

Smart Force-Measuring Ice Skating Blade



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Strain gages from VPG's Micro-Measurements group are used in a new device that attaches to ice skates and measures the compressive force that comes from the impact of landing a leap. With their high precision, the strain gages enable accurate data that can be used to help figure skaters avoid overuse injuries

Company/Institute: Brigham Young University

Industry/Application Area: Force measurement

Products Used:

- EA-13-062TT-350 Strain Gages
- GAK-2-AE-10 Applications Kit
- M-COAT C KIT, RTV SILICONE RUBBER

The Challenge

When figure skaters land from a leap, they can experience five to eight times their body weight; however, they haven't been able to get a fully accurate picture of the impact their leaps put on their ankles and feet. This is because on-ice measurements of the forces associated with figure skating are difficult to record due to the complexity of the sport and not wanting to interfere with the skater during their jumps. The only way to observe indirect measures of the force figures skaters feel has been to have them jump from a box onto a force plate in a lab. To get the hard data, BYU professors Sarah Ridge and Steven Charles teamed up with professor Deb King of Ithaca College in New York to develop a method of measuring forces directly from the skate's blade.

The Solution

The team created a device that attaches to ice skates and measures the compressive forces coming from each impact. The new device lets the researchers observe the real impact on the ice by using strain gages to record that compression, storing the data on the boot, and calculating forces from the data. For the specially designed blade, the team utilized American-made strain gages from VPG's Micro-Measurements group. The gages are attached directly to the stanchions



where the blade connects to the boot. When the stanchions deform due to the force induced by the ice skater, it causes the strain gages to deform as well. Once deformed, the electrical resistance of the strain gages changes. This change is measured as a voltage via Wheatstone bridge circuits and recorded on a data logger located under the boot. The entire sensor system weighs less than a third of a pound and is designed not to touch the ice or interfere with a skater's movement.

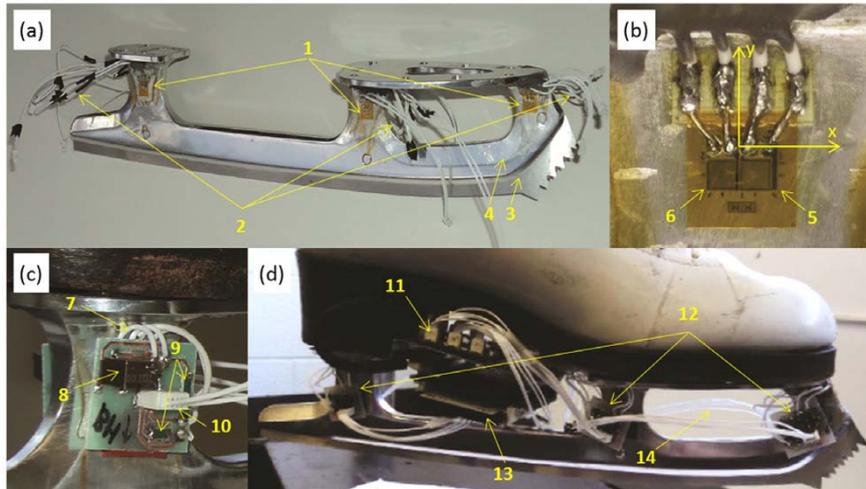


Figure 1: (a) Hybrid skate with strain gages and wires leading from gages to Wheatstone bridge boards (not shown): 1, strain gages; 2, wires to Wheatstone bridge boards; 3, steel blade; 4, aluminum blade holder. The other side of the skate has three sets of gages as well. (b) Strain gage; soldering pad; and wires up close: 5, grid 1 (x-axis); 6, grid 2 (y-axis). The soldering pad provides a larger surface for more reliable soldering. (c) Wheatstone bridge board: 7, wires from strain gages; 8, potentiometer; 9, resistors; 10, wires to signal conditioning board (SCB). (d) Integrated system: 11, SCB; 12, Wheatstone bridge boards; 13, data logger with compact flash card; 14, space for battery. (Photo courtesy of Brigham Young University)

The User Explains

Skaters do 50 or more jumps a day every day that they're training, and they often train at least five days a week if they're competitive skaters. They have a lot of force that they're landing with, over and over again, and this contributes to overuse injuries, including stress fractures in the feet and lower leg, as well as hip and back injuries. To address this problem, we aren't just applying known technology to a new application, we are operating at the limit of what the technology can do. The high-precision Micro-Measurements strain gages in our device give us high-resolution impact data, which we can provide to coaches, physical therapists, and anyone else working with the skaters to help form training routines that minimize overuse risk. Don't miss this great video – [click here](#).

“With VPG's Micro-Measurements strain gages we were able to take force measurement out of the lab and onto the ice to observe the impact that real jumps have on a figure skater's body.”



Acknowledgement:

The mission of the Department of Mechanical Engineering is to: Educate mechanical engineering students to contribute and lead in society. Offer mentoring opportunities for faculty and students to discover, apply, and disseminate new knowledge of real consequence. Provide an educational atmosphere enlightened by the Gospel of Jesus Christ.

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