"Third time lucky" is the saying, but for the third Human Power Team it almost turned out as a year for nothing. The team has been attempting to set the world record for the fastest bicycle powered only by human muscles for two years already. This endeavor to let a Dutchman be the fastest human on earth resulted in a marvelous year with many ups and downs and a world record.

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The third Human Power team set off in September 2012, and consisted of students from Aerospace Engineering and Mechanical Engineering from Delft University of Technology. Because of the importance of the engine, a human being, students from the faculty of Kinesiology from the Vrije Universiteit Amsterdam were also part of the team. The goal of the year was to achieve a new human powered world speed record of over 133.28 km/h. In order to do so, a special recumbent bicycle with an aerodynamic monocoque structure had to be developed. In line with the previous years, the bicycle would this time be called VeloX3.

The design process started with an eight-week research phase, where the work of the previous teams was studied and opportunities for the next year were investigated. A Numerical model was created to compare the influences of the main parameters. It could be concluded that aerodynamic drag causes approximately 75% of the total resistance. Rolling resistance of the tires was responsible for 20% of the losses. A remarkable outcome was that the weight of the vehicle affects the top speed very little. This is due to the fact that the world record course has a small downward slope of less than 0.6%.

CONCEPTUAL DESIGN
In the following period, design decisions on the main components of the bicycle were made. Some components remained the same as in the previous year; the main layout stayed similar to a conventional recumbent bicycle, and the monocoque. The monocoque construction of the second year was incorporated as well. This concept proved its performance on safety several times in the past. Another concept that was continued was the camera system. The VeloX2, which was the predecessor, had a camera system with a monitor in front of the rider. Cyclists were very positive about the clear display. An important change was made for the drive train, which was moved from the front wheel to the rear. This change resulted in a more comfortable steering behavior and a better driving position for the rider.

DETAILED DESIGN
The detailed design phase started with making decisions about how the sub-systems would be implemented. An important aspect in this phase was the aerodynamic monocoque. The largest resistance was aerodynamic. Hence, it was desirable to have the best aerodynamic shape that was able to contain all the sub-systems. Multiple wind-tunnel tests were performed with genuine pleasure for the Aerospace Engineering students (see Figure 1). During this phase, extensive structural calculations were performed on the frame and the monocoque. Based on the results the team set up a comprehensive production plan. Drawings of all sub-systems were made in CATIA to be sure that every subsystem would fit inside the bicycle, and renders of the drawings were used in the design presentation at the end of this phase. The presentation was given to show sponsors, former team members and other people interested in the team’s progress and the final design.

PRODUCTION AND TESTING
The production started with ordering components and manufacturing carbon composite and metal parts. This turned out to be very intensive and time consuming. It became clear that there was a
big difference compared to an university assignment. Everything that was unelaborated still required a solution. After three months, in the beginning of May 2013, the bicycle was finished. The team travelled weekly to the RDW proving ground in Lelystad to extensively test the bicycle in order to prepare it for the competition (see Figure 2). Many adjustments, repairs and replacements were added. In July, the bike competed in its first official event. An hour record attempt was performed in Germany to put the bike and the team under a stress test. On the highway in Germany a truck driving before the van with the two bicycles got a burst tire. The remains blocked the front wheel making the van uncontrollable so the van ended on its side on the shoulder of the road. Luckily, nobody was severely injured but the bicycles were partially damaged. The bikes got patched up before the hour record attempt. All in all, this week was a good preparation for the world record attempt in September.

COMPETITION

Finally, after many months of testing and fine-tuning, the main event for the team (World Human Powered Speed Challenge) approached. One week before the team travelled to the USA, the bicycle left Delft for its journey to Battle Mountain, a small village in Nevada. The ‘305 highway’ is situated close to Battle Mountain and is due to its specifications (minimal slope, straight, 10km in length) it is unique and suitable to perform a legal world record attempt. For this reason, the World Human Powered Vehicle Association (WH-PVA) organizes this event every year and gives teams from all over the world the opportunity to push their bicycles to their limits. All speeds are measured after approximately 8km of acceleration as a time average over 200m.

In a nearby center, all teams were able to prepare (and sometimes repair) their creations (see Figure 3). From this building, it was around twenty minutes driving to the start. During the racing days, the organization closed the highway three times for half an hour. This happened every morning and every evening. Every single day for an entire week. A qualification race on the first day determined the distribution of the time slots over the teams.

BAD WEATHER AND TECHNICAL PROBLEMS

Just after the sun sets the wind normally drops. Since a world record attempt is only legal at wind speeds below 1.6m/s, it was preferable to race at the end of the evening slots. However, this time the weather was different from other years. Three evenings the team decided not to race because of the bad weather conditions. The unpredictable wind gusts and rain resulted in a wet road that was too dangerous for both the driver and the bicycle, especially when driving at high velocities.

Despite the bad weather, the results of the team were still better than the other competitors. However, the team was still far away from the world record. During the first few races, a worrisome pattern was discovered. One of the drivers provided more power compared to the other driver, but his maximum speed was lower. It turned out that there was a problem the driver’s riding position. This resulted in force acting on the monocoque too close to the canopy opening that caused the structure to deform slightly. It was barely visible, but it changed the aerodynamics in such a way that the bike performed far below the predictions.

ALL OR NOTHING

The team detected this particular problem on Friday after trying out many other technical solutions to other possible causes. That last night went by with almost no sleep. With only one racing day left and not knowing whether the solution was the correct one, the team decided to participate in both the morning and evening slots. After the morning slot, it could be concluded from racing-data that the solution to the problem was correctly detected and solved. That evening the weather seemed to be as bad as the other days, but since. Since this was the last opportunity, it was decided to race anyway. In a nerve-racking race, the driver almost decided to quit his attempt because of the wind gusts. There was almost no hope left, but from one moment to another the wind dropped. In an extreme effort the driver, Sebastiaan Bowier, set a new world record by increasing the old one with 0.5km/h to an amazing speed of 133.78km/h (see Figure 4). The second driver, Wil Baselmans reached a top speed of 127.43km/h.