Biomechanics

The primary objective of Biomechanics is to gain a better understanding of the cause-effect mechanisms of sports motions. The basis for the field of Biomechanics is that the laws of mechanics apply to living organisms just as well as they do to inanimate objects. The structural stresses of a tree, the swimming of a shark and the takeoff of a long jumper are all subject to the laws of mechanics in the same way as a square block of wood sliding down an inclined plane in the classical physics experiment. ”Biomechanics is a diverse interdisciplinary field with branches in disciplines as varied as Zoology, Botany, Physical Anthropology, Orthopaedics, Bioengineering and Human Performance” (Bevan 2001). In all of these disciplines the general purpose of Biomechanics is the same: to understand the mechanical cause-effect relationships that determine the motions of living organisms. “In Human Performance, Biomechanics contributes to the description, explanation, and prediction of the mechanical aspects of human exercise, sport and play.” (Hay, J.C. (1993)

The javelin throw

The javelin throw is an athletics (track and field) throwing event where the object to be thrown is the javelin, a spear-like object made of metal and fibreglass.

Rules are similar to other throwing events: competitors take a number of throws, their best legal throw is recorded and the winner is the individual with the longest legal throw. The most noticeable difference with the other events is that rather than a throwing circle as used in discus, shot put and hammer throw, the competitors have a run-up area coated with the same rubberised surface used for coating running tracks, and a painted line on the surface from which they must release the javelin from. The javelin's point must touch the ground first for the throw to be legal.

Javelin throwers gain considerable forward velocity in their run-up to their throws, and as well as strength demonstrate athleticism more similar to running and jumping events. Thus, the athletes share more similar physical characteristics to those athletes rather than the bulky frames of the strength throwers.

The javelin throw has been part of the Summer Olympics since its inception. Although the javelin is currently used only for sport in most areas, it has a long history of use for hunting and warfare. There are, for instance, numerous references to the javelin in ancient Hellenic civilization, who practised a form of javelin throwing at the ancient Olympics. The objective there, however was to throw at a target rather than for distance. (www.iaaf.org)
The Scandinavians adopted the event around 1780 and the javelin underwent an astounding growth, becoming a symbol of national independence for the Finns. In those days the javelin measured 2.60m, weighed 800 grams (as it does today), and was of hickory wood. (www.iaaf.org)

The ancient style of throwing whilst on the run replaced freestyle techniques as did the measuring of single hand efforts as opposed to 'both hands' aggregates.

In 1952 the throw line became an arc, as opposed to a straight line, and throws began to be measured from point of impact to the inside edge of the throwing arc. In 1953 Franklin "Bud" Held (USA) invented a hollow javelin, which increased the surface area of the javelin by 27% (www.iaaf.org), greatly increasing its flight capability and causing the javelin to land horizontally, revolutionising the event. In 1954 Held developed a metal variant, which went further still.
In 1966 the Spaniard Felix Erausquin threw over 100 metres using a rotational technique, which was banned by the IAAF as too dangerous (www.iaaf.org)
The 100m barrier was broken again in 1984 by Uwe Hohn. The IAAF then established new rules for the construction of the javelin to ensure shorter flight times and point first landings (safer and easier to measure). In 1991 the rules were changed to disqualify a new type of javelin with a 'rough' or corrugated tail design. (www.iaaf.org)

The first women's marks were recorded in Finland in 1916. Originally, a javelin weighing 800g was used but this was later standardised at 600g. The first IAAF world record dates back to 1932, the year in which the event made its Olympic debut. A new specification women's javelin, in which the centre of gravity was moved forward by 30cm to obtain a flight similar to the men's implement and to avoid flat landings, was introduced in April 1999, previous records being scrapped. (www.iaaf.org)

Task 3

Method

A subject was chosen to analyse (subject 1) they had the following charactersistics;

Height 178 cm

Weight 77kg

Subject 1 had no previous knowledge or experience of the javelin event, although sporting experience on the whole is quite large. Subject 1 has a sporting history of mainly team sports or ball sports, skills that involve projectiles, in some ways similar to the javelin in that some abilities are the same (hand eye co-ordination, flexibilty etc.) but vastly different in others. The projectile in javelin is obviosly launched with the hand, the experience of subject 1 doesn't cover projectile launching with the hand, rather than with the foot. The technique of the javelin throw of subject 1 was recorded for analysis using a Minolta Z1 dimage digital camera at 640x320 resolution and 30 frames per second.

In the context of sport and exercise, biomechanics is the science underlying techniques. Good technique is characterised not only by effective performance, but also by reduced risk of injury. There are basically two ways of analysing techniques: qualitative and quantitative. A qualitative analysis is based on observation (directly and/or via film or videotape) and results in a more-or-less personal evaluation. In a quantitative analysis, technique is evaluated fairly independently on the basis of measurements taken from recordings (e.g. film, videotape, force-time curves) of the movement.

Qualitative analysis

"A qualitative analysis is the systematic observation and introspective judgment of the quality of human movement with the purpose of providing the most appropriate intervention and advice for improved performance"

(http://www.elitetrack.com/qualitative.html).

In short, a qualitative biomechanics report will be a detailed analysis of an athlete's technique using fundamental biomechanics principles and state-of-the-art technology with the aim of improving the technique of the athlete.

The faults that occurred whilst subject 1 performed their javelin throw are on the attached sheet marked ' fault identification sheet.'The main errors were in technique, although the javelin flew relatively far, the technique was littered with errors, some of which could be assissted by studying the technique(s) below, and undertaking some training exercises on page 5.

Javelin Technique

A. Approach:

1. Grip:

- The "Finnish" grip is very effective, but the "fork" or "V" grip and the "American" grip are useful.
- The javelin is held horizontally at or near eye level.

2. Run:

- Most throwers use 8 to 14 strides.
- Maintain control in the run.

B. Transition:

1. Withdrawal:

- Use straight pullback.
- Withdraw as left leg hits mark and count 1-2-3-4-5.
- Rotate shoulders to side. Keep hips at about 45 degrees.

2. Steps:

- Keep eyes straight ahead.
- Point of javelin near the head.
- Be aggressive, especially on count three.
- Keep palm up.
- Shoulders/hips separated.

3. Cross Step:

- Right leg is soft, bent on landing.
- Right leg usually points towards 45 degrees.
- Achieve body lean from drive of the right leg before plant.
- Keep palm up.

C. Throwing Action:

1. Beginning of throw:

- As weight passes before the right foot, a vigorous push/rotation is started.
- Right leg drive is completed before the left is firmly planted.
- Left foot lands heel first, with a slight flex.
- Right foot finishes drive as left leg blocks.

2. Arm Action:

- Elbow comes through high and over the shoulder line.
- Throwing shoulder is like a whip handle.
- Release occurs near front foot and as high as possible.

3. Release:

- Javelin is released at about 27 to 35 degrees.
- Throwing hand rotates right (inwards) after release, achieving a "thumb down" position.

D. Recovery:

1. As with the other throws, the feet shift and the centre of gravity is usually lowered.

Task 4

Javelin Training Drills

(www.throwers/com/javelin)

1. A medicine ball can be used for almost every aspect of the throw.
2. Throw weighted balls. Keep the weight at four pounds and under.

This drill will aid most parts of the throw particularly those integral to the throw and release by increasing strength and muscle memory (mechanical point 10)

3. Hip drill. Exaggerate your throwing position without an implement. Bend right leg way down, keeping both feet on the ground. Come up and drive the hips forward at the same time. "SNAP". Get the hips to come forward quickly. Drop back again and repeat.

This will improve muscle memory of mechanical stages 7-9

4. Exercises with a javelin:

- Pulls with a partner holding the tail end in different position of the throwing motion.
- Place the javelin tip against a wall and the arm is forced back, getting into the delayed arm position.
- Throwing into a hillside.
- Stretching exercises.
- Lighter implement for arm speed.

The above drills and exercises focus on technique purely, with the emphasis on the positioning of the javelin, and getting comfortable with it, primarily focusing on the opening mechanical stages (1-3)

5. Bounding drills. There are many variations incorporating both the single and double leg responses.

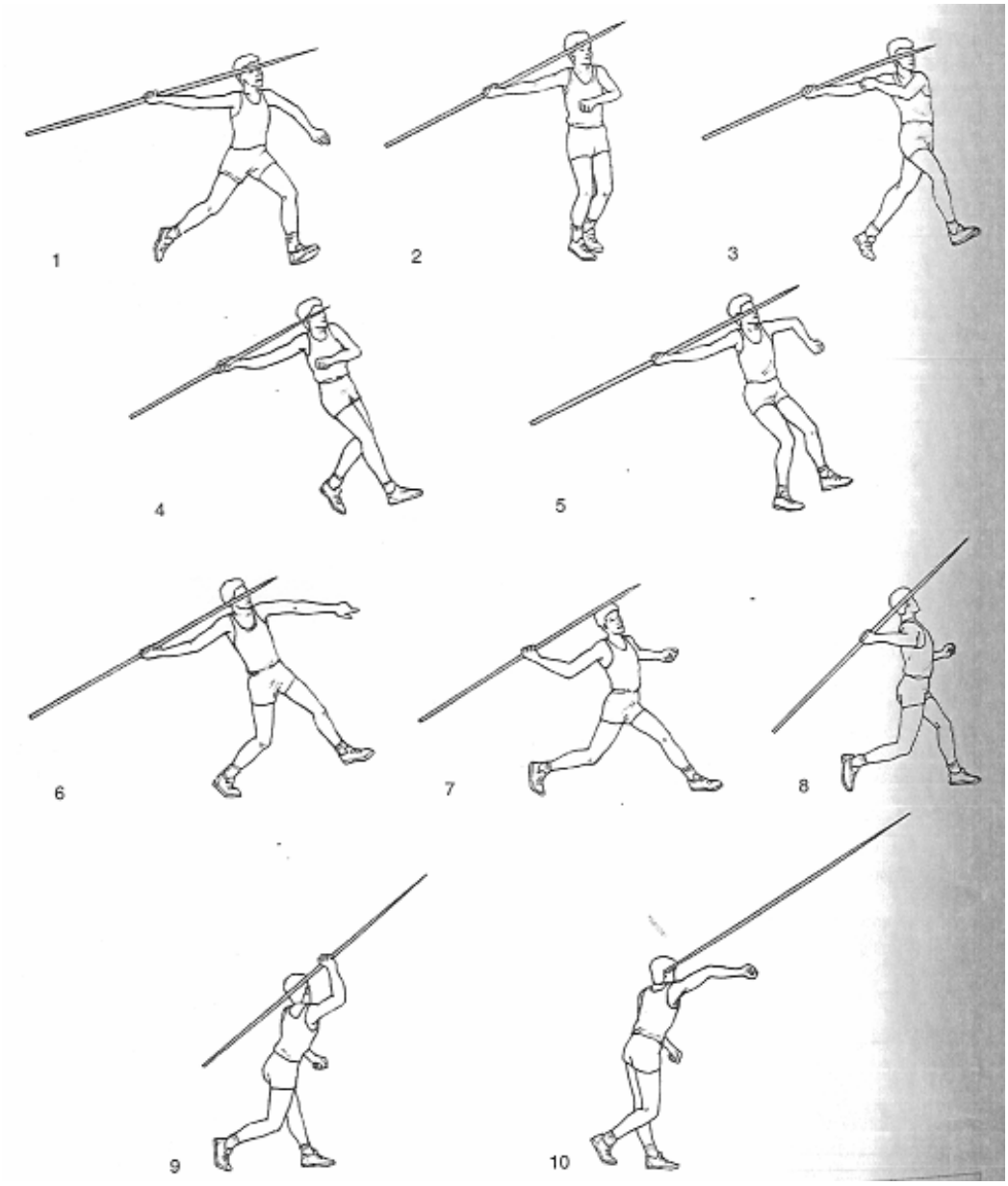
Since the run-up is the driving emphasis behind the throw the bounding exercises will focus on the technique of the opening mechanical stages once more (1-3).

6. Wall pulley. Use the regular handle or make a grip from a broom handle, and situate the pulley such that it operates at 30 degrees to simulate the throw.

This drill focuses on the release action of the final mechanical stages (8-10), the 'snap' against the wall pulley mimicking the release technique, again improving muscle memory.

Task 2

Joint	Frames	Joint motion	Muscle contraction	Active muscle group	Main axis/plane being operated within	Extreme range of motion
Trunk (Intervertebral joints)	1-2	No motion	Isometric	Postural muscles		
	2-3	Rotation right	Concentric then eccentric	Right rotators then left rotators	Horizontal	
	3-4	Rotation left	Concentric	Left rotators	Horizontal	
	4-5	Rotation left	Concentric	Left rotators	Horizontal	
	5-6	Rotation left	Concentric	Left rotators	Horizontal	
	6-7	Rotation right Extension Hyperextension	Eccentric Eccentric eccentric	Left rotators Flexors Flexors	Horizontal	 Hyperextension
	7-8	Rotation left Flexion	Concentric Concentric	Left rotators Flexors	Horizontal	
	8-9	Rotation left Flexion	Concentric Concentric	Left rotators Flexors	Horizontal	
	9-10	Rotation left Flexion	Eccentric eccentric	Right rotators Extensors	Horizontal	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Bibliography

Bevan, M. (2001) Biomechanics of Sport and Exercise 2nd edition, Lima, USA

Hay, J.C. (1993) Biomechanics of sports techniques. Prentice Hall: Englewood Cliffs, New Jersey.

Watkins, J. (1983) An introduction to mechanics of human movement. MTP press, Lancaster.

Webliography

www.coachesinfo.com
www.iaaf.org
www.throwers/com/javelin
www.elitetrack.com/qualitative.html