WING SUIT FLIGHT TRAINING

Jim Cashion
Kevin Valenzuela
BME 473
WHAT IS WINGSUITING?

- Recently popular sport involving jumping out of an airplane or off BASE object
- Utilizes excess fabric to create increased body surface for increased freefall time (Robson & D’Andrea, 2010)
- Allows for increased flight control during freefall
  - Ram-air wingsuits introduced in 1990s (Westman, A., 2013)
- Increased horizontal drive with slower vertical descent
  - Can’t avoid gravity but can fight it
- Body positions taught qualitatively, not quantitatively (Spotted Eagle, 2015)
ACCIDENT RATES

• 2009—4.7 million skydives/220,000 jumpers
  - 1 in 15,412 jumpers dies during jump related activities (1 in 88,000 jumps) (2009 IPC report)
  - 57% freefall accidents due to human error, 1.6% of accidents due to human collision, 3.5% due to hard opening (based on body position at deployment) (Westman and Bjornstig, 2005)

• 1,200-1,500 BASE jumpers worldwide
  - 25% of accidents due to object strike
  - Fatality risk in 2002: 1 in 60 participants (Westman et al 2008)
  - 2011—50% of BASE fatalities during wingsuiting (World BASE Fatality List)
OBJECT STRIKE

- Loss of altitude during wingsuit BASE often results in ground strike
  - Decrease in glide ratio
- Failure to adequately judge needs of terrain
CHARACTERISTICS OF FLIGHT

- **Glide ratio** (Thorington et al 1981)
  - Horizontal distance/vertical drop
  - Achieved based on body position/suit position
  - Multiple suit styles

- **Suit inflation**
  - 3-4 sec—BASE
  - 1-2 sec—skydiving

- **Decreasing surface area increased vertical drop**

- **Poor deployment position can result in injury due to high speeds** (Makela et al 1997)
GLIDE RATIO

- Affected by body size/length (Thorington, et al., 1981)
  - Bigger squirrels must fly faster than smaller squirrels to maximize ratio
  - Bigger squirrels less affected by turbulence
  - Smaller squirrels more maneuverable
  - Humans?

- Multiple suit sizes/surface areas
  - Optimal suit size? Unknown...
  - More surface area is better?
Flying squirrels utilize a wingtip to reduce drag and increase wing-lift ratio (Thornington et al., 1998)

- Allows for improved glide ratio
- NASA study shows 20% reduction in drag and 9% increase in wing-lift ratio on planes using similar design (Whitcomb 1976)
- Effective for human flight?
- Kinematics to increase wing-lift ratio?
- High death rate
- Human error seen as more important for safety than equipment (Mei-Dan, O., 2013)
- Vertical wind tunnels don’t allow for manipulation of glide ratio or BASE jump simulations, only freefall positions where no forward drive is in place
- Body position can alter glide ratio and is unstudied with respect to wingsuit flying: all teaching is qualitative, no quantitative
PROPOSED METHODS

- 30 wingsuiters with at least 300 wingsuit jumps in different sized suits
  - Perform 5 trials from airplane in three different suit sizes (Phantom Edge, Hunter, and Venom Power)
  - Collect kinematic and GPS data
  - Record surface area, height, weight, experience
  - Instructed to perform full performance flight (maximize glide ratio)
  - Kinematic data vs. flight characteristics
  - Estimated cost of trials: $4,000
KINEMATIC DATA

- The Opal (APDM wearable technologies)
  - Inertial Measurement Units (IMU)
  - Full body model
  - Collects kinematic data
  - 3D data collection
  - Potential to stream data or log data
  - Small sensors do not impede movement
  - Accuracy <2.8°
  - Cost estimate: $35,000
FLYSIGHT GPS DATA

- Flysight wingsuit specific GPS device
  - Measures flight performance characteristics
    - Horizontal speed
    - Vertical speed
    - Altitude
    - Glide ratio
  - Cost estimate: $250/unit
TERRAIN MAPPING

• Google Trekker Program
  • 15-lens camera
  • Pictures every 2.5 seconds
  • Maps remote locations
  • Allow for terrain input into simulator
  • Practice BASE “lines” before actual attempt
  • Estimated cost: free (minus man-power cost)
• Kinematic data allows for simulations to examine changes in glide ratio
• Mapping terrain allows for measurement of changes in glide ratio to match changes in terrain
• Program alterations to use kinematic input to adjust simulation
• Estimated cost: unknown
• Quantitative analysis of wingsuit performance
• Kinematic data allows for better training of wingsuiters
• Improved performance characteristics (glide ratio, speeds, etc) allow for increased safety with BASE jumping
  • Help avoid object/ground strike
• Simulation practice will aid in preparation for dangerous activity
ADDITIONAL IDEAS

- Examine different glide ratios as related to kinematic changes
  - Not all mountain flying requires max glide ratio
  - Match slope of terrain
  - What body positions cause what glide ratios?
REFERENCES


