Model technique analysis sheets Part VIII: The Flop High Jump

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by Günter Tidow

The author presents the eighth part of his series dedicated to the analysis of model techniques in athletics events with a study of the Flop High Jump. The first part of this series was published in NSA in 1989. In a supplement to his main article, the author queries the assumption that the flop technique is technically superior to the straddle which it has superseded. He looks at the differences between 'power' and 'speed' flops and compares aspects of these techniques with the straddle. Finally, he lists the possible reasons why the flop has, indeed, superseded the straddle.

Dr Günter Tidow is the Head of the Department of Athletics at the University of Bochum (GER).

Translated from the original German by Jürgen Schiffer.

8.1 The Approach

The flop approach in the High Jump consists of 8 to 12 steps, not taking into account the rather varied preliminary phase (Krejor & Popov 1986/Anzil et al. 1973). The last three to five steps are run in the form of a curve with a radius of approximately 8 to 12 metres. It is a general principle that the higher the approach velocity (maybe up to 8.73 m/sec cf Zhukov/Yufrikov 1984) the greater the radius. The first steps of the approach are run on a tangent which then leads into the so-called 'impulse curve.'

As it is possible to control the direction of the run only during the support phases, the impulse curve itself, naturally, is affected only during the support phases (Müller 1986). In the flight phases, the jumper's centre of gravity (CG) moves in a straight line on the chord of his approach curve (see Figure 1). The term chord is chosen deliberately since the higher the approach velocity, the greater the inward lean of the jumper.

It is assumed that, at the highest point of the flight parabola, the CG is at the same height as the bar. An even more economic form of bar clearance (e.g. with the CG 5 cm below bar height) makes a clearance of 2.45m possible without changing the data used in the model in Figure 1.

The inward lean of the body during the curved section 'automatically' results in a lowering of the CG in the direction of the centre of the curve. The degree of inward lean is dependent on the approach velocity and can be greater than 30°. The corresponding percentage lowering of the CG is approximately 13%, in the case of 30° lean, to 18%

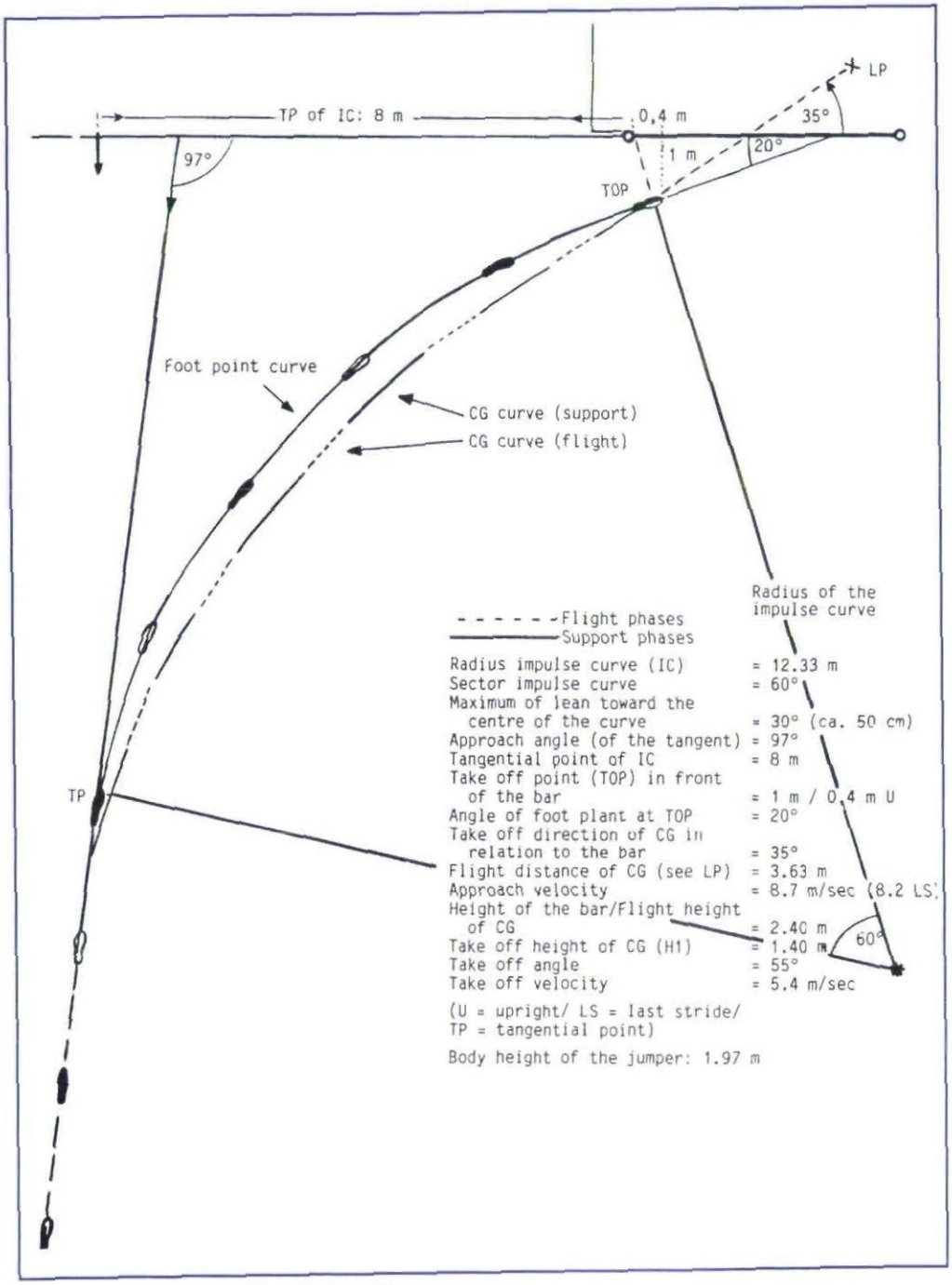


Figure 1: Model of a 2.40m Fosbury flop with corresponding characteristic curves and parameters.

in the case of a 35° lean, if one converts the absolute values of 12 to 15 cm published by Beulke (1974). The maximum degree of lowering is reached during the penultimate stride.

As jumpers strive to take off with their CGs as high as possible, they are forced to straighten up from their lean toward the centre of the curve. This straightening movement starts during the penultimate contact and continues during the last stride until the take-off position has been reached. The resulting 'straightening momentum' (Beulke 1973/ Beulke 1974) has two important advantages which explains the reason for the curved approach of the flop. Firstly, the straightening momentum continues after the take-off according to the law of conservation of *momentum. Consequently, a rotational* momentum about the transverse axis is available. This is absolutely necessary for an economic bar clearance without the need to dissipate energy from the take-off impulse.

Secondly, the straightening momentum runs more or less parallel to the aimed at direction of acceleration, thus leading to a path of preliminary acceleration directed diagonally upwards. This is essential in order to bring about the change of direction of the CG as smoothly and fluently as possible.

Straddle jumpers have no comparable 'assistance'. They have to perform the take-off preparation as well as the take-off itself, including the production of rotational momentum, by themselves as it were, which makes high demands on movement technique. In doing so, a reduction of the vertical proportion of the take-off velocity is unavoidable.

In the flop approach there is a noticable change of the ratio between flight and support time. floppers tend to start the first (straight line) part of the approach with a springy, high knee action and then they switch to an increasing emphasis on stride frequency as they get closer to the bar. In doing so, there is a reduction of the flight time relative to the support time, mainly during the last stride.

However, this trend – particularly as far as the rhythm and the organisation of the last three strides is concerned – is not universal. Some athletes shorten the last stride of their approach in comparison with the preliminary stride, whereas others lengthen it.

At present, it is not possible to identify an optimal solution to this problem. It must also remain open whether primarily (or even exclusively) varying prerequisites in the area of physical condition or motor abilities are responsible for this relatively broad range of movement behaviour.

The question as to what extent the flop-specific curved run is responsible for this variability can only be answered by way of speculation. Possibly one must agree with Viitasalo, who stated that "there is presum*ably no optimal universal style but only an* individually optimal style" (cf Viitasalo 1982).

Therefore, in the further course of this paper, a variant of the 'speed flop', which is thought to be optimal from a personal point of view will be presented and discussed in detail.

8.2 Immediate take-off preparation: penultimate stride of the approach

As in the long jump, the detailed presentation of the flop phases which are relevant from the point of view of technique will start with the penultimate stride. As demonstrated in Figure 2, the push-off phase into the previous third from last step can well be called typical of sprinting (see Figure 2.1), except for the pronounced lean toward the centre of the curve, which is not obvious from this figure.

Comparing Figure 2.1 with 2.2, one can only notice a somewhat longer, "lower" rear support and an upper body which has been straightened from the forward lean typical of sprinting (seen clearly in Figure 2.1).

A corresponding comparison with Figures 2.2 and 2.3 shows a further change: the arm on the outward side of the curve has not been swung to the front simultaneously with the

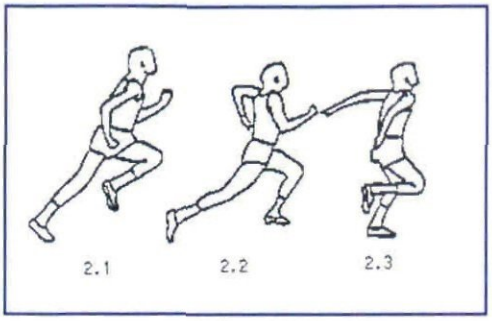


Figure 2: Take-off preparation from fourth from last (2.1) through third from last (2.2) to penultimate foot contact (2.3).

(take-off) leg, but has been held back. This preparation for the double arm swing with its draw-back movement takes place within only a single step. The disturbance to the sprint action therefore is reduced to an unavoidable minimum, and the starting position for the take-off stride taken up (see Figure 2.3).

In the phase now reached there is a lowering of the CG. However, a pronounced lowering of the CG, as is typical of the straddle, is only rarely observed in the speed flop. Neither does the take-off leg show a right-angled locking of the knee joint when it passes the support leg. Therefore, in the rear swinging phase, this leg flexes so that the lower leg is lifted at least to the horizontal (see Figure 2.3). Sjöberg (SWE) however, shows a movement action of the take-off leg in this phase which is more typical of the long jump.

One reason for the differences between the take-off preparation for the speed flop and that for the straddle and the long jump is the pronounced lean of the body towards the centre of the curve during the movement phase discussed here. This inward lean of the body actually dominates this phase. It is the primary means of affecting the lowering of the CG, which is necessary for a smooth change of direction and an acceleration path of optimum length.

Although, in the speed flop, a ground contact on the whole sole of the foot with a more acute working angle in the knee of the free leg is the norm, it must be mentioned that the fastest speed flopper Zhu (CHI) actually demonstrates a heel landing and pronounced flexion of the take-off leg (Tancic 1985). This makes possible the 'uphill step' of the long jumper with a very short flight time. Whether this is the only correct variant of the immediate take-off preparation for the flop of the future remains to be seen. In any case the lowering of the body, plus a somewhat less pronounced lean toward the centre of the curve, facilitates an effective horizontal acceleration of the pelvis through the free leg. This is an optimal preparation for the hip lead which is vital for the lever function of the take-off leg and facilitates a fast plant of the take-off foot.

8.3 Immediate take-off preparation: last approach stride

The forceful horizontal drive of the support leg and the very fast 'pull through' of the other leg leads to a pronounced split which is characteristic of the last stride (see Figure 3.2). In this phase, the trunk leans backwards and the arms are well behind the trunk at the reversal point of the drawback movement in preparation for the double arm swing. The path of the CG during this last stride is flat.

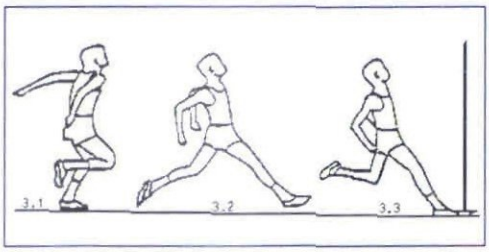


Figure 3: The take-off stride in three phases: from the support of the free leg (3.1) through the split phase (3.2) to the backward lean before take-off (3.3).

The extended take-off leg does not just wait passively for ground contact but performs a downward movement in an active and pre-stretched way. The fact that the flight time of this stride is only half as long as

the flight times of the preceding phases of the approach is therefore understandable. By the time the foot of the extended, or only slightly bent, take-off leg has been planted, the 'backward lean before take-off' has been acquired (see Figure 3.3). The characteristic of this phase is a take-off foot position well in advance of the CG and a backward lean of approximately 10 to 15.° In order to demonstrate the high degree of standardisation (with the exception of the arm action) of this phase, three 'models' of elite world class jumpers are presented in Figure 4.

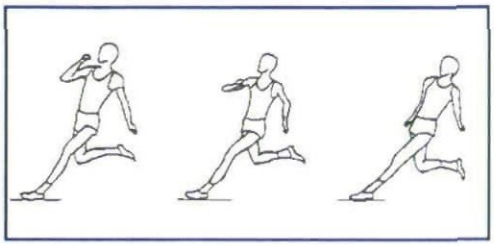


Figure 4: Backward lean before take-off in three world class jumpers.

There is only a slight (passive) change of the hip angle at the side of the take-off leg, in order to ensure the elastic lever function of this leg (as related to the trunk). At this moment, the arms are still held at the back and downward but they are already moving forward and upwards, as is typical of the double arm swing.

Immediately after this, the free leg performs a dynamic forward and upward movement which is contrary to the action of the jumping leg.

8.4 Take-off

The take-off takes place close to the upright at the side of the free leg and approximately 1 metre away from the bar. The jumping foot is planted at an angle of approximately 30° to the plane at the uprights. The speed flopper has approximately 120 to 170 miliseconds of time available for the take-off. Consequently, the pre-tensed, almost extended, take-off leg may only amortize 'passively,' i.e. bend only slightly in the knee joint in order to initiate the change of direction of the CG and also to create an optimal working angle for the jumping muscles. Here, the jumper must 'switch over' as fast as possible from an eccentric to a concentric contraction, while his muscle tension is of the explosive-reactive-ballistic type.

At first, the active use of the arms and the free leg increases the pressure on the take-off leg even further. Only the subsequent locking of these parts of the body with the explosive final extension, makes it possible to reduce some of the load. Thus, the locking indirectly contributes to a more effective vertical force.

The double arm swing is, without question, more effective than the counter arm swing, demonstrated by the original flopper Fosbury (USA) himself, or than the single arm action (which many floppers prefer). Firstly, the double arm swing is 'neutral with regard to rotation,' i.e. it does not oppose the necessary rotation about the longitudinal axis as is the case with the counter arm swing (Müller 1986/Beulke 1973). Secondly, the height of the CG at take-off can be significantly increased by locking the lifting movement of both arms above shoulder height. Finally, a dynamic double arm swing is more effective with regard to transfer of momentum than the two other possibilities.

These arguments also hold true for a straight free leg, as in the straddle. However, in contrast to the arm action, the straight leg swing never caught on. The main reason for this is that the relatively great moment of inertia makes a diagonal and fast upward swing of a straight leg (which will be called 'diagonal upward pull' in the following) more difficult.

It is, however, worth mentioning that 20 years of flop jumping have led to a change from the original flop. While Fosbury himself demonstrated a bent free leg action resembling that used in the long jump take-off, today almost all speed floppers show an opened free leg during the take-off. The greater than 90° angle at the knee joint can be called a compromise which is effective only to

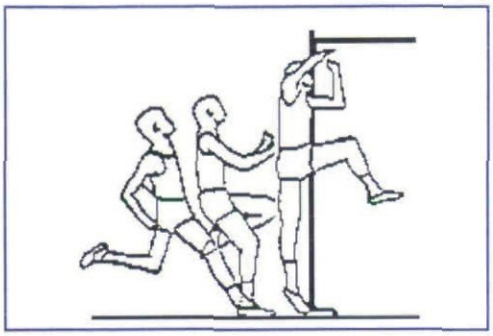


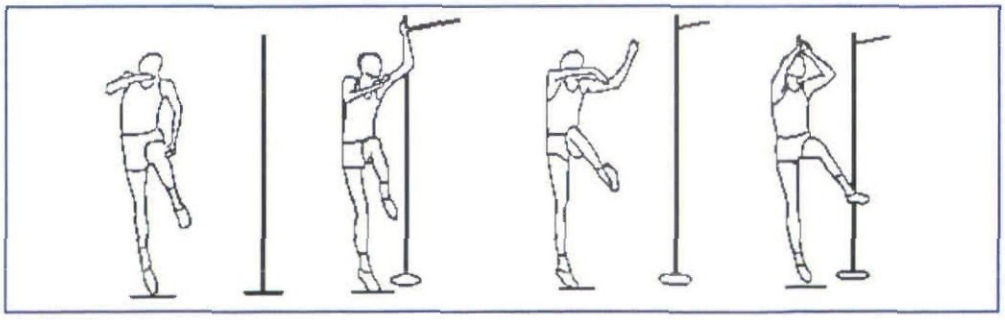
Figure 5: Take off process in three phases: *backward lean prior to take off, amortisation* and take off posture.

a limited extent. The reason for this is that this angle is normally preceded by a leg swing with the lower leg brought to the buttocks. As already mentioned, this is presumably less effective. In any case, the short ground contact time and the comparatively long distance the free leg must cover, in the speed flop, do not allow a 'properly' kicked and extended movement of this leg. On the other hand, a bent free leg does favour an increased angular velocity of this. As far as the take-off height of the CG is concerned, once again the straight free leg swing has the advantage. (Strishak 1982).

Contrary to the view of Reid (Reid 1982), it must be recognised that the diagonal upward pull mentioned above is demonstrated by Fosbury and by almost all other jumpers. The one-sided pull at the pelvis which is caused by this diagonal swing brings about a rotation about the longitudinal axis, which overlaps the already mentioned rotation about the medial axis. Therefore, in the flop, a backwards clearance of the bar has no need for rotation around the transverse axis.

*In Figure 5, the take-off process is pre*sented in three phases overlapping one another. It is particularly important that the longitudinal axis of the jumper's body is vertically aligned at the moment of breaking contact with the ground – i.e. during the final take-off position. Here, the upright nearer to the take-off spot can be used as an ideal object of reference. The often repeated demand that, at the moment of breaking contact with the ground the shoulder next to the bar, should be at the same height as the shoulder at the inner side of the curve (Tancic 1985) is rarely fulfilled. Fosbury shows a lift of the shoulder at the inner side of the curve. From the point of view of anticipation, this seems to be sensible in relation to the following flight towards the bar.The same trend can be observed in Mögenburg (FRG) and Zhu. Sjöberg is the only one to achieve an approximately horizontal alignment of the shoulder line (see Figures 6 to 9). This was also demonstrated by Kostadinova (BUL) in her world record jump in Rome 1987.

Presumably the take-off force, which is different in each case, is responsible for this varying behaviour. If the take-off force is just not great enough, the jumper intuitively ensures that it is directed slightly to the side of his CG by positioning his shoulder axis diagonally to the bar. This leads to a more



 Figures 6-9.

pronounced rotation about the medial axis. Thus, the exactly-vertical alignment of the jumper with a horizontally lifted shoulder girdle is an optimal requirement for very high jumps.

8.5 Flight phase and bar clearance

As already mentioned, all subsequent movements of the jumper are determined by the actions made at take-off, i.e. the trajectory of the CG and the rotational movements are already fixed. However, by an optimal positioning of body segments and simultaneous shifting of partial masses at both sides of the bar it is, at least theoretically, possible to have the CG 'sail through' below the level of the bar.

The optimal configuration for this is a 'forward bend of the trunk,' as was postulated by Hay in the technique bearing his name (Hay 1973). The bar clearance position in the dive straddle fulfills the demand for a horseshoe like posture.

Because of the normally considerably reduced dorsal flexibility of the lumbar spine, *it is rather difficult to achieve an optimal* body shape with the flop. Fosbury himself, for example, performed his jump with only a minimal hyperextension in the hip area and uninterrupted visual contact with the bar (see Figure 10).

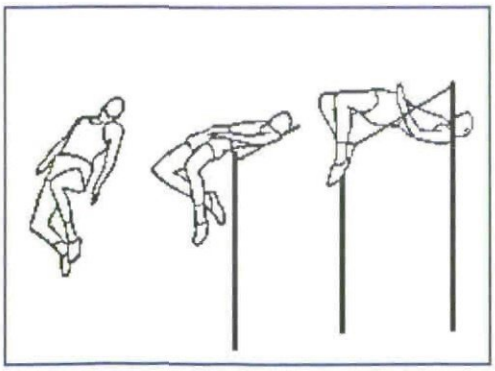


Figure 10: Flight towards the bar and bar clearance in the 'original flop.'

However, even here, technical development has led to some conspicuous changes. For example, during the flight phase the lowering of the counterarm (i.e. the arm on the *opposite side of the free leg) and the result*ing positioning of the arm at the side of the body is now used by very few jumpers. Although this also leads to the lowering of partial mass, so that the 'rest of the body' is correspondingly lifted (see Figure 10), a reaching over the bar with the arm at the external side of the curve and its immediate lowering behind the bar as well as a trunk following this 'guiding movement' with a significantly overextended shoulder and lumbar section (hyperlordosis) leads to a more effective clearance. (see Figure 11).

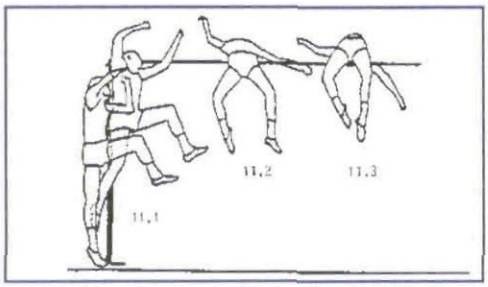


Figure 11: Take-off phase (Figure 11.1), flight towards the bar (Figure 11.2) and bar clearance (Figure 11.3) in the modern speed flop.

The double arm swing demonstrated here is 'opened up' with the arm at the side of the free leg 'leading' and reaching over the bar. The lowering of the free leg together with an active overextension in the area of the cervical spine allows the jumper to achieve a 'bridge formation' with a pronounced arc.

To what extent the arm at the side of the take-off leg can be included into this transfer work – without disturbing the gliding movement over the bar – must remain open. Such a whole-body arc, similar to the gymnastic flic flac – is currently shown only by one world class jumper, namely Henkel (FRG), (see Figure 12). However, even Henkel achieves this body posture only in the *descending part of the flight curve.*

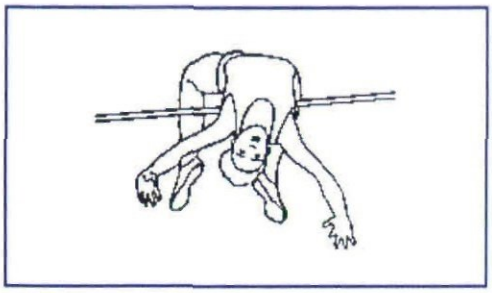


Figure 12: Modern variant of bar clearance (whole body arc).

It is worth mentioning that, during such an overextension, no visual contact with the bar is possible and that the postural reflexes can only be initiated by an active lowering of the head. If one compares the bar clearances shown in Figures 11.3 and 12, it becomes obvious that the optimal performance of the 'flop bridge' demonstrated in both cases not only requires an above average flexibility of the whole spine (and the shoulder joint) but a pronounced overextension ability of the hips as well.

As the hip joint at the side of the free leg is locked or 'held' during the take-off as well as during the first part of the flight phase, it is essential that the free leg is lowered in order to accomplish the required overextension of this joint. Whether this is done actively or whether it is a natural reaction to the lift of the pelvis is immaterial. It remains decisive that the hip joint at the side of the free leg must be brought from a flexed position to a retroversed position within the bar clearance phase.

However, in the case of low jumping heights and correspondingly short flight phases, an active lowering of the free leg, starting immediately after the take-off, is essential. A positive side effect of this is the reduction of the moment of inertia around the longitudinal axis during the flight phase, but, even here, it is more important that the lowering of some body segments causes the lifting of the rest of the body. This brings the pelvis into a more favourable (higher) position.

A possibly optimal alternative to this method of performing the flight phase for smaller high jumpers is discussed by Killing (Killing 1989). If one analyses the action of, for example, Grant (GBR) or Banks (USA) a kind of 'sitting' movement can be observed. This can be interpreted as a kind of preparatory movement introducing and facilitating the immediately following overextension. Correspondingly, within this variant, the hip area performs consecutive movements of extension, flexion, overextension and flexion. The advantage of this 'sit-and-kick-flop' (Killing 1989) is that the 'sitting down' during the rising phase reduces the risk of dislodging the bar with the trunk since the trunk moves away from the bar for a short moment.

Whether this 'sitting-overextension variant' is caused by a teaching method of the flop which is based on sitting down (and later lying down) on a high pile of mats is still unclear.

8.6 Straightening and preparation for landing

If one is to characterise the 'flight behaviour' described and discussed so far in chronological order, the sequence must be:

1) The 'rise' of the whole body,

2) An 'opening' of the arms during bar clearance and 'overextension' in the hip and the cervical spine area. As the rotation impulses about the medial and the longitudinal axes, which overlap one another, are relatively weak, there is comparatively little energy available for a rotation about the transverse axis, which would facilitate the clearance. So the 'release' of the hyper-extension, or 'closing up' action, must be co-ordinated and timed exactly in order not to dislodge the bar with the legs.

A take-off angle of 45 - 55° (speed flop) or 55 - 63° (power flop) (Strishak 1982/ Viitasalo 1982/Nigg 1974) does not, especially in the case of speed floppers, automatically provide a steep, 'narrow' flight parabola, but rather an originally 'flop-typical' relatively straight path of the CG. This can be verified by the

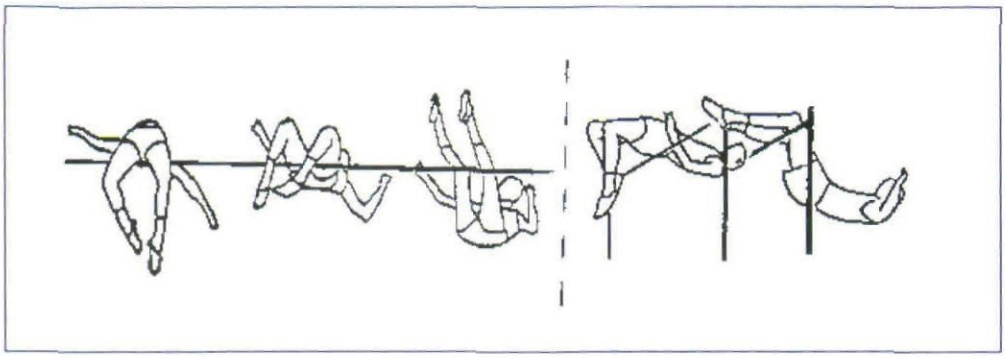
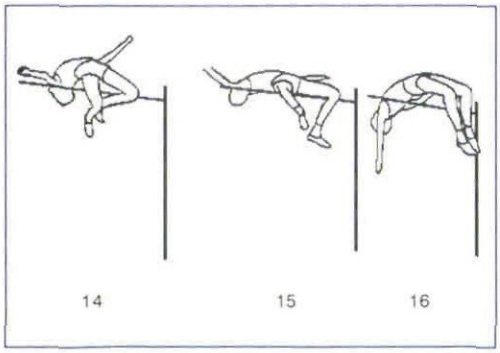


Figure 13: From the bar clearance to the 'release.'

flight distances, which are up to 4 metres in the speed flop. Correspondingly many flop jumpers show a comparatively long gliding phase along the bar. An abrupt lowering of the buttocks immediately behind the bar is much rarer.

In any case, the 'opening' and 'overextension' must be followed by a 'closing' movement. Whether this movement is introduced by an active hip bending, followed immediately afterwards by an extension of both knee joints, whether both movements take place simultaneously or whether they are carried out in reversed order cannot be clearly determined. In practice, many athletes show a smooth movement process initiated by a bending of the hips and with the phases overlapping one another (see Figure 13).



Figures 14 to 16: Variants of bar clearance with pronounced knee bend (Figure 14), slight extension (Figure 15) and pronounced arch of the back (Figure 16).

Presumably, the variant preferred in each case is also influenced by the type of extension movement. It is furthermore dependent on whether the jumper glides over the bar or lowers his buttocks abruptly behind the bar. For the latter technique of bar clearance relatively more rotational energy about the transverse axis is needed, but a less pronounced arch of the back compensates for this (see Figure 15).

If the knees are bent very much in the hyperextension phase as with Sjöberg (see Figure 14), their extension must take place simultaneously with the bending of the hips; otherwise the lower legs would dislodge the bar.

In the case of a pronounced 'arch' and a relatively long gliding movement (see Figure 16) a comparatively long holding of the hip extension is sensible because this arched position is very similar to the form of the flight parabola. In this way the buttocks are kept away from the bar and the flexion of the hips and extension of the knees can overlap one another relatively "smoothly" after the pelvis has crossed the bar.

The flexion of the hips leads naturally to a lowering of this segment of the body mass so that, by way of reaction, another body segment (or the rest of the body) is lifted. In this way the 'reactively' lifted legs can be taken out of the danger zone by opening the knee angle.

Having flexed the hips and extended the knee joints, the jumper assumes an 'L' posi-

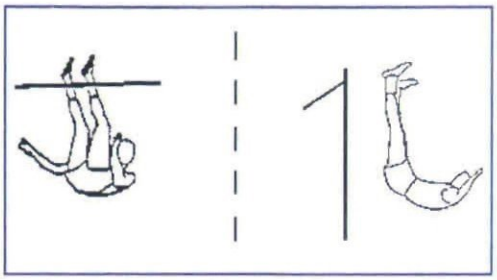


Figure 17: Taking up the L position for landing.

tion as he descends for the landing. (see Figure 17).

If the take-off spot has been correct and if the rotation about the longitudinal axis is sufficient, the longitudinal axis of the body is at a right angle to the plane of the uprights during the landing, which takes place near the upright farthest away from the take-off. The upper part of the back and the arms, which are spread at both sides of the body, hits the landing mat first.

In order to avoid injuries to the face, the 'landing' angle at the hips should be maintained during this process. Parting the legs at the moment of landing is another method which helps to avoid injuries which might be caused by the 'follow through' of the legs or knees.

8.7 Analysis sheet

The 'flop' analysis sheet on pages 42-43 is an attempt to integrate the discussed elements of the phase structure of this technique of high jumping and to present a movement process which has been identified as optimal. In case of problems, which are a natural consequence of the 'telegram style' of a one page sheet, the reader is asked to refer to the relevant section of this article. The synopsis includes:

- illustrations of the relevant phases.
- the corresponding descriptions of the phases.
- the essential phase elements, i.e. observation points within the phases.
- the criteria characterising the movement quality of the phase elements.

Does the straddle deserve to be extinct?

News of Dick Fosbury's revolutionary new High Jump technique, used during the USA indoor season of 1967/68, was first received in Europe with amazement and some scepticism. The reason for this was that the brief description of the movement of the "backward jump", with the athlete "twisting in the air," and the few individual photographs certainly overtaxed one's powers of imagination. This attitude changed immediately when Fosbury won the Olympic title and the 'flop' began its triumphant progress around the world.

One indication of how drastically this technique affected the high jump is shown by the considerable improvement in performance particularly for women and young athletes. The fact that there was not a single straddle jumper in the High Jump final at the first World Athletics Championships in 1983 speaks for itself.

It is, therefore, not quite the paradox it may first seem that Christian Schenk (GDR) on his way to Olympic victory in the decathlon in 1988 caused as much amazement as Dick Fosbury had 20 years earlier. Schenk cleared 2.27 cm using a technique which was unknown to most of the younger spectators – the straddle.

This implies that, although the straddle technique is now regarded as obsolete, it has actually lost very little of its 'performance capacity' and its complete replacement by the flop is not as logical as it may seem.

A perfect high jump technique could be said to be one which facilitates the lifting of the jumper's centre of gravity to a maximum possible height and, at the same time, permits

the clearance of a bar set, ideally, at some distance above the height of the jumper's centre of gravity.

While the first requirement is primarily dependent on the development of jumping power and only secondarily on jumping technique, the second requirement appears to be exclusively the result of the behaviour of the body segments during bar clearance. However, the flight trajectory of the centre of gravity (CG) and the rotational impulses about the three axes of the body are determined at the moment of take-off. It follows, therefore, that technical descriptions which traditionally relate to the behaviour of bar clearance should also include take-off action, which often varies from one athlete to another. In other words, flight behaviour can only develop within the framework pre-determined by the take-off.

The considerable variation in ground contact time of the straddle take-off as compared to that of the (original) flop alone indicates significant differences between the two techniques. In the flop, the time of ground contact is 120-170 ms (see Zhukov & Yufrikov 1984/Muraki et al. 1982/Nigg 1974), whereas in the straddle it is between 210 and 240 ms. While the take-off for the original version of the flop is, in fact, very similar to the long jump, the straddle take-off is 'delayed.' One of the causes of this is that, first of all, the lifting effect of the swinging elements and the rising of the trunk before take-off must be 'waited for' before the take-off leg is allowed to extend explosively.

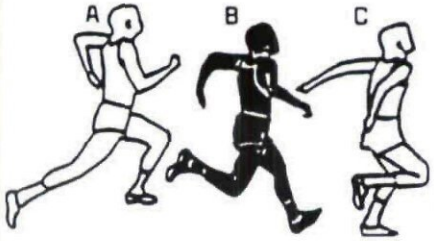
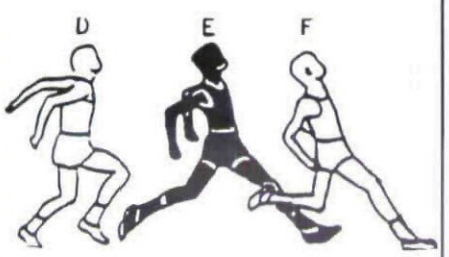
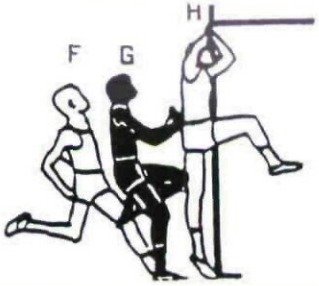
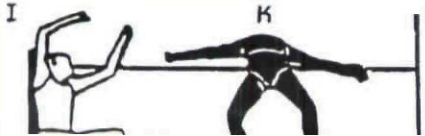
A further reason for the longer take-off time is presumably that the straddle fits very well into a 'biotype' characterized by a relatively high static strength potential and a somewhat lower contractility (Vittori 1971). To that extent, the 'power flop', which includes at least mixed forms of the 'classical' straddle elements – such as the pronounced bend of free leg and backward inclination before take-off and the double arm swing and extended free leg at take-off – is a modern 'compromise' for those jumpers who possess great strength rather than speed. Correspondingly, the ground contact times of the 'power flop' are very close to those of the straddle.

In spite of the different take-off actions of the 'speed' flop and the straddle the resulting flight technique is equally effective as far as the economy of bar clearance is concerned. The values measured for the difference between CG and bar height for both the straddle and the flop vary from +8 to 0 cm (see Kerssenbrock 1969/Nigg 1974/Dapena 1980). Only Viitasalo, in a sample of flop jumpers, measured 'disadvantage' values of up to 9 cm between the highest point of the CG and the height of the bar (Viitasalo 1982).

It may, therefore, be stated that even today the straddle is theoretically a genuine alternative to the power flop for some athletes. It is, however, impossible to verify this hypothesis as the straddle is no longer taught.

The primary causes of this may be the facts that the flop can be learned much more quickly than the straddle and makes significantly less demands on the athlete's physical and motor prerequisites. The flop can be taught even during childhood, i.e. at the favourable learning age, and makes early successes possible. Furthermore, if the flop is taught at an early age, it is not necessary for the athlete to learn a further high jumping technique at a later time, which may be very energy and time consuming.

A further important factor contributing to the 'extinction' of the straddle is the fact that the technique generally puts a higher load on the body. Injuries, primarily in the area of the knee joint, which occur very often in the process of reaching technical perfection, cannot be ignored. Contrary to this, the special orthopedic shoes which are available to the modern flopper (with integral-moulded insoles) have done a lot to neutralise a former weakness of this technique: i.e. high loads on the ankle at take-off caused by transversal accelerations (Krahl & Knebel 1978/Muraki et al. 1982).

FOSBURY FLOP	PHASE	REFERENCE	CRITERION	ASSESSMENT
	I APPROACH: PENULTIMATE STRIDE	A 1 Foot plant 2 Body/trunk 3 Arms B 4 Front supp. BC 5 Supp. knee B 6 Rear Arm C 7 Arms	Contact with ball of the foot in curved path Inclination/slight forward lean Counter arm swing Heel lead Yielding Held Back Parallel/behind trunk	
	II APPROACH: LAST STRIDE	D 8 Trunk 9 Supp. leg DF 10 Take-off leg E 11 Arms F 12 Body/trunk F 13 Foot plant EF 14 Free leg	Upright Horizontal pushing action Fast & active plant/pre-tensioned/'long' Starting double swing Inclination/backward lean 'Through' the bar/optimal position Bending/forward and upward movement	
	III TAKE-OFF	FG 15 Take-off leg FH 16 Arms FH 17 Free leg GH 18 Free knee H 19 Arms H 20 Shoulders H 21 Body	Minimal and passive yielding Active and double arm swing Active knee drive 'Opening' Blocked/bent Lifted/horizontal Vertical/parallel to upright	
	IV RISING	I 22 Head I 23 Outside arm I 24 Body	Looking down onto the bar 'Leading' Rotation about longitudinal axis	

	OPENING	IK 25 Arms IK 26 Free leg K 27 Back K 28 Head	'Opening' Lowering Parallel to bar Backward movement
K L	V OVER-EXTENSION (ARCHING)	KL 29 Arms L 30 Hips L 31 Legs L 32 Back L 33 Head L 34 Longit. axis	Extended/'diving action' Overextended/elevated Bent/directed downward 'Arched' Layed back At right angles to the bar
L M	VI CLOSING (UNARCHING)	LM 35 Pelvis M 36 Head/trunk M 37 Hips M 38 Legs M 39 Arms	Active lowering 'Re-active' counter movement Active bending Synchronous active knee extension Bending
N D	VII PREPARATION FOR LANDING	40 Head 41 Hips 42 Arms 43 Body 44 Legs	Raised Bent/blocked Spreading In 'L position' Extended/directed upwards

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