THE ACCURACY OF THE SKI-JUMPER’S TAKE-OFF

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INTRODUCTION

The accuracy can be defined as the ability of the jumper to finish the take-off at the correct time. The take-off is accurate in the moment when the acceleration of the centre of gravity is finished and passes through the edge of the take-off area. According to Hochmuth (1958) the take-off is finished at the moment when the value of the take-off force meets the level of gravitational force affecting the mass of the jumper and his equipment. Baumann (1979) expressed completion of the take-off as the moment in which the velocity of the body’s centre of gravity is reached perpendicular to the take-off area. Both definitions show two principle ways for exact diagnosis of the factor accuracy. In training practice three terms are used describing the quality of the accuracy: accurate, early, late.

The present study focuses on the following problems:
- quantification of the accuracy,
- relations of accuracy to the other factors of the take-off and to the length of the jump,
- creation of the model which represents the moment of completing the take-off.

METHOD

The following methods were used:
- Dynamometry of the take-off in the natural conditions of the jump. The dynamometric platform, 6 m long and built in the jumping hill K 92 m in Frešnštátl, enables measurement of two key factors of the take-off (Vaverka, 1987):
  - The vertical speed of the jumper’s center of gravity taken in the final 6 m of the take-off. We call it VIGOUR (VI) expressed in [m.s⁻¹].
  - The distance from the edge of the take-off in which the take-off is completed is called ACURACY (AC) expressed in [m].
This method has been used and developed systematically since 1978 and more than 800 jumpers were examined.
- The kinematic analyses was elaborated specially for ski-jumping.
  The method enables modeling of the jumper’s position according to the chosen distance from the take-off edge, the time of the movement, and desired angle parameters of the body’s position. (Vaverka et al., 1992). About 450 take-offs from different events have been analysed since 1990.

RESULTS

Quantification of the take-off accuracy and relation to the length of jump

Table 1 shows the general statistical characteristics of the measured values of accuracy using dynamometry. We can see that the data measured on plastic in the period 1978-1989 are
Table 1

The average values of the accuracy (AC) of the take-off measured dynamosetrically in different time periods and correlation between the accuracy and the length of jump (LJ).

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Plastic</td>
<td>Plastic</td>
<td>Ceramic</td>
</tr>
<tr>
<td>n</td>
<td>408</td>
<td>406</td>
<td>107</td>
</tr>
<tr>
<td>Mean</td>
<td>0.26</td>
<td>0.24</td>
<td>0.14</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.22</td>
<td>0.18</td>
<td>0.12</td>
</tr>
<tr>
<td>$r_{LJ,AC}$</td>
<td>-0.380*</td>
<td>-0.259*</td>
<td>0.0543</td>
</tr>
</tbody>
</table>

* p < 0.01

Fig. 1A, B The accuracy of the take-off based on dynamometric measurement (A) and kinematic analyses (B). Notice: Values marked * are independent variables which were input data to the individual’s cinematic model and non marked values are computed.

CONCLUSIONS
1. The dynamometrically measured data are given in the table.
2. The optimum value of the angle $\alpha_2 = 138^\circ$. The take-off of $\alpha_2 = 135^\circ$ - $141^\circ$. The ideal take-off is depicted before the edge is detected.
3. The diagnostic systems, representing the jumping, elaborated in sensitivity and accuracy.

REFERENCES
almost the same, but the accuracy measured on ceramic is different. The last measurements on the ceramic showed more frequently the value \( AC = 0.00 \) than before. We can see that the distribution of the accuracy is different from normal Gau
curve and the concentration of the values \( AC = 0.00 \) is very high.

Relations of the accuracy to the length of the jump as computed by the Pearson correlation coefficient, is problematic (Table 1). The values of correlation coefficients are negative, two out of three are statistically significant and very low. The reason for these low relations is abnormal distribution of the accuracy.

In our previous study (Vaverka et al., 1991) we investigated the relation between the two factors of the take-off measured dynamometrically (vigour, accuracy) and the length of the jump. Statistical analyses showed that the statistic model expressed by three-dimensional exponential relationship between the length of jump, and take-off vigour and accuracy fits very well with reality.

Discovering of the take-off accuracy model

Fig. 1A schematically expresses all three variants of the take-off accuracy measured dynamometrically. The optimum range is 0.00-0.20 m before the edge, which is classified as an accurate take-off.

For trainers, a very interesting problem is how the visual model looks (position of the jumper) at the moment of take-off completion. A very simple, but informative, model is taken from the angles describing the body’s position. Previous research found that the key angle characterising the take-off is the knee angle \( \alpha_2 \) (Baumann, 1979, Vaverka, 1987).

This angle is the centre of our concentration. From 107 dynamometrically measured and kinematically analysed take-offs in Frenštát p.R, 90 (all evidently late take-offs were discarded) the angle values of the jumper’s position were computed in the moment of the take-off completion and at the edge. The set of 140 jumpers from the competition Innsbruck 92 were analysed by using of kinematic analyses (Vaverka et al., 1992). The results of statistical elaboration of measured data are given in graphical form in Fig. 1B.

CONCLUSIONS

1. The dynamometric and kinematic analyses enables finding the range around the edge in which the take-off is accurate. It is the distance 0.20 m before and 0.15 m after the edge.

2. The optimum value of the knee angle in the moment of take-off completion was found to be \( \alpha_2 = 138^\circ \). The take-off is completed with a very high probability in the range of knee angles \( \alpha_2 = 135^\circ - 141^\circ \). Identification of the knee angle \( \alpha_2 = 138^\circ \) in longer distances than 0.20 m before the edge is diagnosed as an early take-off and longer than 0.15 m after the edge is late.

3. The diagnostic systems, the dynamometry in Frenštát p.R, and cinematic analyses of the ski-jumping, elaborated in our Laboratory, enables quantification of the take-off accuracy very sensitively and are very useful in the training of ski-jumping.

REFERENCES

- Hochmuth G. (1958) Untersuchungen über den Einfluss der Absprungbewegung auf die

ASSESSMENT OF
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1 Introduction
The training of top rank sportsmen in this study provide an example of international rugby squad.

2 Method
Four series of tests were carried out at the University of Bath, UK, over a range of 8 weeks. The tests included:
- quadriceps strength test: the squat test (USA) over a range of 8 weeks;
- spring tests using the Beil whee second power test;
- field tests (speed over 20 yards);
- measurements with an ergometer

The results involved comparing the performance of line forwards (N = 6) with the results of Type Whitney "U" test.

3 Results

3.1 Biodex Tests
The results show no significant difference between forwards and 1st and 2nd line forwards (p = 0.05) between backs and 1st and 2nd line forwards (240° and 300°). The difference in torque at -60° was not significant and the data showed no significant difference (over 30%) in our study where the values were made at 120°. No significant difference in torque between backs and 1st line forwards was seen at 30°. The narrower the gap in torque at -60°, the better the forwards. The difference in torque at -60° was significant in our study where the values were made at 120°. No significant difference in torque between backs and 2nd line forwards was seen at 30°. The narrower the gap in torque at -60°, the better the forwards. The difference in torque at -60° was significant in our study where the values were made at 120°.

3.2 Ergojump spring
The standard series of tests were carried out. The forwards were very clearly superior to 1st and 2nd line forwards (p < 0.01). The backs made an average of 8 jumps (p < 0.01). The behaviour of the backs in the "take-off" test shows no difference.

Figure 2 shows that the backs made 15 second power test (p < 0.01).