DesignNews.com
MARCH 2011
Accelerating Engineering Innovation

Walk A Mile in Your Ski Boots

By Beth Stackpole, Contributing Editor, Design Hardware & Software

As avid users of the company's own products, Black Diamond engineers translate intimate knowledge of customer requirements into optimal designs for extreme climbing and ski gear.

There are few things the product development team at Black Diamond Equipment takes more seriously than its pre-dawn ski runs or rock climbing sessions. A couple of times a week, depending on the season, the team meets up at around 4 a.m. and logs the uphill journey in the dark through the Utah canyons to catch a couple of runs or do a short climb before heading off to work.

Job candidates interested in an engineering role at the manufacturer of high-end climbing and ski gear are subjected to the same hard-core regime as part of the interview process. It's not just about bonding or feeding a shared love of extreme sports. Rather, these early morning expeditions are a key way the firm's engineers stay in sync with the needs of its customers. "It's all part of the Black Diamond culture — within the design department, we're always testing out some sort of prototype gear," says Ben Walker, Black Diamond's director of R&D. "The biggest challenge our type of products present is that it forces the design team to understand what it is our customers want and need. You can look at market research or study up on

Black Diamond's culture calls for engineers to partake in the sports they design for as a way to stay in sync with customer needs.

these activities, but it's not easy to watch someone climbing and get a true understanding of what they're doing or how they're using the equipment. You have to be in their shoes to truly understand what they want."

For Black Diamond engineers, it's not walking in customers' shoes that counts, but rather strapping on their ski boots or knowing exactly what's required from extreme climbing gear, from carabiners and rappels to ice axes and crampons. Because Black Diamond customers tend to be elite skiers or climbers, not recreational users, they take their gear seriously so it's critical the engineering team does the same. Rather than chasing after the latest bells and whistles, Black Diamond customers are all about performance and reliability because they're often entrusting their lives to the equipment since it's used under such extreme circumstances. "Whether you're a mountaineer on a peak in the Himalayas or a skier on the edge of their ability, your focus and concentration is on what the body is doing, and the gear needs to disappear into the background," says Walker. For that reason, Black Diamond's guiding design principle is minimalism, even austere design. "Our gear can't have anything that's superfluous," he explains. "We need to understand how the gear is used … so we can give them everything they need — exactly that and nothing more."

Balancing Act

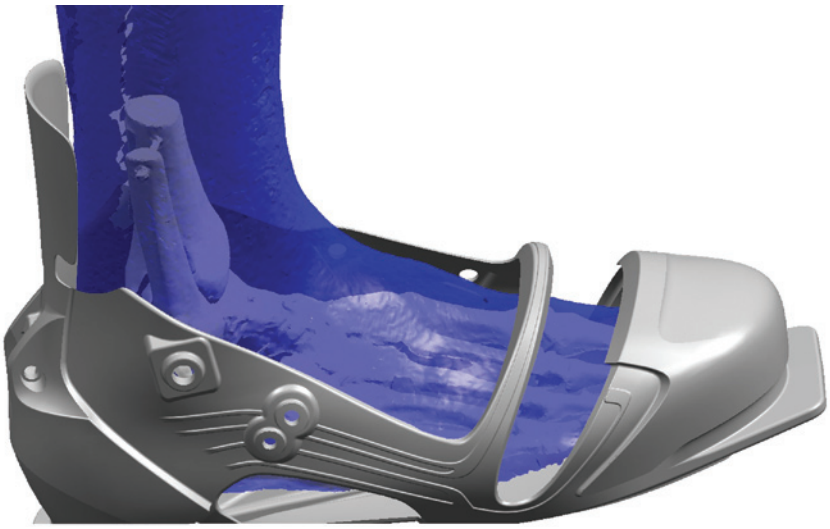
The engineering challenge to achieve that vision varies depending on the product category. In the case of carabiners, the clips used to affix ropes while climbing, the design challenge is all about keeping the form simple and minimizing weight. For skis and ski boots, Black Diamond engineers are chasing a completely different objective, aiming for the highest performance without any extras that would impede the user experience. With these kinds of products, the challenge typically involves innovative use of cutting-edge materials like composites, carbon, aircraft-grade aluminum, different glue and epoxy technologies and polyether block amide (known in the industry as PEBAX) in order to achieve performance and hit optimal weight goals.

To strike the balance, Black Diamond employs a variety of 3D design tools, including CAD, surfacing programs and FEA platforms. One of the most important initiatives was to embrace tools and workflows that fully integrate industrial design and engineering. Unlike consumer products like cars, which have a lot of engineering surrounded by a beautiful shell, most of Black Diamond's products require form and function to be built into the same part, which requires a change in processes so that industrial designers and engineers can work in parallel to ensure flaws or manufacturing issues are caught early in the process.

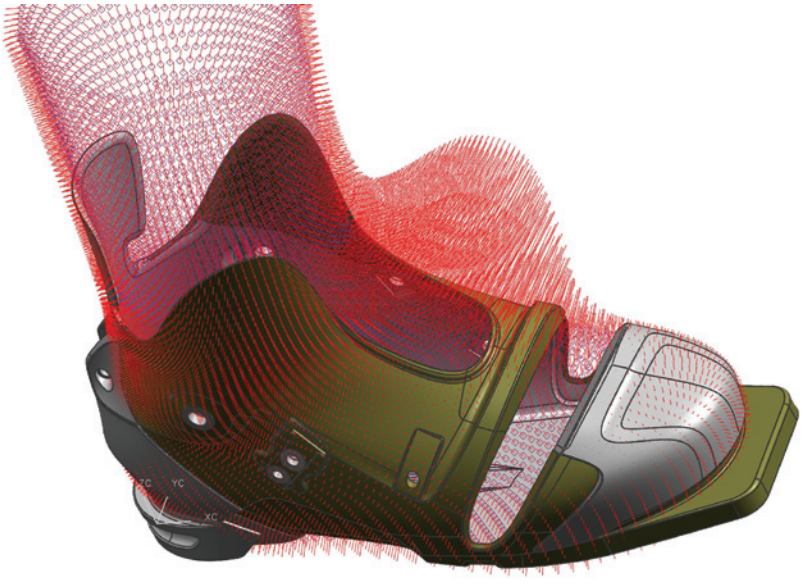
Consider the development of Black Diamond's carabiner product line, the iconic Hotwire product reintroduced last spring with the goal of reducing

weight and updating aesthetics. Using the NX CAD tool from Siemens PLM Software and the Autodesk Alias industrial design suite, Black Diamond created a process by which the same surfaces and models pulled together in NX by the engineering group were simultaneously worked on by the industrial design group using Autodesk Alias without losing design intent and without having to redo surface work as the models were passed between the packages. Engineers took the first pass at the new carabiner design in CAD, next employing Nastran Finite Element Analysis (FEA) tools to optimize materials and weight, then handing the work-in-progress back over to industrial design, which further refined the models for aesthetics. Unlike traditional processes, there were no passing back and forth of stripped-down IGES files and nothing lost in translation — a change that greatly accelerated the new carabiner's time to market.

"With this collaborative approach, industrial designers and mechanical engineers were able to work simultaneously on the same surfaces using the same tools," Walker explains. The results of this approach are pretty impressive. Black Diamond was able to reduce the weight of the Hotwire Carabiner from 45 to 37 gm. A follow-on product, the Hoodwire Carabiner, to be released later this year, pushes the envelope even further, packaging the same lightweight design with new patented technology that enables snag-free clipping and the inability to freeze up under frigid alpine conditions.



NX's Shape Studio freeform modeling capabilities are employed to directly manipulate surface geometry to capture the anatomical nuances of the foot.



Heavy FEA use was instrumental in achieving performance goals on Black Diamond's freetouring ski boots.

FEA to the Rescue

Black Diamond's Fusion technical ice tool is another example of a redesign project that benefited from the early integration of engineering and industrial design. The tool, used in ice climbing on severe alpine terrain, was earmarked for a redesign that called for weight reduction in the neighborhood of 10 percent as well as an updated look. FEA analysis factored heavily into the redesign, especially after the team determined it wasn't an option to simply reduce materials or the size of the original design to achieve its goals. "We didn't feel we could safely reduce more weight with the older design after we did the (FEA) analysis," says Brendan Perkins, design engineer at Black Diamond. Starting with a clean slate, the engineering team gave the designers a basic mockup of what the ice tool's wall thickness should be along with other critical design elements like pick angle and approximate shaft size. Using the same iterative design workflows, the team came up with a new hydroformed aluminum shaft design that was 9.4 percent lighter.

Heavy FEA use was instrumental to Black Diamond's quest to achieve its aggressive performance goals on its freetouring ski boots, which combine the performance of a traditional alpine ski boot with the flexibility of a hiking boot for skiers wanting to access terrain outside of resort boundaries. "If we're constantly being driven by customers to create equipment that doesn't sacrifice from a performance, strength or safety standpoint, yet is still getting lighter and lighter, the only way to do that is through tools like FEA," Walker says. "Previously you might get to an optimized design through engineering know-how and experience, but at this point, further

Black Diamond customers, mostly elite skiers, are looking for performance and reliability when it comes to their gear.

Black Diamond's Fusion technical ice tool is another example of a redesign project that benefited from the early integration of engineering and industrial design.

gains won't come through those means. If you're not using tools like FEA, you've already fallen behind or you rapidly will."

In addition to FEA, innovative materials use, and a process that addresses engineering, industrial design and manufacturability as an integrated function was also core to the development of the Quadrant and Prime, the latest additions to the freetouring boot family. The boots combine a blend of PEBAX and polypropylene materials to achieve the optimal weight and performance characteristics, and additional innovations such as the Boa closure system (a cable system that replaces laces on snowboard boots) were brought into the family to deliver performance without adding weight. Finally, NX's Shape Studio freeform modeling capabilities let Black Diamond designers and engineers directly manipulate surface geometry to capture the anatomical nuances of the foot in addition to analyzing the boot's performance and designing injection molded parts.

Another key differentiator for Black Diamond is its testing procedures, which occur throughout the testing and production process. In addition to formal field testing with more than 400 enthusiasts around the world, the Black Diamond development team is an integral asset. Benchmarking of prototypes and competitors' products occur regularly in the lab and the company has a several hundred thousand dollar freezer environment rigged up, where it does special testing on ski boots in extreme weather conditions using a full data acquisition environment and National Instruments' LabVIEW.

Even with all the formal testing, it's the Black Diamond team that is the best judge of what works and what doesn't. "These sports are so ingrained in the psyche of every person here," Walker says. "Every decision is made with helping skiers ski better or climbers climb more safely with equipment that's less obtrusive. It's what drives us." **DN**

For More Information

Black Diamond Equipment:
http://dn.hotims.com/34927-507
Watch several videos highlighting Black Diamond's technology at:
http://dn.hotims.com/34927-510