Students of TU Delft won second place with their Wasub III at the International Submarine Race in the United States. But the race left them with a bitter afterskate, as the submarine crashed into the side of the course twice.

Tomas van Dijk

A ‘giant manta ray’ glides majestically through the water, its wings powered by a diver in a wet suit, pedalling fit to bust. Meanwhile, a ‘tuna’ with a large mechanical tail makes frantic attempts to get its head off the bottom. Left and right, cyclists flash by in cigar-shaped cocoons, leaving a long trail of air bubbles. Ordinarily, the US Navy patrols uses its kilometre-long indoor basin in Maryland – the David Taylor Model Basin – to test patrol ships. During the two-yearly International Submarine Race (24-28 June), however, the long pool becomes the playing field for some 20 teams of secondary school and university students, most from North America. With their hand-made, human-powered submarines, they race in 100-metre sprints. They’re all trying to break the world speed record of 7.2 knots (13.3 km/h).

This is the first time since the Wasub II fiasco that a group of TU Delft students have dared to cycle under water. In 2006, the Wasub II smashed to pieces when it crashed into the wall, after a piece of the hull broke loose and damaged one of the fins. The students repaired the hole with Plexiglas and transparent tape. Despite this setback, the next day they were still able to achieve a speed of 6.7 knots. This was to remain their best score. On the last day of the competition they crashed into the wall again. The pilot came to the surface gasping for air and was hauled onto the bank by Navy frogmen.

Bloomer was disappointed. He was convinced that his team would win first place with their innovative propulsion system. Wasub III has two contra-rotating propellers, one behind the other. One rotates to the left and the other to the right. ‘This makes the boat much more stable,’ he says, ‘that of the other teams also have contra-rotating propellers. But they are not nearly as good as ours.’ We were assisted in the design by MA- RIN researcher Jan Hamilton, one of the originators of the Hamilton-Mackenzie power prediction for ships and a big name in marine technology. The project leader also had high expectations of the ventilation system. Most of the submarines have holes on the top to release the air that the cyclist exhalés. ‘This means that the exact place at which the air escapes changes. And that makes the vessel unstable. In contrast, we lead the air through a hose to the back.‘

Breathing apparatus

This solution is not high-tech; in fact, it’s quite the contrary. The Dutch navy had given the students an ancient breathing apparatus with only one round outlet for exhaled air. They were able to attach the hose inside the back of the boat to this outlet. ‘A breathing apparatus usually has two oral outputs on the sides. That makes it more difficult to attach a hose – and you don’t want to mess with a breathing apparatus. It has to be safe.’ The fact that the Wasub I performed well back in 2005 reinforced Bloomer’s self-confidence. In that year, this vessel finished in first place in the category of one-person propeller submarines. With a speed of 12 km/h, the submarine was even then approaching the current world record.

This year, thanks to the new diving tank, the students had to take care of much of the vessel’s fine tuning just before the competition started. ‘This is what led to their downfall, and in stark contrast with the extensive preparations of many of the other teams, some of whom have been participating in this challenge for more than 20 years. The internet offers countless videos of participants testing their boats in open water. For example, for months, the team from Florida Atlantic University had been marvelously completing laps in the Atlantic. And a video on YouTube shows students from Washington University doing all kinds of tests on their underwater bike in a large lake. However, there were also several technical aspects that made them into formidable opponents. For example, winner Omer had a special trick that the Wasub lacked. ‘Their sub has a gear system built into it. This system can adjust the angle of the propeller blades such that the propulsion increases during the race and with it, the predalling resistance. This allows the cyclist to accelerate better. This is not a luxury when you have only 100 metres to prove what you can do.’ Other teams had equipped their boats with accelerometers and automatic pilots, which meant that the cyclists could concentrate on producing power rather than continuously adjusting their course. ‘We also tried to make an automatic pilot’, Bloomer tells us, ‘but we didn’t have enough time for that.’

The new project manager, 20-year-old me- chanical engineering student Joshua Neving, who will put together Wasub IV with a new generation of students, thinks the Wasub’s ventilation system is one of its main weaknesses. ‘The system created a difference in air pressure between the front and at the rear of the submarine, so that the pilot did not have access to a constant flow of air. On the other hand, we plan to keep the double propeller system, and we will try to get the steering mechanism to work more smoothly.’