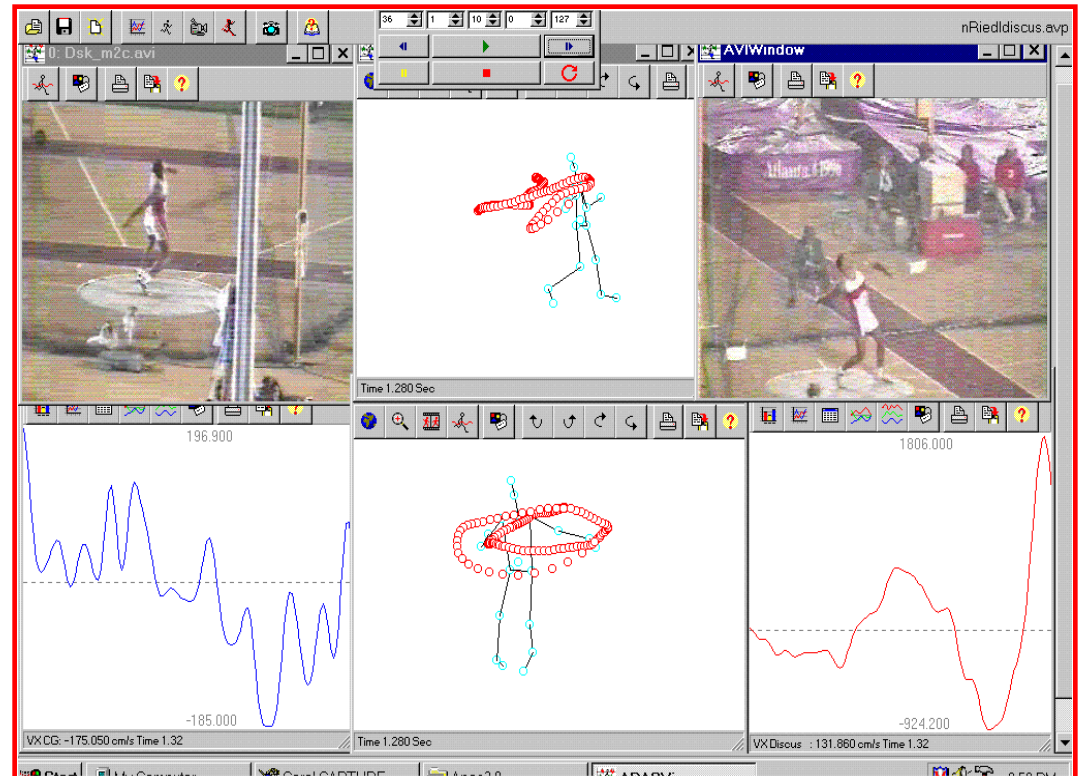
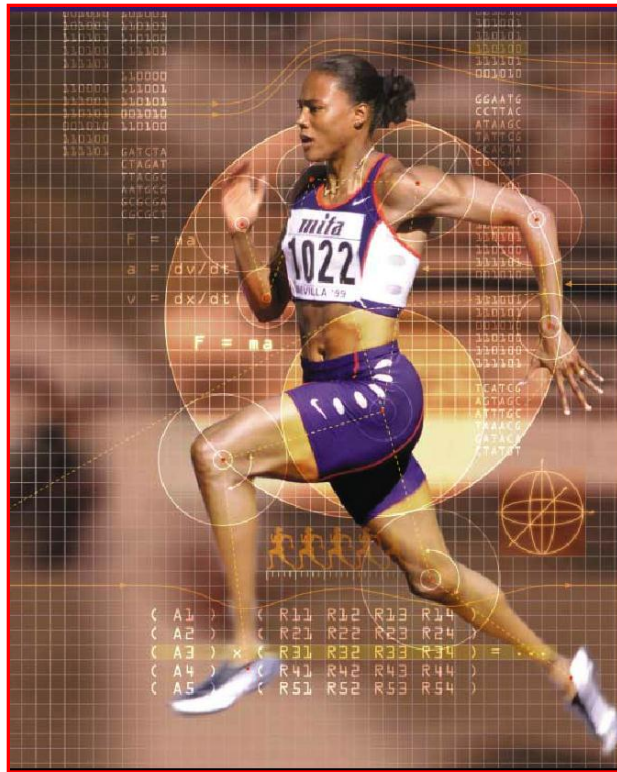


Optimizing Athletic Performance

Through High-Technology
Utilizing the APAS/Wizard System

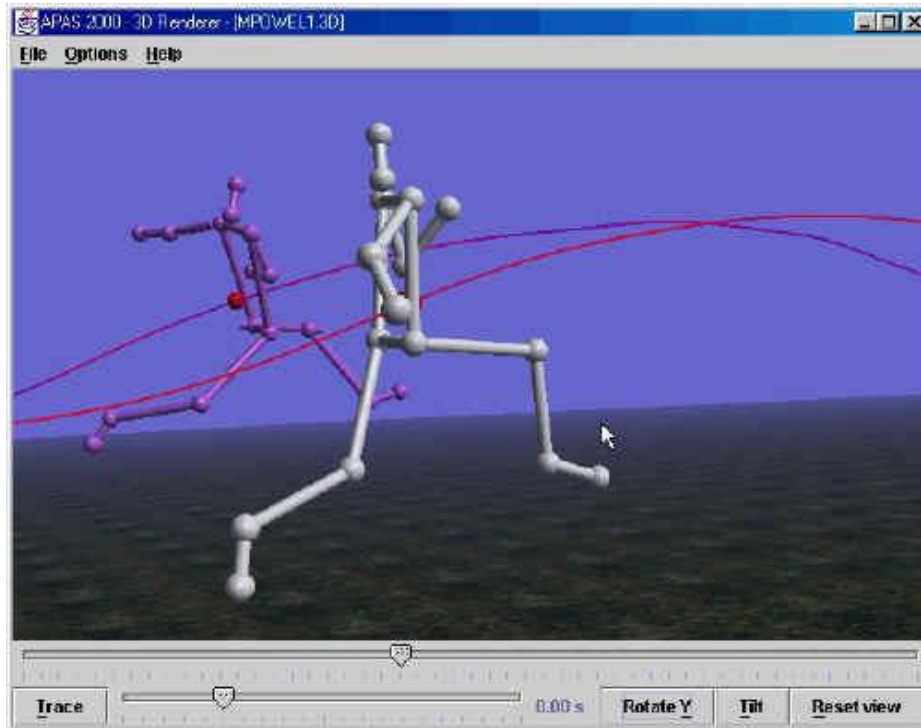


By Gideon Ariel, Ph.D.
Athens Olympics, 2004





MOVEMENT ANALYSIS CAN BE APPLIED TO:



Athletics

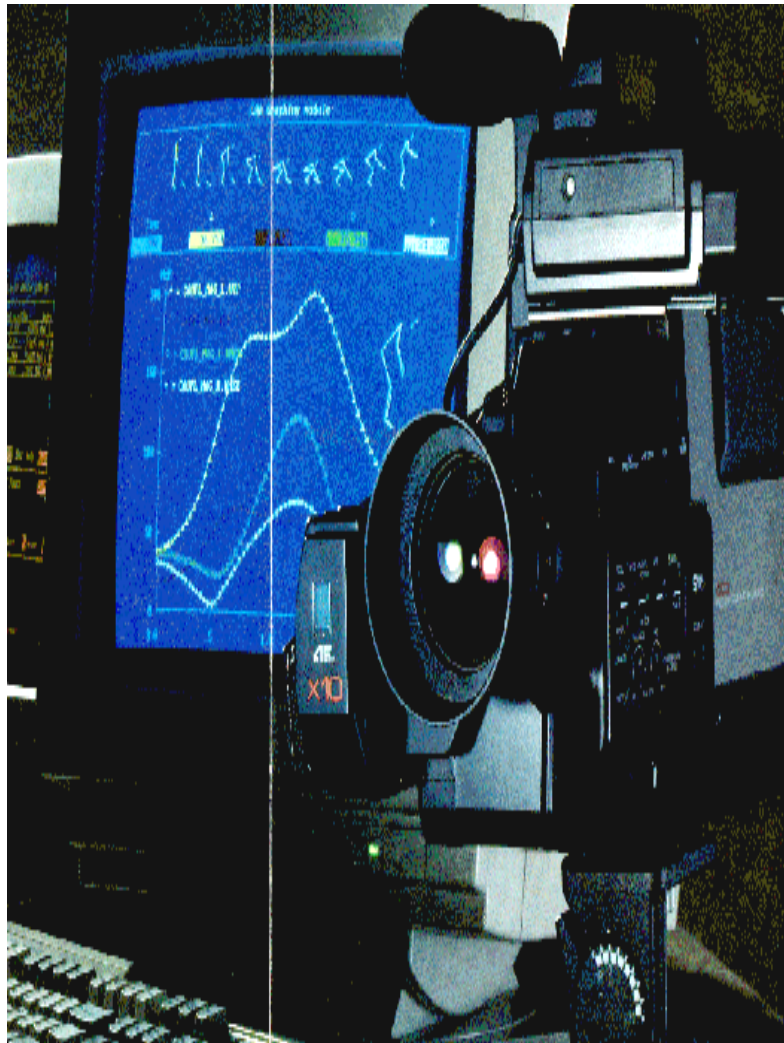
Industry

Medicine

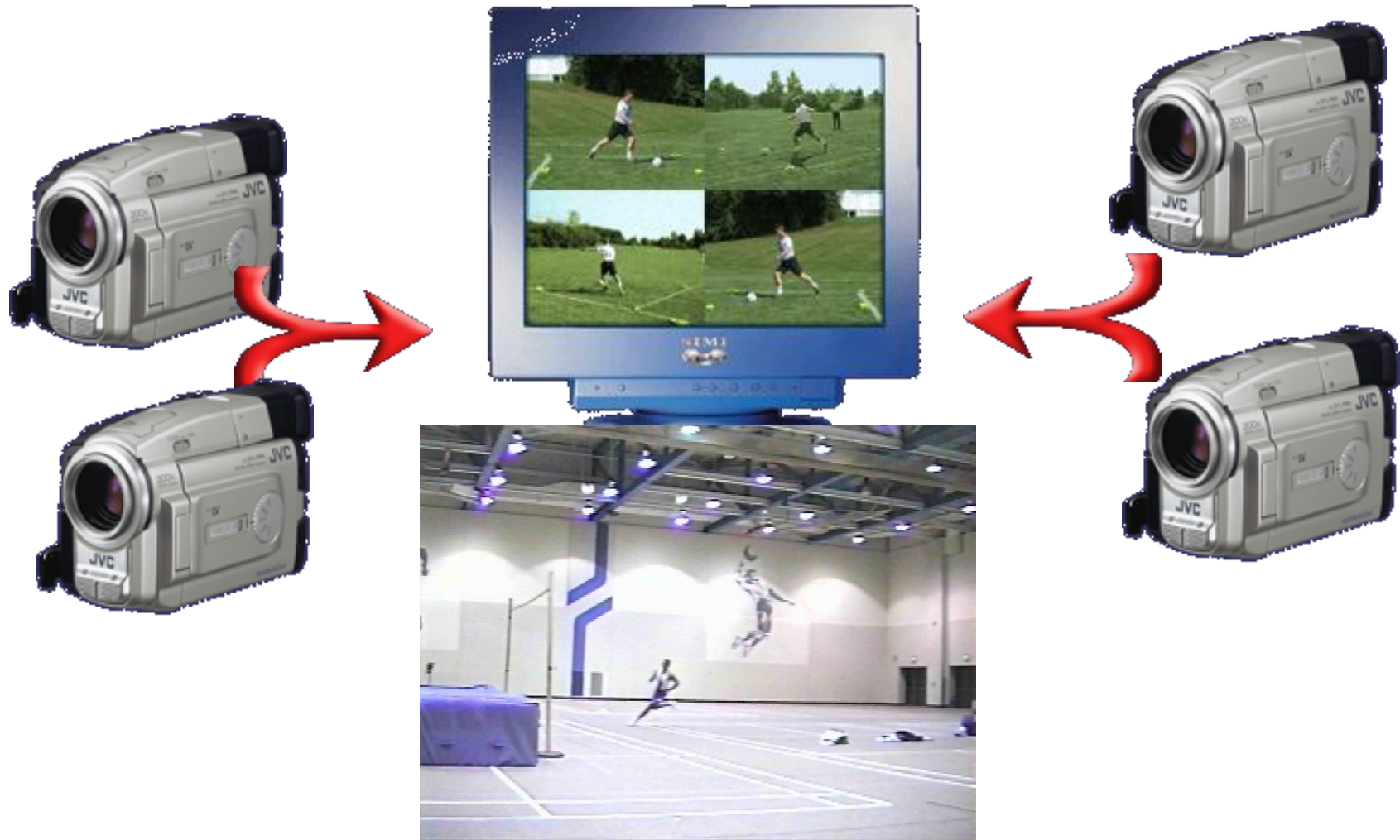
Space



ALL APPLICATIONS UTILIZED SIMILAR QUANTIFICATION TECHNIQUES



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.



The Spectrum of Athletic Performances

- Explosive events

- [Throwing](#)
- Sprinting
- [Jumping](#)



- Endurance events

- Long distance run
- Swimming
- Cycling



- Accuracy events

- [Golf](#)
- Archery



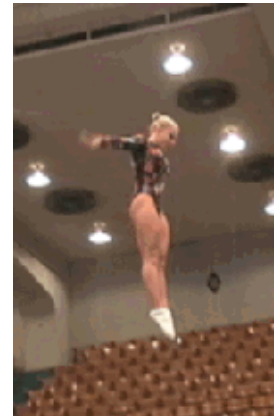
- [Team sports](#)

- Soccer
- Basketball
- Hockey



- Esthetic events

- Figure skating
- [Gymnastics](#)
- Diving

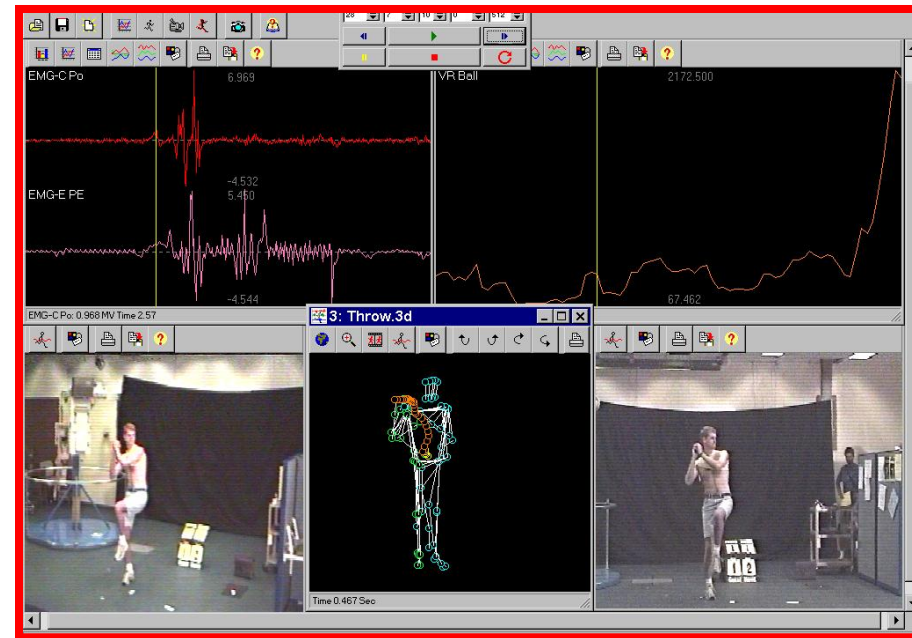


- Multi events

- Decathlon
- Pentathlon

Hardware

- Main Computer System
- Workstations
- High Speed Camera
- Capture Card
- Network
 - Intranet
 - Internet



Analysis of Performance Requires:

Video Recording
Digitizing the Data

Manual

Automatic

Transformation of the Data

2D - Two Dimensional

3D - Three Dimensional



Camera Views



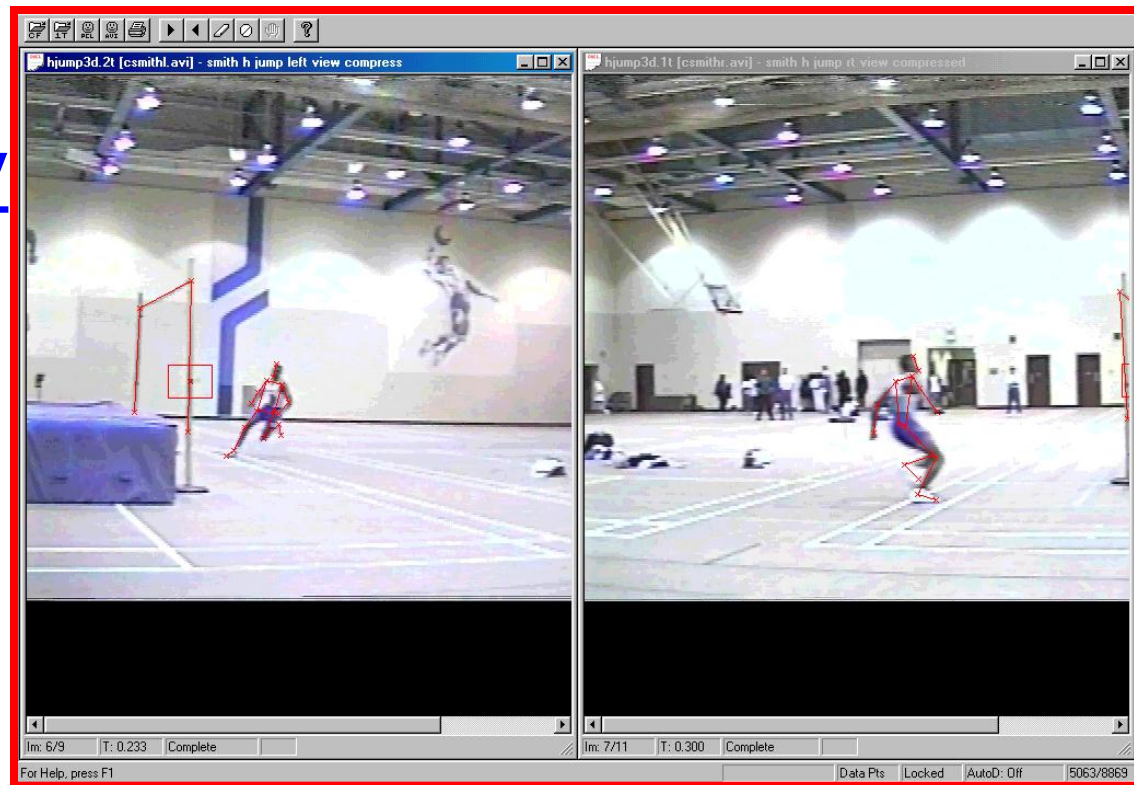


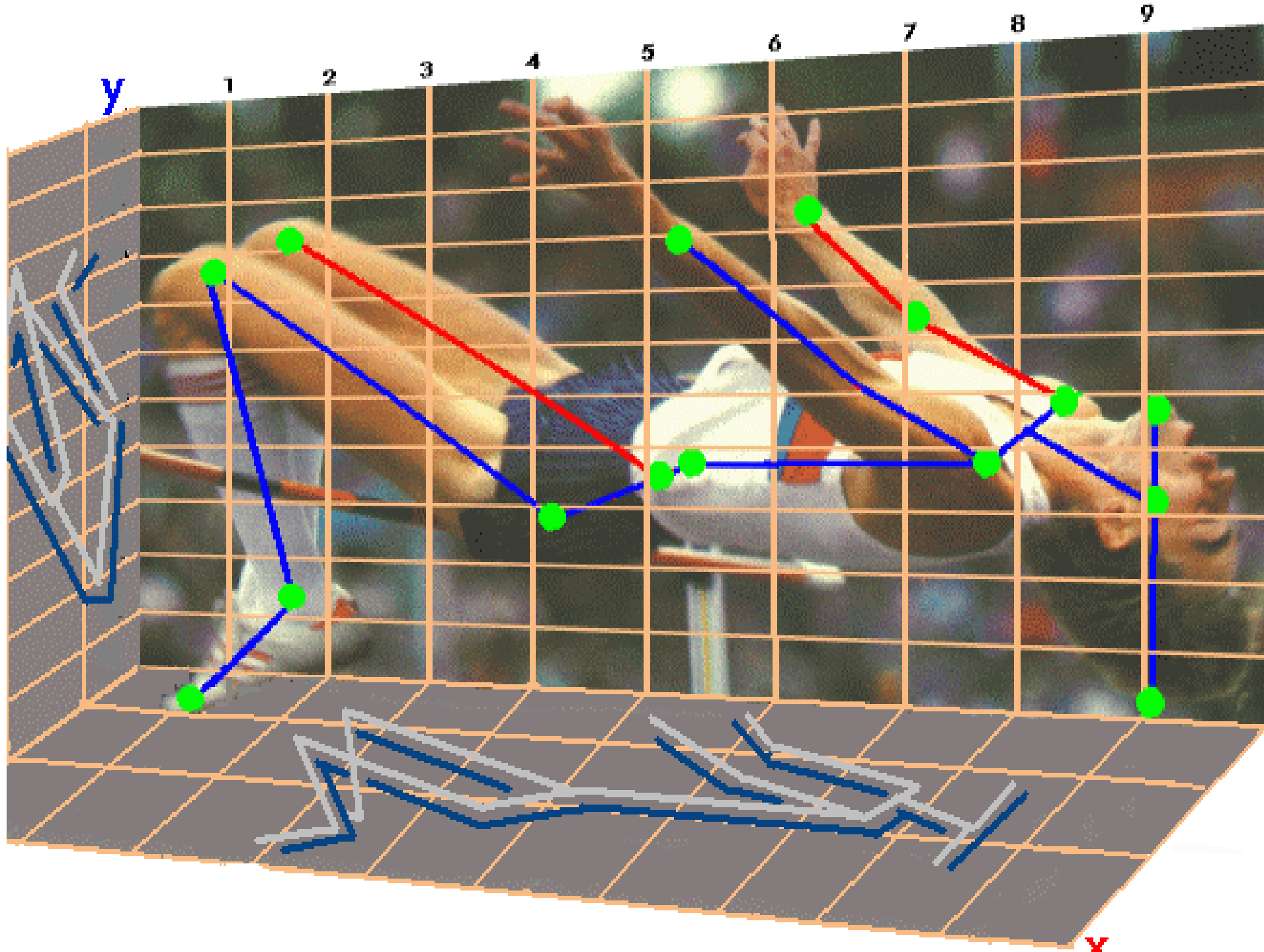
The world record in triple jump of 18.29m by J. Edwards, UK



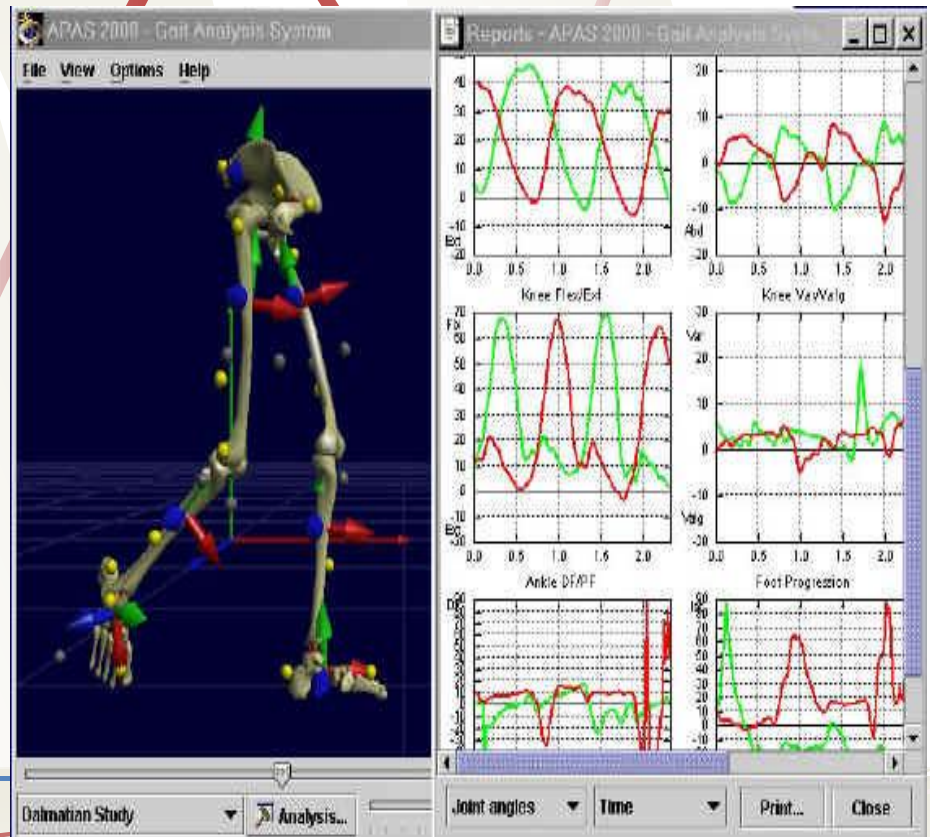
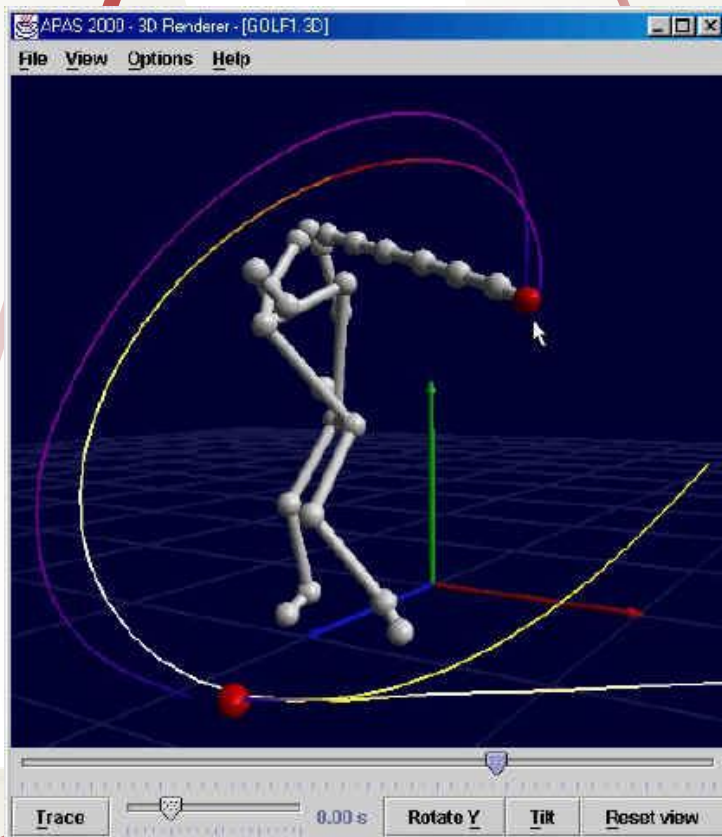
Digitizing

- Manually
- Automatically

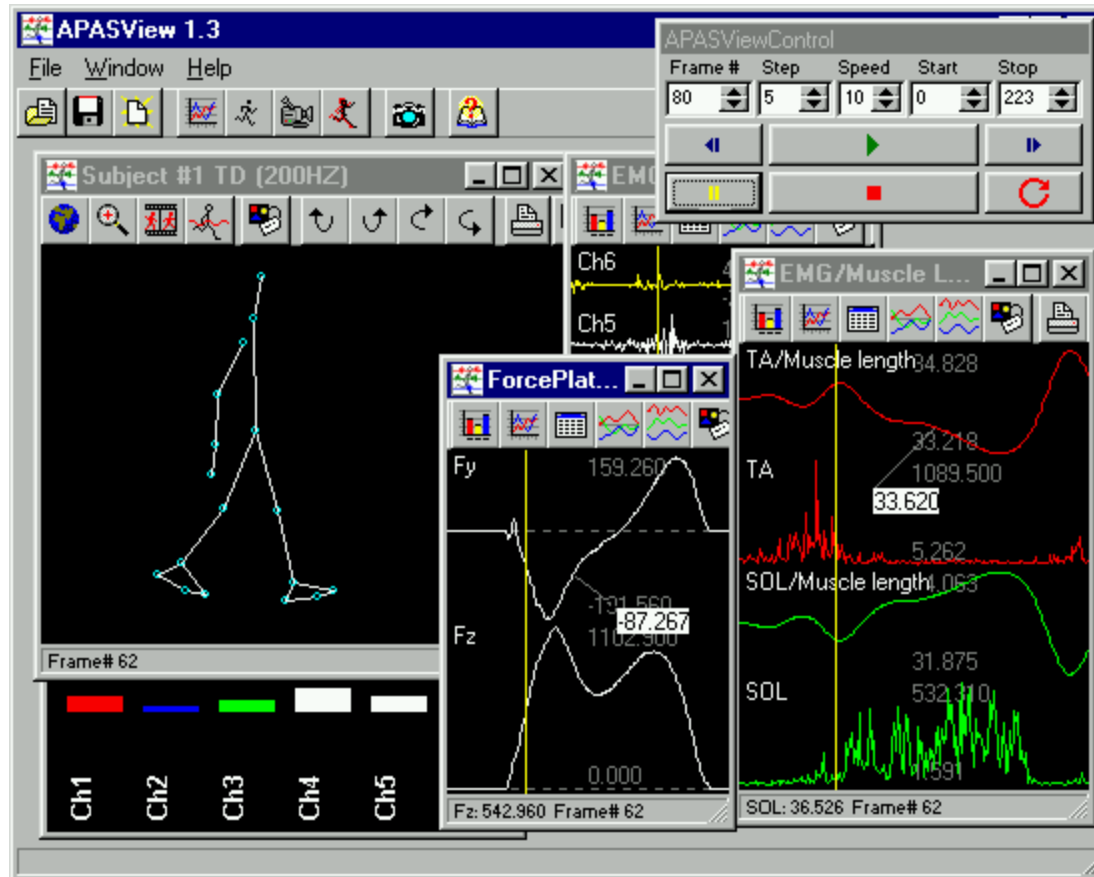




Software Integration



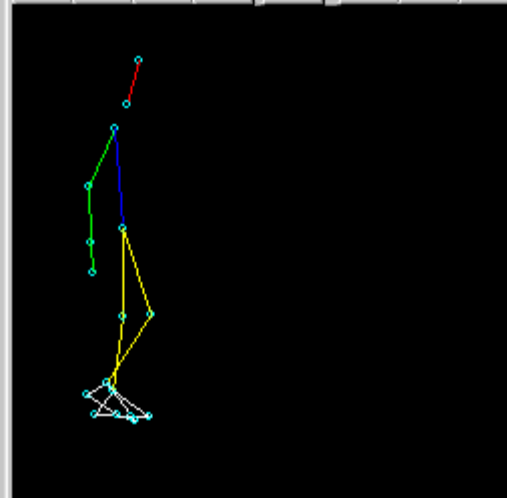
Display and Analysis




Display w.exe

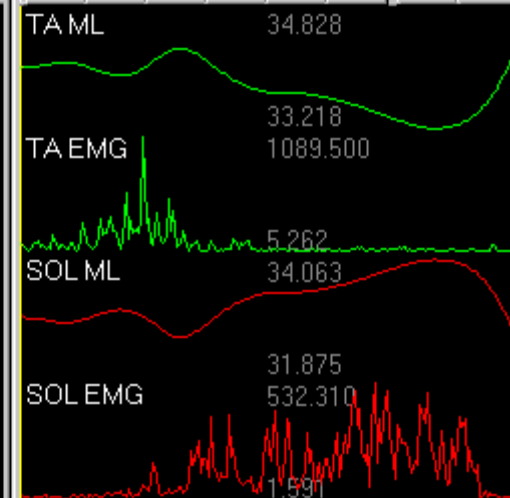


7: Mv2p0.txt



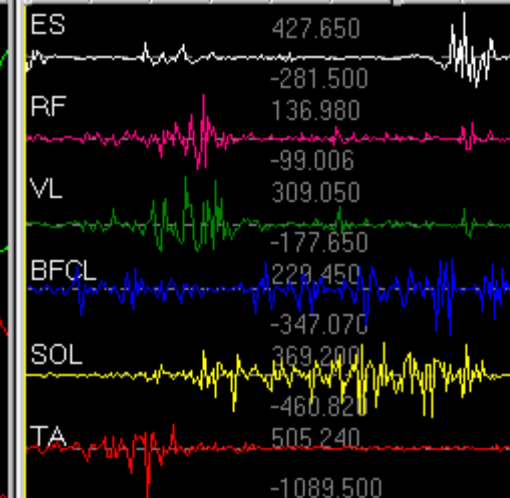
Frame# 0

Muscle Length



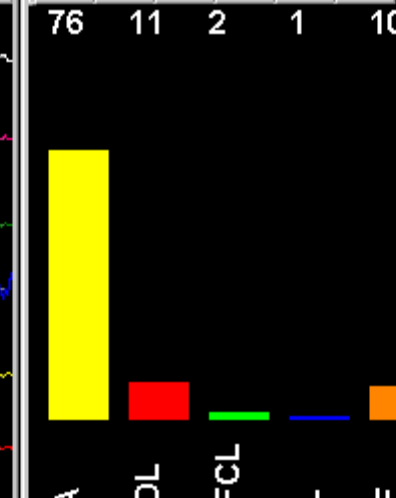
SOL EMG: 9.428 Frame# 0

Raw EMG

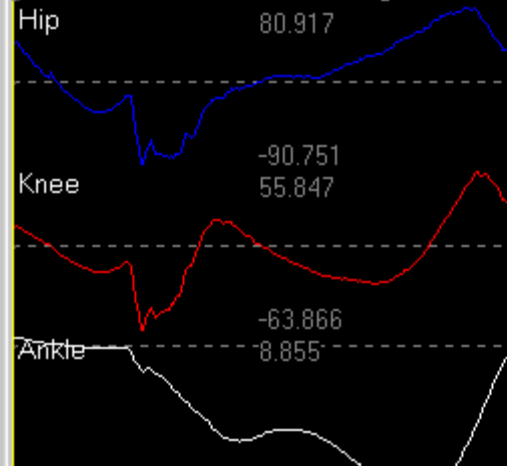
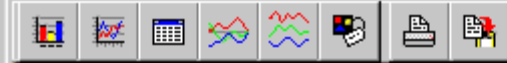


TA: 43.370 Frame# 0

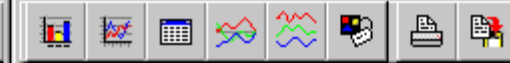
APASViewControl



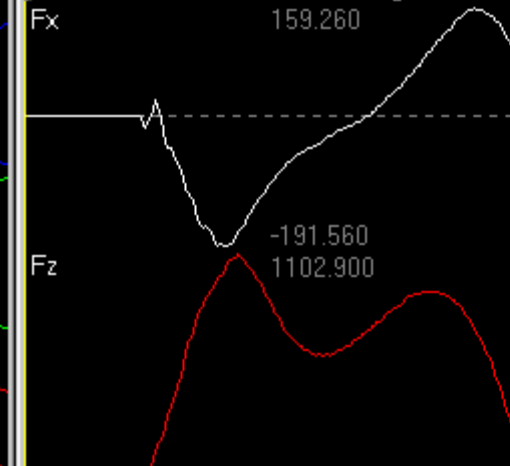
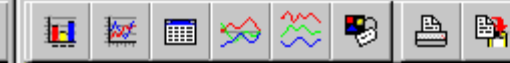
6: Moments.3



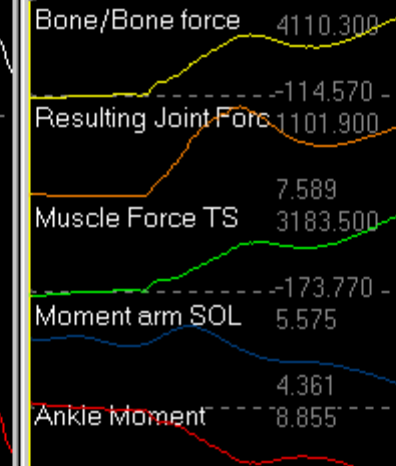
Muscle Length



Forceplate



Bone On Bone Forces





Biomechanical Analysis of Discus Throwing at Olympic Games



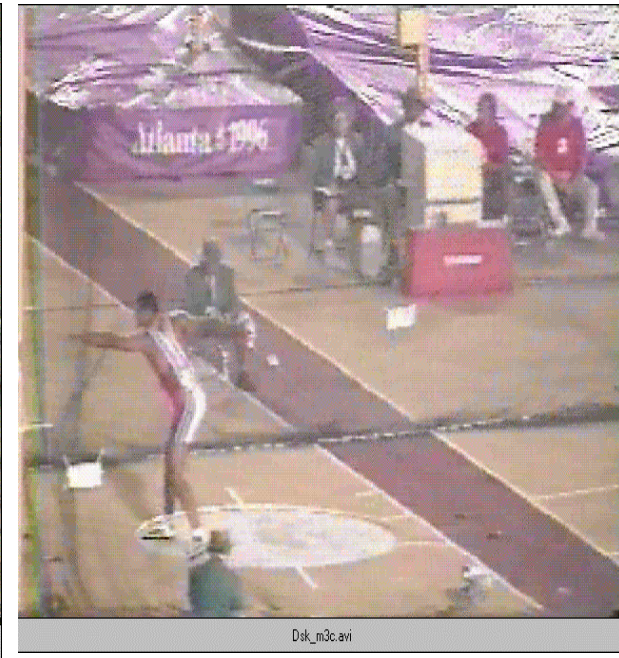
Methods

The track & field project involved collecting video records of the preliminaries and final performances of various events for the immediate development of digital movies to be uploaded on the internet.

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

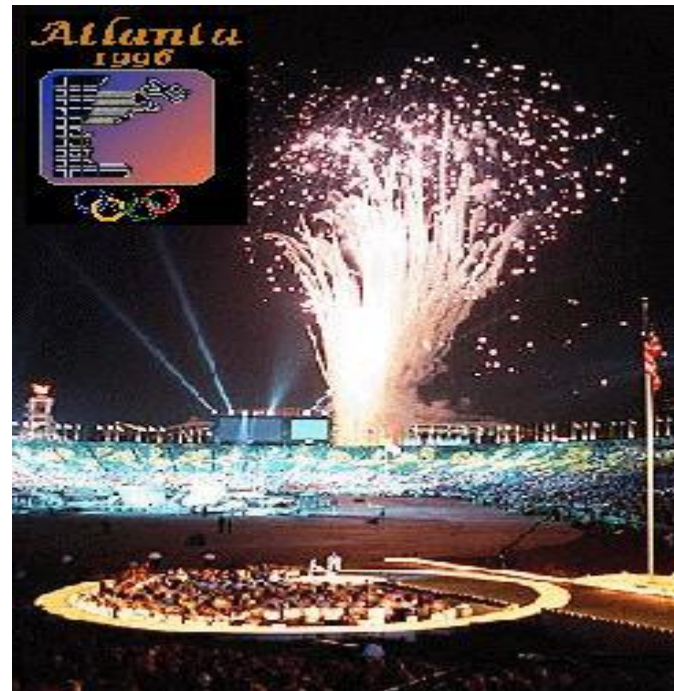


Video Cameras Were Placed in Several Locations to Maximize the Data Obtained for the Event

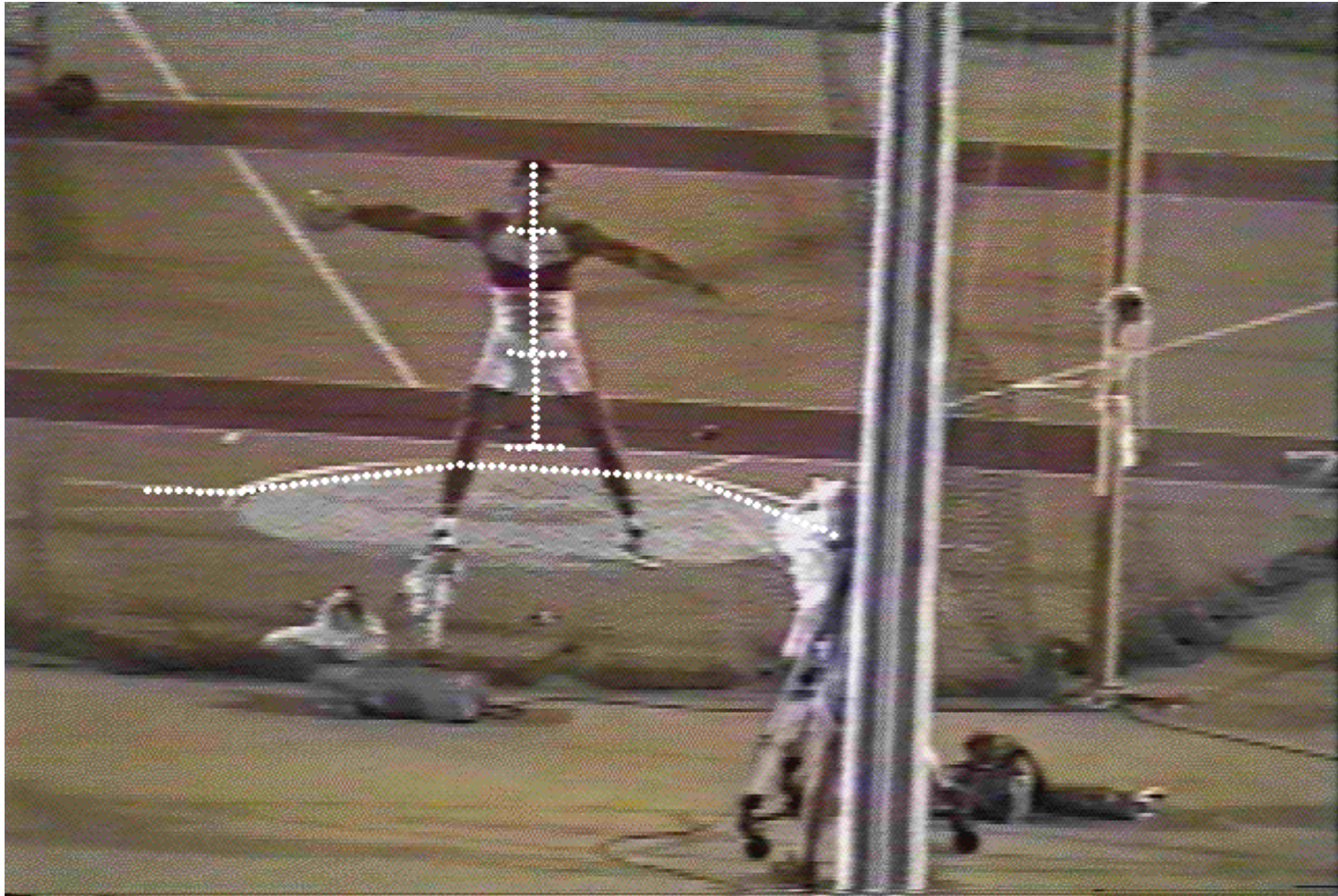


**Because the Discus Throw Involves
Both Linear and Rotary Motion, the
Optimal Data Collection Situation
Utilizes at Least Three Cameras Placed
Appropriately So That None of the
Athlete's Motion Is Obscured**

Dimensions of Known Factors and Various Other Measured Objects in the Field of View Were Used for the Calibration Points



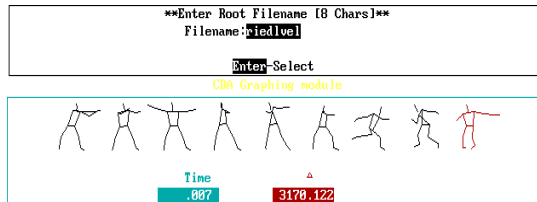
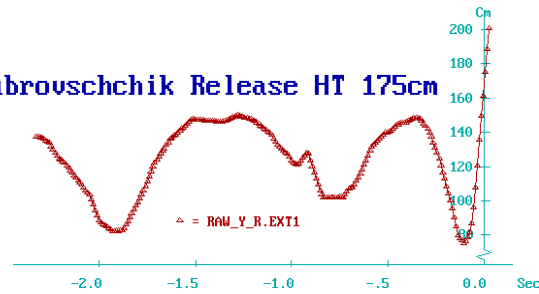
3-D DLT Composite Control Cube



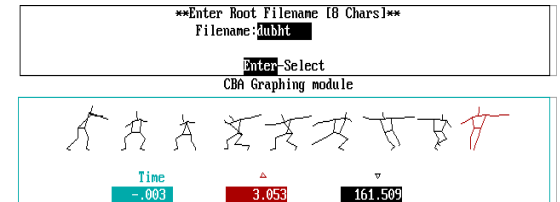
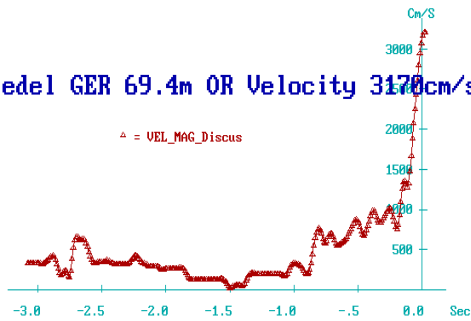
Results



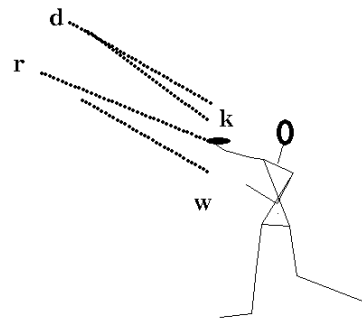
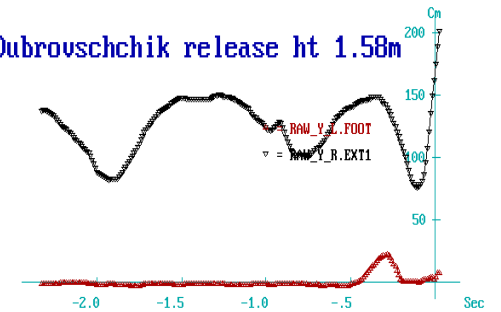
Dubrovichik Release HT 175cm



Riedel GER 69.4m OR Velocity 3170 cm/sec



Dubrovichik release ht 1.58m



DISCUS THROW KINEMATICS



The Order of Finish Was:

Riedel Representing Germany (GER) Winning the Gold,

Dubrovshchik From Belarus (BLR) Finishing Second,

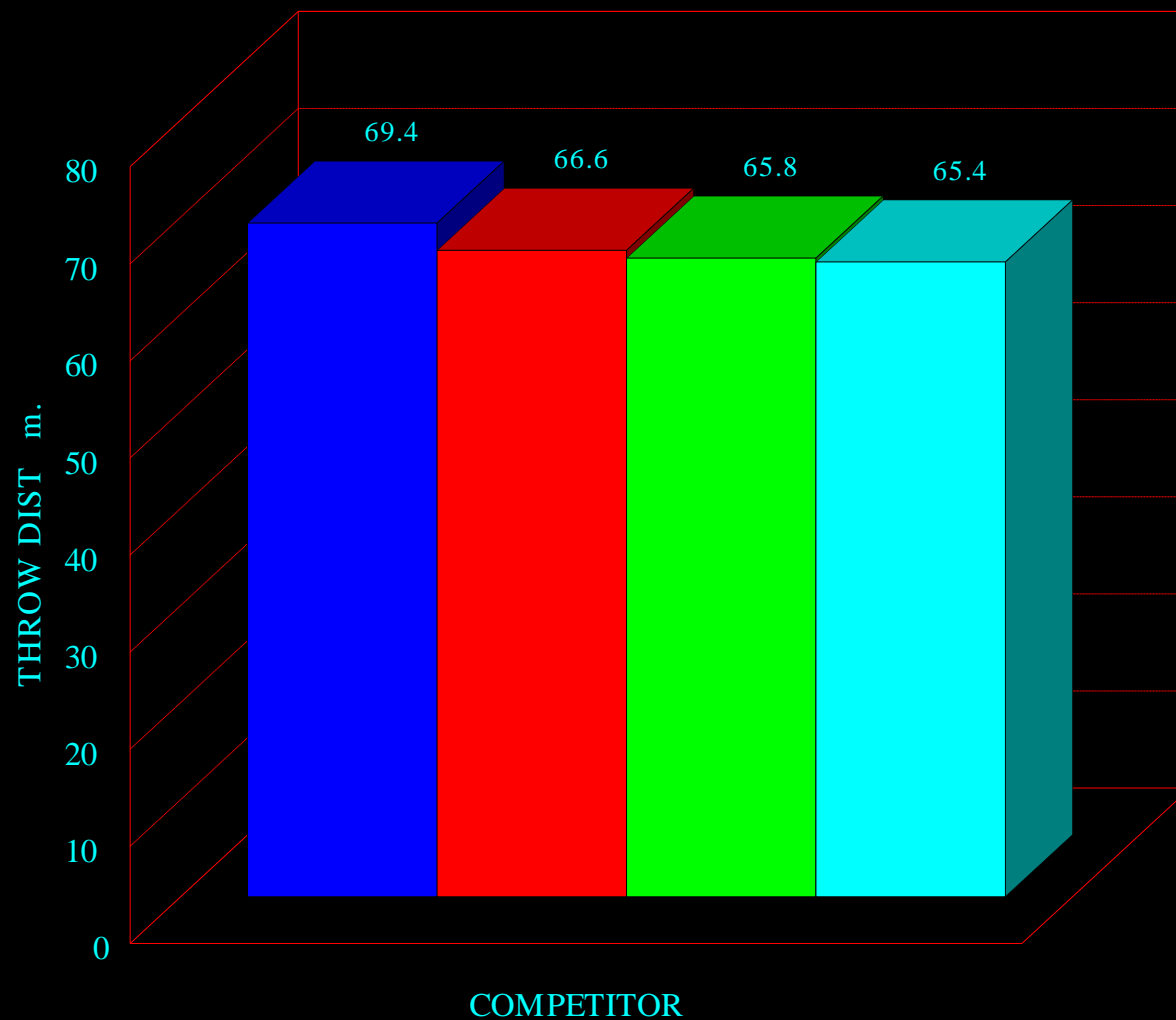
the Bronze Medal Was Won by Kaptyukh From Bulgaria,

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

Washington Throwing Kinematics

Attempt	Distance m.	Velocity $\text{cm} \cdot \text{sec}^{-1}$	Projection Angle rad (deg)	Release HT cm	Move Time sec
Best Throw	65.4	2541 V_r 2134 V_x	.52 (29.9)	120	1.2
Worst Throw	61.3	2441 V_r 1222 V_x	1.05 (59.9)	140	1.4
% Change	-6.3%	-4.0% V_r -43.0% V_x	+100%	+17%	+12%

DISCUS THROW DISTANCE m.



Riedel
Dubrov
Kap
Wash

Enter Root Filename [8 Chars]

Filename:riedlvel

Enter-Select

CBA Graphing module



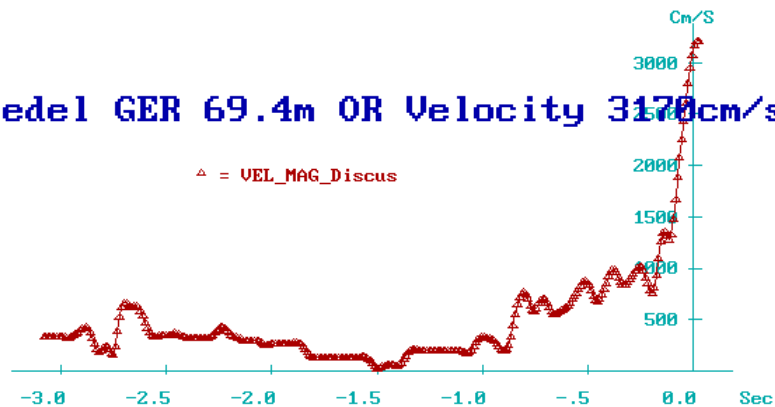
Time

.007

△
3170.122

Riedel GER 69.4m OR Velocity 3170cm/sec

△ = VEL_MAG_Discus

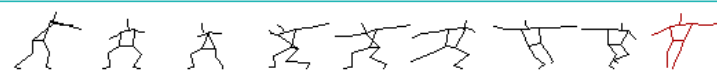


Enter Root Filename [8 Chars]

Filename:dub2vel

Enter-Select

CBA Graphing module



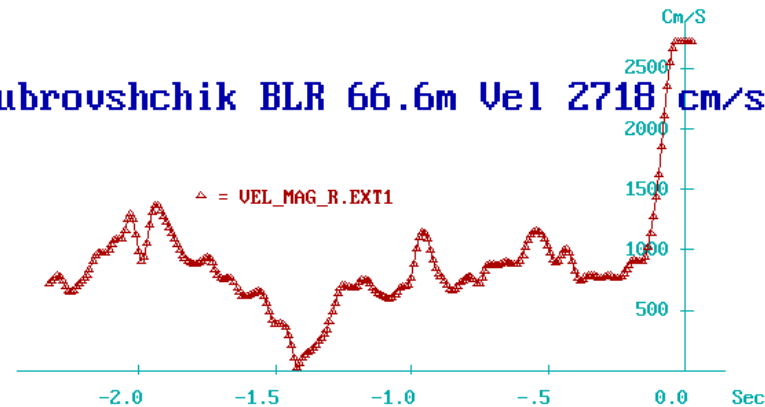
Time

-.003

△
2718.419

Dubrovshchik BLR 66.6m Vel 2718 cm/sec

△ = VEL_MAG_R.EXT1



Enter Root Filename [8 Chars]

Filename:kapvel

Enter-Select

CBA Graphing module



Time

.004

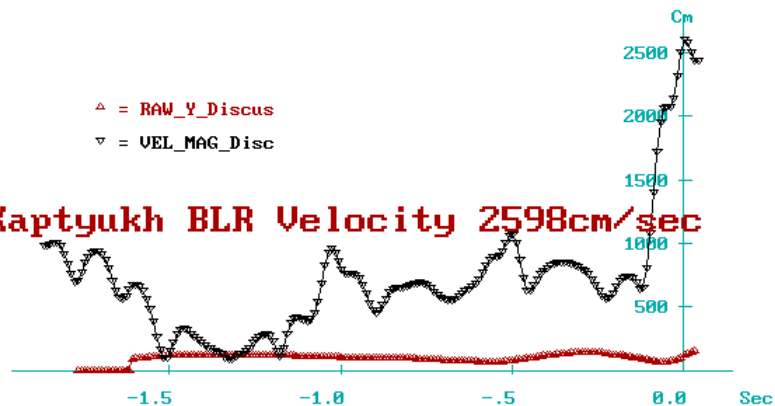
△
121.301

▽
2598.980

Kaptyukh BLR Velocity 2598cm/sec

△ = RAW_Y_Discus

▽ = VEL_MAG_Disc



Enter Root Filename [8 Chars]

Filename:washprj

Enter-Select

CBA Graphing module



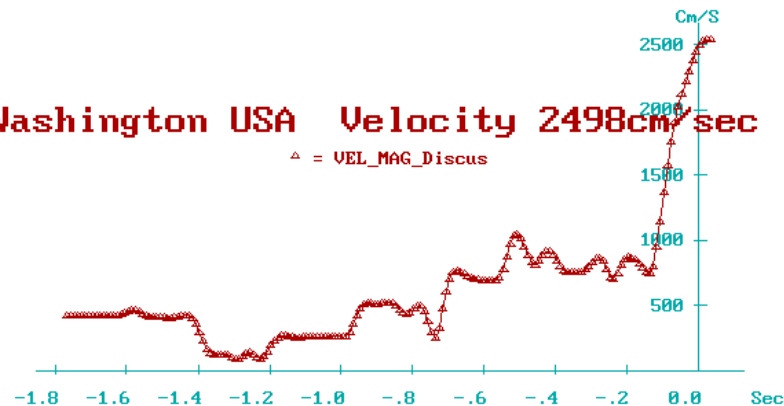
Time

.004

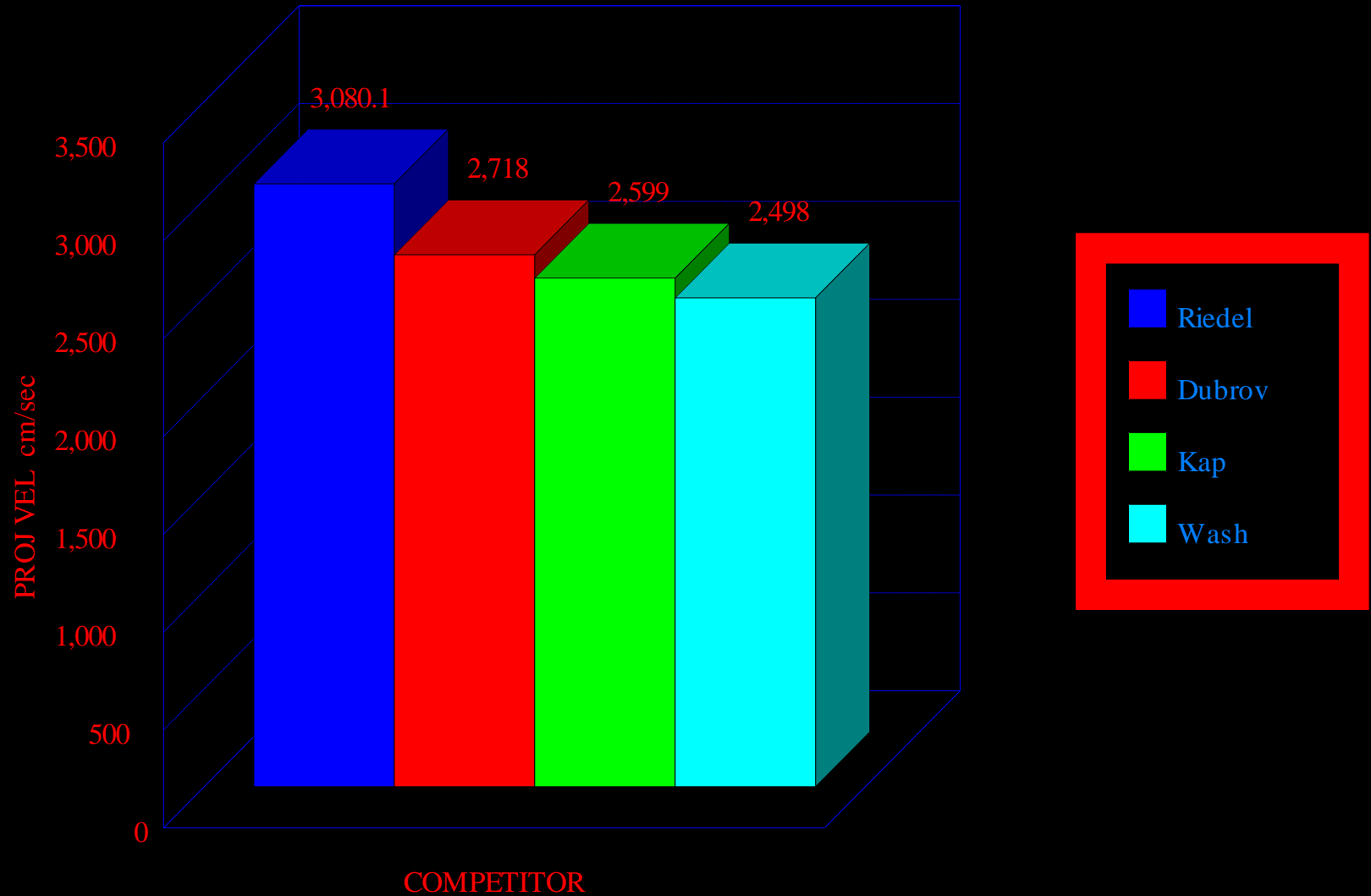
△
2498.010

Washington USA Velocity 2498cm/sec

△ = VEL_MAG_Discus



DISCUS PROJECTION VELOCITY cm/sec



****Enter Root Filename [8 Chars]****
Filename: **dubproj**a

Enter-Select
CBA Graphing module



Time

.007

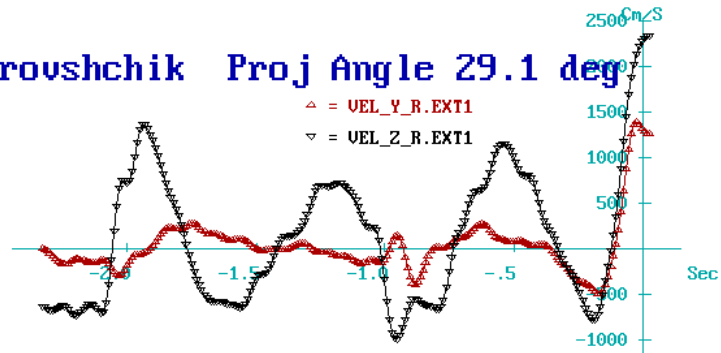
△ = 1289.508

▽ = 2312.862

Dubrovshchik Proj Angle 29.1 deg

△ = VEL_Y_R.EXT1

▽ = VEL_Z_R.EXT1



****Enter Root Filename [8 Chars]****
Filename: **riedlpj**a

Enter-Select
CBA Graphing module



Time

-.003

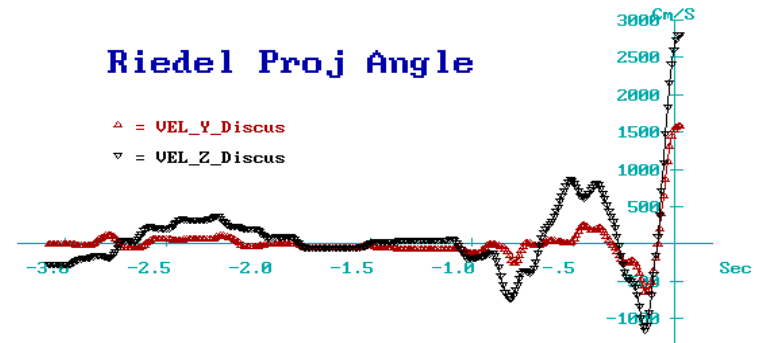
△ = 1529.492

▽ = 2601.733

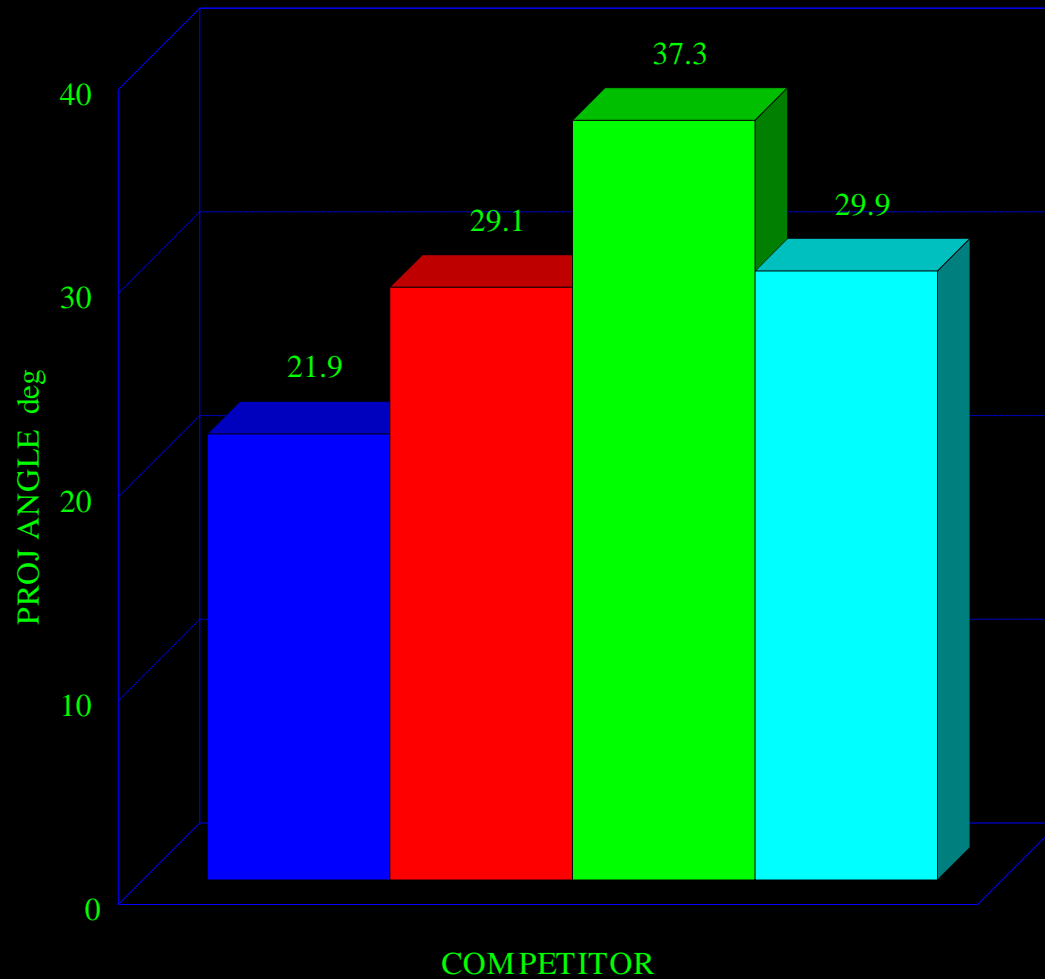
Riedel Proj Angle

△ = VEL_Y_Discus

▽ = VEL_Z_Discus



DISCUS RELEASE ANGLE deg



**The Heights of Release of the Discus Were
1.5 M, 1.75 M, 1.6 M, and 1.21 M for Riedel,
Dubrovschchik, Kaptyukh, and Washington,
Respectively.**

****Enter Root Filename [8 Chars]****

Filename: **dubprj**

Enter-Select

CBA Graphing module



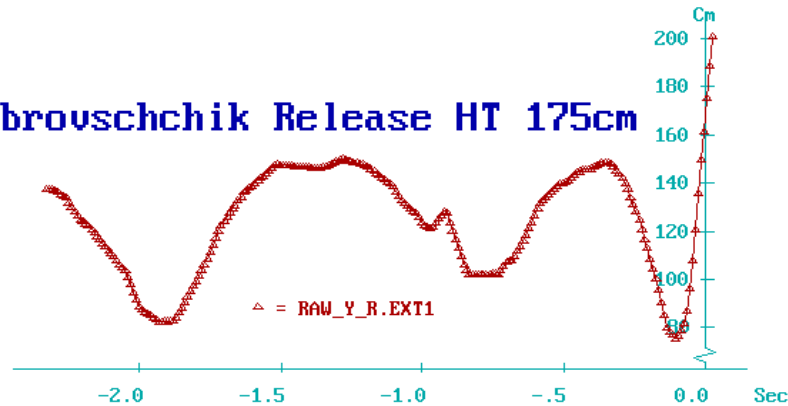
Time

.007

△

175.007

Dubrovshchik Release HT 175cm



****Enter Root Filename [8 Chars]****

Filename: **kapht**

Enter-Select

CBA Graphing module



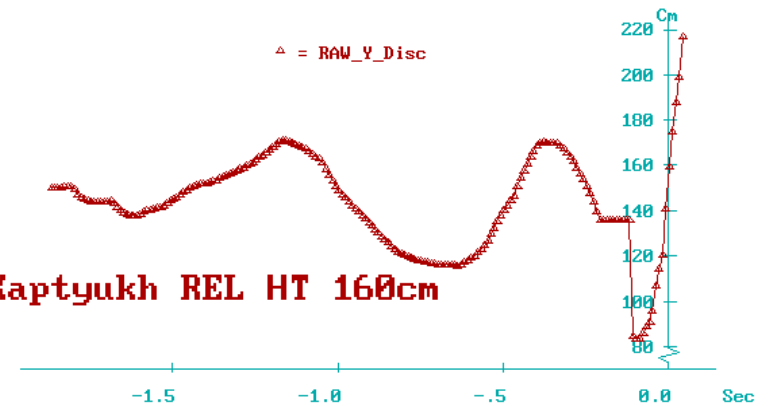
Time

.004

△

159.487

Kaptyukh REL HT 160cm



****Enter Root Filename [8 Chars]****

Filename: **riedelht**

Enter-Select

CBA Graphing module



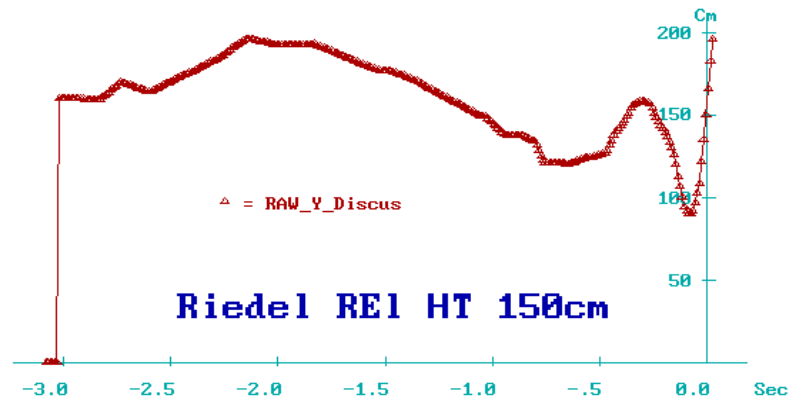
Time

-.003

△

150.044

Riedel REL HT 150cm



****Enter Root Filename [8 Chars]****

Filename: **washht**

Enter-Select

CBA Graphing module



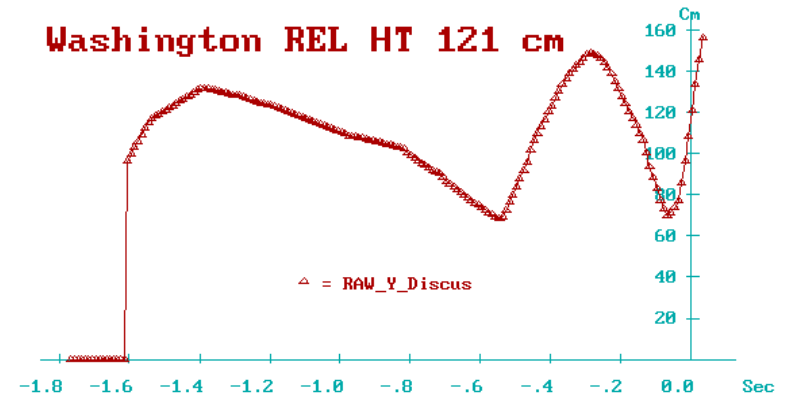
Time

.004

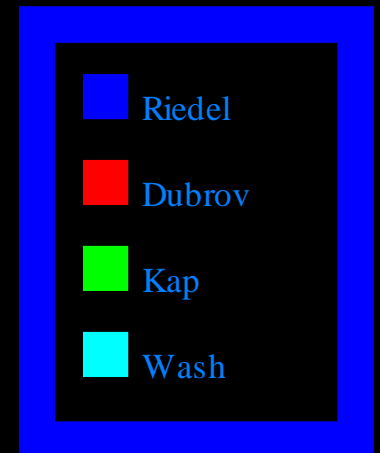
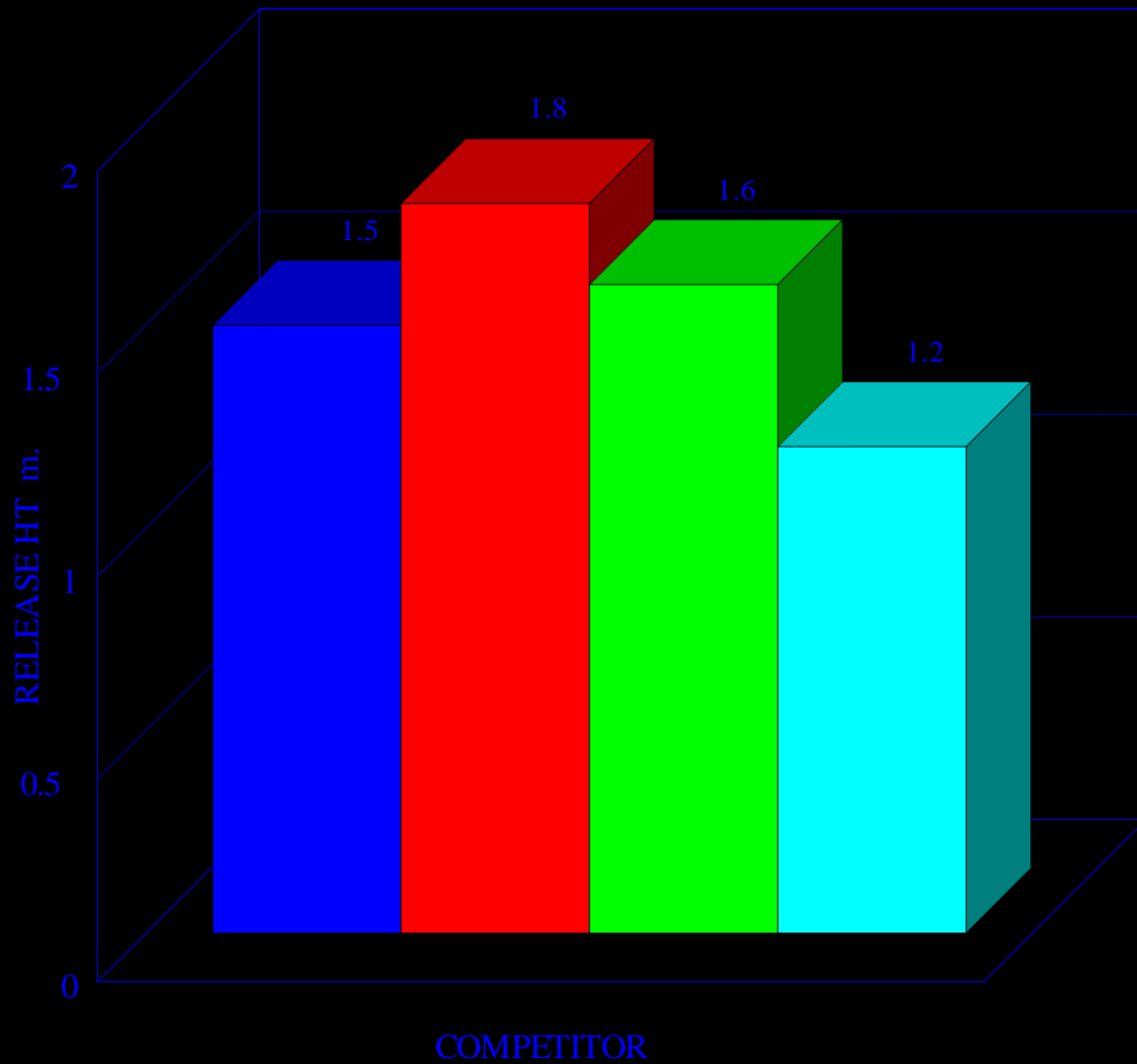
△

121.301

Washington REL HT 121 cm

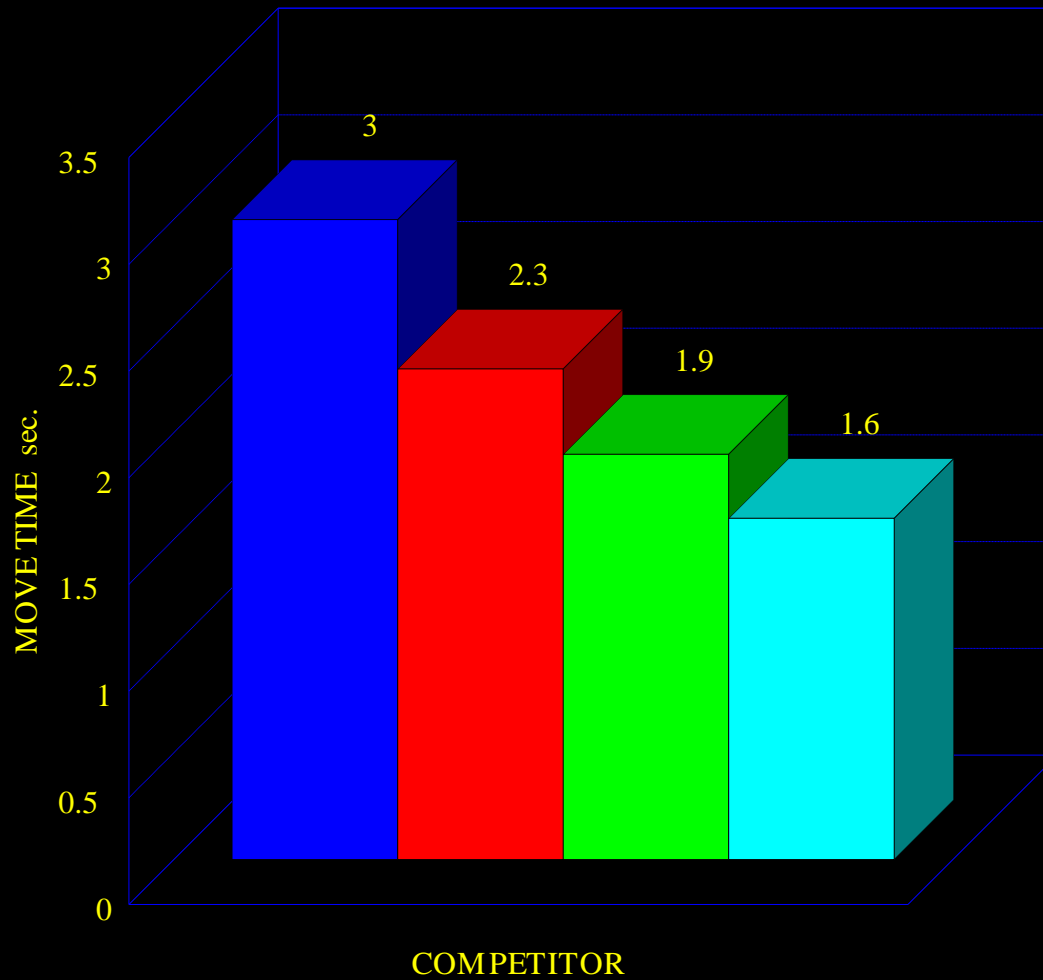


DISCUS RELEASE HEIGHT m.



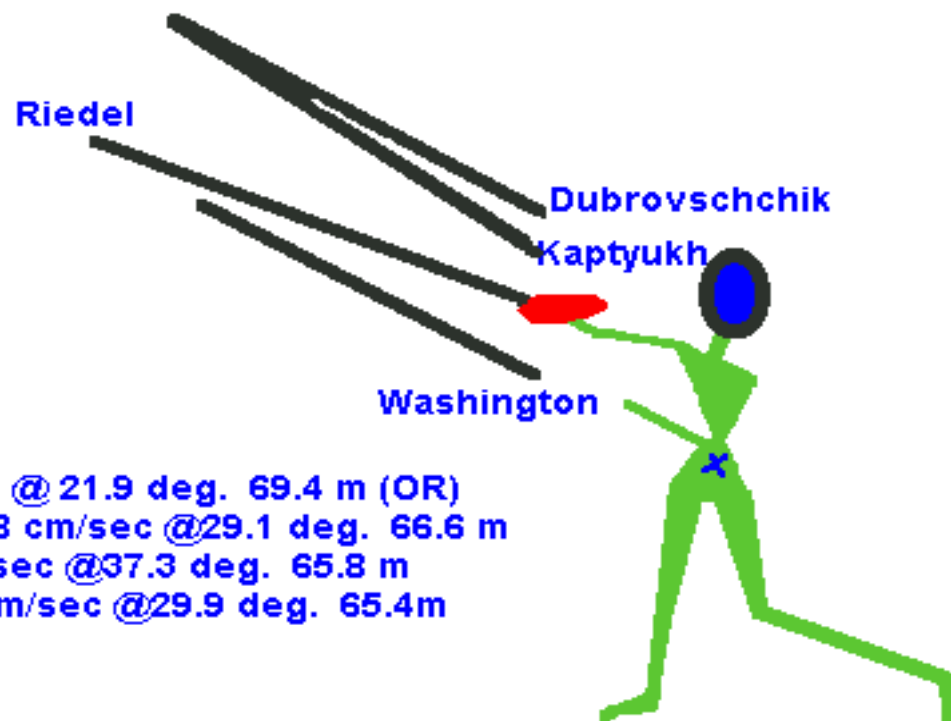
The elapsed times to complete the turns of the throw were 3.0 seconds for Riedel, 2.3 sec for Dubrovschchik, 1.9 sec for Kaptyukh, and 1.6 seconds for Washington.

DISCUS MOVEMENT TIME sec.

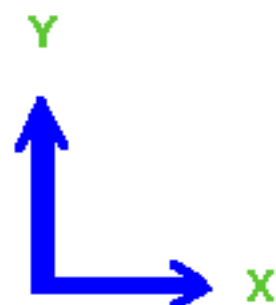


Throwing Kinematics for Top Four Discus Performers at 1996 Atlanta Olympics

Riedel (Ger)	69.4	3080.1	21.9	1.5	3.0
Dubrovshchik (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



Riedel 3080 cm/sec @ 21.9 deg. 69.4 m (OR)
Dubrovschchik 2718 cm/sec @ 29.1 deg. 66.6 m
Kaptyukh 2599 cm/sec @ 37.3 deg. 65.8 m
Washington 2498 cm/sec @ 29.9 deg. 65.4m



DISCUS THROW KINEMATICS

Poor Throw

Best Throw

Washington

DISCUS THROW KINEMATICS



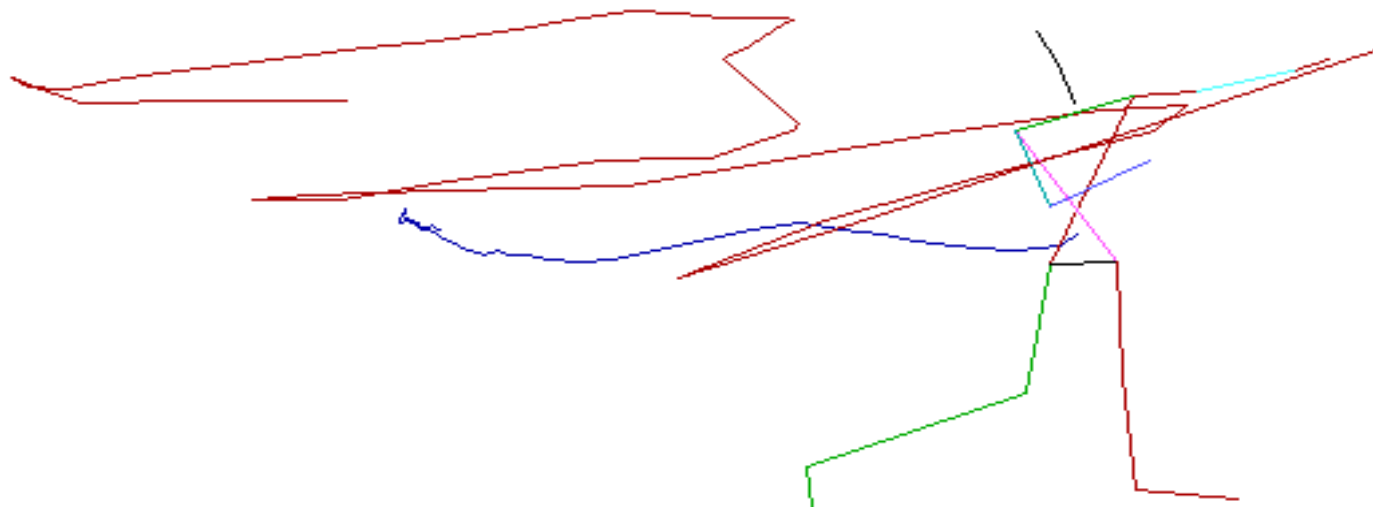
Throwing Pattern Analysis

****Enter Root Filename [8 Chars]****

Filename: **riedstk2**

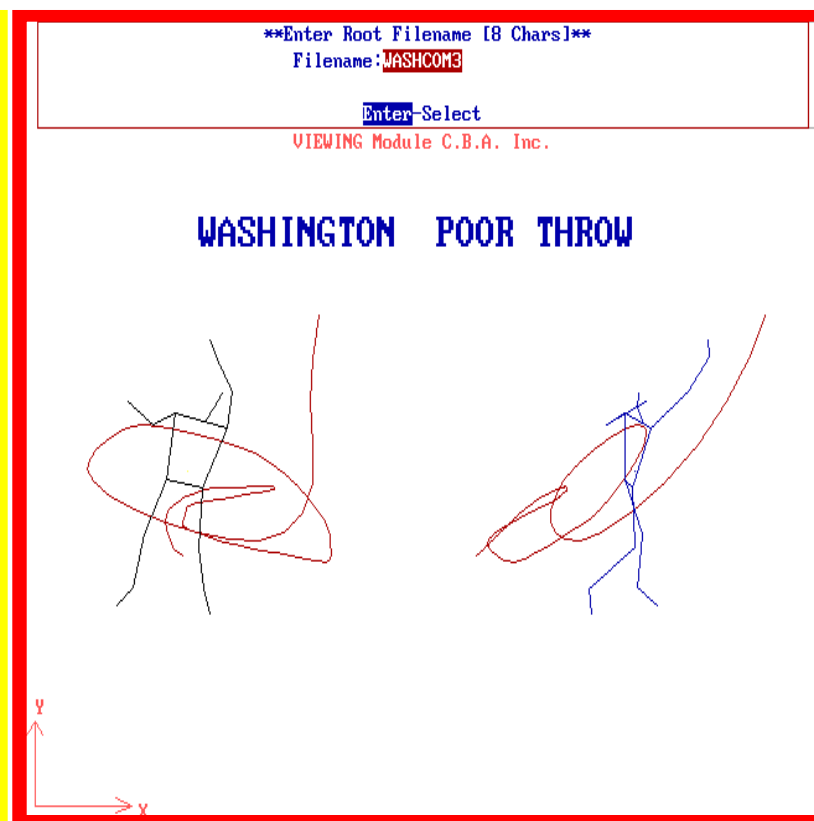
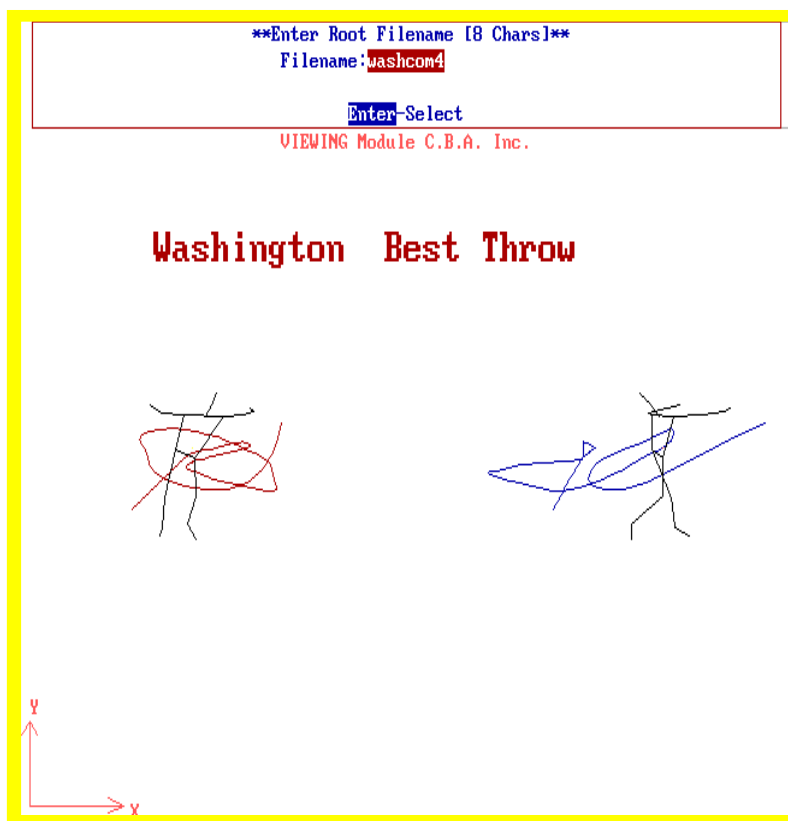
Enter-Select

VIEWING Module C.B.A. Inc.



Riedel GER 69.4 m 3080 cm/sec

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 Dubrovshchik (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

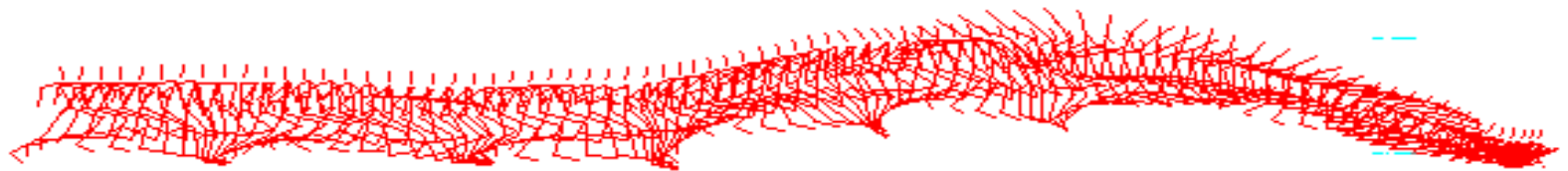




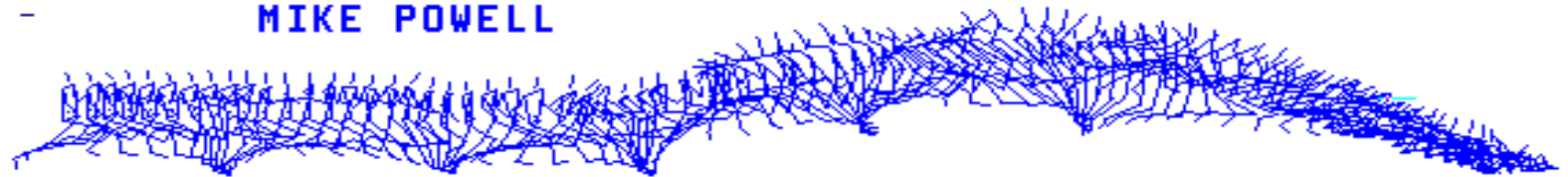
Attempt	Max Angular Horizontal Shoulder Velocity $\text{rad}\cdot\text{s}^{-1}$	Shoulder Ang Velocity at Release $\text{rad}\cdot\text{s}^{-1}$
Best Throw	26.1	13.7
Worst Throw	20.1	11.2
% Change	-23%	-18%

THE CASE OF THE LONG JUMP:

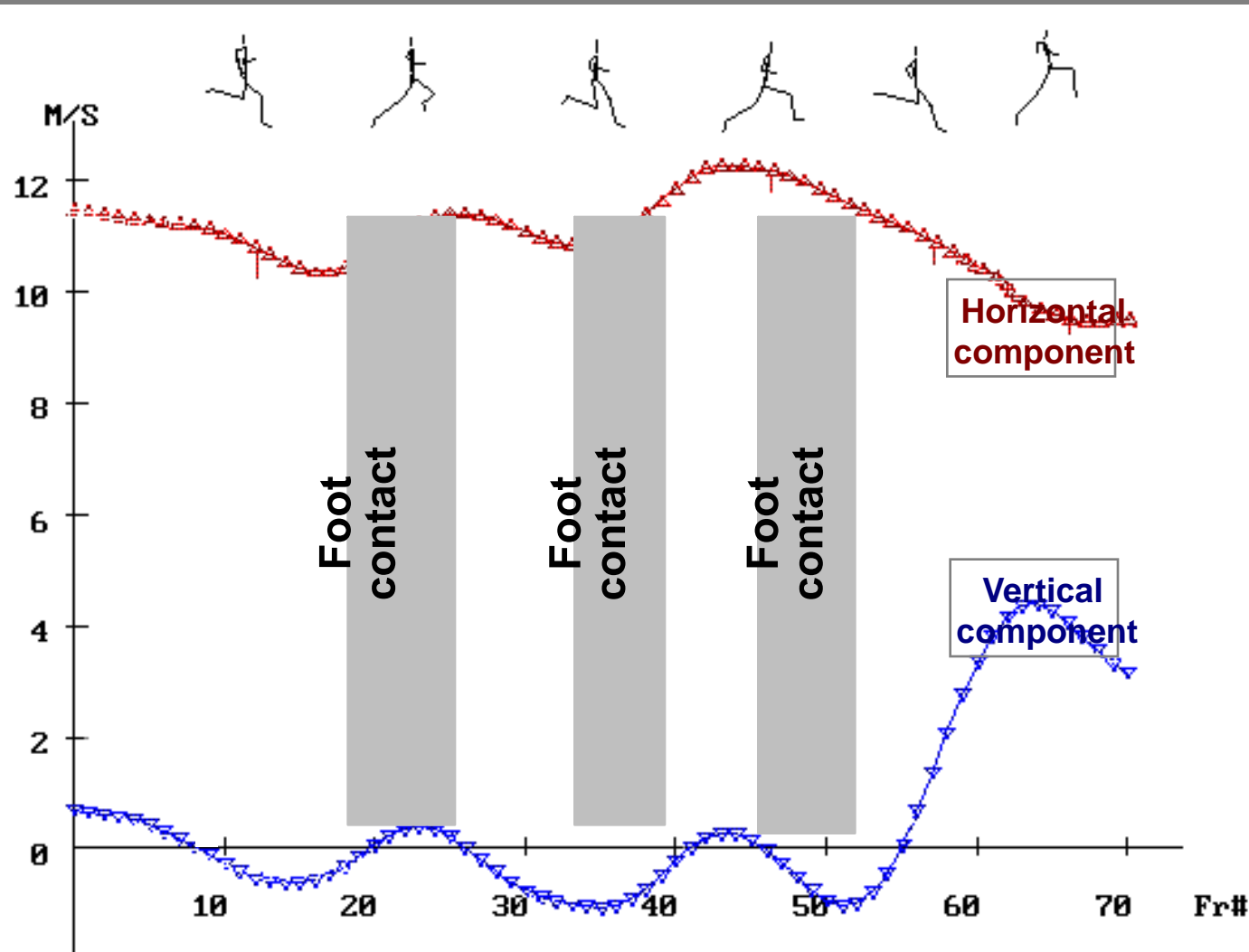
CARL LEWIS



MIKE POWELL

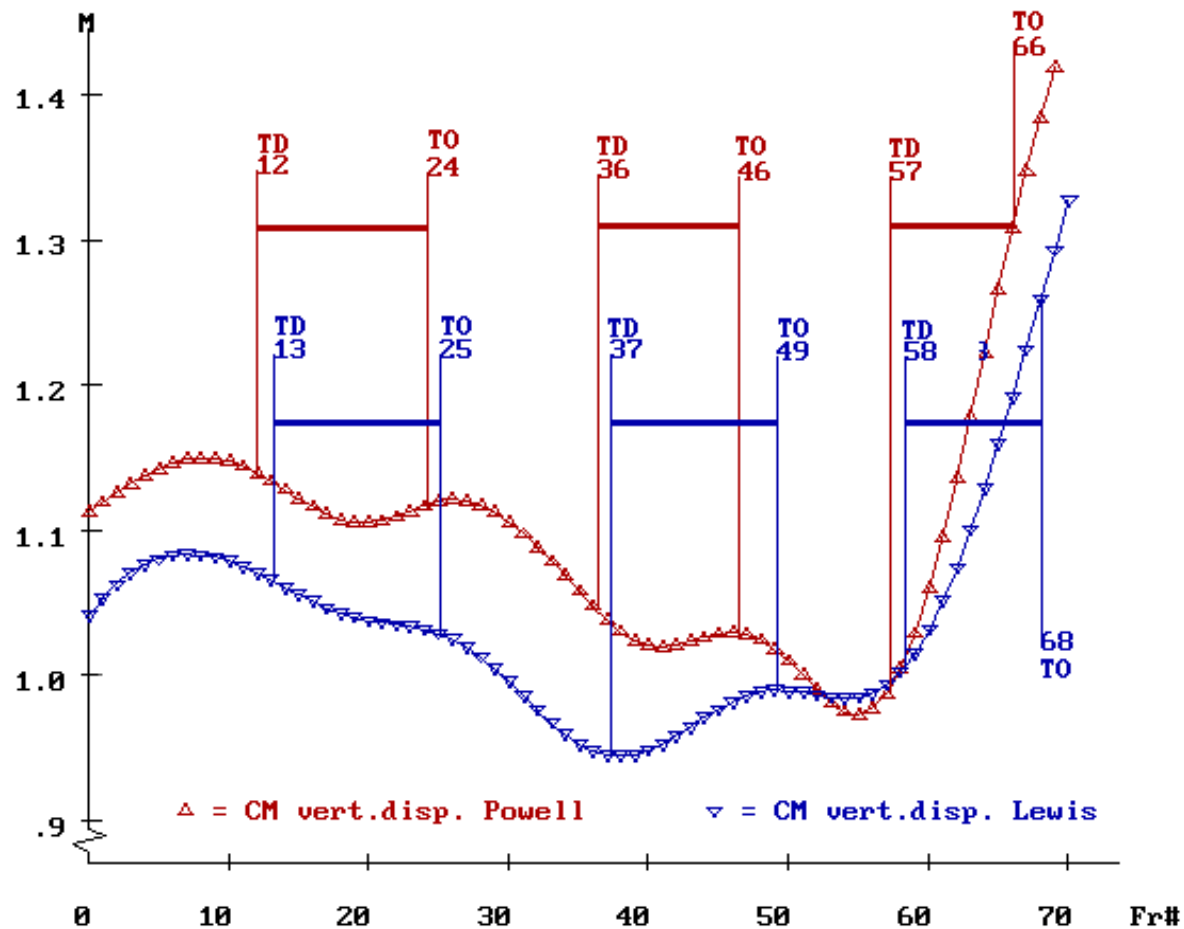


Velocity of the Center of Mass

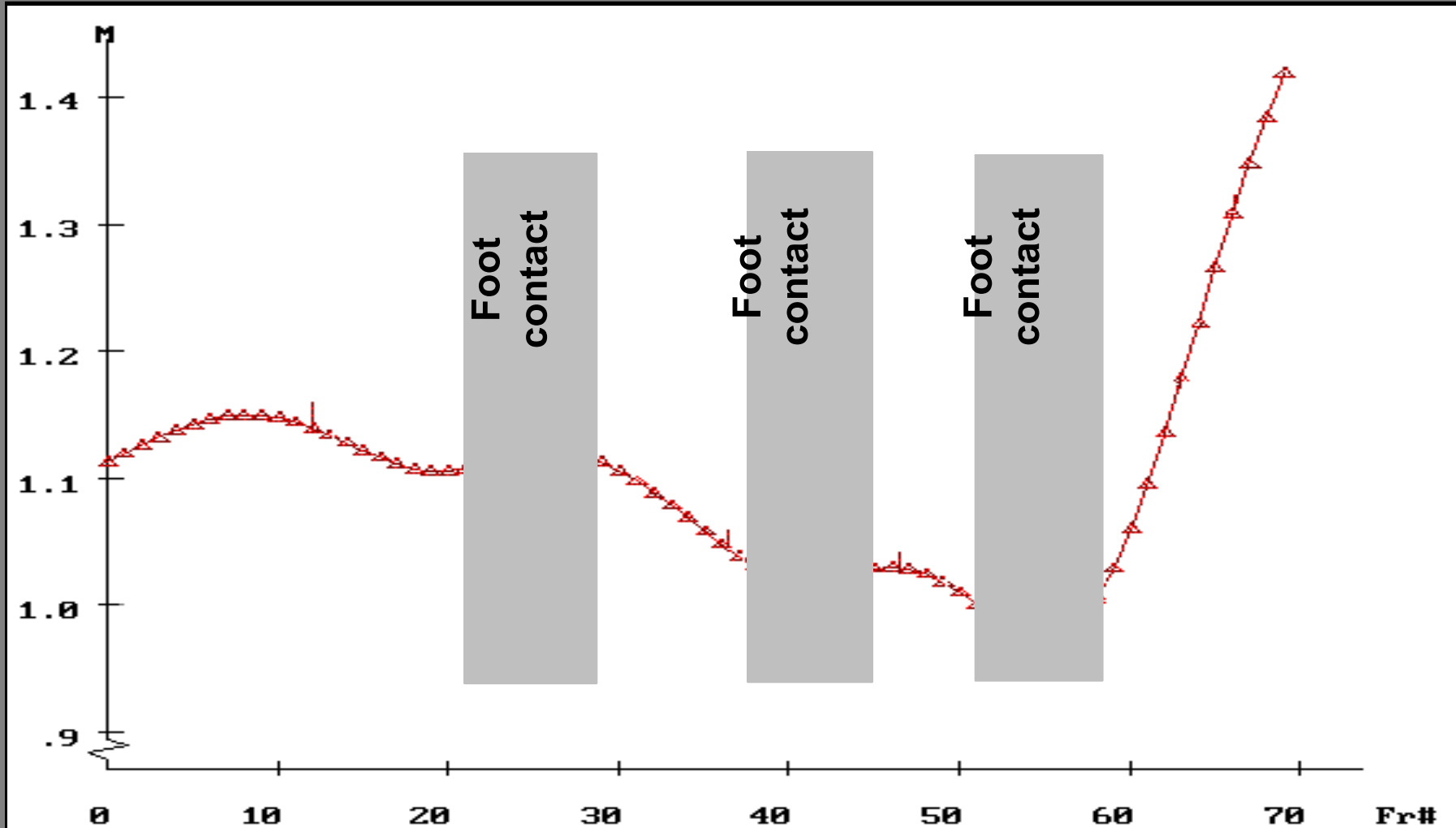


Mike Powell 8.95m - World Record

Change of the Height of CM



Height of the Center of Mass



Mike Powell 8.95m - World Record

Comparative Kinematic Characteristics

Parameters of the Long Jump	M.Powell	C.Lewis
General Information		
Official Distance [m]	8.95	8.91
Effective Distance [m]	8.98	8.91
Favorable Wind Velocity [m/s]	0.3	2.9
The Approach		
Average Speed: 11-6m to the Board [m/s]	10.79	11.23
Average Speed: 6-1m to the Board [m/s]	10.94	11.26
The Length of the Third-Last Stride [m]	2.4	2.23
The Length of the Second-Last Stride [m]	2.47	2.7
The Length of the Last Stride [m]	2.28	1.88
The Take-Off		
CM Horizontal Velocity [m/s]	9.27	9.11
CM Vertical Velocity [m/s]	4.21	3.37
Angle of Projection [deg]	24.1	20.3
Angle of body Lean at Touch-Down [deg]	71.8	77
Angle of body Lean at Take-Off [deg]	73.9	67.5

The Future – The Virtual Coach

- Virtual Biomechanic Desk

- Locate and download your favorite Biomechanical Data from one convenient, easy-to-use interface.

- Software that allows users to share Biomechanical libraries with each other no matter where they are located. Coach_virtual provides a search capability for videos, 3D/2D Files capability for users to communicate in forums of like interest.

- Each Coach is a download/upload source

- Each User Computer, when it is on, it becomes a shared directory

- For more information: <http://www.arielnet.com>



What are the requirement and steps in Purchasing a new Biomechanical System

- Set your objectives for Analysis
- System Tryout
- Perform a full project with the tryout system
- All hardware must be off the shelves
- Software must be downloadable
- Upgrades must be free
- Workstations must be added to the system
- Price must be realistic

THANK YOU

