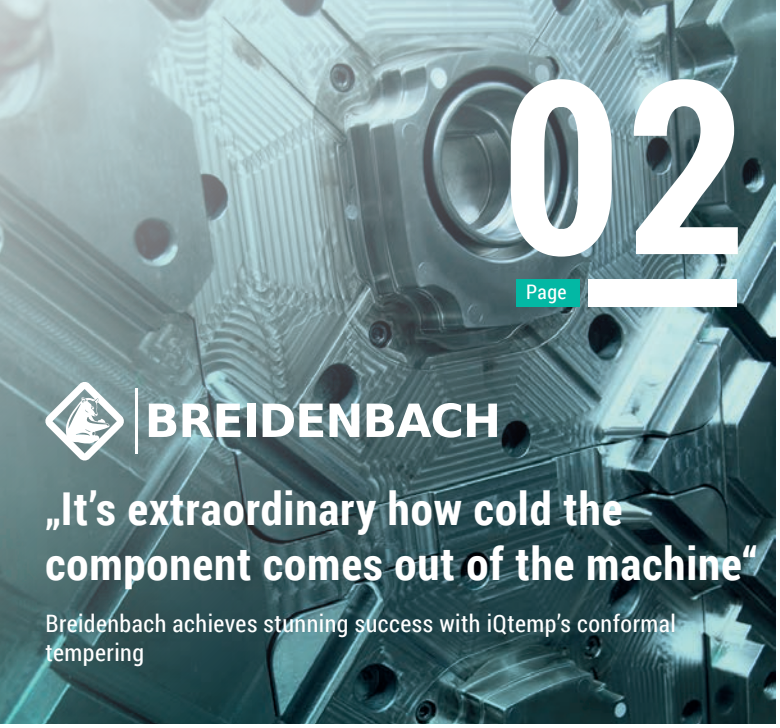

BREIDENBACH

„It's extraordinary how cold the component comes out of the machine"

Breidenbach achieves stunning success with iQtemp's conformal tempering

KÄRCHER

Better than expected

Cooling time reduction by 55% creates more productivity

Pelikan

Cool-down in 5 seconds instead of 12

Output increased by 15%

USER REPORTS

iQtemp

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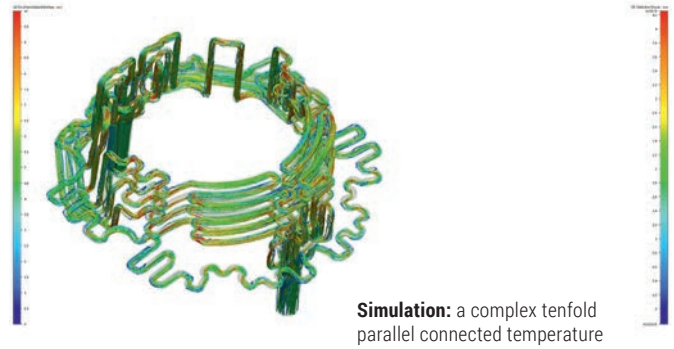
BREIDENBACH

Successfully optimising products and tools requires years of experience and know-how. The plastics processing company F.W. Breidenbach has successfully implemented projects with iQtemp GmbH – a member of Listemann Group – with impressive results and savings.

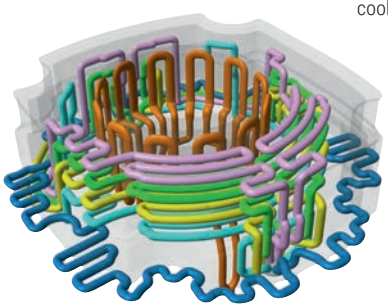
"The order was gone": Sven Rolf still remembers well the request from a customer from 2010. A casing needed to be produced, injection moulded from two components. For the senior management of F.W. Breidenbach, that was nothing unusual, as not every quotation is converted to an order.

The story then became interesting when, two years later, the very same component landed once again on Sven Rolf's desk. ***"The company commissioned at the time couldn't achieve anywhere near the calculated cycle time"***, but he was surprised about the new request for one and the same product.

The objective was to significantly reduce the cycle time of 70 seconds, which was the status quo in mass production, while maintaining or even improving component quality. Using Cadmould simulation software from software house Simcon, a preliminary study was set up on the basis of the existing CAD data, which was provided with the quotation. ***"For us, this preliminary study is standard procedure which forms part of every quotation"***, explains Sven Rolf, who places great importance at this stage on professionalism and attention to detail. Based on this study and with the aid of conformal cooling, the simulated results caused great astonishment with the customer, as at Breidenbach they charted a reduction in the cycle time to a mere 42 seconds.

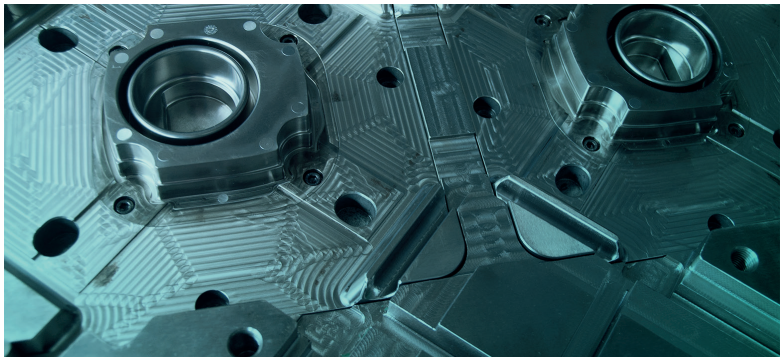


Simulation: a complex tenfold parallel connected temperature control system ensures highest cooling efficency.



Breidenbach therefore received the order the very same day to start manufacturing the tool and to take over the mass production. In order to now obtain valid results, a partnership with iQtemp GmbH – a member of Listemann Group – for optimising the tools. Carlo Hüsken, the Construction Manager at iQtemp, explored various different possible solutions for this project.

A process in which every approach is illustrated with its own simulation. ***"With this development activity, we abandon the conventional route in order to establish the optimum results for the customer"***, explains Carlo Hüsken.



Reduced cycle time – increased productivity: with this 2K-mould the part production increased sustainably

In conversation, Carlo Hüsken recalls that the first contact with Breidenbach was with Andreas Rein, the designer responsible. ***"At that time, we deliberately went to this trade fair, specifically to look for solutions to the complex issue of conformal temperature control."***, states Andreas Rein. The beginning of a now long-standing partnership, during which some products were successfully implemented.

In the preparational phase of the project the team at IQtemp managed to reduce the cycle time down to a value significantly below Breidenbach's initial value.

A cooling core, which was produced by iQtemp via laser power bed fusion (LPBW), was then integrated into the new tool. Its inner workings consist of a very complex and sophisticated temperature control system. Additionally it has a 10-fold parallel channel structure, ensuring a short flow path for the small diameter (up to 3mm) channels while simultaneously guaranteeing a high flow rate. Thus, very large amounts of heat can be removed quickly and efficiently.

These highly complex, parallel-connected cooling systems need to be balanced and CFD simulated. The simulations showed further possible solutions. These included the relocation of the injection point, to name one example. Only that way the optimum insert temperature control could be guaranteed.
"In the old mould that was a neuralgic spot, a major contributing factor for the long cycle times"

"Everything that does not smell of rubber comes from Breidenbach." What Sven Rolf quotes as a joke outlines at the same time the very special know-how of the company. The processing of thermoplastic elastomers (TPE) and thermoplastic polyurethanes (TPU) is the company's core area of expertise. In 1951, F.W. Breidenbach was established purely as a tool production company. As early as in the 1960s, the company began to process soft PVC. ***"Back then, it started with seals and gaskets for the sanitary industry"***, points out Sven Rolf. Renowned companies in the sanitary industry are still catered for today. However, the range of industries has massively increased since then. Today, from the 5,000-square metre production area, with around 65 employees, the company generates a turnover of eight million Euros.

"We place great value on sustainable solutions, in the interests of our customers." Sven Rolf puts the company's philosophy in a nutshell. Great value is placed on reliability. ***"That is ultimately what we measured against. In addition to the necessary experience, that is one reason that leads us again and again to iQtemp."***

For Carlo Hüsken, trust is the basis for good cooperation. ***"We want to deliver good results. Sometimes after a filling simulation it can turn out that conformal cooling is not necessary. In such a case we would not sell a laser-generated cooling core. The focus is always on the result for the customer."***

"It's extraordinary how cold the component comes out of the machine"

After many thousand components have been produced, Sven Rolf's enthusiasm for the project is still noticeable.

Sven Rolf, authorized signatory at Breidenbach

Internal tool shop: ten mould maker manufacture new moulds or repair and maintain customers' inventory mould.

Continous production plant: during the regular visits of Carlo Hüsken the joint tour with Sven Rolf through the production is a must.

The current machinery includes 40 injection moulding machines from manufacturers Arburg and Krauss-Maffei, with clamping forces of 20 to 350 tonnes. Its own in-house tool production, with ten employees, is also well equipped. Besides eroding machines from Agie Charmilles, Breidenbach also has a Hurco 5-axis machining centre.

A completely new tool was built for the end customer – a rotary table with a cavity, in which exclusive, laser-generated cores for cooling were installed by iQtemp. After 16 weeks of production time, it was signed off with the end customer. Fourteen days later, the injection moulding machine was equipped with the new tool for mass production.

"It fascinates you anew with each project, when everything that is worked out in theory also works out in practice."

F.W. Breidenbach GmbH & Co. KG
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High-pressure washers from Alfred Kärcher GmbH & Co.KG, with their unmistakable bright yellow casings, have become a permanent fixture in many German homes and are growing in international popularity. The devices' power and reliability encourage people to use their "Kärcher" as part of their daily cleaning routine, both inside and outside the home. To meet the increasing demand from around the world, Kärcher produces its compact washer by the million every year. More than two million K2 base model pressure washers alone leave the Obersontheim factory every year. However, even this level of production is unable to meet the global demand.

iQtemp's conformal cooling solutions prove a boost to molding productivity

Cooling time reduction by 55% creates more productivity

The use of cores incorporating conformal cooling in the moulds for its plastic casings has allowed Alfred Kärcher GmbH & Co.KG to reduce the cooling time for each part by 55%, giving a huge boost to the company's moulding productivity. The special cores, which were designed by iQtemp, a member of Listemann Group, were produced using metal additive manufacturing technology.

Challenge

One of the Kärcher washers' most recognisable features is their bright yellow casings. This was also one of the key bottlenecks in the manufacturing process. For example, the casings for the K2 series washer are produced on six injection moulding machines, each capable of moulding 1,496 casings a day. This was not enough for Kärcher, which has four assembly lines, operating three shifts per day, to give a production capacity of 12,000 assembled and packed K2 high pressure washers each day.

Clearly, one option would be to add more moulding machines. However, Leopold Hoffer, the coordinator for injection moulding at Kärcher's Obersontheim factory, believed that it should be possible to generate more productivity from the existing equipment. ***"Our aim was to reduce the cycle time from the original 52 seconds to between 40 and 42 seconds,"*** he explained. He approached iQtemp, to work on improving the cooling time in the moulds.

Solution

"The first stage of the project was to obtain data for the existing moulds to determine whether Kärcher's goal was feasible," recalled Carlo Hüsken, who coordinated the project for iQtemp. The existing injection moulding process was mapped with thermographic images provided by Kärcher and simulated using Cadmould® 3D-F simulation software. This revealed that, within the 52 second cycle time, cooling accounted for 22 seconds, with melting at 220°C and de-moulding at 100°C. The mould tool temperature was controlled with water at a temperature of 35°C and a throughput of 10 litres/minute. Hotspots, detected by the thermography, were also modelled, as these areas were responsible for the extended cycle time and needed to be analysed in more detail. With this data, a simulation of 20 cycles was completed, including an analysis of the wall temperature.

Based on a suggestion from Mr Hüsken, the temperature control on the nozzle side was improved for the second simulation run. The beryllium-copper threaded fitting dome for the body cover was provided with additional cooling by inserting two conventional cooling channels into the mould plate on the nozzle side.

Two simulations where then run to assess the potential for improvement through the use of conformal cooling. Conventional mould cooling is made up of a network of drilled channels. Drilling the channels limits the possible geometries that can be produced. Whilst adequate for simple moulds it cannot provide the most efficient cooling in more complex examples. Conformal cooling is based on the use of metal additive manufacturing to produce the core of the mould. Additive manufacturing builds the cores in a series of thin layers. The flexibility of this approach means that cooling channels of almost unlimited complexity can be incorporated. Typically, conformal cooling is used to keep the channels at an equal distance from the mould surface, thus achieving more homogeneous cooling, and/or to improve the cooling of known hotspots to result in better cycle times overall.

The simulations showed that practically all of the hotspot areas could be improved through conformal cooling, with the wall temperatures reduced by up to 70°K.

Finally, in one area where there was insufficient space in the mould to incorporate conformal cooling, Kärcher made clever improvements to the product design in order to alleviate the problem.

Based on the results of the simulations, iQtemp presented a comprehensive improvement plan to Kärcher. This showed that conformal cooling could be used to improve the temperature control of the mould hotspots, thereby achieving a more uniform cooling rate and a reduced cooling time. A modified mould design was proposed that would incorporate two additively manufactured cores to provide conformal cooling at the identified hotspots.

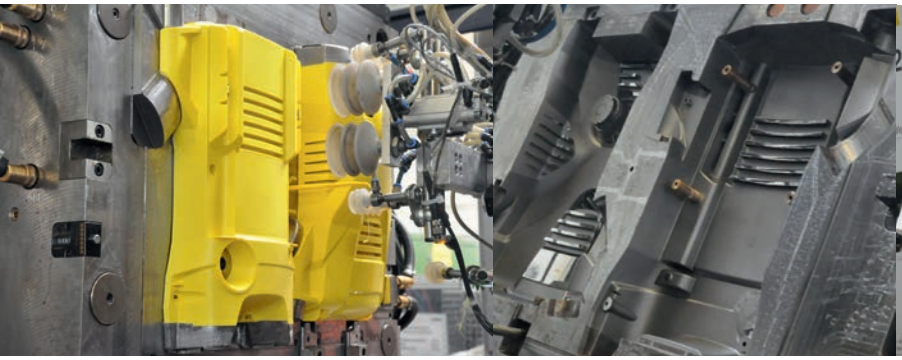
Results

The results from the modified mould design were checked by iQtemp, using thermographic images supplied. These confirmed that the wall temperatures could be reduced by 40K down to 50°C. The cooling time was reduced from 22 seconds to 10 seconds, a 55% reduction. Volker Neu, Technology & Plastics group leader at Kärcher, produced figures confirming that the new mould design, combined with the realignment of some peripheral components (material feed, handling systems, etc.), made it possible to reduce the cycle time from 52 seconds to 37 seconds. As a result, the daily capacity on one machine could be increased from 1,496 to 2,101 castings.
Kärcher then implemented the design changes for the other moulds. The additively manufactured hybrid inserts for these moulds were produced and supplied by iQtemp, with Mr. Hüsken actively supporting the mould-maker during the manufacture of the tooling.

Having initially been sceptical about the project initially, Mr. Hoffer said, ***"At the end of the day, the results were better than expected. iQtemp sold us a complete improvement package, with a holistic consideration and analysis of the mould used to achieve the best results."***

iQtemp always bases its client-specific solutions on a combination of technology. ***"In our case, this meant a mix of conventional cooling technology, project-specific cores produced using additive manufacturing, and vacuum-brazed cores"*** he added. ***"From these ingredients, we created the right recipe for the application."***

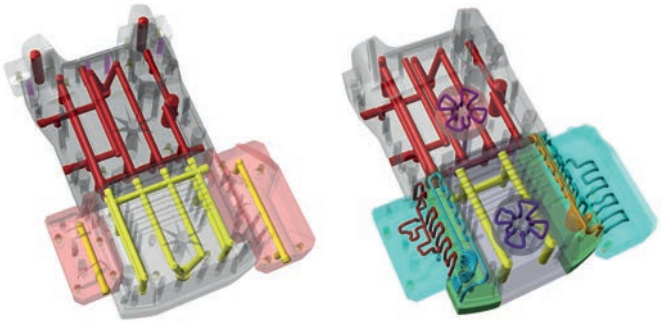
From this project, Mr. Hoffer has gathered important knowledge and experience. ***"In future, we will give more attention to cooling in the design phase,"*** he stated. ***"Cooling calculations will be an essential stage of each mould design at Kärcher. Using this information, we can then make the decision whether to work with conventional cooling or a conformal cooling solution."***



Yellow housing: 2101 parts are produced per day in the injection moulding department of Alfed Kärcher. With the help of the iQtemp cooling system, the Cycle time was reduced from 52 to 37 seconds.

„Cool" team: from left to right Volker Neu group leader Technology & Plastics from Kärcher, Carlo Hüsken from iQtemp, Rainer Aberle team leader plastics and Leopold Hoffer process coordinator injection moulds (both from Kärcher)

"iQtemp's support was excellent. For this project, iQtemp was the right choice and the company will also be the right partner when we need close-contour temperature control in the future," concluded Mr. Hoffer.



Comparison of "before and after": Original design of tool for K2 rear yellow case (left). New design tool for K2 rear yellow case with conformal cooling (right)

Alfred Kärcher GmbH & Co. KG
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Every year, millions of ink cartridges are used for Pelikan fountain pens. Complex technology goes into producing them. To reduce the unit cost, iQtemp has reengineered the mould inserts and, in particular, redesigned the cooling channel.

Who wasn't fascinated by playing with the little pellets from ink cartridges at school? The numerous complex technologies that go into producing a pen of around 20 cubic centimetres or so are usually hidden from the user. Precision, functionality and quality are absolute essentials when it comes to producing a Pelikan fountain pen. The production of ink cartridges is a prime example of the complex technologies which creates new challenges every day for the Pelikan team in Peine-Vöhrum. The single-use product is manufactured by the million every year. An efficient and sustainable manufacturing technique is required here, in order to be able to optimise unit costs.

Tightly sealed: After leaving the injection moulding machine, the ink cartridges are filled.

CONFORMAL COOLING IN THE INJECTION MOULD

Don't blot your copy-book

Manufacturing processes are regularly put through their paces at Pelikan. Is manufacturing up-to-date with current technology and can manufacturing processes be optimised? So, in the manufacture of large-capacity cartridges, optimisation approaches were sought in the injection moulding process for the ink body. ***"The objective was to reduce manufacturing costs"***, explains Helmut Broischer, Head of Engineering at Pelikan. One large-capacity cartridge replaces exactly two small cartridges in the fountain pen.

Specification for new development: 4.5 million shots

"We examined the existing tools to analyse the status quo", explains Günther M. Rehm, Head of Sales & Marketing at iQtemp. ***"In order to meeting the specification, namely, to design a new tool with significantly improved temperature control subject to the proviso of a reduced number of cavities, we focused our attention on eliminating the residual heat in the product."*** The analysis highlighted this as a weak point in the old tool.

iQtemp obtained 3D data for the planned mould inserts from Imre Törö, the design engineer responsible for the project. ***"Ensuring that we took fluid mechanics and suitability for brazing into consideration, we first constructed the very complex cooling channels. These conformally designed cooling channels were then verified using a CFD simulation"***, says Rehm, as he describes the process. CFD stands for Computational Fluid Dynamics.

Injection moulding, fill with ink, then the finale: the glass ball

There are many technologies involved in their manufacture. In addition to the injection moulding, there is an ultrasonic welding process integrated into the machine design for the ink filling. A glass ball is used to seal the cartridge. This must be manufactured with consistent roundness, within a narrow tolerance range. Once it has been placed in the shaft of the cartridge, a defined setting force must be generated between the ball and the shaft, so that the ink does not accidentally leak if the glass ball does not seal correctly. But it must also not sit too tightly, so that it allows the ink to flow freely when the cartridge is inserted into the fountain pen. Manufacturing problems, caused by changes in process parameters, inevitably lead to quality problems.

The old tool for large-capacity cartridges had a total of more than 96 cavities. Since 1986, 420 million cartridges have been produced on it. This equates to approximately 4.5 million closures. ***"That reflects both the quality of our tools and the challenge"***, comments Broischer about these production quantities. The design approach was defined in advance, so that the cycle time could be significantly reduced. They brought in iQtemp, the specialist for conformal cooling, as a partner for co-engineering alongside them. Contact with iQ-Temp was established via a recommendation.

After the customer had given its approval, iQtemp handed over the 3D data for the cooling, including the completely dimensioned and tolerated production drawings for the brazing blanks, to the customer. Using this design specification, Pelikan then manufactured the required semi-finished products in their own toolmaking shop. Once the brazing blanks were completed, they went from Peine and travelled south – their destination was Bendern in Liechtenstein.

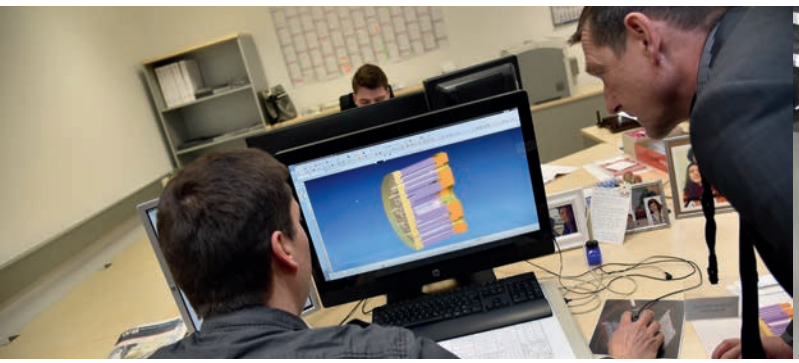
For the perfect assembly: annealed and polished before brazing

At iQtemp, work started with the technical implementation for manufacturing the tool inserts. ***"The blanks first had to be stress-relief annealed"***, explains Rehm. The adherend surfaces must be precisely crafted and flat. They must therefore be polished once again, within a defined tolerance range, before the actual vacuum-brazing process. The parts are then assembled for the vacuum-brazing process with a ready-made brazing foil. ***"Brazing this insert was a real technical challenge"***, recalls the sales representative. This consisted mainly in the technically demanding task of ensuring a permanently tight seal on very narrow brazing surfaces. ***"In addition, we could not allow braze alloy to flow into the drilled holes."***

Cool-down in 5 seconds instead of 12, output increased by 15%

Creation of a new tool with the number of cavities reduced from 96 to 48. Simultaneously, output has risen from 15,120 pieces per hour to 17,510 per hour. The new concept enabled the gating weight to be reduced from 45 grams to just seven grams. In addition, the cooling time could be reduced from twelve to five seconds, so to less than half. The total shot weight is now 40.8 grams, compared with 81.6 grams in the old tool.

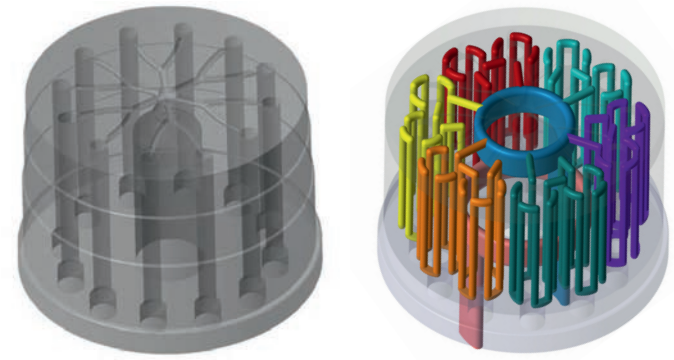
Pelikan has a generously equipped toolmaking shop. It is used for the repair and maintenance of existing tools and for new tool construction. In particular, a high priority is given to the professional training of skilled workers. ***"Young people who receive an apprenticeship contract with us also obtain a guarantee of ongoing employment at the end of their apprenticeship"***, explains Harald Schmidt, the works manager. The requirement for high quality also applies for the tools: ***"For us, they have to have a long service life."***



Fine-tuning during construction: Imre Törö (left) and Günther M. Rehm during the engineering phase.

„Cool" team: from left to right Imre Töro, responsible mould designer at Pelikan, Harald Schmidt techical plant manager, Günther Rehm from iQtemp and Helmut Broicher engineering director at Pelikan

Other important production stages are vacuum hardening and triple tempering of the complete tool insert. ***"Hardness testing and the helium leak test always form part of the conclusion of our manufacturing process, to check the insert for leaks"***, reveals Rehm. Pelikan's in-house project managers are delighted with the results. The new concept for efficient temperature control not only changed the conformal cooling, but the gating process, too. What was originally exclusively intended as a cool runner was replaced with a combination of cold and hot runners.



View of the mould cavity: the conventionally cooled cavity on the left, the conformal cooled version on the right.

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