THE BIOMECHANICS OF THROWING DISCUS

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Discus Throw

- Three-dimensional complex movement
- Aerodynamic effect on official distance
- Many debates about the techniques in coaching literature
- Limited biomechanical studies
- More things we don’t know than things we know
USATF Discus Throw Database

- 3-D biomechanical data of over 300 trials from
  - 1990 Goodwill Games
  - 1990 Olympic Festivals
  - 2001 New Zealand Open
  - 1996 to 2006 USATF Outdoor National Championships and Olympic Team Trials
Discus Throwing Technique

- Full Wind-up
- Right Foot Takeoff
- Left Foot Takeoff
- Unwind
- Single Support on the Back
- Flight
- Single Support in the Middle
- Delivery
- Right Foot Touchdown
- Power Position
- Release
Official Distance of Discus Throw

- Official distance of discus throw
  - Distance lost at the release
  - Vacuum flight distance
  - Aerodynamic distance
Partition of Official Distance

- Point of landing in air
- Point of landing in vacuum
- Front edge of discus circle
- Distance lost at release
- Vacuum flight distance
- Aerodynamic distance
- Official distance
Effect of Vacuum Flight Distance

Official Distance (m)

Flight Distance (m)

r = 0.56
Effect of Aerodynamic Distance

Official Distance (m)

Aerodynamic Distance (m)

$r = 0.46$
Vacuum Flight Distance

- Major component of the official distance
- Mainly determined by release speed
- A reflection of throwing ability
How to Maximize Release Speed

- Appropriate temporal rhythm
- Large hip-shoulder separations
- Large shoulder-arm separations
- Powerful left leg block with full hip and knee extensions
- Appropriate ground contact
Temporal Rhythm
Acceleration Patterns

- Speed (m/s) vs. Time (sec)
- Speed (m/s) vs. Time (sec)
Gain in Speed during Delivery

Gain in Discus Speed (m/s)

Before Delivery

During Delivery
Gain in Speed during Delivery

Flight Distance (m)

Gain in Discus Speed during Delivery (m/s)

r = 0.55
Gain in Speed during Delivery

Gain in Discus Speed during Delivery (m/s)

Gain in Discus Speed before Delivery (m/s)

$r = -0.82$
Temporal Rhythm

- Slow Unwind
- Start acceleration from flight
- Quick left foot landing to form the power position
- Full acceleration during the delivery
Optimum Temporal Rhythm

- Unwind > 0.6 sec
- 0.45 sec < Single support on the back < 0.55 sec
- 0.08 sec < Flight < 0.12 sec
- 0.17 sec < Single support in the middle < 0.22 sec
- Delivery = 0.15 sec
Temporal Rhythm

- Consequences of quick unwind
  - Difficulty to control upper body movements after flight
  - Poor hip-shoulder and shoulder-arm separations after the flight
  - Difficulty to gain speed during delivery
Temporal Rhythm

- Duration of flight is not the shorter the better

- Optimum duration of flight
  - Increase hip-shoulder and shoulder-arm separations
  - Get appropriate body position to start the single support in the middle to minimize the loss in momentum before the power position
Separations
Separations

- 2/3 of the discus speed at release are obtained during the delivery

- Large hip-shoulder and shoulder-arm separations at the power position are critical for gaining discus speed during delivery

- Good separations before the flight are helpful for large separations at the power position
Separations

Hip-Shoulder Separation of Women Discus Throwers (deg)

Below 65 m  Over 65 m

Maximum Backswing
Right foot off
Left foot off
Right foot down
Left foot down
Release
Separations

Shoulder-Arm Separations of Women Discus Throwers (deg)

Below 65 m  Over 65 m

Maximum Backswing
Right foot off
Left foot off
Right foot down
Left foot down
Release
Have Large Separations

• Have large separations at right foot down
  ■ Control of speed and upper body movement before left foot off
  ■ Good separations at the left foot off
  ■ Twist the trunk during the flight
Have Large Separations

- Increase separations during single support in the middle
  - Control speed before left foot off
  - Quick and continue right leg rotation after right foot down
  - Quick left foot down
Twisting Trunk during Flight

- The importance of twisting the trunk during the flight
  - Create hip-shoulder and shoulder-arm separations
  - Appropriate foot position for power position
Right Leg Rotation and Left Leg Block
Leg Actions after Flight

- **Right leg rotation**
  - Increase separations
  - Provide forward drive
  - Not right leg upward push

- **Left leg block**
  - Provide lift
  - Assist to forward drive from right
Ground Contact during Delivery
Ground Contact during Delivery

- Theoretically, retaining contact with the ground provides continuous forward drive and vertical lift.
- Some of elite throwers have both feet off the ground at release.
Ground Contact during Delivery

- Retaining ground contact at the release
  - Left knee and hip were not fully extended
  - Incomplete left block

- Losing ground contact too early
  - Early loss in forward drive and vertical lift
Suggested Ground Contact Pattern

- Keep ground contact as long as possible especially the right foot until the release of the discus
- The left foot may be off the ground in the last portion of the delivery
- Jump up for reverse after the release
Aerodynamic Distance
Aerodynamic Distance

- An important factor affecting official distance
  - Range: 12 m (gain) to -12 m (lose)
  - $74.99 \text{ m} - 8.14 \text{ m} = 66.85 \text{ m}$
  - $64.14 \text{ m} + 3.82 \text{ m} = 67.96 \text{ m}$
Discus Tilt Angle
Arm Tilt Angle

Shoulder

Arm Tilt Angle

Wrist
Arm Tilt Angle

Official Distance (m)

Arm Tilt Angle at Release (deg)
Arm Tilt Angle

- Recommended arm tilt angle at release between 0 and 10 degrees
Good Discus Throw Technique
Good Discus Throw Technique

- Relaxed back swing
- Controlled unwind
- Wide right leg swing
- Vigorous forward drive
- Quick rotation of the hip and shoulder during the flight
Good Discus Throw Technique

- High discus position at right foot landing
- Continue right leg rotation
- Quick left foot landing to form the power position
- Powerful right rotation and left block
- Controlled release with discus at shoulder level
Good Discus Throwing Technique

- Irina Yatchenko
- Nationality: Belarus
- Birthday: 1965/10/31
- Height: 1.84 m
- Weight: 98 kg
Good Discus Throwing Technique

- **Performance:**
  - 2000 Olympic Game Bronze Medal (65.20 m)
  - 2003 World Championship Gold Medal (67.32 m)
  - 2004 Olympic Game Bronze Medal (66.17米)
Good Discus Throwing Technique

- Andy Bloom
- Nationality: USA
- Birthday: 1973/8/11
- Height: 1.80 m
- Weight: 120 kg
Good Discus Throwing Technique

- **Performance**
  - 1997 USATF National Championships
    Third Place (65.30 m)
  - 1998 USATF National Championships
    Second Place (66.42 m)
  - 1999 USATF National Championships
    Third Place (67.46 m)