

A Modern Look at effective Pole Vault Technique

Herbert Czingon

"A modern look at effective Pole vault technique"

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Reshaping and reframing our perception of biomechanics and technical performance in the pole vault!

- How can we learn to distinguish between the role of technical quality and approach speed in relation to height?
- What can we learn from a critical review of the technical performance of the actual world leading athletes, preparing our own next generation athletes?

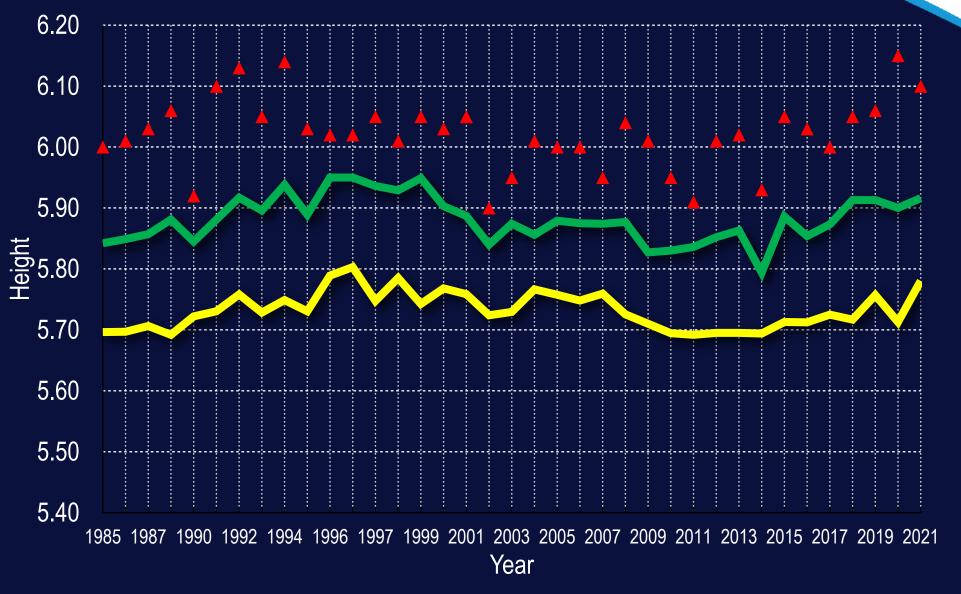
"A modern look at effective Pole vault technique"

- Part 1: The state of the art of pole vault
- Part 2: Mechanics of the pole vault revisited
- Part 3: Practical application of improved biomechanical understanding

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Pole vault Men: Trends

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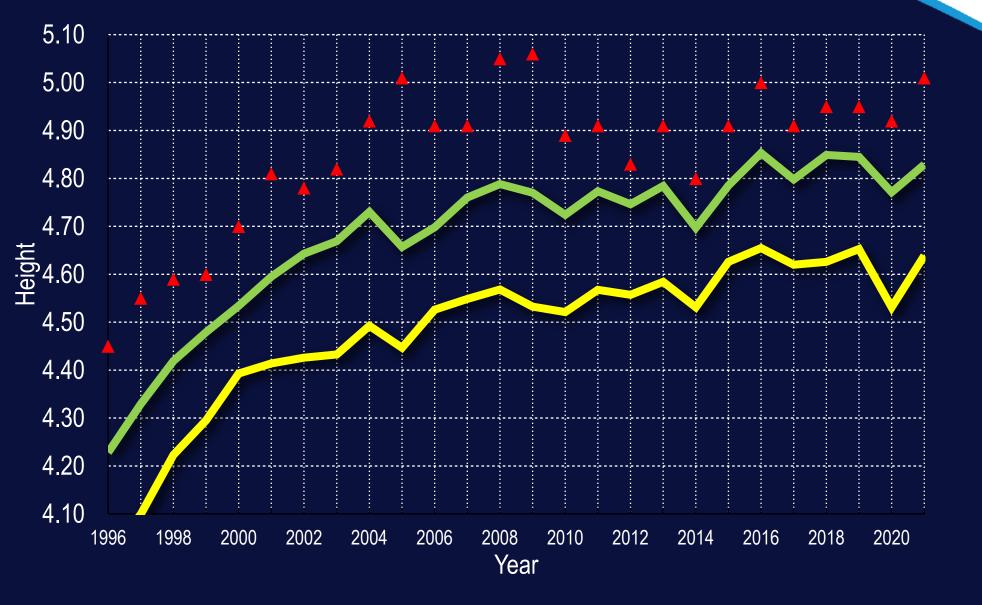
 Best overall decade 1990-2000 due to many vaulters from USSR, now starting for several nationalities

- After Bubka, an overall performance decline happened
- Recovery to the level of 1990-2000 since 2015
- Dominating nations: USA, France, Russia, Germany
- Dominating performance profile: from small to tall, but mostly fast (> 9.5 m/s), with suboptimal technique!
- Remarkable "slow" athletes: Otto, Lisek, Wojciechowski

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Pole vault Women: Trends

- The event buildup (international introduction 1996) took until 2004 and peaked with Isinbayeva
- Isinbayeva dominating despite ups and downs from 2003 until 2013, while the overall situation stagnated.
- **Considerable rise of performance on all levels since 2015**
- Longterm expectations not met yet: 5 metres still is a very rare result.
- Dominating performance profile: from small to tall, but mostly fast (>= 8.4 m/s)!
- These athletes still have room to improve technically!
- Remarkable "slow" athletes: Pyrek, Polnova, Newman

Conclusion

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In the pole vault, during several years, stagnation phases occurred, even in the "young" women's PV.

- In the men's PV, the overall technical level of the era between 1990 and 2000 has never been reached again.
- In the women's pole vault, smaller athletes are still able to beat much more athletic athletes.
- For the future, improving technique will be a major performance factor.

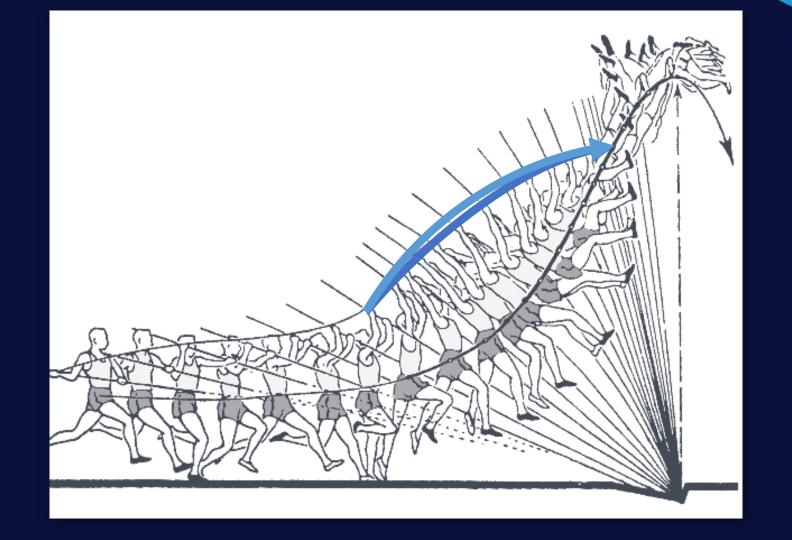
Part 2: Mechanics of the Pole vault

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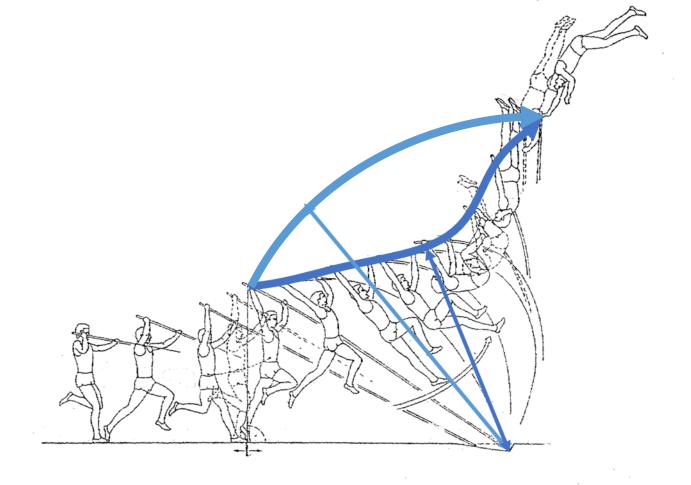
Development from the rigid pole to the flexible pole

- Relation of Approach speed and Height
- The Energy equation of the Pole vault

Rigid pole technique until 1961



Flexible pole technique: Allowed by th<u>e rule in 1961</u>



Consequences of the flexible poles

- Longer approach and faster approach speed
- Performance gain from 480 to 620 (soon!)
- More spectacular and attractive!
- More safety concerns: larger pits, soft padding of hard surfaces to protect poles
- Huge cost for poles: one for every approach length!
- Flight companies are not taking poles any more as baggage!

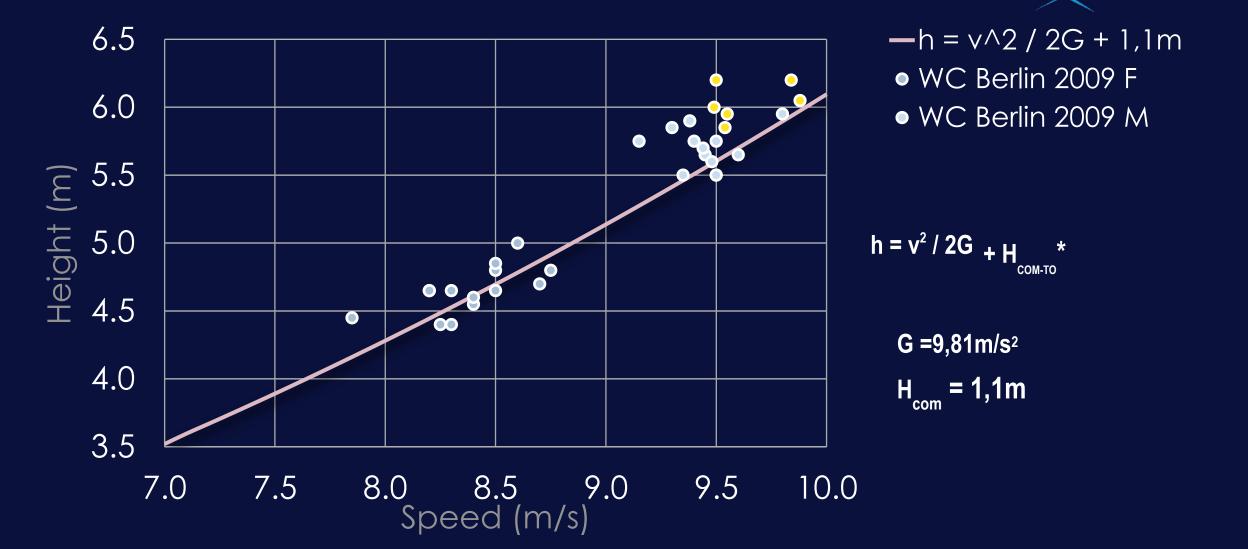
What is "Good Pole vault Technique"?

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Energy Transformation from kinetic energy in the approach to potential energy over the bar

- Intermittently, energy is also stored in the pole and the body of the vaulter: Many chances to gain (and lose!) energy!
- The "Black Box" Concept: Understanding the energy flow
- The "Continuous Chain" Concept: how to best actively connect all the parts

The relation of approach speed and height

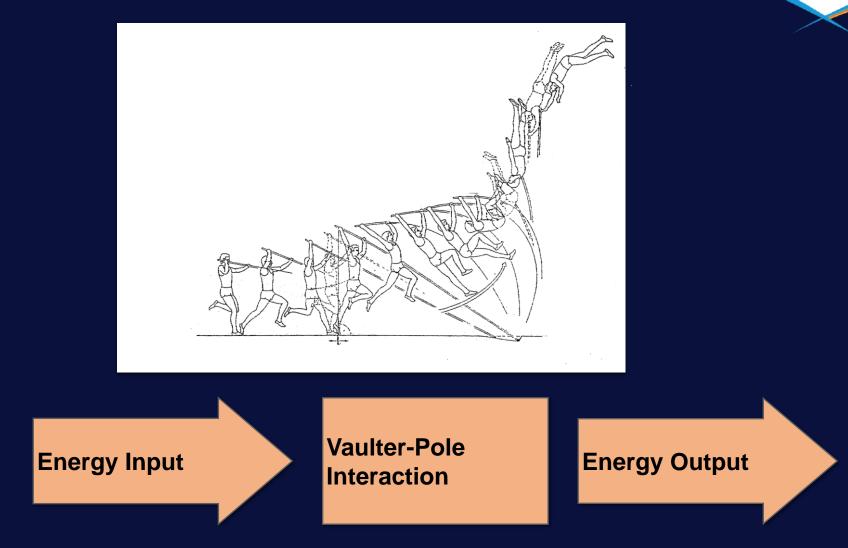


A biomechanical approach

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How to optimize energy production in the pole vault? How to optimize energy transfer in the pole vault? How to avoid losing energy in the pole vault?

The "Black box" Vaulter-pole interaction



EUROPEAN ATHLETICS Pole vault: Energy transformation HIGH PERFORMANCE WEBINAR SERIES то рр то **5000** PR MPB PS HP 4000 3000 energy [joule] pole energy potential energy 2000 1000

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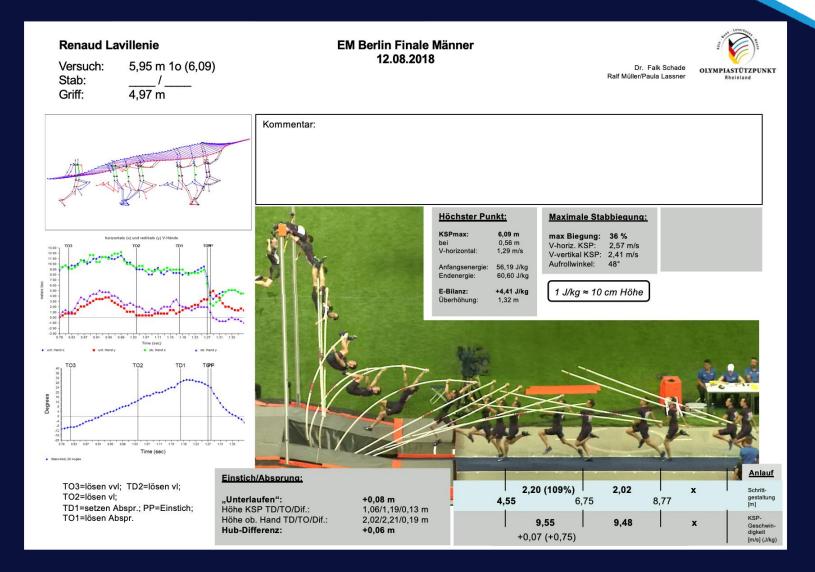
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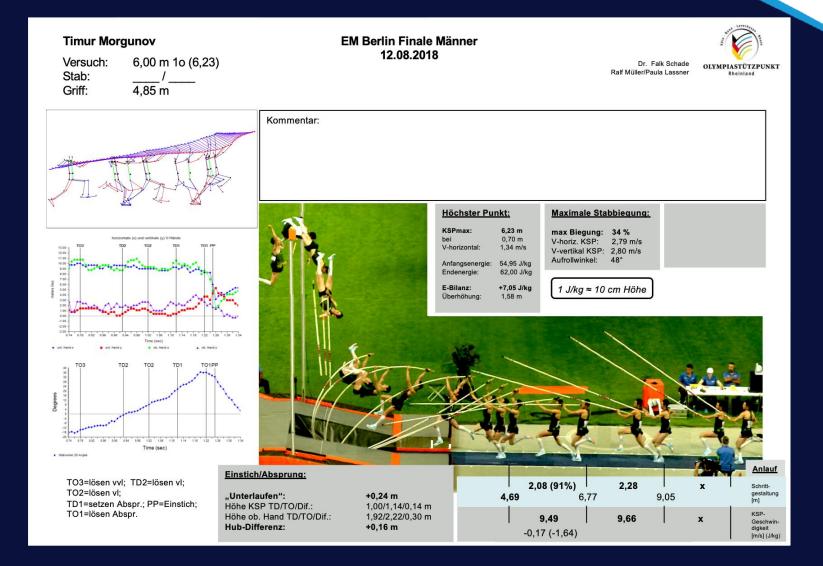
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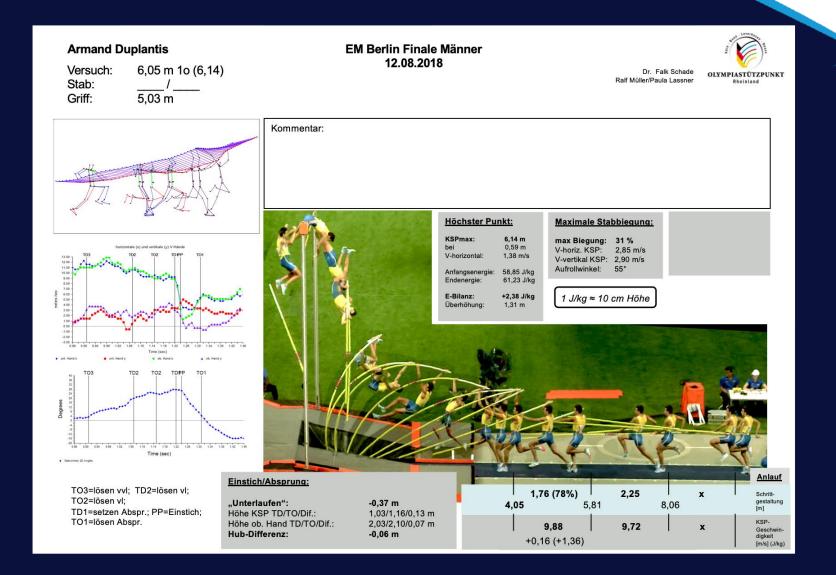
Isinbayeva 5,01m xo WR

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Part 3: How to practice improved biomechanical understanding

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The "Continuous Chain Concept" (from Roman Bocharnikov, athlete for USSR, coaching in USA, Lawrence Johnson, first coach of Katie Nageotte)

The "Black box": Interaction of the athlete with the pole

Technical optimization:

"Active Pole Drop"

"Free Take-Off"

"Whip"

"Extension"

What about the pole?

The "Continuous Chain Concept"

- The pole vault can be looked at as a continuous chain of actions creating energy by the vaulter:
- Avoid passive phases: "Move the pole always!", "Put the pole deeper into the box!", "Overtake the pole!",
- Learn how to feed energy into the system without disturbing the flow of energy that is already in the system!
- The ending phase of an action becomes the preparation phase of the next partial movement: the phases are melting into each other.
- Don't wait for the pole, try to be faster than the pole!
- Use elastic interaction between the pole and you!

Consecutive Phase Structure of the Pole vault

	Preparation Phase	Action Phase	End Phase
1	Approach	Preparation of plant and takeoff	Penultimate Contact
2	Penultimate Contact	Pole Plant and Takeoff Action	C-Position ("Penetration")
3	C-Position	Swing Action	L-Position
4	L-Position	Extension Action	I-Position
5	I-Position	Turn, Pull, Push Action	Fly Away
6	Fly Away	Bar Clearance	Landing

Pole Vault: Optimization of Energy creation and Energy transformation

- Initializing Pole bend: the "initial pole bend peak"
 - Speed of COM, resulting from take-off amortization
 - Locking the pole between upper arm and box: Position of shoulders and arms, connection between vaulter and pole
- Generating additional energy interacting with the pole
 - "Whip-like" swing from C-position until L-position (~max pole bend)
 - "Cork screw" rotation after take-off?
 - "Free-fly" hip extension from L-position until I-position (with quarter-turn, ~pole recoil)
 - "Pull-push-off" from I-position until pole release
 - Free flight from pole release until maximum height of COM

Discussing the "Active pole drop"

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This feature is meant to allow a torque free pole plant action: the movements of the arms and the pole are perfectly coordinated with the last steps before takeoff

Examples: Isinbayeva, Sidorova, Markov, McCarthy...

- Holding the pole in a rather steep angle at the beginning of the approach, it subsequently gets lowered while the COM of the pole remains high until the pole "drops" into the box
- The pole reaches a parallel position to the ground during the penultimate ground contact with the pole's COM approximately at the height of the shoulders.
- Potential advantages: due to the rotational forces without having to lift it, there is not much interference with the last steps of the approach.

Works best with a "free takeoff"!

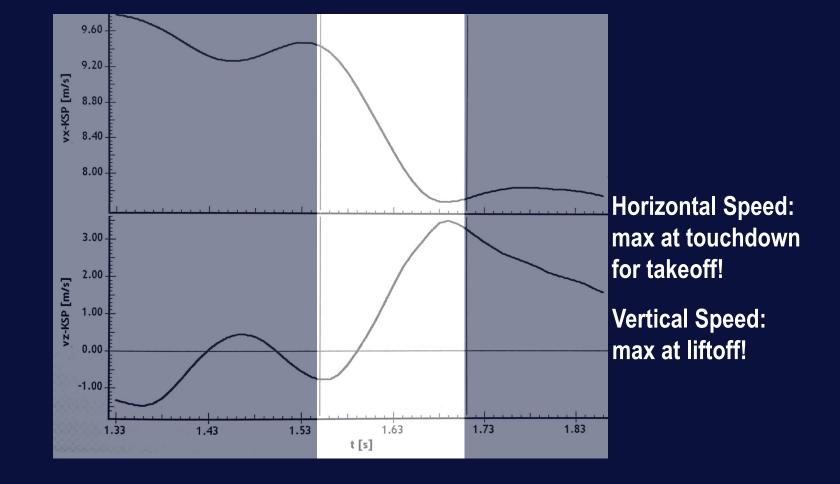
Discussing the "Free takeoff"

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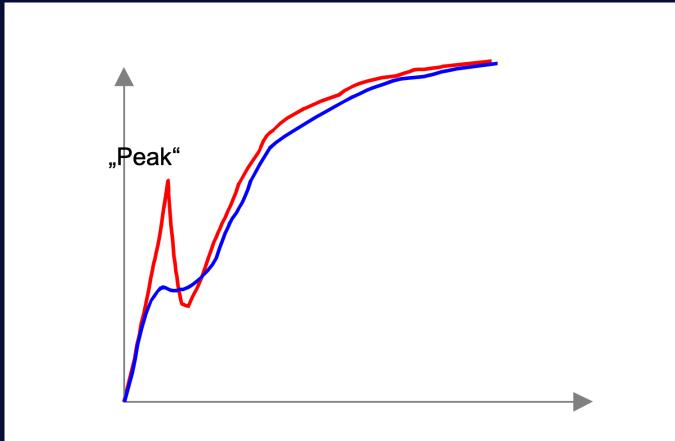
Definition: The pole plant occurs at the end of the takeoff while the pole is rotating forward-upward in jumping direction

- Examples: Bubka, Lavillenie, Sidorova, Morgunov
 - Critical problems to solve during take off and pole plant:
 - Speed loss of the vaulter during the eccentric phase of the takeoff
 - Initial pole bend: "Spike" of vertical forces helpful to initialize pole bend
 - Overlap of both events with negative consequences for the energy transformation from athlete to pole?!

Why "Free takeoff"? 2) Vertical takeoff-speed best at the end of touch down



Why "Free takeoff"? 1) Peak forces at the beginning of the pole bend



Discussing the "Free takeoff": Speed of COM during take-off

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Discussion:

 Coincidence of both processes may cause energy loss for the athlete, because he has to attack the pole while he is vulnerable due to the braking effect of the eccentric takeoff phase.

• "Being under" is only acceptable as long as the resulting "deformation" of his body structures happen "elastically", giving deformation energy back right after it!

• "Free takeoff" only works for athletes with good takeoff abilities!

There may be two relative optimums : the free takeoff and the takeoff after pole plant (e.g., Danny Ecker 600)

What about the pole?

- Mechanically, poles are just springs with a defined stiffness ("Flex number")
- Material does it matter?
- The shape of the building pieces does it matter?
- The weight of the pole does it matter?
- The stability of the pole
- The long term compatibility and usability of the pole
- The continuity of the poles pool of a training center
- The price of the poles

Thank you!