

## AN ANALYSIS OF SOLVING TECHNICAL-TACTICAL PROBLEMS IN ORIENTEERING BY MONITORING HEART RATE

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**Abstract:** The objective of this paper is to analyze the fluidity of technical decisions in orienteering competitions by monitoring the heart rate throughout the race.

We have analyzed the heart rate profile of a group of five orienteers, members of the National Team, with ages between 20 and 47 years old, in 4 types of orienteering events: Sprint, Middle, Long Distance and Relay. The fast pace of the Sprint races (13-15 minutes Winning time) implies, among other factors, a high VO<sub>2</sub> max level, great anaerobic capacity and rapid decision making. The complex technical demands required in the Middle distance events (30-35 min Winning time) do not prevent high level athletes to run close to their VO<sub>2</sub> max capacity. Solving orienteering problems may lead to a diminished pace in an orienteering event. Results have shown (analysis of variance;  $P < 0.001$ ) that the subjects had small variations of their HR averages caused by increased Technical and Tactical tasks during the race, but they were different values depending of the event type.

**Keywords:** elite athletes, heart rates, orienteering, technical aspect.

### Introduction

Orienteering is an endurance sport where athletes must race in a forest, off-trail, in urban parks or urban environment, for 13-120 minutes depending on the type of event (Sprint, Middle or Long Distance). The main factors that differentiate Orienteering from other disciplines are the variety of terrain in which the athletes must compete, steep climbs and descents and diverse ground vegetation. These factors lead to an average running speed of between 2:40-10 min/km and a continuously changing running style, where no stride is identical to the one before it. The success in sports depends on the synergy between mental and physical elements [1].

The energy cost of running is greatly increased in rough terrain and studies revealed that Oxygen cost was about one fourth higher while running in a forest when compared with road running, whereby especially biomechanical differences in stride pattern contribute towards this increased demand [2, 3, 4, 5].

Technical and mental skills are tightly correlated, as they can affect each other negatively or positively. A good technical base, self confidence and healthy attitude can form a solid foundation which will stay with the athlete for a long time buried in the subconscious. Even if the athlete takes an extended break from competitions, most often it is only necessary to compete in a few events to regain what was lost. The key measure to assess an athlete's physical training level is VO<sub>2</sub>max. This is a dynamic value that depends on the fitness level of every athlete.

A greater value means the athlete is capable of a better physical performance. Modern activity tracking devices have multiple functions that

monitor the effect of the aerobic and anaerobic workout, recovery time, VO<sub>2</sub>max, etc.. but all these functions are based on algorithms that take into account the heart rate. What needs to also be considered is the fitness level of the athlete and the fact that the increased effort capacity leads to more efficient workouts and lower heart rates for similar workouts. Also, the well prepared athletes cope better with high variations of the heart rate and can reach a greater efficiency during races.

### Methods and Data source

The authors have analyzed 21 heart rate profiles of five members of the National Team with ages between 20-47 years old, four of which are between 20-28 years old, with an average age of 24.25, in 4 types of orienteering events: Sprint, Middle, Long Distance and Relay. One individual also took part in the National Marathon Championship and his heart rate profile from that event has been included in this study for comparison with his performance during the Long Distance Orienteering event. All athletes have been selected for this study based on the following criteria: over 6 years experience in Orienteering competitions, top spots in the Romanian Orienteering Federation ranking and top results at national and South Eastern European international events. All athletes have been monitored with a Garmin 3 HR device and the results analyzed using Firstbeat Sports and WinSplits software. All athletes included in the study know from their coaches that previous research shows that the optimal strategy in endurance races is to adopt a

uniform running pace that allows for minimal waste of energy [6, 7, 8].

### Data Analysis

**Descriptive Elements.** We will analyze in the first section the dynamic of the technical and tactical decisions, looking at the heart rate variations based on the characteristics of the Orienteering competition and trying to highlight differences between Sprint and Long Distance events.

### Results

The fast pace of the Sprint races (13-15minutes Winning time) implies, among other factors, a

high VO2 max level, great anaerobic capacity and rapid decision making. In the chart below (Fig 1) we notice that RC runs for 15 minutes and 21 seconds with an average heart rate of 187 beats per minute (bpm), with a low HR of 175 bpm at the beginning of the race and a maximum HR of 196 bpm. The lower heart rates in the graph are caused by a slower pace required to solve technical orienteering problems, which is acceptable. Length of the slower sections can be reduced by memorizing route choices in advance, when this is possible.

Fig 1. Heart rate/Training zones, Sprint, CR

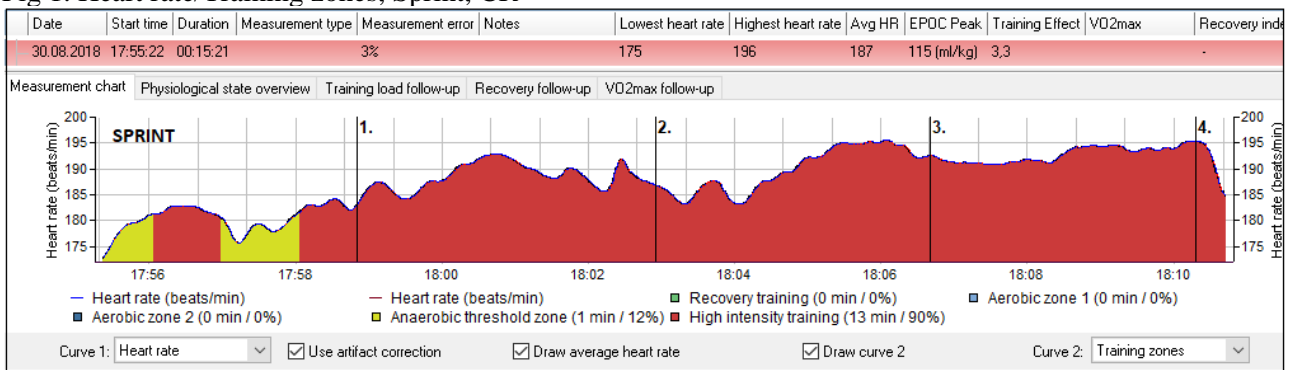


Chart 2 shows the HR profile of the same athlete in a Long Distance event. His fitness level is very good and he runs for 72 min 59 sec with an average HR of 175 bpm, but he also has significantly lower readings on 6% of the race which shows a lower pace caused by uncertainty in decision making process. Other lower HR readings in the chart are the result of a lower physical output during downhill running sections.

Fig 2. Heart Rate/Training zones/Altitude, Long distance, CR

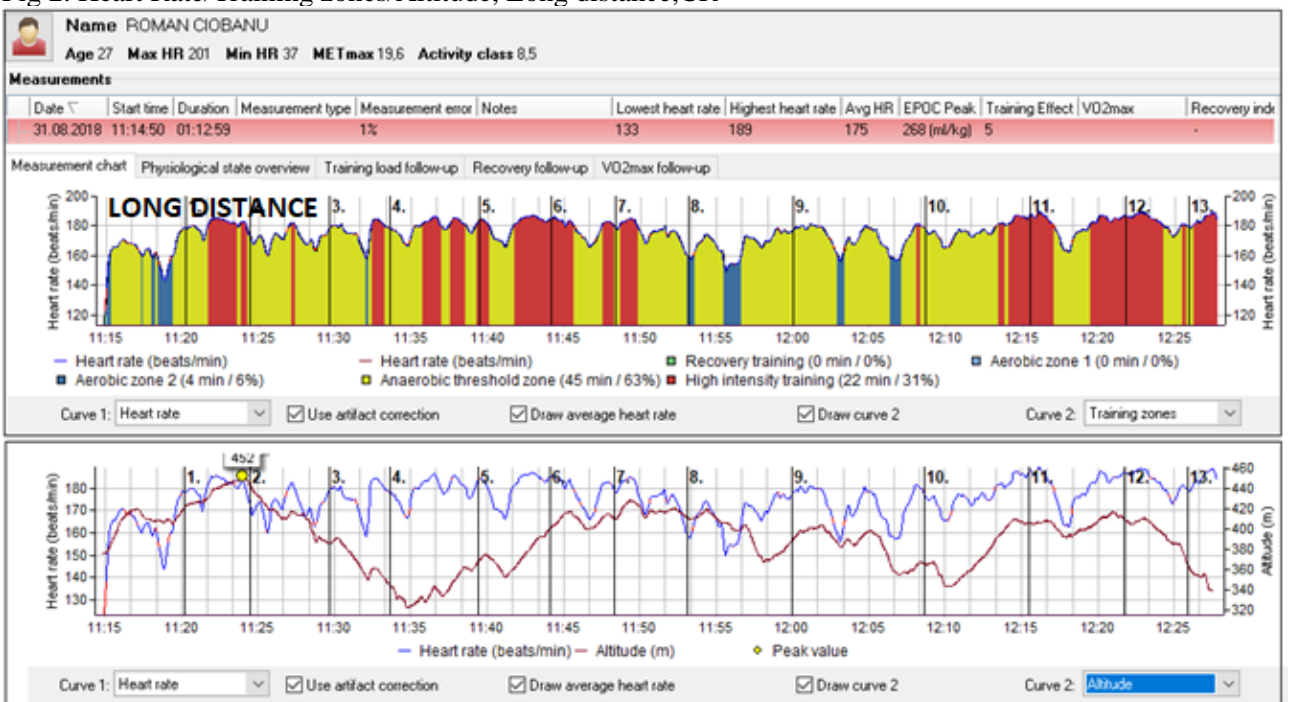
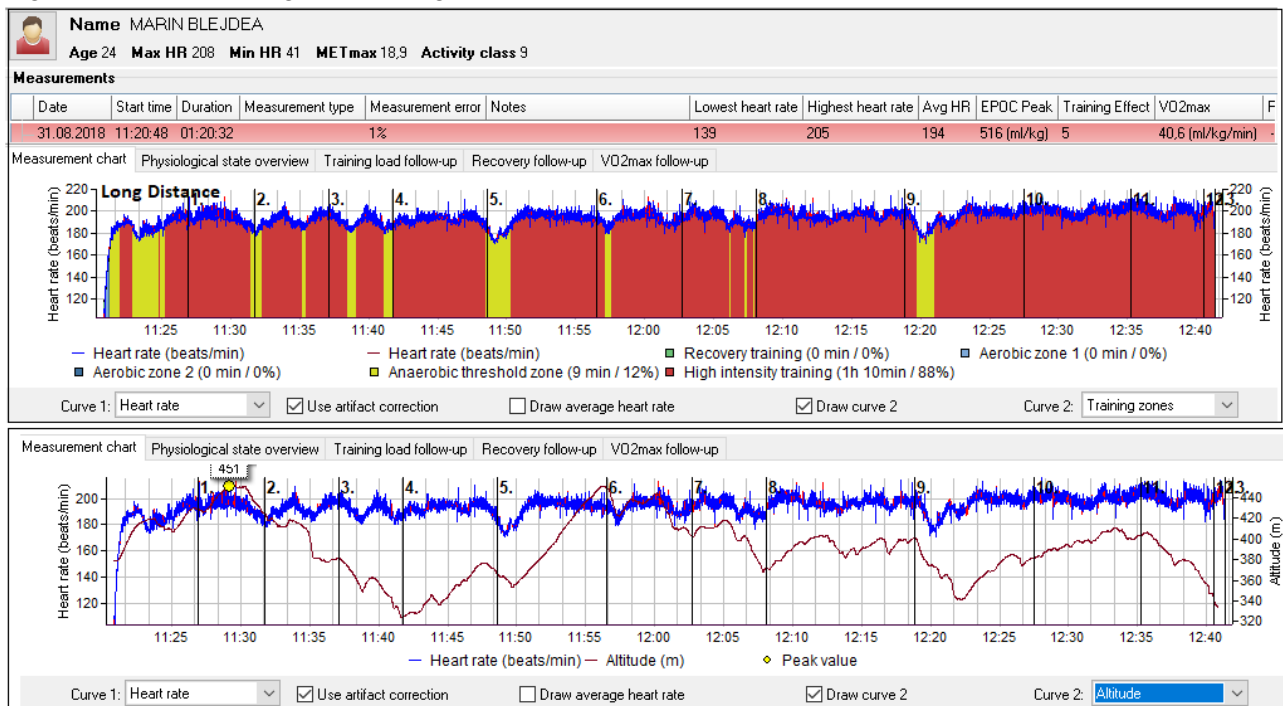


Chart 3. shows the HR profile for AB in the Long Distance event. Even though his total time is 8 minutes longer than that of the previous athlete, his average HR of 194 bpm is 19 bpm higher than that of CR, which

clearly implies that his fitness level is lower. This athlete has no hesitations even though his pace is very high, he has a nice flow in his technical decisions, but he has to improve his physical fitness level.

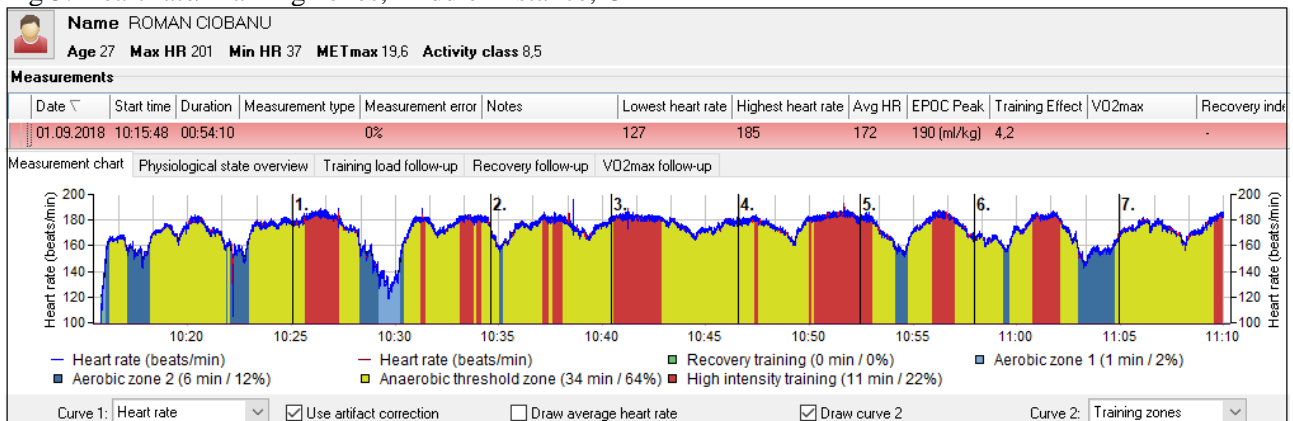
Fig.3. Heart rate/Trening zones, Long Distance, AB



The complex technical demands required in the Middle Distance events do not prevent high level athletes to run close to their VO2 max capacity. Solving orienteering problems may lead to a diminished pace in an orienteering event. Results have shown (analysis of variance;  $P < 0.001$ ) that the subjects had small variations of their HR averages caused by increased Technical and Tactical tasks during the race and they also had variations of the HR correlated with the technical and terrain difficulty.

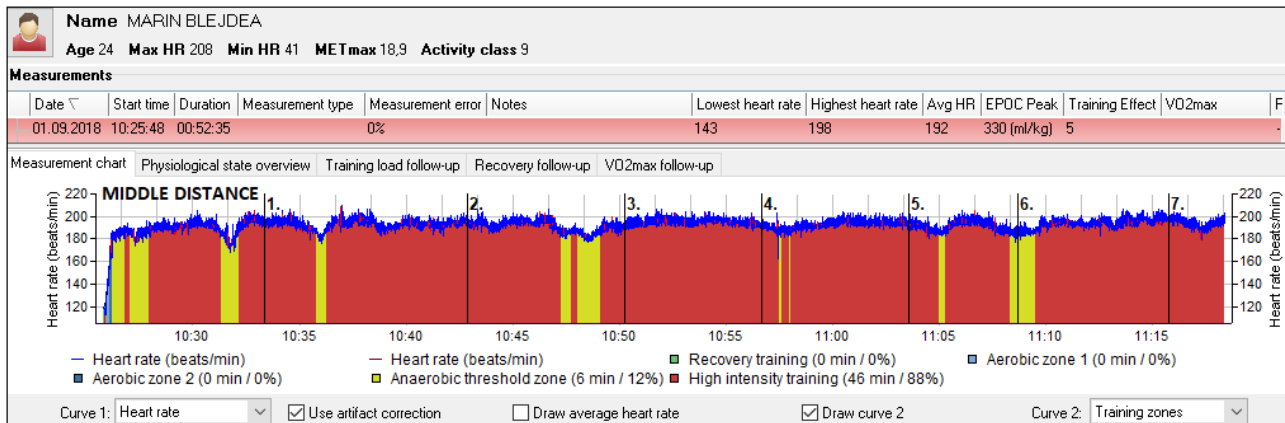
Charts 5 and 6 show the HR variation for both CR and AB in the Middle Distance event.

Fig 5. Heart rate/Training zones, Middle Distance, CR



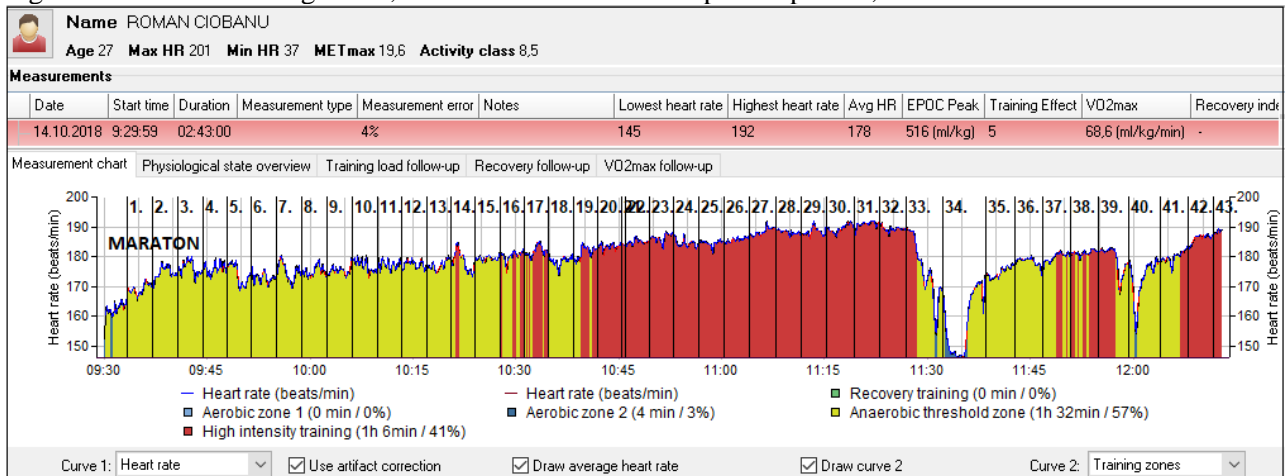
Compared to a less challenging orienteering event, this race totals twice as many slower pace sections (12% compared to 6% in the Long Distance event). The athlete must spend more time improving his technical skills.

Fig 6. Heart rate/Training zones, Middle Distance, AB



The result in the marathon race (Fig 7.) shows that this athlete's physical fitness level allows him to compete in very long races. Chart 6 for AB can only confirm the analysis done for Chart 3. The athlete solves Orienteering problems well, he runs 88% of the race at a high intensity level, but his fitness level is lower.

Fig 7. Heart Rate/Training zones, National Marathon Championship 2018, CR



## Conclusions

This type of study is a simple but effective way of painting a clear picture of the fitness level, technical and tactical skills and mental effort of the orienteering athletes. It is easy to use by any coach and it can be applied on a large scale. The results can help with time allocation in the process of training the athletes.

To order in results in other studies former World-Class orienteer Timo Karppinen already concluded that measured maximum and mean heart rate explains some but not all success in orienteering and proposed deviations from mean heart rate as indicator [9]. Interestingly he already mentioned more than twenty years ago that Standard Deviation of mean heart rate reveals more about success [8]. Interestingly, in all successful races standard deviation was less than 3 beats per minute [8].

Studies indicate that (elite) orienteers pace themselves such that their mean heart rate remains slightly below aerobe-anaerobic threshold (detected range was 167 to 172 beats/min) [10].

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