BIOMECHANICAL ANALYSIS OF THE "O'NEILL"
(Stretched double felge backward to forward swing in hang on the rings)

H. Geiblinger, W. E. Morrison and P. A. McLaughlin
Biomechanics Unit, Dep't of Physical Education and Recreation and
Centre for Rehabilitation, Exercise and Sport Science, Victoria University of Technology

The purpose of this case study was to provide a kinematic analysis and a description of the technique employed by O'Neill performing this novel skill. Data was captured at 50 Hz by two Panasonic F15 video cameras gen-locked and field synchronised, which permitted the calculation of 3D kinematic data using the PEAK Motion Analysis System. The maximum vertical velocity during the downswing phase before the beginning of the O'Neill was -4.21 m/s and reached a value of 3.91 m/s after 0.21 seconds at the beginning of the up-swing. The CG displacement from the start of the up-swing to its highest value was 1.75 m. Maximum angular velocity of the hip angle was -919 deg/sec and for the shoulder angle was -670 deg/sec. The duration of the skill was 1.16 sec starting from the beginning of the upward swing, to completion of a double back somersault layout between the rings without releasing the grip on the rings, to the vertical body position in hang at completion of the skill.

Introduction

Paul O'Neill was the first gymnast to perform the "stretched double felge backward to forward swing in hang on the rings" at the World Gymnastic Championships in Brisbane, 1994. This skill can be placed in the movement category (Brueggemann, 1994) of (backward) rotations in the vertical plane with a flexible horizontal axis of rotation. The O'Neill is listed in the current FIG code of points as an E-part (highest difficulty value) in the table of difficulty. The purpose of this case study is to provide a kinematic analysis and a description of the technique employed by O'Neill in performing this exciting, unique, and novel skill.

Method and Equipment

The rings competition was video recorded with two F15 Panasonic, PAL, cameras positioned on the catwalk approximately 20 metres above the competition area. Time synchronization was performed with gen-locking and time coding at the instant of recording. The two cameras permitted 3-D processing with the Peak Performance Technologies Motion Analysis System. For conversion from video measure to real life, the Peak calibration frame was used as the 3-D scale factor and space facilitator. The frame is 2.05m x 2.05m x 1.3m and has 24 spheres of known locations (x, y, z). Dimensional coordinates from the tape were used in a 21 point body model (Dempster, 1955) and tiltered with a Butterworth low pass digital filter (Winter, 1990) with an "optimal" cut-off frequency determined for each body point. The 2-D views were used to construct the DLT (Abdel-Aziz & Karara, 1971) for 3-D analysis and the differential process (Miller & Nelson, 1973), to yield the kinematic parameters.

Results and Discussion

The maximum vertical velocity during the downswing phase before the beginning of the O'Neill was -4.21 m/s and reached a value of 3.91 m/s after 0.21 seconds at the beginning

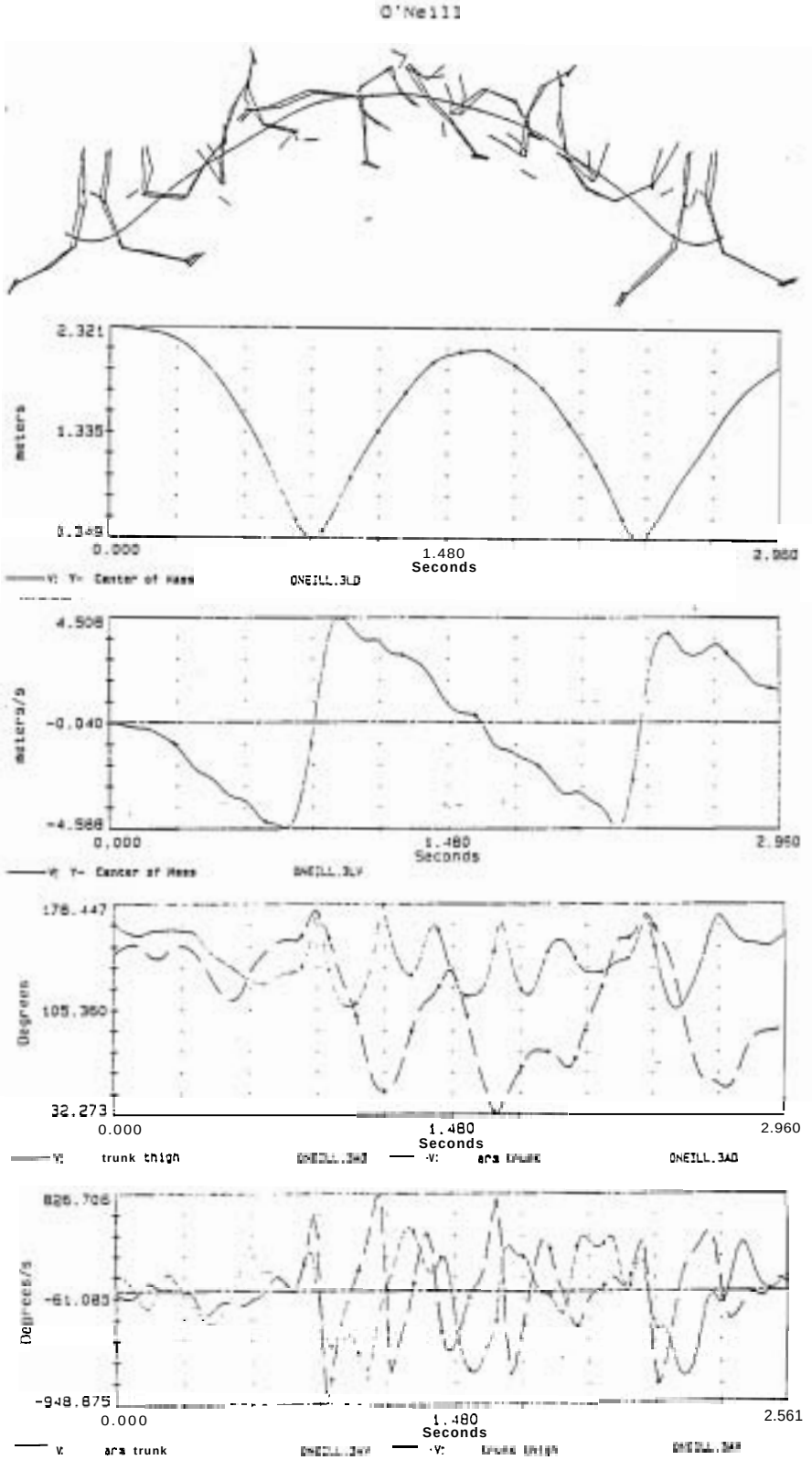

Fig 1. Stretched double felge backward to forward swing in hang on the Rings by O'Neill (USA)

of the up-swing. In the upward swing a reduction in the moment of inertia occured relative to the altered position of the transverse axis as a result of accelerated and controlled muscle flexion at the hip and shoulder joints. With flexible axes of rotation no rotation can appear about an external axis, e.g. rings (Brueggemann, 1989). Ludwig (1993) suggests that the rotation of the trunk around an axis through both shoulder joints becomes the most important determining factor for the swing on the rings.

Parameter	Value
duration of the skill	1.46 sec
max. vertical velocity during downswing	-4.21 m/s
max. vertical velocity at beginning of upswing	3.91 m/s
CG displacement	1.75 m
max. hip angular velocity	-949 deg/sec

Table 1. Selected Parameters of the "O'Neill"

During the up-swing the hip joint reached its lowest value of angular velocity (flexion) distinctly in advance of the shoulder joints. Once the arm-trunk (shoulder) angle reached its minimum value, the hip joint maintained a hyper extention throughout the skill. Also, the arms and shoulders remained under the rings, which was consistent with the findings of Nissinen (1978). This phase of the O'Neill was almost identical to that of a backward giant swing, however, during the upward swing of the O'Neill, the rotational value was maintained, and was assisted by the sideward and downward pushing action of the arms, until the skill was completed. The CG displacement from the start of the up-swing to its highest point was 1.75 m. The analysis of the joint angle movements provides an insight to the mechanism for increasing rotation. The maximum angular velocity of the hip angle was -949 deg/sec and for the shoulder angle was -670 deg/sec. The powerful closing of the arm-trunk angle is the most important technical component for the successful performance of the O'Neill. The duration of the skill was 1.46 sec starting from the beginning of the upward swing, to completion of a double back somersault layout between the rings without releasing the grip on the rings, to the vertical body position in hang at completion of the skill. The unique characteristics and abilities of Paul O'Neill contribute to the execution of this skill.

References

Abdel-Aziz, Y. I. & Karara, H. M. (1971). Direct linear transformation from comparator coordinates into object space coordinates in close-range photogrammetry. In ASP Symposium on Close-Range Photogrammetry. American Society of Photogrammetry, 1-18.

Brueggemann, G.-P. Ed. (1989) The World Championships in Artistic Gymnastics-Scientific Report.

Brueggemann, G. P. (1994). Biomechanics of gymnastic techniques. In *Sport Science Review*. **3,** (2) 79-120.

Dempster, W. T. (1955). *Space requirements of the seated operator*. Aerospace Medical Research Laboratory, Wright Paterson AFB, Ohio.

Ludwig, H-J. (1993). Biomechanische Untersuchungen der Rotationen an den Ringen [Biomechanical Study of Forward and Backward Swings on the Rings] in G-P. Brueggemann et al. Eds. *Biomechanics in Gymnastics-Conference Proceedings*, Cologne: Strauss, 79-88.

Miller, D. I. & Nelson, R. C. (1973). *Biomechanics of Sport. A Research Approach*. Philadelphia: Lea & Febiger.

Nissinen, M. A. (1978). Kinematic and kinetic analysis of the giant swing on the rings. In H. Matsui & K. Kobayashi (Eds.), *Biomechanics VII-B* (pp. 781-786). Champaign, Il: Human Kinetics.

Winter, D. A. (1990). *Biomechanics and Motor Control of Human Movement*. 2nd edition. New York: Wiley.