WATERJET GIVES LUGERS THE EDGE

Fabricator shapes steels for USA Luge

By Thomas Riggs

Piloting a luge demands extraordinary strength, skill, and courage. As their sleds zoom through the curves, turns, and straightaways of a 1-mile track made of packed snow and ice, the athletes on the USA Luge team go at speeds up to 90 MPH and withstand forces up to 7 Gs. One-thousandth of a second can make the difference between gold and silver.

Crafting the sled's runners, also called *blades* or *steels*, for this high-speed, high-stakes sport is serious business. With so much riding on those steels, USA Luge counts on Accurate Waterjet in Phoenix, Ariz.

Arnie Lytle purchased Accurate Waterjet in 2008 after more than eight years at LAI (formerly Laser Applications Inc.), one of the world's largest laser and waterjet companies. Lytle started working with USA Luge in 2006, before he purchased Accurate Waterjet. His wife's grandson, who was an intern with USA Luge, made the initial connection.

Speed Reading: What Is Luge?

Although sled racing has been around since the 1400s, luge events have only been featured in the Winter Olympics since 1964. Today USA Luge recruits athletes starting at age 9, with those older than 20 typically competing at the Olympic level, according to Gordy Sheer, the team's director of marketing and sponsorship. The national team is narrowed to 10 athletes every four years leading up to Olympic competition.

Sleds are custom-made to fit each team member's body size, body type, and way of moving. Luges are about 3 feet long, weigh approximately 60 pounds, and are worth more than $40,000 each. "Each national team athlete gets a customized sled based on size, weight, and preference, and a couple sets of steels," Sheer explained. "The shapes of the steels can be altered depending on conditions, rider preference, and other factors." The team's coaches hand-finish every set of steels before attaching them to the sleds and then tune them further to fit the individual athlete.

The Cutting Edge

Accurate Waterjet shapes new steels for the USA Luge team every four years as new sleds are developed for Olympic competition. "Every four years when we do this, the process changes considerably, and the materials that we cut change significantly," Lytle said. "It's a very involved, high-tech process to develop these sleds and these steels."

To cut the latest generation of steels, which USA Luge will race in the 2020 Winter Olympics in Beijing, Lytle and his team faced a new challenge: For the first time, each steel would be shaped from a single slab of metal approximately 2 in. thick by 2.5 in. wide and 43.5 in. long.

As Sheer explained, the one-piece design demands precise postprocessing after waterjet cutting "to be sure it's shaped perfectly to reduce friction on the steel and maximize speed. Steels must be made to exact specifications with a constantly changing profile along its edge. Some places need to be sharper and some places rounder. It's all relative. Too sharp, and they dig into the ice, creating extra friction."

» Chris Mazdzer (front) and Jayson Terdiman (back) of the United States race in the Lake Placid World Cup on Dec. 15-16, 2018. *Photo by Ayden Meyers.*

A Proprietary Alloy

The metal developed for the team's sleds is similar to stainless steel, though the precise composition of the material is a closely guarded secret, unknown even to Lytle. So how could he determine the best way to cut it?

"In waterjet cutting, it's really a controlled erosion process, not truly a cutting process," he explained. "The thing that affects how fast you

» The steels, shown here on the underside of the luge, are waterjet-cut to within tight tolerances, then finished and tailored for each luge athlete.

» The ADIRONDACK HPX garnet Accurate Waterjet uses for its USA Luge work has a crystalline structure with sharp, angular edges.

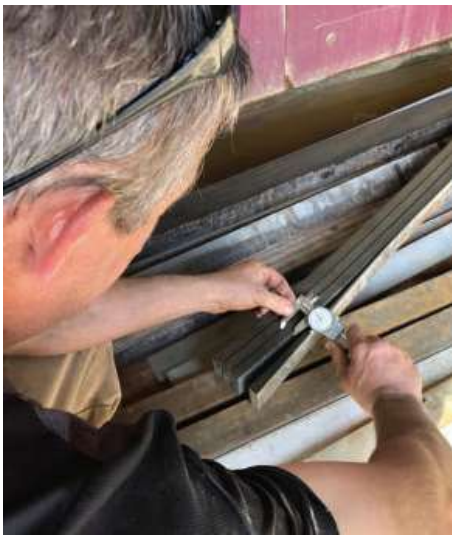
» The raw material for the luge steels comes in bars. These bars are staged and ready to be cut on the waterjet.

can go is the machinability index, which is determined by the composition of the alloy along with the hardness of the material."

Early in his waterjet career, Lytle gained valuable experience by performing efficiency studies, evaluating multiple variables such as how different abrasive grit sizes affect cutting, how varying grades and types of abrasives perform, how different abrasive flow rates affect cutting efficiency, and how different water flow rates are affected by both pressure and orifice size.

Lytle and his team take an experimental approach to determine the best way to cut the unfamiliar alloy. They perform a test cut at a safe operating speed, usually between 70 and 80 percent of the final setting. They then evaluate the test cut and, if the finish is good and well within specified tolerances, increase the speed by about 5 percent. They repeat this until the cut edge gets close to falling out of tolerance, then slow the speed slightly to establish the optimal setting.

This cautious approach was especially warranted for the 2020 games because the 2-in.-thick material is thicker than previous luge steels material. "We didn't want to push it too fast and get striations or lines in the cut," Lytle said. "If you push it too fast, it does not cut fully and wanders back and forth a little bit. You start getting a rough cut, and that is not satisfactory.



» An operator at Accurate Waterjet inspects a cut runner.

The athletes on the USA Luge team go at speeds up to 90 MPH and withstand forces up to 7 Gs. One-thousandth of a second can make the difference between gold and silver.

» The team at Accurate Waterjet that manages the project for USA Luge includes, from left, Ron Marusiak, Jeff Sims, Melinda Mace, and Arnie Lytle.

"On the waterjet, a certain grade of alloy or material generally cuts within a certain range," he continued. "We are cutting to a near net size, so that when the steels go to finishing, they can be machined easily and avoid potential machine hardening, which can be a huge problem in the secondary finishing stage."

Raw material for the steels comes in bar form, and originally the team requested a yield of one or two steels per bar, but Lytle and his team created a toolpath with common-line cutting that allowed the steels to share edges; four cuts in one bar yielded three steels. Creating this better-than-expected yield required a high level of precision. Taper can be an issue, so Accurate modified the programming to slow down the feed rate to cut more precisely. The machining that occurs after waterjet cutting requires that the blanks be waterjet-cut to within very tight tolerances.

For the latest generation of steels, Lytle relied on a Mitsubishi waterjet machine with a KMT intensifier pump that produced a maximum of 90,000 PSI of water pressure, though 70,000 PSI happened to be the most efficient for cutting the steels. The machine has a 0.010-in.-diameter orifice with a 0.030-in.-diameter mixing tube, which fed abrasive at a rate of 1 lb. per minute.

» Luge runners are cut on a waterjet system using 70,000 PSI of water pressure.

Selecting the Right Abrasive for the Job

In the past luge steels comprised several pieces, including a separate edge material that was bonded to a base metal for the main part of the runners. The shop had cut the edge material using a Barton 80 HPA garnet, but this year's one-piece steels called for an entirely new process and another type of garnet, Barton ADIRONDACK® 80 HPX®.

The brand name comes from where it's mined, from Ruby Mountain in the Adirondacks of upstate New York, not far from Lake Placid, where USA Luge is based. In support of USA Luge, Barton donated the garnet used to create the latest one-piece steels. "We are excited to participate in this effort," said Randy Rapple, president of Glen Falls, N.Y.-based Barton International, "and we look forward to seeing the team compete in Beijing."

As Lytle explained, the HPX garnet has sharper edges than HPA, so it's more suited to demanding applications. Wet processing during abrasive manufacturing removes fine materials within the garnet, which reduces the dust during the waterjet process and produces a clean cut.

"With the luge steels, we have a tolerance of ±0.010 in. through 2 in. of steel material," Lytle explained, adding the garnet's sharp edges "cut with less taper, allowing us to hold these tight quality requirements."

Cutting the actual shape of the steels isn't particularly challenging. What is challenging has to do with maintaining processing consistency in 2-in.-thick material during cycle times that are measured in hours instead of minutes.

Lytle added that the sharp edges give the garnet aggressive cutting characteristics, which helps boost cutting speed, in this case by about 10 percent, while still maintaining a high edge quality.

Previously it took the Accurate Waterjet team approximately 8 hours to cut three steels on a 55,000-PSI waterjet system with 80 HPA garnet. Using a waterjet with 80 HPX abrasive and the intensifier running at 70,000 PSI, the fabricator shortened the cut time by two hours.

Cutting the actual shape of the steels isn't particularly challenging. What is challenging has to do with maintaining processing consistency in 2-in.-thick material during cycle times that are measured in hours instead of minutes. As Lytle explained, "The challenge is that it's 2 in. thick, so you have to be sure you have good garnet flow and no interruptions like clogs that can create all kinds of issues and could easily scrap a part."

Part of the Team

In addition to the ever-changing technical challenges of this work, Lytle values the opportunity to contribute to the USA Luge organization. "I am a veteran, and almost everyone in our shop is a veteran or the family of a veteran. We all take our national pride very seriously, and so we like doing things that represent our country."

Lytle has also enjoyed getting to know the athletes. "They are unlike paid professional athletes," he said. "They tend to have more humility. I am proud to be able to help support the team because they don't have the huge endorsements and money coming in like a professional sports team would."

As Accurate Waterjet has refined its craft over the years, so has USA Luge. "Prior to us making the steels, the team had not really medaled much in several Olympics," Lytle said. "Since they started designing their own runners and we've been making them, they've started medaling a little more. We take great pride in helping the team to perform better." **FAB**

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