Three different shapes of avalanche balloons
a pilot study

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Background

- Avalanches = gravitational granular flow
- Specific sedimentation (Inverse grading)

(source: Vulliet et al. 2000)
Previous field studies

- 1975 – 79 (Hohenseter)
- 1978 (Alianz technology center)
- 1980 – 81 (Canada Park Service, Banf)
  - None of the balloon was completely buried. All visible
  - 0 fully, 4 partially – critically, 1 partially – not critically, 1 not buried
    - No balloons: 4 fully, 2 partially – critically, 2 partially – not critically
- 2001 ABS mono airbags, ABS dual airbags and Avagear collar mono type airbag vest (Kern et al. 2002)
  - 3 fully, 3 partially, 1 not buried
    - No balloons: 5 fully, 1 partially
- 2011 ABS dual airbags and Snowpulse collar type mono airbags (Meier and Harvey, 2012)
  - Dummies with airbags were buried significantly less deeper
Josef Hohenseter (1973)

(source: Kroell, 2012)
Aims

- Investigate the behavior of each inflated system in an avalanche.

- Observe if the shape may have influence on burial degree.
Methods and test site instrumentation

- 3 differently shaped balloons (Mammut Lifebag Guide 30, BCA Float 18, ABS Vario 25,)
- Human like dummies (crash test dummies, 80kg)
- Tested in avalanche, triggered by explosives (50kg)
- Backpacks were deployed 60 seconds prior to the avalanche release.
- The position of the dummies was measured with high accuracy GPS (<1m) before and after the avalanche.
- Burial degree assessed (Observational Guidelines for Avalanche Programs in the United States, Greene et al. 2010)
- Several cameras and point of view cameras were placed either in the track or across the track
About the avalanche

<table>
<thead>
<tr>
<th>Initial snow volume</th>
<th>Track</th>
<th>Avg. deposition depth</th>
<th>Max. pressure</th>
<th>Max. speed</th>
<th>Run-out size</th>
</tr>
</thead>
<tbody>
<tr>
<td>280m³</td>
<td>250m</td>
<td>1,5m</td>
<td>125,13 kPa</td>
<td>18.6ms⁻¹</td>
<td>130m x 30m</td>
</tr>
</tbody>
</table>
About the avalanche
### About the avalanche

<table>
<thead>
<tr>
<th>pressure (kPa)</th>
<th>Potential damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Break windows</td>
</tr>
<tr>
<td>5</td>
<td>Push in doors</td>
</tr>
<tr>
<td>30</td>
<td>Destroy wood framed structures</td>
</tr>
<tr>
<td>100</td>
<td>Uproot mature spruce</td>
</tr>
<tr>
<td>1000</td>
<td>Move concrete structures</td>
</tr>
</tbody>
</table>

(source: McClung and Shear 2012)
partially/not buried
partially buried—not critically
not buried
## Results

<table>
<thead>
<tr>
<th>Dummy with:</th>
<th>Movement duration</th>
<th>Track</th>
<th>Average speed</th>
<th>Max. speed</th>
<th>Acceleration</th>
<th>Grade of burial</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCA Float 18L</td>
<td>14 s</td>
<td>114 m</td>
<td>8.1 ms(^{-1})</td>
<td>16.8 ms(^{-1})</td>
<td>3.72 ms(^{-2})</td>
<td>not buried</td>
</tr>
<tr>
<td>ABS Vario 25L</td>
<td>18 s</td>
<td>124 m</td>
<td>6.9 ms(^{-1})</td>
<td>18.6 ms(^{-1})</td>
<td>3.36 ms(^{-2})</td>
<td>partially/not buried</td>
</tr>
<tr>
<td>Mammut Lifebag 30L</td>
<td>20 s</td>
<td>132 m</td>
<td>6.6 ms(^{-1})</td>
<td>17.8 ms(^{-1})</td>
<td>3.56 ms(^{-2})</td>
<td>partially buried–not critical</td>
</tr>
</tbody>
</table>

![Graph showing terrain slope profile of avalanche path](image-url)
Results

- not buried
- partially/not buried
- partially buried–not critical
Results

- 1st field test with three different shapes of the balloons
- None of the dummy was fully or critically buried, all balloons visible
- The farther the dummy was carried it was buried more seriously
- We are not able to judge the efficiency and floating capabilities of the used avalanche backpacks
- Further testing necessary (field trials, simulations...)

Limitations:
- One trial
- The results are valid only for this particular avalanche

Can be the shape of the balloon improved?
ON THE EFFECTIVENESS OF AVALANCHE BALLOON PACKS

Pascal Haegeli, Benjamin Zweifel, Frédéric Jarry, Spencer Logan, Marek Biskupič, Hanno Bilek, Hermann Brugger and Markus Falk

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Inova Q Inc., Bruneck/Brunico, Italy
Out of 100 people caught in avalanches, how many additional individuals could have survived if everybody was wearing an avalanche balloon pack?

\[ \text{Absolute mortality difference} = \text{Mortality}_{\text{User}} - \text{Mortality}_{\text{NonUser}} \]
• Benjamin Zweifel: Swiss WSL Institute for Snow and Avalanche Research SLF
• Frédéric Jarry: French National Association for Snow and Avalanche Studies (ANENA)
• Spencer Logan: Colorado Avalanche Information Centre (CAIC)
• Marek Biskupic: Slovakian Avalanche Prevention Center
• Pascal Haegeli: Canadian Avalanche Association
• Hanno Bilek: Austrian Institute for Alpine Safety
All known well-documented avalanche accidents involving avalanche balloon packs where ...

- Destructive size of avalanche was $= 2.0$
- Individuals were seriously involved in the flow of the avalanche and/or partially or completely buried.
Any additional inputs are welcome
For further information please contact
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Results: IKAR 2013
Thank you for attention!