CMOS sensor, shown with an EF35mm f/1.4L USM lens



The approximately 250-megapixel CMOS sensor

Shot using an EF800mm lens | **Digital zoom + image processing** | **Further magnification**

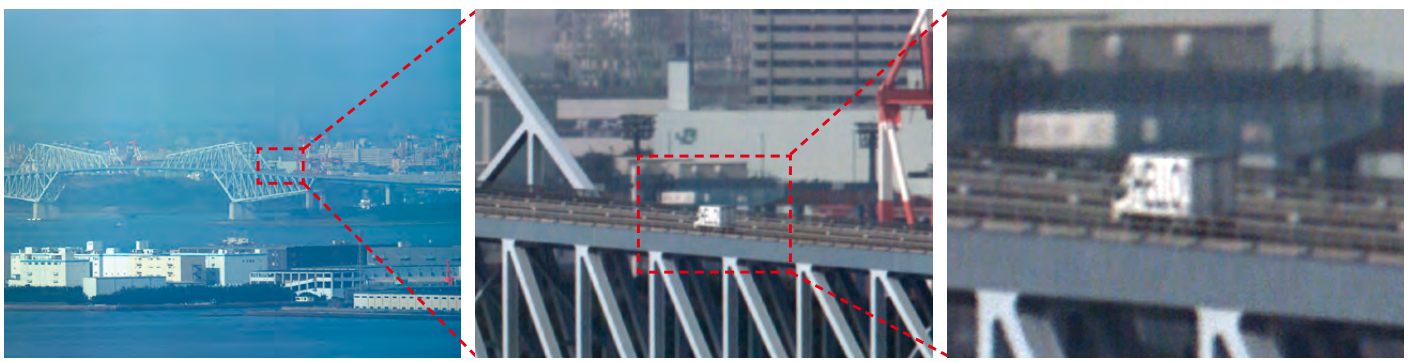


Image captured with a prototype camera equipped with an EF800mm telephoto lens using digital zoom. The image was digitally enlarged and additional image processing was applied. The resulting image enables the identification of a truck driving some 20 km in the distance, which would otherwise be difficult for the human eye to perceive

Faint blue shimmering points of light, emitted by New Zealand glowworms in a pitch-black cave, are captured and amplified by an ultra-high-sensitivity sensor (Location: Waitomo region of North Island, New Zealand)

Ultra-High-Sensitivity 35 mm Full-Frame CMOS Sensor

A CMOS Sensor Capable of Clear Color-Image Capture by the Light of a Crescent Moon

From surveillance to observing natural phenomena, there is a growing need to capture video in complete darkness. Canon has developed an ultra-high-sensitivity sensor capable of Full HD video capture in color with reduced noise, even with minimal subject illumination, conditions under which subjects would be difficult to discern with the naked eye.

One way to make possible the capture of clear video images in low light environments is to enlarge the pixels on the CMOS sensor to increase the amount of light that each pixel is capable of receiving. In 2013, Canon announced the development of a prototype camera equipped with a 35 mm full-frame CMOS sensor for video capture. The sensor featured large-scale pixels measuring 19 µm (µm = micron, one one-millionth of a meter) square. Compared with the CMOS sensor incorporated in Canon's top-of-the-line EOS-1D X digital SLR camera, the pixels on this CMOS sensor have more than 7.5 times the surface area, enabling them to receive greater amounts of light.

In addition to enabling video capture in a dark room with no more illumination than that provided by burning incense sticks (approximately 0.05–0.01 lux), the ultra-high sensitivity 35 mm full-frame CMOS sensor also succeeded in capturing nighttime video (an exceptionally dark shooting environment of less than 0.01 lux) of the Yaeyama-hime fireflies that inhabit Japan's Ishigaki Island. In 2015, the sensor was also used to successfully capture video of the New Zealand glowworms (Arachnocampa luminosa) that live in the Waitomo Caves of New Zealand, using nothing more than the modicum of blue light emitted by the insects themselves.

The ME20F-SH, Canon's first-ever ultra-high sensitivity multi-purpose camera

Canon further refined the performance of the sensor and incorporated it in the company's first ultra-high-sensitivity multipurpose camera, the ME20F-SH, which was launched in 2015 and is capable of capturing color video with a minimum subject illumination of less than 0.0005 lux, equivalent to an ISO sensitivity of 4,000,000 (at maximum 75 dB gain).

Multi-purpose cameras capable of operating in almost total darkness enable image capture in locations that are otherwise difficult to access. In addition to such applications as disaster prevention and crime prevention, other possible uses include measuring equipment and industrial machinery, as well as the shooting of video on the behavior of wild animals in their natural habitat.

● **Comparison of images captured under identical conditions**

Conventional professional-use video camcorder

Test camera equipped with the 35 mm Full HD CMOS sensor

Glossary

CMOS Sensor

A semiconductor imaging element. While CMOS sensors offer such advantages as fast readout speeds, low power consumption and suitability for larger chip sizes, one drawback is that they are susceptible to generating noise. Addressing this issue, Canon developed a unique double sampling noise-cancellation method. This technology was recognized with an Invention Prize in 2004 at Japan's National Commendation for Invention ceremony.

Special Report 1

Canon EXPO 2015 Tokyo

Canon EXPO is a private exhibition that Canon holds once every five years in four countries around the world to showcase Canon Group products and technologies. The company launched Canon EXPO 2015 in New York in September 2015, then took it to Paris in October, followed by Tokyo in November, holding the event at the Tokyo International Forum.

At Canon EXPO 2015 Tokyo, the company introduced cutting-edge technologies and solutions based on the theme "In pursuit of expected value toward Tokyo in 2020." Highlighting its development of visual culture and support of business innovation, Canon offered visitors a glimpse of the company's vision for the future and new value propositions.

Canon EXPO Shanghai was held in May 2016. Through interaction between Canon and EXPO visitors, the company left a lasting impression on all who attended the event.

Cinema EOS System cameras and 8K prototype cameras are featured on the set of this realistically recreated production studio

Professional 8K prototype displays give visitors the opportunity to see firsthand the impressive sense of depth and exceptional image quality made possible by 8K technology

The "Contact Wall" uses the surface of a wall to facilitate communication, enabling a business user to communicate with overseas staff as easily as speaking with someone in the same room

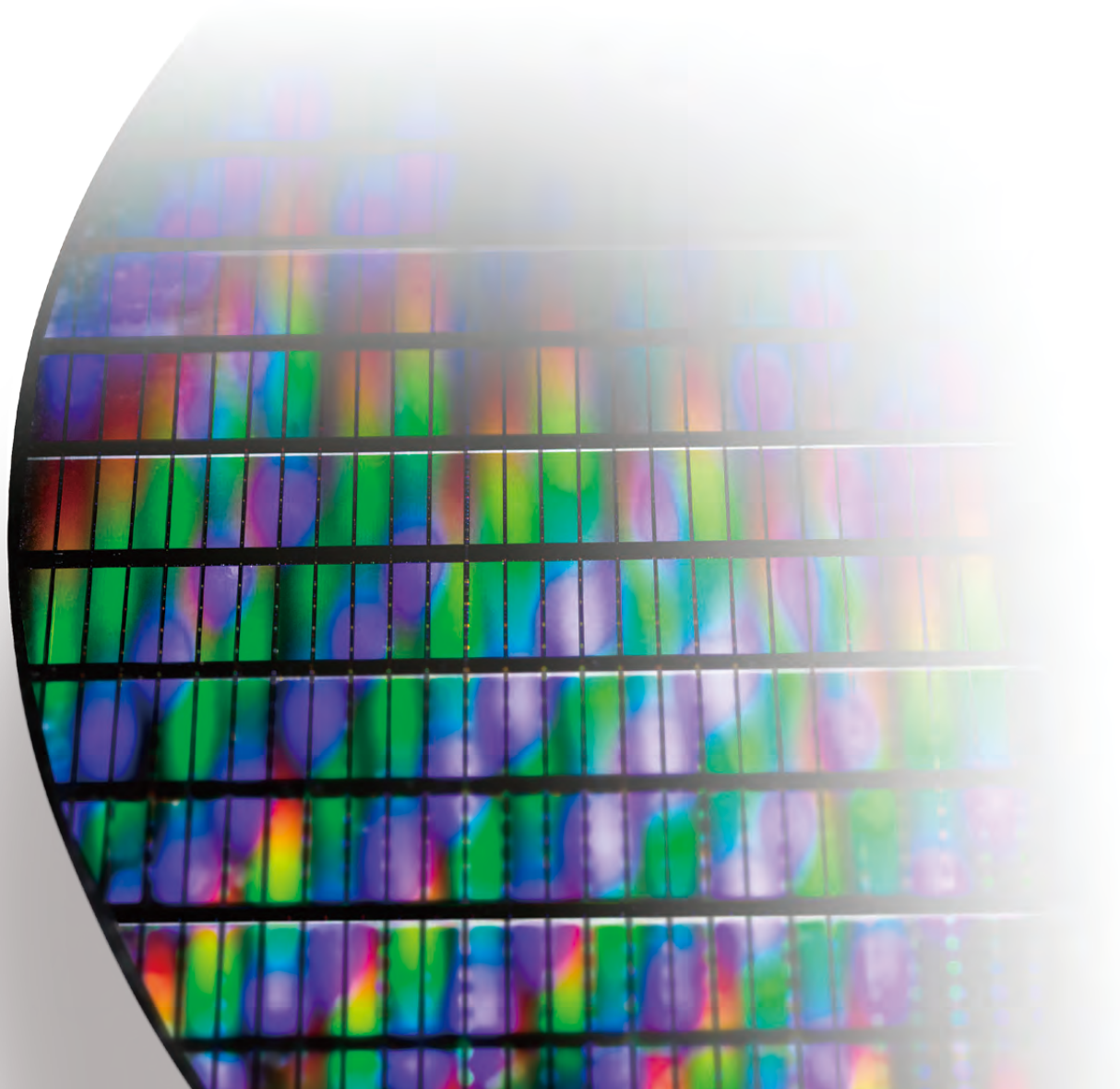
A technology exhibit featuring Canon's "Super Machine Vision." The next-generation machine vision technology enables the real-time three-dimensional measuring in color of a moving subject from a 360° perspective

The "Imaging Airport," created from a large-format, high-resolution print, fills the space with a sense of presence that makes viewers feel as though they are really at an airport

This display, featuring a total of 120 different package designs for Japan's 40 J League soccer teams, highlights digital packaging printing that supports multi-variety small-lot print jobs with short lead times

Supporting Industrial Innovation

Canon's history is a history of cultivating technology. Honing the state-of-the-art imaging technologies for which it is famous, Canon is expanding its presence from the professional, home and office sectors in which the company is currently active, into such new realms as the medical and industrial domains. Canon engineers, through their ever-inquiring minds and insatiable desire to challenge the unknown, continue to support industrial innovation.



Clear, Fast and Dependable: The New Face of Commercial Printing

Digital printing is rapidly making inroads into the field of commercial printing, a sector in which offset printing has been the primary means of producing such printed matter as posters, catalogs, books and newspapers. Since the launch in 2006 of the company's first digital commercial printing system employing electrophotographic printing technology, Canon has been working to popularize digital printing while enhancing the technology's functionality.

Leveraging the Merits of Digital Printing to Enter the Commercial Printing Market

Although commercial printing jobs can involve print runs ranging anywhere from tens of thousands of copies to several million, there is an increasing need for multi-variety small-lot printing. Additionally, the types of printing paper now being used have grown more diverse, including glossy paper, pressure-bonded paper, carbonless paper and card stock. These are the realities of the commercial printing market today, but these conditions also pose challenges for conventional offset printing.

This is why digital printing has been garnering increased attention. Digital printing, which enables printing directly from source data, offers such advantages as small-lot individualized print runs as well as variable-data printing, in which content can be changed from one page to the next. In response to the growing digital printing market, Canon is embracing the challenge to enhance quality while boosting productivity and reliability.

An Extensive Lineup Spanning the Entire Commercial Printing Sector

Commercial printing covers a broad range, from books and pamphlets to packaging. Canon's strength lies in its ability to provide ideal products to satisfy individual customer objectives. The Canon Group, which includes Océ, boasts an impressive product portfolio, from continuous-feed and cut-sheet printing systems to large-format inkjet printers. And all of these products share common operability and user interfaces, so they can be used with the same familiarity.

While Canon works to expand applications for its continuous-feed printing systems for large-volume print jobs, including high-speed printing, variable-data printing and printing on specialty paper, the company's cut-sheet printers for small-lot print runs offer the flexibility to handle everything from the printing of books and manuals to high-image quality print jobs. With an emphasis on speed, image quality and durability, Canon offers a diverse product portfolio designed to meet the needs of any customer.

Looking to the future, Canon has set its sights on the industrial printing sector, aiming to expand the potential of digital printing by enabling printing and package printing on materials other than paper, such as ceramics and metals.

Targeting Commercial Printing's No. 1 Spot in Collaboration with Océ

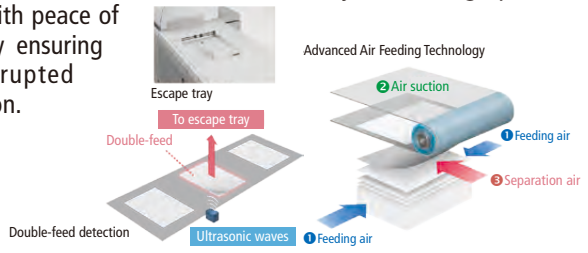
Océ, a venerable company with a proud history spanning more than 130 years, joined the Canon Group in 2010. The competitive printers that Océ develops have garnered tremendous support within the market for their reliability and production capacity. Canon's collaboration with Océ, which boasts a strong presence in the high-end segment of the commercial printing industry in Europe, represents another step toward the realization of Canon's Three Regional Headquarters management system which targets the promotion of innovation in the U.S. and Europe. Targeting the No. 1 position in the commercial printing market, Canon is working to develop unparalleled products through accelerated personnel exchanges and technology sharing with Océ.

Canon and Océ engineers work together on the development of printer controllers and engines

imagePRESS C10000VP

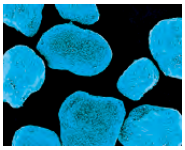
❶Stability: Air feeding for consistently stable paper handling

Advanced Air Feeding Technology employs three air-powered operations—feeding air, air suction and separation air—to deliver consistent paper feeding, even when printing on coated paper. Even if a double-feed should occur, the system's design provides users with peace of mind by ensuring uninterrupted operation.



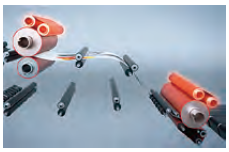
❷High quality: Next-generation CV toner delivers excellent color reproduction

CV toner maintains the micro-dispersion of color materials while realizing optimized fusing characteristics. It even maintains consistent color performance during large-volume print jobs, achieving a level color reproduction that approaches that of offset printing.



❸Productivity: Dual fixing system achieves uniform print speed for all media

A two-path dual fixing system automatically adjusts the paper path according to the quality of the paper being used. The system maintains high productivity even when combining different types of media, such as when printing both single-sided and double-sided output, or on thin paper and thick paper.



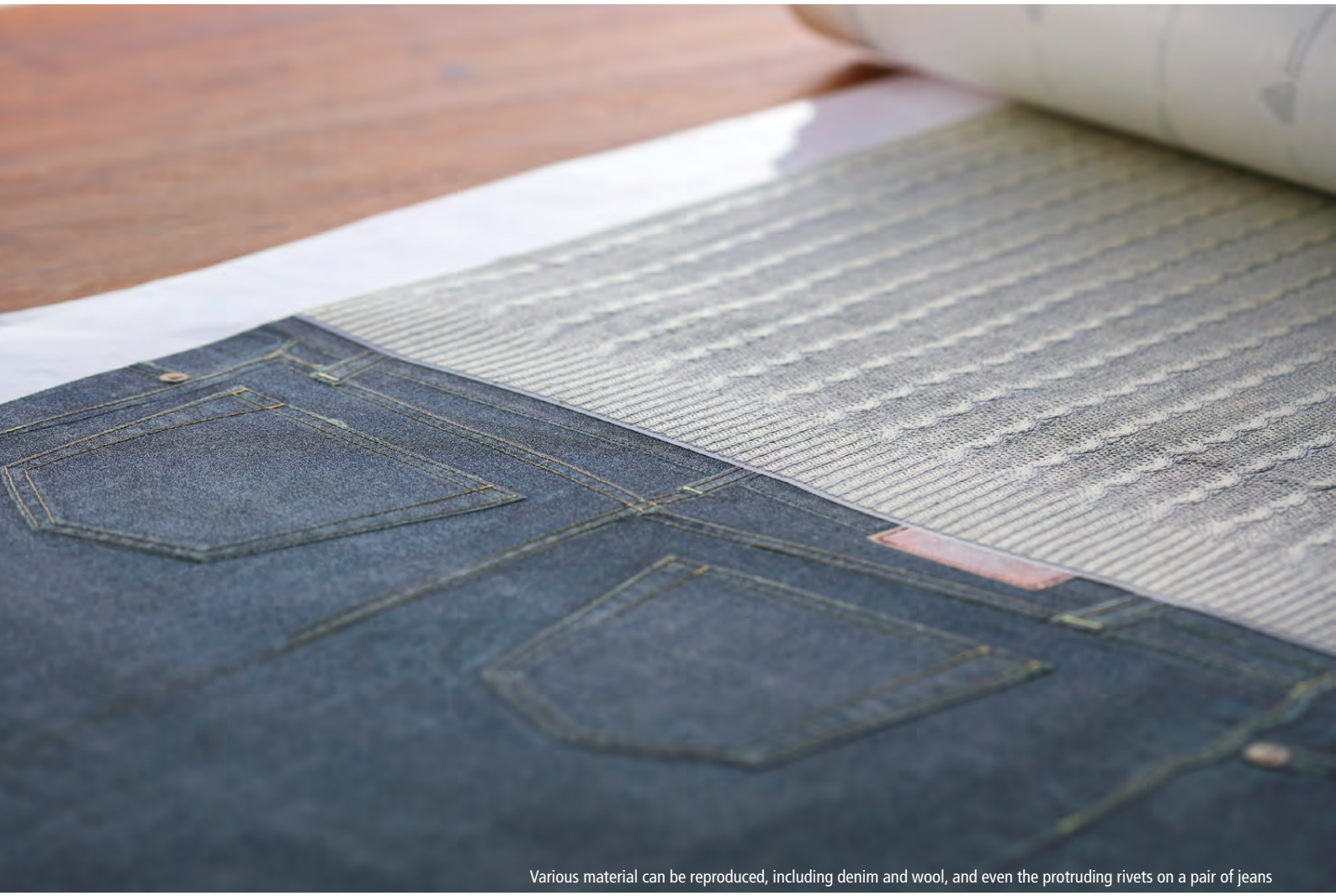
❹Controller: PRISMAsync maximizes print engine performance

This high-functionality printer controller is equipped with print job management functionality. By predicting the duration of print jobs and the timing of paper refills and consumable replacements, it helps to minimize downtime.

Remote Manager
Enables remote print-schedule confirmation, printer monitoring and job-setting changes for up to five print systems via a web browser.

Scheduler
Displays graphs of scheduled print times. Also lets users see at a glance when to replenish paper and consumables and when to remove paper.

Express Material Appearance Faithfully



Various material can be reproduced, including denim and wool, and even the protruding rivets on a pair of jeans

Material appearance refers to the objects' gloss, the stereoscopic effect, and sense of transparency. The acquisition of this information, such as surface reflectance, in addition to color data, is essential for reproducing an object's texture in photographs and other printed items. Canon has been developing technologies that can acquire this high precision material appearance information to reproduce it with printers.

Acquisition Technology Quantifies Material Appearance from Captured Images

An object's reflectance properties, the essential element of material appearance, are determined by its surface contours and luster. In addition to these factors, how an object appears will undergo complex changes depending on the direction from which it is viewed and the position of the light source. That is why Canon developed technology combining multiple light sources and cameras that, by capturing images from all directions at a resolution of several dozen microns, enables the analyzing and digitization of minute surface contours and luster characteristics.

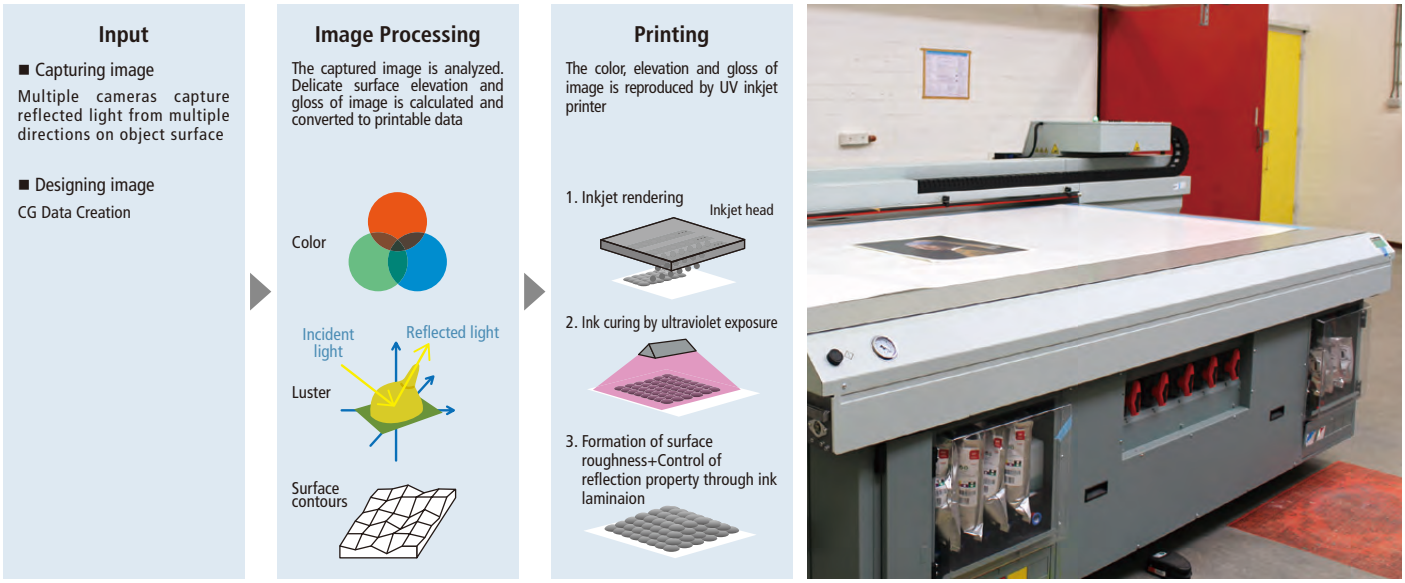
Additionally, when photographing oil paintings and other historical cultural assets susceptible to damage due to the effects of light, material appearance information can be acquired with reduced light exposure, thus minimizing the burden on the cultural properties, through such means as the use of high-sensitivity cameras and HDR* (see glossary at bottom of opposing page for additional information) imaging technology.

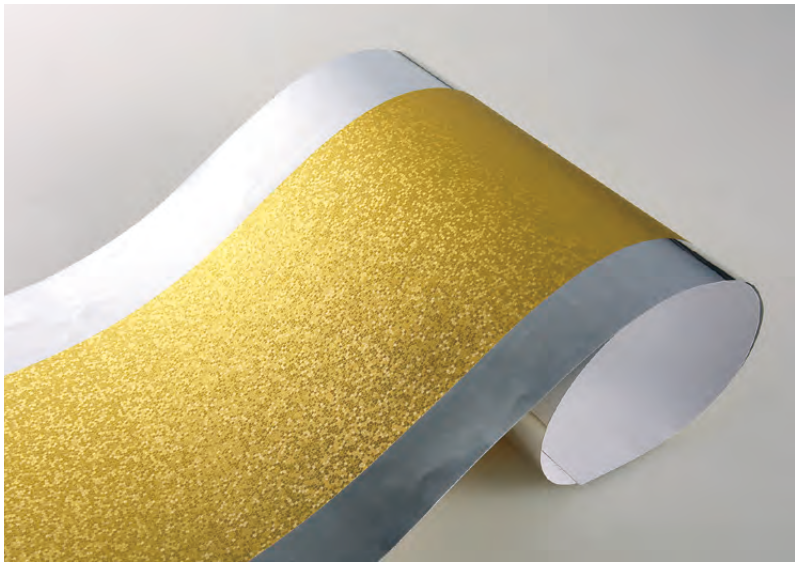
Material Appearance Printing Technology Enables the Expression of Most Any Imaginable Texture

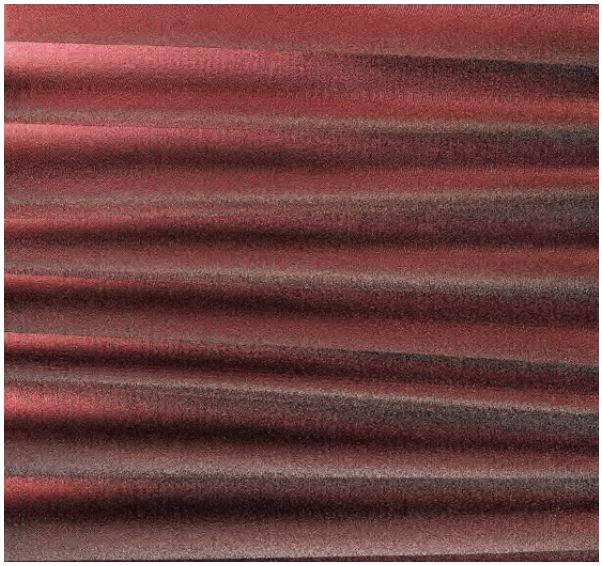
The aim of conventional printing technology was the realization of vivid, sharp images by enhancing the color performance of inks and toner and boosting print resolution. In the future, however, users can look forward to printing technologies that even make possible the reproduction of almost any conceivable material.

Canon and Océ, working in unity, are now developing printing technologies capable of reproducing acquired information. By combining Canon's image-processing technology with Océ's printing technology employing UV-curable printers* (see glossary at bottom of opposing page for additional information), the companies are developing high-quality material appearance printing technology that enables both the printing of surface characteristics measuring up to two centimeters thick and the expression of surface textures. This technology will allow users to not only reproduce the material appearance of actual objects, but also all-new material textures that the world has yet to see.

● **Use of Technology and Production Processes**







Bottom left and bottom right: Material appearance prints of gold leaf and velvet fabric that faithfully reproduce surface contours, luster and color

Top: The Océ UV-curable printer currently under development (not yet released)

Creating New Customer Value through Material Appearance Acquisition and Printing Technologies

Material appearance print technology enables the faithful reproduction of the look and feel of oil paintings down to the subtlest details of the original work, including the brushstrokes and the buildup of paint, the gloss of the finishing varnish, and even the surface cracks that can appear over time. The technology also facilitates new approaches to communication by making possible the creation of reproductions of precious cultural artifacts, which can usually only be displayed in glass cases, that can be directly touched, and thus experienced in new ways.

Additionally, the technology is capable of reproducing the appearance of draped fabrics, including such materials as velvet, whose color and sheen change considerably depending on the angle at which they are viewed, as well as clinquant materials like the gold leaf surface of gilt folding screens. In the future, Canon aims to expand the application of this technology to include wall paper and other interior design materials as well as product packaging.

Glossary

HDR (High Dynamic Range)
Dynamic range refers to the difference between the brightest and darkest areas attainable when capturing a single image. High dynamic range imaging is a technique that combines multiple images captured at different exposures to reproduce a dynamic range greater than is possible using conventional photographic approaches.

UV-curable printer
UV-curable printers are inkjet printers that use UV inks, which instantly dry and adhere to surfaces when exposed to ultraviolet light. UV inks are also highly resistant to water and direct sunlight.

Robot Eyes Set Sights on Future of Manufacturing

In April 2014, with the release of the company's first 3-D machine vision system, Canon marked its entry into a new market offering high expectations for growth. Canon 3-D machine vision systems are capable of rapidly and accurately measuring the location and orientation of parts in three dimensions, supporting the automation and acceleration of production lines for parts feeding.

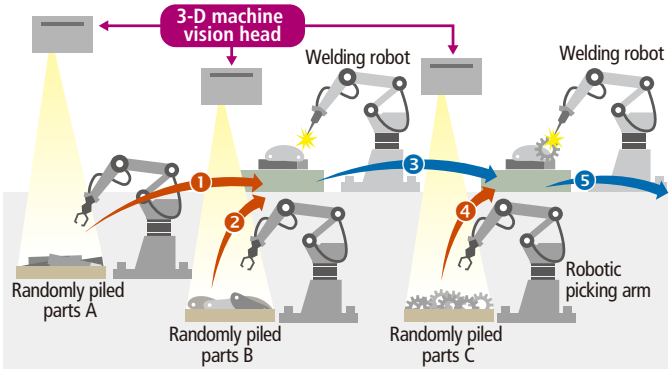
Using 3-D Machine Vision to Solve Issues Faced on the Production Floor

While robots play an essential role in the manufacturing industry, there are some tasks for which they are not well suited. One such task is the selection of individual parts from randomly piled parts in a box or on a pallet.

Previously, to make parts easily accessible for pick-up by robots during assembly, there was a need for workers to first place each part in a designated location, a process that often created a bottleneck amid efforts aimed at streamlining and automating production lines.

Canon 3-D machine vision systems provide a solution for this problem. Machine vision employs industrial image sensors to provide machines with the ability to "see." Today, the most common type of machine vision used is 2-D machine vision, which is ill-equipped to indentify the positioning and orientation of randomly piled parts. As such, Canon developed the RV1100, a machine vision system capable of the high-speed, high-accuracy three-dimensional recognition of objects. This enabled the automation of parts supply, a task that until that time had been performed manually on production lines, opening up new possibilities on the front lines of manufacturing. In July 2015, Canon expanded its machine vision product lineup with the launch of the RV500 and RV300, both of which can pick up smaller-size parts. Accordingly, Canon's machine vision lineup is well suited to satisfy the needs of a wide range of production applications, including those of the electronics industry, which requires the handling of small parts and components.

● **Usage Example: Automobile Manufacturer**



Press parts randomly assembled on a pallet are picked up and supplied to the welding process

Integration of Projector and Imaging Sensor Facilitates Easy Installation, Enhanced Productivity

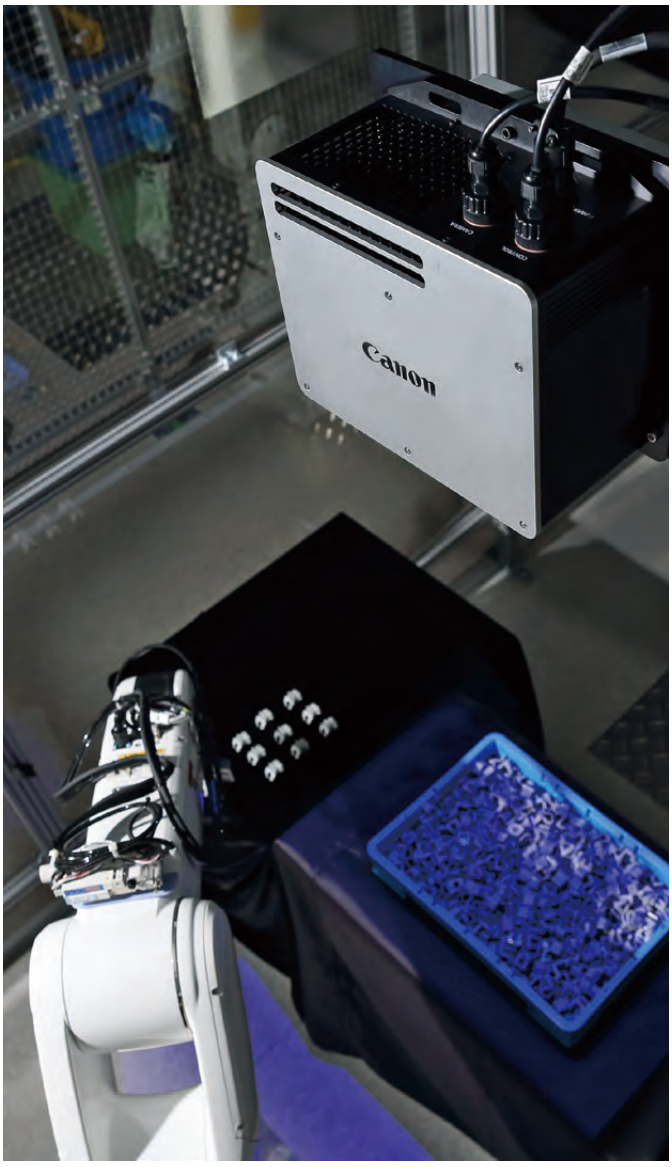
Canon 3D machine vision systems project recognition patterns onto a randomly assembled pile of parts and analyzes the projected images. Based on the analysis of the differences between images of the parts and the multiple projected patterns, the systems are able to recognize targeted objects in three dimensions.

One of the problems with 3-D machine vision systems offered by other companies is that they are often difficult to install. Because the positional relationship between the pattern projector and imaging sensor plays a crucial role in such systems, they must be carefully calibrated and adjusted to ensure proper performance. By comparison, Canon 3-D machine vision systems incorporate both the pattern projector and imaging sensor in a single unit, enabling installation without the need for difficult calibration procedures. Thanks to their lightweight, compact design, they can be installed without having to modify or move existing production lines. Additionally, the systems feature a dust- and water-resistant body design, making them easy to maintain once installed.

Evolving toward High Speeds and High Precision

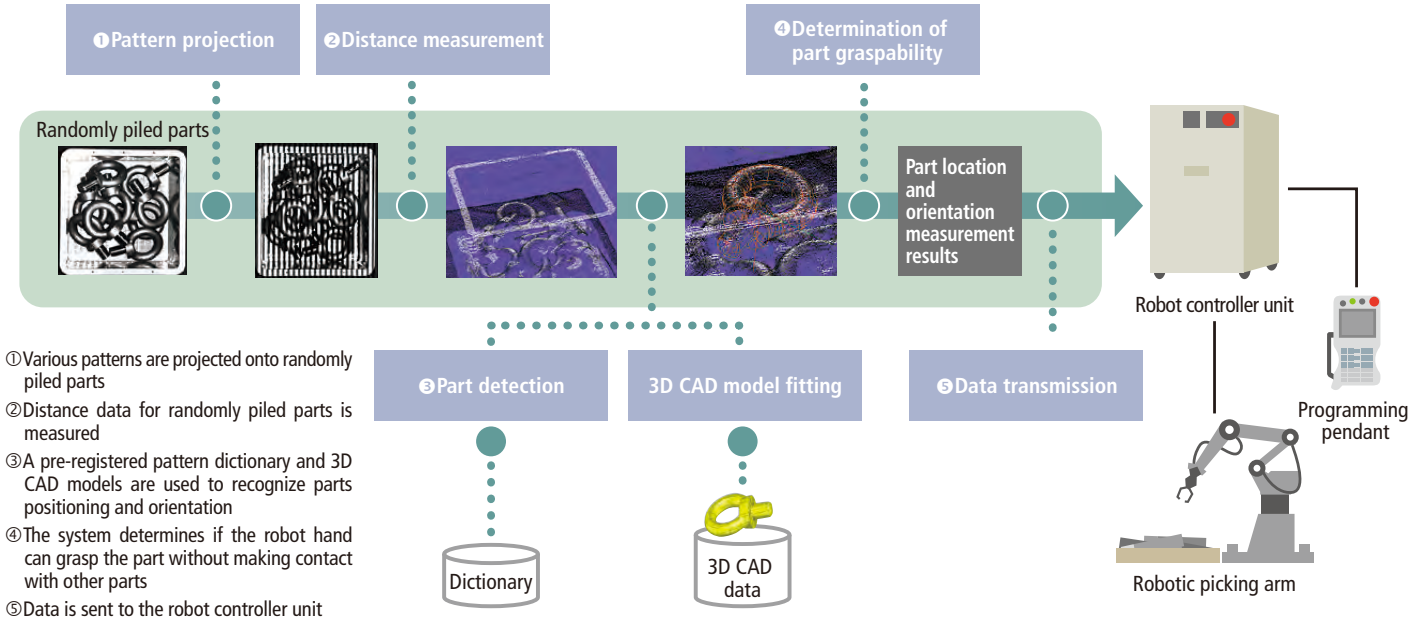
Canon 3-D machine vision systems deliver unrivaled recognition precision. Simply by inputting the CAD data and capturing images of the randomly piled parts, users can easily register parts with curved surfaces, parts with few distinguishing features, and even parts with more complex shapes. Also, by using a new approach that matches CAD data with not only distance measurement data but also gray-scale images, the systems make possible the high-precision recognition of a wide variety of parts.

Canon 3-D machine vision has attracted widespread attention, leading to numerous inquiries and orders from businesses across a range of industries, including companies working in the automotive, electronics, metal components, plastics and chemicals sectors. Aiming to go beyond simply improving its product offerings, Canon is leveraging the 3-D machine vision technologies it has developed with the aim of expanding its business through the introduction of systems for assembly processes and for the automation of defect inspections. In this way, Canon will continue to actively pursue product development as a leader in the machine vision market.



The RV500 takes only approximately 1.8 seconds to recognize randomly piled parts and transmit data to the robotic arm's controller unit. The system helps to accelerate the parts-supply process

● **3-D Machine Vision System Workflow**



①Various patterns are projected onto randomly piled parts
②Distance data for randomly piled parts is measured
③A pre-registered pattern dictionary and 3D CAD models are used to recognize parts positioning and orientation
④The system determines if the robot hand can grasp the part without making contact with other parts
⑤Data is sent to the robot controller unit

Innovators of the Semiconductor Industry

Nothing in the world today supports the advancement of IT devices more than semiconductor chips. Within the technological field of semiconductor lithography, which has supported the fabrication of semiconductor chips over the last half century, nanoimprint lithography is making its presence known as a revolutionary new technology.

Nanoimprint Lithography: The Ultimate Micro Fabrication Technology

The evolution of semiconductor chips has progressed hand in hand with the miniaturization of circuit patterns. The key to this miniaturization has been shortening light-source wavelengths and developing lithography technologies that contribute to further miniaturization. In the early 1990s, Canon introduced its i-line 365 nm wavelength (nm = nanometer, one billionth of a meter) steppers, making 350 nm resolution possible for a variety of imaging applications. Then, in the late 2000s, when new shorter-wavelength light sources were developed through efforts that culminated in the development of an argon fluoride (ArF) immersion lithography system capable of 38 nm-resolution patterning, it was said that miniaturization had reached its technological limit.

As an alternative to efforts aimed at achieving shorter wavelengths, Canon is working to establish a new approach to realizing further circuit miniaturization. This approach is nanoimprint lithography (NIL), which offers the advantages of simplicity, compactness and lower chip costs. Capable of achieving line widths of a mere 15 nm, and maybe even smaller, NIL is poised to revolutionize the semiconductor industry.

Overcoming Numerous Technological Challenges

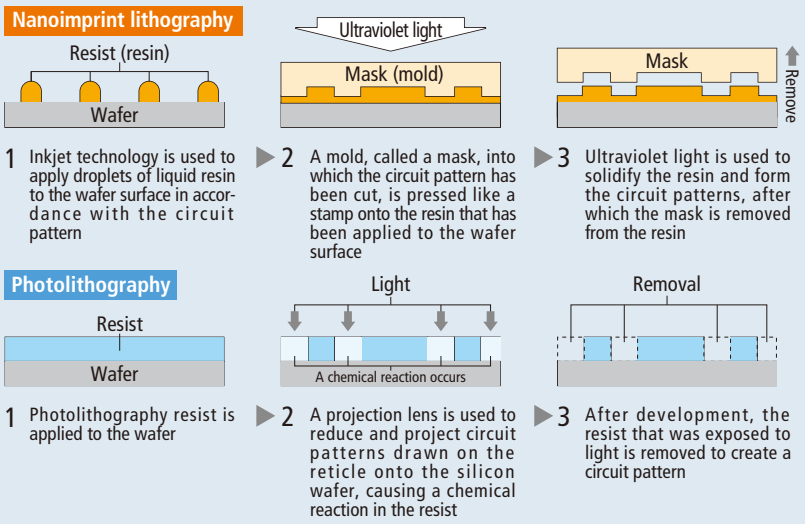
Unlike conventional lithography technology that uses light to etch circuit patterns, nanoimprint lithography fabricates nanometer-scale patterns by imprinting the nano-pattern mask (mold) onto the coated resin on the wafer surface to form circuits. Because the process involves no optical system, it enables the faithful reproduction of the mask's minute circuit patterns on the surface of the wafer.

The challenges that this technology faced, however, were many, which led many to long believe that commercialization would be difficult. Because the circuit patterns are formed using direct transfer, the process requires nanometer-level accuracy. Additionally, mass producing precision devices demands extremely accurate position control and the elimination of particle contaminants. Through the comprehensive development of hardware, software and materials technologies, along with environment control technologies to keep microscopic particles in check, Canon successfully overcame these numerous obstacles.

How Canon Nanoimprint Lithography Works

While photolithography has contributed to reducing the cost of semiconductor chips, as line widths grew narrower, achieving sharp circuit pattern definition became increasingly difficult. Consequently, realizing further miniaturization required a range of innovations that resulted in ever-larger and more expensive lithography systems.

By contrast, nanoimprint lithography does not require shorter-wavelength light sources, instead using the simple approach of physically pressing onto the resin a mask into which circuit patterns have been cut. As such, it enables the creation of lithography systems that are relatively compact in size and has the potential to significantly lower costs. Also, because this approach produces extremely sharp circuit patterns, it is expected to contribute to lower chip-defect rates.



The Goal of Device Mass Production

One of the technologies Canon has developed for nanoimprint lithography controls the amount and positioning of the resin that is 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.

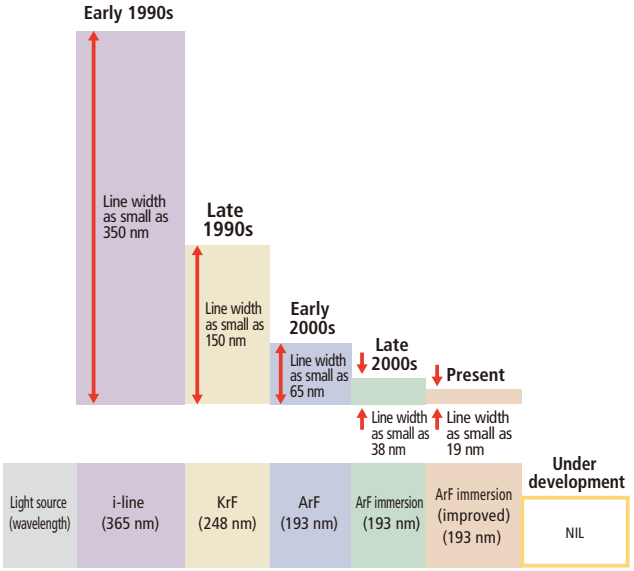
Likewise, when the mask is removed from the wafer, their relative positions must be optimally controlled to prevent the deformation of the convex circuit patterns formed in the resin. Leveraging the expertise the company has accumulated in nano-level control technologies, Canon succeeded in overcoming these challenges, taking a decisive step toward mass production.

Generating Synergies from Different Cultures

With the aim of mass producing nanoimprint lithography systems, Canon is collaborating with U.S.-based Canon Nanotechnologies, Inc. (CNT), which boasts some of the world's most advanced and unique technologies for micro-fabrication devices in the field of nanoimprint lithography.

Essential to Canon's development of semiconductor lithography systems are, in addition to lithography system control and measuring technologies, the service and support know-how that the company has cultivated to date. By merging these with CNT's cutting-edge nanoimprint lithography technologies, Canon aims to break through the miniaturization barrier caused by current physical limits.

● **The History of Semiconductor Miniaturization**



While line widths have halved roughly every five years, progress has stalled since the late 2000s

Testing is carried out with an eye to mass production

Creating a New Mixed Reality: "MREAL"

Mixed Reality (MR) is revolutionizing the manufacturing process as a technology that layers computer-generated (CG) images on top of the reality that surrounds us. Its use is spreading to various types of manufacturing sites, from the automobile industry to the manufacturing, architecture and aviation industries.

Enter a World of Mixed Reality through Head-Mounted Displays

Canon's MREAL System, based on Canon MR technology, consists of a head-mounted display (HMD), underlying middleware, and various sensors. When viewers put on the HMD and view the built-in displays, video cameras positioned at the viewer's left and right eyes capture video and send it to a computer via a controller to be combined with CG images. This allows viewers to experience a full-scale mixed-reality world in which even a life-sized automobile can be generated within a meeting room.

In addition to enabling users to circle the generated CG images, MREAL lets multiple viewers experience the same space at the same time. When the viewer approaches the CG images, they appear bigger, and when the viewer backs away, he or she is able to take in the entire scene. And since objects can be viewed from any angle, MR creates a sense of complete virtual reality-like immersion.

Smooth Imaging through Free-Form Prisms and Positioning Technologies

Canon's MR technology was created through years of research and development and launched in 2012 as "MREAL."

MREAL's strengths lie in two key areas. First is the HMD's compact size and light weight, which was achieved using Canon's proprietary compact free-form prism that creates a space within the HMD enabling the optimal placement of the video cameras. Second is its precise positioning technology, which seamlessly blends CG images and the real world.

Canon also developed proprietary markers that, when attached in advance to real-world objects, enable the MREAL System to perform three-dimensional positioning measurements. MREAL can accurately detect information about the viewer's position and orientation by reading these markers, making it possible to view anything from any point of view.

Development Story: MREAL

From Mixed Reality Technology to MREAL

MR Technology Began as a Collaboration between Industry and Academia

Sensing the potential of technology that combines the real world with virtual images, Canon began development of MR technology in January 1997 with the establishment of the Mixed Reality Systems Laboratory Inc. (MR Lab), working together with the former Japanese Ministry of International Trade and Industry and the Ministry of Posts and Telecommunications.

In 2002, Canon began working on a prototype system for industrial use. The company's development division further refined the system based on feedback from companies that borrowed the prototypes. Although the decision was made to commercialize this technology in 2007, which is when the overall product configuration took shape, Canon faced many hurdles that had to be overcome prior to the product's launch in 2012.

Breakthroughs Lead to the Commercialization of the MR System

One challenge Canon faced was making the system's head-mounted display (HMD) compact and lightweight. Aiming to reduce the number of optical components from the usual array of complex lenses, the company developed a free-form prism which greatly contributed to the HMD's optimal weight distribution enabling viewers to wear it for 30 minutes without tiring. Although producing a free-form surface with the optimal shape was a challenge, the engineering team in charge of optics painstakingly made repeated designs, until they were able to achieve accuracy while maintaining balance.

That was not the only major obstacle the engineers faced in developing the HMD. Because this was Canon's first head-mounted product, the company lacked all manner of vital data.

Engineers involved in MREAL development

The product development team visited a helmet manufacturer to gather such information as positive and negative comfort factors, and gravitational center positioning. As no two people have heads that are the same shape and size, the development team continued searching for the ideal HMD form that would offer a comfortable fit for all users.

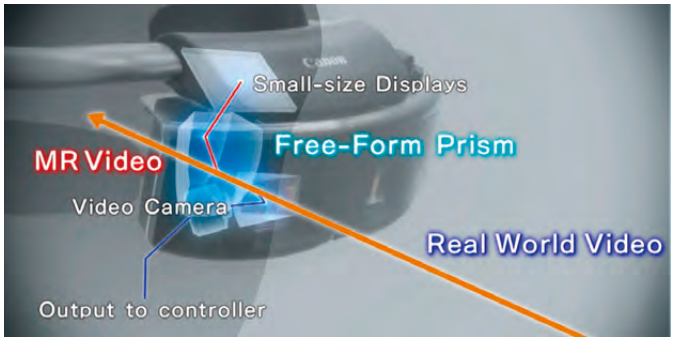
Achieving Natural Imaging in 3-D

Technologies for highly accurate positioning are imperative for blending CG imaging and the real world. Canon made easy positioning possible by having cameras detect markers placed to identify real-world locations.

To do this, the company developed markers that, when affixed to the floor or walls, enable the MREAL System to detect and accurately determine positions and camera angles. The HMD is also equipped with gyro sensors and other technologies that, along with the markers, ensure highly accurate positioning performance.

MREAL HM-A1

MREAL HH-A1



A simplified diagram of the portion of the MREAL HM-A1 HMD positioned in front of a user's eye. In contrast to conventional head-mounted display systems, which tend to be bulky in front of the user's eyes, the MREAL's HMD employs a free-form prism to achieve a compact, lightweight body design, enabling a natural-feeling video experience

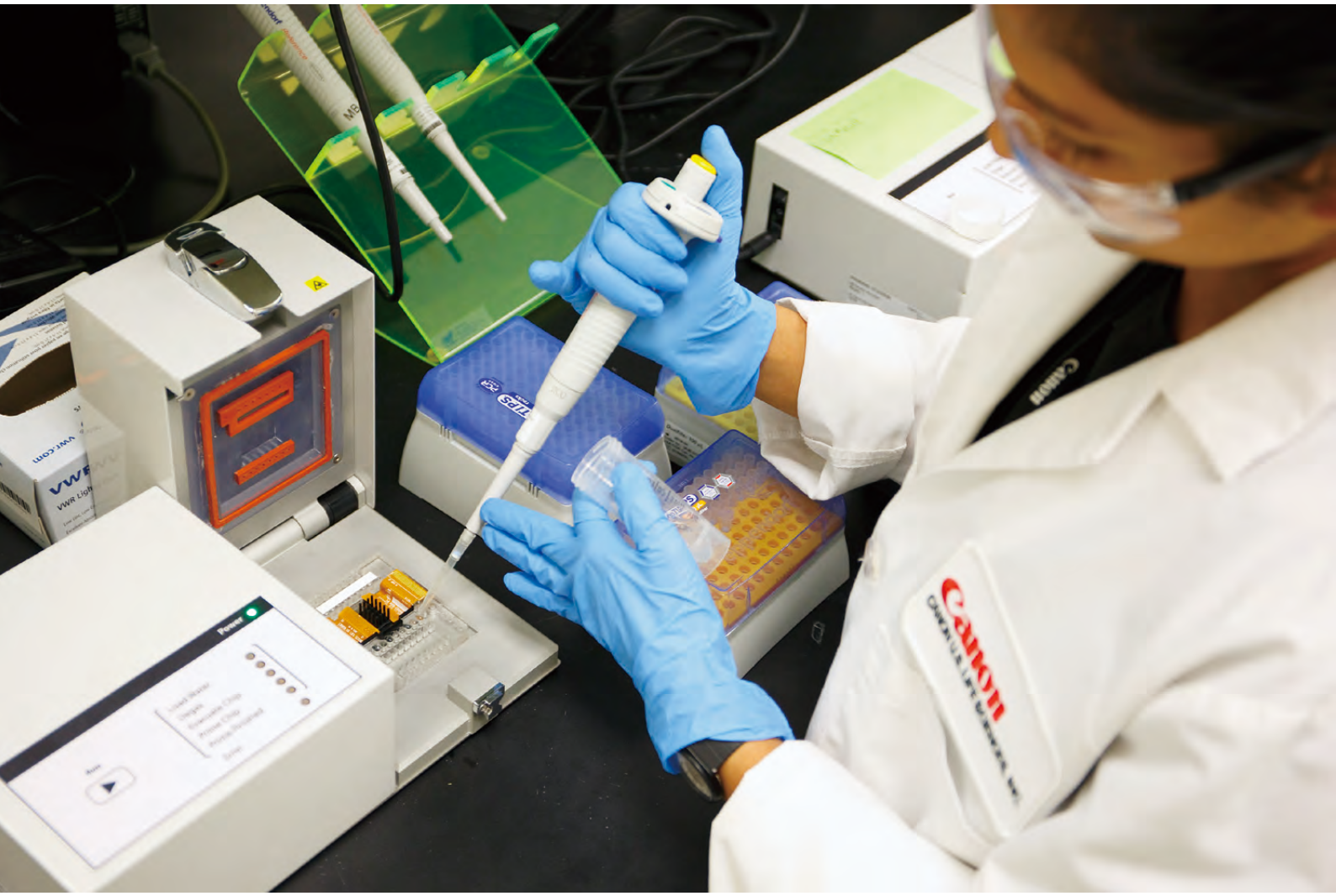
A Powerful Envoy for Canon's Solutions Business

MREAL has begun revolutionizing operations in various industries and manufacturing processes.

At automobile companies, for example, MREAL is being used to confirm exterior designs at full scale even before trial vehicles have been completed; to help with the design of such parts as steering wheels, gauges, gearshifts and accelerators; and also to make it possible to visualize the results of air-resistance simulations and other tests. Additionally MREAL contributes to lowering costs by reducing rework during the design process and the number of man-hours required for manufacturing preparation.

Furthermore, in the field of architectural design, users can employ realistic simulations to create the feeling of actually being inside a building. This enables the confirmation of such aspects as ceiling height and the amount of light a room receives. In this way, concepts at the design stage can be shared between the architect (builder) and the client in a way that ensures their mutual understanding. In the future, Canon's MREAL will also provide content and applications based on individual user needs.

Supporting the U.S.-Based Development of Biomedical Technology



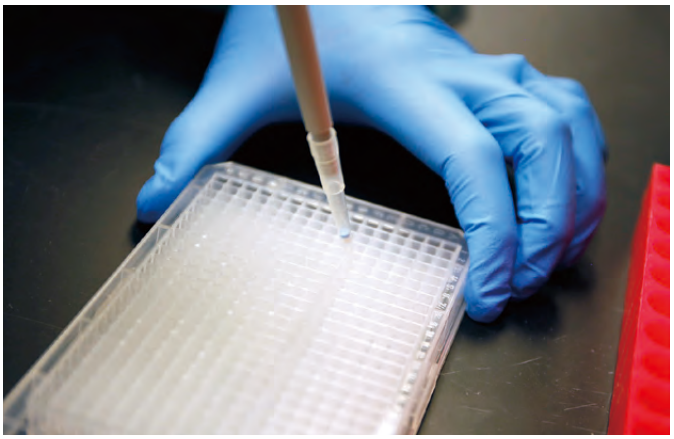
Canon is applying its technological strengths to realize future business growth in the biomedical field. Through cooperation with research institutes in the U.S., a country at the forefront of medicine today, the company aims to expand from research and development to the manufacture and marketing of cutting-edge medical devices and services.

Toward the Commercialization of Genetic Testing Systems that Reduce Hands-on Time

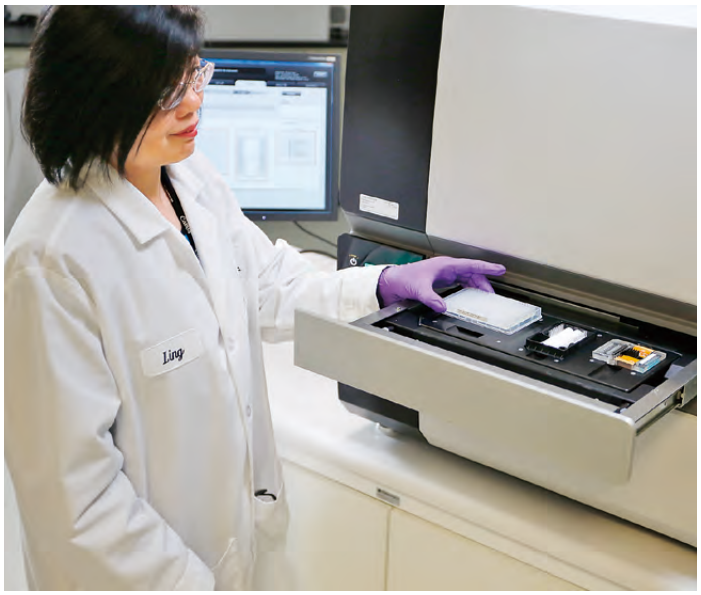
Through genetic testing it is possible to identify susceptibilities to congenital disorders, the likelihood of contracting a disease, and the side effects of medications. But even with the latest devices, simple tests can take 20 to 30 minutes. Moreover, complex tests may take up to a day or longer. In the U.S., Canon is working on developing a prototype genotyping platform that can perform complex tests in a matter of hours.

The prototype genotyping platform* consists of a reagent cartridge and an instrument (see glossary at bottom of opposing page for additional information) that use CMOS sensors and inkjet printing technologies. Canon U.S.A. established Canon BioMedical in March 2015, aiming to commercialize genetic testing systems. In September 2015, Canon BioMedical launched the Novallele genotyping assays* used in research for cancer and hereditary diseases. Development efforts are now underway to make gene variations easier to find by expanding the number of targets from the current 281 to 500.

At the Healthcare Optics Research Laboratory in Boston, Massachusetts, Canon is collaborating with Massachusetts General Hospital and Brigham and Women's Hospital, both teaching affiliates of Harvard Medical School, to develop and commercialize such products as cutting-edge endoscopes and robotics-assisted medical devices that enable greater efficiency compared with manual devices.



Development of reagents by Canon BioMedical



Prototype genotyping platform currently under development at Canon BioMedical

Development of a prototype system comprising image guided navigation software and an insertion robot

An Ultra-Miniature Endoscope Offering New Diagnoses

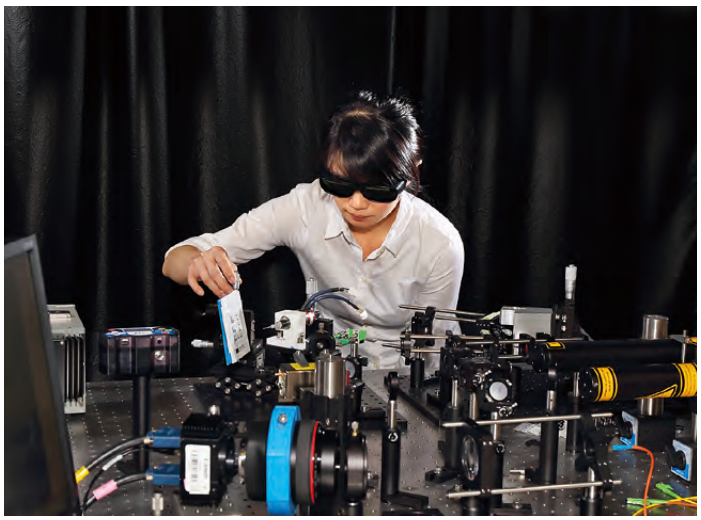
The ultra-miniature endoscope is equipped with an optical system on the tip of the optical fiber that enables the high-resolution real-time observation of blood vessels and intra-articular regions. To ensure that the endoscope does not break while inside the examinee's body, probes must be extremely thin yet sufficiently robust.

Leveraging its technological strengths in such areas as micro-optics fabrication technology, diffraction optics simulation and optical design technology, Canon developed a 0.6-mm diameter ultra-miniature endoscope with a micro-lens and a diffraction grating attached to the end of the optical fiber. Through the commercialization of an ultra-miniature endoscope that is significantly thinner than conventional devices, Canon aims to facilitate early treatment and new diagnostic applications by enabling physicians to observe regions of the body that were previously inaccessible.

Development of a Guiding System for Inserting Needles into Organs

Canon is also developing a system to ensure the precise insertion of needles into organs. Normally, a doctor viewing CT or MRI images outside of the operating room will confirm the location of a cancer site or the target position for a needle.

With this system, however, the physician specifies the target position for the needle to be inserted into the abdominal or chest cavity using image-guided navigation software, upon which the device will set the angle of insertion accordingly and guide the needle insertion to ensure it enters the targeted location of the organ. With this proof of concept system, Canon is also working on the development of motors and sensors that operate in an MRI environment. It is believed that this system will allow doctors to perform such procedures as biopsies or ablation (treatments using either high or low temperature to destroy cancer cells) that rely on the physician's memory with less time and greater accuracy.



Development of an ultra-miniature endoscope for commercialization

Glossary

Prototype genotyping platform
Testing equipment employing microchannel chips and optical technology that detects gene sequence variations of test specimens at high-speeds.
Note: Because this equipment has not been cleared/approved, it cannot be sold, given, or used for clinical purposes.

Novallele genotyping assays
Novallele genotyping assays detect specific base sequences in DNA and amplify the DNA for analysis. The assays differentiate genetic variations as small as a single base sequence known as a single nucleotide polymorphism.
Note: Sold in the U.S. for research use only. Not for use in diagnostic procedures.

Special Report 2

Canon EXPO 2015 New York/Paris

At Canon EXPO 2015 New York, held in September 2015 under the theme "Canon See Impossible," visitors were captivated by the company's genetic testing systems and network cameras, in addition to the cutting-edge technologies of Canon's existing camera and printer business segments.

The following month, Canon EXPO 2015 Paris, under the tagline "Come and See," showcased state-of-the-art products and technologies with a view to future business development in Europe, home to the headquarters of such new additions to the Canon Group as Océ, Axis Communications and Milestone Systems.

■ Canon EXPO 2015 New York

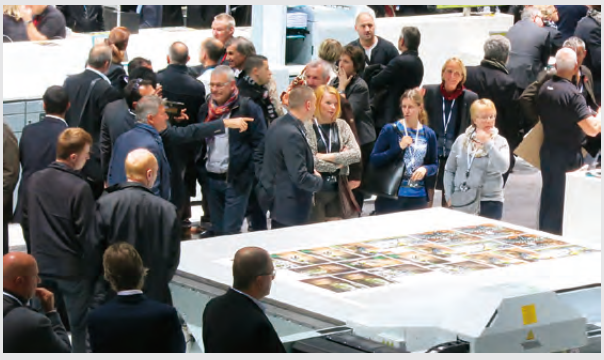
The New York EXPO comprised ten zones, each with a New York City-themed motif, featuring a range of user scenes in which Canon products played a starring role

A colossal printed reproduction of New York's famed Yankee Stadium

The latest healthcare technologies garnered considerable interest among visitors

■ Canon EXPO 2015 Paris

Realized through the merging of Canon and Océ technologies, "Canon Super Creative Printing" even makes possible the reproduction of textural qualities



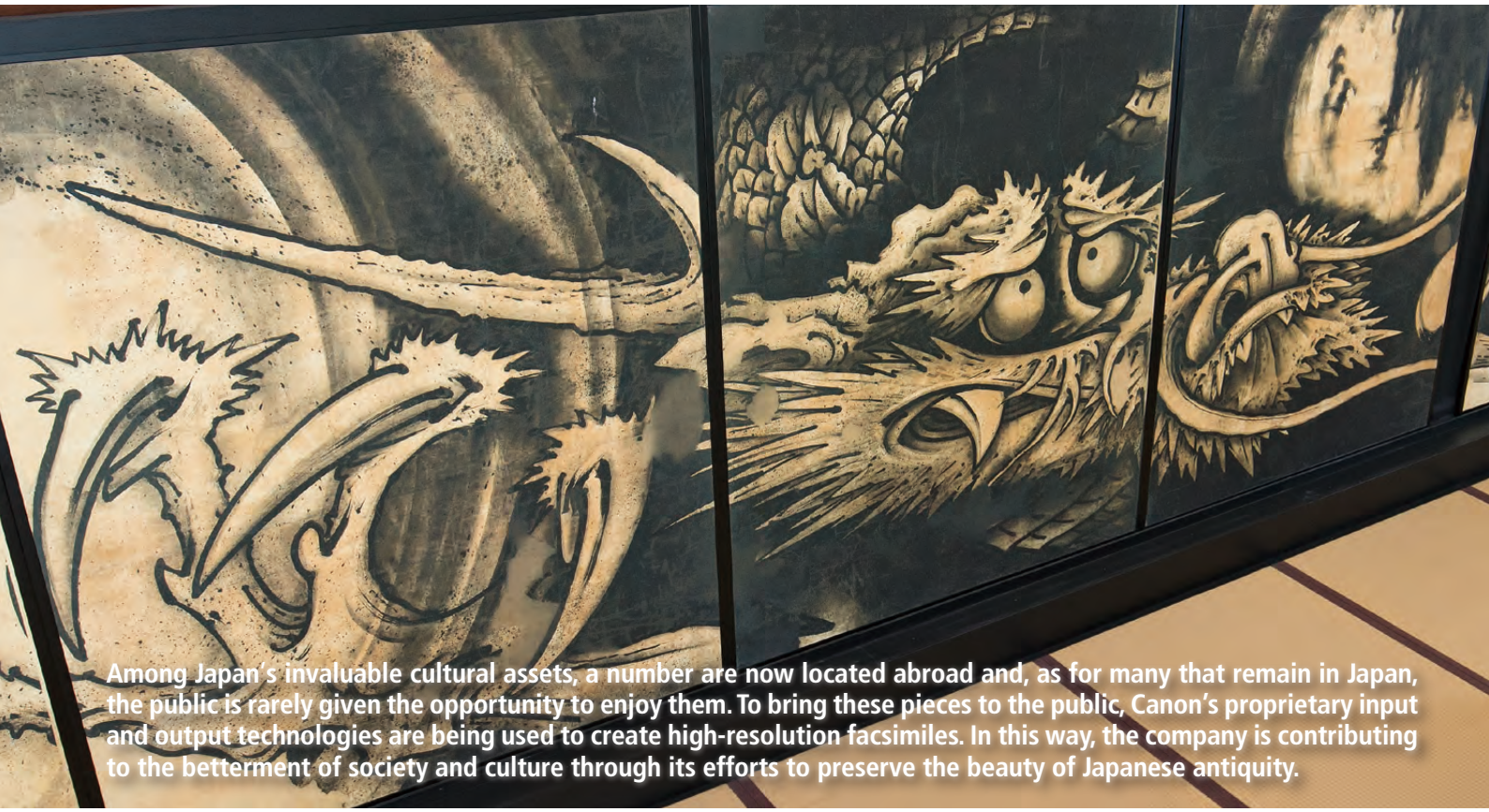
Demonstrations of Océ's Arizona flatbed printer attracted large crowds during the event

Visitors were introduced to the synergies made possible by the combination of Canon, Axis and Milestone in the network camera segment

Skillfully Innovating for the Future

As technology constantly evolves and people's values grow increasingly diverse, Canon endeavors to create products that inspire people worldwide. While expanding business globally, the company is paving the way for social progress and a bright new future by creating environments in which innovation continually thrives.

Using Modern Technology to Pass on the Beauty of Antiquity



Among Japan's invaluable cultural assets, a number are now located abroad and, as for many that remain in Japan, the public is rarely given the opportunity to enjoy them. To bring these pieces to the public, Canon's proprietary input and output technologies are being used to create high-resolution facsimiles. In this way, the company is contributing to the betterment of society and culture through its efforts to preserve the beauty of Japanese antiquity.

Preserving Original Cultural Assets While Making Facsimiles Available to the Public

The Tsuzuri Project is a social-contribution initiative launched by Canon and the Kyoto Culture Association (NPO) in 2007. Temples throughout Japan are struggling to preserve their aged and fragile relics and the Tsuzuri Project enables them to create high-resolution facsimiles of these cultural assets. The facsimiles are created through a combination of Canon's cutting edge digital technologies–from input (image capture) to output (printing)–and traditional crafting techniques found in Kyoto. This allows the original cultural assets to be preserved in a controlled environment while the near-perfect facsimiles can be widely exhibited to the public.

Activities Supported by High-Resolution Facsimile Technologies

A Canon EOS 5D Mark III digital SLR camera is used to capture image data that then undergoes Canon's proprietary color matching. The processed image is then printed in full-scale using a Canon imagePROGRAF large-format inkjet printer. By adding various finishing touches, such as applying gold leaf and mounting the replicas, these high-resolution facsimiles take on an appearance that is almost indistinguishable from the original cultural assets. This state-of-the-art technology allows cultural assets to be preserved and passed down to future generations.

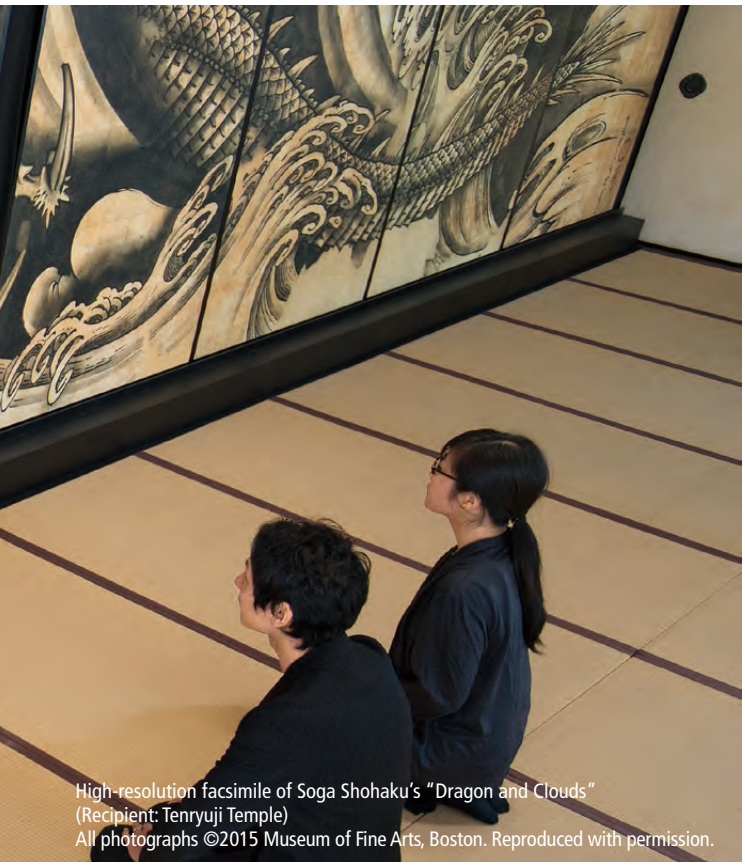
● **Examples of High-Resolution Facsimiles**

National Treasure: "The Wind and Thunder Gods"
by Tawaraya Sotatsu

Edo, 17th century, pair of two-fold screens, both 176.0 x 194.0 cm (L x W)
Printed on washi with gold leaf applied. Owner/Recipient: Kenninji Temple

National Treasure: "Pine Trees"
by Hasegawa Tohaku

Azuchi-Momoyama, 16th century, pair of six-fold screens, both 156.8 x 356.0 cm (L x W)
Printed on washi. Owner/Recipient: Tokyo National Museum



High-resolution facsimile of Soga Shohaku's "Dragon and Clouds"
(Recipient: Tenryuji Temple)

Facsimiles Lead to a Rediscovery of Japanese Culture

To date, high-resolution facsimiles of some 32 works have been created (as of April 2015). Many of the Tsuzuri Project's facsimiles are donated to municipal organizations, museums, or the original cultural assets' past or present owners, and are widely exhibited to the general public. Some are also used in educational settings, such as classrooms and workshops involving Japanese history, culture or art. The project's use of cutting-edge technology has been praised for going above and beyond conventional digital archiving. Enabling more and more people to experience these precious cultural assets from ancient Japan, the Tsuzuri Project is proving instrumental in the creation of opportunities for the public to rediscover Japanese culture.

National Treasure: "The Three Portraits of the Jingoji Temple"
attributed to Fujiwara no Takanobu

Kamakura, 13th century, Three hanging scrolls, image of Minamoto no Yoritomo 143.0 x 112.8 cm (L x W) Printed on silk. Owner/Recipient: Jingoji Temple, Mount Takao

[Production Process]

A Marriage of the Latest Digital Technologies and Traditional Craftsmanship

● Input

Capturing High-Resolution Digital Data

High-resolution digital data captured with a Canon EOS 5D Mark III digital SLR camera is used to print the full-scale reproductions of the cultural assets. The camera is mounted on a specially designed pan-tilt head to capture the original work in segments. The image data is then stitched together on a computer to create a single high-resolution digital image file.

● Color Matching

Highly Accurate Color Matching System

Image processing is applied to the high-resolution digital data using Canon's proprietary color matching system, which accounts for the lighting of the shooting environment to ensure colors are faithfully reproduced from the start, thus eliminating the need for multiple prints. This dramatically reduces the amount of time required for color matching, thereby minimizing the burden on the cultural asset.

● Output

World-Class Printing Technology

Reproducing the three-dimensional feel created by the tonal subtleties and shading of Japanese-style painting is made possible through the use of Canon's imagePROGRAF large-format inkjet printer. The Japanese "washi" paper and silk paper on which the facsimiles are printed were specially developed for the Tsuzuri Project, through the company's research and development, to ensure suitability for printing and the applying of gold leaf and other finishing touches.

● Gold Leaf, Gold Paint and Mica

Reproduced through Time-Honored Traditional Craft Techniques

Reproducing the most significant features used in Japanese cultural assets–gold leaf, gold paint and mica–poses a major challenge for current printing technologies. Traditional craftsmen from Kyoto answered the call with their masterful techniques to help reproduce these features. The unique "antiquing" techniques of this project help reproduce the effects of aging on the gold leaf.

● Mounting

A Discipline Developed in Kyoto

Finally, the pieces are mounted by a Kyoto master craftsman, using mounts unique to Japan. Subtle details are faithfully reproduced to create finished works that appear almost identical to the original assets. If the work is a folding screen, the craftsman will even replicate the timeworn metal parts and the fabric backing; for sliding doors, he will fit them to perfectly match the building to which the work belongs; and for ancient picture scrolls, even replicate the cover materials.

Exploring the Origins of the Universe

Canon, always aiming for the stars, also contributes to developments in the field of astronomy. In recent years, in addition to its joint participation in the Thirty Meter Telescope (TMT) project to build an extremely large 30-meter-diameter telescope in Hawaii, the company has been is in a technological partnership with the University of Tokyo's Tomo-e Gozen project at the Kiso Observatory, and has developed a germanium immersion grating that makes possible a significant reduction in the size of infrared spectrometers.

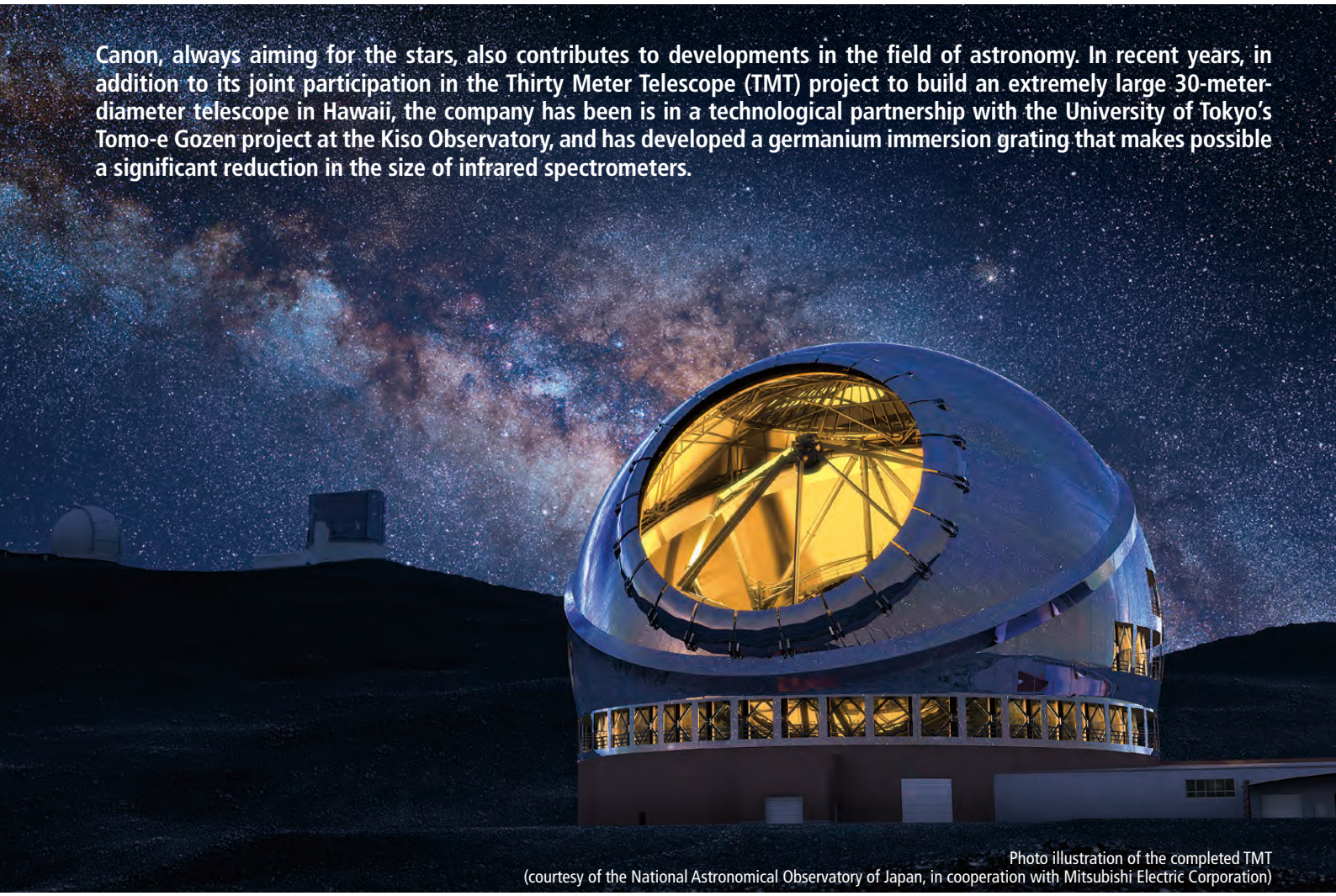


Photo illustration of the completed TMT
(courtesy of the National Astronomical Observatory of Japan, in cooperation with Mitsubishi Electric Corporation)

TMT

Representing Japan in a Major International Collaborative Project

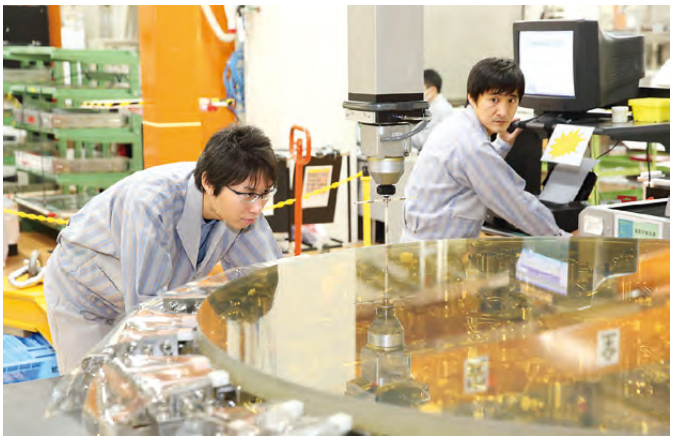
The TMT is a five-nation international collaborative project supported by Japan, the United States, Canada, China and India aimed at promoting the forefront of astronomy. Canon's proven track record in the development and manufacture of optics for the Subaru Telescope earned the company a role in manufacturing the mirror segments for the TMT.

The TMT's 30-meter-diameter primary mirror will comprise an array of 492 segments (574 when including replacement segments), the fabrication of which is being carried out in Japan, the United States, China and India. Japan is responsible for the production of approximately 30% of the mirror segments. Plans call for Canon to handle such work as grinding and polishing the mirror surfaces, outer-shape cutting, and support-assembly mounting. In 2014, the company commenced mass production aspherical grinding processes.

Supporting Future Astronomers through Technology

The hexagonal segments, made of ultra-low-expansion glass, each measure 1.44 meters diagonally with a thickness of 45 millimeters. The maximum asphericity is 0.2 millimeters, requiring a level of precision of less than 2 microns peak-to-valley. Extremely precise measurement of the aspherical surface of the segments is critical to achieve the required degree of precision. Precision polishing is made possible through the company's proprietary contact-type free-form measurement machine (A-Ruler), which enables the confirmation of polishing accuracy during the polishing process.

The TMT is scheduled to be completed in 2024. By that time, project members now in their 20s will be playing a large role as engineers. In this way, Canon engineers continue embracing the many challenges that lie along the way to realizing an extremely large telescope that will serve future generations.



Mass-production aspherical grinding proceeds apace

The Tomo-e Gozen Project

Leading the World in the Exploration of the Dynamic Universe with Extremely Wide-Field High-Speed CMOS Camera

Shigeyuki Sako, Assistant Professor
Institute of Astronomy, School of Science
The University of Tokyo

Exploring the Origins of Life by Movie Observations of Celestial Phenomena

The Tomo-e Gozen is an extremely wide-field high-speed camera for the Kiso Observatory 105-centimeter Schmidt telescope of the University of Tokyo, and is scheduled to see the first light in 2017.

The most impressive features of the camera are its wide field-of-view and movie observation capability. The Tomo-e Gozen will lead us to a new frontier of astronomy, the exploration of the dynamic universe. Its wide-field movie observations will enable us to quickly find transient events of celestial objects, such as supernova explosions marking the end of a star's life and coalescences of neutron-stars accompanied by gravitational waves, and record them with fine-time resolution, regardless of where or when they may occur on the sky. It is also expected to detect more than 10,000 faint meteors invisible to the naked eye every night. Such observation of meteors will provide us with information on interplanetary dust falling on Earth and may shed light on the origins of life.

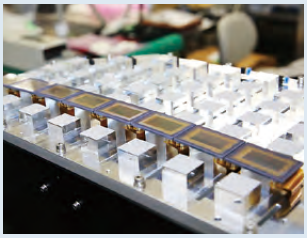
CMOS Sensors:Indispensable for the Exploration of the Dynamic Universe

CCD sensors, which offer high optical sensitivity, have been used as standard imaging devices in astronomy. However, I have employed Canon 35 mm Full HD CMOS sensors for the Tomo-e Gozen, as they have lower noise and exceptionally high-speed readout as well as high sensitivity equivalent to CCDs. Without their low-noise and high–speed capabilities, the movie observations of faint signals would have been virtually impossible. While trends among image sensors have been moving toward large format and small pixel sizes, the Full HD CMOS sensors have large photo-sensitive areas and large pixels necessary for astronomical observations. I am impressed by the depth and breadth of Canon's development efforts. Through the development of the Tomo-e Gozen, we have built a solid relationship based on a mutual exchange of information with Canon providing us technical information on the CMOS sensors, while we offer Canon feedback with evaluations on responses to faint light under dark conditions. I look forward to Canon continuing product development such as the Full HD CMOS sensors in the future.

● **The Tomo-e Gozen:producing wide-field movie data of the universe**

The 84 mosaicked CMOS sensors achieve a wide field-of-view that far exceeds that of other astronomical cameras while maintaining an equivalent level of image resolution. These capabilities allow us to carry out high-sensitivity and high-definition observations in the entire constellation of Orion.

● **Sensor unit of the Tomo-e Gozen (prototype)**



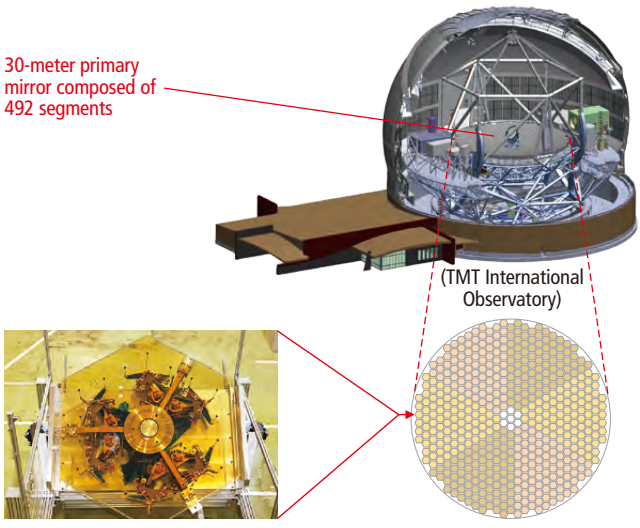
CMOS sensors undergoing laboratory tests in the prototype model. Currently, drive conditions and installation methods are being evaluated with 8 Full HD CMOS sensor chips aligned horizontally. In the final model, a total of 84 CMOS sensors will be installed on the focal plane.

Germanium Immersion Grating

Facilitating Higher-Performance Infrared Spectrometers Could Shed Light on History of the Universe

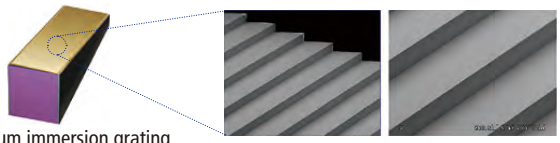
Through the application of proprietary ultra-precision processing technology, Canon succeeded in the processing of single-crystal germanium with nanometer-level precision, an achievement that had proven difficult until now. As a result, the company has developed a germanium immersion grating that enables a drastic reduction in the size of spectrometers for intermediate-infrared radiation telescopes to approximately 1/64th their current volume. The realization of a practical germanium immersion grating has led to a dramatic improvement in the operability of high-performance spectrometers, an achievement that has fueled expectations of higher levels of performance for existing telescopes, space telescopes and next-generation large astronomical telescopes.

● **The segmented-mirror method employed in the primary mirror**



Prototype fabricated by Canon of a segment from the primary mirror

Configuration of the 492-segment primary mirror



Germanium immersion grating (approx. 75 mm (l) × 22 mm (w) × 26 mm (h))

View of grating surface through an electron microscope
Left: 150x magnification / Right: 400x magnification

Supporting Product Originality

Foundational material technologies, such as those for colorants, toners and optical glass, are essential for boosting product competitiveness. Capitalizing on the many decades Canon has invested in researching such materials, the company has compiled its expertise and know-how to establish the Canon Material Bank, a valuable resource for use throughout the company. Canon continues to carry out efficient material research through molecular design technologies and synthesizing technologies in tandem with electron microscope and other high-precision analysis, measuring and parsing technologies.

High-Color-Performance Xanthene-Based Dyes

A Vivid Red that Never Fades

In the past, printer manufacturers did not develop their own colorants in-house, but rather would procure common dyes from other companies, which made it difficult for them to differentiate their colors from those of competing manufacturers. Canon, however, focused its development efforts on xanthenes-based dyes, which boast superior coloration properties, to create a dye capable of producing high-visibility reds. Although finding a practical application for xanthene dyes was considered difficult due to challenges regarding robustness (light colorfastness), the company's research efforts paid off with the successful development of a new magenta dye that enables the printing of reds that are both robust and vivid.

Employing Proprietary Molecular Design in Search of Improved Robustness

Canon began developing new dyes in the 1980s and has now amassed more than 10,000 types of dyes in its Canon Material Bank. The bank represents a database of a diverse variety of technological know-how that, in addition to information on synthetic and physical properties, includes data on the mechanisms behind the breakdown of dyes when exposed to such stimuli as external light and ozone gas.

During the development of the dyes, Canon conducted repeated simulations, molecular designs, synthesis, evaluations and analyses, arranging specific substituents in optimal locations to achieve both desired coloration performance and robustness. The result was the birth of new dyes.

From the Lab to Mass Production

The next challenge that needed to be addressed following the creation of the xanthenes-based dyes in the lab was mass production. Unlike the compact 300 milliliter reaction vessels used in laboratories, those used in mass production, with capacities exceeding 1 ton, are of an altogether different scale. With inkjet printers in particular, because ink ejection must be controlled at the picoliter level, even the slightest amount of impurities during synthesis could cause the ink nozzles in the printhead to clog. Accordingly, the company's element development division and business group conducted joint research aimed at reducing impurities to less than one part per million. The collaborative effort paved the way for commercialization by ensuring consistent ink quality, even during mass production.

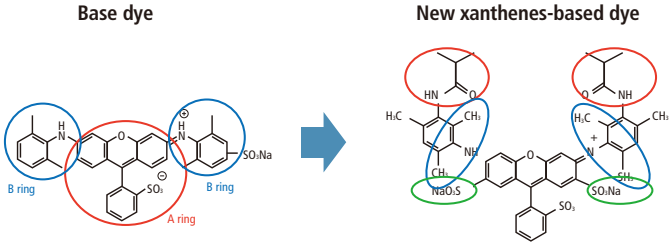
● **Making vivid printing possible through improved color performance**

Earlier product

Printed using new BCI-351 xanthenes-based dyes

Compared with earlier Canon products, CBCI-351 inkjet printer inks realize improved magenta color performance

● **Molecular structure of newly synthesized new xanthenes-based dyes**



Both high robustness and color performance are achieved through the arrangement of substituents in optimal locations

Photo printed with ink using new xanthenes-based dyes

Lead-Free Piezoelectrics

Piezoelectrics: A Valuable Material with Significant Environmental Impact

Piezoelectric materials, which are essential for motors and sensors, have an ability to transform electrical energy into mechanical energy. Most piezoelectric materials, however, contain lead as a principal component. Lead has a negative impact on the environment, which has led to the call for lead-free piezoelectric materials within the industry. In addition to lenses and solder, Canon is trying to eliminate lead from piezoelectric materials, developing new lead-free materials toward the goal to launch new products which include these materials.

Participation in a National Project in Japan

From 2007 to 2012, Canon participated in a national project called the Element Strategy Initiative, launched by Japan's Ministry of Education, Culture, Sports, Science and Technology. The goal of this project was to create new high-functional materials by shedding light on the manifestation mechanisms of functions through research into the roles and properties of elements that make up a substance. Through this project, Canon aimed to propose new lead-free piezoelectric materials that possess piezoelectric properties exceeding those of widely used lead-based piezoelectric materials. These efforts became the basis for research and development being carried out today.

Preparing samples of lead-free piezoelectrics for analysis by sintering combined raw particles

Analyzing and evaluating a synthesized sample to determine its suitability as a material

Designing Brand Value

Corporate image is not limited to products and services; the impressions made by advertising and publicity also play a role in its formation. Through the proposal of new value and the creation of high-quality designs in harmony with all corporate initiatives through which Canon engages with its customers, Canon Design contributes to boosting the company's brand value.

For the Sake of Product Quality

Canon offers a diverse product portfolio that includes not only a broad lineup of cameras, video camcorders and inkjet printers for both professional and general users, but also a wide range of office-use products, such as copying machines and projectors, as well as industrial products like medical equipment and semiconductor lithography systems. What is more, the company also offers web services that provide users with additional ways to enjoy photography.

Aiming to deliver optimal ease of use across a range of usage scenarios, Canon surveys and analyzes customer usage environments, needs and preferences while focusing on appealing designs that enhance user convenience.

Through a coordinated effort among the divisions responsible for product design, user interface design, usability design and visual design, Canon meticulously refines each and every one of its products.

For the Sake of Various Corporate Activities

Aside from products, design also plays an essential role in such areas as Canon's environmental initiatives, CSR activities and recruiting efforts. The messages that the company sends to its customers, as well as employees, must be informative and easy to understand—yet another indispensable role of design.

For the Sake of Tomorrow

What will our world look like five or ten years from now? What changes can we expect to see in the workplace and in our lifestyles? And how will design influence these developments? With an eye to the future, Canon Design attempts to visualize what lies ahead and create new proposals, another important job that is essential for the Canon of tomorrow.

Study-Abroad System for Engineers

Canon, as part of the company's R&D globalization efforts, offers a study-abroad program for its engineers. The Design Center also sends company designers overseas on a similar program. As a result, overseas-study experiences are being put to substantial use in the design development process.

Design Awards

The Canon Design Center proactively participates in design competitions both in Japan and overseas and has been recognized with numerous awards. The opportunity to have designs evaluated by knowledgeable outside authorities not only enhances the quality of Canon designs, but also leads to the growth of the company's designers.

The Frontline of Design

The Story of the Development of the EOS M10

Making Interchangeable Lens Cameras Appealing to Women and Young People!

The EOS M10 was developed as a camera that could be enjoyed by users who had given up on interchangeable-lens cameras, believing they were too hard to use. The first step was user analysis to determine why some users felt interchangeable-lens cameras posed such a high hurdle. Some of the keywords that resulted from the survey included "heavy" and "difficult." One respondent even went so far as to describe such cameras as "scary." As a result, Canon resolved to eliminate such negative images to create a camera that makes photography fun for all users.

To evaluate the shape of the camera, prototypes were created with a 3D printer

Color chips used during the consideration of color variations for covers

Design Focusing on Simple Shapes and Colors

Canon decided to go with a design that was neutral and friendly. With no grip, few dials and buttons and a rounded body form, the camera is simple in style. Additionally, a gray body color was added to the lineup for the first time ever. Inspired by Scandinavian sensibilities, gray was selected for to its excellent compatibility with fashion and interior designs. Close attention was also paid to the use of color in the details, with each color variation employing the same color behind the LCD monitor and even for the screws.

Wide Selection of Options Add to Enjoyment

With a wide range of stylish accessories available for the camera, the EOS M10 was designed to allow mixing and matching, creating a look to coordinate with users' fashion preferences and sensibilities. The face jackets, which cover the body and make the camera easier to hold, are made from a leather-like material that conveys the level of attention that was dedicated to texture. More than 100 face jacket designs were proposed with the final lineup decided through a user preference survey. In this way, various design aspects were not determined simply based on intuition, but are backed up by supporting data.

The camera is available in three body colors. Users can select covers to match their preferences

Strengthening Competitiveness by Patenting Proprietary Technology

Common refrains heard within Canon's research and development division include, "Read patent bulletins rather than research literature," and "Create draft patents rather than reports." Since its founding, Canon has acquired the patent rights to inventions that have laid the foundation for the company's growth. It is in Canon's DNA to avoid patents held by other companies, instead developing original technology and protecting it through patents.

Canon the Top Japanese Company Among U.S. Patent Recipients for 11 Consecutive Years Through Proactive IP Activities

Canon believes that acquiring the patent rights to its proprietary technologies is an essential and important aspect of expanding operations globally.

Every year, Canon engineers submit more than 10,000 ideas with patent applications filed by country and region. In the United States, Canon has been the top-ranked patent recipient among Japanese companies for 11 straight years.

There are two aspects to Canon's intellectual property strategy. The first is defensive–to protect Canon's proprietary core technologies from being infringed upon by others. The second is offensive–to create advantages for Canon's operations by acquiring multiple patents that other companies, not just Canon, need to use, and then negotiating licenses for their use. Through both defensive and offensive intellectual property management, Canon strengthens its product development capabilities.

● **Number of U.S. Registered Patents**

Year	Rank overall (Rank among Japanese companies)	No. of patents
2015	3rd (1st)	4,127
2014	3rd (1st)	4,048
2013	3rd (1st)	3,820
2012	3rd (1st)	3,173
2011	3rd (1st)	2,818
2010	4th (1st)	2,551
2009	4th (1st)	2,200
2008	3rd (1st)	2,107
2007	3rd (1st)	1,983
2006	3rd (1st)	2,366

Figures tabulated by Canon based on annual information issued by the U.S. Department of Commerce

Patent Strategy to Tackle Xerox's Monopoly

Canon's emphasis on intellectual property rights dates back to the 1960s, when the company entered the copying machine market.

In order to break through the airtight patent wall that U.S.-based Xerox had erected for its copying machines, Canon invented the NP method, an all-new electrophotographic technology that did not infringe on Xerox's patents. By acquiring the patent rights to this technology, the company was able to protect the proprietary technology that made it different from other companies. Additionally, by acquiring peripheral technologies, Canon put itself in the position to negotiate license agreements for technologies needed by other companies. This experience created the foundation for Canon's intellectual property strategy and has been passed down through the generations as part of Canon's corporate DNA.

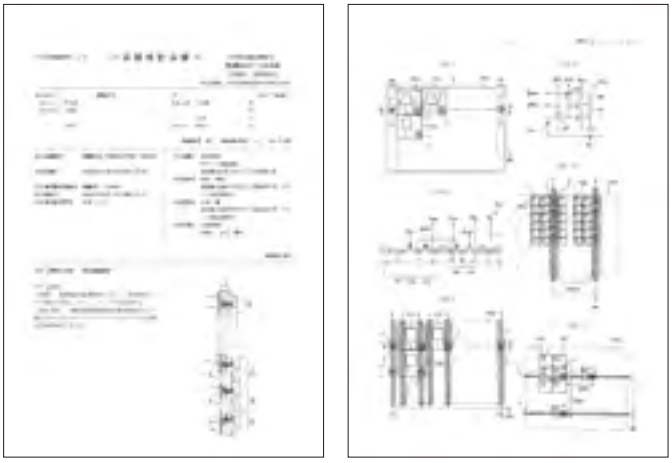
Engineers Work Closely with Patent Engineers to Cultivate Ideas

One major characteristic of Canon's intellectual property strategy is the active exchange of communication between engineers and patent engineers, who are in charge of intellectual property. Some 300 patent engineers at Canon operation sites throughout Japan examine new ideas and the research results of engineers from various angles, searching for ways to maximize the number of inventions that can be generated.

Basic Policy of Canon Intellectual Property Activities

- Intellectual property activities are vital to support business operations
- The fruits of R&D activities are products and intellectual property rights
- Other parties' intellectual property rights should be respected and attended properly

● **Published patent application (excerpt)**



Collaborations with Global Companies

In this day and age, where cars are equipped with multiple cameras and some 100,000 patents exist for smartphones, it has become increasingly difficult for Canon to protect its technologies on its own.

In a move to assert the company's legitimacy and circumvent international patent disputes, Canon signed a cross-licensing agreement* with Microsoft in July 2014. Furthermore, with the aim of reducing patent litigation risks involving Patent Assertion Entities (companies specializing in filing patent-related lawsuits aimed at collecting licensing fees), six companies, including Canon and Google, established the License on Transfer (LOT) Network. As of November 2015, 47 companies have entered joined as members. In this way, Canon is working to coordinate with other companies to strengthen its competitive edge internationally through intellectual property.

* In a cross-licensing agreement, patent-right holders (companies, etc.) grant a license to each other permitting the use of a patent or patents held by the other party.

History of Awards for Canon Inventions

Several Canon inventions have often been awarded Japan's National Commendation for Invention (sponsored by the Japan Institute of Invention and Innovation), presented in recognition of inventions of great merit in Japan. Through the establishment of an internal Commendation for Invention system, Canon gives special recognition to the efforts of engineers and other meritorious individuals for their outstanding inventions.

Canon's Recognition by Japan's National Commendation for Invention and Internal Invention Awards over the Past 20 Years

Name of invention	The Special Prize, National Commendation for Invention, Japan Institute of Invention and Innovation		Internal Invention Awards	
	Year	Name of Award/Prize	Year	Name of Award/Prize
Invention of shading-reduction technology for CMOS sensors	2015	The Prize of The Chairman of Japan Business Federation	2005	President's Incentive Award
Design of a compact, lightweight digital cinema camera with outstanding mobility	2014	The Prime Minister Prize	2013	President's Award for IP Achievement
Invention of a printer using intermediate transfer member, without a cleaning mechanism	2013	The Prize of The Minister of Education, Culture, Sports, Science and Technology	2004	President's Award for IP Achievement
Box-shaped inkjet printer	2006	The Asahi Shimbun Prize	2005	President's Award for Excellence
Large-area sensor for real-time digital radiography system	2005	The Imperial Invention Prize	2001	President's Award for Excellence
Invention for a small-size optical system capable of high-speed zoom	2003	The Asahi Shimbun Prize	2004	President's Award for Excellence
Slim flatbed scanner design	2002	The Prize of The Chairman of HATSUMEI KYOKAI (JIII)	2001	President's Award for IP Achievement
Ozone-less charging method	1999	The Prize of Commissioner of the Japan Patent Office	1991	President's Award for Excellence
Invention of active type distance measuring device	1997	The Asahi Shimbun Prize	1996	President's Award for IP Achievement

Global R&D

The Canon Group conducts business in more than 220 countries and regions around the world. Today, sales outside of Japan account for more than 80% of Canon's consolidated net sales. To ensure that the research from each of these locations flourishes as businesses, the Canon Group actively collaborates with and engages in exchanges with external research institutes.

Canon Research Centre France S.A.S.

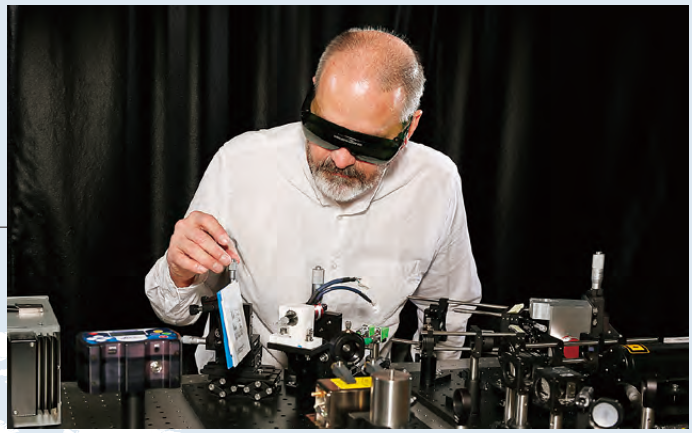
Rennes, France
Research themes: Wireless communications, video transmission

Canon Information Systems Research Australia Pty. Ltd.

Sydney, Australia
Research themes: Image information processing, graphics

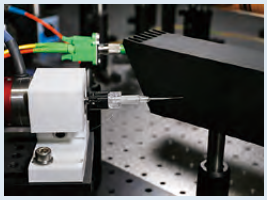
Imaging Systems Research Div. (Canon U.S.A.)

San Jose, California
Research theme: Computational imaging



Healthcare Optics Research Lab. (Canon U.S.A.)

Cambridge, Massachusetts
Research themes: Biomedical optical imaging, medical robotics



Prototype of an ultra-miniature endoscope

Canon U.S. Life Sciences, Inc.

Rockville, Maryland
Research theme: Genetic testing

A cartridge for genetic testing

Three Regional Headquarters Management System: Aiming to Create New Business Sectors

Aiming to expand the company's innovation centers, which are responsible for cultivating business domains, beyond just Japan to include Europe and the United States, Canon is working toward the establishment of a Three Regional Headquarters management system. By leveraging characteristics and capabilities unique to Japan, the U.S. and Europe, mobilizing the leading minds of each region and undertaking basic research, applied research and other R&D, Canon will be able to create new businesses in the future.

For example, in the United States, which stands at the vanguard of cutting-edge technologies in the medical field, Canon established the Healthcare Optics Research Lab (HORL) to carry out research and development in optical technologies. HORL began playing a central role in collaborative research with Harvard-affiliated medical institutions in the U.S., along with Canon's Japan-based research and development divisions.

Industry-Academia Alliances Pursue Cutting-Edge Optical Technology through Collaborative Research

To strengthen its research and development, Canon is bolstering ties with universities.

In 2007, the company jointly established the Center for Optical Research & Education (CORE) in Japan with Utsunomiya University and created an optics curriculum. The Center researches state-of-the-art optical technologies in addition to raising the overall standard of existing technologies. Furthermore, in 2012, clinical evaluations for medical imaging equipment were launched at Kyoto University's Clinical Research Center for Medical Equipment Development (CRCMeD). Canon supported the establishment of CRCMeD, and will continue to promote joint research with universities and research institutes in Japan and abroad with the aim of developing and commercializing science and technology.

Study-abroad Program at Overseas Universities Improves Language and Technical Abilities

Since 1984, Canon has offered its engineers a study-abroad program as one of the globalization initiatives of its research and development operations.

Engineers who participate in this program study cutting-edge or specialized technologies for two years at universities overseas. The objective of this program is to nurture international engineers, as well as acquire technologies that will play a central role in Canon's future. To date, more than 90 Canon engineers have studied abroad at more than 40 universities, including the Massachusetts Institute of Technology (U.S.A.), Carnegie Mellon University (U.S.A.) and the University of Cambridge (U.K.).