Feature Article

Sustainable Environmental Management Network

Reducing environmental impact in parts production processes through technological development

Introducing its policy "Creation without making new parts and without making many prototypes," Ricoh has developed "Technology for Molding Processes with an Ultra-Short Cycle Time," a technological breakthrough which substantially slashes the time, cost and environmental impact of parts manufacturing processes.

Ricoh Production Engineering Center has successfully developed production technologies that utilize simulation-based visualization to improve the production line even from the design stage. These technologies, enabling the dramatic reduction of operating costs and environmental impact, are being introduced in a growing number of our production sites worldwide.

Pursuing a shorter cooling time in the molding process

Ricoh strives to reduce environmental impact in its products across their entire lifecycles. The product parts manufacturing process has of course been playing an integral role in these efforts. Our Production Engineering Center, which is developing and improving overall technologies for parts production, has long been working to reduce both the related costs and environmental impact of parts production processes by creating thinner-walled materials, recycling, introducing highly efficient equipment, and conducting other activities. In 2005, the Center started work on the development of a "Technology for Molding Processes with a Ultra-Short Cycle Time,"[1] enabling more efficient production of molded resin parts and thereby a substantially shorter time for mold processing.

Molded resin parts account for some 40% in terms of the number of items used in imaging equipment such as copiers and printers. They are made by casting heated resin into molds and removing it after cooling. The time to cool the cast resin accounts for more than 60% of the total time required for this process, according to our study. This means a shorter cooling time would lead to the substantial reduction of production costs and environmental impact. On the assumption that cooling cast resin rapidly and removing it more quickly are the two key enablers of achieving a shorter cooling time, we conducted a three-dimensional analysis of the molded parts' heat distribution during the cooling process by using CAE[2]-based software for analyzing mold cooling processes.

1. A technology for producing product parts in a short cycle time. We use the term "ultra" when the required time is reduced by half or more compared with a corresponding conventional process.
2. CAE stands for computer aided engineering, referring to the use of computer-based quantitative simulation to support a preliminary study regarding the design of product parts and related manufacturing processes, and the tools required. In the field of mold processing, the practice/tool, which is often called "injection-molding CAE," is used for preliminary study to determine desirable product shapes and mold specifications.

Considerable improvement of mold design through the visualization of cooling processes

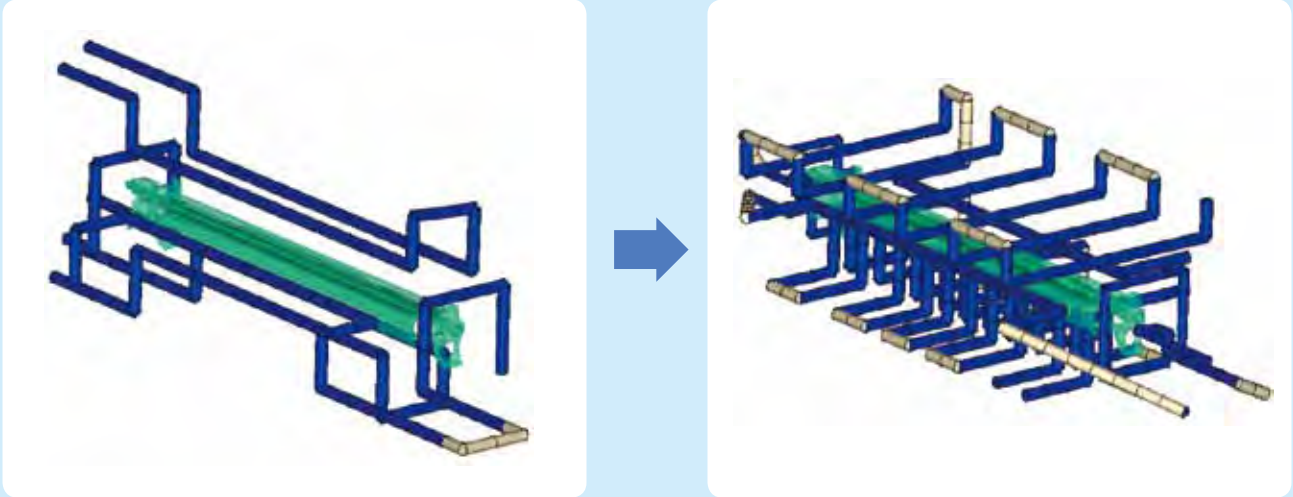
Molds for product parts are equipped with water pipes to cool the cast resin. Ideally, the pipes are placed as close to the resin as possible, in order to cool the resin as quickly as possible. However, designing molds with such a layout is very difficult because it involves very complicated mold structures and because developing a model of a water pipe layout is time-consuming.

To overcome this difficulty, we conducted detailed simulation using the CAE-based software and successfully identified an effective water pipe layout that enables rapid cooling. Furthermore, the water pipe design has become an automated process through the collaborative use of our computer-aided design (CAD) system and CAE. Now, product design staff can freely create a model by checking the simulated model on a PC monitor. As a result, we are able to create molds for product parts which are equipped with a far greater number of water pipes close to the cast resin than was technically possible before. See Figure 1.

Reducing time for mold design by highly accurate simulation

As the next step, we examined the timing of removing the cast parts from the molds. Our heat distribution analyses revealed that there are certain areas (such as thick-walled areas and areas which cannot disperse heat due to their structures) which take much longer to cool down because heat is unevenly concentrated there. Simulation data suggested that an improved mold structure which does not cause uneven heat distribution and ensures that the entire mold is cooled at a consistent pace would allow molded parts to be removed from the molds earlier without compromising the accuracy of their dimensions. This meant that they could be removed before their temperatures dropped as low as under the

Figure 1 **Water pipe models: Before and after improvement**



existing method. Based on the simulation results, a request for a change in mold design, such as the removal of thicker-walled areas to eliminate uneven heat distribution, was submitted to the design department. See Figure 2.

"Without a specific rationale for improvement in the basic design phase, no proposals for improvement can be submitted to the design department. Using the CAE-based analysis allows us to forecast with greater accuracy and include specific quantitative data in our internal proposals, which contributes to effective concurrent activities[3] aiming for dramatic efficiency improvements in our production processes," said Takeshi Hasegawa, the Production Engineering Center. See Figure 3.

3. Cross-disciplinary activities which coordinate and control related manufacturing processes across all relevant functions, such as product development and design, material procurement, production technologies, manufacturing, sales, marketing, service and others.

Reducing processing time and required facility size by half

Such improvement in mold design has resulted in the substantial reduction of cooling time and halved the cycle time of mold processing.

Figure 2 **Main unit design models: Before and after improvement**

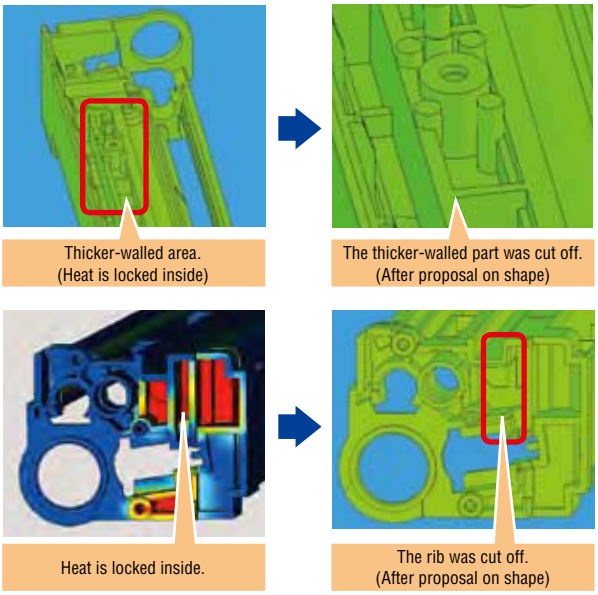
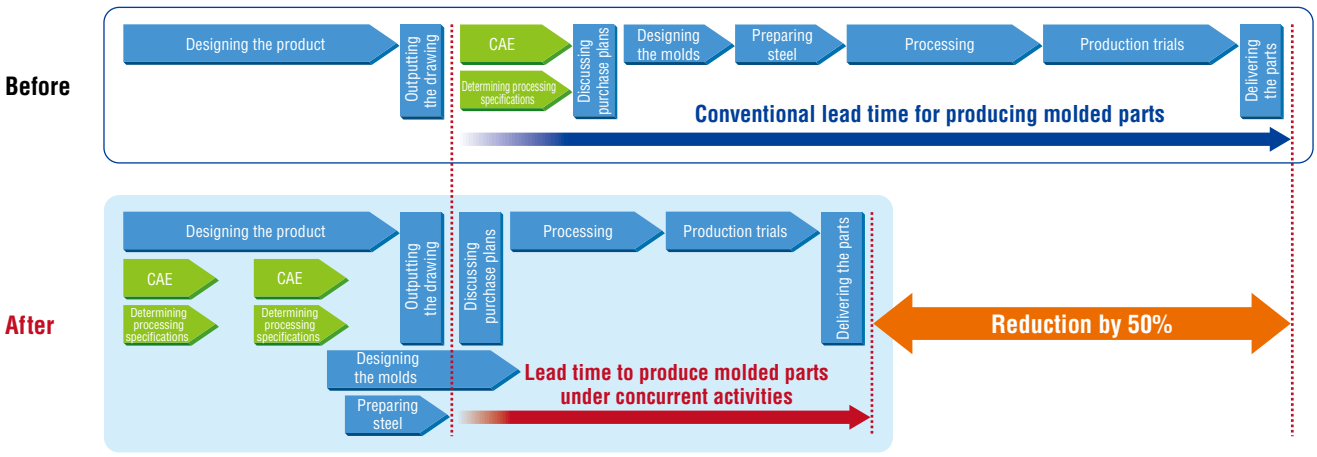


Figure 3 **Concurrent activities to achieve shorter lead time for producing molded parts**



Realizing our policy of "Creation without making new parts and without making many prototypes" through original simulation technology

Takeshi Hasegawa
Deputy General Manager
Parts Engineering Office,
Third Center
Production Engineering
Center

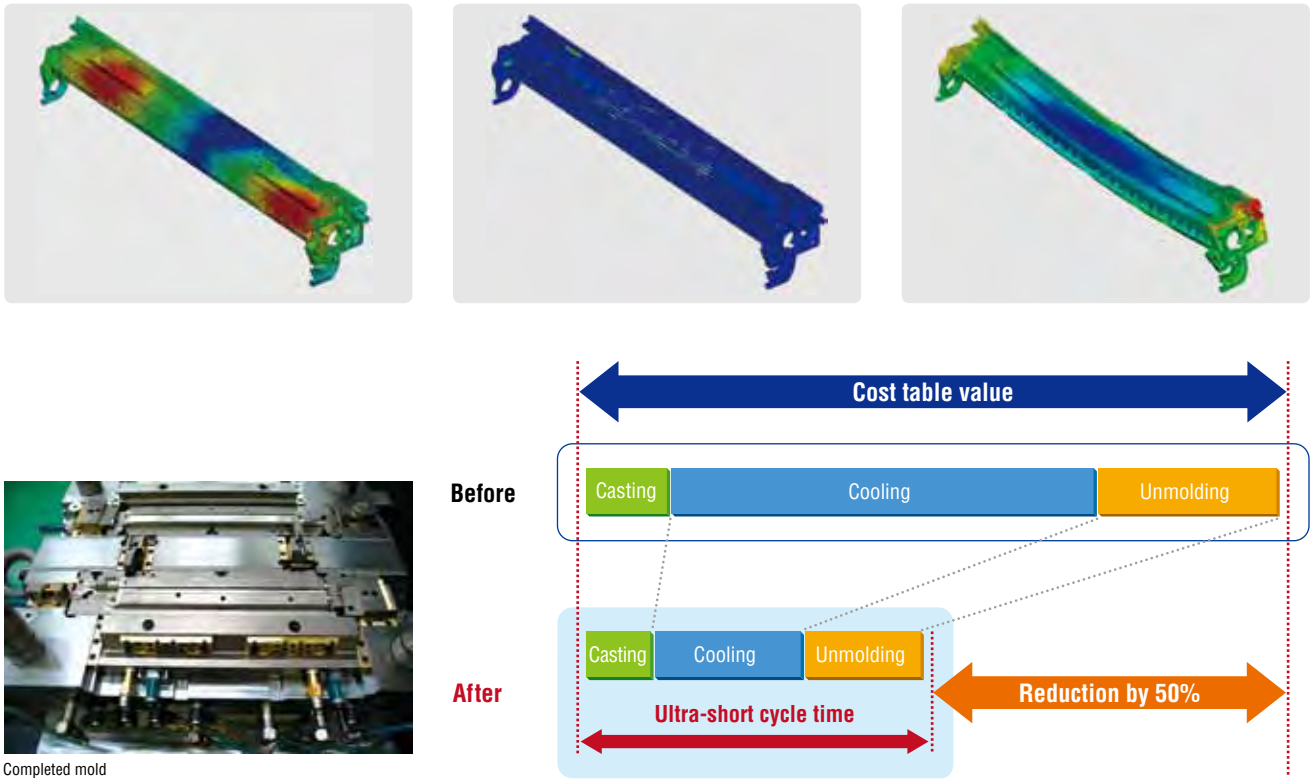
"Through elaborate customization that is tailored to the product parts concerned, you can transform CAE software, which is commonly used by many manufacturers, into an effective tool for highly precise design simulation. We at the Production Engineering Center use this tool effectively to develop Ricoh's original production technologies. Under the policy of "Creation without making new parts and without making many prototypes," we will continue to contribute to environmentally responsible manufacturing which thoroughly eliminates waste and redundancy."

"Reducing the processing time by half has resulted in halving associated energy consumption and labor costs, and even reducing the number of molds and mold making devices in use by half. Application of this technology will enable the substantial reduction of production costs and environmental impact of the manufacturing of molded parts," commented Akinori Tanada of the Production Engineering Center. See Figure 4.

In addition to promoting the Technology for Molding Processes with an Ultra-Short Cycle Time across the Ricoh Group, the Production and Technology Center is also focusing on training engineers who can conduct maintenance and repair work to maximize the useful life of molds. Experienced engineers with special expertise in maintenance visit our parts manufacturing sites around the world to provide practical training on the development of maintenance plans, troubleshooting and other necessary skills.

Toward establishing an efficient production system with low environmental impact, the Ricoh Group, ranging from design to product planning functions, is striving for technological innovation and continually introducing new production technologies in its production bases in the five major regions around the world.

Figure 4 **Reducing cycle time for molded parts production: Before and after the introduction of new technology**



Efficient manufacturing directly leads to the reduction of environmental impact

Akinori Tanada
General Manager
Parts Engineering Office,
Third Center
Production Engineering
Center

"At the Production Engineering Center, the main target of our improvement activities is cost reduction. That said, we are also contributing to reducing environmental impact because greater manufacturing efficiency directly results in lower environmental impact. The energy and resource saving effect of the recently developed Technology for Molding Processes with an Ultra-Short Cycle Time is remarkable. Currently, the application of this technology is limited to the manufacturing of molded parts, which requires high precision. We are planning to introduce it to virtually all product parts, including the outer cover, to realize even greater benefits."