Abstract. Bobsleigh start is a simple action requiring the crew to push as hard as possible and gain maximum initial velocity of the sled at the start. However, detailed computer analysis based on velocity and acceleration data shows that timing of loading play a very important role. In this work we demonstrate that a very important performance parameter commonly called exit velocity can be use as both target and performance measurement. The analysis of time profiles allowed us to modify the timing of the loading and gain nearly 1km/h on the exit speed.

Keywords. Bobsleigh, start, data structure, feedback

1 Introduction to the sport of bobsleigh

The sport of bobsleigh is a sport where athletic performance meets science and engineering. The roots of the sport could be dated back to the late 19th century when the Swiss attached a steering mechanism to a toboggan. It is now accepted that the informal bobsleigh competitions started in 1860. The official start as bobsleigh as a sport is in 1897 when the world's first bobsleigh club was founded in St. Moritz, Switzerland. To date Saint Moritz is considered the home of bobsleigh and it is still the only place with guaranteed competition every year and still on natural track. The sport spread quickly across the alpine countries and by 1914, bobsleigh races were taking place on a wide variety of natural ice courses. The first racing sleighs made of wood but were soon replaced by steel sleighs named bobsleighs. Bobsleigh’s name became popular as crews bobbed back and forth to increase their speed on the straightaways. Te sport has become internationally recognised and governed in 1923 - the Fédération Internationale de Bobsleigh et de Tobogganing (FIBT) was founded. Immediately followed the debut of the sport in 1924 when a four-man race took place at the first ever Winter Olympics in Chamonix, France. As pretty much all other sports the true internationalisation of the sport became a reality after the Second World War. In the 1950s the professional sport had begun to take shape. There and then the critical importance of the start was recognised and strong fast athletes from other sports were drawn to contribute to improvement in performance. The improvement in both technology and performance has led to steady increase in the velocities of the sleds and as a result a number of accidents occurred with certain number of fatalities. Since the 1970s, safety has gradually become a driving issue and technical regulations specifically aiming to curb the number of casualties were introduced. In 1985 – the current regulations were drawn and have been rigorously enforced since.

In 1985, the following sled standards were introduced by the FIBT to place all competitors on equal footing. Regarding athletic performance the rules aimed to curb both the weight of the sled and the total weight, i.e. to effectively prohibit the use of overly heavy crews that the sport has become notorious. The weight restrictions are presented in Fig.1 below.
1.1 The bobsleigh start

All three Olympic track sports; luge, skeleton bobsleigh and bobsleigh use the same track. Only luge has a different start position. Both skeleton and bobsleigh adopted the so called flying start, i.e. the time is taken after crossing a line that is away from the actual starting point. The start procedure is strictly regulated and is described below. It should be mentioned that when the sport originated, crews were sitting and bobbing the sled which provided the name for the modern sport.

The crew pushes the sled from a wooden start block that must be at least 150 cm long, 20 cm wide and 5 cm high from the surface of the ice. The crew cannot pass the block or remove it prior to the start. Once the start is initiated the crew pushes the sled along the “push-off stretch” (FIBT, 2014) which is the part of the track between the start block (wooden board) and the first photoelectric cell. This stretch of the track is postulated to be 15 meters long with a gradient of 2%. As stipulated by FIBT (2014), after the first photoelectric cell (which represents the virtual start-line for the time-taking), the track must follow a straight path so that bobsleds starting off may reach a speed of 35 km/hr or 9.72 m/s.

The stretch between the first photoelectric station must be 50 m long (starting time).

After the first cell the gradient becomes very steep - 12% and all crew members need to “load” i.e. to quickly jump in the sled without any delay as the sled velocity goes quickly beyond the athletes’ maximum running speed. The first person to load is the driver and brakeman is last. The order of the two pushers is decided by the team. The driver loads at the flat section usually immediately after the time start line as shown in Fig. 3 below. By that time the sled is accelerated sufficiently and the role of the driver is to steer the course. The other crew members follow the driver while maintaining a steady course notionally a straight line (in reality they need to follow the tracks created by previous starts). It should be noted that that the entire duration of the start is only about 10 s including the non-timed push-off phase. Within this short period the sled should be accelerated from stationary (status) zero

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Fig. 1. Bobsleigh weight and dimensions regulations for male crews

The weight of the sled itself is imposed as a minimum of 170 kg for 2-man bobsleigh and 210 kg for the 4-man bobsleigh to prevent the use of ultra-light sleds in combination with giant (sometimes overweight) athletes which brought some notoriety to the sport in the 1950s.