**THE BIOMECHANICS OF DISCUS THROWING**

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**Discus Throw**
- Most beautiful human movements in track and field
- Most technical demanding throwing event in track and field
  - High speed
  - Limited space
  - Three-dimensional movements
  - Aerodynamic effect on official distance

**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  
- Flight  
- Single Support on the Back  
- Single Support in the Middle  
- Power Position  
- Delivery  
- Release  
- Touchdown  
- Flight

**Official Distance of Discus Throw**
- Official distance of discus throw
  - Distance lost at the release
  - Vacuum flight distance
  - Aerodynamic distance
The Biomechanics of the Discus Throw

**Partition of Official Distance**

- Point of landing in vacuum
- Point of landing in air
- 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
The Biomechanics of the Discus Throw

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

Gain in Speed during Delivery

Gain in Discus Speed during Delivery (m/s)

Gain in Discus Speed during Delivery (m/s)

Gain in Discus Speed during Delivery (m/s)

Gain in Discus Speed during Delivery (m/s)

Flight Distance (m)

Gain in Discus Speed during Delivery (m/s)

Gain in Discus Speed before Delivery (m/s)
**Temporal Rhythm**

- Slow Unwind
- Start acceleration from flight (accelerate lower body rotation, not the discus)
- Quick left foot landing to form the power position
- Full acceleration during the delivery

**Optimum Temporal Rhythm**

- Unwind $\geq 0.6$ sec
- $0.45$ sec $\leq$ Single support on the back $\leq 0.55$ sec
- $0.08$ sec $\leq$ Flight $\leq 0.12$ sec
- $0.17$ sec $\leq$ Single support in the middle $\leq 0.22$ sec
- $0.15 \leq$ Delivery $\leq 0.17$ sec

**Temporal Rhythm**

- Consequences of quick unwind
  - Difficult to control upper body movements after flight
  - Poor hip-shoulder and shoulder-arm separations after the flight
  - Difficult 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**

- $2/3$ 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
**Hip-Shoulder Separation**

- Left Shoulder
- Right Hip
- Right Shoulder
- Left Hip

**Shoulder-Arm Separation**

- Right Shoulder
- Left Shoulder
- Hip-Shoulder Separation
- Shoulder-Arm Separation
- Discus

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**Separations**

**Hip-Shoulder Separation of Women Discus Throwers (deg)**

- Below 65 m
- Over 65 m

<table>
<thead>
<tr>
<th>Status</th>
<th>Below 65 m</th>
<th>Over 65 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Back</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Right foot off</td>
<td>90</td>
<td>30</td>
</tr>
<tr>
<td>Left foot off</td>
<td>30</td>
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</tr>
<tr>
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<td>-30</td>
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</tbody>
</table>

**Shoulder-Arm Separations of Women Discus Throwers (deg)**

- Below 65 m
- Over 65 m

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<tr>
<td>Right foot off</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left foot off</td>
<td>120</td>
<td>30</td>
</tr>
<tr>
<td>Right foot down</td>
<td>-30</td>
<td>-30</td>
</tr>
<tr>
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</tr>
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</table>

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**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

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**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

- 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**

- 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**

<table>
<thead>
<tr>
<th>Shoulder</th>
<th>Arm Tilt Angle</th>
<th>Wrist</th>
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**Arm Tilt Angle**

- Aerodynamic Distance (m)

- Arm Tilt Angle at Release (deg)
The Biomechanics of the Discus Throw

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

Irina Yatcheko

- 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 m)

### Andy Bloom
- **Nationality:** USA
- **Birthday:** 1973/8/11
- **Height:** 1.80 m
- **Weight:** 120 kg

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## 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)

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