Park Profiler/Jump Analyzer
Practical method for determining terrain park jump performance

J. A. McNeil
Department of Physics
Colorado School of Mines
and
US Terrain Park Council
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I. Terrain Park jump safety as a rider/resort partnership
II. USTPC criteria: Quantifying best practices in terrain park jump design
III. “Park Profiler” - practical tool to measure TP jump
IV. “Jump Analyzer” – software to analyze jump performance
V. Example
Winter Terrain Park Jumps
Satisfies human dream of flying

... but, as Icarus learned the hard way, there are risks.
Terrain Park Jump Safety

Terrain park jumps pose a significant hazard to patrons for head/neck/back injuries.

Two principal concerns:
1. Landing upside down (inverted)
2. Landing “hard”

Legal defense strategy is to place burden of safety entirely on the jumper.

Because a jump CAN be safely taken by a sufficiently skilled and diligent jumper does NOT make it an acceptable jump.

Alternative: Terrain park jump safety is a partnership between the jumper and the resort:

Jumper: follow the well-publicized “Smart Style” advice
1. “ride within your ability”
2. “look before you leap; land on your feet.”

Resorts: 1. offer progressive training programs (coaching, facilities, curriculum)
2. engineer design, build/maintain jumps so as to minimize the principal risks
Is it practical to engineer jumps?

“Standards are essentially impossible for a number of reasons. First, there are an infinite variety of feature sizes, shapes, slope layouts and trails on which Freestyle Terrain may be created. Second, it must be recognized that snow, the medium used for most features, is a malleable substance subject to continuous change due to weather and skier/rider use and various other factors. Third, innovation and new ideas are continually developing. A standardized environment would discourage, rather than encourage, these Developments. Finally, and perhaps most importantly, ...”
Is it practical to engineer jumps?

Freestyle Terrain Notebook (NSAA, 2008)

“Finally, and perhaps most importantly, the “individual use” factor makes standards unworkable in this arena. There is virtually an infinite number of ways that a given feature may be used by an individual as varying speed, “pop,” body movement, take off stance, angles of approach, the attempting of different kinds of maneuvers, landing stance and the type of equipment being used (skis or snowboard) will create a wide variety of experiences for users of all ability levels and experience.”

NSAA position: too much variability for “standards”
The US Terrain Park Council (USTPC) is a non-profit 501(c)(3) membership organization dedicated to providing an open and transparent venue to research, propose, and adopt criteria for best practices in terrain park management, design, maintenance, and operations to maximize user enjoyment while minimizing risk.

USTPC Criteria
2/16/2012
http://usterrainparkcouncil.org/criteria.html

I. Management
II. Planning and Design
III. Operations and Maintenance
USTPC Criterion II.D.1: 
Design of Recreational Jumps

a. start: identified start from full stop ....
b. approach: ... maximum design speed, $v_0$, less than 80% terminal ...
c. transition:
   1. radial acceleration $< 2 \text{ g } \@ v_0$
   2. if salted, start salting $> 1\text{ second } \times v_0$ above transition
d. takeoff: no convex curvature distance of $(0.3 \text{ seconds } \times v_0)$ before lip
e. landing:
   1. equivalent fall height $< 1.5 \text{ m}$
   2. long enough to accommodate takeoff speed $v_0$

How can we “do the numbers”?
USTPC Criterion II
Doing the Numbers

Maximum design takeoff speed, $v_0$, less than 80% terminal:

$$v_T = \sqrt{\frac{2mg(\sin \theta_A - \mu \cos \theta_A)}{C_d \rho A}}$$

Example: \{m = 70 \text{ kg}; \theta_A = 15^\circ; C_d = 0.45; A = 0.6 \text{ m}^2\}

<table>
<thead>
<tr>
<th>$\mu$</th>
<th>0.8 $v_T$ (mph)</th>
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<tbody>
<tr>
<td>0.06</td>
<td>42.7</td>
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<tr>
<td>0.10</td>
<td>37.4</td>
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<tr>
<td>0.14</td>
<td>31.1</td>
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</table>
Design takeoff speed, \( v_0 \), a function of \( \{\theta_T, (x_L, y_L)\} \)

\[
v_0 = \frac{x_L}{\cos \theta_T} \sqrt{\frac{g}{2(x_L \tan \theta_T - y_L)}}
\]

Tabletop form \( v_0 \) tabulated for easy use …

e.g. for \( \{H = 6 \text{ ft}, \theta_T = 20^\circ, \theta_L = 25^\circ\} \)

<table>
<thead>
<tr>
<th>Deck (ft)</th>
<th>( v_0 ) (mph)</th>
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<tbody>
<tr>
<td>6</td>
<td>8.0</td>
</tr>
<tr>
<td>12</td>
<td>11.0</td>
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<tr>
<td>48</td>
<td>22.0</td>
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<tr>
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Jump Analyzer

Software tool to analyze range of jump performance characteristics:

Given jump profile, “Jump Analyzer” calculates

1. range of takeoff speeds based on friction range
2. radial acceleration (compression) in transition
3. curvature in takeoff
4. range of landing points
5. range of landing impacts (equivalent fall height)
6. time of flight versus distance traveled (useful for training)
7. snow budget (volume of snow/unit width)

How do we get the jump profile?
Device for measuring the cross sectional profile of a jump:

Rolled over the jump simultaneously measuring distance and angle of incline – data stored on SD card

How easy is it to use?
Summary

Terrain park jumps pose a special hazard to resort patrons

Safety is a rider/resort partnership

Resort's role – implement “best practices” (NSAA, USTPC, ASTM?)

USTPC/ASTM: Any standard must be science-based AND practical

“Park Profiler” + “Jump Analyzer”: hardware and software tools to quantify jump shape and performance:
1. Range of takeoff speeds
2. Compression in transition
3. Curvature in takeoff
4. Time of flight
5. Impact
6. Snow budget
Additional Information.

Jim McNeil

jamcneil@usterrainparkcouncil.org