Biomechanical Principles in Throwing

By

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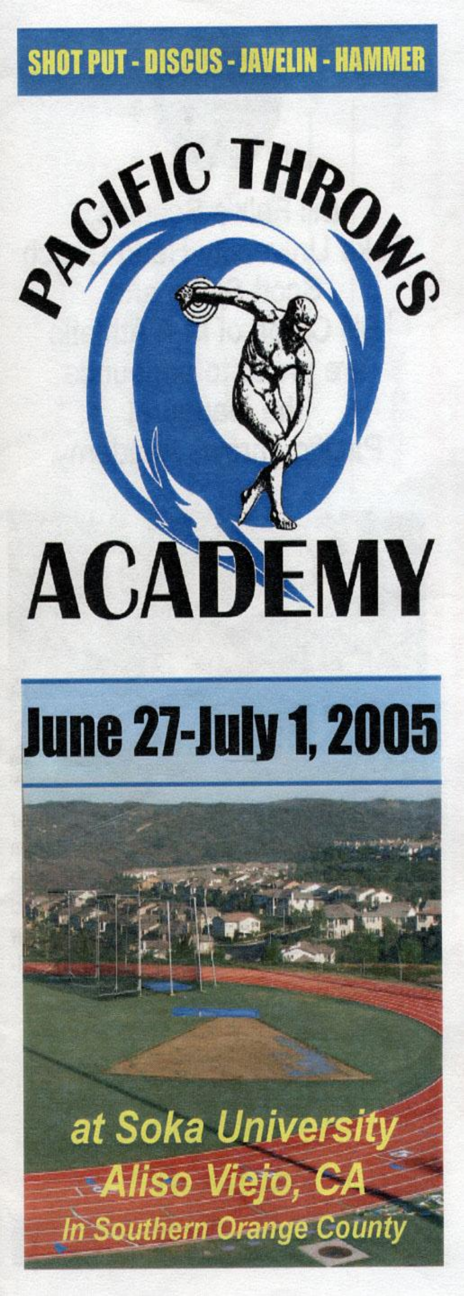
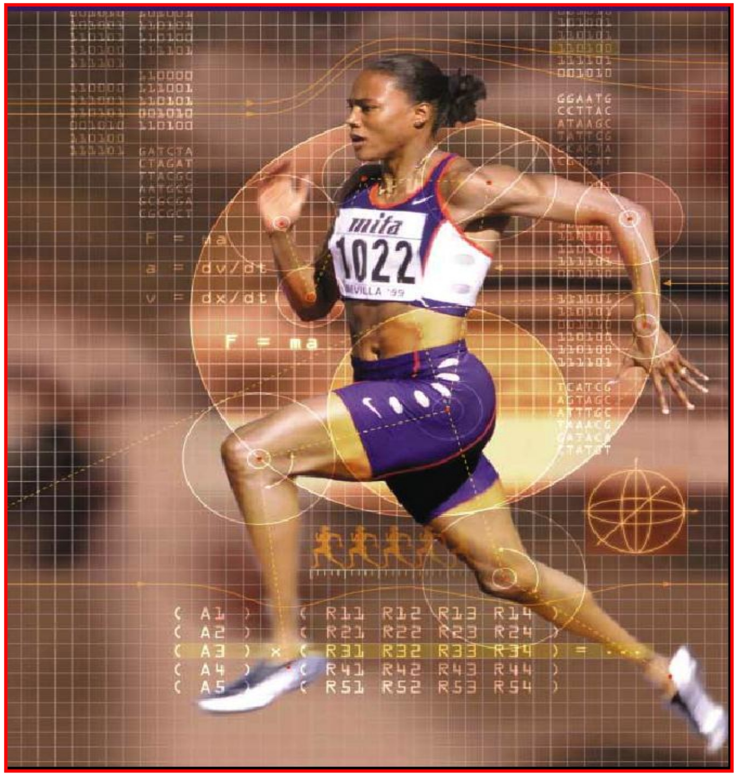
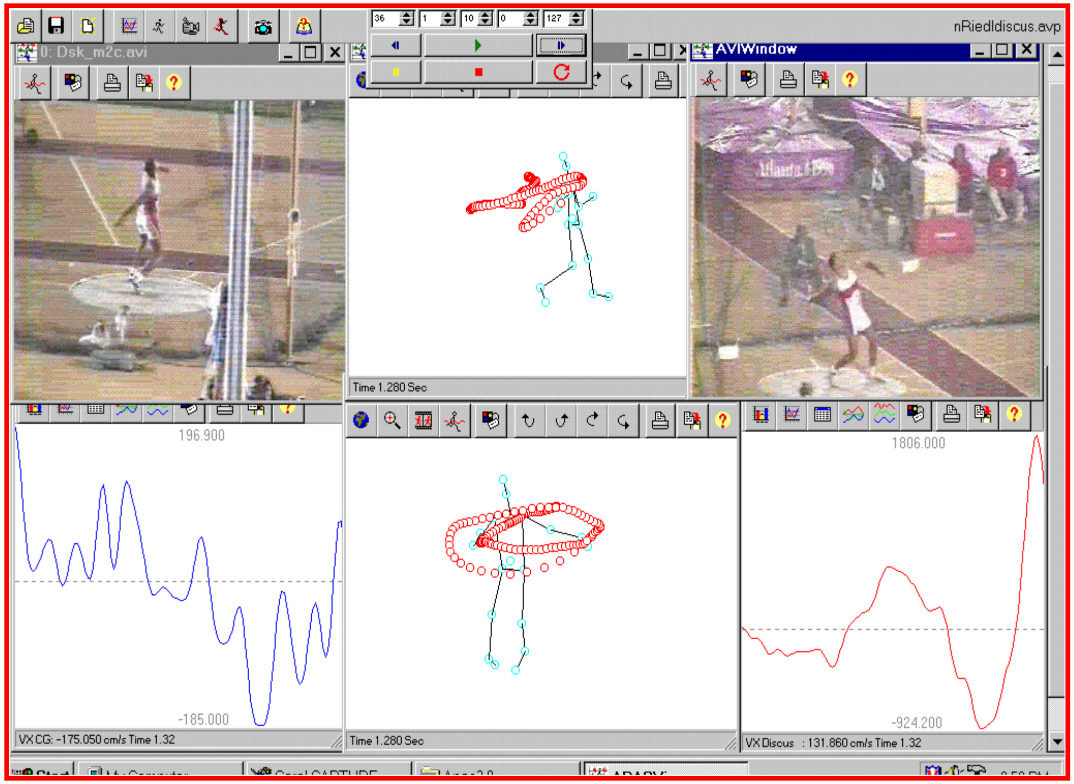
Soka University, Throwing Camp 6-28-05



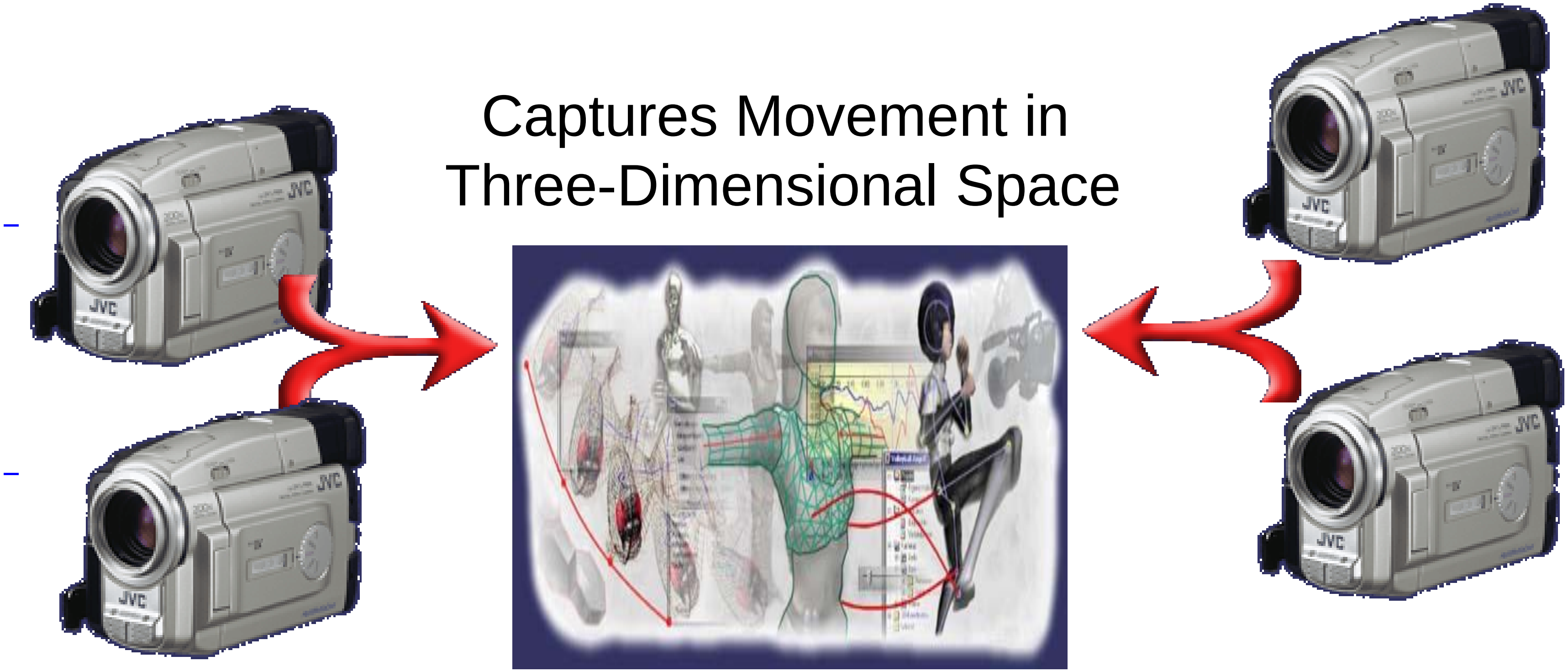
Optimizing Athletic Performance Through High-Technology

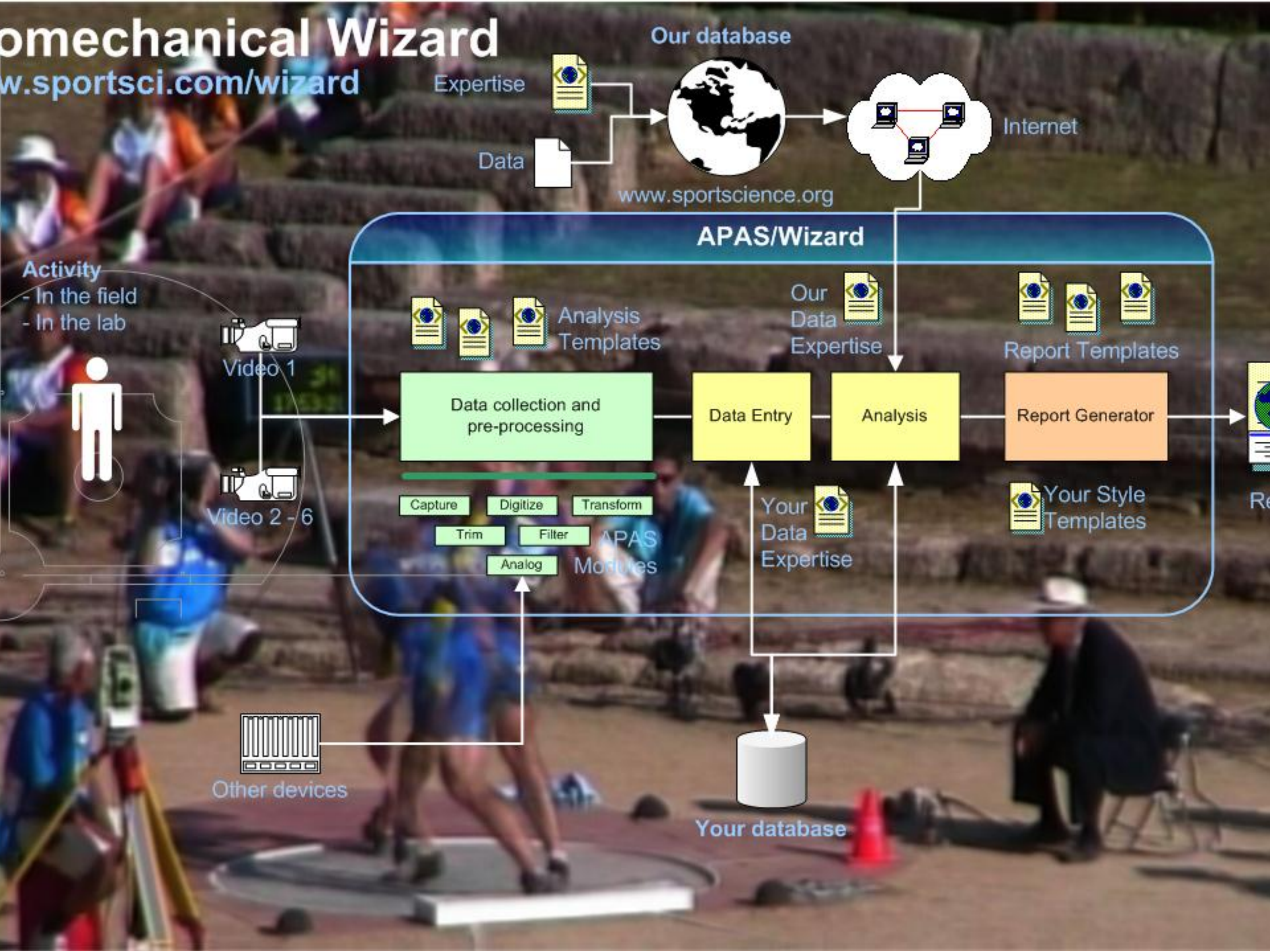
Biomechanics - The field of study which makes use of the laws of physics and engineering concepts to describe motion of body segments, and the forces which act upon them during activity





Capture videos using several cameras simultaneously and save the clips directly as AVI files to your hard disk. This allows you to connect multiple digital video cameras to your computer and to start capturing with one mouse click.



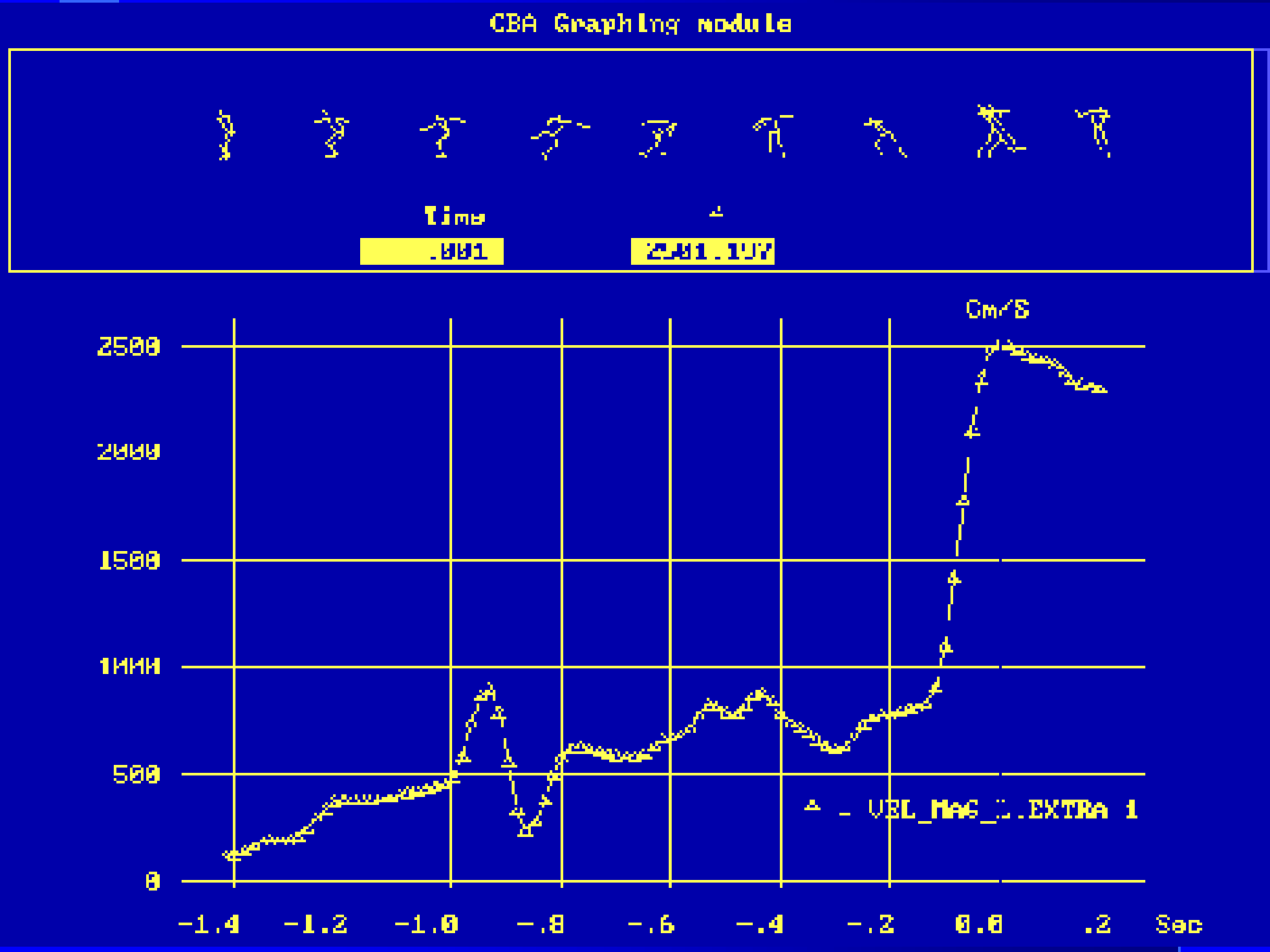

omechanical Wizard
w.sportsci.com/wizard
Our database
Expertise
Data
www.sportscience.org
Internet
APAS/Wizard
Activity
- In the field
- In the lab
Video 1
Video 2 - 6
Analysis Templates
Our Data Expertise
Report Templates
Data collection and pre-processing
Data Entry
Analysis
Report Generator
Capture
Digitize
Transform
Trim
Filter
Analog
APAS Modules
Your Data Expertise
Your Style Templates
Re
Other devices
Your database

Phases of the Discus Throw:

1. PREPARATION
2. ENTRY
3. AIRBORNE
4. TRANSITION
5. DELIVERY

Indications of the Rhythm and Timing of the Throw

PARAMETER	W1	W2	W3	HR1
1. Height of release (cm)	165	205	166	196
2. Angle of release	35.0	36.0	36.7	29.0
3. Release velocity (m/s-1)	25.5	26.3	24.9	25
4. Duration of entry phase (s)	0.45	0.36	0.44	0.40
5. Duration of aib orne phase (s)	0.12	0.02	0.09	0.05
6. Duration of transition phase (s)	0.20	0.21	0.23	0.22
7. Duation of delivery phase (s)	0.16	0.15	0.16	0.27
8. Change of discus velocity in airborne phase (m/s-1)	-0.88	-	1.52	-0.45
9. Change of discus velocity in transition phase (m/s-1)	2.23	2.44	3.07	-0.11
10. Change of discus velocity in delivery phase (m/s-1)	17.88	16.72	13.13	18.31
11. Total change of discus vel. (T+D phase) (m/s-1)	20.01	19.16	16.20	18.20
12. Official throwing distance (cm)	67.34	66.90	66.12	62.0


CBA Graphing module
Time
.001
Cm/S
2500
2000
1500
1000
500
0
-1.4
-1.2
-1.0
-.8
-.6
-.4
-.2
0.0
.2
Sec

Differences:

- Angle of release
- Duration of the delivery phase
- Change of the discus velocity in the transition and the delivery phase

DISCUSSION

Lose of the discus velocity
in the airborne and transition phase

⇓

Necessary increment of velocity
in the delivery phase

⇓

Poor control of the discus in the moment of release

⇓

Consequence: low angle of release
SHORTER LENGTH OF THE THROW

Correction of the training process

It is necessary:

- to increase the discus velocity in the transition phase
- to improve movement co-ordination in the delivery phase

The results of this analysis has showed significant differences in numerous parameters, including those which are considered as a basic: velocity, release angle, height of release, trunk angle, as well as in many others. Since those differences can be treated as the errors of technical execution that significantly influence the length of the throw, suggestions for their correction through training process have been made.

Contributions to Throwing Velocity

- Translated linear velocity of CM & shoulder

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- Hip rotation

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- Hip rotation
- **Spinal rotation**

Contributions to Throwing Velocity

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- Hip rotation
- Spinal rotation
- Horizontal flexion of shoulder joint

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- Internal rotation of humerus

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- Elbow extension

Contributions to Throwing Velocity

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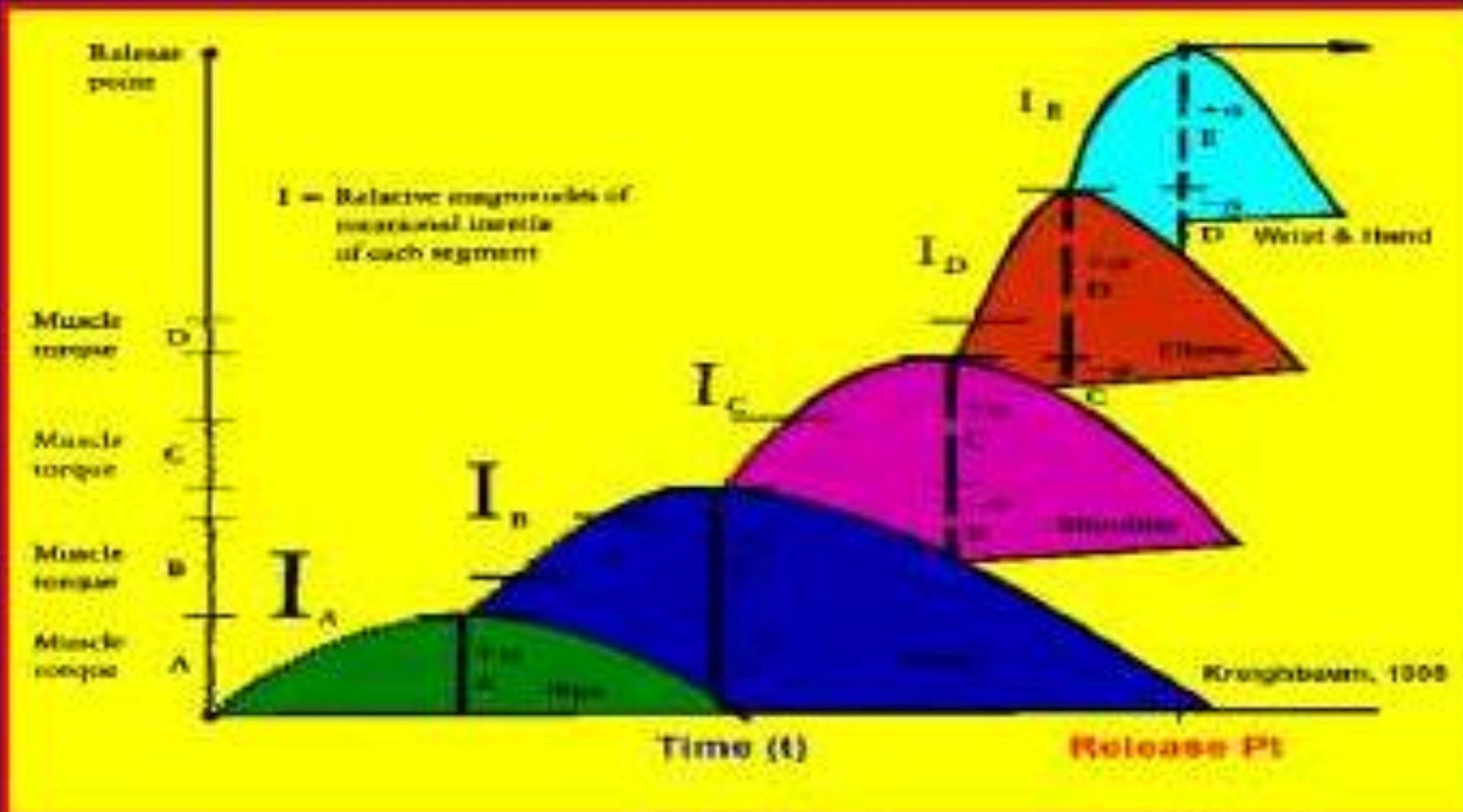
- Hip rotation
- Spinal rotation
- Horizontal flexion of shoulder joint
- Internal rotation of humerus
- Elbow extension
- **Wrist & Finger flexion**

Kinetic Link Sequential Transfer



Elastic Loading

- Extreme stretch of the arm throwing muscles facilitate the throwing motion.

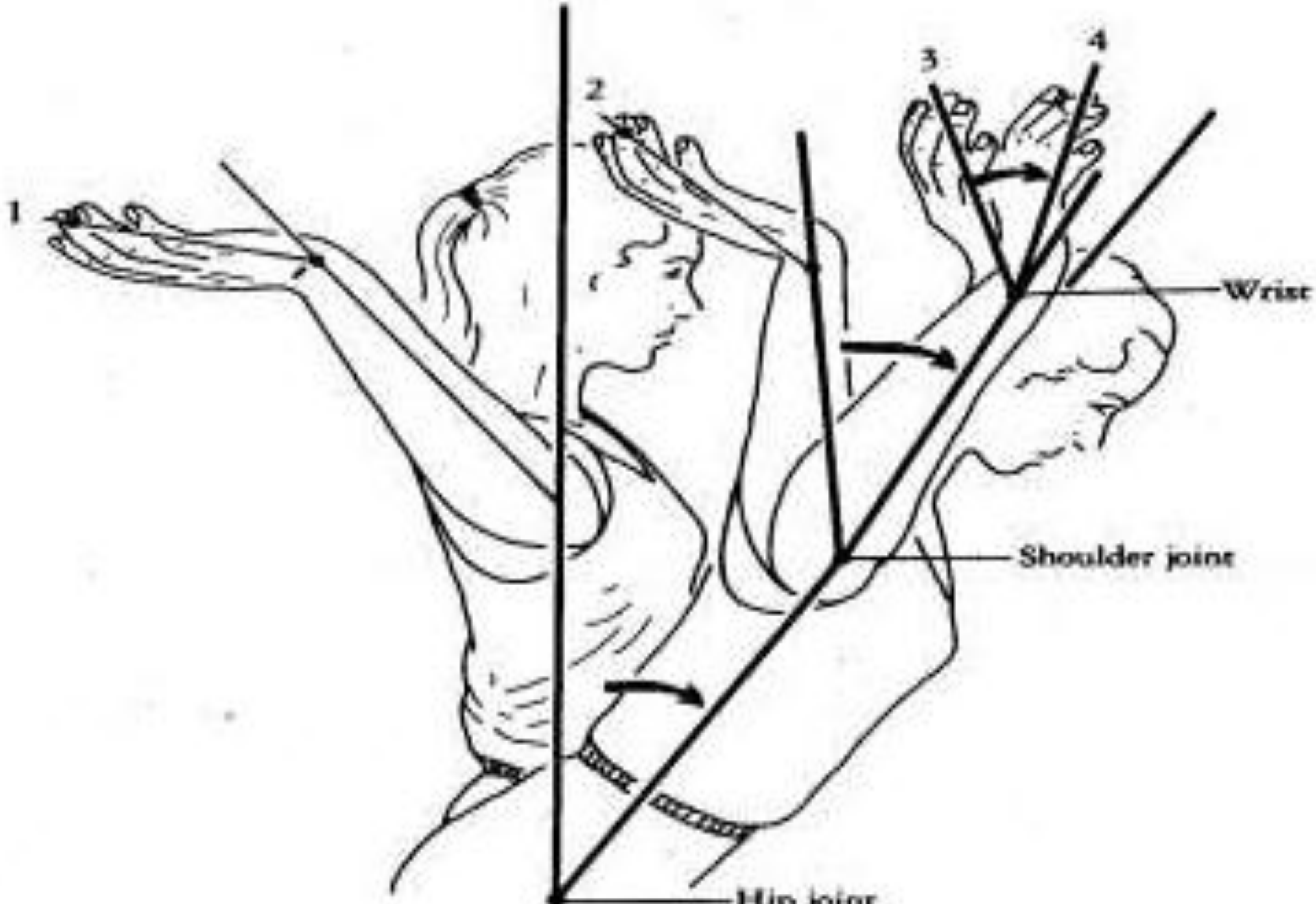


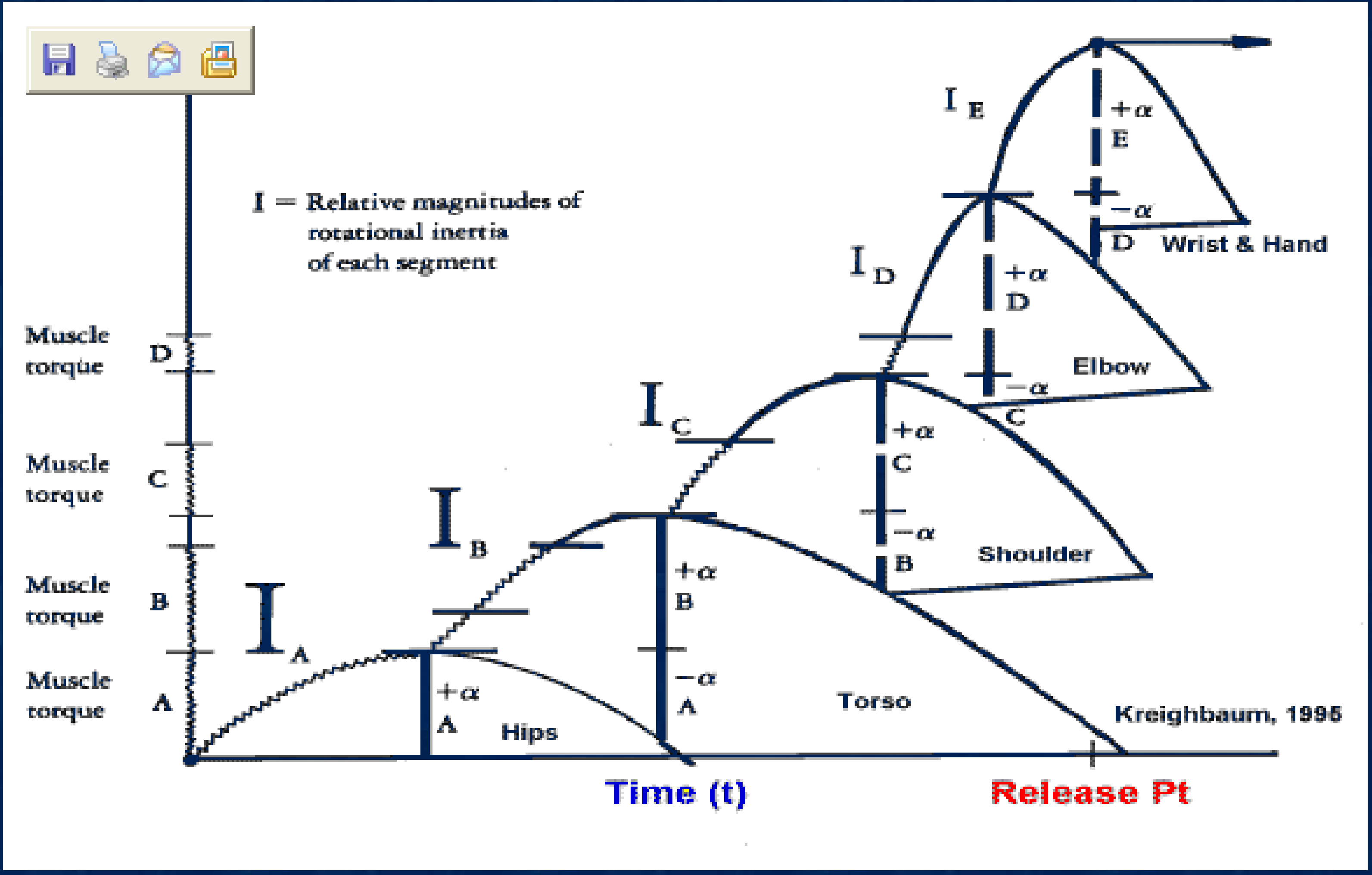
FIGURE K.2

Flexion of the hip, medial rotation of the shoulder joint, and flexion of the wrist with all distal segments of the upper extremity fixed.

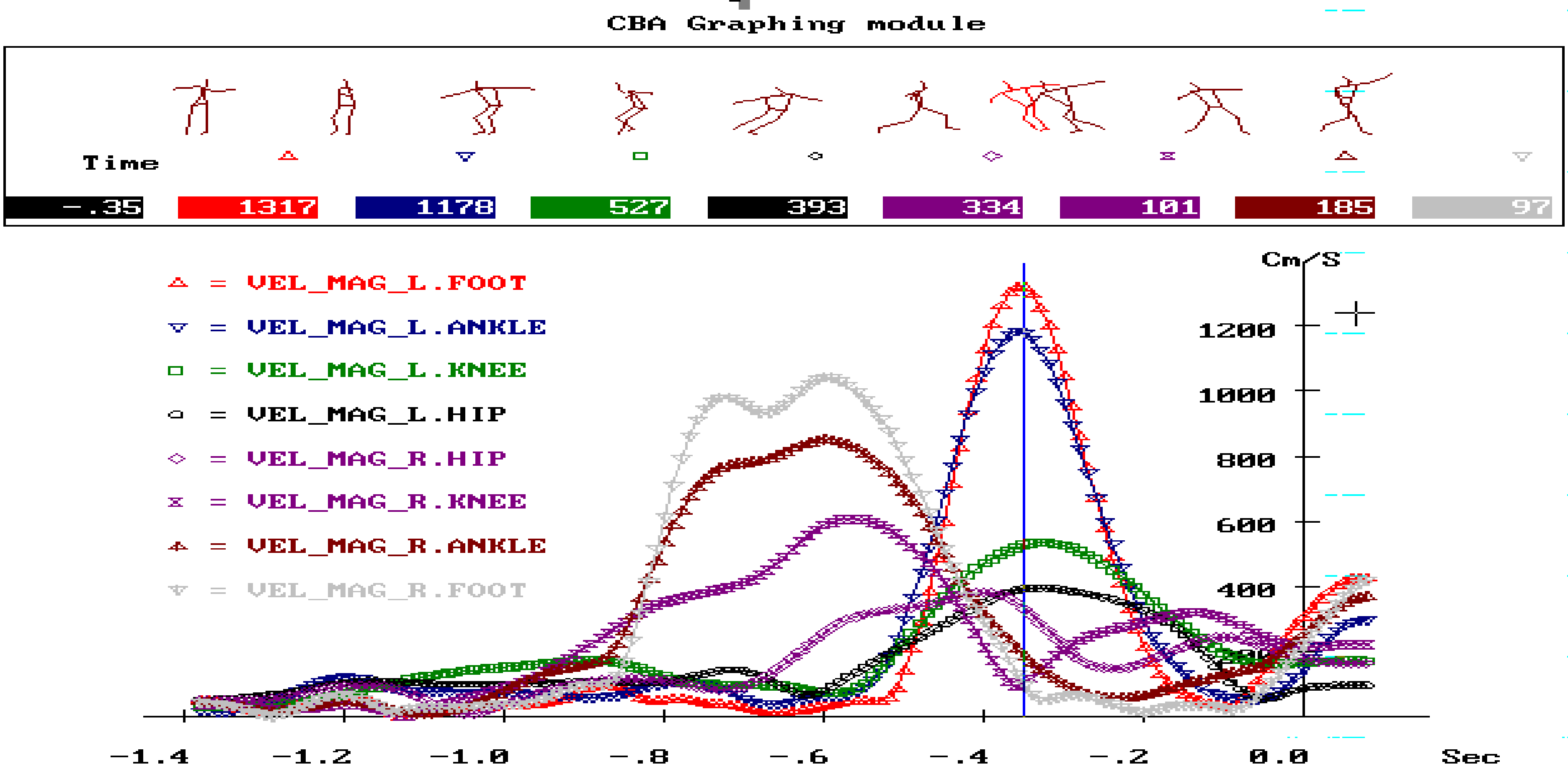
Elastic Loading

- Extreme stretch of the arm throwing muscles facilitate the throwing motion.
- **Elastic loading in combination with sequential muscular acceleration and deceleration lead to the transfer of velocity from the torso to the arm.**

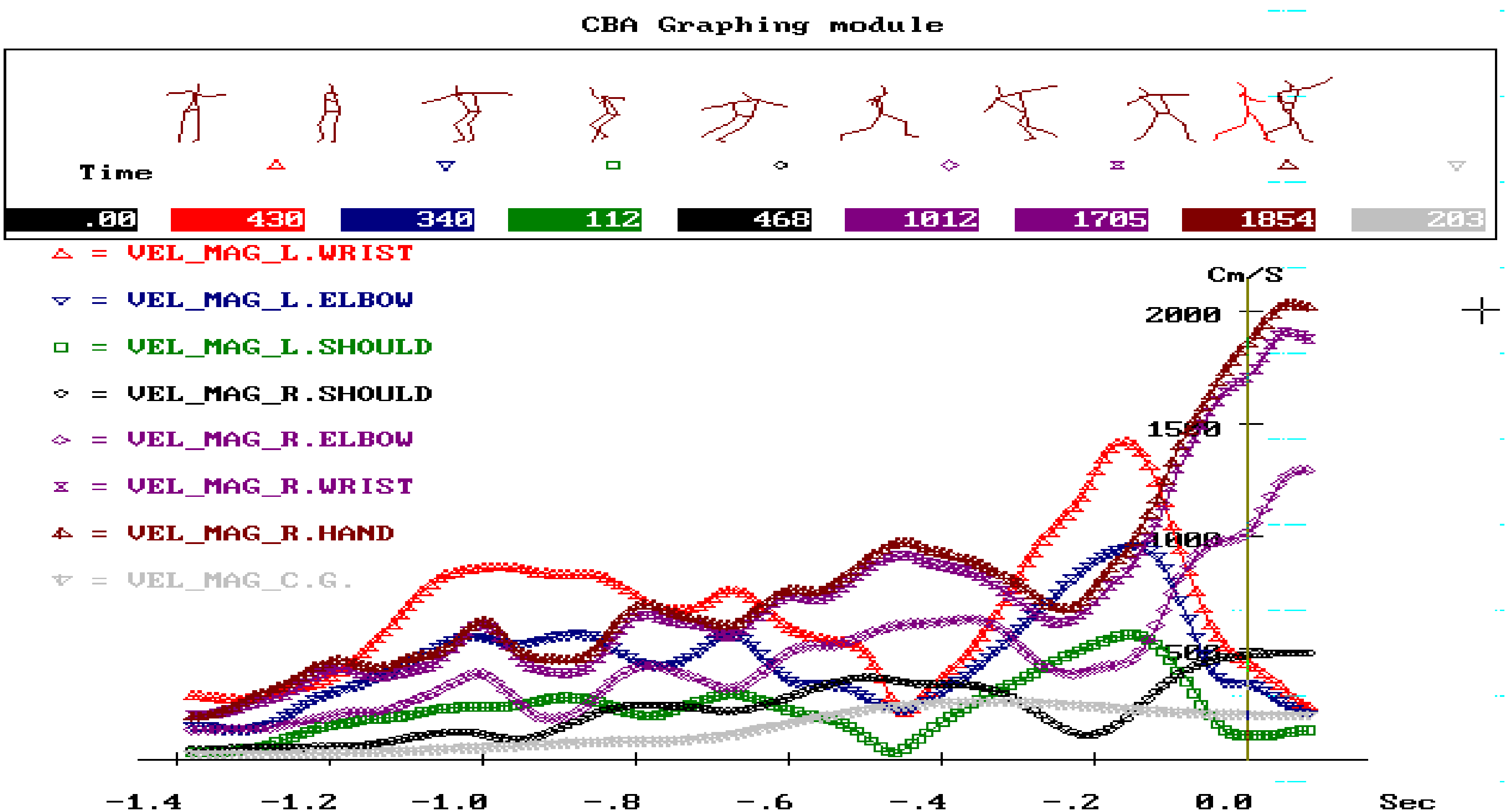
Critical sequential timing between the successive accelerations and decelerations of the segments are necessary for effective kinetic link transfer of velocity (Figure 5). The sequential timing of the trunk rotation, horizontal shoulder flexion and elbow extension transfer the trunk's torsional velocity out through the arm appendage while providing a shortened effective arm radius with a smaller rotational inertia in the beginning of the accelerative phase permitting high rotational velocities and then the extension of the arm leads to a flinging transfer motion which increases the arm radius and tangential velocity.

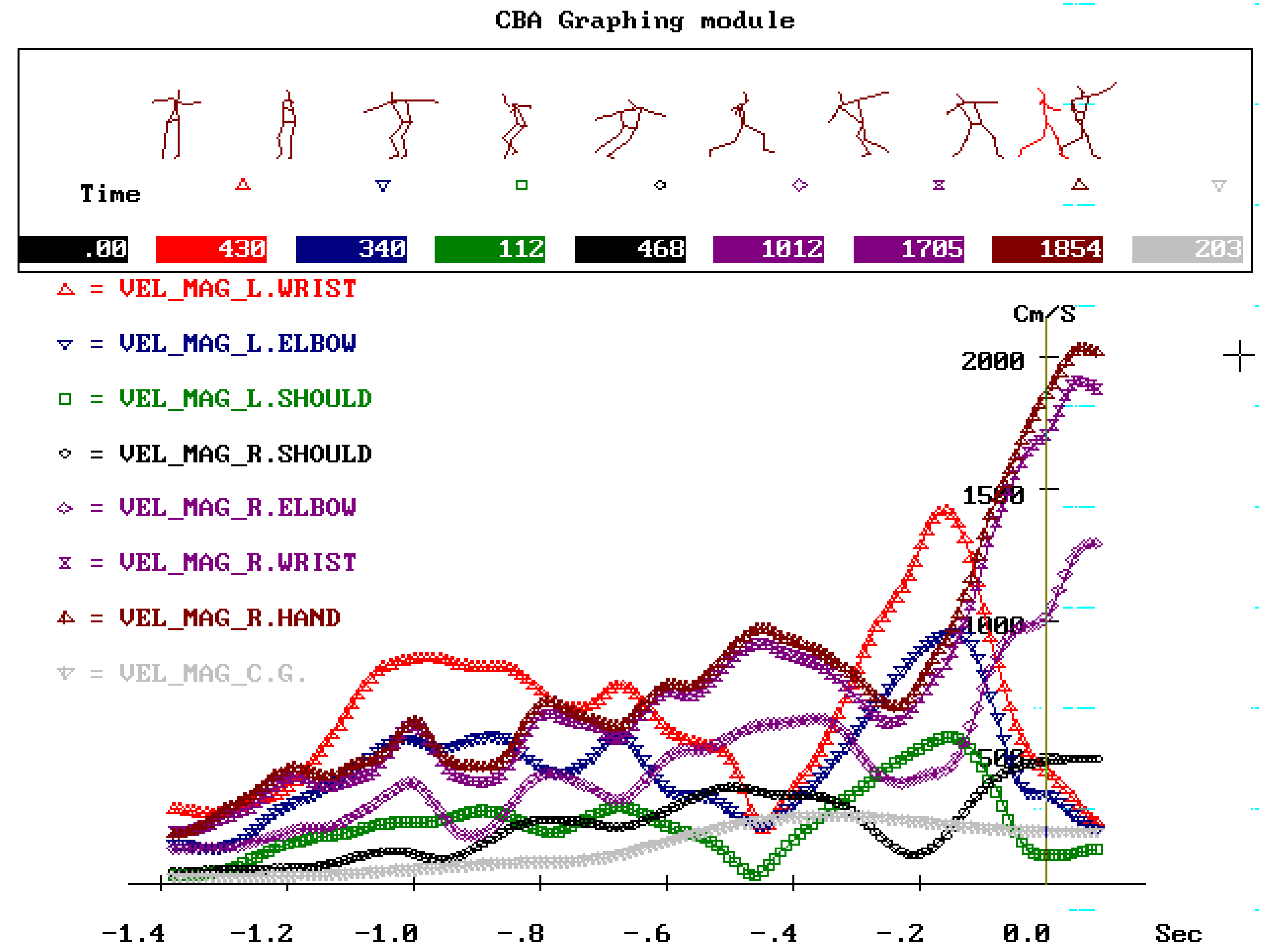


Calculating the Velocities of the lower limb revealed acceleration and deceleration patterns in a unique sequence



Observing the upper extremities reveals a pattern as well.





CBA Graphing module
Time
.00
430
340
112
468
1012
1705
1854
203
= VEL_MAG_L.WRIST
= VEL_MAG_L.ELBOW
= VEL_MAG_L.SHOULD
= VEL_MAG_R.SHOULD
= VEL_MAG_R.ELBOW
= VEL_MAG_R.WRIST
= VEL_MAG_R.HAND
= VEL_MAG_C.G.
Cm/S
2000
1500
1000
500
-1.4
-1.2
-1.0
-.8
-.6
-.4
-.2
0.0
Sec

Biomechanical Analysis of Discus Throwing at Olympic Games

There Were 18 Throwers During the Qualifying Round and the Best 8 Athletes Competed for the Gold Medal in the Final Round.

Video Cameras Were Placed in Several Locations to Maximize the Data Obtained for the Event

Dsk_m1c.avi

Dsk_m2c.avi

Dsk_m3c.avi

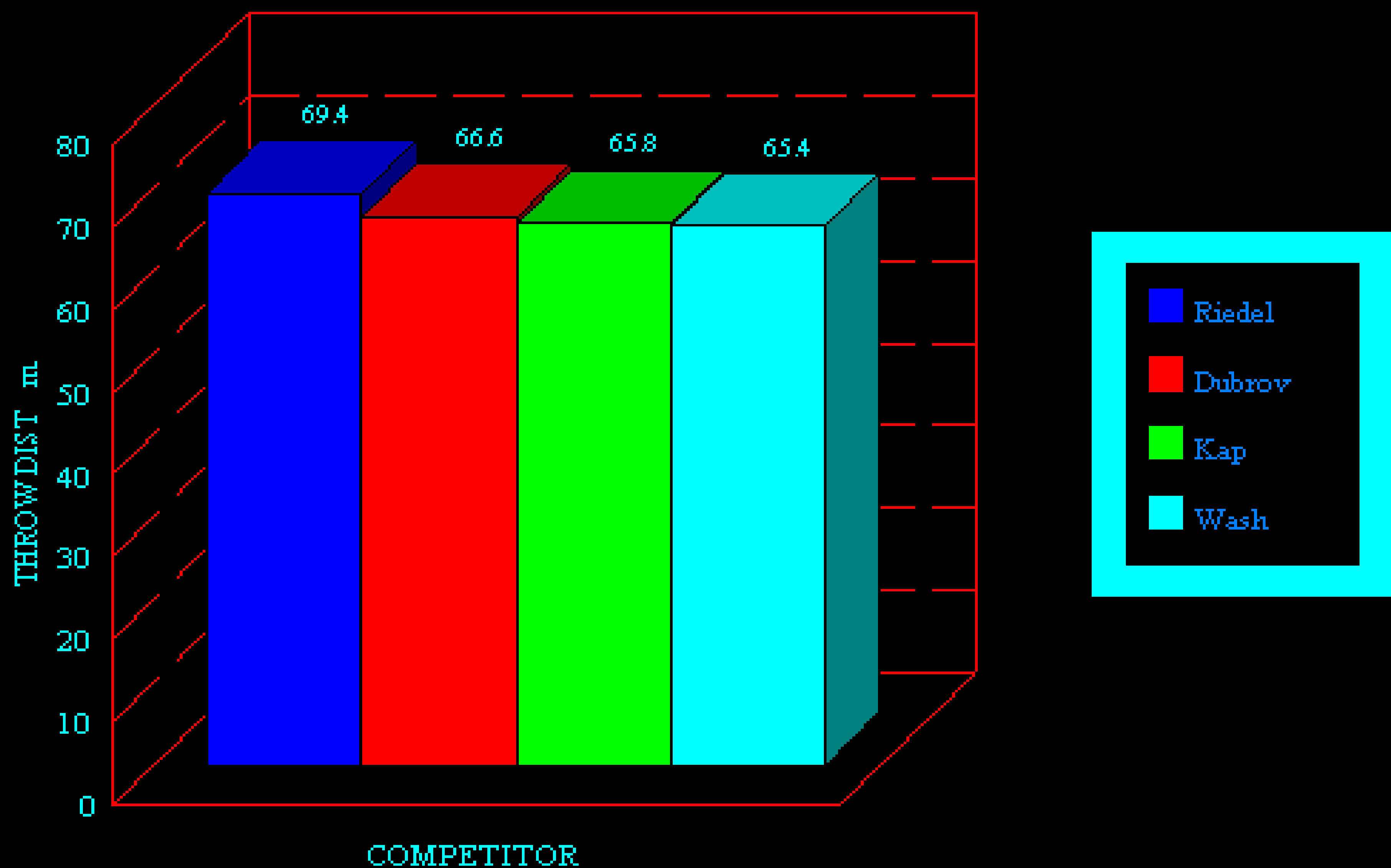
- **The Order of Finish Was:**
  Riedel Representing Germany (GER) Winning the Gold,

  Dubrovschchik From Belarus (BLR) Finishing Second,

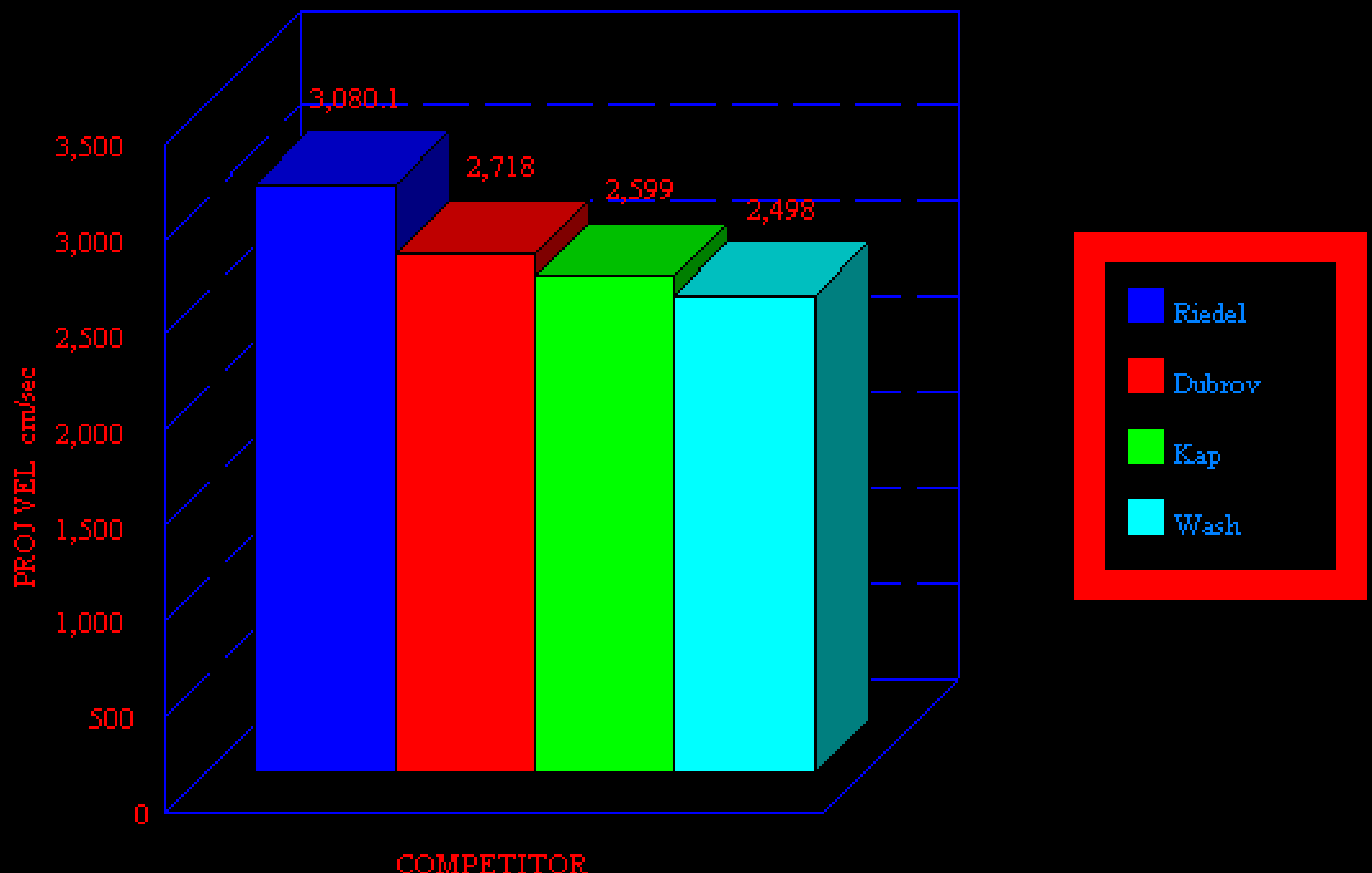
  the Bronze Medal Was Won by Kaptyukh From Bulgaria,

  and the Fourth Place Finisher Was Washington Representing the United States.

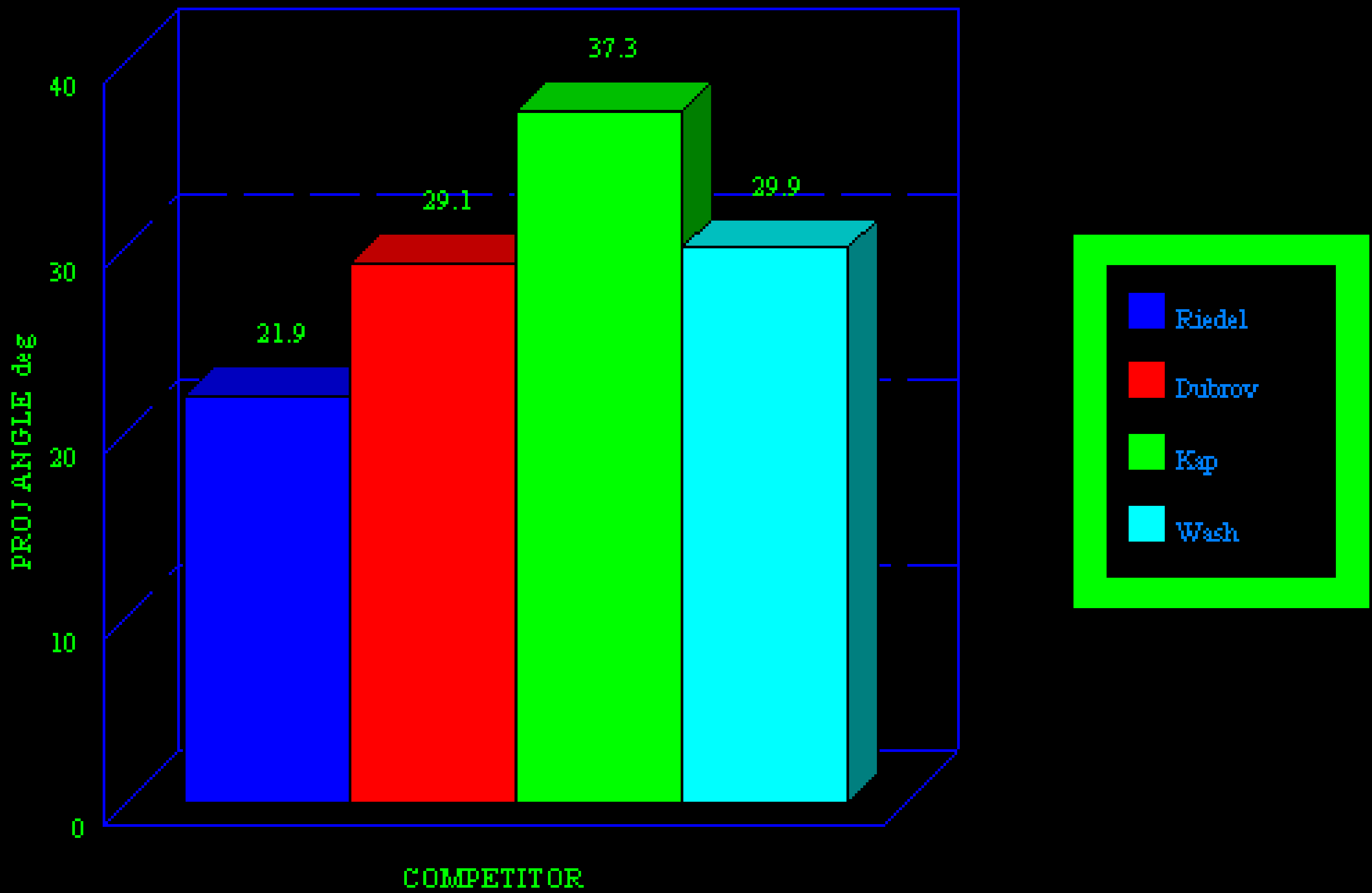
DISCUS THROW DISTANCE m.



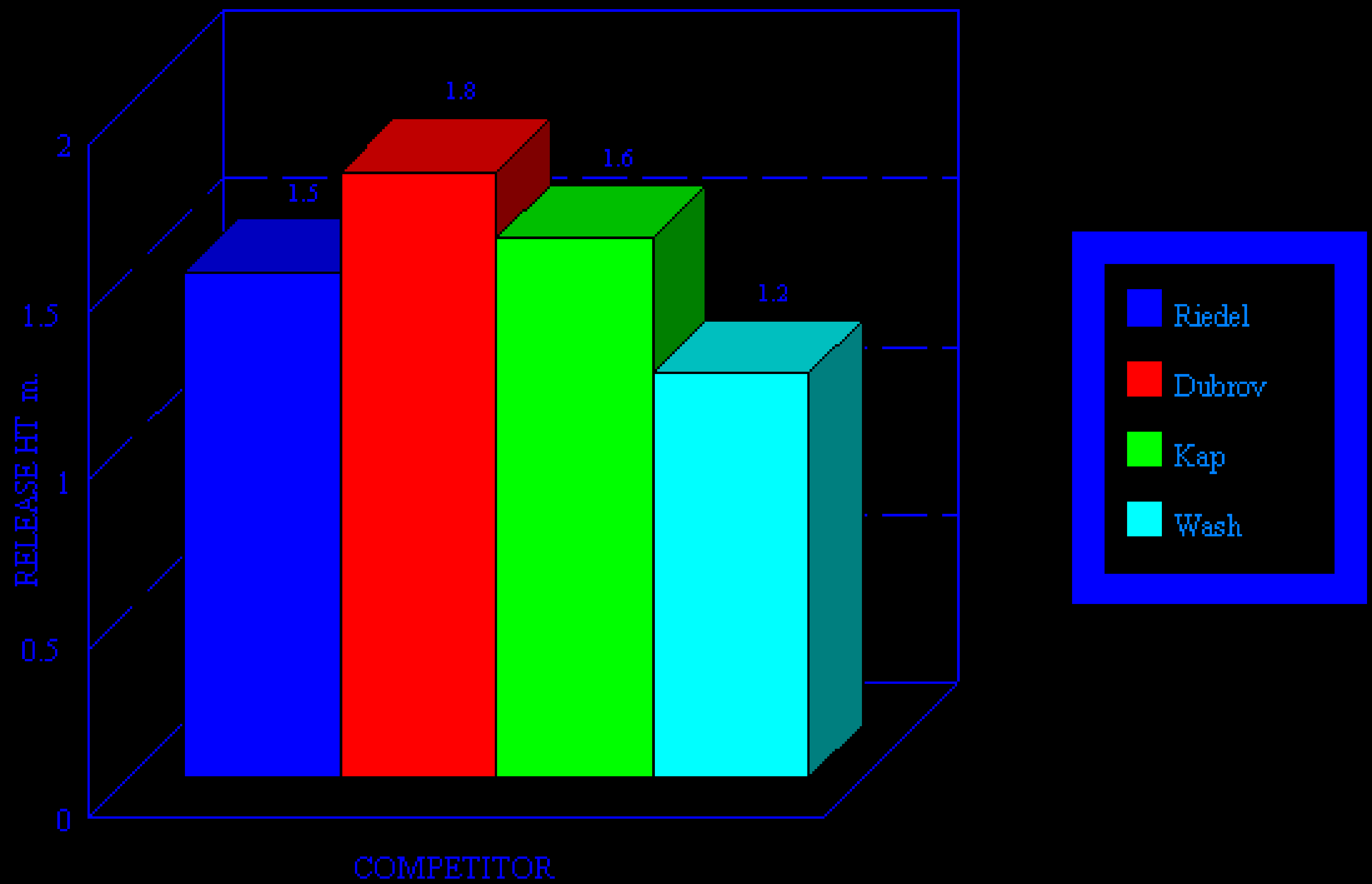
DISCUS PROJECTION VELOCITY cm/sec



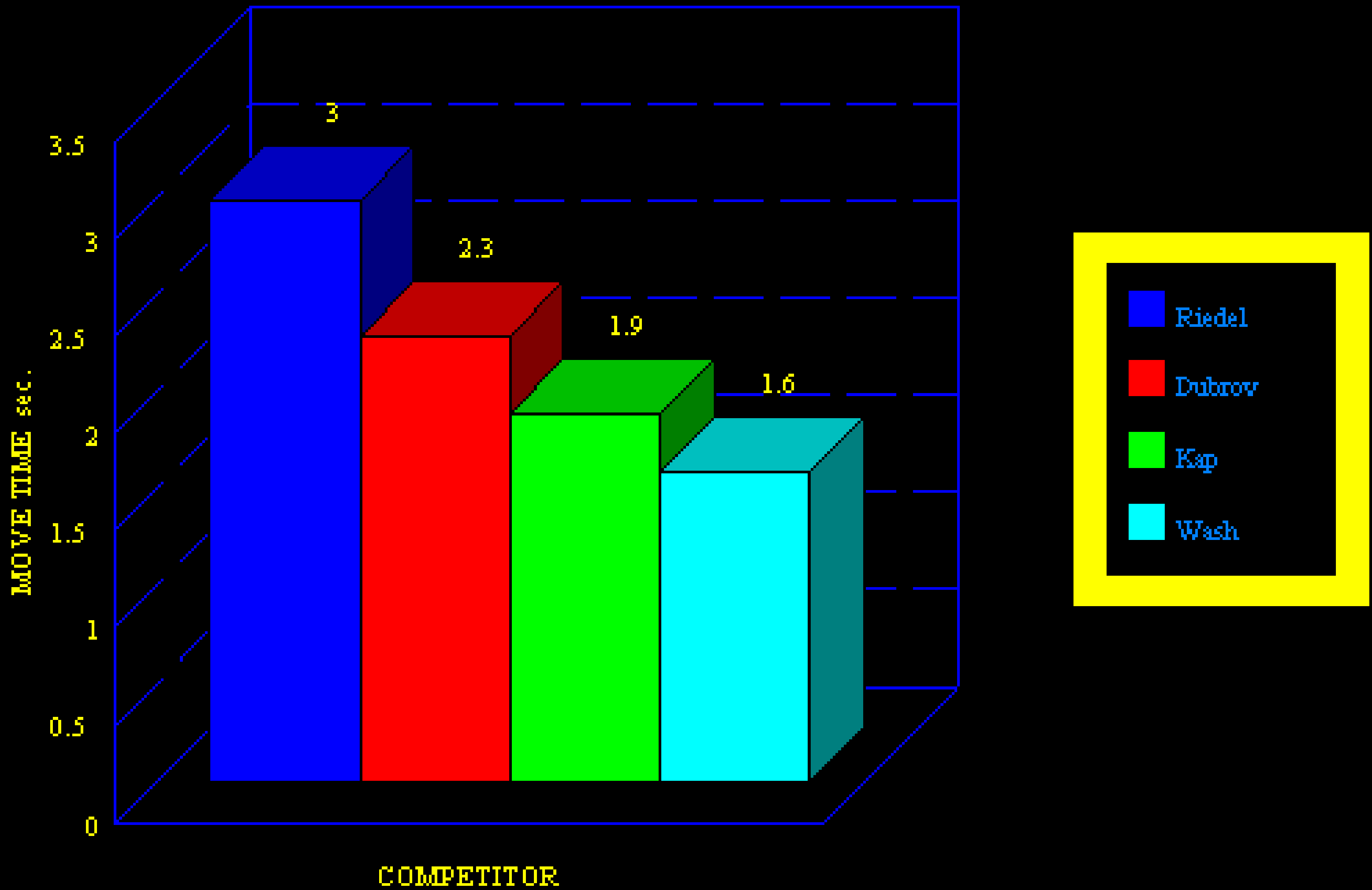
DISCUS RELEASE ANGLE deg



DISCUS RELEASE HEIGHT m.



DISCUS MOVEMENT TIME sec.



Throwing Kinematics for Top Four Discus Performers at 1996 Atlanta Olympics

Riedel (Ger)	69.4	3080.1	21.9	1.5	3.0
Dubrovschchik (Blr)	66.6	2718.5	29.1	1.8	2.3
Kaptyukh (Blr)	65.8	2599.0	37.3	1.6	1.9
Washington (USA)	65.4	2498.0	29.9	1.2	1.6

The Combined Effect of the Projection Velocity, Projection Angle, and Height of Release Resulted in medalist Throws of 69.4 M (Olympic Record) by Riedel (GER), 66.6 M by Dubrovschchik (BLR), 65.8 M for Kaptyukh (BLR), Followed by 65.4 M for Washington (USA). The Aerodynamic Variable of Angle of Attack Was Not Determined for These Throwing Trials


FUTURE
SPORT

Biomechanical Analysis of the Shot-Put Event at the 2004 Athens Olympic Games

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The stadium was Ancient Olympia. The site of the ancient Games of the Olympiad, 2,800 years ago. The site of the modern Games of the Olympiad; the shot put competition was held there.

The Purpose of this study was to analyze the best Shot-put performances in the Athens Olympic Games, 2004. The Shot-Put event at the 2004 Olympics was conducted at the sacred Olympia location. The Biomechanical Analysis of the Shot Put event was sponsored by the International Track and Field Coaches Association. Multiple high speed digital video cameras were placed in specific location on the field at proper angles in order to capture the performance of the athletes in the preliminaries and finals. This was the only biomechanical analysis performed at the Athens Olympic Games where cameras were placed on the performance field.

Two stationary cameras were placed at 45 degrees to each other. In addition 3 more cameras used by the NBC broadcasting were used to assist the other 2 cameras. Temporal and kinematics variables were calculated from the videos records and were analyzed yielding three-dimensional biomechanical results. Pattern of the segments movement were used rather then absolute values, to assist the athletes and the coaches.

Because of limited space, Kinematics parameters presented in this study are for the best 3 final performers. However, analysis was perform for all participants and will be presented in the oral presentation.

Fig 1. Two cameras views of performance

Figure 2. Strobbing photographs to represent the different styles

The resultant velocities curves calculated for the best throws reported at fig

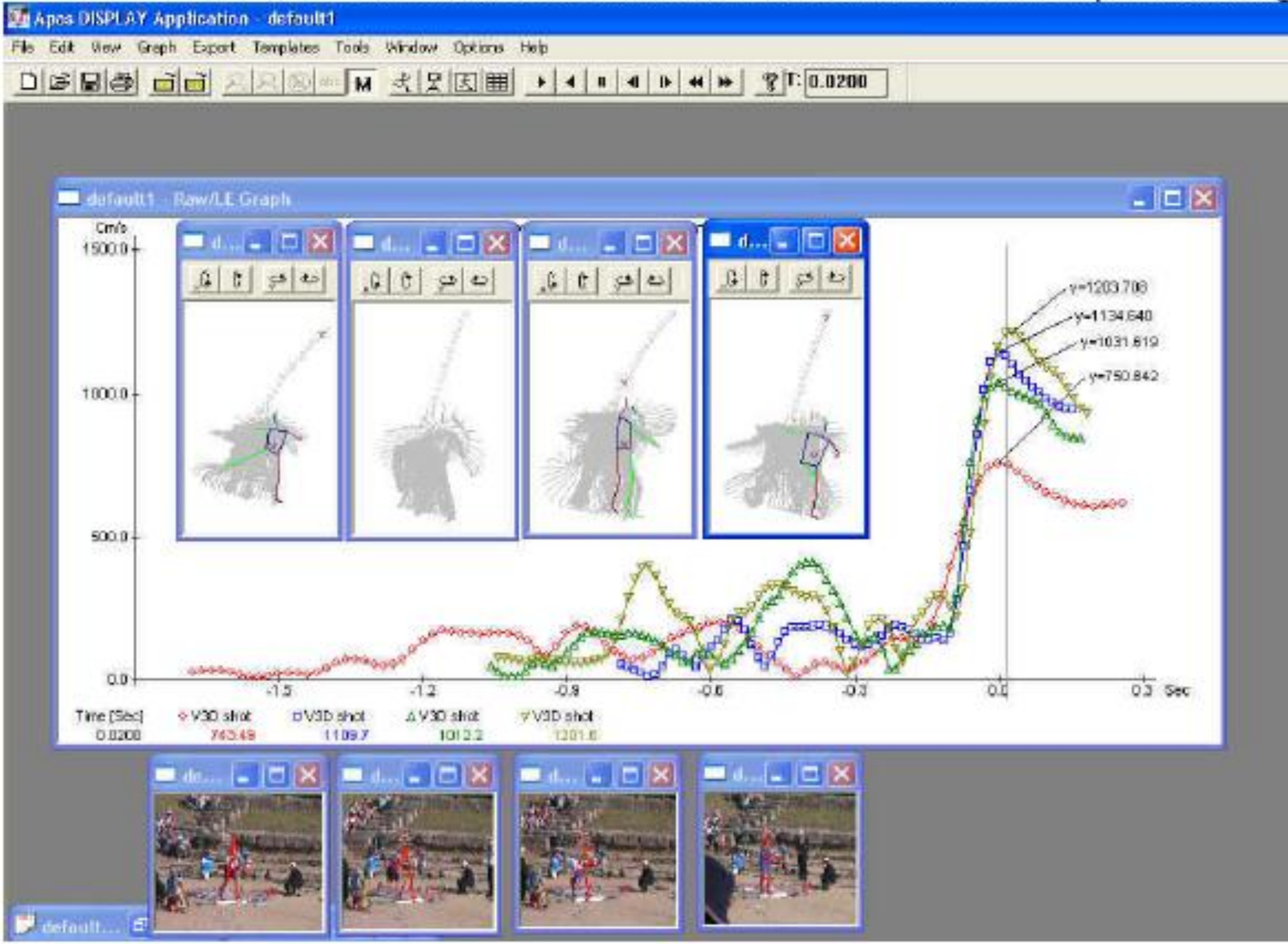

Figure 1. Shot-put velocities curves

Table 1 represent the physical parameters of the three best Throwers

Performer	Place	Distance m	Release Height m	Shot Velocity m/s	Release Angle deg.
Yuriy Belonog	Gold (1)	21.16	2.55	13.85	33
Adam Nelson	Silver (2)	21.16	2.33	13.95	33
Joachim Olsen	Bronze (3)	21.07	2.31	13.60	41

Table 1. Physical parameters results.

Discussion:

The Shot-put distance depends on variety of factors. The angle in which the athlete can achieve the optimal acceleration to his/her arm segments. The release height, release velocity and release angle. The segment acceleration depends on the technique to allow optimal combinations of the above parameters. From the present analysis it was determined that Adam Nelson exhibit close to optimal performance.

THANK YOU