

## DEVELOPMENT OF THE VELOCITY FOR VAULT RUNS IN ARTISTIC GYMNASTICS FOR THE LAST DECADE

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The last decade in gymnastics is affected by two revolutionary changes. The introductions of the new vaulting table replacing the former vaulting horse and the 2006 code of points for the evaluation of the competition exercises with an unlimited system removing the maximum value of 10 points are unprecedented large changes in the history of gymnastics. Using competition analysis of the world championships 1997 and 2007 the development on the apparatus vault focused on the running velocity (laser velocity measuring) is described. The main results are: For Yurchenko vaults 2007 women are as fast as men. There has been an important increase in vault run speed since 1997 for men and women. There is one remarkable exception: On Yurchenko vaults men are as fast as ten years before and there is no effect of the new vault table.

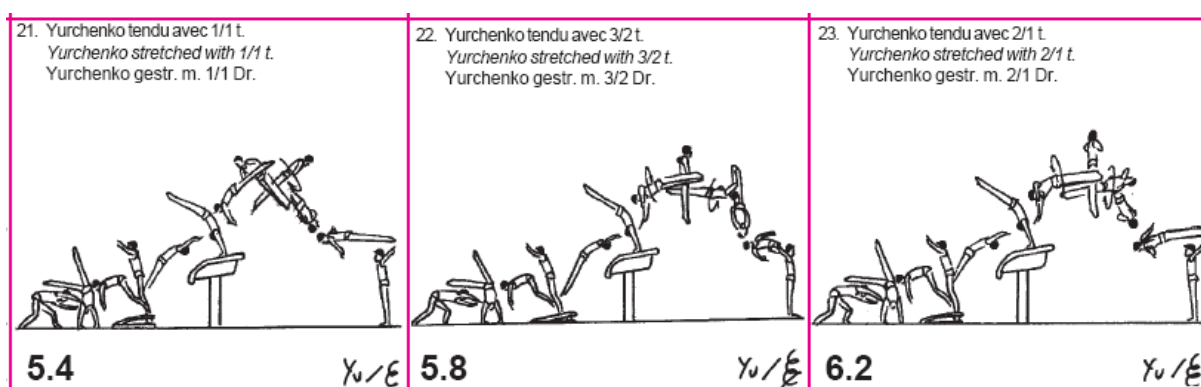
**KEY WORDS:** artistic gymnastics, vault, running velocity, competition analysis

### INTRODUCTION:

The development of women and men artistic gymnastics performance is always affected by the rules for judges' evaluation of the gymnast exercises, the introduction of the code of points (Code de Pointage, CdP) every four years. But in the last decade there are two revolutionary changes, which are unprecedented in the history of artistic gymnastics. In 2001 the International Gymnastics Federation (Fédération Internationale de Gymnastique, FIG) establish the vaulting table (Knoll & Krug, 2002; Sands & McNeal, 2002) first time at the world championships in Ghent (BEL). There was no change like the replacing of the vaulting horse for the new vaulting table in the history of artistic gymnastics.

From 2006 on, the artistic gymnastics rules had a huge change. The former well known "perfect 10" was replaced by an unlimited scoring system. Only the execution value (B-value) remembers to the "perfect 10". The sum of the limited execution value and the unlimited A-value for the content of the exercise is the final score.

One reason for the new vaulting table was the safety of the athletes and injury prevention. Especially for the round-off vaults with a backwards flight to the apparatus, also called Yurchenko vaults (see figure 1), there was a high risk of missing the old vaulting horse. The new apparatus is now the same for women and men, there is only a difference in the height of the table (1.25 m women, 1.35 m men).



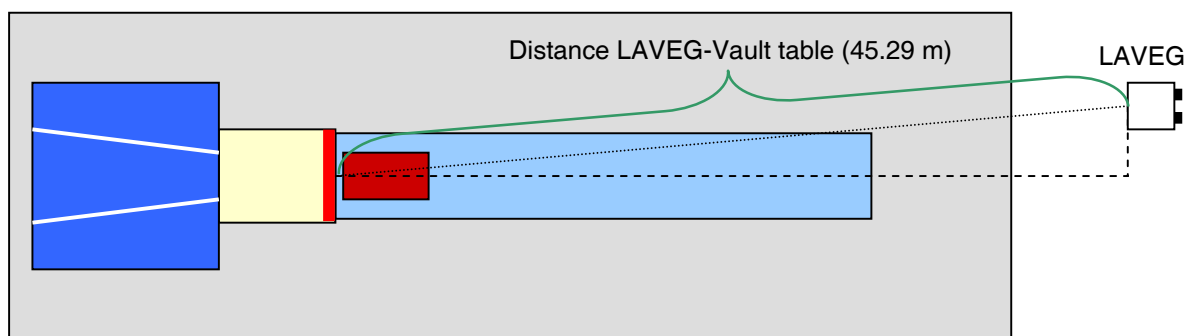
**Figure 1: Examples for the Yurchenko vaults with the A-value (Fédération Internationale de Gymnastique, 2006, 95)**

The vault run is the basis of the energy production for vaulting. There are many studies reporting vault run speeds (Sands & Cheetham, 1986; Sands, & McNeal, 1995, Krug, Knoll, Köthe & Zocher, 1998; Sands, 2000), but these studies are published before the introduction

of the new vaulting table. After a six year period of familiarisation with the new apparatus now we have a look at the vault run speed. With support of the International Gymnastics Federation our Institute were able to measure the velocities at the World Championships 2007 in Stuttgart (GER). The results of the 2007 World Championships are reported and we compare these data with our research results from the 1997 World Championships in Lausanne (SUI), where the vault run-up speed had been measured with the same method. Our comparison of World Championships in 1997 and 2007 is important to describe the influence of the new apparatus and the new unlimited CdP but also the progression of the gymnasts' performance.

**METHOD:**

**Data Collection:** The vault run speed of the gymnasts was measured by the Laser based distance measuring system (LAVEG). The position of the system and the operator was behind the podium for the vault table. The distance to the vault table was 45.29 m. A slight shifting of the measuring system was required because of the local conditions. This shifting results only in a maximum velocity difference of 0.01 Meter per second (m/s) in the running speed. For more details see figure 1. The operator of the LAVEG system must aim at the gymnasts back (lumbar region) during his vault run-up.



**Figure 1: No dimensional sketch of the measuring system in Stuttgart**

All vaults in all competitions of women and men were measured. Individual run-ups had to be excluded from the analyses, because people had been passing the line between running gymnast and the LAVEG-system. Altogether we analysed 561 run-ups for vaults (272 women vaults, 289 men vaults). For more details see table 1.

**Table 1: Number of vaults for women and men in all 4 competitions of the 2007 World Championships**

competition	Women			Men		
	N (gymnast)	N (vault)	N (analyzed)	N (gymnast)	N (vault)	N (analyzed)
C I	189	217	209	212	245	225
C II	24	24	24	24	24	24
C III	8	16	16	8	16	16
C IV	24	23	23	24	24	24
total	253	280	272	276	309	289

**Data Analysis:** For any vault run-up there is a velocity profile as you can see in figure 2. The value of the maximum velocity and the location of this maximum velocity have been applied for detailed analyses. To understand the initial speed in front of the vault table, before the last step on the springboard or the start of the round-off or Yurchenko vault we calculated the mean velocity between 7 and 5 meter in front of the vault table for handspring vaults and

vaults with 1/4 turn in pre-flight and between 10 and 8 meter for the round-off or Yurchenko vaults. Results were reported only for these mean velocities in front of the vault table.

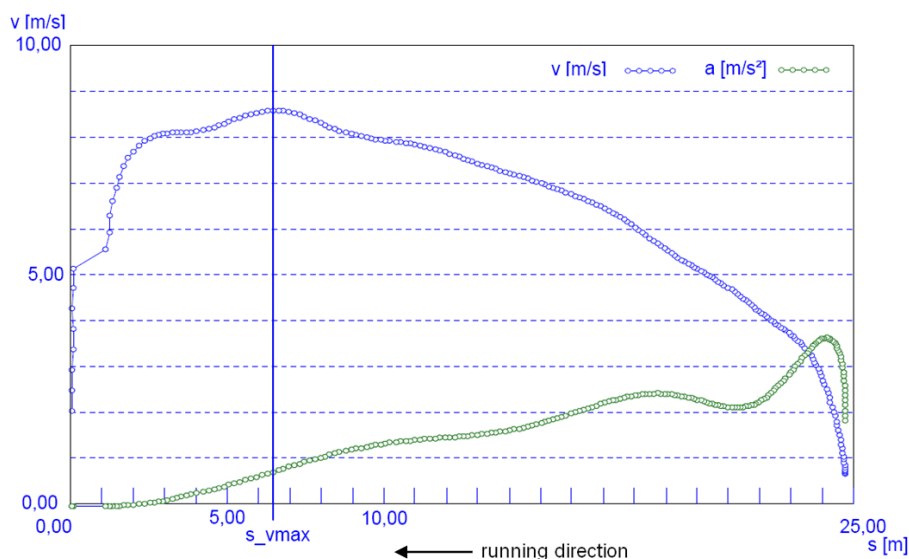


Figure 2: Velocity and acceleration profile of a gymnast

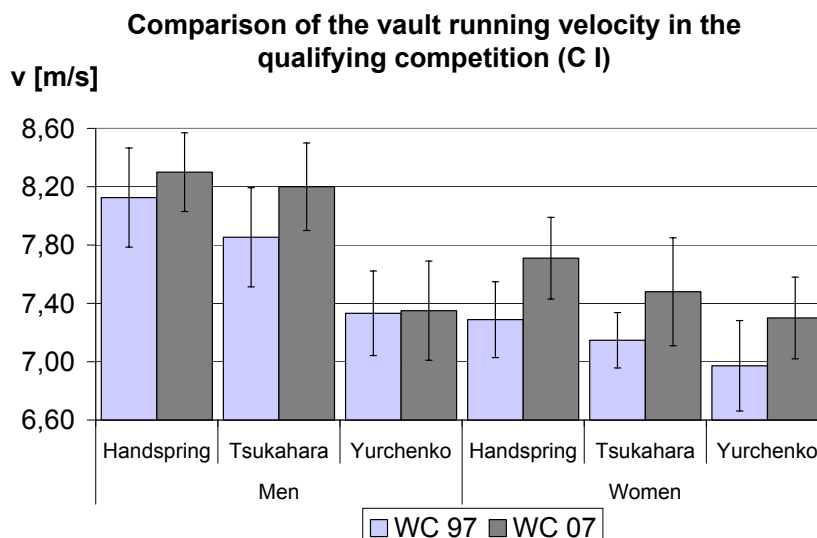
**RESULTS:**

An initial descriptive statistical analysis (see table 2) for the run speed in different vault groups shows the same ranking for women and men. For handspring vaults we found the fastest run-ups, followed by the Tsukahara vaults and the Yurchenko vaults. As we expected and certainly caused by the different physical prerequisites men were faster than women. But for the Yurchenko vaults with the round-off in front of the table there is no difference between men (7.36 m/s) and women (7.33 m/s). On the basis of the energy generated with the vault run-up men and women have the same pre-conditions for their round-off and the vault performance.

Table 2: Number of vaults, mean, minimum and maximum velocity of the gymnasts in the different vault groups Standard deviation (Sdev) is also reported.

	Vault group	Vault group name	N	mean v [m/s]	Sdev v [m/s]	Min v [m/s]	Max v [m/s]
Men	3	Handspring	62	8,39	0,28	7,59	9,00
	4	Tsukahara	169	8,23	0,32	7,31	9,16
	5	Yurchenko	58	7,36	0,35	6,31	8,16
Women	2	Handspring	51	7,74	0,30	7,12	8,37
	3	Tsukahara	27	7,54	0,39	6,95	8,34
	4	Yurchenko	175	7,30	0,30	6,42	7,92
	5	Round-Off and 1/2 turn on the table	19	7,60	0,25	6,88	8,01

Now we look back for 10 years. With only one exception the gymnasts run faster than ten years ago (see figure 4). Only men with their Yurchenko vaults do not show an improvement of the run-up velocity.



**Figure 4: Comparison of the velocities between the World Championships 2007 and 1997**

**DISCUSSION:**

We emphasize that there are three potential reasons for developments. The first is the new vaulting table, second the unlimited new CdP and as a third reason we know that during the last ten years artistic gymnastics underwent a continuous progression like many years before. But it is not possible to separate these three influences and calculate the single effect.

**CONCLUSION:**

The main findings of our investigations are: When executing Yurchenko vaults 2007 women are as fast as men. There has been an important increase in vault run-up speed (exception: men Yurchenko) since 1997.

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