NITTO

Spotlight

NITTO New Product Development

This series of articles describes the behind-the-scenes efforts in product development and manufacturing. In this installment, we interviewed Mr. Asano.

From left, Osamu Asano, Keisuke Shimada, Daisuke Endo, Hiroyuki Shimizu

ATRA ACE "ARA-100"

Over 28 years ago, our company had no wide-diameter electric tool that could drill a hole with a 100 mm diameter, but we finally developed the ATRA ACE A-100. The A-100 was the largest model within its series, weighing 51 kg. I was young back then and had enough strength to lift the A-100 by myself, but now I would never be able to lift it as I am weaker and suffer from lower back pain. Many customers were also requesting that we make the machine smaller and lighter. Therefore, when the time came to upgrade the A-100, we set a product weight that could be easily lifted by one person as our primary goal. Additionally, since the existing A-100 had been designed exclusively for wide-diameter, side-lock Jetbroach cutters, we wanted to design the new model with specifications that also accommodated a variety of other cutting tools, such as small-diameter, one-touch Jetbroach and Hi-Broach cutters, as well twist drills.

ARA-100 (Left) and exisiting A-100

Designing an Electric Drill Right from Scratch

The product consists of the following three primary components: an electric drill, a magnet, and a main body. To reduce the product weight, we thoroughly reassessed the structure and materials of all parts and made innovative changes to every one of them.

Until then, the ATRA ACE had used an electric drill made by a specialized manufacturer. However, a powerful electric drill capable of drilling a 100 mm diameter hole was not available from any Japanese manufacturer back then, and products from overseas could not satisfy Nitto Kohki's stringent durability standards.

We therefore decided to develop an electric drill ourselves. We thought it would be easy to reduce the drill weight, if we could design it exactly the way we wanted. However, as we began to feel our way toward developing an electric drill without possessing any electric drill expertise, we ran into a mountain of problems.

①Side lock Jetbroach cutter (ϕ100mm)
②Twist drill (ϕ32mm)
③One-touch Jetbroach cutter (ϕ55mm)
④One-touch Hi-Broach cutter (ϕ17.5mm)

Because a single-speed electric drill could not accommodate cutting tools of all sizes from narrow to wide diameters (17.5 mm to 100 mm), we designed a two-speed drill. This increased the number of gears, which meant a weight increase. We considered the possibility of making up for this increase by reducing the weight of other parts, but were forced to reduce the size and weight of the gears themselves. In the end, we were able to satisfy both the size reduction and durability requirements by developing a design that achieved a balance between compact size and durability and by changing the lubricant for the gears from a paste grease to a liquid lubricating oil. The use of the lubricating oil allowed us to overcome many issues, including those relating to oil leakage, sealing of the spindle which rotates at extremely high speeds, and selection of lubricating oil (based on criteria including type, viscosity, and volume).

Besides the two-speed gear shifter, we also added a function that electrically makes very minute rpm adjustments to enable handling of hard-to-cut materials.

For the motor case of the electric drill, we adopted a resin in order to reduce size and weight and achieve double insulation. During the resin-molding step, we had to make many corrections before we could realize the desired dimensional precision. The tip of the electric drill was designed to accommodate various types of cutting tools and holders.

Hardness Requirement Satisfied with Design Optimization

To drill a 100 mm diameter hole safely and precisely, the hardness of the drilling machine's main body is essential. To reduce the weight of this main body, we would have liked to use high-strength die-casting. However, when production volume and cost were taken into consideration, cast aluminum was the only viable option. We therefore designed a body that was as lightweight as possible while simultaneously ensuring the required strength.

To accommodate various types of cutting tools, we had to increase the stroke (movable distance) of the slide plate 2.4 times compared to previous models. To achieve this, we eliminated the bracket, which obstructed the stroke, and also came up with the idea of widening the space between the grooves on the slide plate in order to minimize vibration during drilling.

In response to market needs, we also added a drilling position adjustment mechanism not available in the A-100, even though it resulted in a weight increase. This mechanism allows the drilling position to be adjusted by 20 mm forwards/backwards and the rotational angle by 30°.

FMEA to Ensure Safety and Prevent Breakdown

A microcomputer was used for the control circuit, which acts as the brain of the drilling machine. We incorporated a safety function that enables the operator to see the drilling load at a glance based on the LED color and automatically stops the machine if a dangerous condition is reached. We also added a lateral deviation detection function, with improved detection accuracy through the use of an electronic sensor. Furthermore, to ensure a high level of safety, we incorporated a failure mode and effects analysis (FMEA) into the circuit design.

Although we faced many hurdles, we overcame all of them to create the multi-function ATRA ACE ARA-100 weighing only 30 kg (a 40% weight reduction compared to the A-100).

(Osamu Asano, MACHINE TOOLS R&D Dept. Section I)