A Kinematic Analysis of Joint Forces to Alter Mogul Surface Compliance

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What is Mogul Skiing?

- Freestyle Skiing[1]
- Winter Olympics since 1992[1]
- Skiing is the third most popular winter sport.[2]
What’s the problem?

- 20-25% percent of all skiing injuries are knee related[3].
- Large contact force[4].
  - jumping, twist falling, and landing.
Types of Knee Injuries[^5]

- Ligaments damage
- Knee dislocation:
  - patella dislocation
  - knee joint dislocation
- Degenerative joint disease
Knee Angles

- Knee angles from mogul skiing are near perfect for ligament injuries
- Moments and Forces can spike in contact with untuned surface
Previous Research [6]
Tuned Track\textsuperscript{[8]}

- Harvard, Yale, Madison Square garden have experimental tracks decreasing injury rates by 50% and increasing speed by 2-3%
- Average body weight force reduced by 0.71 times hard surface value
Proposed Research

• Want to research 3D kinematic forces on knee joints and ligaments while using synthetically tuned mogul
• Find an optimal surface stiffness to decrease the peak ground reaction force and while retaining speed
• Find different surface stiffness’ to account for different skill levels of skier.
Synthetic Mogul Design

• Gel encased by modular form
• Modular form has high level of vertical compliancy, extreme resistance to horizontal shear
• Allows for variation in the thickness to increase or decrease surface compliance
Testing Approaches [6]
Timetable and Costs

Time allotted:
- Construction and Experiment
- 2 months for equipment to arrive to construct course

Costs:
- Modular form: $3,500 to $4,000 for 6’ X 12’ grid
- Around $20,000 for construction of moguls
- 4 motion capture cameras with 200 fps at each mogul
- Cameras: $20,000
- Constructed reference grid and force plates
- Total around $100,000
References

Questions?