Course Overview

• How skiing works
• How equipment works
• How our bodies work
Course Structure

• Class 1
  – Basic skiing mechanics (no math!)
  – Basics of ski design
  – How turns work
• Classes 2 & 3
  – Technique
  – Teaching methods
• Class 4
  – Tactical applications
  – Boot setup
 Administration

- www.skitechtoday.com
  - Slides
  - Extra materials
  - Course announcements
  - Questions and comments
- ronlemaster@earthlink.net
  - Send me your email address
• Sign the class sheet
• PSIA and USSA credit
  – Send me an email note
The Fundamental Skiing Skill

• Balancing on something that’s moving, while that movement changes
What is Balance?
Physical Concepts

- Momentum
- Force
- Acceleration
- These are all vectors
  - Magnitude
  - Direction
- Center of mass
Momentum & Acceleration

• Momentum
  – A body’s resistance to changing its state of motion

• Acceleration
  – A change in momentum
    • Magnitude – linear acceleration
    • Direction – radial acceleration
Force

- A push or a pull
- Causes acceleration
- Pressure is force spread over an area
Newton’s 1st Law

\[ F = ma \]
What Increases or Decreases Your Momentum?
What Increases Your Momentum?

• A *linear* acceleration
• A force from *outside* your body
  – Gravity
  – Pushing against the snow
    • E.g. skating
What Decreases Your Momentum?

- A *linear* acceleration
- A force from *outside* your body
  - Mostly force from the snow
  - Air drag is the next most significant force
Force From the Snow

• Resistance to being packed
• Resistance to being broken up
• Friction is very small
Reaction Force
What Makes You Turn?
What Makes You Turn?

• A radial acceleration
• Requires a force
What Makes You Turn?

• A radial acceleration
• Requires a force
  – Mostly force from the snow
  – Gravity, but only above the fall line
What Makes You Turn?

- Force from the snow
- But *not friction*
Center of Mass

• The same as center of gravity
Centrifugal Force
Is Centrifugal Force Real?

• Yes and no
• Not a *true* force
• An *apparent* force
  – Something you feel in a frame of reference that’s in a turn
• It can be treated as a force for a skier’s purposes
Resultant Force

• The sum of two or more forces
Component Forces
Twisting Forces

- Torques
- Angular momentum
- Angular acceleration
Balance and Toppling
What is Balance?

• “You don’t fall over”
• The line of action of the resultant on your center of mass passes through your base of support
• If it doesn’t, you topple
Skier as Inverted Pendulum

- Center of mass is above base of support
- Inherently unstable
Frame of Reference
The Fundamental Skiing Skill

• Balancing on something that’s moving, while that movement changes
• Sensing the resultant
• Anticipating changes in the resultant
  – Magnitude
  – Direction
How Skis and Snow Work
Basics

• Skis extract the force from the snow to push on you in the right way so you move the way you want
The Three Important Angles

- Platform angle
- Steering angle
- Edge angle
Platform Angle
Platform Angle

- **Carving**
  - $\leq 90$ deg., ski holds

- **Oversteering**
  - $> 90$ deg., ski slips
Steering Angle
Edge Angle
How Skis Turn

- Self-steering
- Oversteering
- Carving
Oversteering

• Tail slips more than the tip as the ski moves forward
• How most turns are made
Self-Steering by Oversteering
Carving

- Ski doesn’t slip as it moves forward
- The entire edge follows the same path
- First recognized widely around 1960
Oversteering vs Carving

Path of center of gravity
Steering Angles & Self-Steering
Ski Design 101

- Length
- Waist width
- Longitudinal flex
- Torsional flex
- Camber
- Side cut
- Reverse camber and rocker
Reverse Camber on Hard Snow
Reverse Camber on Soft Snow
Photo 55 : Fantaisie sur l'angulation... (ne pas chercher à imiter).
Torsion
Carving Radius

- Determined by reverse camber
- Reverse camber is determined by
  - Sidecut radius
  - Edge angle
  - How deeply the ski penetrates the snow
## Some Typical Carving Radii*

<table>
<thead>
<tr>
<th>Sidecut radius</th>
<th>Edge angle</th>
<th>Carved turn radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>17m (all-mountain ski)</td>
<td>45°</td>
<td>12m (39ft)</td>
</tr>
<tr>
<td></td>
<td>60°</td>
<td>8.5m (28ft)</td>
</tr>
<tr>
<td>12m (full-on carving ski)</td>
<td>45°</td>
<td>8.5m (28ft)</td>
</tr>
<tr>
<td></td>
<td>60°</td>
<td>6m (20ft)</td>
</tr>
<tr>
<td>45m (traditional SL ski)</td>
<td>45°</td>
<td>31.5m (103ft)</td>
</tr>
</tbody>
</table>

*Based on the approximation: \( r_c = \frac{r_{sc}}{\cos \theta} \)

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Implications

• You can’t carve matching arcs with both feet
• Carving a consistent radius turn on a slope is problematic
Carving Radius and Slope
Turn Characteristics
Turn Phases
Transition

• The fundamental skill of advanced skiing
Skier as Inverted Pendulum

- Center of mass is above base of support
- Inherently unstable
Virtual Bump
Types of Turns

• Skidded
• Carved
• Checked
• Partially carved
Initial Steering Angle

- Oversteered turns
- Partially carved turns
In a Nutshell...

- Forces make you go, change direction, and stop
- Forces come from within our bodies and from the outside world
• Gravity gives us momentum
• The snow pushes us through our skis to change our direction, and to slow us down
• We move our bodies (using muscular forces) to get the outside forces to push on us in just the right way. That’s technique.
That’s How Skiing Works
Next Week

- Overview of technique
- Fore & aft movements (Chapt. 4)
- Up & down movements (Chapt. 5)