# BIOMECHANICAL DATA INTEGRATION AS A METHOD FOR COMPARATIVE STLIDIES

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Technological advances have made it possible to integrate, synchronise, and simultaneously display video records, kinematic, kinetic, EMG, and force plate data of human movement. The APASview software is an effective integrated multimedia presentation tool for quantitative and qualitative biomechanical analyses of clinical, sport performance, and industrial applications.

**KEY WORDS:** simultaneous data, multimedia, video, biomechanical analysis systems

**INTRODUCTION:** For many years comparison has been used as a powerful tool to increase the technical ability of the individual athletes. Using visual observation for comparison requires years of experience and is often a difficult task when the movement is fast and short duration. In recent years, video has been utilised in order to freeze the movement for better evaluation of the movement. Biomechanical analysis is another method that can assist the athlete's performance. Historically, biomechanical analysis was available to only a few athletes but, as prices have been reduced, more systems are now available to semi-professional and amateur athletes. In the last few years, the basic functions and operation of biomechanical systems have become simplified in addition to an increasing number of university students receiving formal education in biomechanical theory. Despite improved utilisation of many current technological advances, there is still the need to coordinate the coach's visual observations with the utilisation of the information from biomechanical analyses. Adding to the complexity of the task of performing an accurate visual observation, an analyst may be only able to observe one perspective of a three dimensional human movement at one time. The amount of information that can be extracted from biomechanical analysis is extensive, but requires a skilled analyst to decide which parameters provide the most important information for understanding the actual event performance. It is the intention of this paper to demonstrate how data integration using multimedia techniques can enhance the utilisation of the visual observation in order to combine the power of visual evaluation with the enormous potential of biomechanics. This technique of biomechanical analysis may be beneficially applied to clinical evaluations, sport performance, and industrial analysis.

**METHODS:** Current biomechanical analysis systems have reported RMS errors in accuracy ranging between 0.1% and 2.5% (Richards, 1998). Two common techniques for collecting kinematic and kinetic data were using video or optoelectric based biomechanical analysis systems. An advantage of the optoelectric systems (marking tracker) during the early development of these systems was that it provided more rapid data reduction than the video based systems. But the shortcomings of the tracking systems were that it was very expensive and did not provide a visual record of the subject's movement. Presently, with refinements of autodigitising technologies employed in video based systems, inaccuracies may be as small as .1%. Therefore, accurate biomechanical analysis can be performed at similar data reduction speeds and at lower costs while providing a visual image that can be reviewed by the analyst. Using a video based biomechanical analysis system, the digitised and sampled data output is used as input to a viewing tool that integrates the data.

**Viewing Tool:** The viewing tool, software using a common Windows-based operating system, provides a user interface with three different view options, namely, numerical data, marker trajectory, and video view (Figure 1).

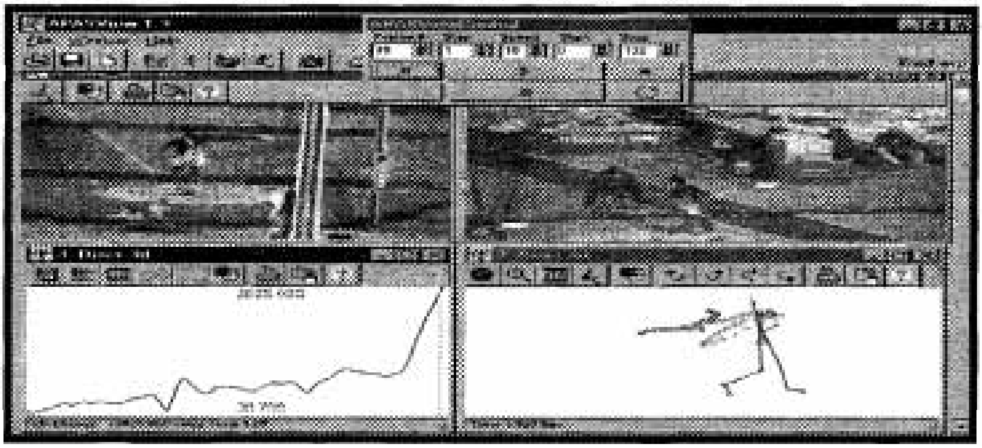

Figure 1 - Integrated views of Olympic gold discus throw

Data View: The data view is capable of showing many different kinds of numerical data parameters, such as, displacement, velocity, force, EMG and so on. Each channel loaded can be manipulated numerically in order to normalise and modify the data. Each individual data channel can utilise a unique colour and a label can be added. The data view can present the data in three different formats, namely, line graphs, bar graphs and numerical table values (Figure 2).

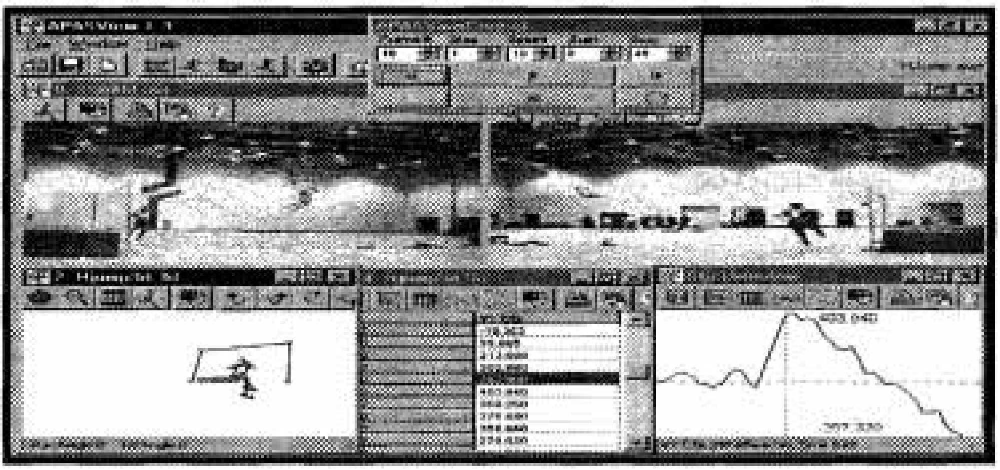

Figure 2 - Data view with high jump video

Stick Figure View: The stick figure view is used to load digitised point trajectory with ground reaction force vector components. The digitised point trajectory and the ground reaction force vectors can be view and rotated in 3D space. In order to superimpose ground reaction force vectors, a point defining the force plate in the global coordinate system must be digitised. Coloration of the interconnected points can define segments to illustrate an interrelationship with established numerical data (Figure 3).

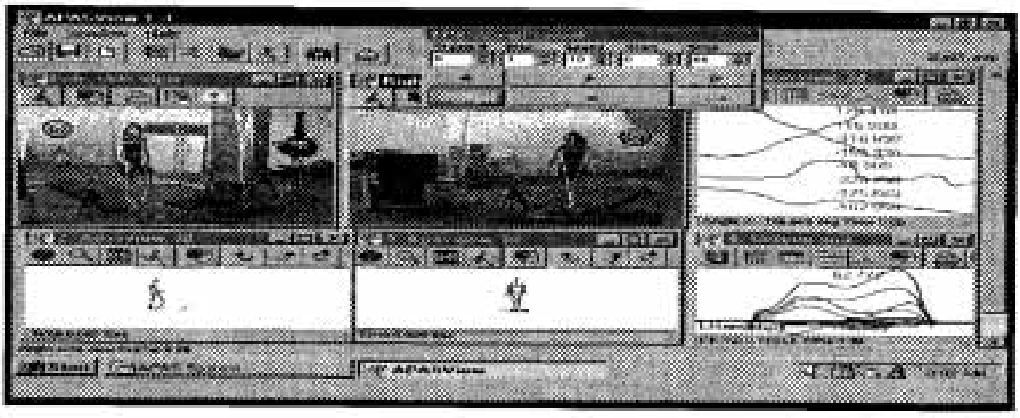

**Figure 3 - Stick Figure View of clinical gait with GRF vectors**

**Sync View:** The sync view makes it possible to load the digitised point trajectory of two different captured trials into the same 3D spatial space, such as the successful and unsuccessful free throw in a competitive situation (See Figure 4).

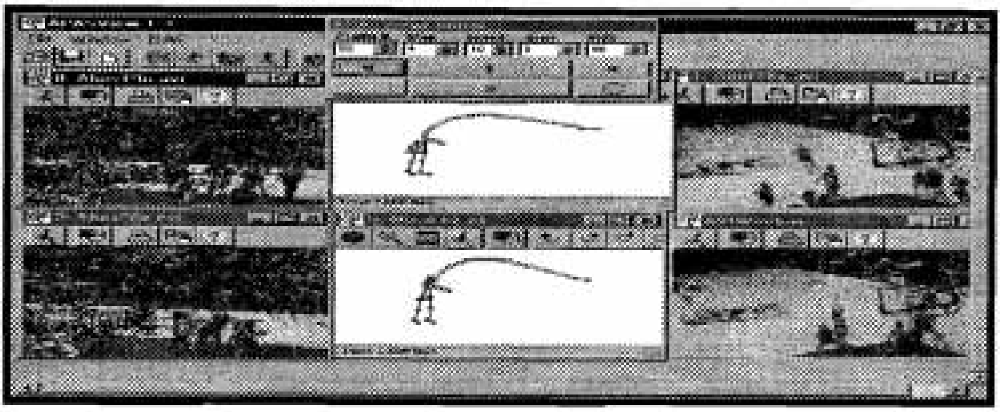

**Figure 4 - Synchronised video of basketball shot**

**Video View:** The video view is capable of superimposing 3D digitised point trajectory and ground reaction force vector onto a 2D video image by using a reverse DLT approach. As with the stick figure view an extra point has to be digitised in order to locate the force plate in 3D space (Figure 5).

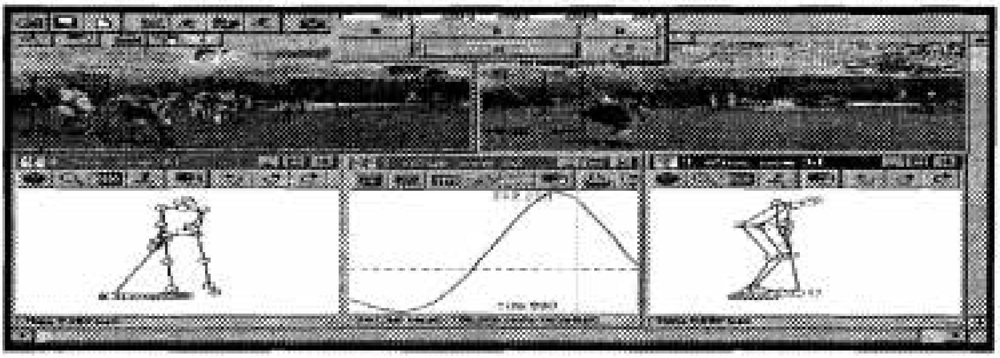

**Figure 5 - Video View comparative views of putting with traditional and prototype**

**Synchronisation:** In order to synchronise the individual views for comparative evaluations it is possible to add a time offset for each view. By choosing a main view and setting it to the zero offset and then by adjusting the offset for additional views, it is possible to create a comparative project similar to the project conducted by Finch, Ariel, & Penny (1998), which contrasted the top discus throwers' performances at the 1996 Atlanta Olympic Games. Also for the stick figure view and the video view, it is possible to time offset the force plate data in respect to the video, if the data sampled is not perfectly aligned using automatic and synchronised triggering of the A/D conversion (Figure 6).

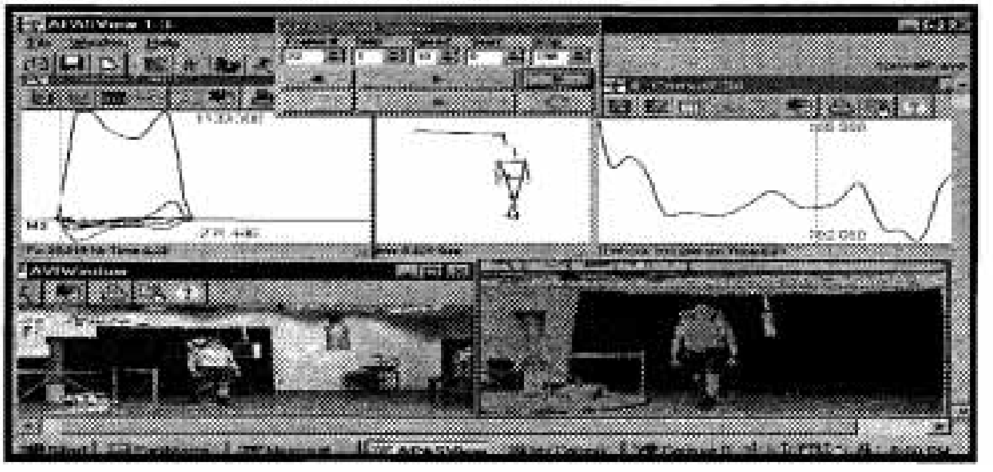

Figure 6 - Superimposed GRF vectors during tethered walking

DISCUSSION: Creating a comparable evaluation setup using video impose certain problems. Video captured at different trials/events and of different athletes will be desynchronised. The capturing of human motion is normally done using standardised video recording equipment, which give a maximum misalignment of 16msec for NTSC and 20msec using PAL. The only possible method for decreasing the misalignment of multiple trials/events is to use higher speed image capturing.

CONCLUSIONS: Integration of video records, kinematic, kinetic, EMG, and force plate data using multimedia techniques can enhance the quantitative and qualitative analyses of sports, rehabilitation, and industrial applications.

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