Athlete Engineered Technology Fine Tuned by CFD

The Science that could bring in Winter Olympic Gold Medals for Bob Skeleton Athletes

Bromley Technologies Founders: CEO Kristan Bromley (right), & Structural Dynamics & Systems Director Richard Bromley (left).

Shelley Rudman, currently ranked #1 Skeleton athlete in the world

A GREAT skeleton ride combines athleticism and courage with the science of physics and meticulous engineering design, according to Professor Kristan Bromley. Over the past 18 years, Professor Bromley, aka Dr. Ice, has used this powerful combination to personally win the 2003-2004 World Cup and the 2008 World Championship titles and three European Championship titles. This winning streak was no fluke, when following the reinstatement of Skeleton at the Winter Olympics in Salt Lake City, Kristan's scientific approach went on to support consecutive medal winning performances as part of a winning streak for British athletes.

Kristan, with a doctorate in the science and engineering behind the Skeleton sport, is CEO of Bromley Technologies Ltd. which he founded with his brother Richard and supports fellow athlete and 2012 world number one Shelley Rudman. Their impressive offices are located on The Advanced Manufacturing Park in Sheffield, England, where they neighbor aerospace giants such as Rolls Royce and the AMRC Boeing. It is here that Kristan works on developing high-performance sports products with a small but dedicated group of engineers and world-class athletes. Their company focuses on developing and manufacturing cutting edge sports products and technology that give Olympic athletes and professional teams a competitive edge. Bromley has forged a world-leading position in Skeleton Sled sport, however their expertise also extends to projects in bobsleigh, luge, composite hockey sticks, sprint footwear and bobsleigh track simulation. More recently Bromley has been nominated to partner the International Skeleton & Bobsleigh Federation in developing the sport's first Paralympic sled designs.

It's the skeleton bobsleigh that has impassioned Professor Bromley. For those unfamiliar with the sport, to briefly describe it would be to say that is it a 90 mph head-first, face-down hurtle on a narrow one man sled down a 1,500 meter ice track against a roaring 5g-force. Runs are timed electronically to the nearest hundredth of a second, and athletes are continually striving to shave off time in pursuit of the perfect run and medal success.

It's a highly tuned performance, and each sled is customized to the athlete. The athlete must be in unison with the sled and the track physics to successfully complete the course. The track is negotiated by the athlete's body using only shoulders and knee pressure on the sled and the occasional 'toe on ice' to induce subtle steering effects. There are no brakes or active mechanical steering elements. Not only is this a great physical feat but also one of mental strength and courage, because there is no place for fear as athletes hurtle down the track at dangerously high speeds, one tiny mistake could be fatal.

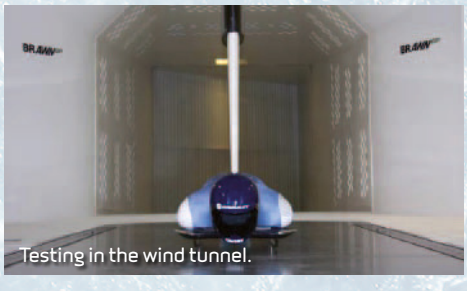
In preparation for the 2014 Sochi Games, Kristan and the experts at Bromley Technologies are putting their sport, engineering, and design knowledge to work to create the fastest sleds on the planet. A meticulous approach to design and testing is being undertaken, consisting of four stages. Stage one, which took place this past summer, included a detailed analysis of the aerodynamics of the athlete-sled system. The focus was on developing equipment that worked optimally with each individual athlete's form. Stages two and three see the team trialing their findings and fine tuning the design and set-up before stage four, the final production ahead of the winter games.

Kristan started his career as a graduate engineer for British Aerospace and is very familiar with Computational Fluid Dynamics (CFD) modeling and simulation techniques, having designed and tested his first sled some 17 years ago for the British Bob Skeleton Association. Kristan uses FloEFD™ modeling and simulation software to optimize the design of the skeletons. Doing the simulation himself, Kristan comments, "When I use a traditional CFD approach to do aerodynamic simulations, it can take weeks to get results back but now I can use engineering feedback within hours."

"An iterative approach is taken with new projects progressing from design to design. During a competitive season I can observe any new developments made by my competitors and combine these with our own ideas hot off the Bromley 'design board'. FloEFD enables me to quickly analyze these ideas to make an initial assessment before further detailed analysis is performed later in the program. It's an extremely efficient way to work in very unforgiving timescales."

For analysis, Kristan uses various flow visualization techniques, including flow lines, pressure contours and maps as well as other data gathered from testing. "I use a mix of visual and numeric outputs to inform me of what's actually happening with respect to air flow around the athlete and the sled. Visualization techniques are extremely powerful, allowing an intuitive approach to design innovation. Numerical outputs enable the direct impact of design changes to be assessed in relation to performance. Drag values from FloEFD are input into Bromley's own track simulation software in order to convert drag saving into time savings. A key part of working closely with athletes is in understanding how the changes made in one area affects other areas. For example, aerodynamic design improvements may have a secondary structural affect on the sled which would change its behavior. This means that design modifications must be made with consideration to how the change will ultimately affect the athlete."

A combination of FloEFD and Pro/ENGINEER Creo™ is used for aerodynamic analysis. In



Testing in the wind tunnel.

keeping with Kristan's "Athlete Engineered Technology" philosophy, he said "We're testing a variety of shapes that work with the geometry of the athlete. When we're talking about an athlete lying on a sled traveling at speeds close to 90 mph, the first part of the equation is the equipment, (the helmet and the sled), the other parts being the athlete and the track. Our goal is to bring all those components together into one system. We can't change the shape of the track or the athlete's body but we can change the shape of the other components to try and optimize the system. The sport is governed by very tight rules and regulations which limit large advancements. Our aim is to find multiple gains, each with a small percentage improvements that combine to make a tangible difference on the track."

The engineers at Bromley Technologies test their CFD predictions against wind-tunnel measurements to validate their results and be assured of accuracy. Reserving time in the same wind tunnel used by Formula One racing teams is expensive, so Kristan aims to use the FloEFD data, benchmarked in the wind tunnel with comparable results, to make multiple design changes within hours rather than days.

Over the past two years, Kristan and his team have worked to narrow down the optimal shape for the sled using simulation results in FloEFD. "We needed to combine aerodynamic design improvements with design modification made in other areas. This was one of our biggest challenges because any modification in one area must not negatively impact upon other areas of sled performance."

The Bromley team has been painstakingly working on numerous sled geometries over the last two years. This has resulted in a shortlist that was tested on ice at the 1994 Olympic Bobsleigh and Luge Track in Lillehammer, Norway in October. "Our aerodynamics program runs in parallel to other areas of development."

"This is a critical stage of the four year development program, where we find out if the virtual gains highlighted in FloEFD translates into real performance improvements on the track. "We need to get on the ice to test the sled. This is the only way we will know if the innovations result in performance gain."

Following testing in October the team will have a busy schedule in order to move into the final development stages in preparation for the Winter Games of 2014, which are less than 500 days away. We will be catching up with Kristan in the next issue and reporting on their results from the track testing.

For More Information…

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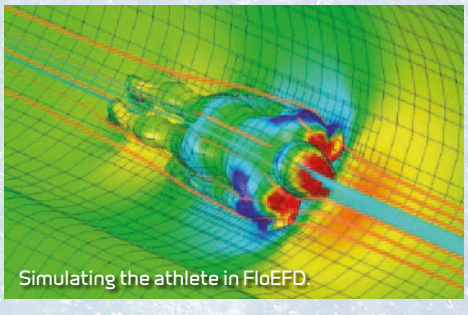

Simulating the athlete in FloEFD.