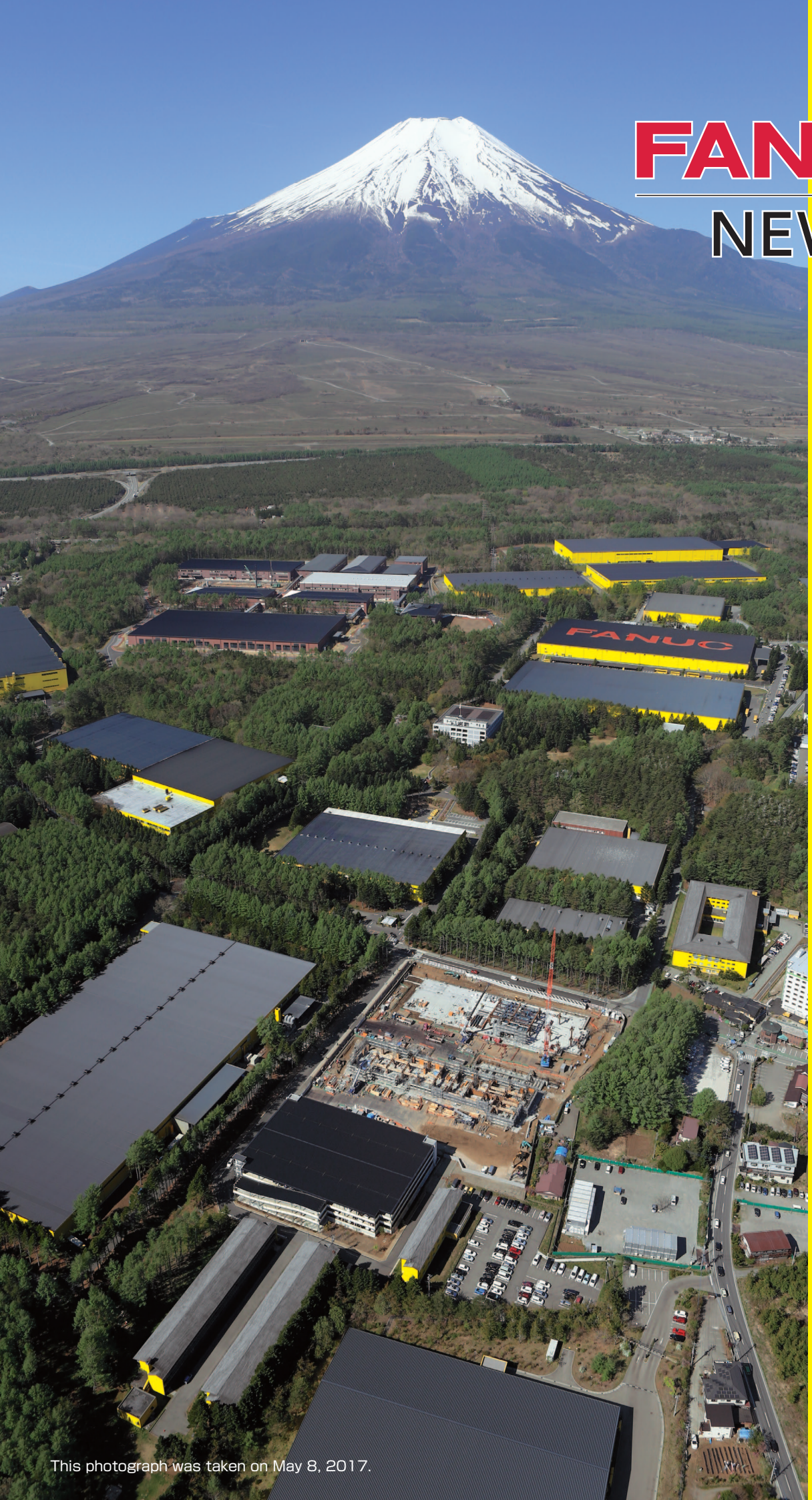
# FANUC NEWS




This photograph was taken on May 8, 2017.

2017-Ⅱ

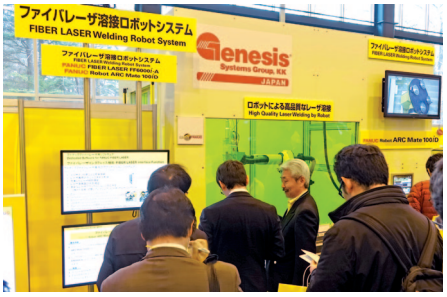
# Exhibition to Present New Products

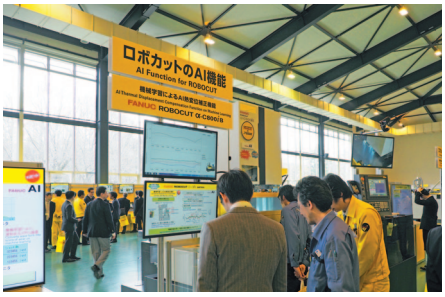
On April 11 and 12, FANUC hosted an exhibition to present new products at the Nature Hall located on the campus of our headquarters. On the first day, despite the bad weather with chilly rains, this year's exhibition also attracted over 7,000 customers, making for a lively and animated exhibition site. In addition to the display of FANUC's IoT, which was more advanced than last year, the exhibition featured offerings under the new theme "FANUC's AI."
The cutting-edge product lineups, which achieve three goals—"Connect," "Visualize," and "Think"—at customers' manufacturing sites and turn them into "Non-Stop Factories" attracted the attention of many visitors and were highly appreciated.

In the exhibition area for "FANUC's IoT," the FIELD system, was on display. This system makes it possible to connect not only old and new FANUC products but also various kinds of equipment, enabling the monitoring and analysis of their operation, preventive maintenance, and the like. Many visitors commented that they wanted to use FANUC's IoT-related offerings immediately.
In the "FANUC's AI" corner, engineers explained that FANUC's AI systems can be implemented in stand-alone machines installed at the edge, and can be used without network connection. They also explained that these systems offer high level AI functions, which enable extraction of characteristics using machine learning and deep learning. Visitors praised their convenience and level of advancement.








The FA area exhibited actual samples of machining using fine surface technology, which is the culmination of FANUC's technologies related to high-quality machining, and this attracted the attention of many visitors. The new flat indicator for the 0*i*-F Series with its sophisticated design was also highly rated. The ROBOT corner allowed many visitors to experience collaboration with a green robot, which does not require safety fences. In addition, a new controller with a higher processing speed that changes the screen more quickly was presented, and the demonstrations of a laser welding robot combined with a fiber laser were highly regarded. Meanwhile, demonstrations of scratch inspections for mobile phone cases using deep learning functions filled visitors with awe.
In the ROBOMACHINE corner, exhibits of thermal displacement compensation by ROBOCUT and ROBODRILL, which have both raised their accuracy levels using machine learning, constantly drew large crowds, and engineers received many inquiries. ROBOSHOT's lineup of Quick Simple Start-up Package, which realize robotization easily, and ROBONANO, which specializes in nano-tech machining that is most suitable for all types of optical molds from small to A4-size, were also well received.

The Service booth presented functions displaying alarm guidance and maintenance guidance at information sites, developed by using machine learning in reorganizing big data on maintenance, which has been accumulated over many years. Many favorable feedback were received.  Visitors commented that these functions could reduce the time needed for maintenance, and could easily be used at worksites too, because they support mobile terminals.



**【Key exhibits】**

| | |
|---|---|
| one FANUC　FANUC's initiatives in IoT and AI | FIELD system<br>FANUC AI |
| FA | |
| ・CNC and Servo technology for high quality machining | Fine surface technology |
| ・Moderniced Series 0*i*-F Design | 10.4" LCD/MDI Unit for Series 0*i*-F |
| ・Compact and lightweight unit for Manual handle feed in safety | Portable manual pulse generator |
| ・AI functions for FA | MT-LINK*i* and Trouble Diagnosis Function, automatic servo adjustment |
| ・Factory visualization | Machine status monitoring function + multi sensor I/O unit |
| ・Accurate simulation of machining of workpieces with complex shapes | *i*HMI new machining simulation |
| ・Total support for tasks in the workshop | Various *i*HMI applications |
| ・Optimized control according to machine status changes | Smart machine control |
| ・Ultra high speed/ultra high precision machining through Servo Learning Control | Linear motor L*i*S-B series |
| ・High speed/high output motor that realizes high efficiency machining | Built-in spindle motor B*i*-B series |
| ・Further size reduction and support for 200 V/400 V power supplies | Servo amplifier $\alpha i$-B/$\beta i$-B series |
| ・Easy selection of servos and provision of the latest model information | Servo sizer |
| ・Fast, highly responsive, and multi-axial synchronous control of industrial machines | Power Motion *i*-MODEL A |
| ・Fiber laser that supports various applications | High speed/high precision complex lasers<br>Fiber laser welding robot system |
| ROBOTs | |
| ・AI functions of robots | Flaw inspection and bin picking through deep learning<br>Zero Down Time function |
| ・Collaborative robots assembly demonstration and hands-on experience sessions | CR-4*i*A, CR-7*i*A, CR-7*i*A/L<br>CR-35*i*A, hand guides |
| ・Vehicle body welding systems using spot welding robots | R-2000*i*C/165F, R-1000*i*C/120F-7B |
| ・Intelligent arc welding system | ARC Mate 100*i*D |
| ・Parts feeder system, high speed aligning system | M-1*i*A/0.5A, M-2*i*A/3S |
| ・Bin picking by 3D matching | M-10*i*A/10M |
| ・Painting systems for vehicle panels | P-250*i*B |
| ・Finished vehicle body transportation systems with an ultra-large robot | M-2000*i*A/1700L |
| ・New controller and vision function | R-30*i*B Mate Plus, *i*RVision |
| ROBOMACHINEs | |
| ・Automation through fusion with ROBOTs | Easy startup packages QSSP (Quick & Simple Startup Package) |
| ・AI functions of ROBOMACHINEs | AI thermal displacement compensation for ROBODRILL and ROBOCUT |
| AI backflow monitor for ROBOSHOT | |
| ・Applications of IoT to ROBOMACHINEs | LINK*i* function of ROBOMACHINEs |
| ・High-efficiency/high-quality machining with ROBODRILL | ROBODRILL $\alpha$-D*i*B series |
| ・Composite molding and precision molding with ROBOSHOT | ROBOSHOT $\alpha$-S*i*A series |
| ・Fast and precise machining with the new functions of ROBOCUT | ROBOCUT $\alpha$-C*i*B series |
| ・New ROBONANO machining models with sub-nano-level precision | ROBONANO $\alpha$-NM*i*A |

# 2017 Round-Table Talk

On April 14, we invited professors and researchers who provide us with continued support to look at new products at the exhibition and later hosted a round-table talk.

## Attendees

| | |
|---|---|
| Toshiro Higuchi | Professor Emeritus of the University of Tokyo |
| Hidenori Shinno | Professor of the Tokyo Institute of Technology |
| Hideki Aoyama | Professor of Keio University |
| Shigetaka Takagi | Professor of the Tokyo Institute of Technology |
| Keiichi Shirase | Professor of Kobe University |
| Atsushi Matsubara | Professor of Kyoto University |
| Hiroyuki Sasahara | Professor of the Tokyo University of Agriculture and Technology |
| Masatoshi Ishikawa | Professor of the University of Tokyo |
| Hajime Asama | Professor of the University of Tokyo |
| Shigeki Sugano | Professor of Waseda University |
| Takayuki Okatani | Professor of Tohoku University |
| Tojiro Aoyama | Professor Emeritus of Keio University |
| Tsunemoto Kuriyagawa | Professor of Tohoku University |
| Eiji Shamoto | Professor of Nagoya University |
| Takashi Matsumura | Professor of Tokyo Denki University |
| Hitoshi Omori | Chief Scientist of RIKEN |

| FANUC Corp. | |
|---|---|
| Yoshiharu Inaba | Representative Member of the Board, Chairman, and CEO |
| Kenji Yamaguchi | Representative Member of the Board, President, and COO (Moderator) |
| Hiroyuki Uchida | General Manager, ROBOMACHINE Business Division |
| Kiyonori Inaba | General Manager, ROBOT Business Division |
| Shunsuke Matsubara | General Manager, Research & Development Administration Division |
| Yoshiki Hashimoto | General Manager, CNC Hardware Laboratory |
| Hidehiro Miyajima | General Manager, CNC Software Laboratory |
| Mitsuyuki Taniguchi | General Manager, SERVO Laboratory |
| Yuji Nishikawa | General Manager, LASER Laboratory |
| Kenichiro Abe | General Manager, ROBOT Mechanical Development Laboratory |
| Tetsuro Kato | General Manager, ROBOT Software Development Laboratory |
| Tong Zheng | General Manager, ROBODRILL Laboratory |
| Satoshi Takatsugu | General Manager, ROBOSHOT Laboratory |
| Yuji Takayama | General Manager, ROBOCUT Laboratory |
| Hon Yonpyo | General Manager, ROBONANO Research Department |
| Akihiko Fujimoto | Deputy General Manager, ROBOMACHINE Business Division |
| Kazunori Ban | Deputy Director, Basic Research Laboratory |
| Masako Sudo | Chief Engineer |

(Titles are current as of April 14)

President

Chairman

**President:** Thank you for gathering today despite your busy schedules. Prior to this round-table talk, you looked at our new products. I would appreciate any comments you have about them.

**Chairman:** Thank you for visiting the Fanuc exhibition to see our new products this year, too. Each year, we exhibit the latest models and functions of FA systems, ROBOTs, and ROBOMACHINEs, but as developers, we tend to overextend ourselves when exhibiting products because of our desire to give visitors a glimpse of future technology. This year's exhibits focus on the latest technologies that can be used today. We put on display high-speed, high-precision, high-quality machining, the smoothness of the machined surface, and various IoT technologies, which are all FANUC's missions, but also tried to make exhibits as practical as possible as exemplified by the simpler and easier-to-use functions, easy-to-view screens, failure prediction, and search systems that enable anybody to take measures against defects based on huge databases of maintenance information. This year, we focused on practical machine learning and deep

learning technologies, as well as AI technology that uses them, as they are expected to meet the needs of the coming age. In these areas, too, we ask for your continued guidance in the future. Your frank comments are much appreciated.

**President:** First, we would like to hear comments from Professor Higuchi.


Professor Higuchi

**Professor Higuchi:** I participate in this exhibition each year, but during the past several years, the way new products have been exhibited has evolved rapidly and become more refined and easier to understand. One characteristic of this year's exhibition is that in addition to the presentation of the latest products, explanations are given about the basic technologies. You explain things carefully so that even engineers outside these fields can understand trends in the fields. Since the exhibits are also extremely useful in studying production engineering and automation technology, I thought students should see these exhibits. If possible, I hope that major exhibits from this exhibition will be put on permanent display so that they can be seen throughout the year.

The two titles of this year's exhibition are "Ease of Use" and "Minimizing Down Time." In terms of "Ease of Use," exhibits clearly indicated how much time and effort you put in to make it so that work could be performed without error. This is probably related to the rapidly decreasing number of skilled workers. As far as "Minimizing Down Time" is concerned, at the front entrance of the exhibition site, there were three slogans: Reliable, Predictable, and Easy to Repair. If I remember correctly, these were announced about three years ago. IoT in the manufacturing industry as typified by Industry 4.0 was brought up at the same time during the round-table talk. At the time, I thought that these two had nothing to do with each other, but in fact, when I thought more deeply about them, I realized that they were closely related. In other words, I came to think that no matter how much progress was made in using a high level of information technology and artificial intelligence to connect machines and factories, systems would not work right if there was no guarantee that individual machines would not fail and operate properly. I believe that as manufacturers make progress in making the most of IoT, they will more keenly recognize the importance of "Minimizing Down Time" and the technologies that underpin them. FANUC constructed a large Reliability Evaluation Building as one of its research and development bases. The company emphasizes reliability evaluation, and research and development aimed at improving it, and such a stance makes me realize how far-sighted FANUC is. I finally started to understand the importance of the three slogans, which made me wonder what they meant at the exhibition three years ago.

**President:** Thank you. Professor Shinno, please.


Professor Shinno

**Professor Shinno:** In my laboratory, we are constructing processing machines and measuring systems that are based on new structural concepts not found in the world and are conducting research on them. When I saw the various new products on display today, I had the impression that there were considerable similarities between them and what we are aiming for. I myself am enjoying creating various machines because when I hear people say something is taboo, I just have to try and make it. In the future, I will continue to work on new projects as much as possible.

Recently, while I was conducting research on fiber laser, I felt that it had higher potential than what it is being used for in the world. It has no tools that can wear away like machines do. It is compact. It controls the tool itself, makes them intelligent, and can be incorporated into various machining systems, and therefore, we are looking for ways of applying it to areas other than cutting and welding, the two areas in which it is currently applied. I looked at a system that combined a lathe with laser, but I hope that at the next exhibition, you will show an exciting machine that combines a ROBODRILL with a fiber laser.

Real-time laser monitoring was on display, but I wondered if FANUC could propose something new as its own unique product. The reason is that a study of research theses on FA sensors and monitoring of processing status indicates that there has been no substantial progress since the 1970s, nor has there been any practical progress in FA sensors used at manufacturing sites. In this sense, I hope that you will try making sensors and signal processing systems based on various measurement principles not seen before, and offer new measurement systems unique to FANUC, and intelligent spindles and similar products that combine machining, measurement, and control functions.

When I looked at exhibits related to CNC controllers, I found that they covered almost all conceivable functions from the viewpoint of CNC technology, which made me wonder if the engineers in charge of developing servo technology and CNC controllers were faced with great difficulties in research and development. It may be possible to offer new CNC controllers that are different from existing ones by introducing the results of research and development in areas other than CNC. I sincerely hope that they will take such an approach.

One of the themes on which I had placed my expectations before I visited the exhibition site was big data and CNC. Exhibits focused on AI and deep learning, but I had the impression that they were rather conservative. Since FANUC covers many areas in which it can use big data effectively, I hope that the company will work actively and make new proposals in those areas.

Finally, due in part to cost problems, manufacturers are not making as much progress in applying new materials as is publicized. On the other hand, in addition to CFRP, various new materials are emerging, but none of them meets industrial needs, and no progress is being made in finding applications that serve as a trump card. A wide range of FANUC products have many components to which new materials can be applied, including ROBOTs, ROBONANO, and spindles. If new materials had been applied to specific new products in positive ways, I would have been even more excited when I looked at them.

**President:** Thank you. As you said, when you really get down to it, it does seem like sensor monitoring technology has not changed much since the 1970s. With respect to spindles, General Manager Uchida will explain as he is responsible for technology in general as CTO.


Uchida

**Uchida:** Although we could not present it at this time, we have started working on the development of failure prediction for spindle motors and spindles using ROBODRILL, and also as a general-purpose servo product. Among the various technologies we have available, we decided to present the thermal displacement compensation function at this time. In ROBOSHOT, it is a wear prevention function for portions subject to wear rather

than a compensation function, and the function is called the AI backflow monitor. In this way, we are also working on systems for preventing wear by performing compensation for portions prone to wear. After collecting a large amount of data and repeated trial and error in the SERVO Laboratory and ROBODRILL Laboratory for a year, we deeply understand how difficult it is to develop products that can be guaranteed.
As a matter of fact, the thermal displacement compensation for ROBOSHOT presented at this time is easy to realize with certain materials and certain molds. However, the real challenge to overcome for commercialization is to make it possible to absorb thermal displacement under many different conditions when the function is used in general products. It is our goal to at least develop the framework of the function for the spindle by next year.
**President:** Now, we would like to hear from Professor Hideki Aoyama.


Professor Hideki Aoyama

**Professor Hideki Aoyama:** I viewed your exhibition with excitement this year, as well. As Professor Higuchi said earlier, it seemed to me that the concept of "Reliable, Predictable, Easy to Repair" from three years ago has served as the base, and that AI and IoT are being utilized as tools to realize that concept. With that in mind, I read a newspaper article stating that FANUC's ROBOTs used in the factories of General Motors issue notifications before they break down, which gave me the feeling that the technology is being steadily introduced into the workplace. As I participate in this round-table talk today, I look forward to finding out how applications of the FIELD system, which you released a year ago, have been expanding. In the exhibition, an application that performs monitoring of the operating rate or visualization of the processing in response to machine alarms was presented. However, I have not been able to gain a clear understanding of what the applications for the FIELD system are like.
As I saw many products on display that used AI, I had the impression that your products are ahead of the times. For example, technologies such as the identification of thermal displacement, servo tuning, and failure diagnosis were presented. It was explained that AI is used for recognition; however, I thought that users would appreciate it if you suggest how data utilization and optimization control can be performed after recognition, or data collection. AI is a mechanism that provides desired information based on cause and effect relationships. On the other hand, I was relieved to hear that products developed based on engineering analyses were also available. When I hear "AI," I feel like the contents of the functions are not quite clear. However, you had various other technologies, including controls, based on engineering analyses, and I thought that it was a very down-to-earth and important approach.
As for the individual themes, I was most excited about fine surface technology. In addition, it was very interesting to see the upgraded smooth tolerance function. I would love to see FANUC develop a mechanism that links CAD, CAM, NC and servos with each other and enables more advanced machining by utilizing CAD data. Another thing that really excited me was smart machine control. I thought it was very interesting. Although I could not understand how temperature and vibration were controlled in real time, the explanation given on how the machined surfaces were totally different when such controls were applied was very interesting.
**President:** Thank you for opinions covering various points. Regarding your comments on the applications of the FIELD system, we are currently working diligently on the development of the FIELD system, and will hopefully be able to respond to your expectations next time. As for linking CAD and CAM data, we also think it is important, and we would appreciate your guidance at another opportunity in the future. The development of fine surface technology is led by Mr. Uchida, so I'd like his comments on that matter.
**Uchida:** I think it would have been interesting if you saw the results of applying various controls using ROBONANO and ROBODRILL. We are considering ways of linking CAM with tools and machining conditions. When a machined surface comes out badly, issues such as a bad NC or machine are mentioned. However, when we examined this matter a few years ago, we found out that all the elements of CAM, NC, servos, machine configuration, tools, and machining conditions were related to the conditions for linkage. There are cases in which CAM is bad and streaks occur due to dust, cases in which the NC interpolation period is too long and it needs to be shortened, cases in which servo rigidity is insufficient and gain adjustment or filtering is needed, and cases in which machine rigidity is insufficient. In addition, tool selection, tool feed speed, spindle speed, or machining conditions are involved. This being the case, we have made it our goal at one FANUC to develop comprehensive technologies that will cover all these aspects so that we can offer consulting services in addition to products and functions.
**President:** Thank you. Now, may I ask for your comments, Professor Takagi?


Professor Takagi

**Professor Takagi:** I was more surprised than excited to see your exhibition. you introduced the FIELD system. This time, AI was added, which has seen increasing popularity in recent years, and I was impressed with how well your products are made using deep learning. What surprised me the most was that machining can be performed with commands in units of 0.1 nanometers in mirror surface machining. I heard that the actual precision is 1 nanometer. However, I specialize in integrated circuits, and the minimum wire width in integrated circuits these days is about 10 nanometers. So, compared to that, the precision of 1 nanometer is amazing. On the other hand, the fact that FANUC still provides maintenance for its products that were developed 36 years ago showed me the broad-mindedness of the company.
In addition, your exhibition on collaborative robots was particularly interesting to me, since I helped with the circuit configuration at the launch of the collaborative robots. Last time, I talked about the necessity of noise reduction technology in order to increase the accuracy of the force sensors of the collaborative robots, and the possible options to accomplish this, including visualization of noise through simulations, multiplexing of the channels, and, if the signal frequency is low, noise canceling. On a side note, I have been serving as the chairman of the committee of The Institute of Electrical Engineers of Japan for researching noise reduction technologies related to integrated circuits for several years, and have many opportunities to hear about noise reduction. Just the other day, I heard from a person from an auto manufacturer that the performance of automobiles is known even without prototypes nowadays. It seems that the method of arranging the wiring inside the vehicle to reduce noise can be visualized by analyzing noise through three-dimensional electromagnetic field analysis. In addition, a person from a component

manufacturer told me that there are many standards related to automobiles, including those for the information transmission system, electric drive system, and vehicle body control system, and they mainly use differential signals that transmit signals using two paths. By doing it that way, the same noise enters the two positive and negative differential signals, and can be cancelled by eliminating the difference between the two signals. According to that person, multiplexing of the channels is necessary and that was how they removed noise.
Recently, I was consulted by a person from FANUC regarding how to design circuits to reduce electrical noise in sensors. For analog circuits, there are things we cannot see until we precisely calculate the effects of the surrounding circuits. After calculating such effects, we start seeing what kind of circuit is resistant to noise. Electronic circuits lack flair; even if they are given a good design, their performance will not improve by 10 or 100 times. On the contrary, however, in designs related to noise processing, without superior electronic circuit design, signals are buried in the noise. So, even if the work is not spectacular, it is necessary to perform good circuit design. The content of the consultation from FANUC at this time was a good example of this, and was also a good experience for me.
**President:** Thank you. I appreciate your guidance concerning sensors and circuits. There is still room for improvement in that area.
**Hashimoto:** Professor Takagi gave advice concerning not only the circuit configuration, but also part selection and arrangement. We realized anew that all such factors are needed to achieve the desired accuracy of analog circuits. We are counting on his continued guidance.
**President:** Thank you for your continued support. Now, I would like to request your comments, Professor Shirase.
**Professor Shirase:** As the chairman said at the beginning that the theme of the exhibition was the latest technologies that can be used today, I thought all of your technologies, such as fine surface technology and smart machine control, were very complete. Although technologies such as tuning the gain or smoothing tool paths have existed from before, I got the impression that you have realized such technologies very effectively with the improvement of the CNC processing capability. In addition, although CNC has been evolving to faithfully perform NC programs, it seems that enough development has been performed to that end. As Professor Hideki Aoyama said, greater coordination with CAD or CAM is desired at this point. Since I am engaging in research myself on non-conventional operations that can be enabled through the integration of CAM and CNC, I would like to see FANUC become a pioneer in this area.


Professor Shirase

For example, when a CAD model is provided, the cutting shape can be faithfully reproduced. To achieve a product one notch above that, however, it would be great if more design data could be incorporated; in other words, I would like to see functions that change the machining conditions or cutting method according to the dimensional tolerance or surface roughness.
However, as Mr. Uchida mentioned regarding the difficulty of developing products that can be guaranteed, there is an obstacle for companies in that they cannot commercialize incomplete products as they will be held liable for them. However, if 350 companies develop applications for the FIELD system, I don't think it's possible for all applications to be highly complete. The key in such a situation is whether the applications are used by users; in order words, if a situation can be realized in which users use the applications even if there is some risk. Although some users may not want to take any risks, there are users who are willing to take risks. So, it would be great if you could provide a good system that enables users who are willing to take risks to use the applications, rather than not commercializing the applications due to their incompleteness. For example, if I was the provider of an application and believed that my application was perfect, as it did not have any problems in the test phase, problems may occur when it was used with other applications. If you are to tell the application providers, "The platform is ready. Please develop applications," without offering a system that provides compensation in such a case, the risk for the application developers is too big and the platform will not spread smoothly. I heard that the FIELD system was made available last August and the SDK (Software Development Kit) will be distributed in April. I would also like to make my research achievements available to users via the FIELD system. I heard that the distribution of applications will start in September. I will be watching how the FIELD system advances.
**President:** Thank you. We also consider coordination with CAM to be important, so we would appreciate your continued guidance. Now, Professor Matsubara, may we have your thoughts?
**Professor Matsubara:** At this time, I would like to talk about your green robots and AI, from the perspective of factory automation. Your green robots have made much progress. When I saw the large robots several years ago, I thought it would be too difficult for them to work alongside humans, and I remember frankly saying so. Now, I have French staff members in my laboratory trying to conduct research using robots. This being the case, a major issue was how to convey matters concerning Japanese safety standards to them, such as how to arrange fences or set movable ranges. However, your green robots have completely eliminated such issues. I thought it was a very innovative and wonderful thing. We can just concentrate on what we would like to do using the robots. For research, they are a technology that can eliminate the barrier between robots and us; so, I would love to see their continued development. Another aspect I would like to mention is AI. There were examples that were far more specific than those in the last exhibition. For example, the AI function of your products can collect measurement data and show correlations immediately. That's all researchers like us in the measurement field for machine tools are doing is just "measuring, collecting data, finding correlations and utilize them." I became a little concerned that, if AI can even perform the task of finding correlations, I might lose my job. However, on further reflection, such tasks can be fairly complex. In the case of thermal displacement compensation, not only the temperature environment but also the operating conditions need to be considered. Machinability is completely different between steel and aluminum. Whether cooling water is poured or not makes a difference. Moreover, there are individual differences among machines, and there are differences in the environments of the factories in which the machines are installed. For example, the environment differs among locations close to a door, those in the middle of the factory or those close to an air conditioner. It is exciting to think about what we can see when such data all comes together. An issue that arises here is that of intellectual property rights–namely, the issue of to whom the data


Professor Matsubara

belongs. What we really need to do now is determine how to treat such data, new ideas or wisdom. Your exhibition has made me think about all these things, and was very exciting. Thank you very much.
**President:** Thank you for your comments. We have developed our large green collaborative robots with a 35-kg payload with the thought that they would be highly marketable, as they can reduce hard physical labor. Actually, the smaller robots are also very popular, and many customers are currently trying them out.
**Uchida:** I have the impression that the professors who have come today are very familiar with actual work sites and collecting data by conducting many experiments, which is very reassuring. As you pointed out, thermal displacement compensation is the most severe in actual work sites. It happens in our factories as well; if we open curtains at a location next to the truck yard, the temperature suddenly drops or increases. What you mentioned is very true for ROBODRILL; we need to assume many conditions for ROBODRILL from now on. We need to develop many systems that automatically collect data. It is a lot of work, and I am realizing how hard it is, especially at this time. Once big data is obtained, analysis, rationalization, and association of data are in the field of deep learning. However, development of the infrastructure for creating the database, for example, performing measurements and observation under many different conditions, must be performed by humans with their wisdom, and I would like your continued support in this respect; so I have the feeling your work load will just continue to increase.
**President:** Thank you. Now, Professor Sasahara, I would like your concluding thoughts concerning factory automation.


Professor Sasahara

**Professor Sasahara:** Since I engage in research on cutting, grinding, and additive manufacturing, my comments may be from a perspective closer to that of a user. Although we enjoyed many interesting exhibitions today, I would like to talk about two of them now.
One is the fiber laser system, which I mentioned last year as well. I was looking forward to seeing what you were going to present this year. In your systems, the linkage operation between the spindle and feed axis is very fast. There are no other machines in which marking can be performed while rotating the workpiece using a lathe spindle at a speed of 120 m/min; this can be achieved only by FANUC's servo and laser technologies. Since these systems are so great, I have been thinking about in what direction you can further advance them. In addition, it was the first time for me to hear about the technology for performing synchronous adjustment of the laser irradiation point movement and laser power. With this technology, for example, the power can be synchronously reduced as the speed reduces when turning a corner. When melting materials, control of the input heat of the laser directly affects the product quality. If your technology can be applied both to fields such as welding or cutting and to additive manufacturing, which requires melting of metal materials, products with higher accuracy and quality can be produced. So, I would love to study this field.
The other point I would like to talk about may be associated with fine surface technology in the future. When engaging in experiments for cutting, the most desired thing is information such as the cutting force, vibration, and temperature near the machining point. Of course, it is important for a machine tool to operate accurately based on a machining program through CNC or the servo. However, ultimately, machining with even higher accuracy or tool life can be realized if it becomes possible to monitor the information on the cutting point where the machining surface is being created and feed that information back into the machine tool. I think that users would appreciate very much if you could develop a system that enables monitoring of the machining point.
**President:** Opinions from the perspective of a user are very helpful to us. Thank you for giving us something to think about.
**Nishikawa:** There are various applications for fiber laser systems. Professor Sasahara, it would be great to work with you, so we ask for your continued guidance.
**President:** Now, to start the last half of this discussion, may we have your comments, Professor Ishikawa?


Professor Ishikawa

**Professor Ishikawa:** I had a great time at your exhibition today. Although some of you might have heard me say this many times, I think that the speed of robots must be increased by actively introducing sensors and applying feedback directly from the sensor. I was able to see some potential for this, so I am looking forward to the realization of fast robots.
After observing your products, I think more importance and emphasis can be placed on sensors. It is questionable that the sensors you currently have will be able to achieve future functions, and there should be a greater variety of them. Aside from the method of stopping a green robot with a force sensor, the method of stopping the robot by an all vision sensor is also available. To that end, inexpensive and fast vision is required.
In addition, since vibrations can be "seen" using acoustic sensors or images, failure prediction by vibration may also become possible.
Though studies on robots and vision have been conducted in my laboratory, I have become interested in machining recently. The machining accuracy can be improved by applying 1 ms visual feedback to the machining control. So, I think it is a good idea to introduce robot sensors in FA or ROBOMACHINEs.
I would really like FANUC to promote the connection between robots and robomachines. In addition, the connection between them can be made more smoothly if they are connected with sensor information, rather than connecting them by a sequence function.
**President:** Thank you very much. We also think that utilizing sensors in NC machines or ROBOMACHINEs as Professor Ishikawa suggested, is an important perspective, and we are currently conducting studies on that matter.
**Professor Ishikawa:** When collecting data, various types of sensors need to be installed. High-performance sensors are expensive. However, sensors just for collecting data do not have to be expensive, just highly reliable, as they do not perform control. Although using many such sensors to collect data may be different from the conventional concept, I recommend that you study it as well.
**President:** Thank you for your guidance. Now, Professor Asama, may we have your comment?


Professor Asama

**Professor Asama:** I mainly observed your robots in the exhibition, and thought that there are three directions that FANUC could take.
The first is the expansion of spatial freedom; this can be achieved by adding one more axis to the

existing robots, or by widening applications by attaching arms to the top of the automatic guided vehicle (AGV).
The second direction is a "human axis." After the new model of the green robots was released, applications that do not require fences have been steadily expanding, including applications in collaborative assembly work. In Japan, labor shortages are expected to occur in the future due to the declining birth rate and the growing elderly population; therefore, it is very important that robots can be used by female or elderly workers. In addition, for elderly workers, vision also becomes an issue. When workers are farsighted due to age, the range of tasks they can perform becomes limited, and I think a work environment that supports them in that respect can make it easier for them to work. Moreover, for collaborative robots, it becomes important to relieve the mental stress of the workers. I remember that FANUC conducted a study on stress imposed on humans when they work collaboratively with robots with Professor Arai, in the Project for Strategic Development of Advanced Robotics Elemental Technologies conducted by NEDO. Recently, we have also been estimating the stress felt by workers when they operate construction machines or the stress of car racers while measuring so-called physiological indices, including heart rate, perspiration, muscle activity, and brain waves. I think it would be interesting to evaluate whether people who are actually working are doing so comfortably with delight and without feeling stress.
The third direction is networks. This is a direction of obtaining more information through collaboration, and I think FANUC is very advanced in this respect. Since current AI is basically based on deep learning, obtaining more information is the key. While many companies are searching for ways to use it, you are working on applications that are very appropriate. Your system is only possible when you can collect useful data after first having superior base technologies to move or process various objects with high reliability and accuracy; this is something that only FANUC could accomplish.
Lastly, I am engaging in robotization in fields such as construction and civil engineering. There is a considerable need among general contractors for robotization of tasks that are difficult for humans. For example, there is a system called BIM (Building Information Modeling) in the construction field and one called CIM (Construction Information Modeling) in the civil engineering field, and an approach called "i-Construction" to promote the adoption of ICT in these systems involving robots or drones is currently being advanced by the Ministry of Land, Infrastructure, Transport and Tourism. I am really looking forward to seeing these systems and the FIELD system start being linked together; if it goes well, FANUC may be able to dive into the civil engineering and construction fields all at once.
**President:** Thank you., and thank you for mentioning AGV as a means of expanding spatial freedom.
**Abe:** In the exhibition of AGVs, the technology that enables batteries to operate for at least 8 hours without having to connect a power cable is one of the key points. I believe that the advancement of AGVs and batteries is necessary for the future development of robots.
**President:** Thank you. Now, Professor Sugano, may I ask for your comments?


Professor Sugano

**Professor Sugano:** I would like to talk about the relationship between collaborative robots and humans, and IoT. Collaborative robots are making steady advancements each year, enabling them to be placed even closer to humans. I believe your green robots will be able to perform operations that are more closely connected with humans, such as teaching or transferring skills. Once such systems are developed, big data or AI will become involved, and they will also affect the design of the entire production system. Therefore, I would like FANUC to advance the development of robots that are closer to humans, both in terms of distance and content.
When such systems start appearing, they will become closely linked to IoT. Unfortunately, it is said that Japan is a little behind when it comes to IoT. However, though it may be true concerning the "Internet" part of IoT, I believe Japan can become stronger concerning the "things" part. In order for Japan to take leading initiatives in this area, discussions were held recently in the "Society 5.0" working group of the Cabinet Office and the Society of Instrument and Control Engineers concerning how IoT can be advanced in the "super smart society." In my opinion, in order for Japan to take leading initiatives in areas including IoT or new big data, businesses need to work hard. In this regard, FANUC has great potential. Moreover, you already have the green robots, which have very deep connections with humans. Using these products as a foothold, you can build a reputation in standardization and all the other areas related to the products. No amount of academic discussion can accomplish this; it can only be accomplished when businesses take the lead.
**President:** Thank you very much. We appreciate your insightful comments concerning the association between collaborative robots and IoT.
**Inaba:** In the sense that the ultimate goal for machines is to connect with humans, we believe that collaborative robots are very important. We would like to start making connections between the data of such products, and connect them to machines, and then to humans. Ultimately, it is our goal to eliminate borders between machines and humans. So, since humans and robots will be working together without fences in the future, I think it will become very important to enable robots to operate autonomously by using AI or by inputting information of their surroundings using sensors, in order to achieve autonomy of robots.
**President:** Now, Professor Okatani, please share your thoughts with us.


Professor Okatani

**Professor Okatani:** I have been engaging in research on image recognition and computer vision, which are the core technologies of what is presently called AI. When I participated in this round-table talk two years ago, I remember saying that it would become possible for computers to recognize things at a human level if the technology called deep learning was used and it could possibly become an innovative technology in the future, but that it seemed like FANUC was not too interested in it. Soon after that, FANUC announced its collaboration with Preferred Networks, and in the exhibition this year, machine learning and AI were used in a lot of products. I was a little surprised by how quickly you have changed your stance (laugh). However, it is not a laughing matter; I think it is a very important attitude.
When it comes to research and development on AI, Japanese companies and universities are all completely losing to U.S. companies and universities. The reality is, companies making huge profits such as Facebook, Microsoft, Google, and Amazon, which are ranked among the top 10 companies by market capitalization, are investing a considerable portion of their profits into this field, and it is impossible to win over such companies in competition, so the distance only increases. Nonetheless,

I think there is no need for Japanese manufacturing companies to be pessimistic at all. Because, although companies like Apple or Google have been secretive and have not shown what they are doing externally before, it has become common for such companies to allow research papers to be publicized, so that they can obtain good researchers for research on AI. This has made it possible to gain a good grasp of what currently can and cannot be done in this field from research papers. So, I think it is very good to have high sensitivity to such areas, as well as to collaborate with other companies, such as Preferred Networks, rather than carrying out all development in-house.
As for deep learning, if there were 10 image recognition problems that humans could solve but computers could not in the mid 1990's, the computers could solve one or two out of 10 problems 15 to 20 years ago, and now they can solve eight or nine out of 10 problems due to the dramatic advancement of research in the past five years. There are issues that still remain to be resolved: one is more advanced intelligence, or in other words, inference based on something like universal common sense. However, that would be a problem regarding language, not images. The other is machining tools that can interact with the real world, like robots. In this regard, AI has not been very successful yet. For studies in these two fields, many smart people are now being employed using a vast amount of money. So, even though we cannot tell at this point whether robots will become capable of freely grabbing things or collaborating with humans at a deep level, I would not be surprised if a revolutionary change occurs in these fields in the near future. I think it is important to pay close attention to any progress in these fields, in order to be able to respond quickly.
**President:** Thank you. As you pointed out, we did not have any such collaboration two years ago. So, we may have changed our stance quickly. As you suggested, we would like to promote research in the field of AI at an early stage, while trying to gain a good grasp of what can and cannot be done in this field. We will need your help to that end, so we appreciate your continued support and guidance. Now, we would like to move to the topic of ROBOMACHINEs. First, Professor Tojiro Aoyama, may we have your comments?
**Professor Tojiro Aoyama:** Today, I would like to talk about how ROBONANO, in particular, has made advancements in the past year. To put it simply, I think that the performance of ROBONANO has become stable. The actual cutting demonstration that takes a rather long period of time at the exhibition is evidence of the company's confidence. I get the impression that the value of ROBONANO as a commercial product has increased.


Professor Tojiro Aoyama

Although it was a big decision to make to adopt hydrostatic guideways a few years ago, I felt that it was the right decision, particularly now.
For nano-machining tools, the ability to perform setup easily in a short period of time is important. You also offer systems with well-coordinated measurements and tools, and I feel like your products have become more user-friendly as well.
In addition, I look forward to seeing your future growth, as I hear that you are going to expand your business in Europe. In Europe, they have their own culture and ideas concerning the use of machine tools, and I believe there is much to learn there.
Another thing I would like to mention is that I believe that actively developing ultra-precision machining tools such as ROBONANO and making constant efforts to improve their performance will make great contributions to the performance enhancement of other products including ROBODRILL and ROBOSHOT. Needless to say, such developments and efforts are greatly contributing to the performance enhancement of CNC as well. Therefore, I think your constant approach to state-of-the-art technologies, such as technological developments for ROBONANO, can be expected to have a great ripple effect on other technological developments.
When I checked the cutting surface roughness at the ROBODRILL exhibition, I was surprised that a cutting surface of the past ultra-precision machining level was achieved by a machine that mainly performs roughing. Although the ROBONANO won't lose its markets to the ROBODRILL, I thought that the development of ROBONANO had an excellent ripple effect on the development of ROBODRILL.
**President:** Thank you. We also feel that ROBONANO has made pretty good progress.
**Hong:** Professor Aoyama gave us advice concerning the hydrostatic guideways and specifically to me when I did not know what to do after that. Since then, he has continued to help us. I think that by demonstrating actual cutting, we were able to advertise ROBONANO as a machine that is harder to break compared to the past ROBONANO. We will probably encounter many issues in the future, so we are counting on your continued guidance.
**President:** Now, professor Kuriyagawa, please share your thoughts with us.
**Professor Kuriyagawa:** I am in charge of two laboratories: a nano-precision mechanical manufacturing laboratory and a biomedical engineering laboratory. Until now, manufacturing only referred to the creation of shapes. However, in the future, the creation of functions will become important as well. For example, technologies such as a "functional interface generation" that fabricates functional surfaces or "functional intelligent interfaces" in which intelligent functions are incorporated into surfaces will be attracting attention. In the medical field, an implant surface with a structure to which bone can easily be attached can be realized. Or, in the case of a dental implant, it is possible to give an antiseptic effect to the extruding portion on the gums to prevent inflammation. The concept of "form generation + function generation" that realizes such things is very important. With an ultra-precision of 100 picometers (0.1 nanometers), ROBONANO is excellent equipment. With picometer-level precision, various functions and performance have been achieved from the perspective of function generation. This function generation technology is about to be used in various places, including the surfaces of high-speed mobile objects such as airplanes, or to reduce wear resistance of the spindles of machine tools, or, in the medical field, in implants as described earlier. I think that manufacturing that adds various functionalities will become important in the future.


Professor Kuriyagawa

In February, a symposium on picotechnology was held by the Science Council of Japan. When describing picotechnology in English, it would be Pico Precision Advanced Processing, or PPAP—the same as the title of a popular song by the Japanese comedian (laugh). The professors who are here today gave lectures in that symposium too. Nanotechnology is a keyword proposed by Professor Taniguchi 50 years ago. Now that we are entering the picotechnology generation, I have high expectations that your systems will play an important role.

Incorporating functions refers to how fine structure and control underlying crystalline structures is to be incorporated rather than simply making the surface smooth. In my laboratory, we are on the verge of doing some interesting things, one example of which is to make the strength of components anisotropic by controlling crystalline structures using laser. Adding such a property will enable you to provide components with higher functions and higher added value.
Furthermore, as Professor Aoyama pointed out earlier, I was amazed by the excellent progress ROBODRILL has made as demonstrated at the exhibition.
**President:** Since ROBODRILL has produced extremely favorable results using our CNC functions, we will be able to recommend our CNC to customers with confidence.
Next, Professor Shamoto, please share your thoughts.
**Professor Shamoto:** I am conducting research on cutting and machine tools, and today, I toured the exhibition site focusing on ROBONANO and ROBODRILL. Earlier, someone expressed the opinion that machine tool technology has reached a limit in the sense that machine tools work as instructed by NC programs, but during the past several years, when I looked at the performance of ROBOMACHINEs and the results of machining, I have felt that machine tool technology was progressing at an extremely fast pace.


Professor Shamoto

First, in terms of ROBONANO, I am deeply moved by the fact that 0.1-nanometer resolution is really put to practical use. This doesn't just mean that machine tools work at the 0.1-nanometer level, but also that such performance is properly shown in the results of processing and their operation. I believe that this is the combined result with fine surface technology, and also due to improvement in the machines' basic performance. I feel that a new age has been opened up, and at the same time, I also feel that recent machine tools are really practical because their prices are steady for the most part even though the performance of all tools is improving. At the next opportunity, we would like to consider this machine as a candidate as well.
When I looked at ROBODRILL two years ago, it had already produced machining results close to a mirror surface, and I really wanted to use it for precision machining if it was able to do that. Not only has ROBODRILL achieved mirror-surface performance but also developed technology to fully utilize the power of a motor and realized iron system cutting, and heavy cutting at that. Recently, I also visited a manufacturer of automotive components and saw a ROBODRILL there. FANUC is steadily advancing the really basic performance of ROBODRILL such as high-speed, high-precision processing, and furthermore, heavy cutting, and this is wonderful. I hope that you will continue this technology development in the future.
Finally, I want information on cutting points in the future. Certainly, machine tools are making progress little by little in the sense that they work as instructed, but it is quite difficult to make dramatic progress. The cutting process is complicated, but conversely, if one can control that process more skillfully, one would be able to more easily distinguish one's cutting technology from others'. I hope that you will obtain information on that process in one way or another and establish a mechanism that enables you to reflect such information in the control of cutting machines.
**President:** Thank you very much. As mentioned earlier, how to obtain information on cutting systems is an extremely difficult issue, but this is also an issue we would like to address from the standpoint of an NC manufacturer.
0.1-nanometer feeding was achieved, but in fact, this was knowledge we acquired only after we actually operated our CNC and servo systems.
**Uchida:** It is true that the same kind of thing also happened at the time of 0.1-nanometer setting and its feedback. Even if we tried using ROBODRILL and NC, we were not able to clarify the effects of actual cutting, but ROBONANO showed clear differences. It is taken for granted that technology does not advance unless observations and measurements can be done. After all, the role ROBONANO plays in making observations and measurements possible are important to develop the most advanced NC.
**President:** Now, Professor Matsumura, please tell us what you think.
**Professor Matsumura:** First, I was quite amazed to learn that ROBONANO had achieved 0.1-nanometer resolution. In addition, ROBONANO can maintain its precision level even if there are chips and dust, and because of this practicality, I found the machine attractive. I saw two uses for cutting with ROBODRILL: cutting high-quality finished surfaces and heavy cutting in rough processing.


Professor Matsumura

In particular, ROBODRILL can cut steel materials efficiently, and this advancement is very attractive. In addition, since the duration of continuous maximum output is limited, the length of time during which materials can be cut at maximum output is indicated, a function that is extremely attractive to users. Another application is that the FIELD system gathers such data and stores the history of machines' torque and load information, thereby diagnosing the deterioration of the machines and informing their users of the timing for maintenance with details. There are differences among individual machines depending on the environment in which they are used and the way they are operated even if they are of the same model. Moreover, since all machines do not have exactly the same characteristics even at the time of shipment, ROBODRILL is expected to develop into a system that supports learning how to master individual machines taking differences among them into consideration. If you further improve the maintainability of ROBODRILL, combined with the use of robots, by thinking about the maintenance of both robots and processing machines, it will evolve into a mechanical system that is even easier for users to use.
Another thing that interested me among this year's exhibits was that I witnessed thermal displacement compensation technology for machine tools. This was another extremely appealing achievement to me. You compensate for accuracy loss by attaching a sensor, but I believe that that is going above and beyond what is expected of a machinery manufacturer. Another issue to address is to correct for the thermal expansion of tools. Essentially, tools expand due to cutting heat at locations close to the machining point, but if a function that corrects this is developed, even higher-precision machining can be achieved. This is technically difficult, but I hope that such monitoring technology will be developed in the future.
Finally, I also have expectations for your efforts toward AI technology. But, I am also apprehensive about addressing all production-related issues through AI and deep learning. In particular, if machines learn unreliable data, they would become unable to make stable judgments and responses. It will become necessary to use modeling and simulation technology in the learning process to

determine whether training data are correct.
**President:** Thank you. In light of using the FIELD system to gather diverse information from ROBODRILL, there is a robot application known as ZDT, and we presented it, thinking that we would evolve it as a function for ROBOMACHINEs and CNC systems in the future.
**Chairman:** Thank you for your comments on a wide range of subjects. After all, I believe that sensing technologies and AI technology, which combines them, have extremely high potential. If we can develop machine correction technology by gathering basic data using many sensors at the experimental stage and using as few sensors as possible for actual products so that machines can display the same capabilities economically, such technology would be extremely practical. Your guidance would be much appreciated.
**President:** Professor Omori, please share your ideas.
**Professor Omori:** Today, I saw exhibits focusing on three areas: ROBONANO, ROBODRILL, and AI. I was a user of an early ROBONANO and have long used ROBONANO for my research. During the past several years, an increasing number of joint research projects with businesses have focused on difficult-to-cut materials. Various challenges have emerged in three areas: curved surfaces, grooves, and large diameters. Some of these problems could not be completely resolved by the previous ROBONANO, so when I saw the new ROBONANO working at the exhibition site today, I felt that it was excellent.


Professor Omori

I often study optical components and evaluate many of them using roughness parameter RMS, but when it comes to cutting, evaluations at the nanometer level are difficult. In particular, components that handle light reflect or control light with an extremely short wavelength such as X-rays. Since the increasingly high accuracy of surfaces is required in accordance with the wavelength of light, it is more and more necessary to control surface accuracy at the sub-nano or pico level to achieve a suitable surface accuracy. At this year's exhibition, I felt that ROBONANO was giving shape to this.
Personally, I would also like to have a ROBODRILL. In general, prior processing comes before final samples are prepared by cutting them using a ROBONANO. Since it takes too long with the ROBONANO, I tend to consider outsourcing the work instead, but this is extremely inefficient in terms of work-related communication and preparations. When I saw how far the ROBODRILL has advanced, I realized the results would be satisfactory in terms of accuracy if the ROBODRILL and ROBONANO were used together to cover all processes from prior to final processing, and furthermore, by minimizing expenses for finish by using the ROBONANO, they will reduce processing time, achieving higher cost performance. I want both of them because they can perform both rough and finish processing.
Then, AI thermal displacement for electrical discharge machines was mentioned earlier. In my student days, I was trained in measuring thermal displacement for electrical discharge machines at FANUC, and therefore, I can deeply relate to this subject. When I saw thermal displacement compensation using AI today, something stirred inside me. Returning to ROBONANO, skills are required for preparations in ultra precision machining, and without such skills, good products are hard to produce. If preparations are made well, the next question is cutting conditions. Meeting such conditions also requires skills, and if you can make this area one that requires no skills, you will be able to provide an environment in which anyone can use ROBONANO. In that sense, the combination of AI with people will become important. In my laboratory, too, we are conducting research on the optimization of machining conditions, but what is important is prioritizing parameters. If it becomes clear which conditions are most important and how effective they are in achieving high machining accuracy, it becomes unnecessary to change other conditions in various ways. If there is prior information in the database for ROBONANO such as "this is very effective in processing this material", it becomes easy for customers to set machining conditions. In addition, I felt that if AI helped with that process, making it possible for even unskilled persons to use ROBONANO, an age would come in which processing at the nano to picometer level would spread.
**President:** Thank you very much. We are glad that expectations for ROBONANO are growing as you said, and we are keenly aware that we must never fail in this area. We will continue toward completion of ROBONANO technology with your guidance. Now, Professor Tojiro Aoyama, please share your thoughts.
**Professor Tojiro Aoyama:** On behalf of the educational and research institutions invited today, I would like to thank you again. Thank you very much for your invitation today. One of the important roles of universities as educational and research institutions is to develop excellent people who will contribute to the formation of an affluent society in the future. Those who are present at this meeting are teachers who are taking leadership in various places of society. At our university, we will make every effort to develop people who support manufacturing in Japan. I hope that FANUC and all educational and research institutions invited today, including universities and research organizations, will continue to work together in the future.
Today, various subjects such as AI and hardware were discussed, but among them, green robots (collaborative robots) are increasingly attracting attention. It is expected that the population of Japan will decrease to around 80 million in the not-so-distant future, and the question is how we should make up for the decrease. I predict that green robots will play an even greater role at production sites.
FANUC hosts a round-table talk each year to provide an opportunity for serious discussions, and this indicates that FANUC's policy is to listen to the opinions of people from universities and other educational and research institutions and apply them in future manufacturing. I believe that this probably leads to the company's stance of considering it important to properly obtain a clear understanding of the opinions and needs of manufacturing sites.
Manufacturing is faced with various technical challenges. For example, one basic issue is to how to handle an object being worked on, determine the position of the tool, and put its blade in contact with the object, and components are machined by solving such basic issues, but I believe that this unsophisticated, basic part of the process is closely connected to users. Then comes AI, but FANUC has solidified the edge part of manufacturing. This stance is extremely important in FA technology, which supports manufacturing. I sincerely hope that you will focus on your core business and work to develop production technologies in the future. An extension of this issue is how you should develop services for users. FANUC is doing a good job addressing both issues.
Today, we were able to have a really in-depth discussion. Let us continue to support manufacturing in Japan in the future so that it can be applied globally. Your continued efforts would be appreciated. Thank you for your participation today.
**President:** Thank you all for attending.

# FANUC Global Conference

This year's FANUC Global Conference was held for three days from March 15 to 17. Representatives of employees from FANUC Group companies worldwide assembled in one place to discuss future product developments and sales strategies. The Conference made full use of the FANUC Forum, which was completed last year, and the largest number of representatives ever participated.


Lively discussions continued about various subjects with the keywords “Transparency and Strict Preciseness,” “one FANUC,” “Reliable, Predictable, and Easy to Repair,” and “Service First.”
In addition to various AI functions using deep learning and machine learning, and fine surface technology for high-quality machining, participants engaged in animated discussions about new products and new functions that will be released in the future. They got a strong sense that FANUC will lead the world in the evolution of manufacturing sites around the world.
On the last day of the Conference, participants visited the Reliability Evaluation Building where various evaluation tests are conducted. They saw the large evaluation equipment and spent time together in the wellspring that is FANUC, which makes all-out efforts to pursue reliability.

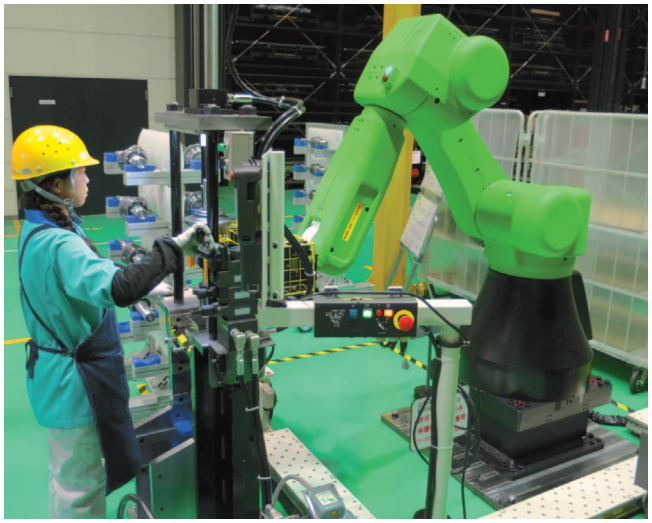
After all sessions ended, Chairman, Dr. Y. Inaba hosted a party where all participants further deepened mutual friendships.

# Collaborative Robot Receives Okochi Memorial Production Prize

FANUC received the 63rd (FY2016) Okochi Memorial Production Prize from the Okochi Memorial Foundation for its highly efficient assembly system using collaboration between collaborative robots and people. The reason for the Prize was that the highly efficient assembly system using collaborative robots in the ROBOSHOT assembly factory was highly rated. On March 24, at the award ceremony held at the Industry Club of Japan, Chairman Hiroyuki Yoshikawa of the Okochi Memorial Foundation presented a certificate of commendation to President Yamaguchi of FANUC.

FANUC developed the world's first 35-kg payload collaborative industrial robot, FANUC Robot CR-35*i*A, which uses safety functions based on its independently developed sensor software. The CR-35*i*A became the world's first collaborative robot that acquired safety certification according to the international standard ISO10218-1, and its high safety enables it to be introduced without safety fences. This robot enables users to achieve greater work efficiency in various operations such as transport of heavy objects and assembly of components.

In the assembly of the ROBOSHOT, FANUC has introduced collaborative robots into the assembly process in which bearing units are inserted into ball screws, thus realizing a highly efficient assembly system in which robots collaborate with people. This system achieves labor saving by turning a two-man job into a one-man job, and substantially lowers the risk of work-related accidents by liberating people from heavy manual work and reducing workloads.



Highly efficient assembly system using collaboration between collaborative robots and people in the ROBOSHOT assembly factory

President Yamaguchi (center) and Senior Managing Director Inaba (right) were officially commended by Chairman Hiroyuki Yoshikawa of the Okochi Memorial Foundation.

The collaborative robot CR-35*i*A makes the most of the world's foremost high payload and long reach, and is being widely applied in various areas such as assembly of automobiles, machining and assembly of machinery, as well as logistics. The CR-35*i*A will accelerate the introduction of robots into assembly processes that have thus far consisted mainly of manual work, and contribute to reducing labor shortages in advanced countries, which are faced with declining birthrates and aging populations.

FANUC has received the Okochi Memorial Prize several times, and this is the fifth time it has received the prize. The accomplishments for which it won the prize were the "commercialization of a large flexible production system with machining cells at its core" in FY1981, the "development of a fully automated production system for multi-layered printed wiring boards" in FY1995, the "development of an unmanned long machining system using intelligent robots" in FY2002, and the "realization of a highly automated motor assembly factory consisting of intelligent robot cells" in FY2008.

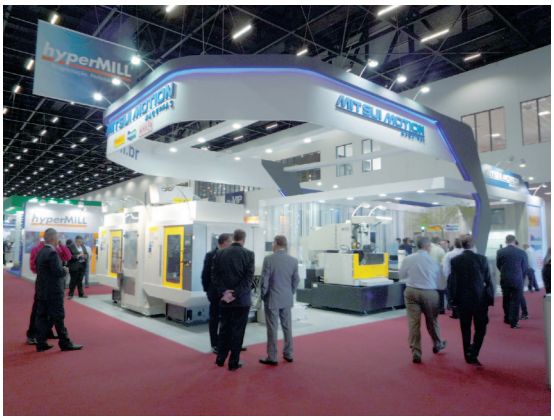
Collaborative robot CR-35*i*A

※ The Okochi Memorial Prize is a prestigious prize awarded each year to remarkable accomplishments in the area of production engineering and production technology in commemoration of the great achievements by Dr. Masatoshi Okochi (1878-1952) to the academic and industrial communities, as head of the Institute of Physical and Chemical Research, for 25 years, from 1921 to the end of World War II. The objective is to contribute to the promotion of science and technology for production, which were the wishes of Dr. Okochi.

# Information on Exhibitions

## EXPOMAFE, Brazil


The International Machine Tools and Industrial Automation Exhibition (EXPOMAFE) took place in São Paulo, the capital of Brazil, from May 9 to 13, 2017.




FANUC South America and its distributor, Mitsui Motion Maquinas, exhibited FANUC products, and in particular, offerings for automation using ROBODRILL and ROBOTs attracted the attention of visitors.

## Machine Tools Africa 2017

Machine Tools Africa 2017, the largest exhibition of machine tools in Africa, was held at the Expo Center in Johannesburg, the Republic of South Africa, from May 9 to 12, 2017. In this highly international event, over 60 companies from Japan, the Americas, Europe, China, South Korea, Taiwan, etc. exhibited machine tools, robots, tools, and other products.
FANUC South Africa, FANUC's South African subsidiary, exhibited ROBOTs and ROBOMACHINEs at one of the exhibition's largest booths, emphasizing the fusion of FA. ROBOTs and ROBOMACHINEs. FANUC's exhibits attracted the attention of customers mainly from local enterprises.


# Company entrance ceremony

New employees

The company entrance ceremony was held on April 3, and 191 new employees joined the FANUC workforce. Chairman, Dr. Y. Inaba expressed his strong expectations for the growth and lively activity of young people who will lead the next generation.

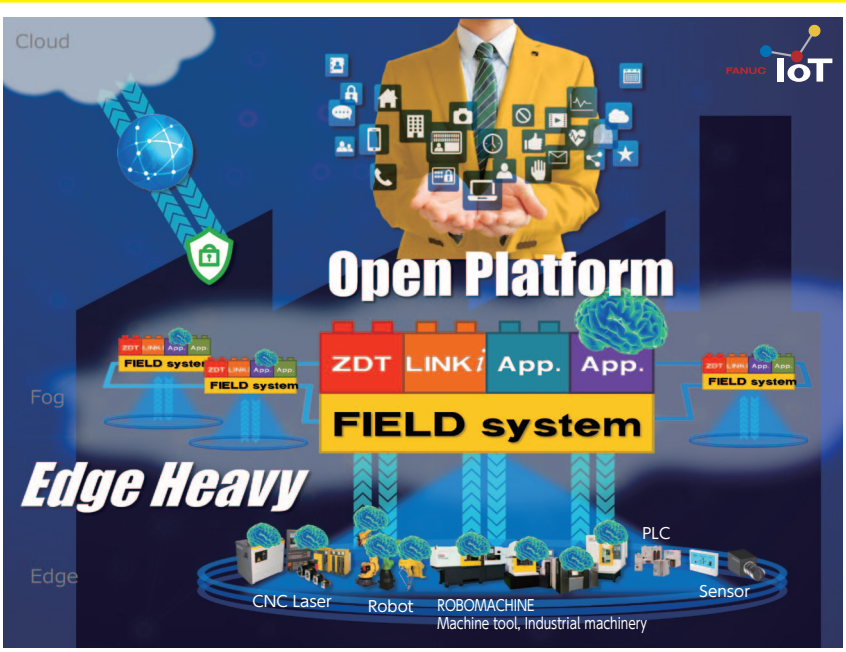
# Four seasons at FANUC

Asian skunk-cabbage

Beautiful and cute Asian skunk-cabbages like white fairies came into bloom. What looks like white petals are botanically not flowers but leaves called "spathe."

# FIELD system

## FANUC Intelligent Edge Link & Drive system




A platform open to everyone, the FIELD system was developed for edge-heavy computing by bringing together the latest IoT and cutting-edge AI technologies. By using this system, FANUC aims to work with partners around the world to make innovations in manufacturing.

FANUC News 2017-Ⅱ

**FANUC CORPORATION**
Oshino-mura, Minamitsuru-gun, Yamanashi 401-0597 Japan
http://www.fanuc.co.jp/
Phone: (81) 0555-84-5555
Fax: (81) 0555-84-5512
Person in charge of publishing:
Naoki Yukisada, Vice Manager, Public Relations Department

©FANUC CORPORATION October 6, 2017 Printed in Japan