BIOMECHANICAL DATA INTEGRATION
LATEST TECHNOLOGY

G. Ariel[1], A. Finch[2] & A. Penny[1]

[1] Ariel Dynamics, San Diego, California

[2]Biomechanics Laboratory, Indiana State University, Terre Haute, Indiana

PURPOSES

DEVELOPMENT OF SOFTWARE AND HARDWARE TO PROVIDE SIMULTANEOUS INTEGRATION OF:

- **Video Images,**
- **3-D Stick Figures,**
- **Kinematic & Kinetic Data in graphic/tabular format,**
- **Analog information from force plate & EMG data**

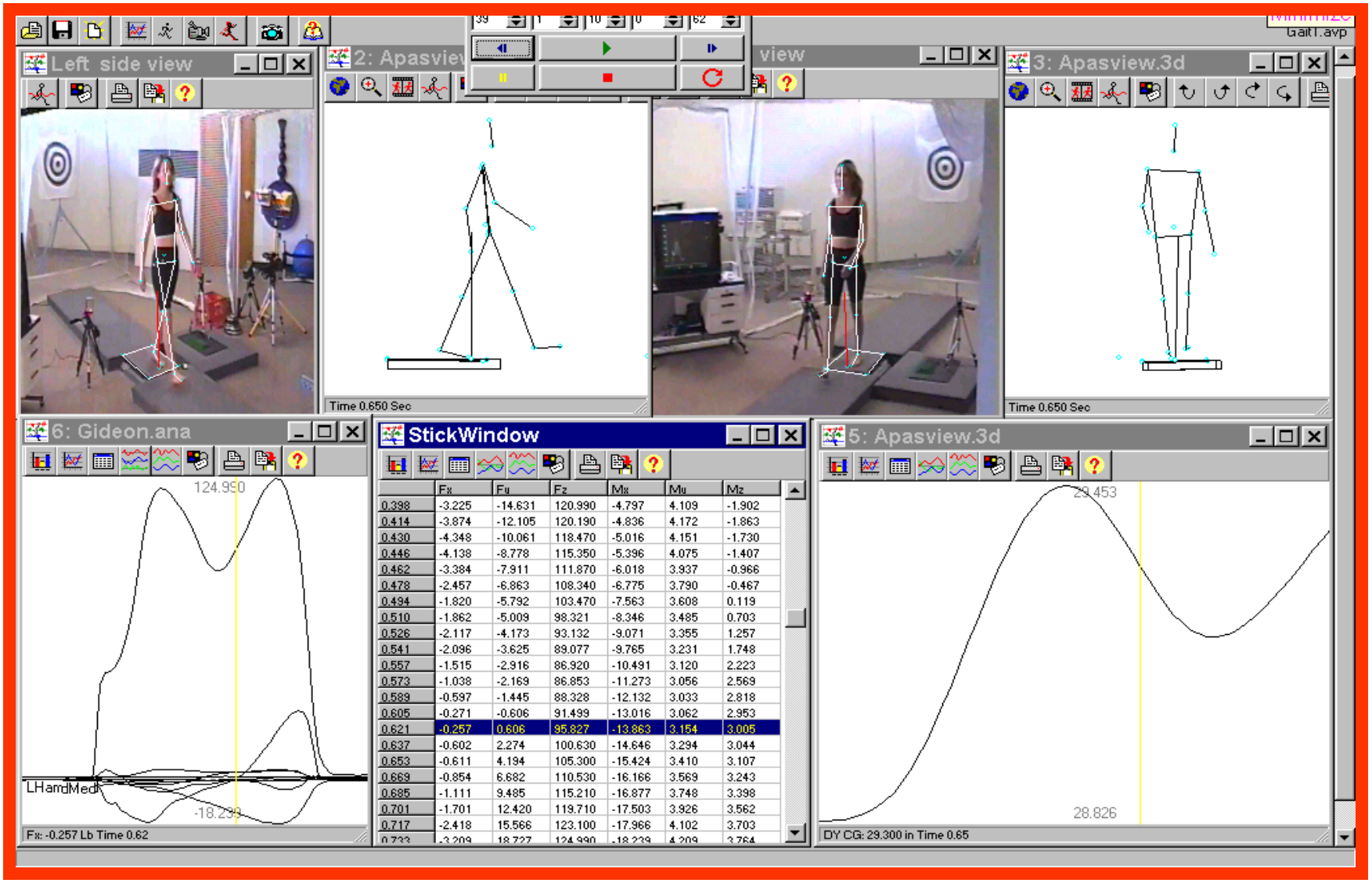
DEVELOP INTEGRATED DATA ANALYSES FOR:

- **CLINICAL APPLICATIONS,**
- **SPORT PERFORMANCE,**
- **INDUSTRIAL APPLICATIONS.**

CLINICAL APPLICATION PROJECT
Pathological Gait Analysis

- **Multiple video views of a patient walking on a force platform were collected.**
- **The video images were digitized, transformed using 3-D DLT, and then smoothed using a quintic spline.**
- **Simultaneous data integration was performed with video images, 3-D stick figures, ground reaction force (GRF) vectors superimposed on the video images, and kinematic/kinetic data presented in tabular and graphic formats (See Fig. 1).**
- **Kinematic and kinetic data were calculated for the gait phases of heel-strike, mid-foot, and toe-off during the patient's right and left walking strides (See Fig. 2).**
- **The visual and numerical integrated data presentation assisted the clinician in evaluating the perturbance of the gait mechanics due to leg length differences.**

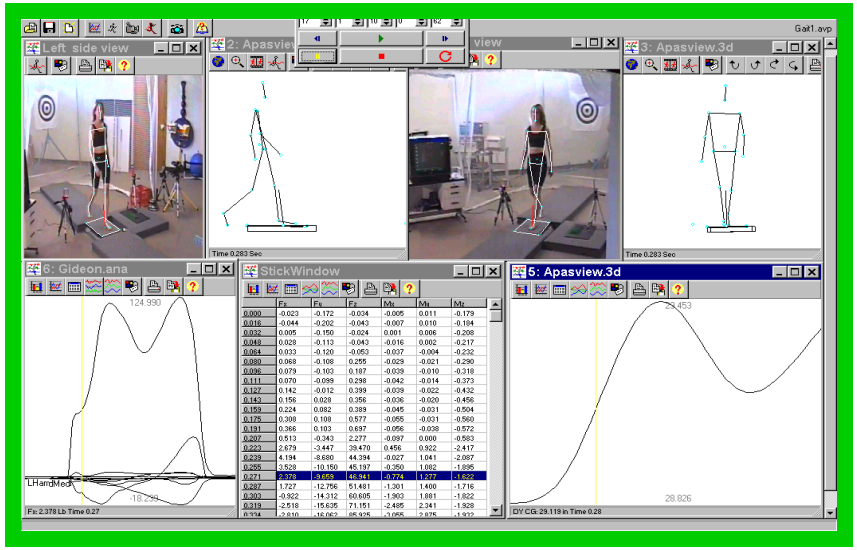
Fig 1. DATA INTEGRATED GAIT ANALYSIS

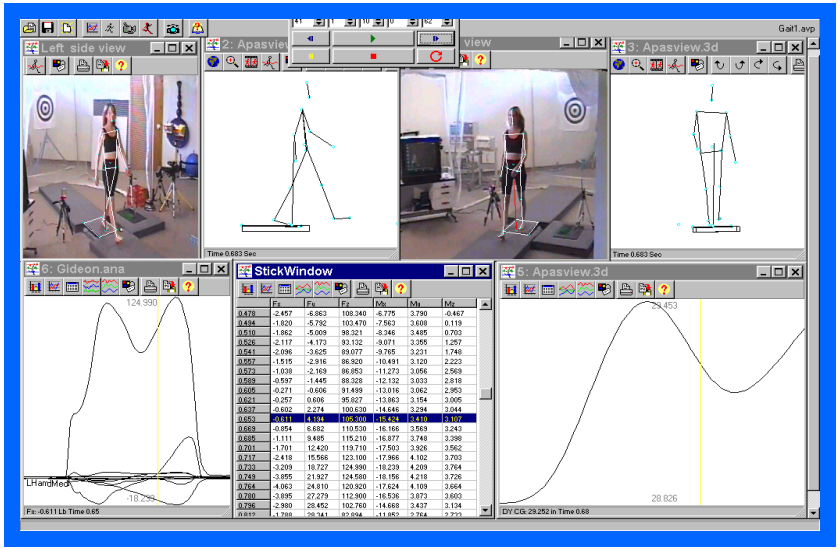


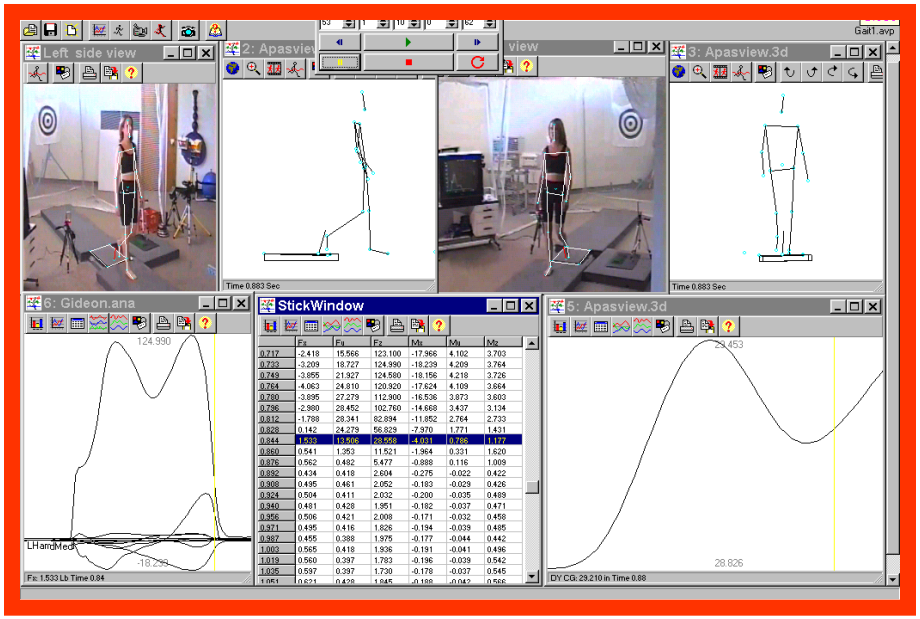
	Fx	Fy	Fz	Mx	My	Mz
0.398	-3.225	-14.631	120.990	-4.797	4.109	-1.902
0.414	-3.874	-12.105	120.190	-4.836	4.172	-1.863
0.430	-4.348	-10.061	118.470	-5.016	4.151	-1.730
0.446	-4.138	-8.778	115.350	-5.396	4.075	-1.407
0.462	-3.384	-7.911	111.870	-6.018	3.937	-0.966
0.478	-2.457	-6.863	108.340	-6.775	3.790	-0.467
0.494	-1.820	-5.792	103.470	-7.563	3.608	0.119
0.510	-1.862	-5.009	98.321	-8.346	3.485	0.703
0.526	-2.117	-4.173	93.132	-9.071	3.355	1.257
0.541	-2.096	-3.625	89.077	-9.765	3.231	1.748
0.557	-1.515	-2.916	86.920	-10.491	3.120	2.223
0.573	-1.038	-2.169	86.853	-11.273	3.056	2.569
0.589	-0.597	-1.445	88.328	-12.132	3.033	2.818
0.605	-0.271	-0.606	91.499	-13.016	3.062	2.953
0.621	-0.257	0.606	95.827	-13.863	3.154	3.005
0.637	-0.602	2.274	100.630	-14.646	3.294	3.044
0.653	-0.611	4.194	105.300	-15.424	3.410	3.107
0.669	-0.854	6.682	110.530	-16.166	3.569	3.243
0.685	-1.111	9.485	115.210	-16.877	3.748	3.398
0.701	-1.701	12.420	119.710	-17.503	3.926	3.562
0.717	-2.418	15.566	123.100	-17.966	4.102	3.703
0.733	-3.209	18.727	124.990	-18.239	4.209	3.764

Fig 2. CLINICAL GAIT PHASES

Heel-strike, Mid-foot, Toe-off







SPORT ANALYSIS - HIGH JUMP

- **Simultaneous video records from a front right and left side viewing perspectives were collected of a high jumping practice attempt (2.29m) of an elite collegiate high jumper.**
- **Data was digitized, transformed, and digitally smoothed at 10 Hz.**
- **The vertical displacements and vertical velocities of the body CM were calculated.**
- **Integration of data analysis of video and kinematic data was performed.**

Fig. 3 High Jump - CM Vertical Velocity

Fig. 4 High Jump Integrated Data

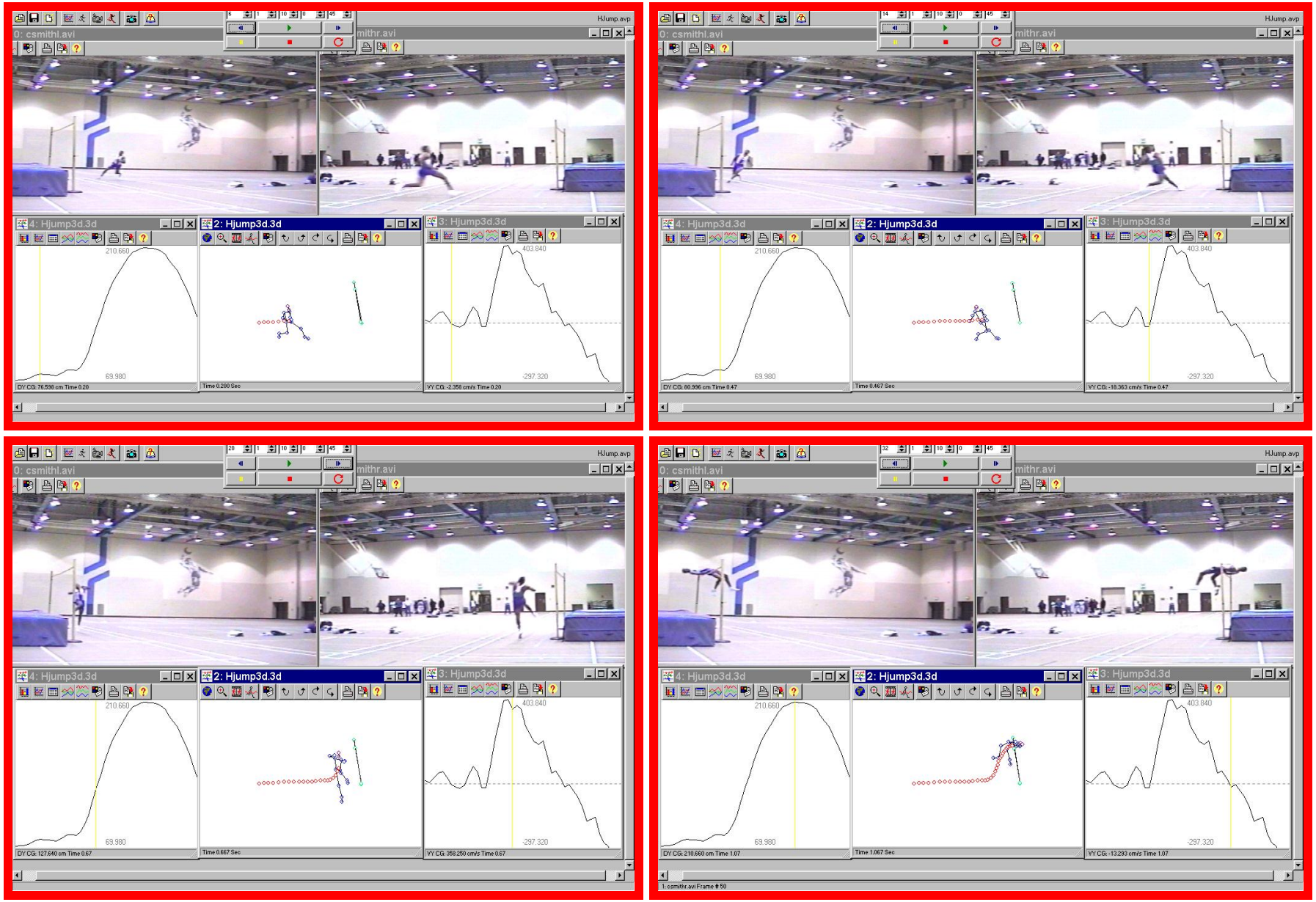
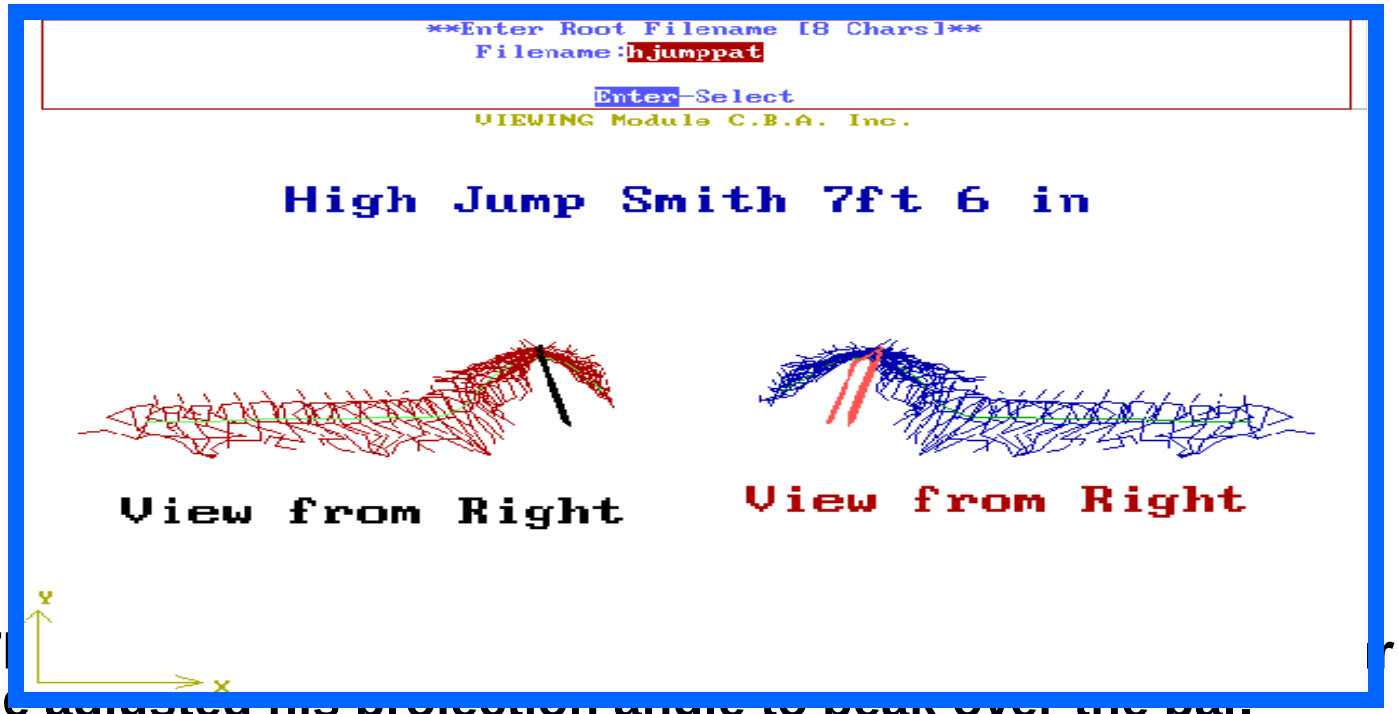


Fig. 5 High Jumper 3-D Stick Figures from 2 Views



- T r but h
- The high jumper's CM was at its apex during bar clearance. The CM passed 18 cm below the 2.28 m bar height (Fig. 5)
- The jumper utilized a hip pike- hip drop maneuver to facilitate leg clearance

INDUSTRIAL APPLICATION PROJECT

- **This application used synchronized 3-D video analysis, and force plate data to examine the effects of unweighting on gait kinematics/kinetics when walking 67 m • sec^{-1} while suspended by a Conva-Lift pneumatic prototype support system (See Fig. 6).**
- **The subjects' foot weights were reduced by 0%, 25%, 50%, and 75% BW by the suspension system.**
- **Vertical GRFs indicated proportional GRF reductions at heel-strike, mid-foot, and toe-off phases (See Fig 7).**
- **This findings indicated that the subjects used similar gait mechanics when walking tethered but they just walked "lighter".**

Fig. 6 EQUIPMENT EVALUATION
Active Traction Prototype

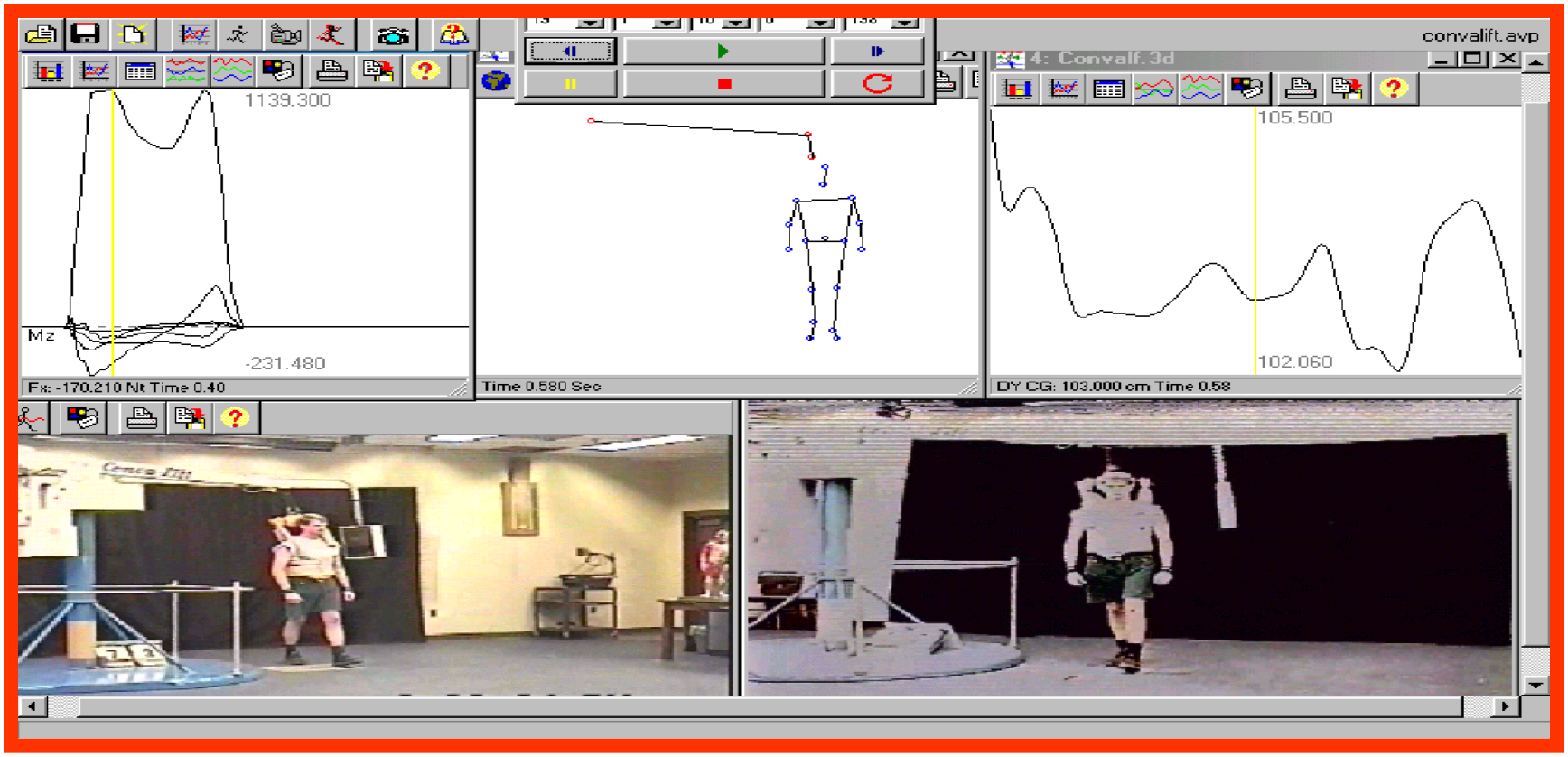
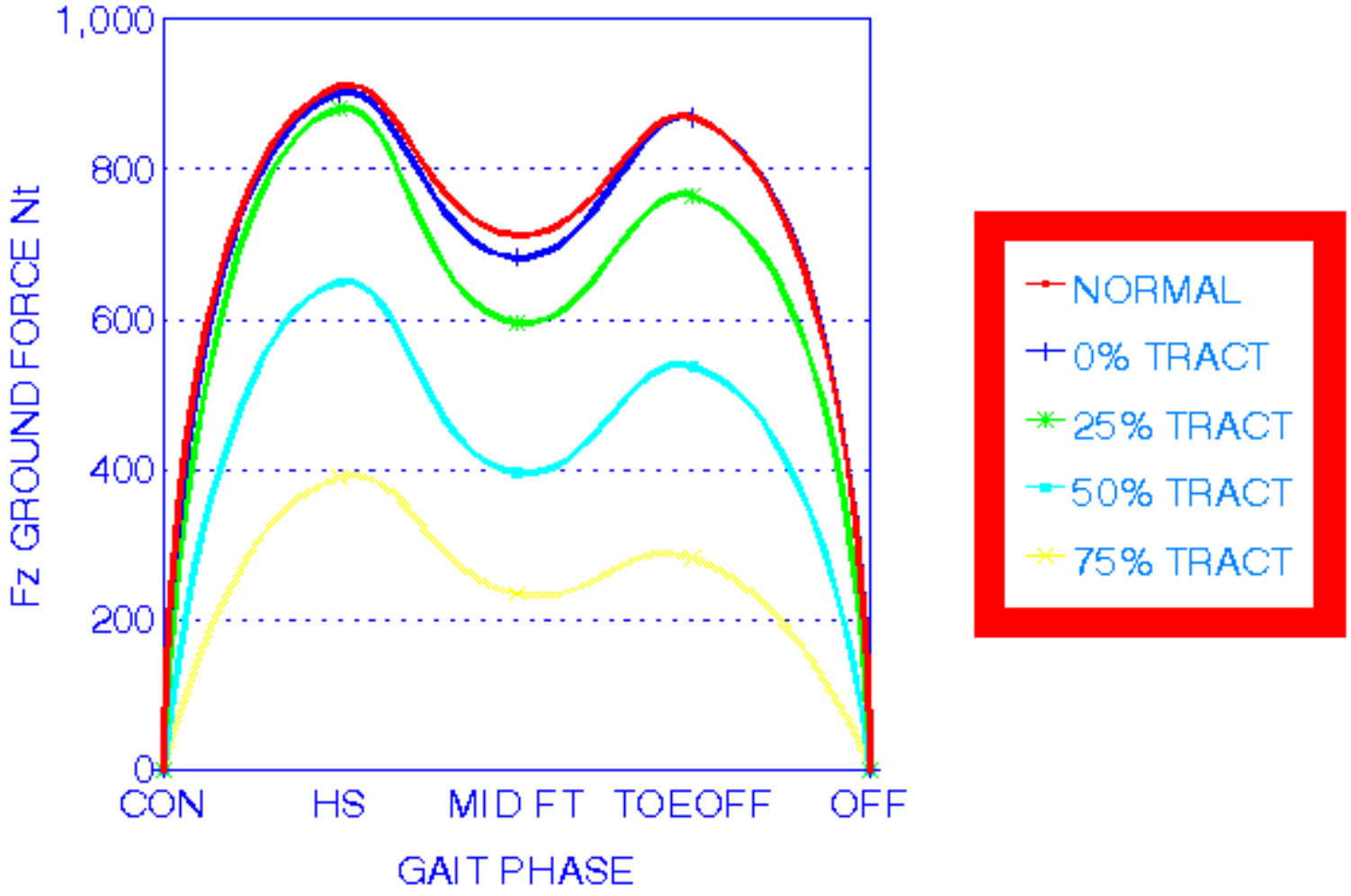


Fig 7. VERTICAL GROUND FORCES WHILE UNDER TRACTION



PROJECT CONCLUSION

Integration of kinematic data and video views on a synchronized time base using

the Ariel APAS view software is an effective method to visually and quantitatively to analyze clinical, sport, and industrial applications.