DIFFERENCES IN BASIC ELEMENTS BETWEEN JUNIORS AND SENIORS AND BETWEEN WOMEN AND MEN IN GYMNASTICS

Jürgen Krug, Klaus Knoll, Rolf Wagner, Andreas Bronst,
Universität Leipzig, Germany

INTRODUCTION: This investigation focused on the results of biomechanics projects carried out by the Institute for Applied Training Science (IAT) during the World Championships 1989, 1994, 1997 and the 1993 European Championships in Geneva. The 1994 and 1997 investigations were also certified as ISBS projects.
Simultaneously, specific scientific projects were also accomplished during World Championships (e.g. Geiblinger, Morrison & McLaughlin, 1995). Comprehensive congress proceedings have documented the scientific state of important studies, among others: Göhner (1982), Göhner (1990), Withlock (1991), Brüggemann & Rühl (1993). Additionally, a selected number of projects in gymnastics were supported by the Medical Committee of the I.O.C. during the 1988 Olympic Games in Seoul, the 1992 Olympic Games in Barcelona and the 1996 Olympic Games in Atlanta. The special feature of this study is to compare certain facts and to summarize the results of several competitions. Thus the targets were:
first to give recommendations for learning and perfecting elements
second to reflect on dangers and risks.
METHODS: Image measuring methods depending on the problem (2D or 3D procedures) were used. In the state of the art analyses the height of the flight elements was evaluated. In a first step an estimated value of the height of flight (time of flight) was calculated. In the second step the heights of CG were measured by photogrammetric procedures. Dynamometrical measurements of apparatus reaction forces combined with special measuring systems were applied on the horizontal bar and uneven bars (Knoll, Drenk & Krug, 1996) to differentiate between gymnastics performances by juniors and seniors and between women and men.
Mathematical models (Knauf, 1986) were used to calculate resultant joint moments of acrobatic jumps. The body was separated into 6 segments.

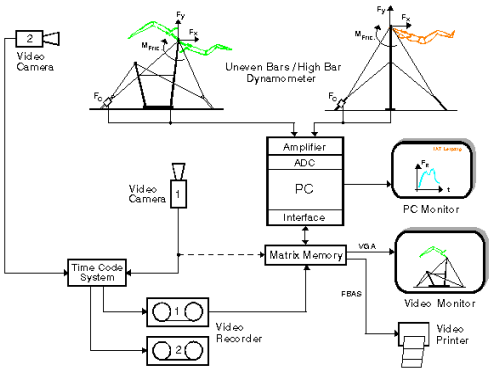

Figure 1: Measuring system for horizontal bar and uneven bars

RESULTS: In performing backward somersaults, men reached flight heights of 2.7 m, women of 2.3 m (relating to CG). Male and female juniors had lower values (Table 1).

Table 1: Maximum values of salto flight heights (m) on the floor

Junior gymnasts		Senior gymnasts		Sport acrobats	
male	female	male	female	male	Female
2.30	1.90	2.70	2.30	3.20	2.70

Comparative studies with dynamometric platforms were made to get initial values for modeling. Junior gymnasts performed several double saltos. Using the mathematical model (Knauf, 1986), maximum joint moments of the ankle, knee and hip joints were estimated. As expected, the highest load was estimated in the ankle. The resultant moment in the hip joint amounted to 850 Nm. Because of the greater strength capacities of men, it was possible to establish other technical characteristics of the flic-flac, as well as of the backward somersault and its take-off. These characteristics of men appeared similar to those of top level sport acrobats who reach flight heights of more than 3 m when executing somersaults.

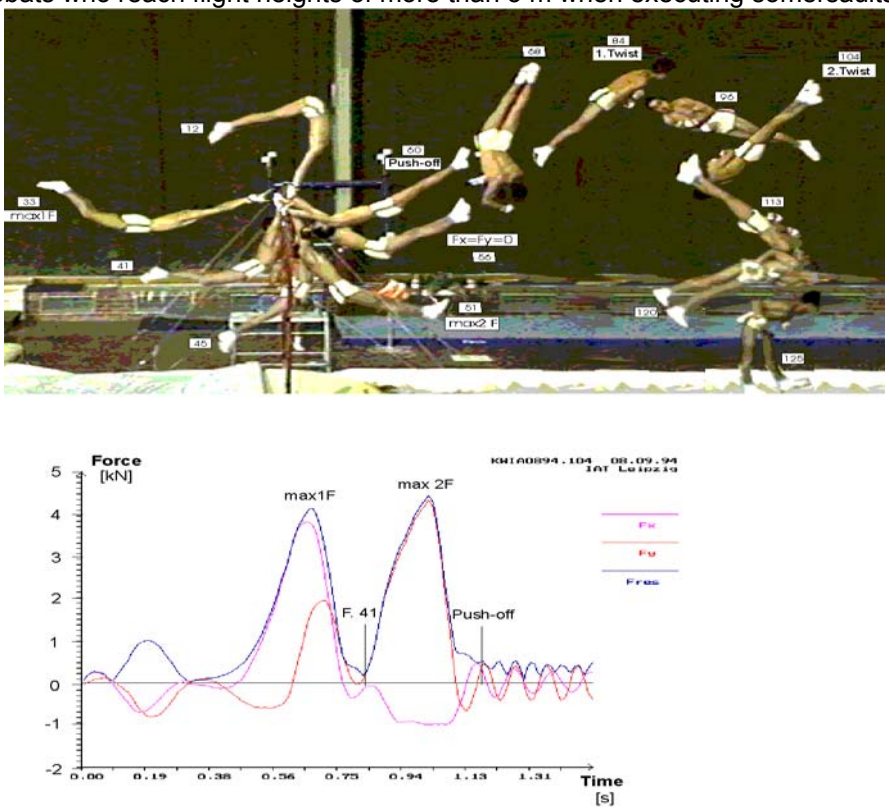

Figure 2: Preparing giant swing and a difficult dismount by male gymnast

On the vaulting horse the running approach velocity is one of the most important parameters. Different measuring systems were used. Since 1994 a laser velocity

system has been employed. Differences in technique could also be shown in the horse vault. The running approach velocity of men was about 1 m/s faster than that of women. At the World Championships in Lausanne these results were significant. Besides, the first flight phase was shorter (in duration) during the period of investigations.

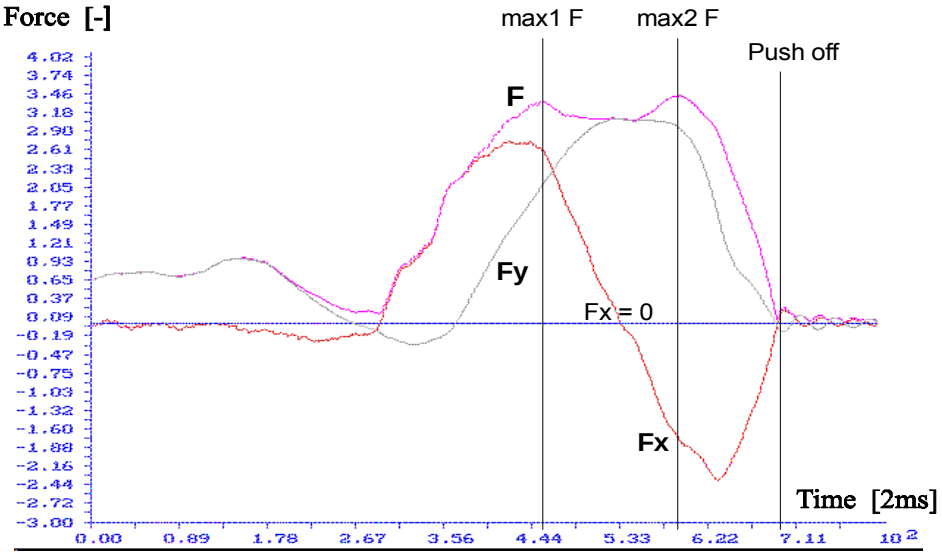

Figure 3: Dynamogram of a preparing giant swing by Khorkina (JEC 1993)

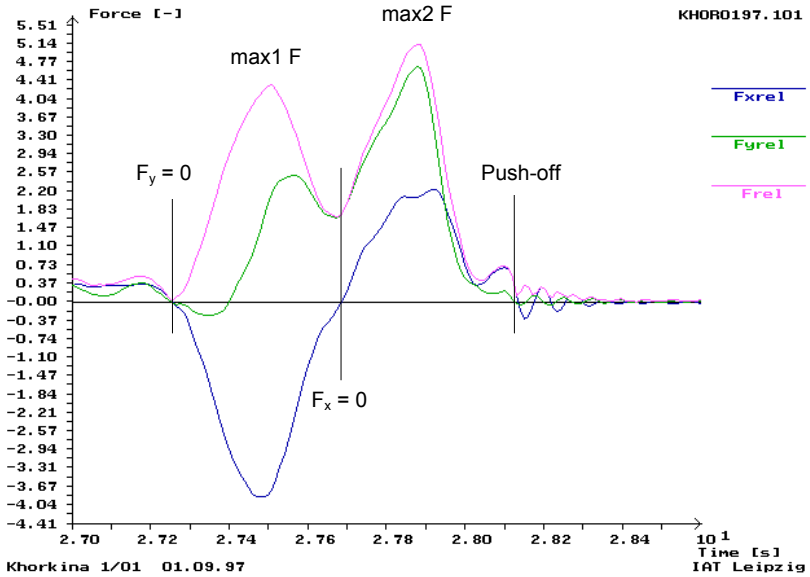

Figure 4: Dynamogram of a preparing giant swing by Khorkina (WC 1997)

Differences in giant swing technique, before difficult flight elements and dismounts on the horizontal bar and the uneven bars were attributed to construction-related differences in the apparatuses used by men and women. In men, higher strength values (up to 6-7 times body weight) were measured than in women (4-5 times body weight). A long-term analysis over 10 years demonstrated a similarity of the giant swing technique in men and women. Figure 2 shows a preparing giant swing and a difficult dismount by male gymnasts. In male and female juniors, lower apparatus reaction forces were measured. The elastic qualities of gymnastic apparatuses were used less effectively by the juniors. In Figures 3 and 4 a technique development of the giant swing with more similarity to men's technique is evident.

CONCLUSIONS: In summary, the investigation showed the necessity to develop special training programs for juniors aimed at the improvement of their endurance, strength, speed and the coordination. In these programs the basic structures, e.g., giant swings, flic-flac, take-off movements and saltos with and without turns should play an important role. Simultaneously, it is necessary to train the following basic abilities:

- power for the take-off movements as well as for flexion and extension movements
- adaptation to fast turns around the longitudinal and transversal axis
- preparations for landing.

All the recommendations for a higher level of abilities should be combined with demands to reflect the specific biological properties and to reduce the risks for juvenile athletes. Interestingly, the results of the 1994 and 1997 ISBS projects proved to be very helpful to the Technical Committees and Working groups of the International Gymnastics Federation (FIG).

REFERENCES:

Brüggemann, G.-P. (1994). Biomechanics of Gymnastic Techniques. *Sport Science Review* **3**(2), 79-120.

Brüggemann, G.-P., Krug, J. (1990). Gymnastic World Championships. Stuttgart 1989. Scientific Report. FIG: Köln/Leipzig.

Geiblinger, H., Morrison, W. E., McLaughlin, P. (1995). Coaching Points: World Gymnastics Championships. Brisbane.

Göhner, U. (1982). Injury Risks and Loading in Gymnastics. Schorndorf: Hofmann.

Göhner, U. (1990). Elite Gymnastics during Childhood. Stuttgart.

Knauf, M. (1986). Biomechanische Modellierung und Bewegungssimulation mit Hilfe von Gliederketten unter Berücksichtigung elastischer Widerlager - ein Beitrag zur Weiterentwicklung der Modellmethode in der Biomechanik. (Biomechanical Modelling and Movement Simulation using a Multi-Body System Considering Elastic Supports - A Contribution to the Further Development of the Model Method in Biomechanics). Habilitation. Leipzig: Forschungsinstitut für Körperkultur und Sport.

Krug, J., Noble, L. (1997). Application for Participation in the 1997-98 ISBS Gymnastics Project.

Withlock, S. (1991). Gymnastics Chronic Trauma. FIG Scientific/Medical Symposium. Indianapolis, IN.