

## Four Handspring Vault Prototypes

Mack, Hennig & Heinen (2018). Movement Prototypes in the Performance of the Handspring on Vault. *Science of Gymnastics Journal*, 10, 2, 245-257

### A Summary by James Major, Davis Diamonds Gymnastics

The authors of this article were mainly interested in testing if a mathematical method called cluster analysis could be used to investigate gymnastics skills. This is of little immediate interest or use to us. However, as a bi-product, they also reported some interesting facts about the handspring vault that could be useful basic information for coaches. Therefore I have written a summary of useful results, editing out the less practical text. Note that the authors use the word “flexed” referring to a joint that is bent and not to tensed muscles. “Stretched” refers to a limb with a joint that is straight. Please see the photoseries on the last page.

### Summary

The authors filmed 100 vaults by 10 different advanced female gymnasts. The average age of the gymnasts was 11 years old. They identified four handspring vault prototypes. Each of the prototypes could be mathematically identified by some biomechanical features that didn't change vault-to-vault, as well as between gymnasts performing a handspring vault of that type.

#### Prototype 1:

Prototype 1 was performed 17 times or 28.3% of the total. Prototype 1 was characterized by

1. Trunk slightly inclined towards the vault table (forwards) with open shoulder angle during touch-down on the spring board. (Were these gymnasts using an over-arm throw hurdle?).
2. Inclined trunk, slightly flexed hip joint and open shoulder angle during take-off from the spring board.
3. Slightly flexed hip joint, open shoulder angle and trunk oriented close to 45° backwards from the vertical during touch-down on the table.
4. Slightly overarched back, and stretched hip and shoulder joints during take-off from the vault table, and
5. Straight back with slightly flexed hip and knee joints. Open shoulder angle during touch-down on the landing mat.

#### Prototype 2:

Prototype 2 was performed 15 times or 25% of the total. Prototype 2 was characterized by

1. Upright trunk orientation with a shoulder angle slightly larger than 90° during touch down on the spring board.
2. Inclined trunk, slightly flexed hip joint, and open shoulder angle during take-off from the spring board.

3. Slightly extended hip joint, slightly flexed shoulder joint, and trunk oriented close to 45° backwards from the vertical during touch-down on the vault table.
4. Considerable overarched back, stretched hip and shoulder joints during the take-off from the table, and
5. Straight back and slightly flexed hip and knee joints, and open shoulder angle during touch-down on the landing mat.

#### Prototype 3:

Prototype 3 was performed 7 times or 11.6% of the total. Prototype 3 was characterized by

1. Upright trunk with shoulder angle less than 90° during touch-down on the spring-board.
2. Inclined trunk, slightly flexed hip joint, and shoulder angle less than or equal to 90° during take-off from the spring-board.
3. Slightly flexed hip joint, flexed shoulder angle, and trunk oriented less than 45° forwards from the vertical during touch-down on the table.
4. Considerably overarched back, stretched hip and flexed shoulder joints during take-off from the table, and
5. Slightly overarched back with stretched hip and knee joints, and open shoulder angle during touch-down on the landing mat.

#### Prototype 4:

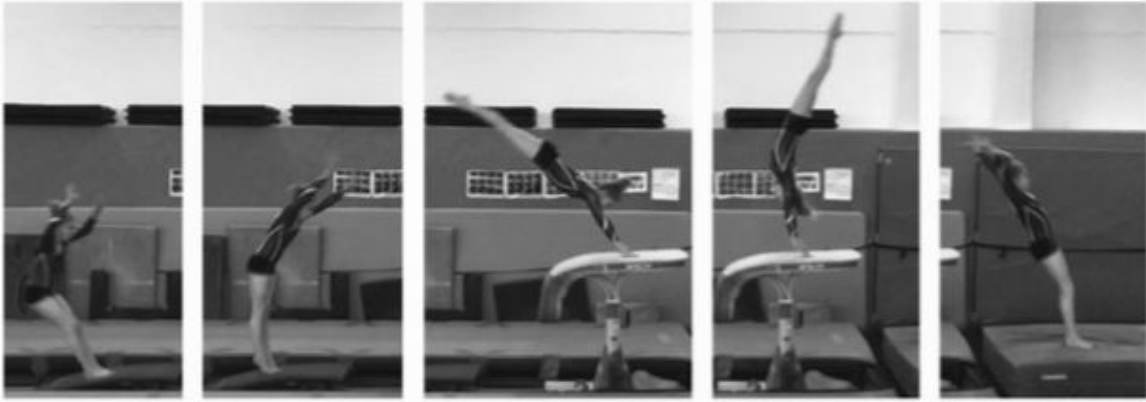
Prototype 4 was performed 21 times or 35% of the total. Prototype 4 was characterized by

1. Upright trunk orientation with shoulder angle larger than 90° during touch-down on the spring-board.
2. Inclined trunk, slightly flexed hip joints, and shoulder angle greater than 90° during take-off from the spring-board.
3. Slightly flexed hip joint, open shoulder angle, and trunk oriented slightly greater than 45° during touch-down on the vault table.
4. Straight back, trunk oriented about +10° from vertical, stretched hip and shoulder joints during take-off from the vault table, and
5. Straight back with slightly flexed hip and knee joints, and open shoulder angle during touch-down on the landing mat.

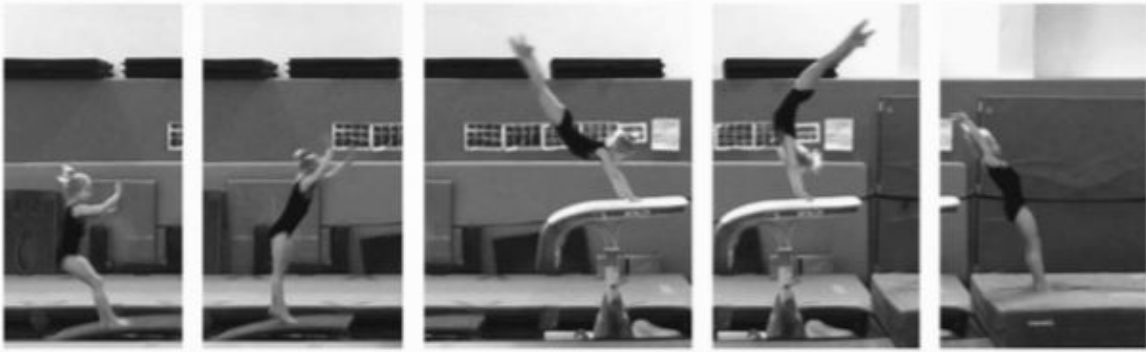
The number of vaults were not evenly distributed between the four prototypes indicating that some prototypes appear more frequently than others. Is this because they are taught more frequently by coaches or some other reason?

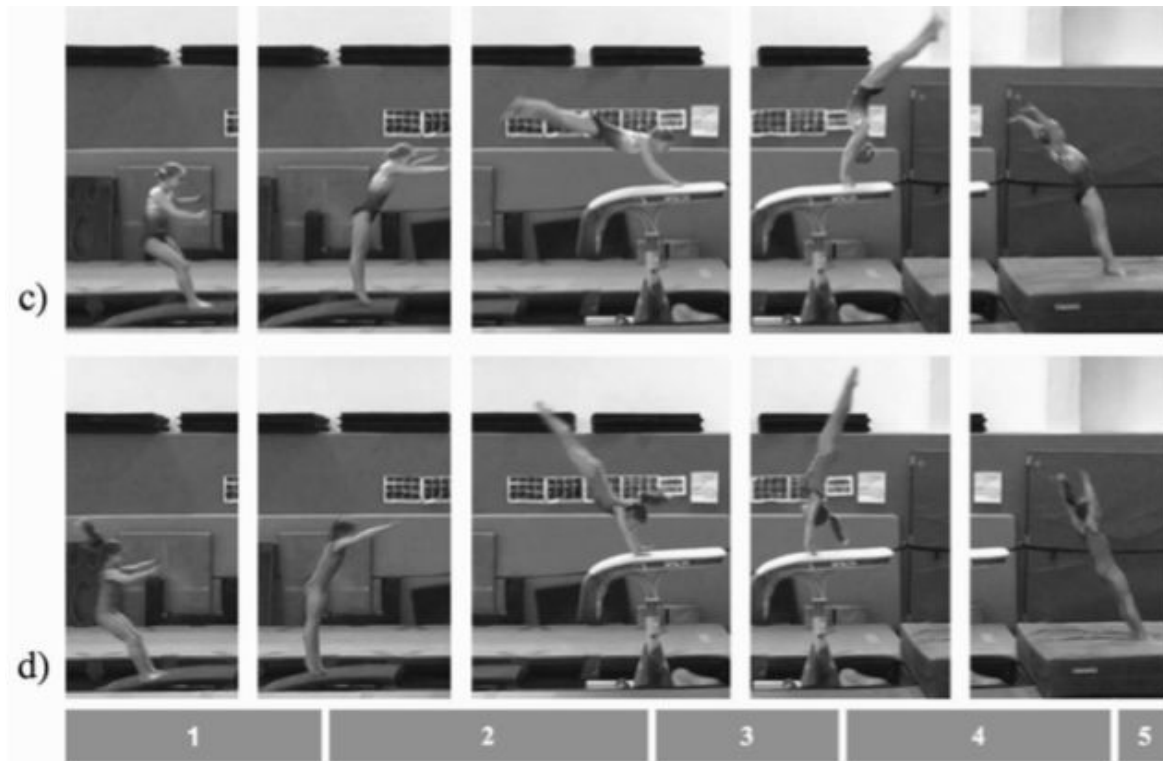
Of the four prototypes, #1 and #4 are characterized by extended knees and hips as well as open shoulder angle. They would get higher scores than prototypes #2 and #3 (FIG Code of Points).

a)



b)





*Figure 3.* Illustration of the four handspring prototypes (see also Figures 1 and 2). a) Prototype #1, b) Prototype #2, c) Prototype #3, d) Prototype #4. *Note:* Each picture sequence shows one exemplary handspring trial of each prototype cluster. The letters “a)” to “d)” correspond to the four clusters in Figure 1. The number “1” to “5” correspond to the movement phases of the handspring (see Figure 2).