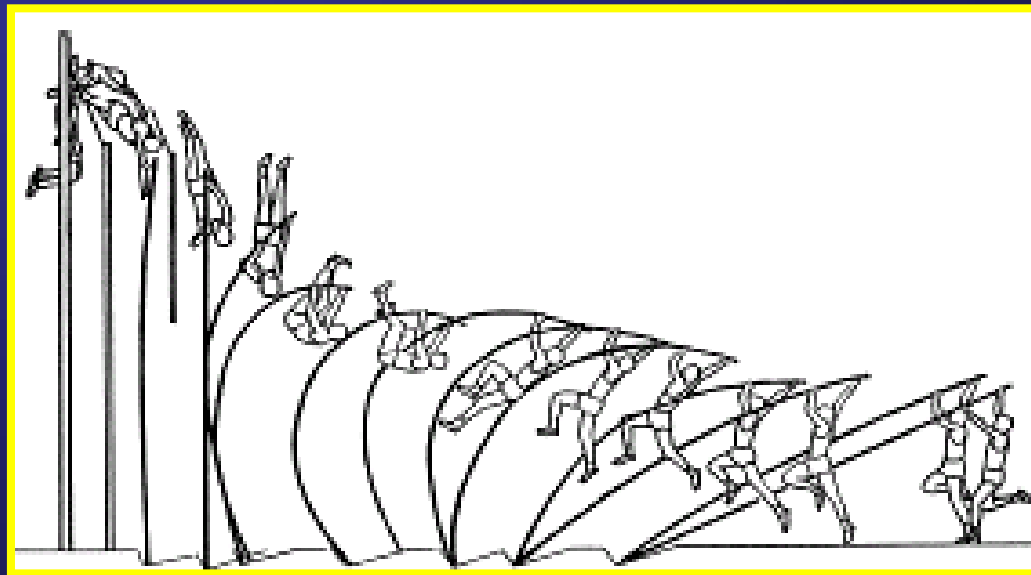


A Mechanical and Pedagogical Study of the Pole Vault



Richie Mercado (USA)
rmercado@sjs.org • www.nacactfca.org

Goals of The Pole Vault Project

- Identify model technical parameters from coaches and scientists (Tidow, Groß & Kunkel, Schade, et al, McGinnis, Linthorne)
 - Identify coaches' own concepts of vital component parts and their interaction
 - Approach
 - Plant
 - Takeoff
 - Swing

The Pole Vault Project

- Website - <http://www2.sjs.org/Mercado/index.htm>
- Wiki / Forum - [http://wiki.sjs.org/wiki/index.php/Pole Vault Project](http://wiki.sjs.org/wiki/index.php/Pole_Vault_Project)
- Surveys
 - Fill in computer file by email
 - Coaches
 - Athletes
- Future Surveys and Questions driven by the ideas of athletes, coaches and sport scientists

Ideological Compromise?

- Micro-managing technique
 - Coaching “paralysis by analysis”
- Holistic view of vault
 - Oversimplification
 - Continuous chain
 - Run-Plant-Swing
- Performance Oriented only
 - Don't care about details; jump high!

The Pole Vault Survey

1. Assess biomechanical concepts of coaches and athletes of all levels
2. Assess teaching competencies and pedagogy of coaches at all levels
3. Is there a consensus on concepts and teaching?
4. Can we help coaches and biomechanists working together to improve vaulting mechanics, teaching, learning, and performance?

The Pole Vault Project Online

Sharing Goal

1. Allow coaches and athletes to share and download research and articles
2. Address major issues of mechanics and teaching / motor learning for the pole vault
3. Establish mechanical bases useful for coaches, athletes, and sport scientists!

International Coaching Responses

Over 30 National and International Level Coaches



Perceived Models

- Identify major technical models *perceived and utilized* by coaches and athletes
 - Petrov Model as Standard(?)
 - Bubka as a prime influence!

Other Models?

- Russian Model (Volkov?)
- Australian Model
 - Alan Launder says there is no Australian model, only his interpretation of the Petrov Model
- French Model
 - Houvion
- Polish Model
 - Krzesinsky (?) Szymczack (?)
- American Model (many styles?)
 - International Success!!!

Styles?

- Power Vault / Drive Vault
- Tall vs. Shorter Vaulter Models
- Long Swing vs. Tuck and Shoot
- Speed Vault (?)
 - *“There have been big, small, tall, and short vaulters who have been successful; there have never been any successful slow vaulters!”*
- Free Take-Off / Pre-Jump / Simultaneous T.O.
- Conclusions on ideal model(s) and teaching points of focus?

Conclusions...

- Tom Tellez – “There is only one way, *the right way!*” But what is that right way?
 - Men and Women should use the same technical model
 - see *NSA Roundtable #40 “State of Women’s PV, 2004 - Is there (or can we expect) a difference between the technical model of vaulting for men and women?”*

Should Men and Women use the same technical model?

- Petrov - “... an ideal technical model for pole vaulting ... for both men and women.”
- Hull - “... basics are similar, but lower strength levels and the slower take-off speeds developed by female vaulters make some actions quite difficult.”

■ Czingon - *“The current generation of male vaulters still has to work hard to get close to what Sergey Bubka achieved a long time ago!”*

■ Schulek - *“...don’t expect major differences... Because women are less muscular, they tend to have a better rhythm in the air.”* [do not “muscle” it as much? ed.]

■ Survey Findings

■ Coaches overwhelmingly agreed, with slight variations similar to NSA responses

Champion's Model vs. Biomechanical Research

see Schade, et al, "A New Way of Looking at Biomechanics of the Pole Vault," (NSA 2004)

- “Nearly every elite vaulter and coach has his/her own philosophy ... and not all agree. *Often these are judged as much on the success of the performer as on how they relate to the fundamental principles of what it takes to vault high...*

■ ... we see a tendency towards a generalized model of technique, sometimes known as the ‘Champion’s Doctrine’, adopted by large numbers of vaulters, regardless of whether the model is appropriate for the individual...

■ ...A knowledge-based approach is a better hope for optimising the training process and finding the individual technical solutions ... [and] calls for a thorough understanding and constantly improving biomechanical knowledge of the event.”

Falk Schade

■ Petrov: *“What does the plant mean? You will get 100 different notions from 100 different vaulters [and coaches? ed.]!”*

Mechanical Studies

- Do biomechanists identify ideal mechanical movements from principles of physical movement?
 - Explanation of Movement
- Do they confirm what successful vaulters do mechanically and reinforce the Champion's Model?
 - Description of Movement

- Findings - A mixture of 1) identification / explanation of motions, and 2) description of what vaulters do
 - *“The hard thing is to identify exactly which movements contribute to energy gains and losses!”*
 - *“Yes, once the athlete leaves the ground biomechanists have done a good job indentifying the most effective technique, but it is what is done leading up to and through the plant and take off that allows the athlete to execute the most effective method; yes... they confirm and reinforce Champion's Model.”*

■ *“Biomechanists identify motions... but sometimes it [does not illuminate] actual pole vault movement.”*

■ *“Biomechanists are key to advancing our sport... [are] extremely difficult for most of the vault. The experience of vaulters therefore plays a great deal into what CAN be done. As for Describing motion, yes, but they also identify possibilities that vaulters can experiment with, or train to be able to do.”*

■ *“[Biomechanists identify/explain ideal motion] only in a very limited way. To my opinion also the data analysis (for instance the Helsinki experiment) could be pushed further. Essentially, yes, they describe motion.”*

■ *“Do biomechanists confirm what good vaulters do mechanically? Sort of – but they cannot really get to the most important things; only speed and angles! Do they establish proper mechanical principles at the fine level? NO!”*

■ *“close cooperation between biomechanists and coaches leads to best results... if you don't understand the biomechanics... you have no chance to help the athlete to optimise his/her potential. But it works both ways, no biomechanists can develop a successful knowledge-based study without understanding the way training and coaching is done in real life...”*

▪ *“Dr. Jim Hay, who did so much for the horizontal jumps, was excellent at listening to athletes and coaches and finding out what they were curious about and/or needed to know.
...exploring other variables and doing scheme related analysis would accelerate learning and eliminate some of the never ending arguments so prevalent in our sport...”*

■ *... biomechanists have a tendency to validate previous works and describe what the best are doing. I would like to see a common denominator list of various kinetics and kinematic factors done across the field in a world class meeting, have that done at the junior level, and then done again at age group meetings ... ” [more on this later...]*

■ *“Yes, they should simply be examining the double pendulum action. Physics can easily help with understanding the vault. Usually [they describe motion], but some biomechanists can suggest new strategies. For example, pole drop technique influences on the forces put into the ground through the left foot at takeoff. Perhaps it was a biomechanist that determined this.”*

■ *“...in the case of biomechanics, these researchers explain scientifically, with an elegant approach, different phases of the jump or the distribution of the energy between the vaulter and the pole.”*

■ *...they can also look at weaknesses in a particular movement and can give interesting facts to what can be done to improve efficiency.*

On what do coaches base their technical model?

- Biomechanical Studies? Champions Model?
- Observation/Video analysis
- Anthropomorphic status
- Individual Neuromuscular traits?
 - Speed / Elastic strength quality
- Findings – Coaches identified most or all of above
 - Emphasis on personal observation / video analysis
 - *“All - If we want to be on top we can not ignore any source of wisdom...”* [Caveat – internet sources!]

Champion's Model

- Findings – many coaches look to champions for design of model
 - Some reject the notion that you follow champion's model
 - Some pick and choose useful parts
 - Some address needs of their own athletes based on successful actions of vaulters who have similar abilities, size, speed, etc...

Champion's Model

- *Studying athletes... may teach us which individual style is working for which individual type. ...comparing yourself to champions, you can find out which champion resembles you most and so his individual style may narrow your search in the 'erector set' for suitable technique."*

Champion's Model

- “[Champion's Model] is dangerous in that the training age, history, biomotor abilities, idiosyncrasies, etc. are all unique to that individual... *I have seen folks notice certain movements or positions on elite folks and then latch onto these items like they are the "answer", when in fact they are results of activity that occurs way earlier in the sequence than given credit for.*”

How necessary and / or possible is it to modify technique of mature or high level vaulters?

- Leave it alone? **No!**
- Change, modify, or enhance what's already there?
 - Difference of opinion – usually dependent on age, experience, & personal will (athlete and coach!)
 - if yes, when and how to structure while still competitive?
 - Preparatory Periods; non-essential year
 - time frame for changes to stabilize?
 - From one season to 2-3 years, depending on competitive stage of career, depth of change, and willingness of athlete

Modifying Technique

- Modify or enhance what is there
- Only radical changes for seniors if the athlete is serious and committed for the long term
 - *“If you knowingly leave it alone you are preventing the athlete from reaching their full potential; accept that in year 1 performance may go down (explain and agree strategy with athlete), look for improvements in year 2, and final completion in year 3.” [Isinbayeva! ed.]*

- “Depends... Only if real improvements (cleared heights) are likely. For athletes that stagnate it may be psychologically helpful to try something new. I always try to change, modify or perfect technical points, if I think it is necessary for jumping higher. We should always try to perfect, but without perturbing the psychological balance (ego, confidence) of the athlete...

- ... One should distinguish, when looking for technical improvements, the run up/takeoff phase, where there is more certainty about the right technique, from the swing phase, which due to the complexity of the multiple pendulum system still holds lots of uncertainty (why did Huffman get an extra push from his roll?).
Radical changes - no!... Ideally one should conceive exercises helping them to realize themselves that a change of movement makes them jump higher.”

Teaching the Vault?

- Is it vital to change fundamental introductory mechanical goals at early ages and avoid pitfalls of the “Champion’s Model”?
 - Mixed responses, but consensus that one must teach well and carefully from the start!
- Role of “Individualized” Models?
 - Majority see the need for individual style within a framework or model
 - Some variance of opinion on whether to constrain the abilities to the model or adapt the model to the abilities!

Style vs. Technique

- *“Style overlays a technical model due to biomechanical considerations ... more than one technical model, ... although most subscribe to Petrov's model, which on paper is the most efficient. It may not be the most efficient model for everyone.”*

General Mechanical Conceptions of Athletes and Coaches in United States? In Europe? In other areas?

- Hypothesis: the answer will be determined by the level of specific coaching education of the population!
 - Coaching systems / certification requirements in place
 - Level of emphasis on competition at young ages
 - Personal Observation / Survey:
 - In USA, there appear to be many under-educated and many poorly prepared coaches
 - “Poor mechanics, due to our tendency in the U.S. to take shortcuts with younger vaulters.”
 - Too much emphasis on early competition

Do we live with technical problems and only adjust for mature athletes?

- Do we attempt minor or major changes in athletes depending on age, level of competition, and physical ability?
 - “Once a person’s neuromuscular patterns are set, it is VERY difficult to change. Under pressure, an athlete almost always reverts to their learned mechanics. That is why is it so important to teach correct mechanics from day 1! Read *Why Michael Couldn't Hit*, Harold L. Klawans. This is a great book explaining neuromuscular learning. What can you do? Work on speed, strength, mental toughness, diet.”

Do we live with technical problems and only adjust for mature athletes?

- What is the timing of those changes, and are they major?
 - 1-2 year adaptation / 2-3 years to stabilize radical changes
 - Some said after competitive season, some early season

“... set up periods of time (macrocycles)... we set goals in height, conditioning and technique. After times without technical training but good conditioning there is a good chance to change and improve technique. Several years, but I would not call it "radical" changes.

“‘Radical’ changes are only possible in the age under 18 and in the first three or four years of vaulting. Morphologically the individual technique doesn't change very much after, but the rhythm gets faster, pauses get ironed out (*“Continuous Chain Model”, Roman Botcharnikov*) and the overall ‘drive’ of the athlete during the jump gets faster.”

“For young athletes (first 3 to 4 years of vaulting, especially in the age under 18) there must be serious schooling! And for mature athletes there is always the need to adjust the technique following improvements of speed, strength etc. It may not be as easily visible as with young athletes, but it is just as important.”

- IF there is a technical model, or at least vital technical competencies regardless of anthropomorphic and neuromuscular attributes, are coaches teaching those aspects correctly and carefully at young ages and from the start?
- Mixed Responses!
 - Some said they do personally, but say that coaching expertise varies greatly!
 - Many said that while it is ideal, it is not always the reality!

Are Coaches Teaching Well From The Start!

- *“...not in my observations of coaches around the US!”*
- *“Right model should be built in young age, correct problems immediately with young vaulters, but Pole Vault is simple if it based on natural movement. Don't make it more complicated!”*

- *“At early ages - yes, I believe sound running mechanics and pole carry are key; ... many coaches do [teach basics well from the start], but I think more time and repetition should be allowed for solid basic mechanic of pole carry, running mechanics, and plant.”*

- *“I think it wise to adhere to a basic fundamental model with a huge emphasis on how to run correctly, plant efficiently, select correct grips and pole models for sessions, teach safety factors and then work on swing patterns and flight issues.”*

Pole Vault and Gymnastics

- Hypothetical and Leading Question – would a judging system combined with performance height for Pole Vault improve the mechanics of vaulting?
 - Many said **NO!** A few offended by the notion!
 - Some said it probably would clean up the sloppy things in technique from young ages on
 - Some remarked that PV coaches would never be able to agree on the standards of judgment (*the same problems we are addressing already...???*)
- Would it improve performance?
 - Some said yes, some said no
 - Most pointed out the obvious: Goal is to jump high
 - Again, the same issue: what will get us there!

Pole Vault and Gymnastics

- *“We can't get five coaches in this event to agree on things like mechanics, training schemes, etc... so I would love to see how agreement would be reached for a grid to award style points...”*

Pole Vault and Gymnastics

- *“If there is motivation to change, people change and adapt quite well. The horizontal velocities obtained in the pole vault make this event a whole different factor in skill transformation. ...”*

Pole Vault and Gymnastics

- *“In my experience, gymnastic and diving coaches fight the same battles we do with confidence, risk taking, eradicating faulty movement patterns, confirming new improved schematics, etc...”*

Wolfgang Ritzdorf –

“Due to its specific characteristics the high jump allows more technical variations than the other Jumps.”

Does the athlete - pole interaction make the pole vault even more susceptible to technical style variations?

Pole Interaction

- Most said yes – a few said the physics is the same regardless of athlete-pole interaction
 - Is physics that simple with the human body?
- *“It can vary very much: compare Scott Huffman to Maxim Tarasov!”*

Pole Interaction

- *“Not if the model stresses the correct interaction between the pole and athlete.”*
- *“Even more than the high jump. See the Huffman Roll and the fact that physically not very strong vaulters achieve good performances, sometimes with peculiar technical habits.”*

[Comment on Huffman!]

Pole Interaction

- *“... technical variations ... are due to their ability to interact correctly with the pole. A wrong interaction is mainly due to vaulter errors [or wrong pole selection? ed]. In a good interaction the pole has to help the vaulter by restoring the energy transferred initially at the take off, if the jumper had realised correctly all the steps after the take off to the drive.”*

Ritzdorf, Order of influence in High Jump

1. Reactive strength capacity
2. Take-off time
3. Preparation of take-off
 - i.e. Lowering of CM; arm action
 - Free elements during take-off
4. Approach velocity

Order of influence in Pole Vault?

1. Velocity_h at takeoff?
2. Velocity_v at takeoff?
3. Preparation for take-off
 - Velocities_h and _v of hands?
 - Minimizing flight times last 3 strides?
4. Post Takeoff –
 - Elastic Strength of Shoulder/Trunk/Hip System
 - Pole Interaction?
 - Timing of Pole Rotation and Swing?

Schade, Bloch, & Czingon, PV Analysis / Feedback Design

- Frequent Analysis at Major Championships
 - Germany
 - World Athletic Final
 - World Championships
 - Oly Games (?)
- Inter- and Intra-Individual Analysis
- Fast Turn-Around Time
 - 5-10 days
 - Ability to implement and evaluate changes!

Schade, Bloch, & Czingon, PV Analysis / Feedback Design

Lattenhöhe	5,81	5,70	5,81	5,60	5,81	5,60	5,91	5,70	4,60	4,60	4,82	4,60	4,87	4,67	4,82	4,60	Bar height
Versuch	2.0	3.0	2.0	1.0	2.0	2.0	2.0	1.0	3.0	3.0	2.0	1.0	1.0	3.0	1.0	3.0	attempf
max KSP	5,99	5,80	5,97	5,78	5,95	5,83	6,03	5,88	4,68	4,71	4,90	4,65	4,99	4,71	4,81	4,77	CM max Height
Griffhöhe	4,95	4,94	4,95	4,82	4,85	4,92	4,94	4,91	4,23	4,22	4,26	4,23	4,39	4,21	4,35	4,34	grip (middle of top hand!)
Überhöhung	1,24	1,06	1,22	1,16	1,30	1,11	1,29	1,17	0,65	0,69	0,84	0,62	0,80	0,70	0,66	0,63	push up (CM not bar!)
Überhöhung obere Hand-Latte	1,10	1,00	1,10	1,02	1,20	0,92	1,21	1,03	0,61	0,62	0,80	0,61	0,72	0,70	0,71	0,50	push up (grip - crossbar)
Weite HP	0,91	0,71	0,56	0,58	0,63	0,60	0,51	0,64	0,79	0,92	0,85	0,43	0,89	0,62	0,59	0,61	distance CM top height
V horiz KSP max	1,83	1,38	1,59	1,20	1,48	1,40	1,24	1,39	1,52	1,33	1,67	1,18	1,53	1,13	1,60	1,33	v horiz CM max
E anf	55,8	53,8	54,3	53,8	53,3	52,9	55,1	55,9	44,8	44,4	46,6	43,3	45,0	40,3	43,9	44,8	start energy
E end	60,4	57,8	59,8	57,4	59,5	58,1	60,0	58,6	47,0	47,1	49,4	46,3	50,1	46,8	48,5	47,7	end energy
E bilanz	4,57	4,05	5,57	3,63	6,16	5,23	4,85	2,66	2,21	2,72	2,82	2,95	5,33	6,52	4,54	2,91	energy difference
maximale Verkürzung in %	24,5	27,4	22,2	28,5	22,0	25,0	24,6	30,7	28,1	26,0	25,7	26,7	29,0	27,2	20,3	25,0	max pole bend %
V horiz KSP bei MPB	3,22	2,82	3,16	2,79	2,73	2,32	3,44	2,77	2,94	2,56	2,95	2,67	1,83	2,36	2,79	3,01	v hor MPB
V vertikal KSP bei MPB	3,43	2,89	3,03	2,72	3,62	3,13	2,92	2,68	2,66	2,32	2,77	2,42	3,12	2,27	2,76	1,98	v vert MPB
Aufrollwinkel	73	62	79	50	63	58	78	57	57	72	63	50	74	50	95	62	rockback angle
Unterlaufen	0,41	0,23	0,40	0,28	0,36	-0,03	0,17	-0,05	0,36	0,17	-0,14	0,15	0,29	-0,03	0,21	-0,08	"under"
H KSP TD	1,10	1,08	1,04	1,07	1,06	1,05	1,02	0,98	0,92	0,95	0,88	0,99	0,98	0,96	0,93	0,95	CM at touchdown
H KSP TO	1,25	1,24	1,23	1,22	1,23	1,23	1,20	1,13	1,05	1,11	1,04	1,09	1,10	1,11	1,10	1,10	CM at takeoff
KSP Hub	0,15	0,16	0,19	0,15	0,17	0,18	0,18	0,15	0,13	0,16	0,16	0,10	0,12	0,15	0,17	0,15	CM lift
HobHand TD	2,20	2,19	2,17	2,14	2,15	2,01	2,11	2,01	1,91	1,96	1,78	1,97	1,97	1,84	1,86	1,87	upper hand touchdown
HobHand TO	2,27	2,30	2,20	2,25	2,28	2,32	2,24	2,19	1,88	2,04	2,00	2,08	2,00	2,14	2,04	2,10	upper hand takeoff
Hub Hand	0,07	0,11	0,03	0,11	0,13	0,31	0,13	0,18	-0,03	0,08	0,22	0,11	0,03	0,30	0,18	0,23	hand lift during touchdown
Hubdifferenz obere Hand KSP	-0,08	-0,05	-0,16	-0,04	-0,04	0,13	-0,05	0,03	-0,16	-0,08	0,06	0,01	-0,09	0,15	0,01	0,08	difference CM+hand lift
V1	9,49	9,27	9,38	9,30	9,26	9,22	9,47	9,60	8,45	8,37	8,69	8,17	8,40	7,83	8,32	8,40	speed in last step
V2	9,39	9,32	9,27	9,30	9,30	9,19	9,46	9,50	8,26	8,26	8,75	8,17	8,44	7,78	8,24	8,26	speed in second to last step
V Diff 1	0,10	-0,05	0,11	0,00	-0,04	0,03	0,01	0,10	0,19	0,11	-0,06	0,00	-0,04	0,05	0,08	0,14	differemce
Absprungweite 0-Linie	3,64	4,08	3,85	3,83	3,73	4,33	4,13	4,44	3,18	3,43	3,95	3,48	3,50	3,63	3,56	3,85	takeoff point
Länge 1	1,97	2,16	1,94	1,93	1,71	2,08	2,23	2,11	1,78	1,86	1,93	1,91	1,94	1,84	1,83	1,94	length last step
Länge 2	2,25	2,12	2,35	2,00	2,08	2,24	2,20	2,23	1,88	2,00	1,90	1,93	1,95	1,67	2,00	1,88	length second to last step
Änderung %	87,6	101,9	82,6	96,5	82,2	92,9	101,4	94,6	94,7	93,0	101,6	99,0	75,4	110,2	91,5	103,2	change %

Brad Walker

Versuch: 5,91m 2.o (6,03)
 Stab: x/x
 Griff: 4,94 m

IAAF World Final Stuttgart 22./23.08.2007

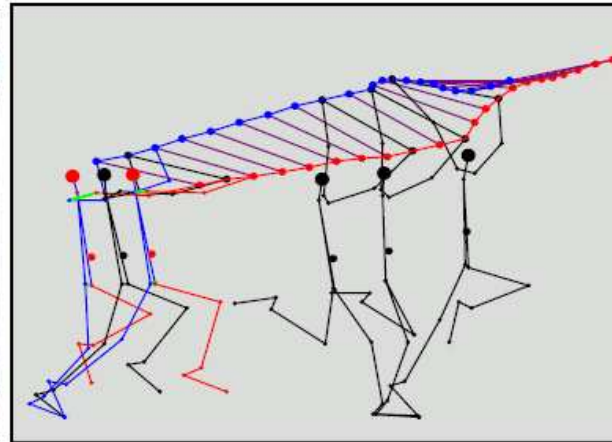


OLYMPIASTÜTZPUNKT
 Rheinland

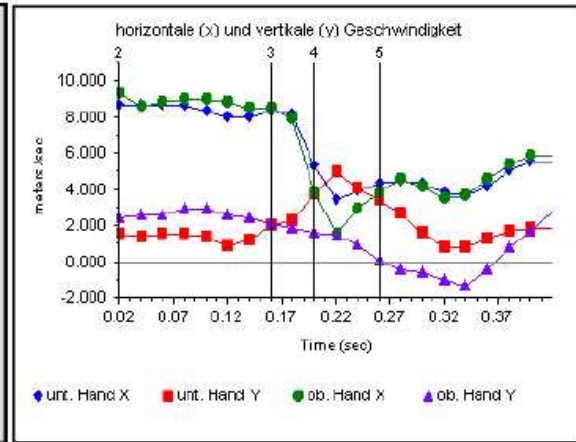
DSHS Köln Inst. f. Biomechanik
 und Orthopädie

Höchster Punkt:

KSPmax: 6,03 m
 bei 0,51 m
 V-horizontal: 1,24 m/s
 Anfangsenergie: 55,10 J/kg
 Endenergie: 59,95 J/kg
 E-Bilanz: +4,85 J/kg
 Überhöhung: 1,29 m



2=lösen vt; 3=setzen Abspr.; 4=Einstich; 5=lösen Abspr.



Maximale Stabbiegung:

max Biegung: 24,6 %
 V-horiz. KSP: 3,44 m/s
 V-vertikal KSP: 2,92 m/s
 Aufrollwinkel: 78°



Einstich/Absprung:

„Unterlaufen“: -0,17 m
 Höhe KSP TD/TO/Dif.: 1,02/1,20/+0,18 m
 Höhe ob. Hand TD/TO/Dif.: 2,11/2,24/+0,13 m
 Hub-Differenz: -0,05 m

4,13	2,23 (101 %)	6,36	2,20	8,56
	9,47		9,46	
		+0,01		

Anlauf

Schritt-
 gestaltung
 [m]

KSP-
 Geschwin-
 digkeit
 [m/s]

Versuch: 5,91m 2.o (6,03)
 Stab: x/x
 Griff: 4,94 m

- Ht. cleared (C.O.M. ht)
- Pole – no info
- Grip ht – 4.94m

Höchster Punkt:

KSPmax: 6,03 m
 bei 0,51 m
 V-horizontal: 1,24 m/s

Anfangsenergie: 55,10 J/kg
 Endenergie: 59,95 J/kg

E-Bilanz: +4,85 J/kg
 Überhöhung: 1,29 m

Maximale Stabbiegung:

max Biegung: 24,6 %
 V-horiz. KSP: 3,44 m/s
 V-vertikal KSP: 2,92 m/s
 Aufrollwinkel: 78°

- Maximum Pole Bend %
 - $v_{\text{Horizontal COM}}$
 - $v_{\text{Vertical COM}}$
 - Rockback Angle

At Peak Height

- C.O.M. Maximum ht. 6.03
- Distance COM behind plane of back of box 0.51m
- Horizontal Velocity 1.24 m/s
- Initial Energy / Ending Energy / Difference 55.10 J/kg / 59.95 J/kg / +4.85 J/kg
- Pushoff Distance (C.O.M.) 1.29m

Hand Movement

m / s

Blue – Top hand

Red – Bottom hand

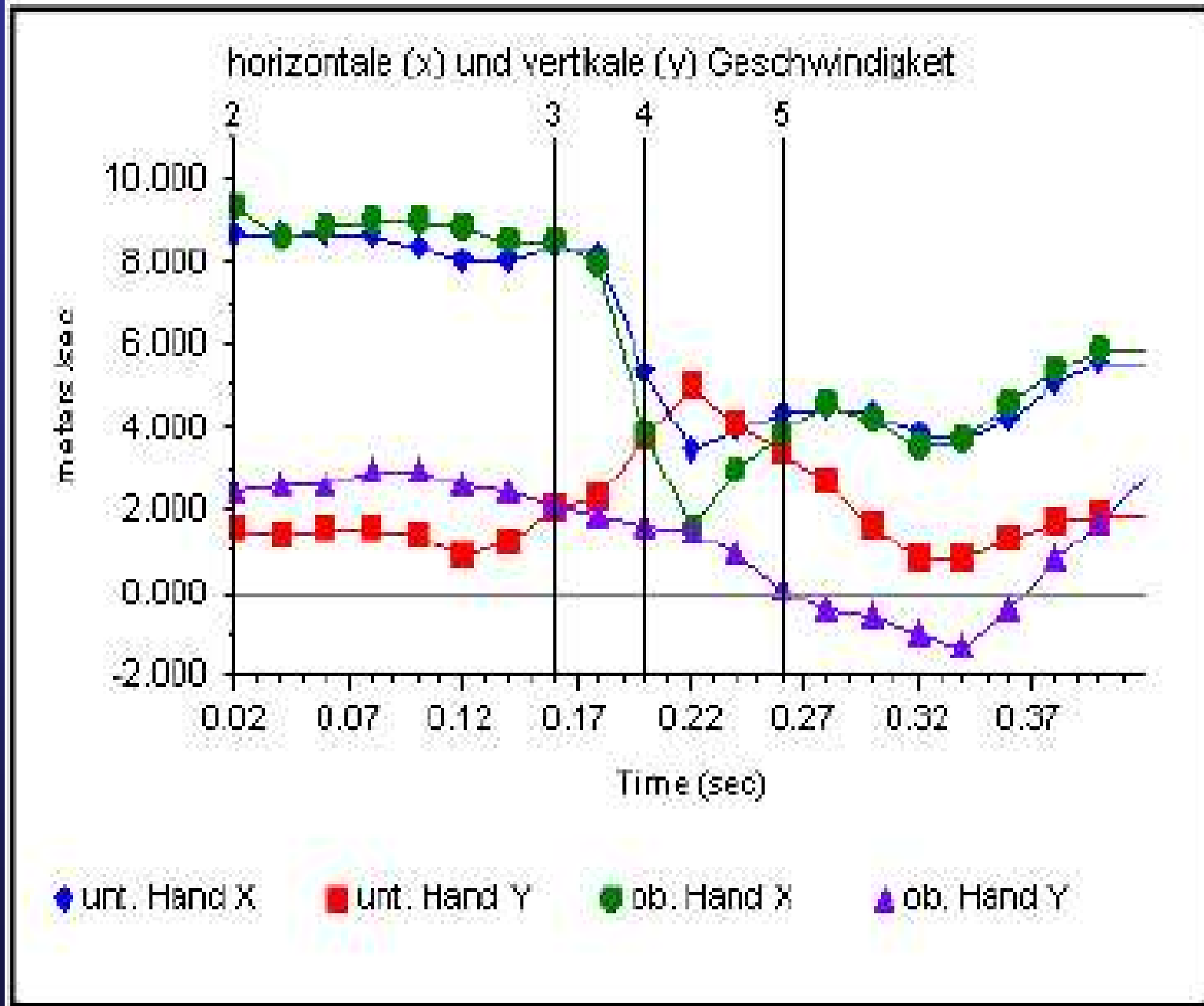
2 = Penultimate Step
Takeoff

3 = TO step landing

4 = Pole Hits back of
box

5 = Takeoff

2=lösen vl; 3=setzen Abspr.; 4=Einstich; 5=lösen Abspr.



Einstich/Absprung:

„Unterlaufen“:	-0,17 m
Höhe KSP TD/TO/Dif.:	1,02/1,20/+0,18 m
Höhe ob. Hand TD/TO/Dif.:	2,11/2,24/+0,13 m
Hub-Differenz:	-0,05 m

• Takeoff

– Under	-0.17m
– C.O.M. TD/TO/Difference	1.02/1.20/+.18
– Top Hand TD/TO/Difference	2.11/2.24/+.13
– Difference C.O.M / Hand Lift	-.05



		<u>Anlauf</u>	
		Schrittgestaltung [m]	
4,13	2,23 (101 %)	2,20	8,56
	6,36	9,46	
	+0,01		
		KSP-Geschwindigkeit [m/s]	

- Last Three Steps (Two Strides) of Approach
 - Penultimate Stride / Takeoff Stride – COM Distance & Velocity

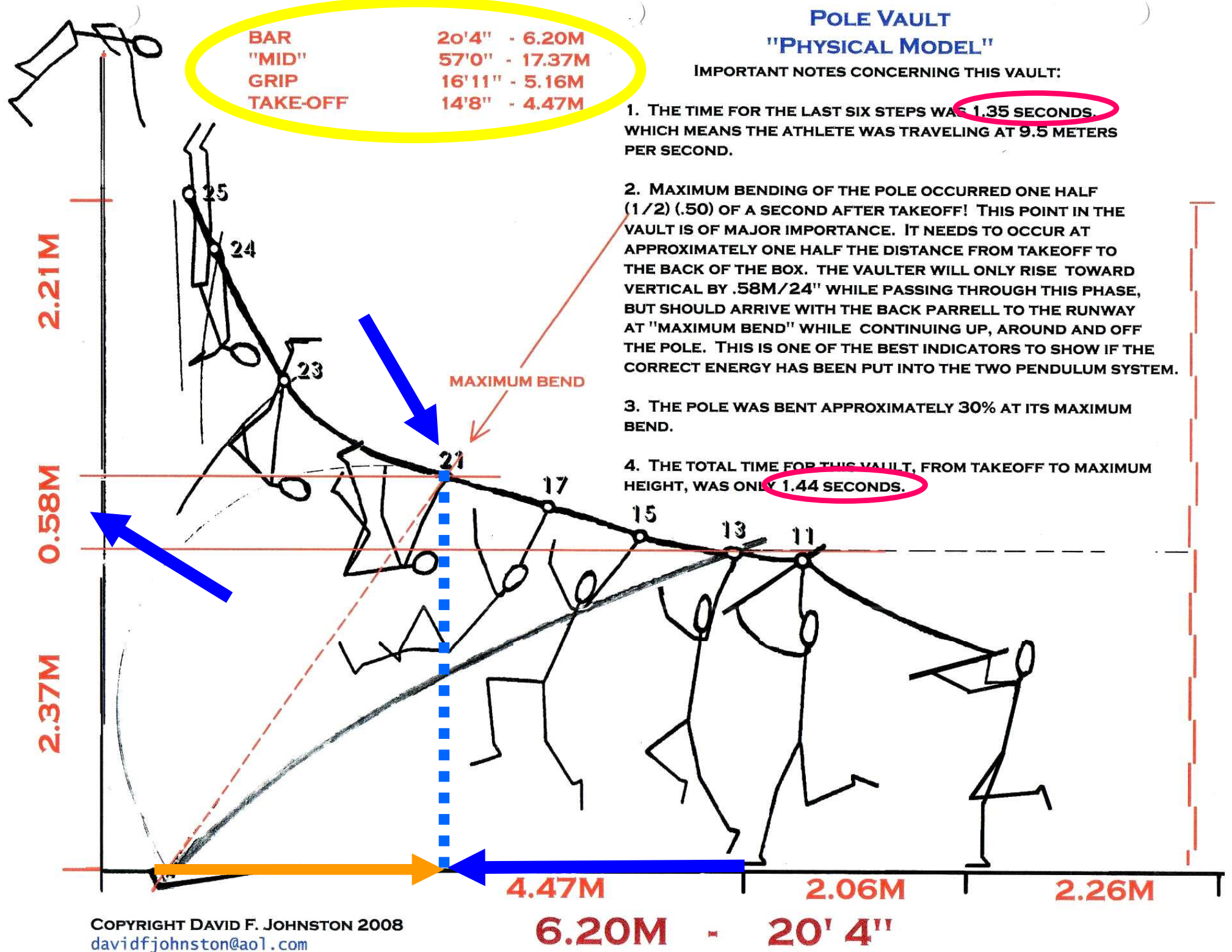
Johnston's Speed-Based Technical Model

1. Approach Speed determines approach pattern and distance, and matches grip and bar height
2. Pole Speed matching Swing Speed
3. Timing of the vault motion regardless of bar height!
 - Can these be confirmed by mechanical studies?
 - #3 can be visually observed by comparing video on www.stabhochsprung.com!
 - **A 4.20 jump (female) and 6.00 jump (male) – same time from Takeoff to release of top hand!**

POLE VAULT "PHYSICAL MODEL"

IMPORTANT NOTES CONCERNING THIS VAULT:

1. THE TIME FOR THE LAST SIX STEPS WAS **1.35 SECONDS**, WHICH MEANS THE ATHLETE WAS TRAVELING AT 9.5 METERS PER SECOND.
2. MAXIMUM BENDING OF THE POLE OCCURRED ONE HALF (1/2) (.50) OF A SECOND AFTER TAKEOFF! THIS POINT IN THE VAULT IS OF MAJOR IMPORTANCE. IT NEEDS TO OCCUR AT APPROXIMATELY ONE HALF THE DISTANCE FROM TAKEOFF TO THE BACK OF THE BOX. THE VAULTER WILL ONLY RISE TOWARD VERTICAL BY .58M/24" WHILE PASSING THROUGH THIS PHASE, BUT SHOULD ARRIVE WITH THE BACK PARALLEL TO THE RUNWAY AT "MAXIMUM BEND" WHILE CONTINUING UP, AROUND AND OFF THE POLE. THIS IS ONE OF THE BEST INDICATORS TO SHOW IF THE CORRECT ENERGY HAS BEEN PUT INTO THE TWO PENDULUM SYSTEM.
3. THE POLE WAS BENT APPROXIMATELY 30% AT ITS MAXIMUM BEND.
4. THE TOTAL TIME FOR THIS VAULT, FROM TAKEOFF TO MAXIMUM HEIGHT, WAS ONLY **1.44 SECONDS**.



Takeoff Point – A Vital Marker?

- Timing of Takeoff and Hands with Pole Contact in Back of Box
- Early, Late, Under, On...
- More important –
 - At what point of Takeoff Foot Contact is the vaulter when pole hits pack of box?
 - Does Pole/Vaulter System “hit” the box, or does the box “hit” the pole/vaulter system?



Does Personal Style Contribute to, or Hinder Performance?

- In the vault, there are many opportunities for athlete – pole interaction to contribute to AND HINDER performance. Do certain movements contribute to / hinder regardless of individual characteristics of the athlete? This is an important question!
- *Examples*
 - *Front Hand in Pole Carry?*
 - *Position of Front Arm at and following Takeoff?*
 - *Rowing Hands forward or down Pole?*

Does Personal Style Contribute to, or Hinder Performance?

- Yes, stylistic movements can both aid and / or hinder performance!
 - Some are consciously initiated / some are reactions to the movements that came before
 - *“Many times what appears to be a unique movement plan is simply that athlete's way of getting back on schedule or back into position from the error railroad they were on...”*

- *“In a model we see the vault as a series of positions. In fact, velocities and accelerations are more important, but difficult to observe. A vaulter may eventually go through the right positions, but not be efficient if his timing is wrong. If a "style" movement is done in such a way that it does not perturb the intended model it should be tolerable. To decide whether a habit (style) is tolerable the vaulter should be able to switch it on or off (for instance vault with and without tucking). Normally he is not able to do so. Such flexibility would however be very useful to explore different possibilities.”*

[Huffman comes to mind...ed.]

Alternative Design?

- Component parts
 - Approach – Speed, Posture and Carry
 - Plant - does it diminish potential of approach
 - Takeoff – Does it effectively translate approach into double pendulum
 - Pole Rotation
 - Swing
 - Pole Interaction – does it aid or hinder energy transfer to the body after pole release?

Problems and Potentials?

- A superset of possible biomechanical effects that in part are complementary, in part overlap, and in part even are contradictory
 - *Ex. the biomechanical advice to keep the center of mass low after take off to allow for a high grip collides, say, for a relatively tall athlete, with the necessity to start a sufficient swing action soon enough to get into inverted position early enough to benefit from the forces the pole's extension generates and could throw us upwards. This action, in return, will generate enough rotational energy to compensate for a slightly higher path of the center of mass...*
- A a superset of mental and motor abilities in the athlete

from a coach's Survey Response

Athlete and Coach Surveys

- Please email me if you are interested in taking a survey for a coach or an athlete
- For current survey results, go [HERE!](#)
- rmercado@sjs.org