Idiots Guide to Safe Pole Vaulting
Vaulting Goals

• 2 fundamental GOALS
• Clear the bar
• Land safely (Secondary for some)
2 Basic Elements of Vaulting

• The Vaulter attempts to move (rotate) the pole to VERTICAL
• The Vaulter attempts to move (rotate) to VERTICAL –
  — (The vaulter attempts to perform a hand stand on top of the pole)
  — (This concept is referred to as the double Pendulum)
Of great importance in pole vaulting is the depth of the body advancement forward during the take-off. With this in mind, even during the take-off the athlete must release the shoulder girdle from tension and drive his chest forward/upward, while at the same time taking off with the support leg and swinging with the free leg.

The quickness and depth of the take-off greatly influence the technique of all the next elements of the vault: the hang, swing and rock-back. Moreover, the performance of the take-off phase determines the rhythm of the subsequent parts of the vault.
POLE VAULT AS ‘DOUBLE PENDULUM’ AND ‘PENETRATION’

By F. Katsikas, G. Papaiakovou, T. Pilianidis and I. Kollias

Biomechanics Laboratory, Department of Physical Education and Sport Sciences, Aristotelian University of Thessalonica, Thessalonica, Greece

Re-printed with permission from Modern Athlete and Coach.

INTRODUCTION

Pole vault, in comparison with the rest of the events in track and field, is one of the most technical events, as well as one of the most exciting and fascinating events. There are many ways in which to understand pole vaulting. Pole vault can be seen as a fight against gravity (Newman, 2003); it can be analyzed through the energy conservation theory (energy production and energy loss) (Armbrust, 1993; Haake, 2000) and finally it can be seen as a ‘double pendulum’ action (McWatt, 1994). This paper discusses some critical points about the optimum synchronization of the pendulums and their influence on the level of penetration.
1. The 'athlete-pole system' (1st pendulum) must be raised up to the vertical position (i.e., pole becomes perpendicular to the ground). To a pole vaulter this action is called 'penetration'. In order for an athlete to achieve good penetration, after taking off, they must remain passive for a short time period with their body fully extended. The optimal time to start the 'rock back' phase is when the line formed from the top handgrip and their hips coincides with the chord of the bending pole (see Figure 1).

Figure 1. The athlete is in position to begin the 'rock back' phase (Abgulo-Kinzler, 1994).
Recognized as an authority on the event, Richard Ganslen, said,

The springing take off deserves serious consideration and all vaulters should experiment with it. Specifically the springing take off helps the take off velocity and swing and aids the vaulter in changing his pure linear velocity to angular velocity.

He also noted, While Dutch Warmerdam initially claimed that he simply ran off the ground, it subsequently became clear that he actually jumped at take off.
vaulting and flexible pole vaulting if they stop thinking of the flexible pole – as a single flexible pole! They should instead think of an infinite series of straight poles, each decreasing infinitely in length until maximum pole bend and then infinitely increasing in length until the pole is again straight, as shown in Figure 5.12.
Vaulting Physics
How the pole moves to vertical

• 3 Determining Factors
• 1 - Vaulter speed (Kinetic energy)
• 2 - Poles Resistance = Grip & Pole flex
• 3 - Vaulter's efficiency at transferring energy into pole (Conservation of energy)
  – The Poles Potential energy – (result of Vaulter's efficiency at transferring energy)
FACTORS AFFECTING PERFORMANCE IN POLE VAULT

According to Muthiah (1986) success in pole vault can be attributed to various parameters of the vault. He suggests:

1. up to 40% is determined by run up speed
2. up to 40% is determined by technique
3. up to 15% is determined by the upper body strength
4. up to 5% is determined by jumping ability.

Critical to all factors is the position of the CM of an athlete, at its highest point of the vault in reference to the back of the box. This is known as the ‘level of penetration’. A vaulter who remains in a long extended vertical position immediately after taking off will cause the athlete-pole system to get to the vertical position more efficiently compared to a vaulter who attempts to swing off the ground immediately. This is because the CM of the athlete remains lower during the ‘swing’ phase of the vault.
1\textsuperscript{st} Factor - Vaulter Speed

- The faster the Vaulter the greater the potential for jumping higher
- Run fast = Jump High
- Provided ... the 2\textsuperscript{nd} Factor
2\textsuperscript{nd} Factor - Vaulter Efficiency

- Things that effect how well the Vaulter transfers running energy (Kinetic) into the poles energy (Gravitational Potential energy)
  - Run
  - Pole Carry
  - Plant
  - Take off
  - Swing
THE APPROACH RUN

9. FAST RUN.
There is a significant correlation between speed over the last 5 meters of the approach run and crossbar height cleared. This is the most important determinant of success in pole vaulting. (see #2 above).

10. VERTICAL POLE CARRY AND POLE DROP.
Elite vaulters employ a pole drop technique during the run up. This reduces the forces imposed on them when they carry the pole in a more horizontal orientation. An possible alternative technique is to push or slide the pole down the runway.

11. MID-MARK (COACH'S CHECKMARK).
A coach's checkmark should be used to mark the optimal position of the start of the fourth to last step. Most vaulters have a coach's checkmark at the beginning of their sixth to last step, but research indicates that this checkmark would be more effective at the start of the fourth to last step. The approach run up until the fourth to last step is programmed, i.e., the vaulter tries to make this part of the approach run the same from vault to vault. But, errors occur, and because of these errors, the vaulter must adjust his steps or "steer" at the end of the approach run in order to hit the correct takeoff mark. The adjustments in the step lengths ("steering") don't occur until the last four steps. A checkmark at the start of the fourth to last step would indicate how accurate the programmed part of the vaulter's approach run was. Adjustments in the vaulter's start mark should be based on how far the vaulter is off the coach's checkmark.

12. ACCELERATE DURING THE LAST THREE STEPS.
Elite vaulters maintain their speed or accelerate into the last steps of the approach run. They also increase their speed from the second to last step to their last step before takeoff. Most developing vaulters slow down during the last three steps. This is easy to do, since this is when the vaulter initiates the pole plant and adjustments in step lengths occur to ensure proper position for takeoff. Many hours of practice are required before a vaulter is able to accelerate during the last steps of the approach run.

13. A LONGER SECOND TO LAST STEP AND A SHORTER QUicker LAST STEP.
Most vaulters take a longer penultimate step and a shorter, quicker last step. This sets the vaulter up for a jumping takeoff. The ratio between the last step length and the second to last step length is between 0.90 and 0.95 for most elite vaulters. Step rate is increased during the last step so that speed does not slow as a result of the shorter step. Elite vaulters overcompensate for the shorter step length by increasing step rate such that speed actually increases during the last step.
Applying the principle of pendular oscillation – or the Swing

Because they could not store energy in a ‘stiff’ pole, athletes had to continue to put energy into the vaulter/pole system after take off so as to keep it moving forward rapidly. They did this by employing a long pendulum swing of the entire body around their hands. Figure 5.6 shows dual Olympic champion Bob Richards executing this long swing to perfection. In his excellent book, “Modern Track And Field”, first published in 1953, J. Kenneth Docerty wrote,

*The all important function of the swing is to maintain the body momentum that has been attained during the run and take off. To delay all action deliberately and to permit the momentum already attained to run its full course are essential.*
Running Energy Losers

• Poor running mechanics
• Stretching (Especially last step) = Slowing down
• Chopping = slowing down
• Inconsistent
• Poor running rhythm (not building up speed)
MECHANICS OF THE POLE VAULT
Mechanical bases of effective pole vaulting technique

Peter M. McGinnis, Ph.D.
Department of Kinesiology •
SUNY College at Cortland
P.O. Box 2000 • Cortland • NY • 13045
e-mail: pmcginnis@cortland.edu

U.S.A. Track and Field
2007 National Podium Education Project
December 13-15 • Las Vegas, Nevada

THE VAULTER

1. TALL AND LEAN.
Elite vaulters are generally tall. Taller athletes have an advantage in the pole vault, especially at the pole strike. A taller athlete usually has a higher reach, and an athlete with a higher reach can strike the pole at a higher angle than a shorter athlete with a lower reach. Perhaps this tip should be entitled "Have a high reach height." Most elite male pole vaulters stand more than 6'0" tall. American record holder Jeff Hartwig is 6'3". Olympic champion Tim Mack is 6'2". American record holder Jenn Stuczynski is 6'0". World record holder Yelena Isinbayeva is 5'8 ½". There are exceptions, of course - Scott Huffman, Greg Duplantis, Svetlana Feofanova for example. Elite vaulters are lean. There are no exceptions to this rule.

2. FAST.
Excellent sprinting ability is necessary for success in the pole vault. During the last steps of their approach runs elite male vaulters reach speeds in excess of 9.5 m/s (29.5 ft/s) while elite female vaulters reach speeds in excess of 8.2 m/s (26.9 m/s). Not all fast vaulters are elite vaulters, but all elite vaulters are fast.
Pole Carry Energy losers

- Low pole carry
- Too much pole movement
- Late pole drop
- Early Pole Drop
Plant Energy Losers

- Low plant
- Late plant
- Blocking plant
- Off center plant
The theses of this chapter are that the factors which were important to vaulting on a stiff pole are still important in vaulting with a flexible pole and that many of the faults detailed in Chapter Six are the same faults that coaches and athletes tried to eradicate in the stiff pole era. Fittingly it was Bubka himself who tied everything together for us when, at the clinic held in conjunction with the 2003 World Junior Championships in Jamaica, he said,

*Before the fibre glass pole, pole vaulters put their focus on moving the pole, then when the flexible pole appeared many people put their focus on bending the pole. The pole (should) bend as a result of the speed and mass of the jumper, therefore, it is more important to concentrate more on moving the pole towards the plane of the bar, rather than being aware of bending it.*

2. *The pole (should) bend as a result of the speed and mass of the jumper.*
To help readers fully appreciate the implications of Bubka’s words and to help them better understand the relationship between stiff pole and flexible pole vaulting, we have broken this statement into three elements and intend to deal with each in turn. Note that we have made minor changes in order to ensure that Bubka’s ideas are presented as clearly as possible.

1. *Before the fibre glass pole, pole vaulters put their focus on moving the pole ......... (Now with the fibreglass pole) it is (also) more important to concentrate -- on moving (it) towards the plane of the bar, rather (than trying to bend it).*

   In this sentence he is emphasising a critical element
2. The pole (should) bend as a result of the speed and mass of the jumper.

This simply re emphasises the importance of the free take off in modern vaulting.

3. When the flexible pole appeared many people put their focus on bending the pole.
Take Off Energy Losers

- Under
- Way Under
- Way Out
17. **HIGH PLANT.**
   The top hand should be as high overhead as possible. This arm should be extended vertically as much as possible. This will help achieve a high pole angle at pole strike (see #14 above). Interestingly, the relative vertical extension of the plant arm for some elite vaulters is less than that of less skilled vaulters. Perhaps the pretension in the muscles in their shoulders and arms (see #15 above) causes these elite vaulters to reduce the relative vertical extension of their plant arm.

18. **TOES OF TAKEOFF FOOT DIRECTLY BENEATH TOP HANDGRIP.**
   At the instant of pole strike (the instant when the pole butt plug first strikes the back of the box) the top hand should be directly above the toes of the takeoff foot. This puts the vaulter in the best position for transferring energy to the pole. This also means that at the instant of takeoff the top hand will be in front of the takeoff foot, since the top hand moves forward as the pole begins to bend. Most vaulters plant the pole with their takeoff foot in front of their top hand. Elite vaulters position their takeoff foot more directly below their top hand.

19. **POLE STRIKE OCCURS WHEN THE VAULTER IS UP ON HIS TOES.**
   Don't plant the pole while you are still on the heel of your takeoff foot. The timing of the pole strike (the instant when the pole first strikes the back of the box) is crucial. The sequence of events occurs like this: the takeoff foot hits the ground (touchdown), the pole hits the back of the box (pole strike), and the takeoff foot leaves the ground (takeoff). These events occur in 0.08-0.12 s (the total time of takeoff foot support) for elite vaulters. For elite vaulters, pole strike occurs in the second half of the support phase, closer to the instant of takeoff. This indicates that they are actively pushing off the ground. They are "on their toes" when pole strike occurs and they actively push the pole upward and forward. If pole strike occurs during the first half of the support phase, closer to the instant of touchdown, then the vaulter will be not be able to actively push the pole upward and forward. The vaulter will be jerked off the ground by the pole. The timing of the pole strike is related to takeoff foot position and the extension of the plant arm (see #16 and #17).

20. **JUMPING TAKEOFF.**
   A fast takeoff velocity is necessary for vaulting high. Elite male vaulters have resultant takeoff velocities faster than 8.0 m/s (26.2 ft/s) while elite female vaulters have resultant takeoff velocities faster than 7.0 m/s (23.0 ft/s). The resultant takeoff velocity is composed of a horizontal (forward) velocity and a upward (vertical) velocity. A fast horizontal takeoff velocity is produced by a fast approach run. A fast vertical velocity is produced by an upward jump at takeoff. Elite male vaulters have horizontal takeoff velocities faster than 7.7 m/s (24.9 ft/s) and vertical takeoff velocities faster than 2.2 m/s (6.6 ft/s). Elite vaulters have takeoff angles between 17 and 19 degrees for men and between 18 and 20 degrees for women. Takeoff angles which are too low may lead to pole breakage.
Figure 6: Comparison between the dynamic and static plant angle. Because of the take-off dynamics and the fixed top hand, the static plant height is necessarily reduced. If one shifts the figure on the right to left, it becomes obvious that the dynamic and static points of take-off are almost identical (Figure according to TIDOW 1989)
Figure 7: Take-off step and pole plant in five phases (7.1 to 7.5)

Figure 8: Pole vault take-off in four phases (8.1 to 8.4)
Despite most vaulters exhibiting an almost extended lower arm and locked elbow joint, the athlete does not take off “against” the pole locked in the box, but, more or less together with it. From this movement behavior at least two advantages can be derived:

1. The transmission losses are reduced to a minimum.

2. The relatively narrow grip required for this movement is an optimal prerequisite to the efficient use of both arms in the following pull, turn and push phase.
The widely expressed opinion that the take-off should be directed “upwards” cannot be recommended. The “tip-take-off” striven for by some vaulters, characterized by a push-off which is similar to a hurdler’s, i.e. from the ball of the foot without touching the ground with the heel, has a different objective. As far as physics is concerned, the vaulter should try to maximize the penetration impulse during the take-off. By doing so he succeeds in converting kinetic to potential energy and thereby shortening the “true axis of the pole” (cf. GANSLEN 1968), that is, the radius within which the whole system rotates. So, at the moment of maximum bend, the length of the chord of the pole curve is only 70% of the resting length of the pole (cf. ALLMANN 1983; GEESE & WOZNICK 1980).
Swing Energy Losers

- No swing
- Bent swing leg
- Double leg swing
- No knee drive
POLE BENDING PHASE

21. LOWER HAND INITIATES POLE BEND.
This begins at the pole strike and continues only briefly into the follow through phase, until about 0.20 s after takeoff. The force exerted against the pole by the lower hand greatly reduces the compressive force necessary to bend the pole. Although the pushing action of the lower hand is instrumental in initiating the pole bend, it also slows down the rotation of the vaulter. So, the pushing action only occurs for a brief period of time. Shorter vaulters may have to push more than taller vaulters.

22. SWEEPING AND WHIPPING EXTENDED TRAIL LEG.
The centripetal force generated by the sweeping, whipping action of a long and extended trail leg loads the pole and maintains the vaulter's swinging momentum.

23. HANGING AND SWINGING FROM TOP HANDGRIP.
The force exerted by the hands downward toward the butt end of the pole is a compressive force or column load which is primarily responsible for bending the pole. The larger this force is and the further this force is away from the butt end of the pole, the easier it is to bend the pole. Therefore, the vaulter should attempt to swing from his top hand to ensure that this force is exerted on the pole as high as possible. The vaulter should neither pull with this arm nor flex at the elbow, rather the vaulter should think of this arm as a cable and let the pulling force of the pole pull through this cable. Keeping the body swinging in an elongated position will also increase the force which bends the pole. Some pulling force will be exerted by the bottom hand after its initial push to start the pole bending. This pulling force assists the vaulter in rotating his body upside down. Vaulters who used a large pushing force with the bottom hand to bend the pole (see #21) will have to pull with a much larger force in the bottom hand in order to set upside down.
POLE STRAIGHTENING PHASE

24. AXIS OF ROTATION MOVES FROM TOP HAND TO SHOULDERS.
During the long swinging action of the vaulter immediately following takeoff, the vaulter's axis of rotation is around the top handgrip. As the pole reaches maximum bend, this axis of rotation moves from the hands to the shoulders. The vaulter's hips and legs are lifted upward relative to his handgrip.

25. CENTER OF GRAVITY ALIGNED WITH OR BEHIND THE POLE.
Allowing the center of gravity to pass in front of the pole while the vaulter extends upward produces a moment about the handgrips which causes the vaulter's backward rotation to stop. The legs and trunk then begin to drop and rotate towards the bar. To avoid this, the vaulter should try to stay as close to the pole or behind it as he inverts, extends and turns. The vaulter should strive to "beat the pole" - get into position on top of the pole to take advantage of the energy return from the pole. Pole selection and grip height (see #8 above affect the ability of the vaulter to "beat the pole".

RELEASE AND CLEARANCE

26. SAFE LANDING.
Vaulters who land safely in the pit are happy vaulters. They have more fun and are able to vault again. Ensure safety by using a larger than minimum size pit, padding or removing hard surfaces near the pit, padding standard bases, using a box collar and using common sense.
Energy Loss Scoring

• Is a result of the actions that precede it
• The only source of energy is the Run
• You can’t transfer 100% of run energy
• Everything else is an energy loser
• The question is how much energy do you create and how much do you lose through the actions of vaulting
3rd Factor – Pole Resistance

• 2 Elements in pole resistance
• Grip Height
  – Determines Radius of the jump
  – Higher grip = longer radius = more resistance
  – Taller Vaulter = Shorter Radius
• Pole Flex
  – Provides a base-line measurement for the amount the pole deflects (resistance)
  – Smaller Flex # = Stiffer pole
Linthorne – Energy loss in the Pole Vault

Abstract
A model of pole vaulting with a flexible pole was developed with the aim of predicting the optimum take-off technique and pole characteristics for a typical world-class pole vaulter. The key features of the model are that it includes the interdependence of the take-off angle and the take-off velocity, and that it accounts for the energy losses in the pole plant and take-off phases of the vault. A computer simulation program was used to systematically investigate the effect of different combinations of take-off velocity, take-off angle, grip height and pole stiffness on the performance of a world-class male vaulter. For the highest vault with this model, the vault height and the optimum combination of take-off velocity, take-off angle, grip height and pole stiffness were in good agreement with measured values for world-class vaulters using fibreglass poles.

The results from the model were compared with those from a model of vaulting with a rigid pole. There was a clear performance advantage to vaulting with a flexible pole. The flexible pole produced a 90 cm higher vault by allowing a 60 cm higher grip and by giving a 30 cm greater push height. There are two main advantages of a flexible fibreglass pole over a rigid pole made of steel or bamboo. A flexible pole reduces the energy dissipated in the vaulter’s body during the pole plant, and it also lowers the optimum take-off angle so that the athlete loses less kinetic energy when jumping up at take-off.
Why do vaulters jump higher with a flexible pole?

Pole vault performances suddenly improved when the flexible fibreglass pole was adopted in the early 1960s, and some observers decried their use, believing that the pole was ‘catapulting’ the vaulter up over the bar (Cramer 1970). However, this catapult notion is dispelled by the fact that the vaulters’ push heights did not increase much when the fibreglass pole was introduced (Jeitner 1967; Jagodin 1973). A notable feature of the adoption of the fibreglass pole was the large increase in grip height. At the end of the steel pole era the grip heights of world-class vaulters were at about 4.10 m, whereas those of early fibreglass vaulters were 60 cm higher at about 4.70 m (Jagodin 1973). The higher grip height is commonly considered to be the main advantage of the flexible pole.
Many articles have appeared in coaching journals attempting to explain the higher grips used when vaulting with a flexible pole. For example, Attig (1979) and Geese (1987) argue that a flexible pole bends to some shorter effective length, reducing the moment of inertia of the vaulter on the pole, and so enabling the pole to rotate to vertical more easily. Unfortunately, this argument violates the principle of conservation of energy (Linthorne 1989). A vaulter’s grip height is actually determined primarily by the kinetic energy at take-off. The higher the kinetic energy at take-off, the longer the pole the vaulter is able to rotate to vertical.
The most credible explanation for the higher grips when using a flexible pole is that the pole reduces the shock experienced by the vaulter, and so less energy is dissipated in the vaulter’s body during the take-off (Stepp 1977; Linthorne 1989; Armbrust 1993). The vaulter therefore has a higher take-off velocity, and is able to rotate a longer pole to vertical.
There is a lesser known difference between vaulting with a flexible pole and vaulting with a rigid pole which may also be important. Linthorne (1994) noted that the take-off angles for vaulters using fibreglass poles are lower than for vaulters using bamboo or steel poles (Angulo-Kinzler et al. 1994; Ganslen 1961). He suggested that part of the contribution to the advantage of a flexible pole may be that the optimum take-off angle is lower, and so the vaulter does not lose as much kinetic energy when jumping up at take-off. As regards the present study, it was therefore expected that a successful model of pole vaulting must produce two key results: (1) the vault height and grip height are considerably higher with a flexible pole than with a rigid pole; and (2) the take-off angle is lower with a flexible pole than with a rigid pole.
FACTORS AFFECTING PENETRATION

Take off velocity, grip height, and the stiffness of the pole are the three major factors that influence the level of penetration. These factors will now be discussed.

*Take off velocity*

The two main parameters, which provide the energy needed to push the pole to the vertical position, are (i) the horizontal speed on the runway, and (ii) vertical speed or jumping ability of the athlete during the short ‘take off’ period. The take off takes very little time, ranging from 0.11 to 0.14 seconds (Chang, 2002; Katsikas, 1992).
Grip Height (affecting planting angle of the pole)

Provided that everything else is equal, a pole vaulter's grip height determines their potential vaulting height more than any other criterion (Johnson, 2002). Since 1956 the pole vault world record has drastically improved with flexible poles (either made of fiberglass or more recently of carbon fiber). This improvement in men's performance can be observed in Figure 3 (Attig, 1979; Quercetani 2000).

![Figure 3 Improvement of the men's world record in pole vault from 1912–2000.](image)

From the graph in Figure 3 it can be observed that there has been significant improvements in performance since 1961. Examining in depth the factors largely responsible for this improvement, Johnson (2002) argued that grip height was the most important. Flexible poles, compared with stiff poles, allow higher grips as the bend causes a reduction in the axis of rotation from 0.80 to 0.90m (Bergeman, 1979; Ganslen, 1961; Houvion, 1982; linthorne, 1994).

As can be seen in Table 3, the improvement in performance from 4.76m (with rigid poles) to 5.45m (with flexible poles) up to 1980 was 0.69m. Schmolinsky (1983) concluded that the improvement was mainly due to the higher grip of 0.63m (90.9%) whilst only 0.06m (9.1%) was due to clearance efficiency or catapulting by the flexible poles.
Grip/Flex Relationship

• Poles Rated Flex vs Grip Flex
• Lower grip = Stiffer Flex
• Lower flex number = stiffer (more resistance)
  – Example
    • 14’ - 150lbs - 21.2 Flex @ Tested grip of 13’9
    • Same Pole with grip @ 12’9 = 16.8 flex – equivalent to 13’ 170
  – 6” lower grip = 10lbs increase in stiffness
  – 6” lower grip = 2.2 lower flex
“To a vaulter, flex numbers help describe how flexible -stiff or soft- a pole is going to perform.

To manufacturer’s flex numbers are a measure deflection when poles are suspended on two supports of a given span and a weight is hung in between the supports. The amount the pole bends or deflects, measured in centimeters (by most manufacturers), is the flex number.

(The Pole Vault: An Engineers Perspective - Jeffrey P. Watry Senior Engineer Gill Athletics, 2004)
• i) Smaller Flex # = Stiffer Pole
• ii) Larger Flex # Lighter Pole
• iii) Manufactures are proprietary in how they measure flex and as a result are all slightly different.
• iv) Gill poles are all measured the same across all pole lines. Carbon poles. FX, Mystic, Skypoles are all consistent from one brand to the next.
• v) A 14’ 20.0 Gill pole is slightly different than a 14’ 20.0 UCS pole or Nordic pole etc
• vi) Pole Flex is relative to pole length
• (1) 13’ - 21.3 IS NOT EQUEL to 13’6” - 21.3
• (2) Longer poles are measured at longer spans
• (3) Example: 13’ pole might have the supports placed 1’ from each end so the actual test span (distance between the supports) is 11’
• (4) 13’6” pole measured span would be 11’6”
• (5) Longer pole with the same flex of a shorter pole is stiffer than the shorter pole
• (6) Rule of thumb is a 6” longer pole is 10lbs heavier than the same flex # on the shorter pole.
• “In layman’s terms, the rule of thumb is that per six inches of grip change, there is a 10lb change in rating. If you use a 14’ 150 lb pole- at 13’6” it would react more like a 161lb rated pole.”
• (The Pole Vault: An Engineers Perspective - Jeffrey P. Watry Senior Engineer Gill Athletics, 2004)

• b) Test Weight
• i) 1.0 in Flex = Approx 5lbs Test Weight
• ii) .2 in flex = approx 1 lbs test Weight
The Vaulter/Pole Relationship

- The relationship between Vaulter speed, Vaulter efficiency & Pole resistance
- Not a static place
- Infinite number of adjustments
• 2) What determines Grip Height
  • a) Vaulter Speed + Vaulter Efficiency = Vaulter Force at TO – Pole Resistance determines GRIP
  • b) Kinetic Energy = Force at Take-Off
  • c) Force at Take off = Mass, Acceleration (Vaulter Speed), Vaulter Height + Vaulter Efficiency at Take Off
3) How the flexible pole aids the Vaulter
   a) Lessens poles resistance
   b) Allows the Vaulter to become more efficient by making it easier to transfer energy
   c) Allows Vaulter to move pole to vertical easier
   d) Enables the Vaulter to grip higher
   e) In some cases the Vaulter gains energy back from the pole

(1) Only if the vaulter rotates upside down and then only if the pole rotates to vertical
How the Vaulter Moves to Vertical

• How the pole moves to vertical is a barometer of the jump
  – Number one thing you watch
  – Too fast or too slow equally bad

• Vaulters' ability to rotate to vertical is a result of the poles rotation to vertical
Lack of Control

• 100% of vaulting related accidents stem from loss of control
• Lack of control is a result of the vaulter pushing beyond they’re skill level
• Lack of control is a result of lack of/or bad mechanics
• Too much pushing is BAD RISK MANAGEMENT
Control Factors

• Single biggest factor
• Trying to hold to high
  – Not enough pole speed to get to vertical
Top Vaulting Myths (Lies)

• “Gotta Hold HIGH to Jump HIGH”
• “The more you bend the pole the higher it’ll throw you”
• “Bending the pole is a short cut to success”
• “You have to force the pole to bend”
• “Vaulters need to vault BIG every day”
• The weight label is the “Must Grip Line”
• Force your way up on BIGGER POLES
Top Truths of Vaulting

• “It’s POLE VAULTING not POLE BENDING”
• The goal is to move the pole to vertical
• Safe Vaulting is driven by SOLID MECHANICS
• Solid Mechanics leads to vaulting EFFECIENCY
• Efficiency leads to high vaulting
• Bending the pole is a natural extension of good mechanics
• You don’t have to PUSH to have success
Elements of Progressive Vaulting

• Practices predominantly from 3, 4, 5, 6 “lefts”
• Starts small and incrementally increases pole, grip & run as the vaulter demonstrates greater mechanical proficiency
• The Vaulter “GROWS” their way down the runway
• Lots of small reps. To develop muscle memory
Progressive Thinking

• I think what you need to do is look at learning the vault as a progression of knowledge and skills. You start real small and buildup as your knowledge and skills improve.

• You wouldn't start teaching trig functions the first day of freshman math class and you don't start teaching "pole bending" the first day of vaulting class. You go through a whole long set of foundation building skills that lead up to the BIG skills.

• You need to learn how to add & subtract, multiply and divide before you can do Algebra and Geometry.

• Unfortunately, many people don't learn those skills, they whip out the calculator, because it’s easier.

• Vaulters do the same thing "BENDING the POLE" is like the calculator.

• It's a short cut

• As a result, they don't become grounded in the skills and understand the mechanical foundation of vaulting.
Grip’n & Rip’n

• For many Vaulters the goal is BENDING THE POLE.

• It becomes the Holy Grail, the SHORT CUT to success.

• They by-pass the foundation core skills of Pole Vaulting,
Short Cuts

- They by-pass the foundation core skills of Pole Vaulting,
- the running,
- planting,
- take-off,
- swinging skills,
- and then eventually hit a wall because they don't have the skills to advance.
- And for far to many literally hit the wall or the floor or the standards or the box and have injuries.
Progressive Mantra

• The real goal in vaulting is moving (rotating) the pole to vertical and then to rotate the Vaulter to vertical.

• IT'S NOT BENDING THE POLE!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

• Those 2 things can happen independently of weather the pole bends or not.
• The basis of ALL vaulting is STIFF POLE VAULTING!!!!!!!!!!!!!!!!!!!!!!!!!!!!

• In progressive Vaulting the Vaulter incrementally grows their vault a left at a time

• The vaulter needs to EARN their way down the runway and up the pole.
• They need to learn how to improve their mechanics to earn the right to move back a left and up a hand on the pole

• Before you can do 4 lefts you need to show me you can execute from 3 lefts and before you can do 5 lefts you need to execute from 4 lefts & 5 & 6 & 7 & 8

• Same thing with the grip. Grip's not going up until you can prove you can rotate the pole to vertical.
• If the vaulter is moving the pole fast to vertical then they move up a hand at a time until it stops moving.
• Once they've gone as far as they can go from 3 they move back to 4 lefts and start moving up a hand at a time until it stops.
• We do the same thing all they way down the runway.
Vaulting Gestalt

- Shrinking the Vault into a manageable size
- Focus on elements while practicing the whole
Vaulting Relativity

• Smaller jumps are faster than larger jumps because the radius of the jump is shorter.
• The result is that the mechanical elements are of shorter duration in smaller jumps than larger jumps.
• The mechanics of vaulting stay the same but are relative to the size of the vault in terms of SPEED, FORCE & TIMEING.
Progressive Pole Speed

• If the vaulter is moving the pole fast to vertical then they move up a hand at a time until it stops moving.
• Once they've gone as far as they can go from 3 they move back to 4 lefts and start moving up a hand at a time until it stops.
• We do the same thing all the way down the runway.
Progressive Mechanics

• You can teach all of the fundamental mechanics of vaulting from 3 lefts (or rights)
• Running consistency,

• Consistent first step

• Running rhythm,

• Driving thru the last 6 steps,

• Body posture - Not leaning back
Plant

- Plant timing feeling the left (or right) foot stick the ground
- 3 step plant

- High Active Plant, Not a low blocking passive plant

- In the BIG collision know as the plant you want to be the hit-er not the hit-ee
Take Off

• Out/ON Step
• Not way under step
• Get the last step down
• Don't streatch
• drive off/ jump off the ground (there's no jumping unless the step is under)
• Swinging / Swinging to Vert
• swing from hands
• long trail
• Rotating
• Pull/Turn
Teaching Lefts

• You can teach all of these things and teach it more because you can do a lot more reps from 3 or 4 & 5 lefts

• As they improve and can start moving the pole faster we move the grip up a hand at a time.

• It’s a long hard slow process but it sets the foundation of skills that the Vaulter depends on for the remainder of their vaulting lives.
Process

• When they can't go any higher from 3 lefts I move them back to 4 lefts and we keep grinding away at step, Plant, swing.
• When they max out at 4 lefts I introduce 5 lefts.
• But no matter how many lefts I'm always watching how fast the pole rotates to vertical.
Vaulter Confidence

• As the vaulter becomes more skilled, they run faster, more consistently and become more confident on the runway because they have more confidence in their ability to execute the mechanics.
Scariest Thing in Vaulting

• Standing at the end of the runway thinking,
  • “Hope my step is ON!”
  • “Hope my Plant is up”!
  • “Hope I make it in the PIT!”
Bottom Arm Block

- Young vaulters that learn to do the bottom arm block have an incredibly hard time learning how to rotate on the pole because the bottom arm block stops them from swinging and rotating. It's real good for forcing the pole to bend but bending the pole doesn't necessarily move (rotate) the pole to vertical.
Evils of the Bottom Arm Block

- Tend to over bend the pole
- Tend to “OVER POLE” Pole Too Big
- Tend not to move the pole to Vertical
- Block too long and chop off their swing
- Block too long and have difficulty rotating
Progressive Vaulters

• Typically the vaulter becomes more efficient and jumps HIGHER from a SHORTER RUN and LOWER GRIP.
• AND it's SAFER because the vaulter is MORE UNDER CONTROL
Vault Psychosis

- Only does a couple “pop-ups” before going back to Long run
- “Runs threw” a lot
- Every jump is MAX effort
- Over Grips
- Bends the pole A LOT
- Doesn’t get the pole to VERTICAL
- Pole moves (rotates) slowly to vertical
- Likes getting “TAPPED”
<table>
<thead>
<tr>
<th>8 Lefts</th>
<th>TO</th>
<th>Pant</th>
<th>MID</th>
<th>L-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adj Stp</td>
<td>13.0</td>
<td>19.5</td>
<td>26.5</td>
<td>33.5</td>
</tr>
<tr>
<td>Adj Step Lngth</td>
<td>6.5</td>
<td>6.5</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Adj StrideLngth</td>
<td>13.5</td>
<td>14.0</td>
<td>14.0</td>
<td>13.0</td>
</tr>
</tbody>
</table>

Take off 13-5 (should be 13)
R 20
L 27
R 34
L 40-4
R 47
L 53
R 59
L 65
R 71
L 77
R 82-6
L 88
R 98-6 (Starting point)
## Pole Grip Run

<table>
<thead>
<tr>
<th>Pole Assignments</th>
<th>Run</th>
<th>Grip</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Lefts</td>
<td>32'</td>
<td>10'3</td>
</tr>
<tr>
<td>4 Lefts</td>
<td>13'6&quot;/145</td>
<td>52'</td>
</tr>
<tr>
<td>5 Lefts</td>
<td>14/155</td>
<td>13'</td>
</tr>
<tr>
<td>6 Lefts</td>
<td>14/155</td>
<td>13&quot;3'</td>
</tr>
<tr>
<td>7 Lefts</td>
<td>14/160</td>
<td>13&quot;6'</td>
</tr>
<tr>
<td>8 Lefts</td>
<td>14/160</td>
<td>13&quot;6'</td>
</tr>
<tr>
<td>100'</td>
<td>4.49</td>
<td></td>
</tr>
</tbody>
</table>

### Additional Data

<table>
<thead>
<tr>
<th>Pole Assignments</th>
<th>Run</th>
<th>Grip</th>
</tr>
</thead>
<tbody>
<tr>
<td>30'</td>
<td>40'9&quot;</td>
<td></td>
</tr>
<tr>
<td>31'9&quot;3&quot;</td>
<td>42'9&quot;</td>
<td></td>
</tr>
<tr>
<td>34'9&quot;3&quot;</td>
<td>43'10</td>
<td></td>
</tr>
<tr>
<td>36'9&quot;6&quot;</td>
<td>48'10'3&quot;</td>
<td></td>
</tr>
<tr>
<td>38'10&quot;</td>
<td>50'</td>
<td></td>
</tr>
<tr>
<td>30'9&quot;</td>
<td>41'9&quot;3&quot;</td>
<td></td>
</tr>
<tr>
<td>33'8&quot;3&quot;</td>
<td>45'10'</td>
<td></td>
</tr>
<tr>
<td>34'8&quot;6&quot;</td>
<td>46'10'6&quot;</td>
<td></td>
</tr>
<tr>
<td>35'9&quot;6&quot;</td>
<td>48'10'</td>
<td></td>
</tr>
<tr>
<td>29'8&quot;6&quot;</td>
<td>40'9&quot;3&quot;</td>
<td></td>
</tr>
<tr>
<td>31'8&quot;9&quot;</td>
<td>41'9&quot;</td>
<td></td>
</tr>
<tr>
<td>34'12&quot;1&quot;</td>
<td>56'13</td>
<td></td>
</tr>
<tr>
<td>30'</td>
<td>40'</td>
<td></td>
</tr>
</tbody>
</table>

### Additional Data

<table>
<thead>
<tr>
<th>Pole Assignments</th>
<th>Run</th>
<th>Grip</th>
</tr>
</thead>
<tbody>
<tr>
<td>100'</td>
<td>4.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.98</td>
<td></td>
</tr>
<tr>
<td>5.03</td>
<td>4.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.98</td>
<td></td>
</tr>
</tbody>
</table>

### Additional Data

<table>
<thead>
<tr>
<th>Pole Assignments</th>
<th>Run</th>
<th>Grip</th>
</tr>
</thead>
<tbody>
<tr>
<td>100'</td>
<td>4.78</td>
<td></td>
</tr>
<tr>
<td>4.82</td>
<td>4.82</td>
<td></td>
</tr>
<tr>
<td>4.82</td>
<td>4.82</td>
<td></td>
</tr>
</tbody>
</table>

### Additional Data

<table>
<thead>
<tr>
<th>Pole Assignments</th>
<th>Run</th>
<th>Grip</th>
</tr>
</thead>
<tbody>
<tr>
<td>100'</td>
<td>4.24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.24</td>
<td></td>
</tr>
</tbody>
</table>

### Additional Data

<table>
<thead>
<tr>
<th>Pole Assignments</th>
<th>Run</th>
<th>Grip</th>
</tr>
</thead>
<tbody>
<tr>
<td>100'</td>
<td>5.38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.38</td>
<td></td>
</tr>
</tbody>
</table>