The Leading Edge of Ultra-Fine-Precision Technology

Major Japanese auto and appliance makers like Toyota, Sony, and Panasonic are household names in countries around the world. But the real source of Japan's manufacturing strength lies in the country's small and medium-sized enterprises, which account for 99% of all companies in Japan. This first installment of a new series on SMEs possessing highly distinctive technologies and know-how spotlights two companies in the field of high-precision engineering. Japan Echo *reports on* ***Shu-Hou****, whchi has expanded the possibilities of product design with its high-precision printing technology, and* ***Dai-ichi Sokuhan Works****, which helps elevate the image accuracy of laser printers with its precision measuring equipment.*

Shu-Hou

Enabling Direct Printing on Curved Surfaces

Fukui Prefecture faces the Sea of Japan, and as part of the "snow belt," it is blanketed in snow during the winter months. It is richly endowed with nature, though, and has long maintained agriculture, forestry, and fishery industries. In addition to industries such as textiles, machinery, and eyeglasses, Fukui is also famous for beautiful traditional crafts, such as lacquer ware and *washi* paper. Yet another industry for which the prefecture is known is its several nuclear power plants.

President Koji Muraoka

It is in Fukui City, located in the northern part of the prefecture, that printing company Shu-Hou Co., Ltd. is headquartered. The company's printing technologies have been drawing attention from many industries, such as communications devices, autos, and electronics. Using printing technology with an unparalleled level of precision, Shu-Hou has developed technology capable of direct printing on curved surfaces, a feat previously considered impossible.

By achieving detailed patterns and gradations, the company's technology succeeds in creating textured products with a high-quality feel. At the same time, the technology can reduce costs and production time; as a result, Shu-Hou has been receiving inquiries about this revolutionary method even from outside of Japan.

The process is currently being applied to a large number of products, including mobile phones, eyeglass frames, and automotive products, such as steering wheels and dashboards. Surprisingly, it was by an accident of fate that Shu-Hou stumbled on the notion of printing directly onto three-dimensional objects.

Thinking outside the Box

Initially, the development of curved-surface printing evolved from an attempt to print a photo portrait on a cup as a wedding gift. Shu-Hou had been in the eyeglass business since its founding, but complications involving transaction partners and the Pharmaceutical Affairs Law rendered focusing on eyeglasses a risky proposition. The company therefore shifted its gaze to gifts and novelties, rolling out new business plans. One was to offer cups with photographs of guests' faces printed on them as souvenirs from the newlyweds, but when they approached printing companies they were turned away, being told that it was not possible. It was then that Shu-Hou began to attempt the printing on its own.

"We were complete novices at printing, and that may be why we were able to come up with a new idea," says Shu-Hou President Koji Muraoka .

At the time, conventional wisdom was that it was impossible to

print on a curved surface. Photos could be printed on special paper or film and then transferred, but that was as close to curved-surface printing as was possible. Direct printing would require technology for printing dots far smaller than conventional printers.

Over the course of six years, Shu-Hou reduced the conventional 10–20 micrometer dots down to one-tenth that size, developing an unprecedentedly precise technology, capable of printing dots only 1–2 micrometers in diameter.

The resulting ultra-precise printing equipment was developed entirely in-house. Designs and colors have no blur, and if a hundred items are printed, each will be identical to the next. The design flows seamlessly between the assembled parts of devices like cell phones, even when the individual parts are printed separately. A wood-grain steering wheel can be printed so accurately that it has the texture and quality feel of natural wood.

Shu-Hou's technology is used in a wide range of products.

Potential for New Markets

Shu-Hou's highly novel idea has given rise to a string of original technologies. First, the surface of the object is printed with a special substance that repels paint. When paint is applied over that, it sticks to the parts that have not been printed and stays off the parts coated with the special substance, creating a textured surface. This process enables ultra-fine textures that cannot be achieved using molds. Printing on three-dimensional surfaces normally requires the use of several molds, moreover, but since Shu-Hou's technology does not rely on molds, it has resulted in significant savings in both cost and time.

The company has also developed a revolutionary technique for penetrating materials themselves through printing. Because no coating is needed, the surface texture is not lost. And since the ink permeates the materials, the colors and pattern are not lost even when the surface is damaged.

Name: Shu-Hou Co., Ltd.
Address: 2-5-5 Odoro-cho, Fukui, Fukui Prefecture 919-0327
President: Koji Muraoka
Business: Production of special eyeglass frames, printing on curved surfaces, printing using ultra-precise conductive wiring
Capital: ¥430,000,000
Employees: 76 (as of April 20, 2009)
Website: http://www.shu-hou.co.jp (Japanese only)

Shu-Hou uses what appears to the naked eye to be an ordinary-looking transparent film. Under a microscope, however, a lattice of fine lines that are 1 micrometer in width becomes apparent. When metal plating is applied over these printed lines, it creates an ultra-precise conductive wiring. In the future, Shu-Hou says it hopes to use this printing technology in such fields as semiconductors, paper-thin televisions, and photovoltaic cells.

"As products become thinner and more compact, there will be more and more applications for our printing technologies," says Muraoka. "They will bring to life applications once considered impossible, reduce costs and lead times, and help conserve energy in the production process."

Shu-Hou's unique approach is breathing new life into the printing industry.

Dai-ichi Sokuhan Works

The Analog Route to World-Class Precision

Like Fukui, the city of Ojiya in Niigata Prefecture is also part of Japan's snow belt, receiving over 5 meters of snowfall annually. Dai-ichi Sokuhan Works Co. was founded here in 1944 as a manufacturer of precision measuring equipment. Since then, DSW has become a leading company in its field, claiming roughly 30% of the domestic market in screw gauges, which are devices for measuring the precision of screw threads and other items.

In 2005 the company's ultra-precise angle-indexing device received the Minister of Economy, Trade, and Industry prize in the Monodzukuri Nippon Grand Awards, instantly boosting the company's name recognition in Japan. The apparatus, which boasts

Name: Dai-ichi Sokuhan Works Co.
Address: 826-2, Tsubono, Ojiya, Niigata Prefecture 947-0044
Representative Director and President: Yoshikazu Kimura
Business: Production and sale of gauges, measuring instruments, and ball screws
Capital: ¥1,020,490,000
Employees: 247 (as of June 2008)
Website: http://www.issoku.jp/en/

world-class indexing accuracy of 0.2 seconds (1/1800 of a degree), was developed using DSW's measurement expertise.

Its optical measuring machines, capable of measuring internal diameters as small as 0.1 millimeter—marketed under the Issoku brand—have earned the trust of customers, and DSW has grown to establish a solid reputation, both in Japan and overseas. The answer to DSW's digital-age quest for precision, though, was unexpectedly found in analog methods.

Perfecting Lapping Technology

The product that made DSW famous is an angle-indexing device used when turning an item being processed on a fixed pitch during grinding with a numerical control lathe or milling machine. The ultra-precise angle-indexing device DSW developed indexes accurate angles with 720 serrations that couple with absolute precision.

DSW's angle-indexing apparatus.

The degree of precision is 0.2 seconds, "equivalent to hitting a hole-in-one on a 300-kilometer golf course," says DSW Representative Director and President Yoshikazu Kimura. The device is often used for measuring the angle of the mirrors that are at the heart of laser printers, contributing to improved image accuracy.

One factor that enables this level of precision processing is DSW's lapping technology. Lapping is a method of hand-grinding a metal surface using a finely pulverized lapping compound. According to Kimura, the process "requires experience, know-how, and manual dexterity. What's more, because you're working on the scale of 1/1000 of a millimeter, the kind of instinctive feeling that comes from experience is even more important." For this reason, the company conducts years of steady on-the-job training in order to boost employee skills.

Practice Makes Perfect

There are three parts to the lapping process: rough lapping, intermediate lapping, and finish lapping. After about a year of initial OJT in rough lapping, a worker moves on to the later stages. The amount of time it takes to be able to conduct finish lapping varies from person to person, but generally it takes about 10 years.

"We've created a manual, but with lapping, you can't always go by the book," notes Managing Director Mamoru Hara , who is in charge of the Technology Division. "The fastest way to become an expert is through practice and by closely observing experienced lappers at work."

Measuring Technology

Another factor supporting precision processing is measuring technology, which is used to inspect the finished equipment to ensure that the dimensions are in line with the design. Accurate measuring is the key to manufacturing precision equipment.

"We don't sell products," Kimura explains. "We sell measurements. Measurements are the standards used in making products, so it's a major responsibility."

President Yoshikazu Kimura

Measuring technology is DSW's lifeline. In order to prevent inaccuracies due to thermal expansion from changes in temperature, the measuring room is kept at a constant 20 degrees Celsius and 50% humidity, 24 hours a day, 365 days a year.

"Normally, inspections are made at only one point, but we test six different places," says Kenji Ishihara, DSW's quality-control manager. "Inspections are conducted not once but three times, moreover, in order to boost precision."

There is constant improvement in the accuracy of inspection devices. "But the final test is the human eye," Kimura contends. "This may be analog, but it's extremely important." DSW possesses some of the world's most precise processing technologies, but those technologies, ironically, are reliant to an unexpected degree on human skills. HJ