Performance Support in Finnish Javelin Throw

Riku Valleala
KIHU – Research Institute for Olympic Sports

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Contents of the presentation

- The history of javelin research in Finland
- Different methods and feedback
- Individual Throwing Techniques
- Way to Rio 2016
Introduction

lähtönopeus 28.5 m/s

heittokäden kynärkulma 125 astetta

välistä painopisteen nopeus 6.1 m/s

tukijalan polvikulma 178 astetta

lähtökulma 31.8 aste

heiton pituus 83.74 m

takimmainen jalan polvikulma 135 astetta

tukiaskelleen pituus (jalkojen välinen etäisyys) 164 cm
Factors affecting to throwing distance

Throwing distance

Release parameters
- Release speed
- Release angle
- Release height
- Release angle of attack
- Release angle of side-slip
- Release pitching moment

Aerodynamic factors
- Javelin
- Wind
- Gravitation

Modified from:
- Hay, 1993
- Morriss and Bartlett, 1996
Javelin research at 1990s

- The whole 90’s very active time
- Special project during 1991-1999
- 78 athletes, totally 315 throws analyzed
- 3D motion analyses, ”throwing gate”, speed radar
Javelin research at 1990s
Javelin research at 1990s

- Javelin gun was developed
  - For testing javelin flight characteristics
  - From an old anti-aircraft gun
  - Pneumatic launch
- Extensive model testing with the gun 1995-1998
  - Diff. between and inside javelin models
  - COG tests for women’s javelin
  - Change of IAAF rules for women’s javelin 1999 (3 cm change of COG)
- The gun again in action in 2008 for the modern models
Javelin research on the 21st century

• Technique analyses again starting in 2004
  – Gradually increasing year by year
  – Latest years
    • 2-3 training camps
    • 2-3 competitions per year analyzed

• During 2005-2016
  – Totally 753 throws analyzed
    • 207 competition throws
    • 458 training throws
  – 552 for men and 231 for women
Methods and feedback: Traditional motion analysis

• For measuring
  – Javelin release parameters
  – Body movements during throwing

• Basic 3D motion analyses since 1991

• Frame rate development
  – 1990s: **100 / 60 fps**
  – 2004-2006 **125 fps**
  – 2008 -> **250 fps**
  – 2014 -> **200 fps**
Methods and feedback: Traditional motion analysis

- In competitions
  - 2-3 throws/athlete
  - Digitizing the whole body landmarks + javelin
  - About 30 different variables
  - Results in 1 week after competition

- Accurate and systematic info about competition throws

- Coaches waiting impatiently release speed values and other results...
Methods and feedback: Traditional motion analysis

- In training camps
  - 4-8 throws/athlete from one training session
  - Digitizing only javelin + some extra points
  - 9-18 different variables
  - Results in 8-24 hours
- Fewer variables – better understanding and usability
- Feedback faster, but still… it should be instant
Methods and feedback: Fast motion analysis

- For instant feedback about release parameters
- Used from 2013 once a year in April indoor
- Using Simi Motion
- Reflecting markers on the javelin + autodigitizing
- Results for the release parameters in 2 min.
Methods and feedback: Fast motion analysis

- Concentrating on the control of the javelin
Methods and feedback: Fast motion analysis

- Concentrating on the control of the javelin
Methods and feedback: Fast motion analysis

- Concentrating on the control of the javelin
Methods and feedback: Force plates

- For getting accurate information about force production in 3D
- Together with fast motion analyses indoor
- So far, mostly visual and qualitative feedback than systematic statistical results
Methods and feedback:
Force plates

Ari Mannio: Resultant force of brace leg vs. release speed
Methods and feedback: Pressure insoles

- For analyzing pressure distributions and force production
- Novel Pedar system
- 99 recording units/insole
- Sampling rate 100 Hz
- Received data:
  - Pressure distributions under feet
  - Calculated total forces
  - Timing and force profiles
- Insoles used twice at two different training camps 2011
Methods and feedback: Pressure insoles

- Force production curves of throwing steps:
Methods and feedback: Pressure insoles

• Individual visual analyzing probably the most rewarding way
• Pressure distributions not very useful
• Insole measures pressure, so calculated total forces represent only vertical forces!
  – Horizontal forces even more important in javelin
Methods and feedback: Speed radar

- For getting the approach speed
- Reliable variable would be the speed of the COM
  - But, it needs full body digitizing
- So, speed radar was used in 2012 couple of times (also in 1990’s)
- From behind or from the front view
- BUT too much problems and noise in signal for getting usable data
Methods and feedback: Ultimate player
Note! With javelin gun:
- no rotation in javelin
- no oscillations
- attack angles 0
- no wind in this case
800 g javelins, 39 degrees

- Polyn. (Nordic Orbit, Carbon 1)
- Polyn. (Nordic Orbit, Carbon 2)
- Polyn. (Nordic Airglider, Steel)
- Polyn. (Nordic Champion, Carbon)
- Polyn. (Ote Composite FX)
- Polyn. (Nemeth Classic 95)
There are differences within the same javelin model between "individuals"
The new Finnish carbon javelin "Angon"

- Developed by One Way Sport
- Co-operation with One Way and Tampere Univ. of Technologies
  - Goal to have a javelin stiff enough but easy to throw
- A lot of testing in practice with Finnish throwers
- Javelin gun shows that it’s very stable in air and flight distance comparable to other carbons.

http://www.onewaysport.com/angon/
Individual results

Mannio: Release parameters by time from 2008->2015

- Release angle
- Release speed
- Release angle of side-slip
- Release angle of attack
Ruuskanen: Release parameters by time from 2008→2015

- Release speed
- Release angle
- Release angle of attack
- Release angle of side-slip
Individual results

Pitkämäki: Release parameters by time from 2008->2015

- Release speed
- Release angle
- Release angle of attack
- Release angle of side-slip
Individual results

- Hip and shoulder rotation in pulling phase

Antti Ruuskanen 88,98 m - Hip and shoulder rotation angles

Tero Pitkämäki 82,34 m - Hip and shoulder rotation angles
Individual results

- The path of the javelin

Antti Ruuskanen 88,98 m - Path of the javelin from above

Tero Pitkämäki 82,34 m - Hip and shoulder rotation angles
Individual results

• Path of the javelin: Zelezny (89,66) and Räty (86,60) in Barcelona 1992 (Mero et al.)

Forces better along the long axis of javelin. Propably smaller attack angles.

Extra speed by shortening the radius at the end of the throw. Bad attack angles produced easier.
Individual results

- The path more straight in the longest throws?
  - Zelezny, Yego, Röhler…
Individual results
Individual results

Birmingham 2015
Javelin Throw Men

2. KEN Julius YEGO 85.95
Individual results

<table>
<thead>
<tr>
<th>Player</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
<th>Result</th>
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<tr>
<td>Ruuskanen</td>
<td>87.46</td>
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<td>Pitkämäki</td>
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<tr>
<td>Thomas Röhler</td>
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<td>83.64</td>
<td>82.54</td>
</tr>
</tbody>
</table>
Individual results

Mannio: Right leg knee angle at final foot contact

Ruuskanen: Knee angle at release

Utriainen: Release point of the javelin

Sormunen: Distance btw left and right at moment of final foot contact
4 male throwers, over 80 m: Individual averages compared to group average (9-24 throws/athlete)
Individual differences

- Variables that differ between throwers:
  - Angle of attack and side-slip
  - Point of the release compared to support leg
  - L shoulder – R foot distance at R leg touch down
  - L-R foot distance sideways during pulling phase
Individual differences

- Variables that are very constant
- And their approximate values for average 81 m throw
  - Release speed: 28.3 m/s
  - Approach speed: 5.9 m/s
  - Pulling distance: 1.72 m
  - Pulling time: 0.107 s
  - Right leg knee angle: 135 degrees
  - Support leg knee angle: 175/158/161 degrees
  - Length of the final step: 1.60 m
  - Hip rotation angle: 116/80 degrees (start/end)
Way to Rio 2016

• Goals (from 2014)
  1. Efficient throwing performance
  2. Good control of the javelin
  3. Individually optimal technique

• Deeper co-operation
  – Biomechanists “to be the part of the family” in throwing team

• Training camps
  – Biomechanist present at camps
  – Fast feedback + self-evaluation of the throwers
Thank you!