BASE Jumping & Wing Suit Flying – Are these guys really Crazy?

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BASE Jump

No airflow to stabilize body position
Less aerodynamic control
A single canopy sport

Highly versatile parachuting system
Inflated pilot chute starts the deployment process, pulling the canopy out of the container.
BASE JUMP

ANTENA

Avoid objects collision...
BASE JUMP
span

How low can you go....
BASE JUMP
EARTH
Climb - Jump
"Sub Optimal" landing areas...
BASE JUMP - Sub Disciplines
Aerobatics
Cave Jumping
Wing Suit Flying
Non BASE "BASE"
Contrary to the wide perception, it is NOT only about a chute that doesn’t open, this is actually extremely rare occurrence in BJ!
How Dangerous is **BASE Jumping**?

An Analysis of Adverse Events in 20,850 Jumps From the Kjerag Massif, Norway

Soreide K, Ellingsen CL, Knutson V.

*Journal of Trauma*. May 2007

- During an 11-year period, a total of 20,850 jumps resulted in 9 fatal and 82 nonfatal accidents

- Helicopter activation occurred in one-third of accidents
Postmortem examination of fatalities revealed multiple, severe injuries sustained in several body regions.

Most nonfatal accidents were related to ankle sprains/fractures, minor head concussion, or a bruised knee.

But that was in a “safe” and “sterile” environment, a high Norwegian's fjord cliff...
We evaluated a group of 102 BASE jumpers between 2006 and 2010.

BASE jumping participants were included if they had been involved in the sport for at least 3 months and had made at least 10 jumps.

Jumpers who jumped rarely and from only 1 “safe” object were excluded.

The Epidemiology of Severe and Catastrophic Injuries in BASE Jumping

Omer Mei-Dan, Michael Carmont, Erik Monasterio
Clinical Journal of Sports Medicine, 2012
68 active jumpers = 5 % of the total world BJ population (back then..) with a balanced coverage of age, gender, experience, and countries of origin
Median time respondents had participated in BJ was 5.8 years
(range, 6 months to 17 years)

Median number of jumps was 286
(males, 316; females, 96)
(range, 15-2300; Figure 4)

Forty-four jumpers (65%) were involved in other adventure sports.
These were mainly rock climbing and snowboarding
The subjects conducted 19,497 jumps with an average 0.2% severe injury rate (2 severe injuries per 1,000 jumps).

Jumpers spend a total of 15,000 jumping days leading to an injury per 384 jumping days or 2.6 significant injuries per 1,000 jumping days.
There were 39 reported injuries sustained by 29 different jumpers, indicating that 43% of jumpers have sustained at least 1 severe injury during their time in the sport.

5 jumpers were involved in 2 separate accidents
1 had 3 separate accidents
1 had 4 separate accidents
Mean Abbreviated Injury Score (AIS) was 3.2

The AIS is categorized as:
1 - minor
2 - moderate
3 - severe, not life threatening
4 - serious, life threatening
5 - critical, survival uncertain
6 - maximum, currently untreatable

<table>
<thead>
<tr>
<th>Type of Injury</th>
<th>No. Incidents</th>
<th>AIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU-related multitrauma (pneumothorax, ACLS required, head injury, and cervical spine)</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Head injury/concussion</td>
<td>2</td>
<td>4/3</td>
</tr>
<tr>
<td>Fx thoraco–lumbar–sacral spine</td>
<td>6</td>
<td>4/3</td>
</tr>
<tr>
<td>Fx ribs</td>
<td>5</td>
<td>4/3</td>
</tr>
<tr>
<td>Fx/Dx upper limb (arm, forearm, and scapula)</td>
<td>4</td>
<td>4/3</td>
</tr>
<tr>
<td>Fx upper limbs (hand/wrist)</td>
<td>4</td>
<td>3/2</td>
</tr>
<tr>
<td>Fx femur</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fx Dx/open Fx of ankle/tibia fibula</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Fx ankle (simple)</td>
<td>9</td>
<td>3/2</td>
</tr>
<tr>
<td>Fx talus</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fx calcaneus</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fx foot (mid/forefoot)</td>
<td>7</td>
<td>3/2</td>
</tr>
<tr>
<td>Tear Achilles</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Head major laceration</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

ACLS, advanced trauma life support; Fx, fracture; Dx, dislocation.
61% of BASE jumping accidents involved the lower limbs,
20% involved the back/spine,
18% were chest wall injuries
13% were head injuries
52% required acute surgical intervention
72% of the jumpers had witnessed death or serious injury of other participants in the sport.

43% jumpers had suffered significant injury.

76% had at least one “near miss” incident.

Only 6% of the jumpers in this series have never sustained an injury, never had a near miss, and never witnessed a fatality or critical injury.
Average time in the sport:
“Untouched” jumpers 2 years
Rest of the jumpers 5.8 years

Average number of jumps made:
“untouched” - 23
Rest of the jumpers - 286

>> If you have not injured or almost killed yourself while jumping or have not seen a jumper die yet, you are probably new to the sport of BJ
The role of experience in respect to injury occurrence:

- 30% of injuries occurred when jumpers had performed < 50 jumps
- 25% of injuries occurred around the 100 jumps mark
- 31% between 200 and 500 jumps
BASE Jumping has **12** times the fracture rate and **16** times the hospitalization rate of skydiving.

Injury rate is **30** times higher than Skydiving.
So, if you feel that BASE jumping is too dangerous.....
You can always switch back to skydiving......
Fatalities in BASE and Wing-Suit flying
“BASE fatality list”

The relatively small number of BASE jumpers worldwide and their streamline communication enabled the precise documentation of fatality data.

Since 1985, BASE jump fatalities are documented and updated regularly as an open source containing reports on the attributable factors leading to the incident described for the benefit of future participants.
Hitting the wall when jumping in proximity to surrounding objects or when canopy is opened facing the object jumped from

No airflow to stabilize body position
Less aerodynamic control
Aerobatics

lack of control / vertigo / too slow= hitting ground prior to deployment
lose of body position/orientation- chute is not deployed in box position
Calculation of the approximate overall BASE jumping annual fatality risk during the year 2002 was of one fatality per 60 participants per year.

The fatality rate associated with skydiving from 1994 to 2009 has gradually increased, from 0.008 to 0.01 per 4,000 solo jumpers per year.

As so, the overall annual fatality risk in BASE jumping is approximately 40–65 times higher than in skydiving.
We are in 6/2016 and the current number is 284 (June 5th), it was 230 at the 2014 version of this talk...

25 years - 106
10 years - 178
Since 1981 to date, there were 316 BASE jumping documented fatalities attributed to a population of presumably less than 2500 jumpers, indicating an estimated 10% overall fatality rate since its evolution.

Fatality rates for BASE jumping seem to be consistent, with a moderate increase corresponding with the growth of the sport:

2009 - 15
2010 - 16
2011 - 20
2012 - 19
2013 - 24
2014 - 25
2015 - 27
2016 - 37

WHY?
Can a human being fly?
Turn around time...
2002 to 2007:
61 BASE jumping deaths, 10 (16%) - wing suit related

2008 to 2011:
59 fatal events, 29 (49%) - wing suit related

2013, 21 of 24 (87%) fatalities were wing suit related

Same trend is seen through 2016
Fatalities in Wingsuit BASE Jumping

Omer Mei-Dan, MD; Erik Monasterio, MD; Michael Carmont, MD; Anton Westman, MD, PhD

**Table 2. Incident mechanisms contributing to fatality**

<table>
<thead>
<tr>
<th>Fatal incident mechanism</th>
<th>No. of fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wingsuit glide path miscalculation</td>
<td>17</td>
</tr>
<tr>
<td>Wingsuit equipment failure</td>
<td>1</td>
</tr>
<tr>
<td>Pilot chute complication</td>
<td>5</td>
</tr>
<tr>
<td>Exit complication</td>
<td>7</td>
</tr>
<tr>
<td>Unknown</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
</tr>
</tbody>
</table>
2013: 19/24 (80%) fatalities occurred between April and October
Fatalities by country of incident, categorized as with or without a wingsuits

The countries from which most wingsuit BASE jumping fatalities were reported: Switzerland (13), Norway (7), and France (8) → Europe 82%
Description:

Report that has come to light is that Jumper had shown up in Lauterbrunnen with his experience in base jumping at 10 slider down base jumps prior to this base trip...

Jumper was a very experienced skydiver with AFF rating and tandem master and a few thousand skydives...

Which is why the base community can’t understand why he felt the need to rush into base jumping and jump a wingsuit on his 10th base jump. Witnesses stated he made 12 jumps in the valley in the days, leading up to the incident.

The jumper exited from yellow ocean, an object that has a 350^ meter rock drop and only 425 meters to the landing area. His Flying in his wingsuit (venom) was very head high and slow and therefore likely flying in a stall.

The canopy gets to line stretch but at the same time he hit the ground the canopy and bridle draped over the power lines (lower voltage).

There was 2 joined possible causes for death... Impacting ground at extreme force was the primary cause of death (possible low pull or pc caught in burble).

1.) This jumper had only 10 low altitude BASE jumps and ignored all advice from his fellow travelers and jumpers in the valley at the time.  

2.) This jumper didn’t register for the Landing card making it hard for Police to identify him and contact his family. He had no information from the SBA nor informed himself on the various exits and their profiles.  

3.) This jumper assumed yellow ocean was a suitable exit for beginners, not considering that this exit doesn’t have sufficient height to practice Wing-suit flights!  

4.) Excellence in skydiving experience can help awareness and reactions in BASE, but it doesn’t substitute proper training and preparation in this very different environment!

This fatality could of easily been prevented if the jumper had slowed down and re-evaluated his jumping...
Date: August 13th, 2013  Nationality: French  
Object Type: Earth  
Location: Devolouy, France  
COD: Impact  
Clothes / Suit: Wingsuit X-bird

Description:
Was the first to go from a 3 way wingsuit from the house of cards... After exit he was flying to cross over the ridge or what is called the First house of card and impacted with nothing out trying to out fly the first ledge... This has rocked the smaller French community from the bourne area and has made everyone think to take a step back....

Date: August 16th, 2013  Nationality: Polish  
Object Type: Earth  
Location: Samoëns / Sixt-Fer-à-Cheval, France  
COD: Impact (proxy flying)  
Clothes / Suit: Wingsuit

Description:
Whilst flying a line he impacted a ledge in flight and was killed instantly...

Date: August 17th, 2013  Nationality: French  
Object Type: Earth  
Location: Dent de l'Arcusaz, France  
COD: Impact  
Clothes / Suit: Wingsuit

Description:
He had flown the normal line flown by experienced jumpers from this exit,BUT wrong appreciation of the height on the way of the grassy dome then too low. Slide and Impact in the grass.

Date: August 23, 2013  Nationality: Spanish  
Object Type: Earth  
Location: Dumpster, Lauterbrunnen, Switzerland  
COD: Impact  
Clothes / Suit: Wingsuit X2

Description:
“We were in Switzerland, we made this jump many time before, no complications compared with some that we have these days back. It was a Three way X-bird was second and me after Him. We were flying near the wall, but in a “safety way”, and you see that at some point it has come too close, seemed about to hit a part of the wall that was more prominent, he has turned to avoid that, but has made the turn too sharp and minced, as when rotating a plane and goes some head down... He could not regain that ground has played with the slope and impacted ....
Table 1. Sex of parachutist suffering fatalities, related and unrelated to the use of wingsuits\textsuperscript{4}

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of total fatalities</th>
<th>No. of wingsuit fatalities</th>
<th>No. of nonwingsuit fatalities</th>
<th>% Wingsuit/nonwingsuit fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>165</td>
<td>38</td>
<td>127</td>
<td>30</td>
</tr>
<tr>
<td>Female</td>
<td>15</td>
<td>1</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>180</td>
<td>39</td>
<td>141</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion...

Wingsuit-related BASE jump fatalities appear to be increasing as this version of base jumping becomes more popular.

Most fatalities are attributed to cliff or ground impact, and most are the result of flight path miscalculation.

As with many other extreme sports, limited experience also seems to be a contributing factor to wingsuit fatalities.
The rapid development in wingsuit design, combined with the jumper’s motivation to push the boundaries, may in essence have led some jumpers to act as test pilots of new wingsuit concepts.
So what do we do about it?
So what do we do about it?

- Proximity flying - the “problem” of better glide ratio and experience
- Mis calculation
- Pilot chute caught in air burbles
- Take-off aspects (slipping / stability / “feeling of void/no speed”)
- Experience (2 of the fatalities – first wingsuit BASE jump…)
Personality characteristics in mountaineers and BASE jumpers – are they really crazy?
CRAZY

From the 16th Century
...originally meant ‘to break in pieces, shatter’

...Mad, especially as manifested in wild or aggressive behavior

Medico-legal definition
...mental illness of such a severe nature that a person cannot distinguish fantasy from reality, cannot conduct her/his affairs due to psychosis, or is subject to uncontrollable impulsive behavior.
wild behavior, fantasy from reality
RESEARCH phases

Stage 1

Determining accident and fatality rates experience and personality characteristics in a group of climbers and BASE jumpers

TCI

Temperament

1. N.S. (Activating/Exploratory)
2. H.A. (Inhibitory/Aversion to risk)
3. R.D. (Maintaining/positive rewards)
4. P. (perseverance/ resistance to extinction despite frustration)

Character

1. S.D. (Autonomy/ willpower)
2. C. (Integral part of humanity/society)
3. S.T. (Connectedness to universe/nature)
<table>
<thead>
<tr>
<th>TCI scales</th>
<th>TCI subscales</th>
<th>High scorers</th>
<th>Low scorers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novelty seeking</td>
<td>NS1 excitability</td>
<td>Exploratory</td>
<td>Reserved</td>
</tr>
<tr>
<td>Novelty seeking</td>
<td>NS2 impulsivity</td>
<td>Impulsive</td>
<td>Rigid</td>
</tr>
<tr>
<td>Novelty seeking</td>
<td>NS2 extravaganze</td>
<td>Extravagant</td>
<td>Thrifty</td>
</tr>
<tr>
<td>Novelty seeking</td>
<td>NS4 disorderly</td>
<td>Rule-breaking</td>
<td>Orderly</td>
</tr>
<tr>
<td>Harm avoidance</td>
<td>HA1 pessimism</td>
<td>Pessimistic</td>
<td>Optimistic</td>
</tr>
<tr>
<td>Harm avoidance</td>
<td>HA2 fearfulness</td>
<td>Fearful</td>
<td>Risk-taking</td>
</tr>
<tr>
<td>Harm avoidance</td>
<td>HA3 shyness</td>
<td>Shy</td>
<td>Outgoing</td>
</tr>
<tr>
<td>Harm avoidance</td>
<td>HA4 fatigability</td>
<td>Fatigable</td>
<td>Vigorous</td>
</tr>
<tr>
<td>Reward Dependence</td>
<td>RD1 sentimentality</td>
<td>Sentimental</td>
<td>Objective</td>
</tr>
<tr>
<td>Reward Dependence</td>
<td>RD2 sociability</td>
<td>Open</td>
<td>Secretive</td>
</tr>
<tr>
<td>Reward Dependence</td>
<td>RD3 sociability</td>
<td>Friendly</td>
<td>Detached</td>
</tr>
<tr>
<td>Reward Dependence</td>
<td>RD4 dependence</td>
<td>Approval-seeking</td>
<td>Independent</td>
</tr>
<tr>
<td>Persistence</td>
<td>PS1 eagerness</td>
<td>Enthusiastic</td>
<td>Hesitant</td>
</tr>
<tr>
<td>Persistence</td>
<td>PS2 hard-working</td>
<td>Determined</td>
<td>Easily discouraged</td>
</tr>
<tr>
<td>Persistence</td>
<td>PS3 ambition</td>
<td>Ambitious</td>
<td>Lazy</td>
</tr>
<tr>
<td>Persistence</td>
<td>PS4 perfectionism</td>
<td>Perfectionistic</td>
<td>Underachieving</td>
</tr>
<tr>
<td>Self-directedness</td>
<td>SD1 responsibility</td>
<td>Responsible</td>
<td>Blaming</td>
</tr>
<tr>
<td>Self-directedness</td>
<td>SD2 purposefulness</td>
<td>Purposeful</td>
<td>Aimless</td>
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<tr>
<td>Self-directedness</td>
<td>SD3 resourcefulness</td>
<td>Resourceful</td>
<td>Helpless</td>
</tr>
<tr>
<td>Self-directedness</td>
<td>SD4 self-acceptance</td>
<td>Hopeful</td>
<td>Hopeless</td>
</tr>
<tr>
<td>Self-directedness</td>
<td>SD5 self-actualizing</td>
<td>Self-actualizing</td>
<td>Unfulfilled</td>
</tr>
<tr>
<td>Cooperativeness</td>
<td>CO1 social tolerance</td>
<td>Tolerant</td>
<td>Prejudiced</td>
</tr>
<tr>
<td>Cooperativeness</td>
<td>CO2 empathy</td>
<td>Empathetic</td>
<td>Self-centered</td>
</tr>
<tr>
<td>Cooperativeness</td>
<td>CO3 helpfulness</td>
<td>Considerate</td>
<td>Hostile</td>
</tr>
<tr>
<td>Cooperativeness</td>
<td>CO4 compassion</td>
<td>Forgiving</td>
<td>Revengeful</td>
</tr>
<tr>
<td>Cooperativeness</td>
<td>CO5 conscience</td>
<td>Principled</td>
<td>Opportunistic</td>
</tr>
<tr>
<td>Self-transcendence</td>
<td>ST1 self-forgetfulness</td>
<td>Acquiescent</td>
<td>Controlling</td>
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<tr>
<td>Self-transcendence</td>
<td>ST2 transpersonal identification</td>
<td>Altruistic</td>
<td>Individualistic</td>
</tr>
<tr>
<td>Self-transcendence</td>
<td>ST3 spiritual acceptance</td>
<td>Spiritual</td>
<td>Skeptical</td>
</tr>
<tr>
<td></td>
<td>Normal (181)</td>
<td>BASE Js (68)</td>
<td>Climbers (49)</td>
</tr>
<tr>
<td>-------</td>
<td>--------------</td>
<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td>NS</td>
<td>19.0(5.8)</td>
<td>22.8(5.7)*</td>
<td>21.6(5.2)*</td>
</tr>
<tr>
<td>HA</td>
<td>12.4(6.9)</td>
<td>7.9(6.3)**</td>
<td>9.06(4.7)**</td>
</tr>
<tr>
<td>RD</td>
<td>22.1(6.1)</td>
<td>18.1(6.8)*</td>
<td>19.9(6.2) *</td>
</tr>
<tr>
<td>P</td>
<td>31.3(11.5)</td>
<td>28.1(8.3)</td>
<td>27.4(8.0)</td>
</tr>
<tr>
<td>SD</td>
<td>32(7.0)</td>
<td>33.4(6.7)*</td>
<td>35.5(5.0)*</td>
</tr>
<tr>
<td>C</td>
<td>33.6(6.7)</td>
<td>33.7(5.6)</td>
<td>34.1(4.6)</td>
</tr>
<tr>
<td>ST</td>
<td>28.9(9.74)</td>
<td>18.8(10.5)**</td>
<td>17.4(10.4)**</td>
</tr>
</tbody>
</table>

(* = p < 0.05, ** = p < 0.001)
Harm Avoidance (HA)

Jumpers HA spread

Mean HA score in normal population = 12.4

St. d. = 6.0
Stage 2
Personality characteristics (TCI), experience and physiological stress responses (alpha amylase and cortisol) to BASE jumping at a single event, on Bridge Day 2014
Fig. 1. Mean salivary cortisol levels (11 novices, 68 experienced jumpers; no difference significant at any time point).

Fig. 2. Mean salivary Alpha-amylase levels (11 novices, 68 experienced jumpers, differences significant at each time point).
Class 1 [36.4%] – “masterful” (NS, ha, SD)
Fearless self-confidence, highly experienced (lots of jumps) and low sympathetic arousal (alpha-amylase)

Class 2 [33.7%] – “trustful” (ha, SD, CO)
Relaxed, collegial, trusting with intermediate experience and low HPA reactivity (low cortisol pre-jump)

Class 3 [29.9%] – “courageous” (HA, sd, st, P)
Anxious but determined with little experience and high sympathetic arousal (alpha-amylase)
CONCLUSION

BASE Jumpers highly resilient – self-directed, persistent and risk-taking

Heterogeneous in their motives and stress reactivity in the HPA and sympathetic stress systems

High anxiety (HA) and social detachment (rd) – high cortisol reactivity

Persistence (P) high alpha amylase
EXPERTS CALL IT THE DEATH ZONE.
CLIMBERS CALL IT BEING ALIVE.