Diving Performance – Beyond Drag

Part 2 of 4

By Ron Evan Smith

In part 1 of "Diving Performance – Beyond Drag", we identified that ocean conditions are driving swimming speed requirements for divers that are well beyond the speeds that current scuba gear and diving techniques can deliver. Whereas most divers can achieve sustained speeds of about 1 knot and sprint at about 1.5 knots, the ocean conditions require speeds more along the lines of 3 knots sustained and 5 knots in a sprint. We also noted that while the deviance between required and realized swimming performance is very large, it has become normalized within the diving culture, and as a result, little has been done to rectify the situation.

In this instalment of "Diving Performance – Beyond Drag" we will take a look at how this performance gap can be closed and get an idea of the technology that might make it possible.

Closing the Performance Gap

What does it take to close this swimming speed performance gap? First, it requires identifying that the problem exists and committing to doing something about it. Then you need to look at the physics. It may not be as hard to solve as you think, and in fact, I believe the solutions can be far less imposing to recreational diving logistics than the adoption of rebreather technology.

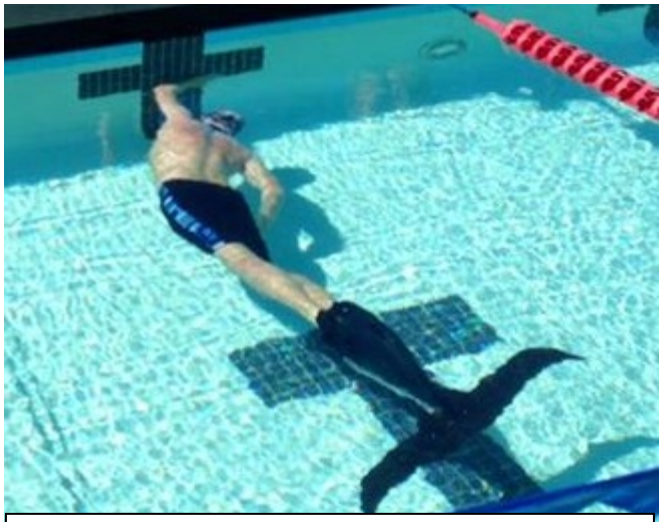
I do not expect the performance gap to be closed in one step. I'm proposing 3 knots sustained and 5 knots in a sprint as a long term goal for the scuba diving industry. Falling short of the requirement is not necessarily the end of the world. We've been operating at a severe deviance of the requirement for decades. However, new incident reports are published every year recording diver emergencies that precipitated, at least initially, from divers not being able to cope with the ocean currents and conditions that they find themselves in. People have died because of this. It is high time the diving industry start making some efforts toward solving this problem of inadequate swimming performance in the ocean.

The Physics

To simplify the discussion, let's just focus on the cruise part of the requirement. I am proposing to go from a 1 knot cruise to a 3 knots cruise, a three fold increase in speed. All things remaining equal, the power required goes up with the cube of the speed, so the increased power delivered to the water needs to increase by 3 cubed, or 27 times. Obviously, this is not going to be done physically just by kicking the fins harder, but maybe the fins can be more efficient at converting work into forward thrust.

If the average scuba fin is 12% efficient (poor, but this is about the efficiency of many popular scuba fins), simply using fins that are more efficient to close the

performance gap requires fins with an efficiency factor of (12%)*27, or fins operating with efficiency of about 324%. This is not possible. In practice, achieving more than 80% is very difficult and achieving more than 100% would be creating a perpetual motion machine (it violates the laws of physics and is impossible).



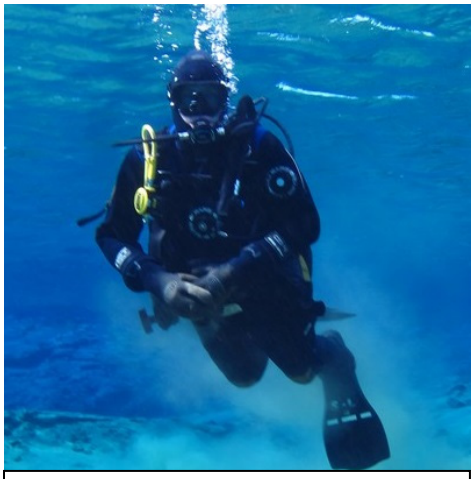
A diving fin that's over 70% thrust efficient
https://youtu.be/I4MKdazfEVM

To be realistic, let's not assume we are going to get all the way to 80%. However, if we assume we can get propulsion that is at least 70% efficient at converting body power to net forward thrust, the jump from 12% to 70% can get us from 1 knot to 1.8 knots. That's certainly a useful step in the right direction, but it closes less than half the gap to our cruise requirement.

The next place to look for more performance is to cut the drag of the diver. To get from 1.8 knots to 3 knots, a speed factor increase of 1.67, the diver's overall drag coefficient will have to be reduced to less than 22% of its typical value. That's a little more than a reduction factor of 4 in overall diver drag.

Can it be done?

In theory, Yes! A recreational scuba diver is very draggy. The difference between where we are starting from and a streamlined fusiform body shape like that of a dolphin is more than factor of 10 drag reduction. So, a factor of 4 is certainly within the realm of possible. The real question is *'how can we get there from a technology standpoint'*?



We're starting with enormous drag

From drag tests that I have done, comparing a diver wearing typical recreational scuba equipment to a freediver shows an approximate doubling of the diver's drag. So, even if we could magically make the scuba equipment disappear, we have only gotten halfway to our goal of a factor 4 drag reduction. From this, we can see that the technology will have to streamline the diver as well as streamline the scuba equipment in order to achieve the performance goal.

However, every bit helps. Better efficiency means less work and easier more relaxed diving. Even if we don't fully realize the speed requirement, the less deviant from it we operate, the more enjoyable diving will be.

This analysis shows us that a diver who can meet this proposed speed requirement will look very different from today's diver. They must be streamlined and may look more like the fusiform shape of cetaceans than a 4 limed person. They may even be using a monofin like a competitive freediver instead of the bi-fins ubiquitous with scuba diving today as it will be difficult to get 70% thrust efficiency from bi-fins. The important thing to know is that a solution for meeting the performance requirement is possible. The industry just needs to work on developing the technologies to get there.

Baby Steps

Many divers will be resistant to any change in diving technology that they are not comfortable with. Psychologically, it will be easier to accept technology that looks familiar. It is okay to reach the speed requirement over time. My goal is to get divers to realize that there should be a swimming speed goal and that we should be actively trying to move toward that goal.

It is possible to make a scuba kit that looks and functions similar to contemporary scuba equipment, but that greatly expands the swimming performance of the diver beyond the usual status quo for the industry. By making swimming performance a priority, we can adopt better performing diving fins and actively look to reduce the drag of our scuba equipment. I recently did this myself just to show an example of what can be done without making radical changes to the familiar scuba architecture. In the next installment of "Diving Performance – Beyond Drag" we will take a look at my experiment and the performance results I have been able to achieve. I think you may be impressed.

Conclusion Part 2

We have shown that it is physically possible for a scuba diver to achieve a sustained cruise speed of 3 knots. This requirement can be met if we can incorporate a diving fin system that is at least 70% efficient at converting leg energy into net forward thrust and also reduce the diver's overall drag to less than 22% of the normal drag of a recreational scuba diver. In theory, these are things that can physically be done if the technologies to achieve these goals are pursued.

In the next instalment, we will take a look at some real world hardware that attempts to partially close the performance gap to get us closer to conquering the oceans.