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Development of the Biomechanical Simulation System to Evaluate Physical Variables in Javelin Throw

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Abstract

The use of information technology (IT) and highly sophisticated devices in learning and evaluating training process is very common in today>s sport sciences. The research aimed is a Trying to identify using of the biomechanical simulation system to evaluate physical variables in javelin throw. A new movable biomechanical simulation system to expect the javelin throwing distance and evaluate physical variables was developed, which consisted of a 800g sledge to be accelerated along a rope and a LAVEG measure unit. Takeoff angles can be adjusted within the range of 26 - 40 degrees. The takeoff height can be likewise adapted to the individual conditions of the athlete. By a laser-steered measure unit (LAVEG) the speed of the throw carriage can be determined. 20 male athletes were selected. The research proves that only 10 seconds are needed to show the expected distance. This research also recommends using this new movable technological biomechanical simulation system in learning and evaluating training processes.

Key words: *JAVELIN THROW, PHYSICAL VARIABLES, BIOMECHANICS.*

Introduction

The throwing events in athletics, including the javelin throw, can be said to be acyclic movement exercises performed at maximum speed. Because of its contribution to release velocity, which is the key to achieving maximum throwing distance, speed is the essential prerequisite for success in these events. According to the laws of physics, release velocity has the greatest influence on distance attained in any throwing event. This is both a guiding and target parameter. Therefore, release velocity should always be maximized while the values of the other factors should be optimal. Achieving high release velocity values in any throwing event requires great accelerations and velocities of the body's kinetic chain.

The javelin throw is one of the four throwing events in the Track and Field. It is a technically difficult discipline. Due to the large loads, especially in the shoulder and back area, In addition to a technically challenging discipline that requires high coordination ability and tremendous speed strength. In the javelin throw, the speed at which the performer releases the implement is by far the most important factor. For an 80m throw, the release speed will be approximately 30 m•s-1 (121 km•h-1). For some elite athletes over 70% of this speed is developed in the 50ms immediately before the javelin's release (Morriss & Bartlett, 1996). This high percentage shows just how important the movements of the smaller body segments are to the acceleration of the implement. The throwing phase in the javelin is main acceleration phase of the technical principle to the level to be attained power and release velocity with optimum angle (Bauersfeld & Schröter, 1998) and (Joch, 1993). The basic acceleration stage starts from planting front leg position till the release of the javelin as Tutjowitsch (1969) and others indicate and as it shows in Figure (1) according to the Joch (1993).

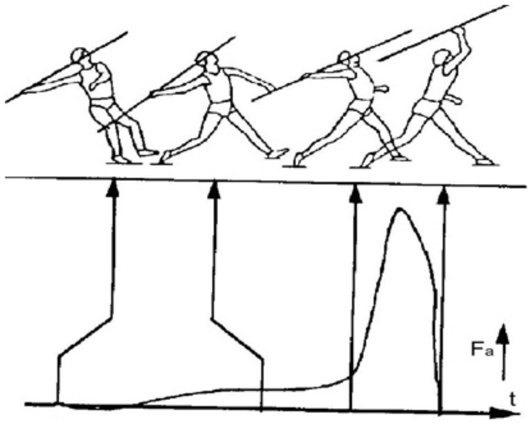


Fig. 1. the acceleration phase in the javelin throw (Joch, 1993, S. 172)

For javelin throwing, the high speed of the movement in the release phase causes problems for athletes, coaches, and researchers because feedback on movement performance is hardly available. Usually the athlete receives only feedback in form of throwing distance. Since e.g. indoors the necessary area is not always available for appropriate throwing distance, alternatives for this special purpose must be developed.

During the bracing stride, the throwing arm should be still extended in a relaxed way and aligned horizontally. This is important because allowing the throwing arm to drop will make it exceedingly difficult, if not impossible, to achieve the required bow tension of the whole body. The extended posture of the arm is justified by the advice to make the final acceleration path as long as possible. This creates maximum v0, when v0 correlates with throwing distance (0.92) that is considered by Bartonietz (1987) that throwing distance is influenced by the following main variables:

1) Velocity of release 2) Angle of release

3) Angle of attack 4) Height of release

The achieved result of the throw depends on Physical variables, motor abilities, and throwing technique (Göhner, 1999) and (Ballreich & Kuhlow,1986). In Tutjowitsch's opinion (1969) the throwing technique requires great throwing explosive strength and the ability to perform the elements in the precise moment and in limited space. The javelin thrower has to optimize the angle of release, the release velocity and the height of release so as to achieve the maximum throwing distance. The javelin throw result (D) may be physically defined by the following formula on the assumption that air resistance is disregarded (see Fig. 2).

Figure (2) show Physical variables for the acceleration

$$D = \frac{v^2{}_0}{g}\cos\alpha_0\left[\sin\alpha_0 + \sqrt{\sin^2\alpha_0 + \frac{2gh_0}{v^2{}_0}}\right]$$

g Acceleration of gravity α_0 Angle of release D Throwing distance
h_0 Height release v_0 Velocity of release

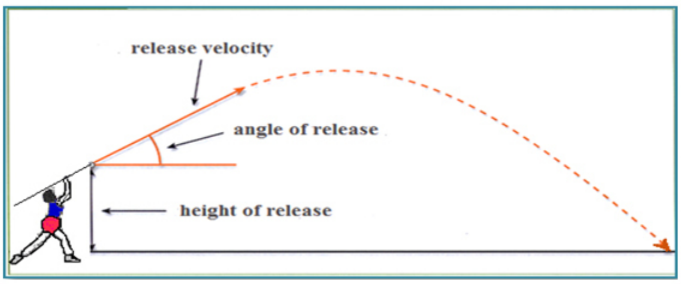


Figure 2: Trajectory of a javelin throw

phase in the javelin throw. The best combination of throwing speed, angle and height of ejection. The highest correlation exists between the throwing distance and release velocity. That is the most important factor in throwing. Schwuchow (1986) indicates that the throwing distance influenced with many complicated mechanical variable like V0 release velocity of throwing , α0 angle of release, h0 height of release.

When the main objective is to achieve more distance, the athlete should be aware of the principles of biomechanics and some important characters such as the angle and velocity of release. The studies of Hinz (1991) and others show that the velocity was more influencing in throwing distance which reached 30m/sec for male. Such information seem to be very difficult to get and evaluate through vision of a movie analysis due to the high speed of movement, see figure 2 that shows the ideal angle of release with 38 for male athletes, according to Schwuchow (1986). In recent decades, the sports science discipline in track and field javelin throwing is concentrated. The following summarizes the current state of knowledge of the movement structure, javelin throwing technique, physical parameters of the javelin throwing and the use of special rapid information in the context of the development and improvement of the javelin performance is presented (see Fig. 2).

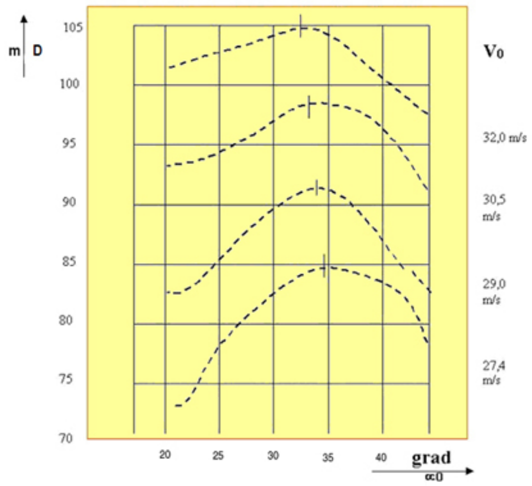


Fig. 2. Relationship between TD, α0 and V0 (Schwuchow, 1986, S. 12)

Sport history development of the Javelin

With the beginning of the 20th Century and its increasing organization of the sport has evolved over the decades, the javelin throw technique more and more improved. This is also good to pursue the permanent increase in javelin throw distance. The results presented in fig. 3 Records in javelin throw since 1883.

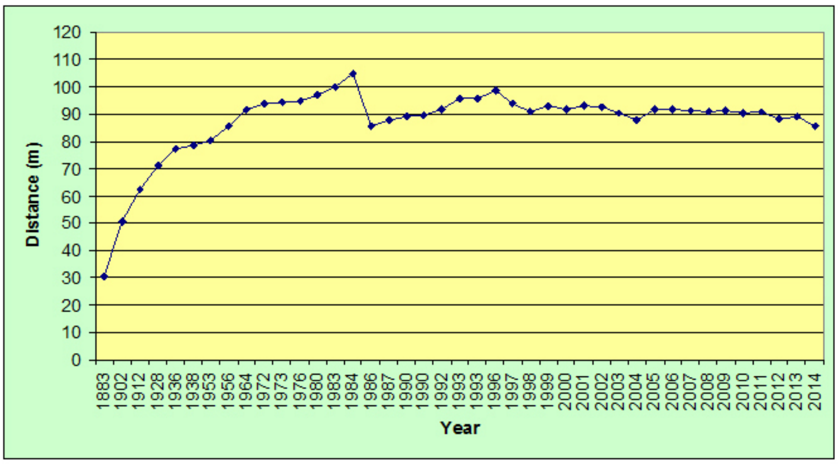


Fig. 3. Diagrammatic of records in javelin throw

Not just the throwing technique, but also the material had influence on the achieved javelin performance. 1953 „Bud Held“ (USA) get the javelin (wood), Which increased the ability to fly horizontally, and paying the javelin left. In 1954, he then developed a variant of metal, which could be thrown further.

Due to the technical, material and training-progress, the IAAF had to make several regulations to prevent large and thus dangerous throws in athletics stadiums. With this technique, the javelin could be thrown for over 100m. The 100m line was then crossed again in 1984, after which the IAAF setting out a new regime for the javelin Construction. «In response to this wide-open spaces was moved by a rule change from 01.04.1984, the focus of the javelin to 4cm in front, which had reduced widths, hitting a steeper and better selection options than in the peer Sail result (Jonath 1995 et al.). As of 01/01/1992 it has banned any roughening of the javelin so that a smooth surface and required characteristics without any user intervention. Since 1996, the permanent improvement of the record in the javelin is stagnating. It seems as if an increase in the javelin throw performance in the context of regulations is hardly still possible.

In recent decades, the sports science discipline in track and field javelin throw on the optimization of a perfect throwing technique and their training is concentrated. The following summarizes the current state of knowledge of the movement structure, javelin throw technique, physical parameters of the javelin throw and the use of special rapid information in the context of the development and improvement of the javelin performance is presented, see fig. 4.

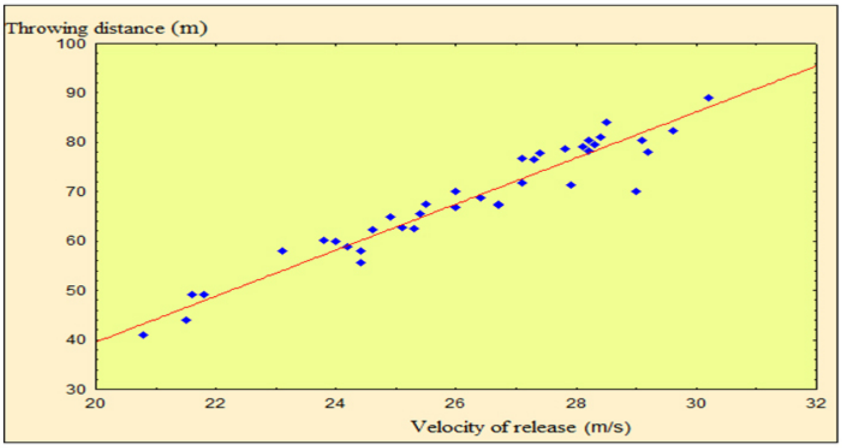


Fig. 4. Relationship between D and V0

Fig. 4 shows the relationship between throwing distance and speed velocity during javelin competition which reached 0.95 positive significant.

A problem in the area of the javelin throw is the high speed of movement in the ejection phase, the objective feedback from the athlete’s own perception of movement very difficult. Usually the athlete receives the feedback about the quality of projectile motion solely on the distance thrown. As for example in warehouses not always necessary space for such throws given, it is for this specific purpose, to develop alternatives that provide at least the dominant primary determinant of throw, the departure rate information.

The methodical approach of fast objective feedback information can be justified by the fact that self information and subjective perceptions of the movements are consciously compared with the objective information from the outside (Farfel 1977).

Aim of Research

The aim of this study is a Trying to identify using of the biomechanical simulation system to evaluate physical variables in javelin throw.

Research hypothesis

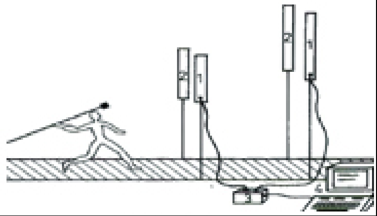
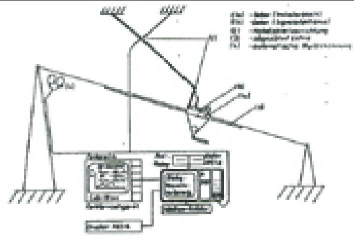
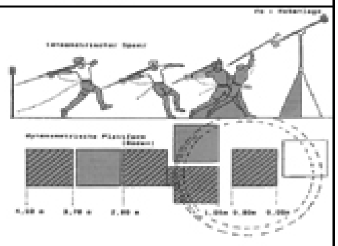
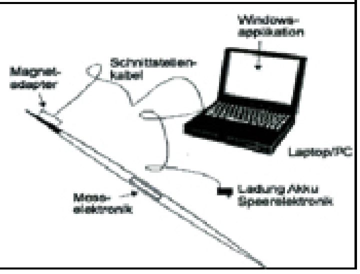
According to the research objectives, the research hypothesis assembled as the following question.

Could we expect the throwing distance (D) in relation to the velocity of attack using a technological movable system (V0)?

Biomechanical simulation system in the javelin throw

The previous research findings were an indicator to discuss all the mechanical systems in javelin throwing events. Researchers put them in table 1 according to their manipulate date.

Table 1: Work for biomechanical simulation system in the javelin throw

Author	Para-meter	Measuring method	Principle sketch
Viitasalo, J., Korjus, T. (1987)	V_o , α_o	Light cells	
Köllner, J., Dörr, J., Wiese, G. (1989)	V_{max} , S_a, $V(t)$	receiver of acceleration	
Adamczewski H. (1995)	V_o , α_o	Light cells	
Schmucker, U., Warnemünde, R.; (2001)	V_o , S_a	velocity sensor	

In the first of those studies Vitasalo (1987) used light signal to measure the angle and the velocity of the attack of the javelin throw. This study is similar to Adamczewsk (1995) which innovated this mechanical system in the IAT. Those throwing methods are the best methods regarding to measure the velocity and to reach the information in less than 20 sec. but the negative point is the missing accuracy of the throwing velocity measurement.

The other devices by Köllner et al. (1989) which were innovated in Halle (Germany) is a training device rather than measuring device, especially when combined with 4-30 kg and not movable. Schmucker et al. (2001) innovated another mechanical system with the javelin increased in weight about 50 g, so most mechanical factors are not accurate. The descriptive method is the suitable way to handle such information, but this study is more advanced by using the laser light as modern and sophisticated device activities.

Research Method

Research Methodology

The descriptive style is the suitable one for this research and to study also the relationship between distance performance and speed velocity to predict distance performance.

Research Sample

There were 20 athletes selected as randomly from college of sport education in Assiut University, Egypt. Everyone has performed three throwing attempts according to the IAAF regulations on the field and other three ones on the information technological system in javelin throw. The best attempt was selected from both of them respectively. For statistical analysis the Average - standard deviation and F-value for age, body mass and height (Table 1).

Table 2: Characters of the sample (N = 20)

Variables	mean	standard deviation	skewness
Age (years)	18	0.70	0.16
Body Mass (Kilogram)	84.4	7.30	-0.02
Height (Meters)	173.6	5.50	0.26

Procedure

Biomechanical simulation system for immediate information in the javelin throw

Sport has become, in all sectors, closely linked to the use of technology. The use of the computer with modern instruments has now become a medium of instruction in many areas of sports, which assists in the process of assessment and forecasting directly and objectively. Learning, in recent time, became an investment process which is connected with production and economic abilities. Sport and physical education became strongly connected with technology and using computers with new measuring devices became more familiar with learning and training methods. Gesse (1992) and Daugs (2000) believe that information technology could help to get fast information about sport performance. Grosser & Neumaier (1982) indicate that feedback information about athlete movement were very fast (20-30s). When such fast information comes directly, it would be better to store movement information in athlete's memory.

Basic approach

The basic idea of the simulation, the acceleration of a javelin throw javelin model is used on an inclined plane. A tube functions as a model of a spear and is located on an approximately seven-meter-long rope. The rope is) between two fixed points at different heights tense (inclined plane. The spear model (tube) can slide freely between the two points, so that the javelin thrower this speed with the hand in the direction of the elevated point. So that the athlete will be given the option of dropping technique of the javelin to exercise control on the model (Fig. 5).

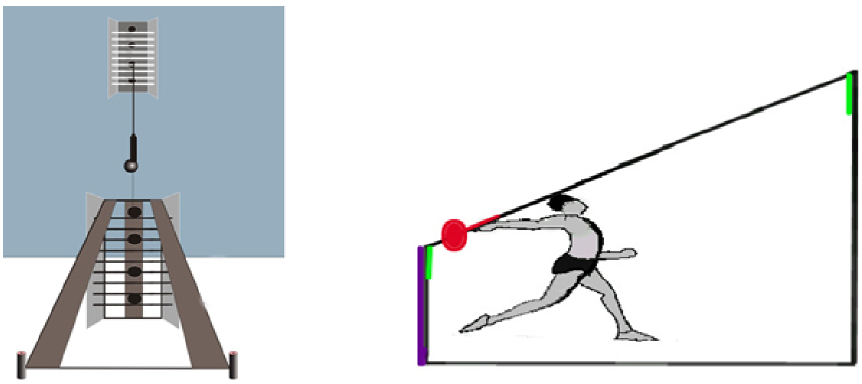


Figure 5: The technique of the javelin throw on the model

In addition to simulating the dropping technique should be both rapid and quantitative statement about the speed of the javelin throw model possible in order to meet the demand to use the unit as a rapid information to. The problem of velocity measurement is achieved using a laser measurement device (LAVEG), the distance by measuring the javelin throw model in relation to the laser facility in a position to determine the dropping during simulation, the values for these physical parameters. However, this can only be done in conjunction with an appropriate software (DAS3) and hardware (PC or laptop).

The entire system consists of 3 parts indicated

1. Including steel rods and litter sled.

2. LAVEG laser speed device and special software (DAS3 - Program) for the electronic evaluation.

3. PC or laptop

A movable technological system for the analysis of the javelin technique was developed, which consisted of a 800g sledge to be accelerated along a rope and a LAVEG measure unit. Takeoff angles can be adjusted within the range of 26 - 40 degrees. The takeoff height can be likewise adapted to the individual conditions of the athlete. The LAVEG is connected to a PC or laptop using the DAS3 - program, which was also developed by the company JENOPTIK can thus very quickly about the speed of the throw will be seen and evaluated immediately after the sled test on the screen. Due to the high relationship between release velocity and throwing range in javelin, the release velocity of the simulated javelin throw serves as indicator of the throwing performance. This information can be provided as feedback within 5 to 10 seconds on a screen (Fig. 6).

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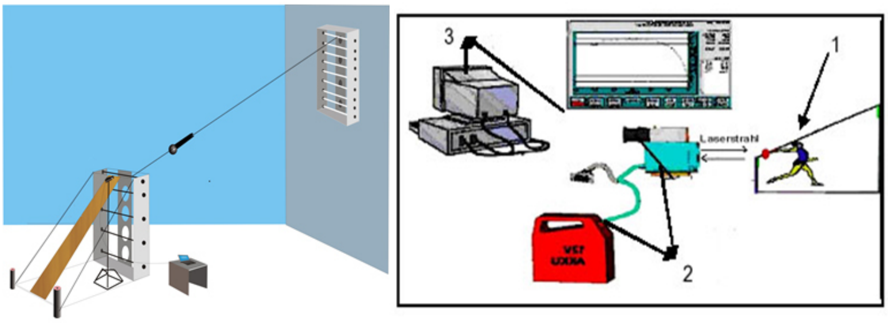

Figure 6: biomechanical simulation system in the javelin throw

Later in the program, there are DAS3 data on the screen numerically and graphically and presented with various additional information to determine the relationship between velocity and distance to time, and velocity to time with a diagram chart to describe this relationship on the axle Y, X accordingly, it shows the connection of those parts within 10 sec. (Jenoptik, 2000).

Statistical analysis

For the statistical analyses SPSS (version 11.5) was used (Bortz, 2005).

Discussion and final results

With the help of linear regression, we can now directly relate to each other 2 parameters. In the subsequent regression is expected to be predicted with any other characteristic feature of X and Y, the connection can be represented by a straight line. In addition, a precise statement for Y can be taken as soon as X is known. This means: «What is happening to Y in terms of X» (Rohland 2000).

The coefficient correlation was 0.84 which is statistical value in indicator 0.01. Fig. 7 shows these consequences (the expectation formula for this variable) Distance of throw =static factor variable X S1.

$$(D)=3{,}957+3.237 \; * \; (V_0 g)$$

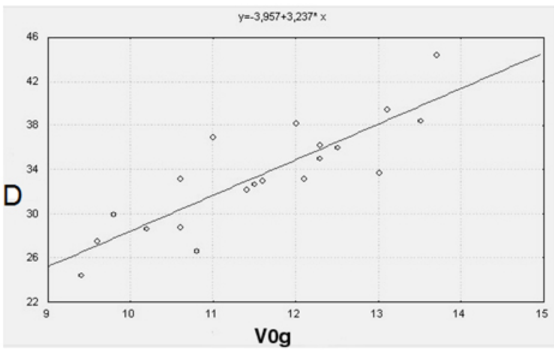

Figure 7: Representation of the connection between the parameters D and V0g

The Technological Movable System in the javelin throw can measure the maximum velocity, which owns the slide on the rope.

Bartonitz (1985) and Tunnemann (1995) through their research ,prove that program of mechanical training have an positive influence on the physical abilities and it could use as special way to measure mechanical and physics of performance.

Results In less than 10sec we could predict of the distance performance throw expectation formula. (D)=3,957+3.2366*(V0g) which is better than manipulating through video analysis or movie camera in addition to highly coast of training halls, trainers, training programs and other things .Also this device is movable ,easy to carry and store and do not need large space.

The results, which the coaches immediately after the test are available, this can have a positive impact on the performance of athletes wide. Here, the use of quick information when measuring training so far proved to be particularly successful, as reflected in various scientific works (Freyer, 1992; Fricke et al. (1992); Knoll, 1995; Daugs 2000) confirmed is. This is the Quick-understand after Thorhauer (1971), as an «objective» additional information that can be obtained by using technical measuring equipment.

Suggestions

1. Using this new simulation system to predict the distance performance and evaluate physical variables in Javelin throwers.

2. Test and evaluate learning and training programs

3. Using this system to test some mechanical variables in sport events especially those which are from repeated movement type.

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