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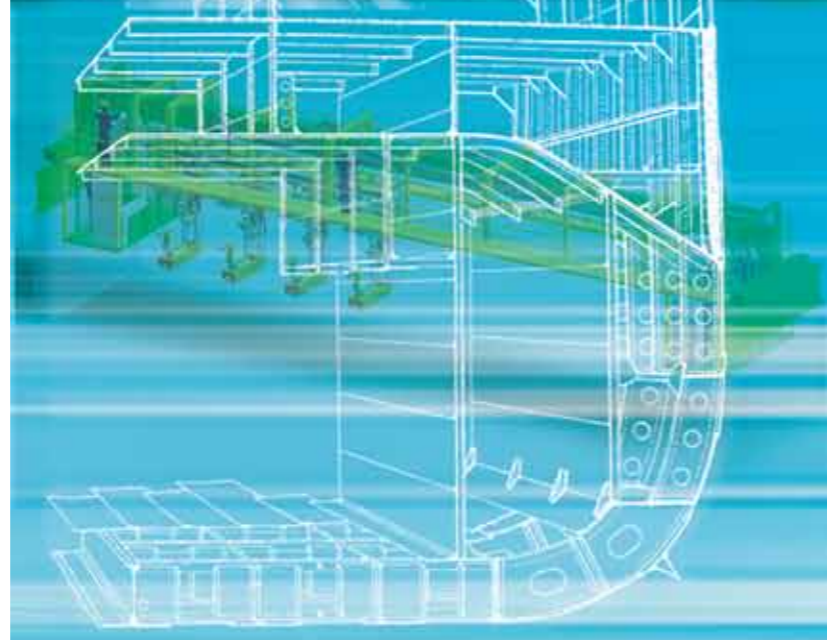
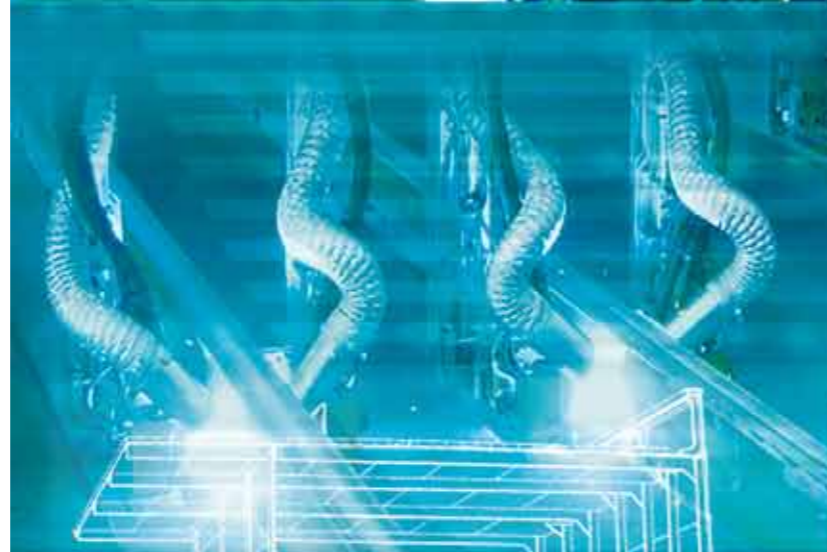
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# KOBELCO WELDING TODAY

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*KOBELCO Puts the Customer First with All-in-One Product and Service*



# Welding Business to make organizational changes

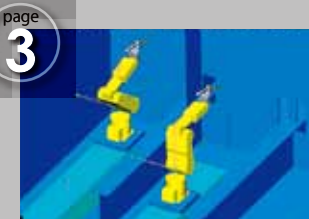
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Kobe Steel, Ltd.'s Welding Business has changed the name of the Marketing Department to the Marketing Center and made other organizational changes, effective January 1, 2017.

## 1. Background and purpose

The Welding Business is implementing a basic policy of strengthening the three "Ms" of Marketing, Monodzukuri and Manpower to achieve its goal of becoming "the world's most reliable solutions company" under Kobe Steel's Fiscal 2016-2020 Medium-Term Group Management Plan.

It is anticipated that the environment surrounding the welding business will see a recovery in domestic demand, centering on the construction industry. However, demand in overseas markets, such as China, South Korea and Asia in general, as well as North America and Europe will likely continue to be sluggish. With competition intensifying, uncertainty over the future outlook is increasing.

From a global standpoint, these conditions suggest the importance of further strengthening marketing functions and activities, from market and product strategies by region and area to business planning and implementation. With further cooperation within the Group in Japan and overseas, the Welding Business aims to create products, services and welding solutions that customers truly seek.

To create a structure that can deliver KOBELCO's excellent welding products throughout the world, the Welding Business has reorganized the Marketing Department into the Marketing Center.

## 2. Organizational changes

The Marketing Department is now called the Marketing Center. Within the Marketing Center, the following departments have been newly established:

- (1) The International Sales & Marketing Section and the international planning function in the Planning & Administration Department have been combined to form the Global Operations & Marketing Department.
- (2) The Marketing Planning Section has now been placed under the direct supervision of the Marketing Center.

A chart depicting the new organization of the Marketing Center is shown in Figure 1.

Figure 1: Chart of new organizations of the Marketing Center



# Another year of progress in welding automation

Dear KWT readers! My name is Manabu Nagata, Head of the Technical Center, and I'd like to express my heartfelt gratitude for your continuous patronage of Kobelco products. I wrote about the development of welding automation last May in KWT Vol.19 No.2, which also featured a discussion of another important issue for the Welding Business – namely, Kobe Steel's mid-term management plan and the launch of KOBELCO VISION "G+" in April, 2016. I am now happy to report on three ways that welding automation has been making progress since then.

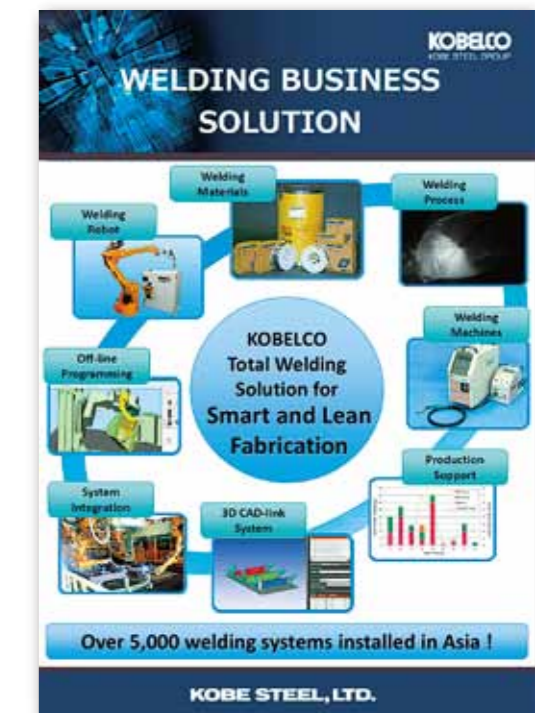
Firstly, progress can be seen in the ARCMAN™ robotic welding system for steel-framed building fabrication in North America. In Japan, demand from steel fabricators for systems of this kind is high because of the strict seismic requirements for steel-framed buildings as well as due to the lack of welders. Regarding overseas steel-framed building fabrication, the need for high quality welding is also increasing in tandem with rising demand for high-rise buildings, though not as strongly as in Japan. Following these trends, we received an order for the ARCMAN™ system from a renowned American steel fabricator last fiscal year. And at the same time, we developed a flux cored wire for this application while preparing for the operation of the system.

More good news is in the development of the ARCMAN™ robotic welding system for hull assembly in shipbuilding. You will find a more detailed description of this in this issue's Technical Highlight. The story shows how we have been able to widen the application range and develop an advanced robotic system that differs from the conventional ones by utilizing a fruitful combination of 3D-CAD, the ARCMAN™ welding robot and an assortment of suitable welding consumables.

Finally, our "total welding solution" was displayed at CeBIT2017 in Hannover, Germany last March. Held annually in Germany, CeBIT (Centrum für Büroautomation, Informationstechnologie und Telekommunikation) is the world's largest international information and communications trade fair. Because Japan was selected as a partner country this year, many Japanese enterprises, including Kobe Steel, took part in this event. Although Kobe Steel's display featured only panels and videos, the prime ministers in both Germany and Japan dropped by the booth and listened to an explanation of our welding solutions. Below is one of Kobelco's displays, showing our range of products and technologies, such as welding consumables, robots, power sources, procedures, processes and system integration in a round circle.

By organically uniting these products and technologies, we can supply customer-oriented solutions to our clients. We are determined to introduce ever more advanced and practical products and technologies, while improving the links amongst ourselves and between us and our customers.

As I mentioned in the KWT Vol.19 No.2 issue, Kobelco representatives will visit you directly to introduce our latest products and technologies and listen to your requests. I believe that the achievement of the mid-term management plan depends on whether we can serve our customers' needs accurately. We will expand our activities to fulfill our business vision in becoming "the most reliable welding solutions company in the world," while rotating the cycle of "needs→dealing→improvement" and obtaining feedback without pause.



# ARCMAN™ Robotic Welding System for Hull Assembly in Shipbuilding

## 1 Preface

Kobe Steel's Welding Business provides customers with excellent products and services that support their Monozukuri (production system innovation) capabilities, while aiming to remain the most reliable enterprise for total welding solutions in the world. In accordance with our latest 2016-2020 mid-term management plan, welding automation for the shipbuilding industry has been making progress as one of the solution businesses.

In many industries, including shipbuilding, a lack of skilled welders has been of increasing concern as the field sees older welders retire without attracting enough younger ones; accordingly, the need for multi-skilled workers and/or labor-saving systems is urgent in order to increase production efficiency.

This article will discuss a newly-developed robotic welding system for hull assembly in shipbuilding that raises productivity.

## 2 Features of a robotic welding system for hull assembly

### 2.1 ARCMAN™ robotic welding system

Almost all large steel ships have been built by the block construction method in recent years.

Block construction involves dividing a planned ship into several blocks, prefabricating the blocks at a shipyard assembly plant (Figure 1) before affixing them on a dock or a slipway. The prefabrication of each block – or section of a ship – includes steel cutting, processing and finishing the sub-assembly on an assembly line before the block is moved to a dock or a slipway for block-to-block joining.

Figure 2 shows a perspective view of joined blocks and the welding lines inside blocks (circled area), which are located in the parallel portions (excluding curved portions) of a ship.

Figure 2: Perspective view of joined blocks and welding lines inside blocks

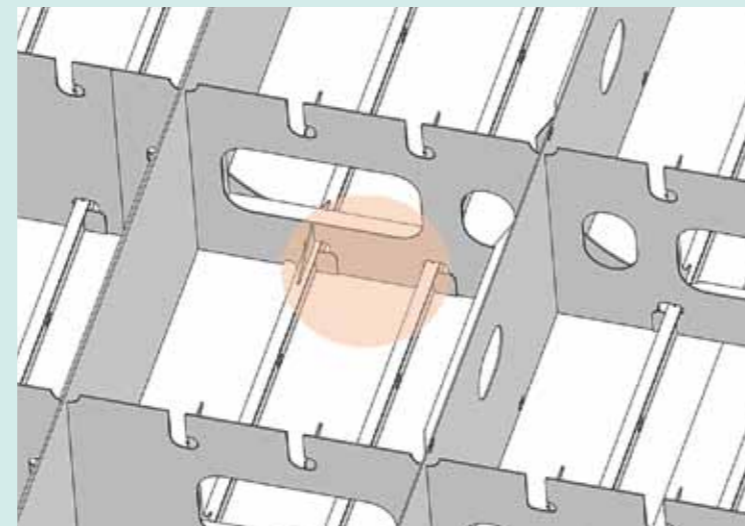
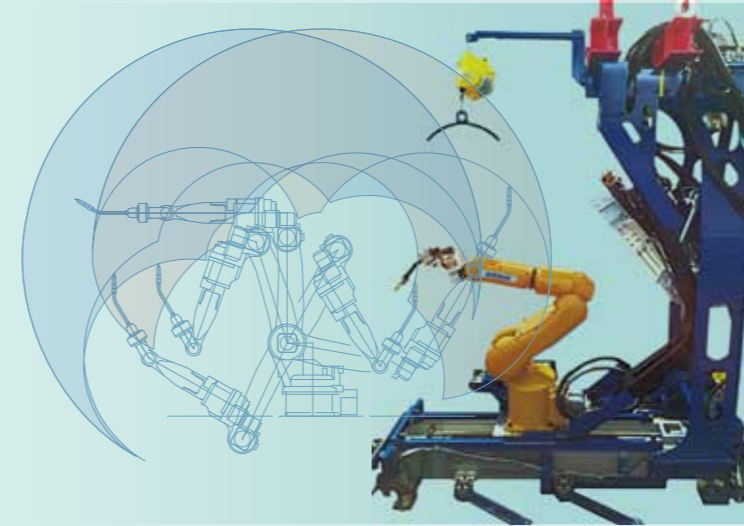


Figure 3: Arrangement of ARCMAN™ robots



Figure 4: Extremely small-sized ARCMAN™ robot and robot-carry (the ARCMAN™ set) for narrow spaces



The ARCMAN™ robotic welding system is designed to be applied in enclosed spaces inside the blocks of a ship's parallel-portion. An arrangement of ARCMAN™ robots is shown in Figure 3.

One important design factor is that a robot should fit in the narrow space inside a block. Therefore, the new robot is small enough to be set and able to weld in a space as narrow as that shown in Figure 4.

The small-sized ARCMAN™ robot is mounted on a robot-carry that is designed to be light in weight for easy transportation. The robot and robot-carry (hereinafter called the ARCMAN™ set) is hooked to a crane, and can be transported between blocks as shown in Figure 5. The ARCMAN™ set is lowered into a block until the robot-carry touches down upon the bottom plate. The robot-carry then sets its position with an automatic positioning device. Afterwards, the robot selects the target program and starts welding.

Figure 1: Schematic outline of sub-assembly and assembly in the prefabrication of a block for hulls

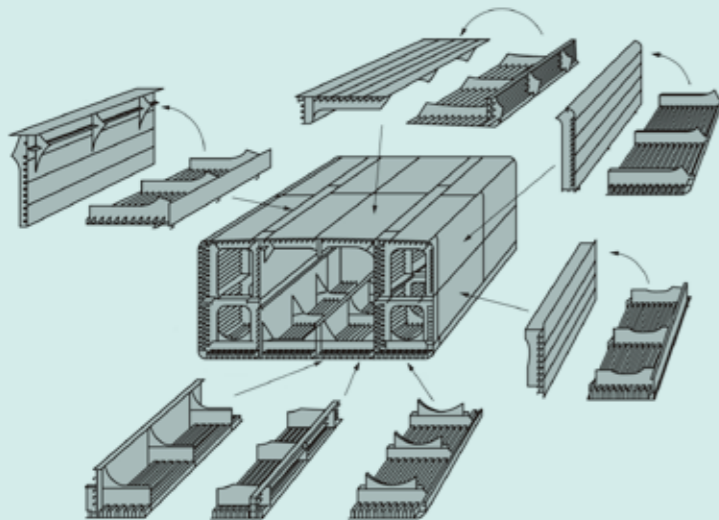
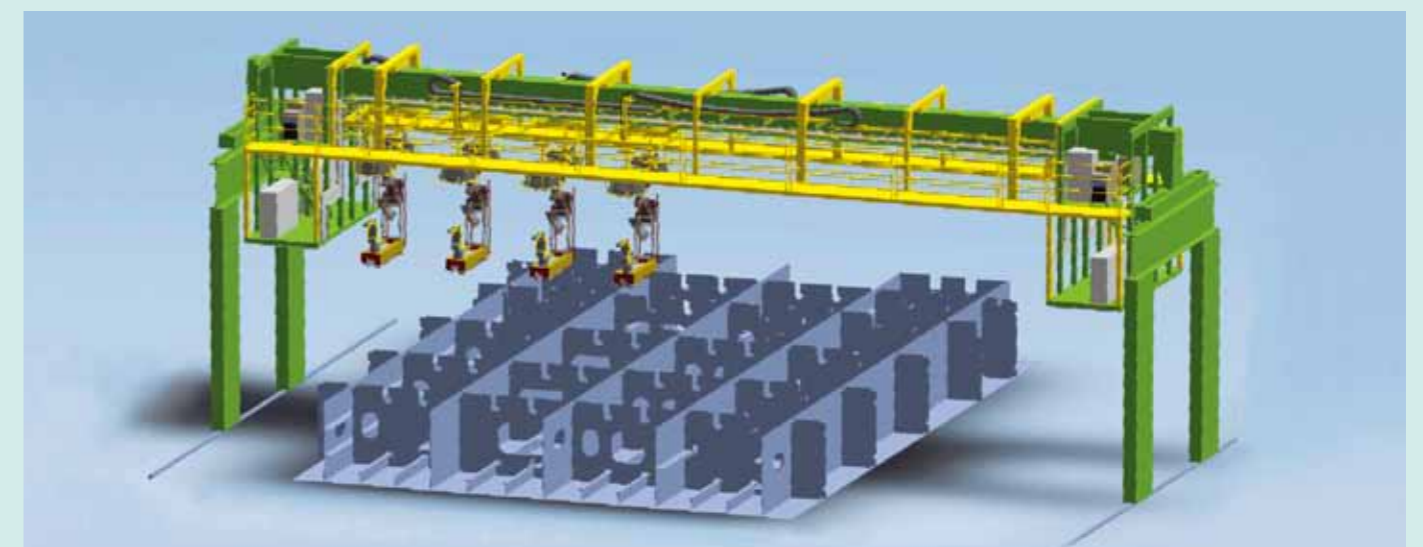


Figure 5: The ARCMAN™ robot and robot-carry (the ARCMAN™ set) arrangement for a block



Controlling the welding robot is the new “CB type” controller, which has more functions, is simpler to operate and performs better than conventional controllers. Some notable features include arc sensing technology that enables the tracing of distortion caused by welding heat (one of the ARCMAN™’s strongest advantages), vibration damping control technology, an abundance of pre-installed welding conditions, simpler operability and excellent responsiveness of the teaching pendant. Improved safety and maintenance features as well as extras like sliders and positioners that allow for integration with other systems add to the attractiveness of the ARCMAN™ system.

Figures 6 and 7 show the ARCMAN™ set, being transported to an actual application site, while hooked to a crane, and the one, setting its position with an automatic positioning device after lowered on to a bottom plate, respectively.

Figures 8 and 9 show the welding operation at an actual application site, respectively.

### 2.2 Application of the ARCMAN™ robotic welding system

The ARCMAN™ robotic welding system has been designed to be applied in a space enclosed by a longitudinal member and a transverse member as shown in Figure 10.

Figure 11 illustrates the confined space shown in Figure 6, with Nos. ① to ⑤ representing the welding lines to be welded by the ARCMAN™ system.

- ① Horizontal fillet welding between a bottom plate and a transverse member, and between a bottom plate and a collar plate
- ② Vertical-upward fillet welding between the web of a T-type longitudinal member and a transverse member.
- ③ Vertical-upward fillet welding between a collar plate and the web of a T-type longitudinal member.
- ④ Vertical-upward fillet welding between a collar plate and a transverse member.
- ⑤ Horizontal fillet welding between a stiffener and the face of a T-type longitudinal member.

The vertical upward fillet welding of the web of a longitudinal member (② and ③ in Figure 11) and the horizontal fillet welding of a stiffener (⑤ in Figure 11), can tolerate a gap of up to 5 mm. At all corners of the welding lines, boxing welding (see Figure 15) is programmed to be applied.

### 2.3 Teaching software: SMART TEACHING™

At the parallel-portion of a ship, many linear members are installed in parallel. However, though similar, their

sizes are so different that the ARCMAN™ system cannot be programmed via typical robot teaching. On the other hand, by integrating data from 3D models, an effective teaching method has been developed.

Designing with 3D models is now common in many industries, including shipbuilding, where 3D design has been used to identify problematic structural members or to check whether one member interferes with other members or not.

The offline teaching software “SMART TEACHING™” developed for the ARCMAN™ set utilize 3D models of ship-blocks for robot teaching. The ARCMAN™ set can easily create a robot teaching program with 3D model data in three steps:

- (1) Loading 3D model data
- (2) Automatically selecting the welding line to be welded inside an enclosed space of a ship block
- (3) Programming the robot teaching system

The 3D model data uses the versatile “Standard for the Exchange of Product” (STEP) format rather than CAD in order to maintain flexibility. Figure 12 shows a typical 3D model.

To extract a particular welding line out of multiple lines,

the program analyzes and applies the information of a certain shape of a space in the 3D model data, utilizing the versatile STEP format mentioned above. The program studies the shapes in each enclosed space, and recognizes the intersections made by the longitudinal and transverse members as fillet welding joints to be welded.

The coordinate data in relation to the joint as well as the shape of the enclosed space are accumulated as the welding information data of the particular welding line. Figure 13 shows how the software displays the data of a selected welding line and the shape of an enclosed space.

The robot teaching program is prepared as follows:

- (1) The welding start and finish points are established, based on the welding information data.
- (2) The robot’s movements for conducting welding are prepared.
- (3) Additional movements, such as touch sensing corresponding to the shape of the enclosed space, are entered.
- (4) The welding parameters corresponding to the shape of the enclosed space and the welding position are selected.

Figure 6: The ARCMAN™ set is transported to an actual application site, while it is hooked to a crane.



Figure 7: After lowered on to a bottom plate, the ARCMAN™ set fixes its position.



Figure 8: The ARCMAN™ set started welding.



Figure 9: The ARCMAN™ set’s welding is in operation.



Figure 10: Enclosed space for ARCMAN™ robotic welding system application



Figure 11: Illustration of the welding lines inside a space such as Figure 10

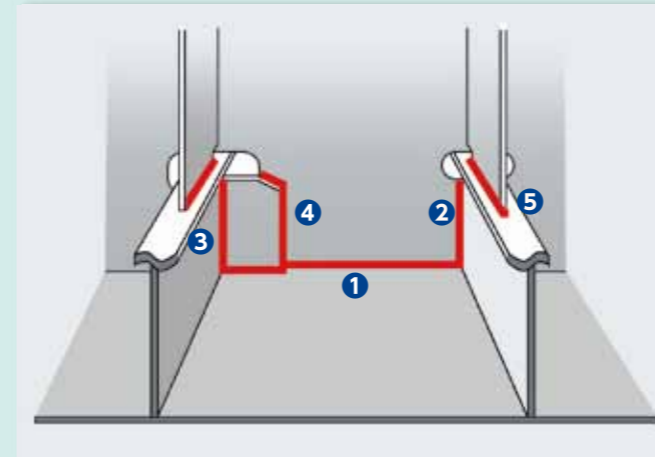


Figure 12: Typical 3D model

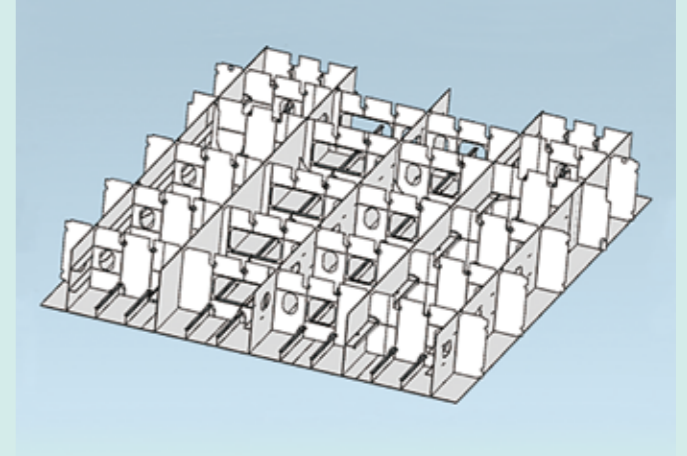
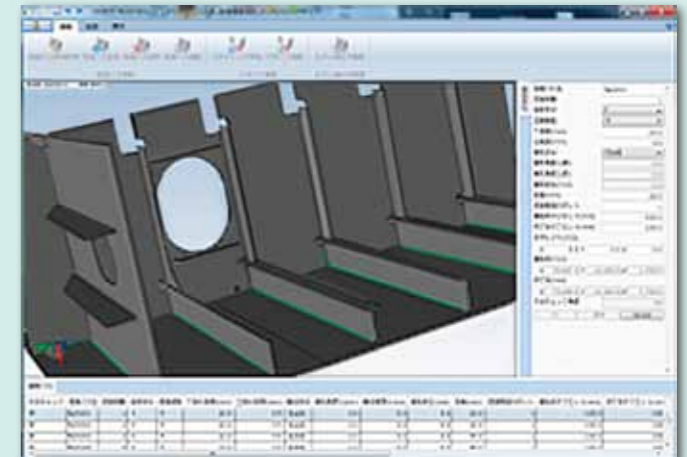


Figure 13: The software interface showing a selected welding line and the shape of an enclosed space



After the robot teaching program is prepared, the software can display a simulation of the program (see Figure 14).

Because it is difficult to use software to calibrate position errors between positions designated by the teaching program and real work-piece positions, a positioning device is installed in the robot-carry.

Once the teaching program has been entered in each robot, welding can be started at any time.

### 2.4 Welding

Of all stages in the shipbuilding process, assembly requires the most welding and accounts for over 50% of the total consumption of welding consumables. As for welding consumables, rutile type flux cored wires (FCWs) account for the highest amount of consumption.

Kobelco's representative FCWs for shipbuilding are F DW-100 and F DW-100V. Both are for all position welding though the latter is particularly excellent at gap resistance at vertical upward welding.

A number of tests comparing the performance of these two FCWs in robotic welding for a ship have found that

Figure 14: Welding simulation of the robot teaching program

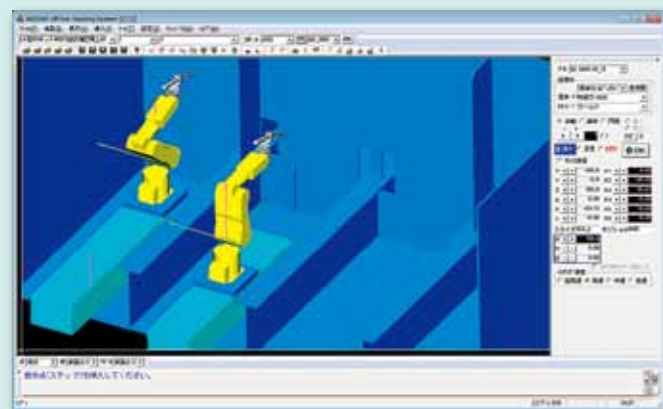


Figure 15: Weld connection between horizontal fillet-boxing welding and horizontal fillet welding



F DW-100 would be the better choice in horizontal-fillet and vertical-fillet welding as well as horizontal-boxing fillet welding.

In one set of tests, F DW-100 performed better in relation to the arc tracing function, which is a fundamental property in robotic welding. The tests examined arc tracing with and without inclination; joint gap resistance, which is common at the hull assembly stage; and also tapered gap resistance in vertical position welding.

In other tests, use of F DW-100 resulted in better bead appearance. This was true for the beads at the connection between vertical upward and horizontal fillet welding, as well as at the connection between horizontal fillet-boxing welding and horizontal fillet welding (see Figure 15).

These tests have shown that F DW-100 satisfies the demands of both horizontal-fillet and vertical-fillet welding as well as horizontal-boxing fillet welding. Figure 16 shows the bead appearance by robotic welding with F DW-100.

In addition to improving the quality of welds produced in the vertical upward direction, increasing efficiency of vertical upward welding can improve block welding as a whole because it occupies a large amount of time in the block assembly stage.

Therefore, such efforts to improve productivity as by shortening the sensing time that corrects errors during work-piece assembly, increasing welding speeds, and improving gap treatment quality are a focus of ongoing development. For example, a new back-and-forth weaving function installed in the ARCMAN™ robot combined with the CB type controller enables the arc voltage to be set at both vertical and flat member sides independently. Welding procedure experiments such as these will further contribute to improve the quality of horizontal fillet welding.

\*F: FAMILIAR™, our Trade Designation

Figure 16: Bead appearance by robotic welding with F DW-100



### 3 Future plan

In March 2014, the Industrial Internet Consortium (IIC) was established by five American companies - AT&T, Cisco Systems Inc., GE, Intel and IBM – in order to create standards related to Internet of Things (IoT). It has subsequently been joined by other enterprises and organizations in the USA, Germany and Japan.

These companies aim to promote automation and productivity through remote operation of machinery, while collecting operational data through sensors and networks. Other aims include raising operational efficiency and decreasing maintenance costs through data analysis. These technologies will be established as de facto standards, eventually helping to realize the platform in which the data of other companies' machinery and devices is installed.

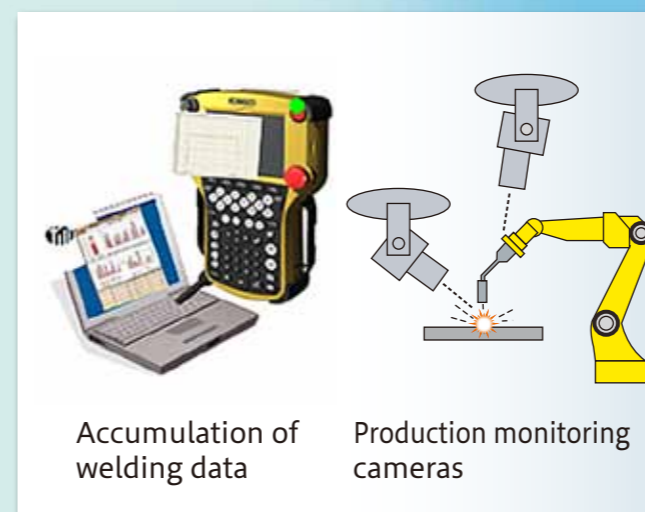
On October, 2016, the IoT Acceleration Consortium (ITAC) in Japan concluded memorandums of understanding for IoT cooperation with the Industrial Internet Consortium (IIC), the USA.

It is believed that Japan will accelerate its activities aimed at realizing the next industrial revolution by advancing these efforts in the field of IoT.

Kobe Steel is also helping to promote the process of informatization. AP-SUPPORT™, software for production support, allows for the visualization of operational data, thereby, preventing errors such as moment stops and improving productivity.

New programs have been installed in the CB type controller that can reduce welding errors by accumulating operational data through arc monitoring and grasping situational details through the use of production monitoring cameras. Figure 17 shows examples of these new programs.

Figure 17: New programs in the CB type controller



### 4 Postscript

This article discussed the ARCMAN™ robotic welding system for the hull assembly stage in shipbuilding. The ARCMAN™ set combines a welding robot and robot carry that enables welding in the confined and narrow space inside blocks with a robot teaching system that contains optimum welding parameters and robot movement information.

The ARCMAN™ system can raise the efficiency of operations hampered by limited workforces and improve productivity at various welding stages.

Aiming to remain as the premier welding solutions company, we will continue to develop not only our line-up of welding consumables but also panel line technology such as robotic welding systems for hull assembly and sub-assembly fabrication.



KWAI and Kobelco group members pose in front of the Kobelco booth.

**F**ABTECH is North America's largest metal forming, fabricating, welding and finishing event. FABTECH 2016 was held at the Las Vegas Convention Center in Las Vegas, Nevada on November 16 – 18, 2016.

1,481 exhibitors took part in the three-day annual event, which occupied 54,434 m<sup>2</sup> of exhibition floor space and attracted 31,110 visitors from 120 countries. Compared with FABTECH 2015 in Chicago, Illinois, which lasted four days, the latest event saw significantly lower numbers among both exhibitors and attendees. Even though FABTECH 2016 was one day shorter, the low attendance may yet be a sign of the times in North America.

Kobelco Welding of America, Inc. (KWAI), the Welding Business' group company in North America, has now participated in this event 28 times. FABTECH, formerly known as the AWS Welding Show, has long offered the opportunity to display KOBELCO products and technologies, to meet up with friends and customers, and collect sales leads.

At the exhibition, KWAI focused on promoting PREMIARC™ DW-308LP-XR, a stainless steel flux cored wire (FCW) that generates low hexavalent chromium; PREMIARC™ DW-G308L, a stainless steel FCW for welding thin-gauge plates; and PREMIARC™ TG-X308L, a stainless steel TIG wire for root pass-one side welding without back shielding. The "ONLY ONE" exhibition theme highlighted flagship products that identify KOBELCO as a leading manufacturer of welding consumables.

In 2016, the Welding Business established a sales and marketing base at KWAI in order to target the welding

automation business for such industries as structural steel, construction equipment, bridge construction and railcar manufacturing in North America.

FABTECH 2016 was especially significant for KOBELCO because it was the first time that ARCMAN™ MP (welding robot) and new SENSARC™ AB500 (power supply), key components of KOBELCO's robotic welding system, were exhibited in North America.

The ARCMAN™ MP display at FABTECH generated a lot of interest from potential users and put the spotlight on KOBELCO as being a producer of not only top quality welding consumables but also advanced robotic welding systems. I believe we went a long way toward achieving our goal of establishing the Welding Business as the world's most reliable welding solutions company.

Reported by **Tan Wee How**,  
Member of the Global Operations & Marketing Department,  
Marketing Center, Welding Business, Kobe Steel, Ltd.



Friends, customers and attendees gather in get-to-know-you meetings at the Kobelco booth.

## KWE's social and educational activities



Figure 1: Acknowledgement: CITAVERDE



Figure 2: Welding Practice



Figure 3: College teachers posing with Melvin

**D**ear KWT readers! My name is Rob Berkers, General Manager, Operations in Kobelco Welding of Europe B.V. (KWE). I have been working here since the 1st of May, 2000 - always with a big smile.

We manufacture both mild steel and stainless steel flux cored wires (FCWs) at KWE, which is strategically located in Limburg Province, southern Netherlands. The surroundings are very nice (see Figure 4).

We have recently established social and educational activities to support local schools and we intend to expand them step by step.

One of them involves close contact with a local school called CITAVERDE College. Although the school had opened as an agricultural school, it has expanded into other fields, such as Environment, Recycling and Sustainability. In the school, waste materials such as wood and others are recycled and reborn into something different, as shown in Figure 1.

Another way we support this school is through welding. The CITAVERDE College is currently reviewing the strengths and weaknesses of their welding course in order to raise students' abilities to the level required by industries for employment. Their current curriculum is limited to such areas as welding dissimilar metals, operating automatic welding and cutting equipment, fabrication and special welding processes. Although there are technical teachers who can teach these subjects, their experience is limited. Therefore, the college asked KWE to help them review and understand new requirements.

KWE began the training with a general introduction to safety and then continued with how to select an optimum KOBELCO welding consumable out of a wide range. Because KWE produces FCWs, the focus was on semiautomatic Flux-Cored Arc Welding (FCAW) with a selection of gas-shielded FCWs for carbon and stainless steels (Figure 2). Robert Melvin, Technical Service Manager, who is also a welding expert, gave a lecture and lesson as shown in Figure 3.

At the end of the training, the college teachers had gained insight into how to develop a new curriculum for their Welding Training Program that is realistic and appropriately aligned with their achievement goals.



Figure 4: The front view of KWE